

COMMISSIONERS OF PUBLIC WORKS  
OF THE  
TOWN OF SUMMERVILLE

WASTE WATER PIPING SYSTEMS  
ENGINEERING MANUAL  
REV. 9/15/17

**PART 1 - DESIGN CRITERIA**

The following criteria shall be followed in the design of gravity wastewater collection and force main systems within the SCPW wastewater service area. Designs shall also meet the requirements of the latest revision of the SCDHEC "Standards for Wastewater Facility Construction: R.61-67" and local codes. Facilities shall be designed by a Professional Engineer registered in the State of South Carolina. All submittal drawings, specifications and design calculations shall bear the seal and signature of the Design Engineer.

The design and construction of wastewater mains and services shall be in accordance with the best established practices. The criteria outlined below shall be followed unless unusual conditions require a variance. Each variance must be approved by SCPW in writing prior to being implemented.

**1.1 DESIGN CALCULATIONS****1.1.1 FLOWS**

Design flow rates shall be calculated using SCDHEC's "Unit Contributory Loadings to All Domestic Wastewater Treatment Facilities" hydraulic loading chart, with one exception. SCDHEC approved a variance allowing an assessment of 350 gallons per day per residential unit instead of the standard 400 gallons per day.

All systems shall be designed to transmit the average flow and the anticipated peak flow rate. The minimum peak flow to be considered shall be 250 percent of the average daily flow rate.

All gravity wastewater systems shall be designed and constructed to prevent inflow, infiltration and exfiltration. However, for conservative reasons, the design flow may be required to include 100 gallons per inch of the pipe's inside diameter per mile of pipe per day. This additional flow must be used to size the pipe but shall not be included in the SCDHEC permitted flow rate.

**1.1.2 FRICTION LOSS**

Gravity wastewater line designs shall utilize the Manning formula with a coefficient of roughness factor of 0.013.

Head loss due to friction in force main pipes shall be determined using the Hazen-Williams formula. The Hazen-Williams "C" factor for PVC shall be 140, while that for ductile iron pipe shall be 130.

### 1.1.3 VELOCITY

Gravity wastewater piping shall be designed and constructed to produce minimum velocities of 2 feet per second when flowing full. Minimum design slopes shall be as follows, unless otherwise authorized by SCPW in writing.

<u>Pipe Diameter</u>	<u>Pipe Grade (%)</u>
6"	0.50
8"	0.40
10"	0.30
12"	0.22
15"	0.15
18"	0.12
21"	0.10
24"	0.08
30"	0.07
36"	0.05

Force main piping shall be designed and constructed to produce minimum scouring velocities of 2.5 feet per second.

### 1.1.4 SIZE SELECTION

All gravity wastewater systems shall be designed and constructed to flow no more than 75% full at ultimate peak flow conditions.

The minimum allowable gravity wastewater main diameter is 8 inches. The minimum allowable gravity sewer service to be maintained by SCPW is 6 inches in diameter, regardless of whether it is a single or double service. The minimum allowable force main diameter is 4 inches.

## 1.2 PLAN REQUIREMENTS

The following design requirements shall be considered when preparing the construction drawings.

**1.2.1** Wastewater systems shall be located within public rights-of-way, where practical. Gravity mains shall be located 5 feet minimum inside public

rights-of-way and outside parallel roadways. Force mains shall be located 3 feet minimum inside public rights-of-way and outside parallel roadways.

- 1.2.2** Wastewater easements, and/or a combination of public rights-of-way and wastewater easements, shall be 10 feet minimum on either side of the centerline of gravity wastewater mains and appurtenances. The easement, and/or combination of rights-of-way and easement, associated with force mains shall be 7.5 feet minimum on either side of the pipe centerline.

If the depth of cover over a gravity main exceeds 10 feet, the width of the sewer easement and/or right-of-way combination shall be two times the depth of cover (i.e. Main with 11 feet cover will be required to have 22 feet easement width). The maximum easement width will be required from the upstream manhole to the downstream manhole.

- 1.2.3** Gravity wastewater main piping shall be constructed with a uniform grade and alignment between manholes. Gravity wastewater service piping shall be constructed with a uniform grade between the main and approved bends, between approved bends and the cleanout, or between the main and cleanout where bends are not permissible.

- 1.2.4** The minimum earth cover allowed for gravity and force main piping to be maintained by SCPW is 3 feet. Force main cover shall not exceed 5 feet, except where the mains are deflected with bends below site conflicts. The maximum allowable cover for SCPW service piping at the property line shall be 6 feet. The minimum allowable earth cover for PVC private service piping is 1.5 feet. Ductile iron pipe may be permitted on a case by case basis where the minimum cover over public and private gravity piping cannot be attained due to site, slope and elevation considerations.

- 1.2.5** Horizontal separation between any wastewater gravity or force main pipe and a water pipe shall

be a minimum of 10 feet, measured edge to edge. In cases where it is not practical to maintain a 10 foot separation, a deviation may be allowed on a case by case basis, subject to SCPW and SCDHEC approval. Such deviation may allow the installation of a wastewater pipe closer to a water pipe provided the water pipe is laid in a separate trench or on an undisturbed shelf located on one side of the wastewater pipe. In this case the bottom of the water pipe must be at least 1.5 feet above the top of the wastewater pipe. The water pipe must be constructed of ductile iron pipe. The sewer pipe must be constructed of C900 PVC pipe.

- 1.2.6** Wastewater pipes crossing water pipes shall be laid to provide a minimum vertical distance of 1.5 foot between the bottom of the higher pipe and top of the lower pipe. Where practical, the water pipe shall be installed over the wastewater pipe. Regardless, at the crossing the water pipe must be constructed with one full length of ductile iron pipe. The sewer pipe must be constructed with one full length of of C900 PVC pipe. The joints of both pipes shall be as far from the crossing as possible. Special structural support for the pipes may be required.

Wastewater pipes crossing under storm drain piping and other utilities shall be designed and constructed to provide 1.5 feet of clearance. Depending on the size and type of storm drain or utility being crossed, SCPW may require C900 PVC pipe or in extreme circumstances C900 PVC wastewater piping in casing to be installed.

- 1.2.7** No portion of the wastewater system shall be located within 100 feet of a public water supply well.
- 1.2.8** No storm, exterior foundation, areaway, HVAC condensate, surface or roof drains shall be connected to sanitary wastewater systems.
- 1.2.9** Dumpster pads, car washes and outside sinks shall not be connected to the wastewater system unless

they are covered and the site is sloped away from the source of extraneous water.

- 1.2.10** Discharges from pool overflows, filters and backwash units shall not be connected to the wastewater system.
- 1.2.11** Minimum 4-foot (inside) diameter, precast concrete manholes shall be located at the ends of all mains and at all changes in pipe grade, diameter and alignment. The maximum allowable distance between manholes shall not exceed 400 feet, unless prior approval is obtained in writing from SCPW and SCDHEC. (Note: It is suggested that the maximum distance used in design not exceed 395 feet to allow room for surveyor/contractor error.)

Where inside drops are required, the minimum inside diameter of the manhole shall be 6 feet.

- 1.2.12** Manholes shall be equipped with cast or ductile iron frames and covers set at elevations greater than the 50-year flood elevation, unless prior approval to use watertight covers is obtained in writing from SCPW. Manholes located in pavement, sidewalks, or areas affected by street runoff shall have O-ring sealed frames and covers without vent holes. The manholes shall also be equipped with inverts constructed, after pipe installation, from concrete or a mixture of bricks and mortar.
- 1.2.13** Wastewater mains and services shall be designed such that they enter manholes at the lowest possible elevation to allow the waste to flow uniformly through the manhole instead of spilling into it. Where necessary, 6-foot diameter inside drop type manholes shall be constructed. A maximum of two inside drops shall be allowed in 6-foot diameter manholes. Outside drop manholes are not allowed.
- 1.2.14** The maximum allowable invert elevation difference from the inlet side of a 4-foot diameter manhole to the outlet side is 1.5 foot. The maximum allowable invert elevation difference between the

inlet and outlet of a 6-foot diameter manhole that does not contain drop piping is 2.0 feet.

The minimum allowable invert elevation difference from the inlet to the outlet is 0.1 foot for all manholes. The minimum allowable invert elevation difference from the inlet of an inside drop to the outlet is 4 feet.

- 1.2.15** The interior angle between a manhole's inlet pipe(s) and outlet pipe shall not be less than 90 degrees. The interior angle between manhole inlet pipes shall not be less than 30 degrees.
- 1.2.16** Where the diameter of the inlet pipe into a manhole is smaller than the diameter of the outlet pipe, the elevation of the crown of the smaller pipe shall match the crown of the larger pipe.
- 1.2.17** If the slope of the main entering a manhole exceeds 2.00%, the invert of the inlet pipe must be 6 inches minimum above the invert of the outlet pipe.
- 1.2.18** The number of sewer services connected directly to manholes shall be maximized.
- 1.2.19** Services shall be installed perpendicular to the downstream main.
- 1.2.20** A cleanout is required at the right-of-way or easement line for each individual service. The cleanout shall be installed by a licensed plumbing contractor, during the connection of the residential or commercial plumbing system to the SCPW wastewater system, not during the installation of the mains.
- 1.2.21** The Developer is responsible for installation of any and all necessary improvements under the supervision of SCPW personnel, including the installation of wastewater services for commercial developments.
- 1.2.22** Combination air release and vacuum breaking valves shall be installed at high points in force

mains to allow air to be vented from the system and to prevent vacuum conditions from occurring. Combination air valves shall not be installed in areas subject to flooding.

- 1.2.23** Grease traps, grease interceptors (automatic, self-cleaning) and oil/water separators may be required to prevent fats, oils, grease, soaps, soils and/or grit from entering the public wastewater system via discharges from restaurants, car washes, auto repair shops, laundries, hotels, schools, etc.

Whenever being installed to collect waste from a kitchen, it is important that all kitchen sinks, dishwashers, mop basins and floor drains be plumbed through the trap. The waste from garbage grinders, toilets, bathroom sinks, showers, etc. shall not be routed through the trap. They shall be installed as close to the fixtures discharging the undesirable waste as possible without hindering accessibility for cleaning and maintenance.

Each application shall be reviewed by SCPW on a case by case basis. However, the minimum allowable trap size for under the sink type interceptors shall be equivalent to the peak discharge capacity of fixtures being served, with the minimum allowable size being 40 pounds, or 20 gallons per minute. Grease interceptors are required to have a minimum 90 percent efficiency rating. Twenty four hour detention time is required for grease traps and oil/water separators, based on the calculated maximum daily discharge. The minimum trap and separator capacity, measured by volume on the inlet side of the baffle, is 1,000 gallons. It goes without saying that the size of the trap shall be based on verified efficiency rating, flow rate and storage capacity.

- 1.2.24** The Developer shall be aware that any service relocations necessitated to accommodate development will be performed by SCPW at a cost to the Developer (i.e., service relocations to accommodate driveways).

- 1.2.25 Main extensions to adjacent parcels where wastewater service is not currently available shall be required.
- 1.2.26 The material used for service piping must match that of the new main to which it is connected. The only exception is in locations where the main is PVC and ductile iron service fittings and pipe are required due to depth considerations.
- 1.2.27 Private service connections to SCPW's wastewater system will not be permitted until the structure being served is completely "roughed-in" or enclosed to prevent storm water from entering the system.

### 1.3 STANDARD CONSTRUCTION NOTES

- 1.3.1 All materials and installation procedures must meet the requirements of the Summerville CPW, SCDHEC and the manufacturer.
- 1.3.2 The Developer shall be aware that any wastewater system relocations necessitated to accommodate the development will be performed at the Developer's expense (i.e. service relocations to accommodate driveways).
- 1.3.3 Six inch wide, green metallic warning tape shall be placed 18 inches above all gravity and force main wastewater systems. Number twelve (#12) solid strand, copper or extra high strength copper clad carbon steel wire, with green polyethylene insulation shall be taped (every 5 feet max.) to the top of all force mains and services. Each wire shall terminate at a valve.
- 1.3.4 In locations where the wastewater main is designed to have less than 5.5 feet of cover, the water main shall be installed with full joints of ductile iron pipe centered at the pipe intersection. The wastewater service pipes shall be installed with full joints of C900 PVC pipe centered at the pipe intersection.

- 1.3.5** All wastewater system and water or storm drain pipe crossings shall have 1.5 feet minimum vertical separation. Otherwise, a joint of ductile iron pipe will be required on the water pipe, centered at the crossing. A joint of C900 PVC pipe or in extreme circumstances C900 PVC pipe in casing will be required for the wastewater pipe, centered at the crossing.
- 1.3.6** The contractor shall provide SCPW written notice 48 hours prior to initiating construction and/or making connections to the existing system. This includes return trips after layoffs exceeding 5 working days.
- 1.3.7** All gravity and force main wastewater systems shall have 3 feet minimum cover. Force main piping shall have 5 feet maximum cover, except where bends are used to deflect the lines above or below conflicts. Gravity wastewater services shall have 6 feet maximum cover at the property or easement line.
- 1.3.8** SCPW must be provided with a complete wastewater system as-built prior to the final inspection being scheduled.
- 1.3.9** In areas where the existing grade requires fill to obtain 3 feet minimum cover over the proposed wastewater system, the fill must be placed prior to construction of the wastewater system being initiated.
- 1.3.10** Construction of the wastewater services and force main piping shall not be initiated until the final site grades have been established (+/- 0.5 foot). A letter from the Engineer stating that this condition has been met should be obtained by Contractor prior to starting construction.
- 1.3.11** The invert in of the existing manhole that a new sewer main extension is connecting to shall be plugged until the permit to operate is issued by SCDHEC.
- 1.3.12** Prior to final acceptance, the Contractor shall perform a CCTV inspection of the wastewater system with SCPW personnel present. The Contractor shall

provide SCPW 48 hours written notice prior to scheduling the inspection. SCPW will perform a re-inspection 18 months after the wastewater system has been accepted to identify any manufacturer's or installation defects before the two year warranty expiration.

## **PART 2 - CONSTRUCTION STANDARDS**

The following standards shall be followed in the construction of wastewater collection and force main systems within the SCPW wastewater service area. Also see the "SITEWORK" section of these specifications for other applicable standards.

### **2.1 Scope of Work**

Work under this section of the Specifications shall consist of furnishing all materials, equipment and labor necessary for the installation of wastewater pipes, fittings, manholes, detection wire, warning tape, valves, boxes, check valves, combination air valves, casing pipe, miscellaneous concrete, concrete structures and all other appurtenances shown on the drawings and/or specified herein. All materials and work shall comply with the requirements of the contract documents, these specifications and manufacturers' recommendations.

### **2.2 Construction Materials**

All materials or products which come into contact with wastewater shall be certified as meeting the design standards of the American National Standards Institute, American Society for Testing Materials, the American Water Works Association and the American National Standard Institute/National Sanitation Foundation. Where ANSI, ASTM, AWWA and NSF standards are cited, it is inferred to mean the latest revision shall take precedence.

Wastewater pipe, fittings, manholes and appurtenances shall be of the type, size, class and diameter shown on the plans and as stated below.

Where these specifications state "preferred manufacturer" or specific model numbers, there shall be no substitutes without prior written approval. Approvals will be issued on a case by case basis.

**All materials must be domestically manufactured**, with the noted exception in the section covering air release valves.

### 2.2.1 Pipe

The following shall be used as standard gravity wastewater pipe sizes within the SCPW service area: 4 inch (private services and replacements only), 6 inch, 8 inch, 10 inch, 12 inch, 15 inch, 16 inch, 18 inch, 20 inch, 21 inch, 24 inch, 30 inch and 36 inch. The following shall be used as standard force main pipe sizes within the SCPW service area: 4 inch, 6 inch, 8 inch, 10 inch, 12 inch, 16 inch and 24 inch. No other pipe sizes will be allowed without prior written approval from SCPW.

All gravity and force main pipes shall either be polyvinylchloride (PVC) or ductile iron (DI) pipe and shall bear the National Sanitation Foundation Seal of Approval. They shall generally have push-on, integral bell joints with rubber gasket seals, except where flanged pipe is required in association with pump station construction. Provisions shall be made to allow for expansion and contraction. Laying lengths shall be 13-14 feet for PVC gravity pipe and 18-20 feet for C900 PVC gravity pipe and force main pipe, except where necessary to install fittings and appurtenances.

PVC used for force main pipe and gravity wastewater mains and services in certain instances shall be Type I, Grade I conforming to ASTM D2241, D1784, D3139, F477 and made from clean, virgin materials. It shall be SDR 18, Class 235 conforming to AWWA C900. For waste water pipe larger than 12 inches SDR 18, Class 235 conforming to AWWA C905 may be considered on a case by case basis. Written approval must be obtained prior to its use. Preferred manufacturers are CertainTeed, Diamond, JM Eagle, National, North American and Sanderson.

Internal restrained joint C900 PVC is permitted for use through steel casing associated with road crossings and as part of the restraint system necessary to protect fittings from movement due to forces exerted by the water within the pipe. The pipe materials must meet those cited above. The "BullDog™" PVC pressure pipe integral joint restraint system, consisting of a ductile iron restraint casing, ductile iron restraining ring and standard Rieber gasket, shall be utilized. The casing and ring shall be e-coated

with "Aqua Armor" resin. Preferred manufacturers are Diamond (Diamond Lok-21) and JM Eagle (Eagle Loc 900).

PVC used for gravity wastewater mains and services shall be Type I, Grade I conforming to ASTM D3034 (for sizes 4-15 inches in diameter), F679 (for sizes 18-27 inches in diameter), D1784, D3212, F477 and made from clean, virgin materials. The pipe shall be SDR 26 or Schedule 40 (private services only) PVC with bell and spigot joints. Private PVC service pipe may also be solvent weld pipe meeting the requirements of ASTM 1785. Preferred manufacturers are Diamond, JM Eagle and National. National's DR 25 "Extra-Heavy" PVC gravity wastewater pipe (13' joints), meeting ASTM D1784, ASTM D3139, AWWA C900 & C905, may be used as an alternate.

Flanged joint DI wastewater pipe, unless otherwise noted, shall be Class 53 for pipes 4 inches in diameter and Pressure Class 350 for pipes 6 inches in diameter and larger. All DI wastewater pipes shall be designed and manufactured in accordance with ANSI/AWWA A21.50/C150 and ANSI/AWWA A21.51/C151 with a minimum 350 psi pressure rating, with the exception of the 250 psi rating allowed for restrained, push on joints for DI pipe with a diameter of 24 inches. The joints for push on, bell joint DI pipe shall comply with ANSI/AWWA A21.11/C111, while joints on flanged pipe shall comply with ANSI/AWWA A21.15/C115. DI pipe exteriors shall be shop primed per ANSI/AWWA A21.51/C151. DI pipe interiors shall be coated, a minimum 35 mil thickness, with Protecto 401 ceramic epoxy.

Preferred manufacturers for push on, bell joint DI pipe are American (Fastite), Griffin (Tyton), McWane (aka. Atlantic States, Clow or Pacific States) (Tyton) and US Pipe (Tyton). Preferred manufacturers for flanged joint DI pipe are American (Toruseal gasket) and US Pipe (Flange-Tyte gasket).

Restrained joint, DI wastewater pipe may be required by the Engineer, SCPW and/or as noted on the plans. Preferred manufacturers of restrained joint, DI wastewater pipe shall be American (Fast Grip), Griffin (Field Lok 350 or Snap-Lok), McWane (aka. Atlantic States or Pacific States) (Sure Stop) or US Pipe (Field Lok 350).

DI wastewater pipe installed in corrosive soils shall consist of materials unaffected by such soils or shall be

isolated from the soil by a protective polyethylene encasement conforming to ANSI/AWWA A21.5/C105. The specifications for the encasement can be found in Section 2.2.6 below.

### 2.2.2 Valves

Plug valves are required on all force mains where directed by the Engineer and/or SCPW. Plug valves buried along the route of a force main shall be equipped with mechanical joint ends and square operating nuts located a maximum of 4 feet below the ground surface. Plug valves installed above ground or in vaults below ground shall be equipped with flanged joints and hand wheels. The valves shall open when the operating nut or hand wheel is rotated in a counterclockwise/left direction.

Plug valves shall be eccentric type valves equipped with ASTM A126 cast or ASTM A536 ductile iron bodies and one piece plugs and stems, welded nickel seats, permanently lubricated stainless steel bearings, and stainless steel hardware. The plugs shall be fully encapsulated in nitrile rubber. The interior and exterior of the bodies and bonnets shall be coated with 6 mils minimum fusion bonded epoxy meeting AWWA C550. The valves shall have a minimum pressure rating of 150 psi and shall conform to AWWA C504 and AWWA C111/ANSI A21.11. The preferred manufacturers are Clow (5412 or 5413), Milliken (Millcentric Series 600 N1AG or BG), Pratt (600) and Val-Matic (5800 or 5900). All plug valves shall be installed horizontally, except those associated with the quick disconnect bypass at pump station sites.

Check valves shall be flanged, clog free, self cleaning, ball type valves suitable for horizontal installations. They shall be equipped with type 316 stainless steel or fusion bonded (6 mil minimum) epoxy coated cast or ductile iron bodies with matching access covers, stainless steel hardware, and nitrile rubber coated metal balls. All shall be rated for working pressures up to 145 psi. Preferred manufacturer are Danfoss Flomatic (408), GA Industries (240) and HDL (5087).

Air release valves shall be installed at high points in the force main. The devices shall be equipped with a minimum 1-1/2 inch diameter HDPE outlet, a standard 2 inch national pipe thread inlet, a reinforced nylon body, 316

stainless steel hardware, ball valve and float spindle, and composite float, valve body, valve cover and valve basket. They must be suitable to use at working pressures up to 250 psi. These devices do not have to be manufactured domestically. The preferred manufacturer is ARI (D-025).

Each buried valve shall be equipped with an approved valve box and concrete collar. Valve boxes and drop lids shall be domestically manufactured with Class 35 cast iron. The boxes shall be two-piece, screw type with a minimum inside shaft diameter of 5-1/4 inches. The lid seating area of the valve box shall be 7-9/16 to 7-5/8 inches diameter at the top and 6-5/16 to 6-3/8 inches diameter at the bottom. The drop lids shall have a maximum overall depth of 3.5 inches. The lids shall be 7-5/16 inches diameter at the top and 5-3/4 inches diameter at the bottom. Each shall be suitable for traffic loads. "SEWER" shall be cast on the top of each cover. Preferred manufacturers are East Jordan (8550) and Tyler Pipe (6850).

Concrete collars shall be made of 3000 psi concrete with two #3 reinforcing bars spaced evenly between the inside and outside edge of the collar. The collar inside diameter shall be a minimum of 2 inches larger than the valve box top section. The collar shall also have a minimum outside diameter of 16 inches and a minimum thickness of 2 inches.

### **2.2.3 Gaskets and Lubricants**

All rubber gaskets and lubricants shall comply with ANSI/AWWA C111/A21.11.

Gaskets, O-rings and other products used for pipe and fitting joints shall be made of a continuous ring of styrene butadiene rubber (SBR) material compounded to resist deterioration and microbiological growth. They shall have smooth surfaces, free from pitting, blisters, porosity or any other defects to assure a permanent watertight seal.

Gasket lubricants shall be non-petroleum based, insoluble in cold water and non-toxic. They shall not support the growth of bacteria, impart taste or odor into the water, or have a deteriorating effect on the gasket. Lubricants shall not contain detergents, soaps, organic solvents or

other harmful ingredients. Lubricants shall be semi-paste, easily applicable, adherent to the inside of the bell and shall remain in a usable state throughout the range of temperature in which the pipe is typically installed. Lubricants shall be delivered to the job site in unopened containers bearing the manufacturer's name and trade name or mark. The use of vegetable shortening as a lubricant is prohibited.

#### 2.2.4 Taps

**Force Main** tapping sleeves rated at 250 psi are required for taps larger than 2 inches in diameter. Tapping sleeves shall be used in conjunction with flanged plug valves and ball check valves meeting the specifications outlined in section "2.2.2 VALVES" above. The sleeves shall be two part, "full circle" tapping sleeves with removable bolts and triangular side bars. The body, flange, nuts and bolts shall be made of heavy gauge, 18-8 type 304 stainless steel. The flange shall conform to AWWA C207. A 3/4 inch diameter, stainless steel, national pipe thread test plug for pressure testing the installed sleeve is required. Gaskets shall be SBR or NBR rubber complying with AWWA/ANSI C111/A21.11 and shall provide a full circumferential seal. Preferred manufacturers are Cascade (CST-EX), Ford (FTSS), JCM (432), Mueller (H304SS), Romac (SST-III) and Smith-Blair (665).

Under no conditions will a "wet" tap of equal size to the existing force main be allowed.

**Gravity Services** being connected to mains that are under construction shall be installed using PVC or DI fittings as described in section "2.2.5 Fittings" below. Similarly, the preferred method of connecting a gravity service to an existing cast iron, ductile iron, asbestos-cement or vitrified clay main is by means of "cutting in" a service tee-wye using the types of fittings described below.

A wastewater tapping saddle may be installed on existing, PVC gravity wastewater mains with prior written approval from SCPW. The saddles are to be equipped with an adjustable, 3.5 inch wide, type 304 stainless steel strap meeting ASTM A193. The body of the saddle, which shall not be in contact with the wastewater, shall be constructed of ductile iron per ASTM 536 and protected

with a corrosion resistant paint. The gasket shall be made of an SBR or NBR material compounded to resist deterioration. The gasket shall assure a permanent and watertight seal, and shall be free from pitting, blisters, porosity and any other defects. All bolts, nuts and washers shall be made from type 304 stainless steel. The preferred manufacturer is Romac (CB).

Under no conditions will a tap of equal or larger size to the existing gravity pipe be allowed without the installation of a manhole. Similarly, taps 8 inches in diameter and larger shall be accomplished by installing a manhole in the existing main.

### **2.2.5 Fittings**

**PVC Gravity Wastewater Fittings** (public and private) shall meet the same ASTM material, thickness and joint requirements as those listed above for PVC gravity wastewater pipe, plus they must meet ASTM F1336. PVC fittings 8 inches in diameter and smaller shall be molded in one piece, while fittings 10 inches in diameter and larger shall be molded or fabricated in accordance with ASTM 3034, Section 7.11 with standard pipe bells and gaskets. The preferred PVC fitting manufacturers are Harco, Multi Fittings (Trench Tough Plus Heavy Wall) and Plastic Trends.

PVC service fittings shall be used only on public services with depths of cover between 3 feet and 8 feet. PVC bends are only permissible at the property or easement line closest to the customer's point of connection.

PVC private service fittings shall only be used where depths of cover equal or exceed 1.5 feet. Private service fittings may also have solvent-weld, glue type joints.

**Ductile Iron Gravity Wastewater Fittings** shall be required on all public mains and services with depths of cover greater than 8 feet and less than 3 feet. They are also required on private service pipes with depths of cover less than 1.5 feet. Mechanical joint type ductile iron fittings are required at the main and any bend between the main and property/easement line, specifically where the main has 8 feet of minimum cover and the service includes a bend and/or a grade differential between the customer's end of the service and the main greater than 4 feet.

Slip-on joint type fittings may be used for the single or double wye where the plumber is to connect the customer's service at the property/easement line, at transitions from DI to PVC pipe, and at the main where the main has less than 8 feet of cover and there are no bends in the service piping.

Mechanical joint type ductile iron fittings shall be pressure rated at 250 psi and shall conform to ANSI/AWWA A21.4/C104, A21.53/C153, A21.51/C151, A21.11/C111 and A21.16/C116. The fittings shall be manufactured using ASTM A536 ductile iron coated on the interior and exterior with fusion bonded epoxy (6 mil minimum). The mechanical joint flanges used in conjunction with these fittings are not required to be restrained. Preferred manufacturers are American, Star, Tyler, and US Pipe.

Slip-on joint type ductile iron fittings shall have deep bell, gasketed joints that are air test rated. The fittings shall conform to ASTM D3034, ASTM F1336, ASTM F477 and AWWA C153. They shall be manufactured using ASTM A536 ductile iron coated on the interior and exterior with fusion bonded epoxy (6 mil minimum). The preferred manufacturer is Harco.

**Force Main Fittings** shall be ductile iron, mechanical joint type fittings meeting the same specifications described above for ductile iron, mechanical joint gravity wastewater fittings. Each fitting shall be equipped and shipped with restraining flanges, gaskets, and low alloy steel nuts and bolts.

**Restraining Flanges** shall be used on all force main fittings, conforming to the same AWWA/ANSI standards as the pipe and fittings. They shall have a minimum 250 psi pressure rating and coated on the interior and exterior with fusion bonded epoxy (6 mil minimum). For fittings 8 inches in diameter and smaller the preferred restraining flanges are Ebaa Iron "Megalugs" (1100-DIP, 2000PV-PVC), Ford "Uni-flanges" (1400-DIP, 1500-PVC), Romac "Grip Rings", Smith-Blair "Cam-Lock" (111-DIP, 120-PVC), Star "Stargrip" (3000-DIP, 4000-PVC), Tyler Union "TUF Grip" (1000TLD-DIP, 1500TDW-DIP & PVC, 2000TLP-PVC) and US Pipe "MJ Field Lok" (DI, PVC), and. For fittings larger than 8 inches in diameter, only the Ebaa Iron, Ford and Smith-Blair flanges shall be used.

**Flanged couplings and dismantling joints** shall be used when necessary to connect plain end ductile iron pipe to flanged fittings. The assembly shall have a minimum 150 psi pressure rating. The body of the assembly shall be constructed of ASTM A536 ductile iron and coated on the interior and exterior with fusion bonded epoxy (6 mil minimum). Wedges and rings shall be matching ductile iron or stainless steel. Wedge bolts shall be 3/4 inch minimum diameter. The preferred assemblies are Ebaa Iron "Megaflange" (Series 2100) and Romac (RFCA, DJ400, DJ405).

**PVC Pipe Joint Restraints** may be required by the Engineer and/or SCPW to restrain pipe lengths in conjunction with, or in lieu of, installing concrete thrust blocking or other means of restraint. Joint restraints shall meet or exceed the requirements of Uni-B-13-94 "Recommended Performance Specifications for Joint Restraint Devices for use with PVC Pipe" and shall be pressure rated at 150 psi. All flange sections shall be ASTM A536 ductile iron, split ring style with serrated edges. All hardware shall be type 316 stainless steel. The preferred manufacturers are Ebaa Iron (1500-00SS4), Ford "Uni-flange" (1390-X), Romac (611) and Smith-Blair "Bell-Lock" (165).

**Pipe Transitions and Adapters** may be required to joint PVC or DI pipe to aforementioned valves and fittings or to existing PVC, DI, cast iron, asbestos cement or vitrified clay pipes. See the chart below for approved connection methods.

<b><u>Connection</u></b>	<b><u>Preferred Transition/Adapter</u></b>
DI pipe to MJ fitting	Standard ANSI/AWWA A21.11/C111 gasket made of natural SBR compound
SDR 26/35 PVC pipe to MJ fitting	MJxSDR natural SBR gasket as manufactured by Harco or Romac
SDR 26 PVC pipe to SDR 26/35 PVC pipe	PVC "knock-on" coupling as manufactured by Harco or Plastic Trends
DI pipe to SDR 26/35 PVC pipe	DI MJ FBE sleeve with MJxSDR gasket on PVC end, Hymax reducer or Harco DI "Sewer x DIOD Adapter"
DI pipe or SDR 26 PVC pipe to cast iron pipe	DI MJ sleeve with MJxSDR gasket on PVC end, Hymax Reducer coupling or Romac Macro
DI pipe or SDR 26 PVC	Hymax Reducer coupling or Romac

pipe to AC pipe	Macro coupling
DI pipe or SDR 26 pipe to vitrified clay pipe	Hymax Reducer coupling
DI pipe to DI slip-on Fitting	Harco "DIOD x Sewer" adaptor
PVC to CIPP	7-inch Hymax coupling in presence of SCPW inspector

### 2.2.6 Polyethylene Encasement

Polyethylene encasement shall be 8 mils minimum thickness, linear low density film conforming to ANSI/AWWA 21.5/C105 and ANSI/ASTM D1248. Polyethylene encasement is required on DI pipes and fittings in contact with concrete thrust blocking and may be required elsewhere as directed by the Engineer, SCPW and/or where noted on the plans. For pipe sizes 3 inches to 16 inches in diameter the encasement shall be green in color. For all other pipe sizes the encasement shall be green if available, otherwise black will suffice. The preferred manufacturers are AA Thread, FE Fulton, Repcor, Infinity Plastics and Trumbull.

### 2.2.7 Steel Casing

Steel casing shall be ASTM A139, Grade B, steel pipe with no more than one continuous, longitudinal weld. The steel shall have minimum yield strength of 35,000 psi. Casing shall be shipped in 20 feet minimum lengths with no "mid welds", unless shorter lengths are approved in writing to accommodate job specific constraints.

The casing shall have a minimum inside diameter and wall thickness as specified on the drawings. However, all casing shall have a minimum wall thickness of 3/8 inch. Casing 3/8 inch thick shall be primed and coated with coal tar epoxy on the interior and exterior with a minimum 8 mils dry film thickness. Otherwise, 1/2 inch thick, uncoated casing, may be used. The preferred manufacturer is Southland Pipe.

The contractor shall be responsible for determining if the casing size and thickness shown on the drawings are adequate for installing the casing and inserting the carrier pipe. If the minimum dimensions are not adequate, the contractor shall use a larger size and/or thicker casing at no extra cost to SCPW and/or the Engineer.

Carrier pipe shall be supported and centered inside the casing with polymer plastic or high density polyethylene pipe supports, with rubber grip wrapping around the carrier pipe as necessary. Each spacer shall have a minimum of 5 skids and all hardware shall be 300 series stainless steel. A 1-inch maximum clearance shall be allowed between the outside edge of the spacers and the interior of the casing. Casing spacers should be installed using double backed tape provided with the spacers in order to fasten them tightly to the carrier pipe. The preferred manufacturers are BWM (KP), Cascade (Phoenix Gold) and Raci (Medium).

Each end of the casing shall be sealed by means of a brick and mortar bulkhead.

#### **2.2.8 Tracer Wire and Warning Tape**

Tracer wire shall be 12 gauge, solid strand, copper wire, or extra high strength copper clad carbon steel wire, designed for direct bury applications. The wire shall be insulated with 30 mils minimum thickness, green, low density, high molecular weight polyethylene.

Cable splicing shall be accomplished per manufacturer requirements. The preferred splice is manufactured by 3M Direct Bury Products (DBY6).

Metallic warning/detection tape shall consist of an aluminum foil encased in plastic. It shall be a minimum of 6 inches wide, 5 mils thick, green in color and denote "Sewer Main Below" in black letters.

#### **2.2.9 Concrete Thrust Blocking and All Thread Rod**

The use of concrete for restraining should be considered a secondary option to restrained joint pipe and must be approved in writing. Concrete mix used for thrust blocking shall have a 28-day compressive strength of not less than 3,000 pounds per square inch.

All thread rod used in conjunction with thrust blocking shall be 3/4 inch in diameter, manufactured from 316 stainless steel and shall conform to ASTM F593.

#### **2.2.10 Manholes**

Manholes shall typically consist of a base section, one or more riser sections, an eccentric cone or flat top, grade risers, an invert, frame and cover. The requirements for each are described below.

**Bases, Risers, Cones and Flat Tops** shall be constructed of reinforced, corrosion resistant, precast concrete manufactured and tested in accordance with ASTM C478. Concrete used in the casting process shall have a minimum 28 day compressive strength of not less than 4,000 psi and a maximum absorption of 8 percent of the dry mass. The concrete design mixture shall include, at a minimum, five 94 pound bags of Portland cement, 1 gallon of ConShield Microbiologically Induced Corrosion prevention solution or ConBlock MIC manufactured by Concrete Sealants (substituted for 1 gallon of water in the design mix), and 5 pounds of Southern Color Company #821-M or Davis Colors #10327 pinkish brown, natural iron oxide tint per cubic yard batched. Reinforcing shall be Grade 60 steel. Below is a list of minimum concrete thicknesses for various manhole sections:

<u>Concrete Item</u>	<u>Minimum Thickness</u>
Cover over reinforcing steel	2 inches
Base section wall (4 and 5 ft. diam. MH)	5 inches
Base section wall (6 ft. diam. MH)	6 inches
Base section floor (all MH)	6 inches
Riser section wall (4 and 5 ft. diam. MH)	5 inches
Riser section wall (6 ft. diam. MH)	7 inches
Cone wall at riser (4 and 5 ft. diam. MH)	5 inches
Cone wall at riser (6 ft. diam. MH)	6 inches
Cone wall at ring and cover (all MH)	8 inches
Flat top (all MH)	12 inches

Only eccentric cone sections shall be used. All concrete manhole sections shall be free from large voids ("honeycombs"), cracks, chips and burrs. Suitable lifting holes with a safety locking feature are required in each manhole section for ease of handling. The lift holes shall contain plastic inserts and shall not completely penetrate the wall of the manhole section. Preferred manufacturers are Hanson (Heidelberg Cement) and Knight's Precast.

**Pipe Entrances** shall either be cast or cored into the precast manhole sections a minimum distance of 1 inch off the manhole floor. Each entrance shall be circular in

shape with a diameter no less than 2 inches greater than the outside diameter of the pipe being installed. In locations where the main upstream of the manhole has a slope exceeding 2.00 percent, the pipe entrance must be 6 inches above the outlet invert and no less than 4 inches greater than the outside diameter of the pipe being installed.

Entrances shall contain a six-inch minimum length, flexible manhole sleeve ("boot") made from a high quality synthetic rubber. The sleeve shall be fastened to the precast structure using a stainless steel expansion ring, which is secured in place by tightening a stainless steel expander wedge or threaded rod to the required torque. The torque must be field checked after all transportation of the manhole has been completed and the manhole is set in place. The sleeve shall fasten to the pipe with an adjustable stainless steel pipe strap. The seals between the pipe, sleeve and structure shall be watertight. The preferred manufacturers are NPC (Kor-N-Seal) and Press-Seal (PSX Direct Drive).

**Inverts** shall be constructed using cast-in-place concrete or layered bricks and mortar.

Cast-in-place concrete used in the construction of inverts shall meet the same specifications as the precast manhole sections, including the addition of the ConShield Microbiologically Induced Corrosion prevention solution or ConBlock MIC manufactured by Concrete Sealants. Cast-in-place concrete shall be field applied after the entrance and exit pipes have been installed.

Only solid concrete bricks meeting ASTM C140 and C55, with a minimum compressive strength of 4,000 psi, shall be used. The standard size for brick shall be 2.25 x 3.625 x 7.625 inches. Mortar shall be of a Type II - M masonry mix consisting of clean water, 1 part Portland cement, 1 part masonry cement, 6 parts sand, and 3 ounces of ConShield Microbiologically Induced Corrosion prevention solution or ConBlock MIC manufactured by Concrete Sealants (substituted for 3 ounces of water in the design mix) per 10 pounds of Portland cement. The 28 day compressive strength for the mortar shall be a minimum of 4,000 psi.

**Manhole Joints** shall seat together in a tongue and groove fashion. The seal between two manhole sections shall be permanently watertight. To accomplish this, a flexible

butyl rubber, 0.875 minimum thickness sealant shall be placed between the tongue and groove portions of the manhole sections. The preferred sealant manufacturer is ConSeal (CS-102, CS-302).

The exterior of the manhole joints shall be wrapped with a polyolefin backed joint tape and 3 layers of 18 inches wide, 80 gauge hand blown packaging film. The joint tape shall be a butyl resin sealant resistant to punctures, tears and abrasions. The tape shall aggressively bond to the concrete. The minimum dimensions for the tape shall be 9 inches wide and 0.10 inch thick. The preferred manufacturer is ConSeal (CS-212).

In wet conditions, as recommended by ConSeal, the tongue and groove section of the joint and the joint exterior shall be coated with high performance bonding agent or surface primer. The preferred manufacturer is ConSeal (CS-300).

The interior joints shall be sealed with mortar meeting the same specifications as that outlined in the "Inverts" section above. The mortar shall extend 3 inches above and below the joint. The minimum thickness of the mortar at the joint shall be 0.5 inch, then it shall taper back to the manhole structure 3 inches on each side of the joint.

**Manhole Steps** shall not be installed. Cast in place step holes shall be filled with grout matching the specifications outlined in the "Inverts" section above.

**Manhole Frames and Covers** shall be domestically constructed of heavy duty, cast iron conforming to the requirements of ASTM A48, Class 35. All castings shall be made accurately to the required dimensions. Each shall be of uniform quality and free from blow-holes, porosity, hard spots, shrinkage, blisters, distortions or other defects. The contact surface between the frame and cover, and the frame and concrete manhole top section, shall be machined to make contact along the complete perimeter for uniform bearing. The assembly shall be able to withstand traffic loadings.

Typically manhole frames shall have the following dimensions: 7.50 inches depth, 0.50 to 0.75 inch thickness, 22 inches clear opening and 25 inches minimum frame opening at the cover seat. Frames to be cast inside flat slabs shall have the following dimensions: 4 inches

depth, 1-inch thickness, 22 inches clear opening and 23.75 inches minimum frame opening at the cover seat. Where it is necessary, on a case by case basis, to lower an existing manhole top elevation less than 6 inches, the existing frame, may be replaced with an inverted frame. Inverted frames shall have the following dimensions: 24-inch cover seat, 31.5 inch top flange, 23.75 inch lower outside diameter, 0.5 inch thickness, 4 inch depth and 21.875 inch minimum opening.

Each cover shall have a minimum 1-inch thickness and 23.50 inches diameter. "Sanitary Sewer" or "S" shall be cast into all covers. With the exception of covers required in watertight applications, covers shall be provided with a vent hole and two non-penetrating pick holes. Where the Engineer and/or SCPW require watertight frames and covers, a high quality Nitrile or Neoprene rubber gasket with a minimum thickness of 0.125 inch shall be placed in accordance with manufacturer's recommendation between the frame and cover and the cover shall not include a vent hole.

Preferred frame and cover manufacturers are as follows:

Standard Frames & Covers

East Jordan Iron Works	V-1384 Frame	V-1384 Cover
US Foundary & Manu.	USF-668 Frame	KL Cover

Waterproof Frames & Covers

East Jordan Iron Works	V-1384 Frame	V-1384 Camlock Cover
US Foundary & Manu.	USF-668 Frame	KL-BWTL Cover
US Foundary & Manu.	USF-195 Frame	E-ORS Cover (runoff)

Flat Slab Frames & Covers

East Jordan Iron Works	V-1384-4 Frame	V-1384 Cover
US Foundary & Manu.	USF-1261 Frame	KL Cover

Inverted Frame

East Jordan Iron Works	285511 Frame
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Manhole frame and covers located within 2,500 piped feet of a pump station, and in other locations where corrosive environments are known to exist, shall be of composite construction, manufactured by East Jordan Iron Works.

Manholes located in pavement, sidewalks, or areas affected by street runoff shall have O-ring sealed frames and covers without vent holes.

**Manhole Coatings** shall be applied as recommended by the manufacturer and where directed by the Engineer and/or SCPW. Coatings shall be utilized to rehabilitate existing brick or precast structures, prevent hydrogen sulfide attack and/or minimize possible groundwater infiltration. Below is a list of manhole and wet well applications requiring a minimum 100 mils monolithic coating thickness of Ultra High Build Epoxy. The preferred epoxies are Mainstay DS-5 and Raven 405. If "build back" of existing structures is required prior to application of the epoxies, 0.5-inch Quadex Calcium Aluminate or Mainstay ML-72 MicroSilica Restoration mortar will be required.

- Existing, uncoated/unlined pump stations being upgraded
- Manholes receiving a force main connection
- Existing and new manholes within 1,000 piped feet, upstream and downstream, of a manhole receiving a force main connection
- Existing pump stations and manholes requiring surface and/or structural rehabilitation

SCPW reserves the right to require alternative coatings for each situation described above, as deemed necessary.

#### **2.2.11 Grease Traps**

**Under the sink type grease interceptors** shall be constructed of stainless steel or fabricated steel with an acid resistant epoxy coating on the interior and exterior. The devices shall be self cleaning with the grease being removed automatically on a pre-programmed, timed basis and deposited into a container external to the interceptor. Each device shall be equipped with a removable, solids screening basket and a vented, inlet flow control device to restrict the influent flow to or below the rated device capacity. The inlet and outlet connections shall be located near the top of the device. Interceptors shall conform to the current Plumbing and Drainage Institute Standard PDI-G101 and the National Plumbing Code requirement regarding 2 pounds grease detention per each gallon per minute of flow. The minimum allowable size is 40 pound or 20 gallons per minute. The preferred

manufacturers are Highland Tank/Lowe Engineering (AGI) and Thermaco (Big Dipper).

**Precast concrete grease traps** shall be constructed of reinforced concrete and shall conform to all the requirements for precast manholes listed above (ie. pipe entrances, joints, frames and covers, bedding, concrete, reinforcing, wall thickness, etc.). The minimum permissible size is a 1,500 gallon capacity tank with a baffle wall located within 3 feet of the outlet pipe.

A manhole frame and cover shall be placed on each side of the baffle to provide access for cleaning and inspection. The baffle wall shall be 4 inches thick concrete, or concrete filled 8 x 8 x 16 inches concrete block, with a pass-through pipe to allow water flow through the baffle.

All piping associated with the trap shall be a minimum of 4 inches diameter PVC or ductile iron. The invert of the inlet pipe shall be one pipe diameter above the invert of outlet pipe, and the baffle pass through pipe shall be one half pipe diameter below the invert of the inlet pipe. Tees shall be installed on the ends of all pipes within the trap. The tees shall be installed such that the branch is at the end of the pipe, and the run sides of the tee are aligned vertically. A spool piece of pipe shall be installed in the low sides of the tee runs such that they extend toward the bottom of the trap.

#### **2.2.12 Bedding Stone**

Pipeline bedding material and foundation stabilization material for precast structures shall conform to ASTM C33, Grade No. 57 crushed stone. The stone may be granite or crushed concrete with particle sizes ranging from 0.25 to 0.75 inch in diameter.

### **2.3 Execution**

All work shall be conducted in accordance with the latest version of the OSHA safety standards set forth in the Federal Register Volume 36, Number 75. The Contractor shall be responsible for all safety precautions and programs associated with the work, and shall comply with all applicable laws, ordinances, rules, regulations, and orders of any public body having jurisdiction for the safety of persons or property, and their protection from

damage, injury, or loss. The Contractor shall erect and maintain all necessary safeguards for such safety and protection until the work is completed and accepted by SCPW. The Contractor shall notify SCPW and other responsible parties of locations where injuries or property damages have occurred, and shall be responsible for rectifying each situation immediately at the Contractor's own expense.

The Contractor shall give the Engineer and SCPW prompt written notice of any significant changes in the work or deviations from the plans and specifications.

### **2.3.1 Rights-Of-Way, Easements and Permits**

Prior to beginning any construction activities, the Engineer and/or the Developer must obtain all necessary rights-of-way, easements, permits and other legal documentation. The Contractor shall be responsible for becoming familiar with the requirements of these items, and shall confine the work as required to comply with them. Any damages caused by the Contractor outside the legal limits stipulated in these documents shall be rectified by the Contractor and/or the Developer at no cost to SCPW. SCPW requires wastewater easements to be a minimum of 10 feet wide on each side of wastewater mains, services and appurtenances, or twice the depth of the mains, services or appurtenances, whichever is greater. SCDOT Encroachment Permits shall be prepared by the Engineer and submitted to SCPW for review and execution.

The entire right-of-way or easement shall be cleared and grubbed per the plans, permits, and legal documentation. Trees, roots, stumps, asphalt, concrete, debris, etc. shall become the property of the Contractor and shall be disposed of properly, in accordance with local rules and regulations.

### **2.3.2 Alignment and Grade**

Wastewater mains, service pipes and all necessary appurtenances shall be installed per the alignment and grades indicated on the approved plans. In cases where the plans call for filling the site to achieve the required minimum depths of cover, the site fill must be placed and compacted prior to the wastewater system installation. Regardless of whether cut or fills are

required, the final site grade (+/- 0.5 foot) must be established prior to initiating construction of the force main and gravity sewer services. A letter from the Engineer stating that this condition has been met should be obtained by the Contractor prior to starting construction.

Gravity mains shall be constructed on a straight line with a uniform slope between manholes. Gravity services shall be constructed on a straight line and uniform grade between the main and customer's point of connection, or where bends are permitted, from the main to the bend and between the bend and customer's point of connection. For SCPW gravity wastewater mains and services, maintain a minimum depth of cover of 3 feet measured from the top of pipe to the finished grade of the land. SCPW gravity wastewater service piping shall also have a maximum cover of 6 feet at the customer's point of connection. Private service pipe is required to have 1.5 feet minimum cover, unless ductile iron pipe is installed.

For force mains, maintain a minimum 3 feet and maximum 5 feet depth of cover. The force main shall also be installed a uniform, horizontal distance off the edges of roadways or property lines. Mechanical joint bends shall be used on force main piping to traverse curves and at sudden changes in horizontal or vertical alignment.

If the trench is incidentally excavated below the required grade, the over excavation shall be backfilled as necessary to the proposed grade with bedding stone. Work shall proceed in the upstream direction with the bell end laid upgrade.

Force main fittings and gravity wastewater service wyes at the customer's point of connection shall be marked with 2 inch diameter PVC capped pipe until the as-built surveys are complete.

### **2.3.3 Trench Excavation**

Excavation is unclassified. Complete all excavations regardless of the type of materials encountered. The Contractor shall be responsible for determining the type and extent of various materials which will be encountered in the excavation.

The minimum trench width shall be 2 feet wider than the outside diameter of the wastewater main or service being installed, unless prior approval is obtained from SCPW. Variances may be allowed for specialty equipment, limited working space, safety considerations, protection of private property and structures, etc. In general, the maximum width of the trench will not be limited, except where adjacent structures are susceptible to damage and easements or rights-of way widths restrict such operations. However, trench widths should be kept to a minimum to avoid excessive earth loads on the pipe. The trench shall be excavated to provide a level cross section along the bottom and vertical sides extending to 12 inches above the top of the pipe.

#### **2.3.4 Bedding**

**Gravity Pipe Bedding** shall be Class B, compacted, #57 crushed concrete or granite bedding and tamped backfill material, unless otherwise directed by the Engineer and/or SCPW. The bottom of all wastewater pipe trenches shall be excavated uniformly, smooth and free from stones, roots and foreign material greater than 3/4 inch in diameter. Regardless of the type of soil encountered, or its moisture content, a minimum thickness of 6 inches of bedding stone shall be required under the pipe the full trench width. Stone shall also be placed on each side of the pipe, from the bottom of the pipe to a point 3/4 the way to the top of the pipe. If soil unsuitable for properly supporting the pipe is encountered, it shall be removed until firm, dry, desirable soil is found, then the mucked depth shall be backfilled the full trench width with stone. Bell holes must be prepared in the stone bedding to prevent bearing on the bells.

**Force Main Pipe Bedding** shall be Class B, shaped bottom with tamped backfill, unless otherwise directed by the Engineer and/or SCPW. The bottom of all force main pipe trenches shall be excavated uniformly, smooth and free from stones, roots and foreign material greater than 3/4 inch in diameter. Typically, the loose soil left by the excavator will suffice as bedding. However, #57 crushed concrete or granite bedding stone may be required to provide support along the pipe barrel and at fittings, depending on soil conditions and/or as directed by the Engineer and/or SCPW. If soil unsuitable for properly supporting the pipe is encountered, it shall be removed

until firm, dry, desirable soil is found, then the mucked depth shall be backfilled the full trench width with stone. Bell holes must be prepared in the stone bedding to prevent bearing on the bells.

### **2.3.5 Dewatering**

No pipe, fittings, precast structures or other appurtenances shall be installed in a wet trench. It is the Contractor's responsibility to provide all the necessary labor and equipment to keep excavations free of water. The water shall be pumped to a nearby drainage system, with all precautions taken to prevent erosion, damage to adjacent property, traffic hazards, etc.

### **2.3.6 Backfill**

Backfill material for the pipe zone, which is defined as the area from the bottom of the bedding to 12 inches above the top of the pipe by the entire width of the trench, shall be placed and consolidated by hand. Care shall be taken to avoid disturbing the pipe while the backfill is being placed. The bedding and backfill material in the pipe zone shall be manually tamped in 6 inch lifts with a "T bar" or equivalent equipment to a standard proctor density, in accordance with ASTM D698, of 95 percent.

Backfill above the pipe zone shall consist of approved, suitable backfill material, free of debris, tamped in 6 inch lifts to a minimum of 90 percent of maximum density for undeveloped areas and 95 percent for developed areas, as determined by ASTM D1557. Typically, suitable materials will consist of well graded, coarse granular materials with maximum particle sizes smaller than 2 inches in diameter, sands, silty sands, clayey sands or flowable fill. Soil with more than 35 percent of its weight passing a #200 sieve shall not be used for backfill. If the existing trench walls are determined to be unsuitable, the Engineer and/or SCPW may require the entire pipe zone to be backfilled with bedding stone.

Backfill shall be placed regularly such that no more than one joint of pipe is exposed at a time. When backfill is being placed in the trench mechanically, care shall be taken to prevent free fall of the soil from the equipment

onto the pipe zone until a minimum of 2 feet of soil has been placed over the pipe. At no time shall any heavy or sharp objects be allowed within the backfill material.

Any settlement during the Contractor's warranty period shall be repaired immediately at no cost to SCPW. SCPW reserves the right to require the Contractor to provide all necessary compaction testing, at the Contractor's own expense, by a certified soil testing company to verify the project's most strict specifications have been met.

See the section of these specifications entitled "SITEWORK", along with the plans and permits related to the project, regarding specific backfill requirements under roads, structures, ditches, etc.

### **2.3.7 Pipe Handling, Inspection and Cleaning**

The pipe shall be shipped, stored in a designated area and delivered to the job site in a safe manner. It shall be stacked and stored such that the barrel of the pipe is supported uniformly and evenly, and the bell ends overhang. Pipe shall be unloaded off trucks by means of proper equipment, or by manually handling one joint at a time. At no time should the pipe be dropped from, or rolled off, the delivery truck.

The Contractor shall provide and use proper implements, tools and facilities for the safe and proper execution of the work. All pipe, fittings, precast structures and appurtenances shall be lowered into place by means of a crane, sling or other suitable tools or equipment as to prevent damage to the pipeline materials and protective coatings and linings. The materials are not to be dropped, rolled or dumped into the excavation.

Each joint of pipe, fitting, precast structure and appurtenance shall be inspected for possible damage and defects. Damaged and unacceptable materials must be removed from the job site and SCPW shall be notified. All lumps, blisters and excess coatings that do not lessen the integrity of the material shall be removed from the bell and spigot ends of pipes and fittings.

The interior and joint surfaces of the materials shall be kept clean and free of foreign matter. Whenever work stops at the end of a day, or for any extended period

during the day, a temporary plug shall be installed to keep debris and other matter from entering the pipe. The bell and spigot ends of pipe and fittings shall be thoroughly cleaned and dried per the manufacturer's recommendations. All joint surfaces are to be free from unapproved and petroleum based oil and grease before the pipe is laid.

### **2.3.8 Pipe Cutting and Beveling**

Pipe shall be cut with a milling type cutter, rolling pipe cutter, abrasive saw cutter or a fine-toothed hand saw. Flame cutters and plasma cutters are not allowed. Cuts shall be made squarely and perpendicular to the pipe's length to assure proper assembly. Where existing P 401 lined DIP is cut, a P401 touch up kit is required.

Each cut made for a bell connection shall be beveled in accordance with the manufacturer's recommendations. The bevel shall match the one provided by the manufacturer on a new joint of pipe. Beveling the pipe shall be done with a beveling tool, carpenter's file, or abrasive saw cutter. The new "home" location mark shall be established on the cut joint of pipe by using the spigot end of a full joint as a reference.

Pipe to be installed into mechanical joint fittings shall be square cut, not beveled. Pipe to be installed in push-on joints shall be beveled as described above. Pipe ends for couplings shall be installed per the manufacturer's recommendations.

### **2.3.9 Pipe Installation**

Prior to connecting flanged pipe, the faces of the flanges shall be thoroughly cleaned and all foreign material and unapproved or petroleum based oil and grease removed. The rubber gaskets shall be checked for proper fit and thoroughly cleaned. Care shall be taken to assure proper seating of the flange gasket. Bolts shall be tightened systematically so that the pressure on the gasket is uniform. Torque-limiting wrenches shall be used to ensure uniform bearing insofar as possible. If joints leak when the hydrostatic test is applied, the gaskets shall be removed and replaced, and the bolts shall be uniformly re-tightened.

Prior to connecting mechanical joint, push-on and restrained joint pipe, the interior of the joints and the exterior of the spigot end of the pipe shall be thoroughly cleaned of all foreign substances and unapproved or petroleum based oil and grease. Pipe shall be joined in accordance with the individual manufacturer's recommendations. The Contractor shall provide all special tools and devices, such as jacks, chokers, and similar items required for proper installation. Lubricant for the pipe gaskets shall meet the requirements of the manufacturer and these specifications.

No deflection in alignment or grade is permissible for gravity wastewater piping without the installation of a manhole (for mains), bend (for services) or cleanout (for private services). For force mains the maximum permissible deflection at joints shall not exceed the manufacturers' recommendations or the maximum allowed by AWWA C600. Each force main pipe length shall be installed without being flexed or bowed, in order to traverse curves and elevation changes. All deflection must take place in the force main pipe joints or by means of mechanical joint fittings. The SCPW rule of thumb states that deflection is acceptable if the pipe being installed can remain deflected in an open trench without the aid of support (i.e. a pipe bar or material backfilled behind the deflected pipe).

Wastewater service pipe to be maintained by SCPW shall be a minimum of 3 feet deep (unless ductile iron pipe is approved for shallower depths), maximum 6 feet deep at the right-of-way/easement line and laid on a uniform grade and alignment from the main to the right-of-way cleanout. The exception is deep services crossing under roads with SCPW approved bends. All other requirements regarding bedding, backfill, road crossings and separation from water and drainage pipes shall meet the same specifications as for gravity wastewater mains detailed above. It is preferred that all double services be located at a property corner and all single service be located in the middle of the lot being served. Regardless of the service location, it shall be at a right angle to the main. Where practical, double services shall be installed.

Wastewater service pipe for private ownership shall be installed per the required plumbing codes, with the following exceptions: the pipe shall be bedded equivalent

to force mains as described above, and a minimum of 1.5 feet of cover is required over the top of the service pipe unless ductile iron pipe is being installed. Service connections installed within the public right-of way, but not intended for immediate activation, shall terminate with a 6 inch by 6 inch single or double wye. Each side of the wye shall be plugged such that they are watertight, and the wye shall be marked with a 2 inch capped PVC pipe. The marker pipe shall extend from the end of the wye to a point 2 feet above grade. The Customer's plumber shall be responsible for constructing the cleanout, at the right-of-way or easement line at the time of connection to the SCPW wastewater system.

PVC gravity wastewater pipe shall be installed in accordance with the latest revision of ASTM D2321. Similarly, PVC force main pipe shall be installed in accordance with the latest revision of ASTM D2774, ductile iron gravity pipe shall be installed in accordance with the latest revision of ASTM A377, and ductile iron force main pipe shall be installed in accordance with the latest revision of AWWA C600.

SCPW also requires the installation of a minimum 10 foot, joint free pipe section at all manhole and fitting entrances and exits.

### **2.3.10 Manhole Installation**

Manholes shall be installed in accordance with the alignment and grade indicated on the plans (preferably out of roads and near property lines). Each shall be set plumb with the frame and cover located as far from traffic and other hazards as possible. Manholes shall be carefully handled and inspected for chips, cracks and voids prior to installation and backfill. Each joint and pipe entrance shall be constructed to be watertight.

The base of the manhole shall rest on a 1 foot minimum thickness stone bed to prevent settlement and misalignment. The joints between the base and subsequent sections shall be thoroughly cleaned and dried prior to the application of the manufacturer's recommended joint primer and associated joint sealant. The exterior walls of each manhole shall be thoroughly cleaned and dried a minimum of 10 inches on each side of the joints prior to application of the manufacturer's recommended primer,

joint wrap, and 18 inches wide packaging film. The interior walls of each manhole shall be thoroughly cleaned and dried a minimum of 8 inches on each side of the joints prior to application of the mortar sealant.

The frame and cover shall be properly set in a bed of mortar and aligned over the top section of the manhole. Where it is necessary, concrete bricks or precast concrete grade rings ("doughnuts") shall be set in mortar to adjust the top to the finished grade. However, there shall be no more than 18 inches of adjustment allowed between the top of the precast structure and the bottom of the frame and cover. Where directed by SCPW, the frame and cover shall be set in a tilted position to conform to the slope of the roadway, driveway, sidewalk or other land feature. The exterior and interior joints between the structure, grade adjustments and the frame and cover shall be sealed with a minimum 0.5 inch thick mortar sealant. Where manhole tops are located in yards, paved areas or roadway shoulders in populated areas, they shall be set flush with the existing or proposed ground elevation at a minimum, or at a maximum of 0.10 foot above grade. In wooded areas, undeveloped areas and along drainage ditches, manhole tops shall be set above the 50 year flood elevation, or 1 foot above grade, whichever is greater. Where water tight frames and covers are required, 1-7/8" ram neck shall be applied between the frame and riser before grouting the outside of the frame.

Steps shall not be installed. Preformed step holes shall be filled with grout.

The invert channel shall be a minimum of 1 inch wider than the outlet pipe diameter, and its depth shall be 75 percent of the pipe's diameter. The channel and shoulders of the invert shall be formed to a trowel (no brush marks, ridges or burrs) smooth finish using concrete, or by layering concrete bricks and mortar. Each layer of mortar, including the final coating, shall be a minimum of 0.5 inch thick. The shoulders of the invert shall be a minimum of 2 inches higher at the manhole wall than at the top of the invert channel. Curves with large, uniform radii shall be provided as necessary to direct flow through the manhole and allow room for the installation of 1-foot long wastewater plugs, mandrels and other apparatuses.

Pipe entrances at the invert shall extend a minimum of 1 inch and maximum of 2 inches inside the manhole. Pipe entrances for inside drops shall not extend more than 6 inches into the manhole, unless it becomes necessary to accomplish the installation of the drop fittings. At all pipe entrances, the pipe shall be secured in place using concrete brick pieces between the pipe and the manhole wall. The annular space remaining between the pipe and the manhole wall shall be filled with mortar to form a watertight seal. The mortar shall extend inside the manhole a minimum of 0.5 inch.

Where inside drops are required, there shall be one full joint of ductile iron pipe entering the manhole and extending to the vertical drop pipe. The tee for the drop shall be mechanical joint ductile iron, however the vertical drop pipe and bottom bend may be PVC or ductile iron. Inside drops shall be supported by stainless steel pipe hangers connected to the manhole wall with a maximum spacing of 2 feet. The spacing between supports shall depend on the size and weight of the material involved.

The lift pin holes provided for transportation and setting of the concrete manhole structures shall be grouted water tight and covered with a 1-foot long strip of joint wrap.

Manhole coatings and admixtures shall be applied or added in strict accordance with the manufacturer's recommendations and SCPW requirements.

### **2.3.11 Valve Installation**

Force main valves shall be installed where indicated on the plans (preferably out of roads and near property lines). Valves shall be carefully handled, cleaned and checked for operation prior to backfill installation. A minimum thickness of 6 inches of bedding stone or a solid concrete block is required under valves not installed inside a structure. Care shall be taken to ensure that no soil, rock or other obstacles that would interfere with the valve operation are left in the valve. All valves shall be installed plumb and restrained according to these specifications. Valves shall be installed per manufacturers specifications.

Valve boxes are to be centered over the valve's operating nut and shall extend truly vertical to the ground surface.

A spool piece of PVC force main pipe shall be used to span the gap between the valve box and the valve in cases where the valve box is not long enough to reach from the ground surface to the operating nut. Under no circumstance shall the PVC riser pipe or valve box be in contact with the valve such that surface loads bear on the valve.

The maximum distance between the finished ground surface and the top of the operating nut shall be 4 feet. Valve extension stems shall be installed by the Contractor at no additional cost to SCPW where required. Extensions shall be equipped with a centering ring 1 inch in diameter smaller than the pipe supporting the valve box and a set screw to affix the extension to the operating nut of the valve.

Combination air valves shall be installed at high points in force mains, and in accordance with the manufacturers' recommendations. They shall be installed inside a 4-foot diameter manhole section, or a built-in-place masonry vault, with no base. The structure is to rest on a bed of 1-foot thick bedding stone such that it will drain freely.

#### **2.3.12 Polyethylene Encasement**

Wherever metal pipe, fittings and appurtenances come into contact with concrete thrust blocking, and where denoted on the plans and/or directed by SCPW and/or the Engineer, they must be wrapped with a polyethylene film. All open ends and damaged areas of the film shall be secured with duct tape. If the damaged film cannot be repaired, it shall be replaced with new film.

#### **2.3.13 Tracer Wire and Warning Tape**

Metallic warning/detection tape shall be placed 18 inches above all wastewater mains and services. Number twelve (#12) copper wire with green insulation shall be duct taped (every 5 feet max.) to the top of all force mains.

#### **2.3.14 Restraining Force Main Pipe and Fittings**

Where unbalanced forces exist in force mains, the pipe and fittings shall be securely anchored by using restrained joint pipe and fittings. Valves and fittings shall have mechanical joints and shall be installed with restraining

flanges and a bed of 6 inch thick bedding stone or a solid concrete block.

Concrete thrust blocking may be permitted by SCPW on a case by case basis and must be approved in writing. They shall be sized and installed as outlined in these specifications, and/or as directed by SCPW. Blocking is to be poured into place between the polyethylene wrapped fitting to be anchored, 3/4 inch thick plywood forms and undisturbed ground. The blocking shall be placed such that the pipe and fitting joints are accessible for repairs, being careful not to pour concrete on the bolts of the fittings. Where it is not practical to install blocking behind fittings in the typical manner, a concrete "deadman" may be poured in front of and rodded to the fittings using all thread rod. In these situations, the amount of concrete blocking must be double the typical amount.

Restrained joint pipe shall be installed as per the manufacturer's recommendations. See the detail drawings associated with these specifications for the lengths of restrained pipe required on each branch of specified fittings.

All thread restraining rods shall be used in conjunction with concrete thrust blocking. SCPW also requires a 10 feet minimum, joint free pipe length into and out of all valves and fittings.

SCPW shall be given the opportunity to inspect all restraining prior to backfill.

### **2.3.15 Connections to Existing Mains and Structures**

**New Force Main** connections to existing force main shall be made under the direct observation, or in many cases, with direct participation of SCPW personnel, except as otherwise directed. Tapping sleeves/saddles and valves shall be furnished, installed (per the manufacturer's recommendations) and air pressure tested to 100 psi for 15 minutes by the Contractor. SCPW shall then make the tap into the main at a fee to the Contractor.

**Gravity Service Connections** to existing mains shall either be accomplished by installing a manhole, tapping the main, or removing a section of the main to install a tee wye

fitting. Regardless of the methodology, it shall be the Contractor's responsibility to furnish and install all the necessary materials, and to construct the connection under the direct supervision of SCPW.

**Connections to Existing Precast Structures** shall be accomplished by coring through the wall and installing a flexible sleeve or "boot". Each entrance shall be circular in shape with a diameter no less than 2 inches greater than the outside diameter of the pipe being installed. The inside of the structure shall be grouted watertight. A new invert shall be properly formed to accept the flows from the added pipe, including if necessary, breaking out the existing shoulder and invert.

#### **2.3.16 Highway and Railroad Crossings**

Installation of highway and railroad crossings shall conform to the permits of all agencies having jurisdiction, SCPW requirements, and the plans. In general, steel casing shall be installed in the location and alignment shown on the plans by means of tunneling, boring or jacking steel pipe with welded joints. Casing spacers are required on the carrier pipe being installed. Casing end seals or brick bulkheads are required at each end of the casing. Only restrained joint ductile iron pipe shall be installed inside of the casing.

**PART 3 - TESTING AND INSPECTION**

SCPW personnel must be afforded full time access to the site. All work and materials shall be subject to testing, inspection and approval prior to final acceptance. Daily inspections shall be conducted, and if determined necessary a full time inspector may be assigned to the project at an hourly cost to the Contractor. Any Contractor not on the most current list of SCPW approved contractors shall be subject to hourly inspection fee. SCPW inspectors shall be on-site to verify construction practices and materials, not grades and alignments. Hence, daily inspections do not alleviate the Contractor from having to correct deficiencies identified during the final inspection.

The Contractor shall perform "self testing" of the system to verify its integrity prior to scheduling the final inspection with SCPW. Final inspections shall not be scheduled or performed by SCPW personnel until 48 hours after receipt of the written request for inspection and copies of the preliminary as-built drawings. During the inspection the Engineer, Contractor and/or representatives from each office shall be present. There is no charge for the initial inspection. However, a \$60 per hour charge may be assessed to the Contractor for subsequent tests and inspections, if necessary and prior to acceptance of the system.

Any deficiencies found shall be corrected immediately. Methods used shall be approved in advance by SCPW.

SCPW reserves the right to perform any or all of the following inspection procedures. The wastewater system being inspected shall not be accepted until it has successfully passed each inspection. Also, until the system has been accepted and permitted for operation by SCDHEC, a secured plug shall be installed in the lowest manhole to prevent any flow or debris from entering the existing wastewater system.

The Contractor shall furnish all necessary safety equipment, test plugs, air compressors, gauges, pumps, water supply hoses and other appurtenances to conduct these inspections.

Prior to any of the inspections, gravity mains and manholes shall be thoroughly cleaned with a high pressure, hydraulic cleaning machine and all debris shall be collected and removed at the end of each main segment. After the cleaning is complete, and just prior to the inspection, the Contractor will be required to dump approximately 100 gallons of clean water

into every "dead end" manhole in the system, so that low spots or "bellies" can be identified during the inspection procedures.

If the SCDHEC operating permit is not issued within 3 months of the date of the final inspection, SCPW reserves the right to require the contractor to re-perform all testing.

### **3.1 Pipeline Lamping**

Lamping shall be performed to determine if a section of gravity wastewater main was installed in a straight alignment, and to verify it is clear of obstructions. In some cases, especially with larger diameter pipes, lamping may allow the physical condition of the main's interior to be evaluated.

To accomplish a lamping project the Contractor shall supply two bright light sources, one 4-inch diameter, non-magnified mirror, and the necessary manhole entry safety equipment.

One SCPW inspector will enter a manhole with a light and the mirror, while another shines the second light into the manhole at the other end of the main. The first inspector will use his light and the mirror to look down the line. If the inspector can see a full circle or moon at the next manhole and cannot see any ponding water or light reflections off ponding water, then the line is considered to be clear of obstructions and free from deflection. However, if any portion of the circle is obstructed, further investigations and possible repairs may ensue.

Best lamping results are obtained when the light sources are inserted into each end of the main and rotated around the inside pipe circumference.

### **3.2 Closed Circuit Television Inspection**

Video inspections of the gravity wastewater main and selected services shall be performed in effort to locate low spots ("bellies"), separated or mis-aligned joints, pipe deflection, leaks, obstructions, debris and tap locations.

The Contractor will provide and operate the video equipment. The Contractor shall furnish the necessary safety and excavation equipment to enter the manholes and expose the randomly chosen services to be inspected. The inspection must be recorded on CD/DVD for future reference.

All deficiencies shall be brought to the attention of the Contractor such that repairs can begin immediately. As a rule of thumb, ponding water confined to one PVC gravity wastewater pipe length may be considered acceptable. Other deficiencies shall be reviewed on a case by case basis, as long as leaks are not present and the structural integrity of the system has not been compromised.

### **3.3 Mandrel Test**

PVC gravity wastewater mains and selected services are to be tested with a mandrel for possible deflection ("out of roundness") and joint offsets. SCPW reserves the right to require deflection testing on ductile iron gravity wastewater mains, although there is concern the mandrel could damage the required pipe linings.

Mandrel testing shall be performed by the Contractor, under the direct supervision of SCPW personnel. The Contractor will be responsible for supplying the necessary rope and manhole entry safety equipment. SCPW shall typically provide the rigid, 5 percent deflection mandrel to be used during the test. However, the Contractor shall be required to do so where the pipe is larger than 15 inches in diameter and/or the SCPW mandrel is too long to fit into the invert channel.

The Contractor shall be responsible for inserting a rope through each section of main. The rope in the main shall be secured to one side of the mandrel, while a second rope is tied to the backside of the mandrel. The pipe will be considered as having failed the test if a man of average strength and stature cannot pull the mandrel through the section of pipe. At this point, the mandrel shall be retrieved from its point of origin, and the location of the deflected pipe shall be marked, excavated and repaired.

### **3.4 Air Testing**

Air testing gravity wastewater mains may be required to detect cracks and leaks that may contribute to root growth, infiltration, exfiltration, and/or soil and debris entering the system. Air testing shall conform to ASTM F-1417 (Plastic Pipe).

This test shall be performed by the Contractor, under the direct supervision of SCPW personnel. The Contractor will be responsible for supplying the necessary rope, plugs, pressure

gauge, air compressor, stop watch, manhole entry safety equipment, etc. to perform the test.

The test procedure shall be as follows. A mechanical plug with a rubber gasket, or an inflatable plug, shall be inserted, expanded and secured into each end of the section of main being tested. Each plug shall be braced with a 4-inch square timber laid between the plug and the manhole wall to prevent blowout. The lower plug shall have a threaded tap connection to allow air to flow into and from the section of main being tested. A pressure hose shall be connected to the tapped plug and run outside of the manhole to a pressure gauge with a scale large enough to read half pound gradations between 0 and 5 psi clearly and accurately (a logarithmic scale is recommended). After the pressure gauge is installed, there shall be a shut-off valve placed between the gauge and the air pressure supply device. A pressure regulator is recommended for installation in the air supply line to prevent test pressures from exceeding 8 psi.

After the setup is complete, the test pressure shall be slowly supplied to the main until it reaches 4 psi and stabilizes. The pressure shall be allowed to slowly drop to 3.5 psi on its own. The stop watch shall be ready to begin timing the test when the gauge reads 3.5 psi. The test will conclude when the pressure drops to 2.5 psi. If the time for the pressure to drop from 3.5 to 2.5 psi equals or exceed the lesser of the two calculations from the formulas below, the pressure test will pass. Otherwise, the faulty joint(s) shall be located and repaired.

$$\text{Formula 1} \quad T = 0.011 [(L1) (D1^2) + (L2) (D2^2) + (L3) (D3^2) \dots]$$

$$\text{Formula 2} \quad t = \frac{28.33 [(L1) (D1^2) + (L2) (D2^2) + (L3) (D3^2) \dots]}{[(D1) (L1) + (D2) (L2) + (D3) (L3) \dots]}$$

Where: T and t = the minimum allowable pressure drop in seconds  
 D1 = the diameter of the main being tested in inches  
 D2 and D3 = the various diameters of service connections in inches  
 L1 = the length of the main being tested in feet  
 L2 and L3 = the various lengths of service pipe being tested in feet

### 3.5 Infiltration / Exfiltration Test

An infiltration/exfiltration test may be required to determine the estimated amount of infiltration into, or exfiltration out of, a section of wastewater main and its service connections. The maximum rate of infiltration/exfiltration shall not exceed 100 gallons per inch of inside diameter of the pipe per mile of pipe per day.

This test shall be performed by the Contractor, under the direct supervision of SCPW personnel. The Contractor will be responsible for supplying the necessary rope, plugs, measuring devices, water supply hose, manhole entry safety equipment, etc. to perform the test.

The following test description is actually an exfiltration test, however, it shall be assumed that the amount of water that exits a flooded sewer system will equal the amount of groundwater that could theoretically enter the same wastewater system under high groundwater and average wastewater flow conditions.

All inlets and exits into and out of the upstream and downstream manholes on the section of main being tested shall be plugged, with the exception of the pipe being tested. Each required plug shall be expanded in the pipe and secured to the manhole where it is installed. The main, services and both manholes shall be completely filled with water. The water shall remain in the system a minimum of 4 hours prior to the test being initiated to allow the system to reach its maximum absorption, and such that all trapped air can escape. After the first 4-hour period expires, the system shall be recharged with water such that the manholes are again full. The main shall again sit for a period of 4 hours, at which time the distances from the tops of the manholes to the new water levels shall be measured. The dimensions of the manholes in the void areas shall also be measured. The amount of leakage shall then be calculated. If the leakage exceeds the allowable noted above, the test will have failed, and the defects shall be located and repaired.

### **3.6 Force Main Pressure Test**

Wastewater force mains and appurtenances shall be subjected to and successfully meet a pressure test conforming to AWWA C600 for DI pipe and AWWA 605 for PVC pipe. The test pressure shall be 150 percent of the system's working pressure, but not less than 150 psi.

The system shall be slowly filled with water and all air evacuated through air release valves or other means. A suitable test pump, furnished by the Contractor, shall be connected to the system by means of a water service tap, and the proper test pressure shall be slowly applied to the system. The test pressure shall be maintained for a minimum of two hours.

**Leaks, if found, shall be repaired immediately.** Methods of repairs must be approved in advance by SCPW.

Leakage shall be limited to the following formulas. However, the leakage test is not the sole determining factor in passing a pressure test. Should the pressure drop more than 7 psi during the two-hour test, the test will automatically be considered invalid. Also, should the gauge at the test pump fail to drop to 0 psi after the test, the test will be considered invalid. SCPW reserves the right to install additional gauges throughout the test area to validate the accuracy of the gauge at the test pump.

For DI Pipe

$$L = [SDP^{0.5}] / 266400$$

Where:

L = allowable leakage (gallons/hour)

S = length of pipeline tested (feet)

D = diameter of pipe (inches)

P = average test pressure (psig)

For PVC Pipe

$$L = [NDP^{0.5}] / 14800$$

Where:

L = allowable leakage (gallons/hour)

N = number of joints in length tested

D = diameter of pipe (inches)

P = average test pressure (psig)

(Note: the above formulas have been modified from the AWWA standards to meet SCPW's criteria of allowing only half the allowable leakage)