

COMMISSIONERS OF PUBLIC WORKS
OF THE
TOWN OF SUMMERVILLE

WATER DISTRIBUTION SYSTEMS
ENGINEERING MANUAL
REV. 8/25/17

PART I - DESIGN CRITERIA

The following are criteria that shall be followed in the design of water distribution systems within the SCPW water service area. Designs shall conform to the latest revisions of the "State Primary Drinking Water Regulations" 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.

1.1 DESIGN CALCULATIONS**1.1.1 FLOWS**

Water mains shall be designed such that the minimum residual pressure under maximum instantaneous demands and fire flow conditions does not drop below 25 psi.

Residential design flow calculations shall be based on the following "Maximum Instantaneous Flows for Residential Areas" chart from Ameen's Community Water Systems Source Book.

# Residences Served	Flow/Residence (gpm)	# Residences Served	Flow/Residence (gpm)
1	15.0	91-100	2.0
2-10	5.0	101-125	1.8
11-20	4.0	126-150	1.6
21-30	3.8	151-175	1.4
31-40	3.4	176-200	1.3
41-50	3.2	201-300	1.2
51-60	2.7	301-400	1.0
61-70	2.5	401-500	0.8
71-80	2.2	501-750	0.7
81-90	2.1	751-1,000	0.5

gpm = gallons per minute

The design flow for single family and multi-family residential developments shall be 20% of the maximum instantaneous flow plus a minimum 1,000 gallons per minute fire demand.

Commercial design flow calculations shall be based on 1 gallon per minute per fixture unit. The number of fixture units will be determined by the current version of the local building codes. For commercial developments, the minimum fire demand shall be 1,000 gallons per minute.

Calculations must be run with the full fire demand placed on each hydrant individually.

Where water services 2 inches in diameter and larger are installed with required flushing devices, 100 gallons per minute shall be added to the design flow rate.

1.1.2 FRICTION LOSS

Headloss due to friction in 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

The minimum flushing velocity is 2.5 feet per second for all water pipes. Approved flushing devices must be designed such that the velocity in the main exceeds the minimum without causing the residual pressure in the system to drop below 25 pounds per square inch.

1.1.4 HYDRAULIC COMPUTER MODELS

Steady state or static models of the system are acceptable. The existing system may be represented by a fixed grade node utilizing the static pressure from a flow test and the site elevation, or a pump with three operating points may be modeled. The theoretical pump curve should include the following operating points: zero flow at the recorded static pressure from the flow test, the system design flow (see Section 1.1.1 Flows above) at the calculated residual pressure, and the calculated available flow at a residual pressure of 25 pounds per square inch. The following formula shall be used to calculate the unknown pump curve information.

$$Q_d = Q_t \times (P_s - P_d)^{0.54} / (P_s - P_r)^{0.54}$$

where: Q_d = Design/Calculated Max. Flow (gpm)
 Q_t = Actual Flow from Test (gpm)
 P_s = Static Pressure from Test (psi)
 P_d = Calc. Residual/Min. Allowable (psi)
 P_r = Residual Pressure from Test (psi)

1.1.5 FLOW TESTING

Flow tests used in conjunction with the design calculations must be dated no more than 12 months prior to the date the calculations are to be submitted to SCDHEC for permitting.

1.2 PLAN REQUIREMENTS

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

- 1.2.1 Water mains shall be designed a uniform distance (3 feet minimum) off the edge of pavement or back of curb. If necessary to vary the distance, the transitions should be accomplished using bends.
- 1.2.2 The number of joints and fittings under roadways and parking areas should be minimized.
- 1.2.3 Water easements, and/or a combination of public rights-of-way and water easements, shall be 7.5 feet minimum on either side of the centerline of the water main and appurtenances.
- 1.2.4 Developments greater than 25 lots in size, and/or those SCPW deems may be critical to area wide pressure and water quality concerns, shall be required to have two sources of water supply or connections to adjacent developments. The sources shall be located at the far extremities of the development, if possible. If a secondary feed or loop is not available, supply lines should be stubbed to adjacent properties for future extensions.
- 1.2.5 Water mains serving cul-de-sacs shall terminate in a hydrant, or shall loop around the entire cul-de-sac back to the supply main on the intersecting road.
- 1.2.6 Mains shall be a minimum 4 inches in diameter.
- 1.2.7 Where a loop is not possible or preferred, a minimum pipe diameter of 6 inches is required and the main must terminate with a fire hydrant. In cases where the existing supply main is less than 6 inches in diameter, SCPW may approve the installation of smaller diameter mains that terminate with flushing hydrants.
- 1.2.8 Road distances between hydrants shall not exceed 1,000 feet for single family residential developments and 500 feet for multi-family residential and commercial developments. Local fire codes, such as those requiring hydrant placement within 100 feet of a fire

sprinkler system Siamese connection or within 500 feet of the farthest commercial building corner, may require reduced hydrant spacing and should be investigated.

- 1.2.9 Hydrants shall typically be placed at intersections, ends of cul-de-sacs and on property corners.
- 1.2.10 Road distances between valves shall not exceed 1,000 feet, with the number of main line valves located at intersections and immediately adjacent fire hydrants being maximized. If space is limited, specify the use of Foster adaptor couplings to eliminate the need for long spool pipe pieces between fittings and valves. Valves shall not be placed in curbing.
- 1.2.11 All water services and hydrants shall be at right angles to the main, except where required by SCPW to avoid taps and fittings under paved areas.
- 1.2.12 Single services shall be located in the middle of each lot, with the exception of those services to be placed on property corners shared by the lot owner and an open space. Double services shall be placed on property corners, including those corners shared with a hydrant.
- 1.2.13 Single services shall be a minimum 1 inch diameter pipe, and shall be installed inside 2 inch diameter Schedule 40 PVC casing under all roads. Double services shall be a minimum 1 inch diameter pipe split into two 1 inch services. Double services shall also be installed inside 2 inch Schedule 40 PVC casing under roads.
- 1.2.14 The maximum water service length shall be 65 feet without prior written approval.
- 1.2.15 Fire line services shall be 65 feet maximum, distance between the main and backflow device, to limit "dead water" zones. If allowed within structures, the backflow device must be installed horizontally and adjacent an exterior wall.
- 1.2.16 Water piping shall have a minimum 3 feet and maximum 5 feet of cover, except where deflected under or over obstructions using bends. The individual deflection locations should be denoted on the plans and profiles.

- 1.2.17** Ductile iron pipe shall be placed under all roads and ditches where 3 feet of cover is not attainable. Ductile iron pipe shall also be installed between all bends associated with a vertical deflection.
- 1.2.18** Horizontal separation between any water pipe and gravity or force main wastewater pipe shall be a minimum of 10 feet, measured edge to edge. In cases where it is not practical to maintain 10 feet separation, a deviation may be allowed for separation from a gravity wastewater pipe on a case-by-case basis, subject to SCPW's and SCDHEC's approvals. Such deviation may allow the installation of the water pipe closer to a gravity wastewater 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 18 inches minimum above the top of the wastewater pipe.
- 1.2.19** Horizontal separation between any water pipe and storm drain pipe shall be a minimum 18 inches, measured edge to edge. Consideration should be taken with regard to service and main taps that may not be feasible due to the proximity of the water main to the storm drain piping.
- 1.2.20** Water pipes crossing wastewater pipes shall be installed to provide a minimum vertical distance of 18 inches between the bottom of the higher pipe and top of the lower pipe. Where practical, water pipes shall be installed over wastewater pipes. Regardless, at the crossing the water pipe must be constructed with one full length of ductile iron pipe and the waste water pipe must be constructed with one full length of C900 PVC sewer pipe. Otherwise, the pipes may be PVC installed inside 20 feet of steel casing. The joints of both pipes shall be as far from the crossing as possible. Special structural support for the pipes may be required.
- 1.2.21** Hydrant drains and air release valves shall not be connected to or located within ten feet of wastewater or storm drain systems. Similarly, no water main or service shall pass through or come in contact with any part of a wastewater manhole or storm drain structure.

- 1.2.22** There shall be no connections between the distribution system and any pipe, pump, hydrant or tank whereby unsafe water or other source of contaminate material may be discharged or drawn into the system.
- 1.2.23** All water main and service piping should be located outside of contaminated areas. Where it is necessary to install water piping across a contaminated site, prior approval must be granted by SCPW and SCDHEC and the pipe and gasket materials must protect the water system from being contaminated.
- 1.2.24** Water lines shall not be installed less than 25 feet horizontally from any portion of a wastewater tile-field or spray field, without being properly protected and approved in advance by SCPW and SCDHEC.
- 1.2.25** The diameter of all wet tap connections shall be a maximum of seventy five percent of the diameter of the existing main. In cases where the new main is equal to or larger than the diameter of the existing main, a tee must be cut into the existing main with a valve installed on the new branch. Also, if the existing main does not contain a valve within 500 feet of the proposed tap, SCPW may require additional valves for directional flushing purposes.
- 1.2.26** Air release valves shall be installed at high points in water mains to allow air to be vented from the water system. Air release valves shall not be installed in areas subject to flooding.
- 1.2.27** The use of 90 degree bends should be kept to a minimum, with the exception of those located adjacent to hydrants at the ends of cul-de-sacs.
- 1.2.28** Any strainers required on fire systems shall be the responsibility of the owner/developer.

1.3 STANDARD CONSTRUCTION NOTES

The following are the minimal construction notes required to be added to each set of design drawings.

- 1.3.1 All materials and installation procedures must meet the requirements of Summerville CPW, SCDHEC and the manufacturer.
- 1.3.2 Construction of the water system shall not be initiated until the final site grades have been established (+/- 0.5 foot). A letter from the design engineer stating that this condition has been met should be obtained by the water main contractor prior to starting construction.
- 1.3.3 The Developer shall be aware that any water system relocations necessary to accommodate the development will be performed at the Developer's expense (i.e. service relocations to accommodate driveways).
- 1.3.4 Six inch wide, blue metallic warning tape shall be placed 18 inches above all water mains and services. Number twelve (#12) solid strand, copper wire with blue insulation shall be taped (every 5 feet max.) to the top of all water mains and services. Each wire shall terminate at a valve, hydrant or curb stop.
- 1.3.5 In locations where the wastewater system is designed to have less than 5.5 feet of cover, the water main shall be installed with a full joint of ductile iron pipe and the sewer main shall be installed with a full joint of C900 PVC sewer pipe, centered at the pipe intersections.
- 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 water lines shall have 3 feet minimum cover and 5 feet maximum cover, except where bends are used to deflect the lines above or below conflicts.
- 1.3.8 SCPW must be provided with a complete water system as-built prior to the final inspection being scheduled.
- 1.3.9 Water system appurtenances are drawn out of scale for clarity. Wherever possible, valves and fittings should be installed as close together as practical.

- 1.3.10** All water main and wastewater or storm drain pipe crossings shall have 18 inches minimum vertical separation. Otherwise, a joint of ductile iron pipe will be required on the water pipe and a joint of C900 PVC sewer pipe will be required on the wastewater pipe centered at the crossing. Casing may be required on a case by case basis.
- 1.3.11** Water main pressure test results and bacteriological testing results are good for a period of 30 days from the date they were conducted. If the submittal for the permit to operate has not been sent to SCDHEC prior to this period expiring, retesting of the system will be required.

PART 2 - CONSTRUCTION STANDARDS

The following standards shall be followed in the construction of all water distribution systems within the SCPW water service area.

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 water pipes, fittings, detection wire, warning tape, backflow prevention devices, valves, boxes, check valves, air release valves, fire hydrants, flushing hydrants, 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 the manufacturers' recommendations.

2.2 Construction Materials

All materials or products which come into contact with the drinking water shall be certified as meeting the specifications of the American National Standard Institute/National Sanitation Foundation Standard 61, "Drinking Water System Components - Health Effects" and NSF 372, "Drinking Water System Components - Lead Content". The certifying party for ANSI/NSF Standards 61 and 372 must be accredited by ANSI/NSF. Where ANSI, ASTM and NSF standards are cited, it is inferred to mean the latest version shall take precedence.

Water pipes, valves and appurtenances shall be of the type, size, class and diameter as shown on the plans and as stated below. All

water pipe material, solder and flux shall be lead free (less than 0.2 percent lead in solder and flux, and less than a weighted average of 0.25 percent in pipes and fittings).

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 pipe sizes within the SCPW service area: 1 inch, 2 inch, 4 inch, 6 inch, 8 inch, 10 inch, 12 inch, 16 inch and 24 inch. No other pipe sizes will be allowed without prior approval.

Water pipes 4 inches in diameter and larger shall be manufactured using polyvinylchloride (PVC) or ductile iron (DI). Water pipes 2 inches in diameter and larger shall be manufactured using polyvinylchloride (PVC), polyethylene (PE) or ductile iron (DI). One inch diameter water pipes shall be manufactured using polyethylene (PE). All water pipes shall bear the National Sanitation Foundation Seal of Approval. DI or PVC water pipes 2 inches in diameter and larger shall have push on, integral bell joints with rubber gasket seals, with the exception of 2 inch diameter PVC glue joint pipe required through bored casing. One and two inch diameter PE water pipes shall be continuous, joint free lengths terminating with compression fittings at the corporations and curb stops. Provisions shall be made to allow for pipe expansion and contraction. Laying lengths for push on, bell joint pipes shall be 18-20 feet, except where necessary to install water main fittings and appurtenances. All pipes shall be installed in strict accordance with the manufacturers' instructions.

PVC water pipe shall be Type I, Grade I conforming to ASTM D2241, D1784, D3139, F477 and made from clean, virgin materials. PVC water pipe 2 inches in diameter shall be Schedule 40 (ASTM D1785). Water pipe 4 inches in diameter and larger shall be SDR 18, Class 235 conforming to AWWA C900. For 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).

One and two inch diameter water pipe shall be made of premium quality, high grade PE-4710 resin. The pipe shall be SIDR 7, Class 200 iron pipe size tubing meeting AWWA C901 and ASTM D2239. The exterior of the service pipe shall be solid blue in color. Preferred manufacturers are Charter (Blue Ice), Endot (Endopure) and Silverline (Ultra-Pure).

Push-on and flanged joint DI water pipe, unless otherwise noted, shall be Class 51 for pipes 4 inches in diameter and Pressure Class 350 for pipes 6 inches in diameter and larger. All DI water 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. Cement mortar linings shall comply with ANSI/AWWA A21.4/C104. DI pipe interiors and exteriors shall be coated with a minimum 1 mil thick asphaltic paint per ANSI/AWWA A21.51/C151.

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 water pipe may be required by the Engineer, SCPW and/or as noted on the plans. Preferred manufacturers of restrained joint, DI water 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 water 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.

2.2.2 Valves

One inch diameter water service lines are required to have a corporation at the main and curb stop at the meter. These two valves shall be brass ball valves pressure rated at 300 psi minimum and constructed in accordance with AWWA C800-89. The ball of the valve shall be coated with a fluorocarbon and supported by two EPDM seat gaskets.

Ball valves used as corporations shall be 1 inch diameter and constructed with male "CC" (tapered) threads on one end and a Mueller (H15073) Instatite or Ford (C06-44-U) Ultra-Tite fitting on the other. The preferred manufacturers are Ford (FB600-4-LN), McDonald (4701BL) and Mueller (B25005).

Ball valves used as curb stops shall be 1 inch diameter and constructed with female iron pipe size threads on each end and a lock-wing, tee head. Curb stops shall connect to 1 inch diameter iron pipe size PE water service pipe by means of a Mueller (H15426) Instatite or Ford (C86-44-U) Ultra-Tite fitting. The preferred manufacturers are Ford (B11444W), McDonald (6101W) and Mueller (20200, full port).

Gate valves shall be installed on pipes 2 inches to 12 inches in diameter. Unless otherwise specified and approved, gate valves shall be mechanical joint, resilient seat, wedge type valves with ASTM A126 cast iron or ASTM A536 ductile iron bodies and bonnets, 2 inch square cast or ductile iron operating nuts (located 4 feet maximum below the ground surface), non-rising ASTM B138 bronze or 304/400 stainless steel stems, triple O-ring stem seals and 304 stainless steel hardware. The wedge shall be fully encapsulated with molded EPDM 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 conform to AWWA C509 and/or C515 with a minimum 250 psi pressure rating. Valves shall open when the operating nuts are rotated in a counterclockwise/left direction. Each valve shall be

equipped with an approved valve box and concrete collar. The preferred manufacturers are American AVK (45 or 25), American Flow Control (2500), Clow (2639-F6100 or 2640-F6100), Mueller (A-2360-23) or US Pipe Valve & Hydrant (A-USP1).

Butterfly valves shall be installed on pipes 16 inches in diameter and larger. Unless otherwise specified and approved, butterfly valves shall be non-rising stem, mechanical joint, resilient seat type valves supplied with a square operating nut located a maximum of 4 feet below the ground surface. Valves shall open when the operating nuts are rotated in a counterclockwise/left direction. The assemblies shall include ASTM A126 cast iron or ASTM A536 ductile iron bodies, cast or ductile iron discs/vanes with 304 stainless steel edges, 304 stainless steel shafts, EPDM rubber seats secured to the bodies, 304 stainless steel bearings and 304 stainless steel hardware. The bodies and discs/vanes shall be fusion bonded epoxy coated (8 mils min). Butterfly valves shall be pressure class 250B minimum and conform to AWWA C504. Each valve shall be equipped with an approved valve box and concrete collar. Preferred manufacturers are Clow (4500), Crispin K-Flo (500 & 47), Mueller (Linesal XPII 5227-20), Pratt (HP 250II) and Valmatic (2000).

Air release valves shall be installed at high points in the water 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 epoxy powder coated steel body and clamping flange, 316 stainless steel hardware, ball valve and float spindle, and Delrin 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 H-Tec (986).

Valve boxes and drop lids shall be 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 3-1/2 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. "WATER" 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 inside diameter shall be 2 inches larger than the valve box top section, with a minimum outside diameter of 16 inches and a minimum concrete thickness of 2 inches throughout.

2.2.3 Hydrants

Fire hydrants shall comply with AWWA C502 standards for "dry barrel", compression type hydrants that open against pressure and have a minimum pressure rating of 250 psi. The boot or shoe shall have a minimum 6 inch diameter mechanical joint inlet. The main valve opening shall be 5.25 inches in diameter. Each hydrant shall have a traffic "breakaway" feature utilizing a two-part breakable flange and safety stem coupling. The nozzle section shall be permitted to rotate a full 360 degrees. Hydrants must be designed to permit removal of all working parts up through the barrel without excavation or disassembling the nozzle section.

The upper body or nozzle section shall consist of two 2.5 inch diameter hose nozzles and one 4.5 inch diameter pumper nozzle. The bonnet, weather cap, nozzle section, lower barrel, shoe/base and nozzle caps shall be manufactured with ASTM A126 Class B cast or ASTM A536 ductile iron. Nozzle threads shall be ASTM B584 bronze with mechanical removal features, set screws, lock rings, etc. and must conform to existing national standard specifications and ANSI B26. No cap chains shall be included.

The interiors of the nozzle section, lower barrel and shoe/base shall be coated a minimum of 6 mils thick with a two part thermosetting epoxy or polyurethane conforming to AWWA C550, excluding those manufacturers utilizing standard ductile iron pipe joints as the lower barrel. Coatings shall be non-toxic, impart no taste to water and protect all seating and adjacent surfaces from corrosion, scale buildup and tuberculation. Manufacturers utilizing ductile iron pipe sections for the lower barrel must utilize ductile iron pipe and coatings specified in the pipe section (2.2.1 Pipe) of these specifications.

Field application of coatings to the exterior of the nozzle section and lower barrel shall consist of a minimum two coats of yellow (B55Y300), high gloss, Sherwin Williams KEM 4000 acrylic alkyd enamel. Field application of coatings to the bonnet, weather shield and nozzle caps shall be the same as the nozzle section, except the color shall be white (B55W311). The exterior of the shoe/boot shall match that of the boot interior as described above. No paint shall be applied to the operating nut, weather cap or reservoir filler plug.

The hydrant shall be provided with a double O-ring sealed grease or oil reservoir that automatically lubricates all operating stem threads and bearing surfaces each time of operation. The lubrication chamber is to have an external filler point to avoid dismantling any portion of the hydrant during regular maintenance. The stem design will incorporate anti-friction bearings to ease operation. An outside weather cap is required. The entire system shall be completely sealed from the waterway and external contaminants with NBR/Buna-N rubber gaskets.

The operating nut, dual drain ring and nozzle threads shall be cast from ASTM B584 bronze. Stems/rods shall be manufactured from 304 or 410 stainless steel. Traffic breakaway stem/rod couplings shall be fusion bonded epoxy coated cast iron or 304 or 410 stainless steel. All interior and exterior hardware (nuts, bolts, pins, etc) shall be type 304 stainless steel.

The valve shall be constructed with a dual bronze, fast closing barrel drain, bronze, cast or ductile iron upper and lower plates and a rubber main valve.

Hydrants shall open left in a counterclockwise direction. The hydrant opening direction shall be cast on the outer casing of the hydrant. Castings shall also indicate the hydrant type, design, manufacturer's name and the date manufactured.

Copies of AWWA certified flow standards must be made available. Preferred manufacturers are American AVK (Nostalgic 2780), American Flow Control (B-84-B-5), Clow (Medallion) and Mueller (Super Centurion 250 A423).

Hydrants must be equipped with an Assured Flow Sales GradeLoc.

Flushing hydrants shall comply with AWWA C502 standards for "dry barrel", compression type hydrants that open against pressure. Hydrants shall be rated at 150 psi. They shall meet all the requirements of fire hydrants regarding operating nuts, stems, working parts, painting, coatings, nozzles, stem design, full 360 degree rotation, body castings, and repairs without dismantling. Flushing hydrants shall be equipped with one 2 inch diameter national pipe inlet and one 2.5 inch diameter removable flushing nozzle and cap. Flushing hydrants shall be installed above ground. Preferred manufacturers are Kupferle (Eclipse 2) and Mueller (A411).

2.2.4 Gaskets And Lubricants

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

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

Gasket lubricants shall be non-petroleum based, insoluble in cold water and non-toxic. They shall not support the growth of bacteria, nor impart taste or odor to the water. They shall not contain detergents, soaps, organic solvents or other deleterious ingredients, nor have deteriorating effects on the gasket. 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.

2.2.5 Taps

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

Service saddles for taps 2 inch in diameter and smaller shall comply with AWWA C800 and have minimum pressure ratings of 250 psi. Saddles for taps smaller than 2 inches in diameter

are to be used in conjunction with corporations (ball valves), having "CC" threads. Saddles for 2 inch diameter taps shall be used in conjunction with a 2 inch diameter brass nipple and a 2 inch diameter gate valve, each having national pipe threads. All service saddles shall consist of a NSF approved, epoxy, nylon or fusion plastic coated ductile iron (ASTM A536) body and 304 stainless steel double straps with matching nuts and washers. A 3 inch minimum width, 304 stainless steel, single strap saddle may also be used. The seal between the tapping saddle and the water main shall be accomplished with an O-ring, SBR or NBR rubber gasket attached to the body of the saddle in a controlled groove to prevent creep and possible seal blowout. Preferred manufacturers are Cascade (CNS2, CS12, CS22), JCM (406), Mueller (DR2S), Romac (202NS) and Smith-Blair (317). Service taps shall not be installed on mains less than 1 inch in diameter larger than the proposed service pipe.

Tapping sleeves rated at 250 psi are required for taps larger than 2 inches in diameter. Tapping sleeves shall be used in conjunction with resilient seat tapping 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).

2.2.6 Fittings

Residential water service fittings shall be domestically manufactured and constructed of heavy, "no-lead" brass conforming to ANSI B16.15, ASTM B62, AWWA C800, and ANSI/NSF 61 and 372. Connections to 1 inch diameter iron pipe size PE tubing shall be made using Mueller "Instatite" or Ford "Ultra-Tite" connections. 1 inch double service tees shall be installed where required using a brass tee with all branches having female iron pipe size threads. All service fittings shall have pressure ratings above 150 psi. Preferred manufacturers are Matco Norca, Merit, and Lee.

Commercial water service fittings to be used in conjunction with 2 inch diameter Schedule 40 PVC pipe shall be pressure rated at 200 psi. The fittings shall be manufactured from ASTM A536 ductile iron with deep bells, ASTM D3139 push on joints, and SBR rubber gaskets conforming to ASTM F477 or they shall be threaded ASTM B584 bronze. The preferred manufacturer is Harco.

Water main fittings for pipes larger than 2 inches in diameter shall be ductile iron, mechanical joint type, fusion bonded epoxy coated (4 mils minimum) fittings pressure rated at 350 psi. Fittings shall conform to ANSI/AWWA A21.4/C104, A21.11/C111, A21.16/C116, A21.51/C151 and A21.53/C153. Preferred manufacturers are American, Star, Tyler/Union, and US Pipe.

Restraining flanges shall be used at all mechanical joint fittings. The flange assembly shall have a minimum 150 psi pressure rating and fusion bonded epoxy coated (4 mils minimum). The flanges shall be constructed of ASTM A536 ductile iron. Wedges and rings shall be matching ductile iron or stainless steel. Wedge bolts shall be 3/4 inch minimum diameter.

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 "TUFgrip" (1000TLD-DIP, 1500TDW-DIP & PVC, 2000TLP-PVC), and US Pipe "MJ Field Lok" (DI, PV). 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 fusion bonded epoxy coated (4 mils 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. The restraining rods and 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).

2.2.7 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 blue in color. For all other pipe sizes the encasement shall be blue if available, otherwise black will suffice. The preferred manufacturers are AA Thread, FE Fulton, Infinity Plastics, Repcor and Trumbull.

2.2.8 Steel Casing, Casing Spacers and Casing End Seals

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 a brick and mortar bulkhead.

2.2.9 Tracer Wire and Warning Tape

Tracer wire shall be 12 gauge, solid strand, polyethylene insulated copper wire or copper clad carbon steel wire meeting the National Electrical Code standards for Type USE-2 per UL 854 and UL 44 for direct bury cables. The insulation shall be blue in color.

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, blue in color and denote "Water Main Below" in black letters.

2.2.10 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.

2.3 Execution

All work shall be conducted in accordance with the plans, specifications and the latest version of the OSHA safety standards set forth in the Federal Register. The Contractor shall be responsible for all safety precautions and programs coinciding with the work. It shall also be the Contractor's responsibility to comply with all applicable laws, ordinances, rules, regulations, and orders of any public body having jurisdiction for the safety of persons or property, and to protect employees, persons and property from damage, injury, or loss. All necessary safeguards for such safety and protection shall be erected by the Contractor. The Contractor's duties and responsibilities for the safety and protection of the work shall continue until such time as all the work is completed and accepted by the Engineer and SCPW. The Contractor shall notify the SCPW and responsible parties for 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 provide 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 applicable 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 that new water easements are a minimum of 7.5 feet wide on each side of water mains, services and appurtenances.

The entire right-of-way or easement shall be cleared and grubbed per all applicable documents, plans, permits, etc. All 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

Water system installations shall not be initiated until the final site grades have been established (+/- 0.5 foot). A letter from the design engineer stating that this condition has been met should be obtained by the water main contractor prior to starting construction. Installation of water mains, service pipes and appurtenances shall be in accordance with the alignment and grades shown on the approved plans. Water pipes shall have a minimum depth of cover of 3 feet and maximum depth of 5 feet of cover, measured from the top of pipe to the finished grade of the land. Depths over 5 feet may be acceptable at pipe locations where deflections under conflict crossing occur.

Mechanical joint bends shall be used to traverse sharp curves and sudden changes in depth. All fittings 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. The Contractor is responsible for becoming familiar with the kind and extent of various materials which will be encountered in the excavation, and shall complete all excavations regardless of the type of material encountered.

The minimum trench width shall be 2 feet wider than the outside diameter of the water main 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 as a result of excessively wide trenches. The bottom of the trench shall be excavated to provide a level cross section along the bottom of the pipe, and vertical sides shall extend to 12 inches above the top of the pipe.

If the trench is incidentally excavated below the required grade, the over excavation shall be backfilled as necessary to the proposed grade with #57 granite or crushed concrete.

2.3.4 Bedding

The bottom of the trench shall be excavated uniformly, smooth and free from stones, roots and foreign material greater than 3/4 inch in diameter. Typically, loose soil left by the excavator will suffice as bedding. However, #57 granite or crushed concrete may be required to provide support along the pipe barrel as directed by the Engineer, SCPW and/or depending on soil conditions. If the soil is wet and/or hard, a minimum thickness of 6 inches of bedding shall be required. If soil unsuitable for proper support of 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 in 6 inch lifts. Bell holes must be dug to prevent bearing on the bells. All fittings and valves must have 6 inches of #57 granite/crushed concrete or concrete blocks for bedding.

2.3.5 Dewatering

No pipe, fittings, blocking 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. However, all precautions shall be taken to prevent erosion, damage to adjacent property, traffic hazards, drainage system disruption, etc.

2.3.6 Backfill

The backfill material in 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 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

size 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 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. The pipe shall be fully covered with a tarp any time it is being transported. It shall be stacked and stored such that the bell ends overhang and the barrel of the pipe is supported uniformly and evenly. Pipe shall be unloaded and transported at the job site with proper equipment or manually handling each joint. At no time should the pipe be dropped from, or rolled off, any transportation vehicle or equipment. All stockpiled pipe shall not remain located outside in the elements for more than thirty days without being fully covered by a tarp.

The Contractor shall provide and use proper implements, tools and facilities for the safe and proper execution of the work. All pipe, fittings 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.

Every pipe, fitting, and appurtenance shall be inspected for possible damage and defects. Damaged and unacceptable materials must be removed from the job site. All lumps, blisters and excess coal tar or epoxy 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 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. Each cut shall be beveled in accordance with the manufacturer's recommendations. The bevel shall match that of the manufacturer's 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 of all oil, grease and foreign material. 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 uniformly so that the pressure on the gasket is evenly distributed. 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 joint and the exterior of the spigot end of the pipe shall be thoroughly cleaned of all oil, grease and foreign substances. Pipe shall be joined in accordance with the individual manufacturer's recommendations. The Contractor shall provide all tools and devices, such as special jacks, chokers, and similar items required for proper installation. Lubricant for the pipe gaskets shall meet the requirements of the manufacturer and these specifications.

The maximum permissible deflection at joints shall not exceed the manufacturer's recommendations or the maximum allowed by AWWA C600. Each 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 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).

Water service pipe to be maintained by SCPW shall be a minimum of 3 feet deep, and laid on solid ground. Services shall be installed in casing under roads. All other requirements regarding bedding, backfill and separation from sewer mains shall meet the same specifications as for water mains detailed above.

2.3.10 Valve Installation

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 installing backfill. A minimum thickness of 6 inches of bedding stone or a solid concrete block is required under valves. Care shall be taken to insure that no soil, rock or other obstacles that would interfere with the valve's operation are left in the valve. All valves shall be installed plumb and restrained in accordance with these specifications.

Valve boxes are to be centered over the valve's operating nut and perpendicular to the ground surface. A spool piece of 6 inch diameter PVC water pipe shall be used to span the gap between the valve box and the valve in cases where the valve box is insufficient in length to reach from the ground surface to the operating nut. Under no circumstances shall the PVC riser pipe or valve box be in contact with the valve to prevent the possibility of 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. Where extensions are required, they shall be equipped with a centering ring 1 inch in diameter smaller than the pipe supporting the valve box over the valve and a set screw to affix the extension to the operating nut of the valve. Valve extension stems shall be installed by the Contractor at no additional cost to SCPW.

Air release valves shall be installed per the manufacturer's recommendations. They shall be installed inside a 4 feet diameter manhole section, or a built-in-place masonry vault, with no base. The manhole is to rest on a bed of 1 foot thick, free draining, bedding stone.

2.3.11 Fire and Flushing Hydrant Installations

Hydrants shall be installed where indicated on the plans (preferably on a property line). Hydrants shall be carefully handled, cleaned and checked for operation prior to installing backfill. A minimum of 6 inches of bedding stone, or a solid concrete block, is required under the hydrant boot/shoe. Seven cubic feet of bedding stone is also required as backfill around the hydrant boot/shoe to allow the hydrant to properly drain through the weep holes. Care shall be taken to insure that no soil, rock or other obstacles that would interfere with the operation are left in the hydrant.

The hydrant shall be installed plumb and restrained according to these specifications. The safety or breakaway flange shall be installed above ground, but no more than 3 inches above grade.

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 mains and services. Number twelve (#12) solid strand copper wire with blue insulation shall be taped (every 5 feet max.) to the top of all water mains and services. Each wire shall terminate at a valve, hydrant, or curb stop. Continuous runs, utilizing wire "looping", is preferred.

2.3.14 Restraining Pipe, Valves, Hydrants and Fittings

At locations where unbalanced forces existing in pipes, valves, hydrants, fittings and other appurtenances, the system shall be securely anchored using restrained joint pipe lengths and fittings. The use of concrete thrust blocking will be considered by SCPW on a case-by-case basis and must be approved in writing. Regardless of the type of restraining chosen, valves, hydrants and fittings shall have mechanical joints and shall be installed with restraining flanges.

All valves, hydrants and fittings shall be installed on a bed of 6 inch thick stone or a solid concrete block. There shall be a 10 foot minimum continuous section of "bell-free" pipe on each side of a fitting.

Concrete thrust blocking shall be sized and installed as shown on the plans, 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. In these situations, the

amount of concrete blocking must be double the typical amount.

Restrained joint pipe shall be installed per the manufacturer's recommendations. See the appendix of 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 shall be given the opportunity to inspect all restraining prior to backfill.

2.3.15 Wet-Tap Connections

All 2 inch diameter and larger taps shall be made by the contractor under the direct observation, or in most cases, with direct participation of SCPW personnel. Tapping sleeves/saddles and valves shall be furnished, installed and air pressure tested to 100 psi for 15 minutes by the Contractor. Afterward, SCPW will make the tap into the main (with the reserved potential of an expense to the Contractor).

Two inch and smaller connections shall be constructed in whole by SCPW, with the cost for such connections collected as part of the water connection fees.

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. brick bulkheads are required at each end of the casing. Only restrained joint ductile iron pipe shall be installed inside of the casing.

2.3.17 Disinfection

Before any potable water main is placed into service, it shall be flushed clear of any soil or debris and disinfected with chlorine or calcium hypochlorite. Flushing must be approved by SCPW in advance, and SCPW reserves the right to

charge for the water consumed. The sterilizing solution shall be introduced at one end of the main as water is slowly being withdrawn from the other end and all stub outs. The solution shall be introduced such that 50 ppm of free chlorine exists throughout the main. The solution shall remain in the main for a minimum of 24 hours. The water shall have a minimum residual chlorine concentration of 25 ppm at the end of the 24 hour period, or the disinfection process shall be repeated.

After the required 25 ppm chlorine residual is achieved, the main shall be completely purged and re-filled from the existing water system. A minimum of two water sample sites shall be identified by the Contractor, with the assistance of SCPW personnel. The number of sites will depend on the length of the main (one sample per 1,500 feet of main minimum) and must include all dead-end mains. At each location a standard water spigot is to be installed. A minimum of two consecutive water samples must be collected from each site and analyzed by a SCDHEC approved laboratory.

The first sample must be collected 24 hours minimum after the main is thoroughly flushed. The second sample shall be collected a minimum of 24 hours after the first sample. No flushing, other than the running of a single 5/8 inch diameter hose near each sample site, shall be allowed during the sampling period. As each sample is collected, the chlorine residual must be measured and recorded at the time the sample is taken.

The samples are to be absent of total coliform bacteria. If the membrane filter method is used for the coliform analyses, non-coliform growth must also be reported. If the non-coliform growth is greater than 80 colonies per 100 milliliters, the sample results are invalid and must be repeated from all sample sites until consecutive samples pass.

SCPW will verify the Contractor's samples with a confirmation sample being collected from each sample site. If SCPW has two consecutive samples with positive bacteriological growth, the disinfection and/or sampling process shall be repeated. The Contractor shall furnish all necessary pipe, hose extensions or transportation to the sampling sites, and shall exercise care in the use of water. The Contractor shall bear all costs for bacteriological testing.

All chemicals/products added to the public water supply shall be third party certified as meeting the specifications of ANSI/NSF 60.

2.3.18 Testing and Inspection

No final pressure tests or inspections will be scheduled until all the requirements in "SECTION I, PART 3, STEP 4" of SCPW's "General Project Requirements" have been satisfied.

Continuity testing shall be conducted on the tracer wire installed in conjunction with the water main. Testing results shall be provided to SCPW's field representative.

The mains, services, hydrants, valves, fittings and appurtenances shall be subjected to and must successfully meet a pressure test conforming to AWWA C600 for DI pipe and AWWA C605 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 to allow all air to be evacuated through the air release valves, hydrants, and services. A suitable test pump and pressure gauge, furnished by the Contractor, shall be connected to the system by means of a service tap or hydrant connection, and the required test pressure shall be slowly applied to the system. The test pressure shall be maintained for two hours. The pressure gauge shall be glycerin filled with a minimum 3 inch diameter face, 5 psi maximum gradations and 200 psi maximum pressure.

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.

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 meets SCPW's criteria of allowing only half the allowable leakage)

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.

The first pressure test and final inspection shall be at no cost to the contractor. However, a \$100 per hour charge may be required to be paid for subsequent tests and inspections, if necessary and prior to acceptance of the system. The pressure test is good for a period of 30 days from the date it was conducted. If the submittal for the permit to operate has not been sent to SCDHEC prior to this period expiring, retesting of the system will be required.