

SECTION 3.0

DESIGN CONSIDERATIONS FOR WATER SYSTEM EXTENSIONS

3.1 GENERAL

The intent of this section is to provide the Developer or Engineer with Guidelines which will assist in the development of Contract Documents for water system extensions for which acceptance by the Commission will be sought. As a minimum, the Contract Documents for any proposed extension must address satisfactorily the topics contained herein.

3.2 LOCATION AND ALIGNMENT

3.2.1 Depth of Cover

Water mains shall be designed to provide a cover of no less than three feet (3') but no more than five feet (5') as measured from the top (crown) of the pipe to the finished grade. Where this requirement cannot be met due to unavoidable conflicts in grade, the Department Engineer shall be consulted so that a solution acceptable to the Commission may be determined. If, in the opinion of the Department Engineer, conditions warrant greater or lesser depths of cover than that required above, special measures, such as the use of ductile iron pipe for shallow installations, or additional easement widths for deeper installations may be required by the Commission.

3.2.2 Relationship of Mains to Property Lines, Rights-of-Way and Structures

All water mains shall be located within dedicated street rights-of-way or permanent water main easements such that the Commission's maintenance and repair forces have unrestricted access to the line and all appurtenances thereof.

3.2.2.1 Water mains shall be centered in a permanent easement of adequate width to allow excavation and maintenance of the line. In no case shall the permanent easement for water mains be narrower than that given by the table below.

Pipe Diameter	Minimum Easement
Less than 12"	10'
12" - 24"	15'
Greater than 24"	20'

3.2.2.2 Under certain conditions, the Department Engineer may require such additional easement as deemed appropriate. Such easement shall be centered on the water main unless directed otherwise by the Commission.

3.2.2.3 Approval of water main extension plans shall be contingent upon the procurement of all easements necessary to meet the above requirements and upon the execution of an encroachment agreement with the owner of each right-of-way which the proposed main will cross. See Section 5.7 for the requirements for submission of easement documents.

3.2.2.4 Water mains shall be located no closer than ten feet (10') horizontally to buildings or substantial surface structures.

3.2.3 Relationship of Water Mains to Sanitary Sewers

3.2.3.1 Water mains shall be laid at least ten feet (10') laterally from existing or proposed sewers, unless local conditions or barriers prevent a ten foot (10') lateral separation, in which case:

3.2.3.1.1 The water main is laid in a separate trench with the elevation of the bottom of the water main at least eighteen inches (18") above the top of the sewer; or

3.2.3.1.2 The water main is laid in the same trench as the sewer with the water main located at one side on a bench of undisturbed earth, and with the elevation of the bottom of the water main at least eighteen inches (18") above the top of the sewer.

3.2.3.2 Whenever it is necessary for a water main to cross over a sewer, the water main shall be laid at such an elevation that the bottom of the water main is at least eighteen inches (18") above the top of the sewer, unless local conditions or barriers prevent an eighteen inch (18") vertical separation; in which case both the water main and the sewer shall be constructed of ferrous materials and with joints which are equivalent to water main standards for a distance of ten feet (10') on each side of the point of crossing.

3.2.3.3 Whenever it is necessary for a water main to cross under a sewer, both the water main and the sewer shall be constructed of ferrous materials for a distance of ten feet (10') on each side of the point of crossing. A section of water main pipe shall be centered over the crossing.

3.2.4 Relationship of Water Mains to Storm Sewers

When underground structures or storm sewers are encountered, twelve inches (12") minimum vertical separation and five feet (5') minimum lateral separation shall be maintained. Water main and storm sewer crossings shall be constructed in accordance with the Standard Details.

3.2.5 Location Under Paved Areas

Water mains shall be located outside of proposed or existing paved areas except where required at intersections, cul-de-sacs, street crossings by water mains, other paved areas which must be crossed, or where structures or other obstacles make this impossible. When a new water main must be located under an existing or proposed paved area it shall have a minimum cover of three feet (3') as measured from the top of the pipe to the finished subgrade. Water mains proposed within paved areas should be designed to avoid parking spaces whenever possible. Water mains located in cul-de-sacs should be projected straight through, and the main should terminate at the property corner with the hydrant or blow off located on the property corner/right-of-way. If design of the cul-de-sac does not allow this, a 90° bend should be used to direct the main to a property corner, thereby allowing water services to be installed in accordance with Section 3.2.9.

3.2.6 Location of Fire Hydrants

3.2.6.1 Fire hydrants shall be installed with the back of the hydrant being located at the right-of-way line with preference being given to street intersections. In no case shall any portion of a hydrant be closer than five feet (5') to the back of the curb or two and one-half feet (2.5') to the backslope of a roadside ditch.

3.2.6.2 Hydrants shall be oriented so that the pumper nozzle faces the roadway and so that the nozzle centerline is a minimum of eighteen inches (18") and a maximum of twenty-four inches (24") above finished grade. See Standard Details.

3.2.6.3 Non-residential structures shall require fire hydrants to be located such that each structure or portion thereof will be within four hundred feet (400') of a hydrant. This determination shall be made via vehicle access routes (roadways, fire lanes, etc.) and by hose placement from the firefighting equipment in lieu of linear measurements.

Multi-family residency (apartments, townhouses, condominiums, etc.) shall require fire hydrants to be located such that each structure or portion thereof will be within four hundred feet (400') of a hydrant. This determination shall be made via vehicle access routes (roadways, fire lanes, etc.) and by hose placement from the firefighting equipment in lieu of linear measurements.

Residential subdivisions (one and two family dwellings) shall require fire hydrants to be located within four hundred feet (400') of the structure.

3.2.6.4 For any non-residential structure that has a fire sprinkler system or a standpipe system, a fire hydrant shall be no more than 100' from the fire department connection. This hydrant shall be dedicated to the fire department connection and shall be in addition to the hydrants required by Section 3.2.6.3. The hydrant shall be located on the supply side of the backflow prevention device.

3.2.6.5 Where possible, fire hydrants shall be located a minimum of fifty feet (50') from any structure.

- 3.2.6.6 For proposed subdivisions where the location of structures is not known, hydrant spacing shall be measured along the street right-of-way with spacing provided as shown in 3.2.6.3 above. Measurements across lots, which front on different streets, will not be permitted for purposes of satisfying hydrant spacing requirements.
- 3.2.6.7 Structures located on multi-lane streets or highways shall require fire hydrants located on the same side of the roadway as the structure. Multi-lane shall be defined as a street, highway, avenue, road or thoroughfare having four (4) or more lanes including the center turn lane.
- 3.2.6.8 In the case of a water main extension along streets with four (4) or more lanes, fire hydrants shall be required on both sides of the street or roadway in accordance with Section 3.2.6.3 above.
- 3.2.6.9 Dead end mains shall be provided with a hydrant when required by Section 3.2.10 of the Manual.
- 3.2.6.10 Each phase of a project shall be designed and constructed to provide the minimum number of hydrants necessary to conform with the North Carolina Fire Code (latest edition) upon completion of the phase.

Guidelines for determining the minimum number of hydrants as published in the North Carolina Fire Code, Appendix C are included in this Manual as Appendix B.

3.2.7 Location of Gate Valves

- 3.2.7.1 Each intersection of water mains shall have one less main valve than the number of intersecting pipes, i.e. crosses shall have three (3) main line valves, a tee intersection shall have two (2) main line valves. Valves shall not be located in the curb and gutter.
- 3.2.7.2 A proposed connection of a new water line to an existing water line shall include provisions for the addition of sufficient valves to the existing water line to meet the intent of Paragraph 3.2.7.1. If there are existing valves located in close proximity to the proposed connection, the Commission will not require that valves be added to the existing water line except in unusual circumstances.

- 3.2.7.3 Each fire hydrant shall have a hydrant branch valve in accordance with the Standard Details. Valves on a hydrant branch shall not be located in curb and gutter.
- 3.2.7.4 In addition to the valves required at tees, crosses, hydrants, etc., in-line valves shall be provided at intervals no greater than 1,500 feet unless otherwise approved by the Commission because of unusual circumstances.
- 3.2.7.5 Valve boxes shall be installed on all valves in accordance with Section 3.4.10 of this Manual and as shown in the Standard Details.

3.2.8 Location of Air Release Valves

- 3.2.8.1 Mains twelve inches (12") or larger in diameter, which have a change in elevation of fifteen feet (15') or greater, shall have an air release valve meeting the requirements of Section 7.8 of the Manual installed at the highest elevation of such change.
- 3.2.8.2 The Commission may also require air release valves in other instances where, in the opinion of the Department Engineer, the possibility of excess quantities of air accumulating in the proposed main exists.
- 3.2.8.3 See the Standard Details and Section 7.8 for requirements of the Commission regarding taps for air release valves.
- 3.2.8.4 Manual air release valves shall be installed in a standard meter box. Automatic air release valves shall be provided with a standard manhole.

3.2.9 Location of Services

- 3.2.9.1 Plans for projects which propose the creation of lots shall include the provision of water services to each lot, including any residual parcels and areas reserved for future lots. The size and location of services shall be based upon the anticipated use of the lot and require the

Commission's approval. The Commission may agree to waive its requirement that water services be installed to each lot within nonresidential subdivisions if there is insufficient information available to permit proper sizing of services and they can be conveniently installed by the Commission at the time service is requested.

- 3.2.9.2 Greenville Utilities Commission reserves the right to require individual water and sewer services to each building or tenant space.
- 3.2.9.3 Water meter boxes shall be set flush with the finished grade and located on the street right-of-way limit at the center of the lot for which service is installed, unless directed otherwise by the Commission or this Manual.
- 3.2.9.4 When project design dictates that electric cables are to be placed on the same side of the roadway with the sidewalk, the water meter box for that side shall be located six feet behind the edge of the sidewalk.
- 3.2.9.5 Water meter boxes shall not be located within driveways, sidewalks, or other paved areas subject to vehicular traffic unless approved otherwise by the Commission.
- 3.2.9.6 Water meter boxes shall not be installed within a ditch slope. Where the right-of-way limit for a street is within a ditch slope, the meter box shall be installed a minimum of 2.5 feet behind the top of the ditch bank.
- 3.2.9.7 Easement shall be provided for all water meter boxes not located in existing rights-of-way or easement.
- 3.2.9.8 Water services shall be located perpendicular to the main.
- 3.2.9.9 Plans should not propose the crossings of public and private utilities.

3.2.10 Location of Blow-Offs and Dead End Hydrants

- 3.2.10.1 Dead ends on mains six inches (6") in diameter or larger shall be provided with a standard fire hydrant at the terminal end. Materials and installation shall be as required by the Commission for standard fire hydrants.

3.2.10.2 Dead ends on mains four inches (4") and smaller in diameter shall be provided with a blow-off meeting the requirements of Section 7.4.2.2 of the Manual and the Standard Details.

3.2.10.3 All water lines shall be terminated in accordance with the Standard Details with blow-offs and hydrants located on property corners whenever possible.

3.2.11 Location Of Backflow Prevention Assemblies

The location of backflow prevention assemblies shall be in accordance with the requirements of the Terms and Conditions.

3.2.11.1 In general, all backflow prevention assemblies shall be located outside of the structure and before any branch connections to the private system, with preference being given to the property line/right of way, unless otherwise approved by the Commission.

3.2.11.2 Backflow assemblies shall be required for any application in which possible pollution or contamination of the public water supply system could result from a backflow cross-connection.

3.2.11.3 In accordance with the Terms and Conditions and the Rules Governing Public Water Supply Systems, the severity of the potential effects shall determine the minimum degree of protection required. The Commission will review each case on an individual basis.

3.3 SIZING OF WATER MAINS

3.3.1 General

Water mains are to be sized in accordance with this Manual and good engineering practice. The standards included herein are minimum standards.

The Engineer shall design the water distribution system based upon the available supply and the project needs.

3.3.2 Pressure Requirements

Water mains shall be sized so that a minimum residual pressure of 20 psi is obtained during peak demand plus fire flow. Where higher

pressures are required, it shall be the responsibility of the individual property owner to provide the necessary booster pumping facilities.

3.3.3 Fire Hydrants

All fire hydrants shall be installed on a six-inch (6") leg with a six-inch (6") hydrant branch valve.

3.3.4 Private Mains

Private mains shall be sized by the Engineer in accordance with Section 3.3.5 of this Manual. Backflow prevention shall be provided in accordance with Section 3.2.11 of this Manual.

3.3.5 Minimum Fire Flows

3.3.5.1 General

Unless otherwise required or permitted by the Commission, water distribution systems shall be designed to provide the fire flow required by the guidelines contained in this Section. The Commission's existing facilities may or may not be adequate to provide the required fire flow at the time of design and construction of the planned development; however, the Commission shall provide the Engineer with an estimated value for the system pressure at design fire flow available at the point where the planned development is to connect with the Commission's existing distribution system. This value may be based upon the actual system pressure available or calculation of the pressure which shall be available upon reinforcement of the existing system. The Developer or his Engineer shall provide the Commission with the value (subject to approval) of the design fire flow necessary to meet the requirements of this Section.

The value for design fire flow and supporting documentation shall be submitted with the preapplication package should the Commission require the submission of such a package (See Section 2.3). The design fire flow and supporting documentation shall also be submitted for approval with the design calculations as required by Section 5.2.

3.3.5.2 Fire Flow Conditions

Selection of the size of the water main for fire flow capacity shall be such that the main will deliver the discharge required by Section 3.3.5.3 and conform to the minimum sizing requirements of Section 3.3.5.4, as applicable, including the peak user demand of the development. A minimum residual pressure of 20 psi shall be available at all points of the planned distribution system at fire flow plus peak user demand.

3.3.5.3 Fire Flow Requirements for Buildings

Guidelines for determining residential peak user demand as published in the North Carolina Administrative Code, Title 15A, Subchapter 18C are included in this Manual as Appendix A.

Fire flows are dependent upon the type of construction, the total floor area of the buildings and other factors within a project. In order to provide an adequate design, developers should consult with the City of Greenville Fire/Rescue Department for required design criteria.

Guidelines for determining fire flow for all residential and non-residential buildings as published in the North Carolina Fire Code, Appendix B are included in this Manual as Appendix B.

3.3.5.3.1 Where buildings are separated by less than ten feet (10') between exterior walls, the minimum draft available to any hydrant serving the development shall be 1500 gallons per minute (gpm) plus peak user demand with a minimum residual pressure of 20 psi.

3.3.5.4 Non-Residential Areas

As a minimum, the recommendation of the Insurance Services Office shall be met. These recommendations include the following for non-residential developments.

- a. The minimum size main shall be 8-inch with 8-inch or larger intersecting mains in each street; 12-inch or larger mains shall be used on the principal streets and for all long lines that are not connected to other mains at intervals close enough for mutual support.
- b. Arrangements using very small mains, designed for domestic service only and incapable of providing fire protection supplied by larger mains in a gridiron too wide to provide good fire protection are considered unsatisfactory. The use of dead end 6-inch and smaller mains to provide fire protection shall be avoided.

3.4 INSTALLATION OF WATER MAINS AND APPURTENANCES

3.4.1 General

The Contract Documents for water system extensions shall insure that the following standards and performance requirements are met in regard to the installation of mains and all appurtenances thereof.

3.4.2 Construction Safety

The Contract Documents shall address the responsibility for the safety of the workmen and the general public. The Contractor shall be required to adhere to the requirements of the NCDOT and the City of Greenville with regard to traffic safety and traffic control devices. Additionally, the Contractor shall be required to perform all work in accordance with all applicable federal, state, and local laws. The Contract Documents shall state that the Commission has no responsibility for nor authority to enforce job safety requirements. The "Standard General Conditions of the Construction Contract" prepared by the Engineers Joint Contract Documents Committee may be used as a guideline for preparation of the Contract Documents.

3.4.3 Replacement of Damaged Facilities and Structures

The Engineer shall insure, through the Contract Documents, that all structures, pavements, utilities and other facilities which may be damaged as a result of project work are replaced or repaired in a manner which meets the approval of the owner of such facilities or any governing bodies having jurisdiction.

3.4.4 Connection to Commission Owned Facilities

Language shall be included in the Contract Documents which states that no connection to or alteration (including operation of valves, hydrants, etc.) of the Commission's facilities shall be performed without the Commission's specific approval. The Contract Documents shall require that all pipe, valves, taps, fittings, etc., which could possibly contaminate the Commission's facilities be thoroughly disinfected prior to their use. The Contract Documents shall also include a requirement to keep excavations for such connections completely dewatered and to use the utmost care to avoid contamination of Commission owned facilities.

3.4.5 Salvage of Commission Owned Facilities

When project work results in removal of Commission owned facilities and equipment, the Contractor shall be required to deliver those facilities or equipment undamaged to the Commission's Operations Center, if requested to do so by the Commission.

3.4.6 Water Main Construction and Excavation

3.4.6.1 Pipe installation shall be performed only in the presence of the Commission's Representative, except as authorized by the Commission.

3.4.6.2 The Contract Documents shall specifically address excavation, pipe foundation and bedding, pipe installation and haunching requirements. Satisfactory construction materials shall be identified and either construction methods or performance standards shall be specified. If standard references are cited in lieu of specific requirements, the Engineer shall furnish the Commission, at no cost, two (2) copies of the cited references, if requested to do so.

- 3.4.6.3 No deviation from the line and grade shown on the Approved Plans shall be permitted by the Contract Documents without the approval of the Commission. Any proposed deviation will require submission of revised Contract Documents to the Commission for review and approval.
- 3.4.6.4 Pipe cutting, where necessary and where permitted, shall be done in accordance with the written recommendations of the pipe manufacturer.
- 3.4.6.5 The Engineer shall require fittings at sufficient locations to minimize the possibility that pipe joint deflections will exceed the maximum horizontal or vertical joint deflections recommended by the pipe manufacturer. Unless the Engineer requires the use of a specific manufacturer's pipe, he shall assume, for design purposes, that the allowable deflection is the minimum found in the industry. Layout of plastic pipe larger than six inches (6") in diameter shall be based upon the assumption that no deflection can be accomplished by bending the pipe barrel.
 - 3.4.6.5.1 Longitudinal deflection for six-inch (6") diameter and smaller AWWA C900 pipe shall be such that the minimum bending radius (Rb) of the deflected pipe center is equal to or greater than the value obtained by use of the following relationship. $R_b = 300 \times D$ where Rb is the minimum bending radius in feet and D is the nominal pipe inside diameter in feet. Longitudinal bending of PVC pipe effected through mechanical means will not be allowed.
 - 3.4.6.5.2 Longitudinal deflections for ductile iron pipe shall not exceed the values given in ANSI/AWWA Standard C600 which are as follows:

MAXIMUM LONGITUDINAL DEFLECTIONS FOR DUCTILE IRON PIPE						
	TYPE OF JOINT					
	PUSH-ON			MECHANICAL JOINT		
NOMINAL PIPE SIZE (INCHES)	DEFLECTION ANGLE (DEGREES)	MAXIMUM OFF SET Joint (Inches)		DEFLECTION ANGLE (DEG-MIN)	MAXIMUM DEFLECTION Joint (Inches)	
		18 Ft.	20 Ft		18 Ft	20 Ft.
4	5	19	21	8-18	31	35
6	5	19	21	7-7	27	30
8	5	19	21	5-21	20	22
10	5	19	21	5-21	20	22
12	5	19	21	5-21	20	22
14	3*	11	12	3-35	13.5	15
16	3*	11	12	3-35	13.5	15
18	3*	11	12	3-0	11	12
20	3*	11	12	3-0	11	12
24	3	11	12	2-23	9	10
30	3*	11	12			
36	3*	11	12			
42	3*	11	12			
48	3*		12			
54	3*		12			

*For 14-in. and larger push-on joints, maximum deflection angle may be larger than shown above. Consult the manufacturer.

- 3.4.6.6 The Contract Documents shall require the Contractor to prevent surface water from accumulating in the trenches. Trenches shall be free of water during pipe installation.
- 3.4.6.7 The Contract Documents shall require trench excavation to provide vertical curve chords which will not exceed the permissible deflection of the pipe. The bottom of the trenches shall be accurately graded to provide uniform bearing and support for each joint of pipe on undisturbed soil at every point along its entire length.
- 3.4.6.8 The Contract Documents shall provide for the placement of No. 57 crushed stone in the bottom of the trenches when unstable material is encountered. Such unstable material shall be removed to the depth required by the Commission and replaced with No. 57 crushed stone such that the pipe will be adequately supported throughout its entire length. Excavation below the planned pipe invert elevation as shown on the Approved Plans shall be refilled with No. 57 crushed stone.
- 3.4.6.9 The Contract Documents shall require thrust blocking at each horizontal and vertical change in direction of a main. Trenches shall be excavated to provide uniform support of the blocking on undisturbed soil. The concrete shall be placed as shown in the Standard Details and shall not interfere with the removal of any bolts, fasteners, or fittings. Ductile iron fittings shall be wrapped in polyethylene prior to placement of the concrete blocking.
 - 3.4.6.9.1 In lieu of concrete thrust blocking, piping systems 12 inches and smaller in diameter may be restrained through the use of restrained joint pipe or approved joint restraint devices meeting the requirements of Section 7.2.6. The minimum length of piping to be restrained shall be as set forth in the table below.

*Restrained Length (ft.)					
Pipe Size (in.)	4	6	8	10	12
Pipe Cover (ft.)					
3.0	16	24	31	38	46
4.0	15	23	30	37	43
5.0	14	22	29	36	42

* Above values are the lengths of restrained pipe required on each side of fitting. Above values are for 45° horizontal bend. For other horizontal bends multiply above by the following coefficients: 90° - 2.4; 22 1/2° - 0.48; 11 1/4° - 0.24; dead end - 2.4.

The use of joint restraint devices on vertical bends and on piping systems larger than 12 inches in diameter shall not be utilized unless approved by the Commission. The Engineer shall submit documentation to the Commission for its review and approval demonstrating that the joint restraint system to be utilized will provide the needed restraint. The Contract Documents shall specify the joint restraint method to be used and shall clearly indicate the minimum length of piping requiring joint restraint.

3.4.6.9.2 The use of combined thrust restraint systems employing concrete blocking and joint restraint devices, based on each system being designed to resist a percentage of the resultant thrust force, shall not be permitted. The use of combined systems based on each system being designed to resist all of the resultant thrust force are permitted.

3.4.6.10 The Contract Documents shall include the requirement that NC One Call shall be contacted forty-eight (48) hours prior to any excavation. The documents shall also note that locations of existing utilities by NC One Call are valid only for ten (10) days after the date of location.

- 3.4.6.11 The Contract Documents shall advise the Contractor that pavement cuts within the City of Greenville require a permit from the City of Greenville Public Works Department.

3.4.7 Backfilling

- 3.4.7.1 Backfilling shall be performed only with the approval of a Commission's Representative.
- 3.4.7.2 Terms used to indicate backfill zones are capitalized and are defined in Section 1.3.1.2.
- 3.4.7.3 Special care shall be taken in writing the Contract Documents so that backfilling for water mains and appurtenances will be done in a manner which will provide satisfactory support and restraint of all pipes, fittings, valves, equipment and structures. As a minimum, Initial Backfill for water mains shall be compacted to 95% Standard Proctor as determined by the AASHTO-T99 method.
- 3.4.7.4 The Haunching and the Initial Backfill shall be free of materials which might in any way damage the pipe or preclude proper compaction of the backfill. Acceptable soil materials are ASTM 2487 soil types SW, SP, SM and SC.
- 3.4.7.5 The Final Backfill shall be provided using materials and methods suitable to provide the compaction necessary to prevent settlement which would adversely affect existing or proposed land use. Unless otherwise permitted by the Commission, compaction shall be no less than 90% Standard Proctor as determined by AASHTO-T99. Backfilling within the right-of-way of the NCDOT, the City of Greenville, railroads, and other rights-of-way shall be subject to the right-of-way owner's requirements.
- 3.4.7.6 All water mains shall be installed with three-inch (3") wide metallic detectable tape. The tape shall be clearly marked "Water" and shall be centered over the main, twelve inches (12") below finished grade. Any breaks in the tape shall be repaired in accordance with the manufacturer's recommendations.

3.4.7.7 The Contract Documents shall require the disturbed ground surface to be graded to prevent ponding of water, and to be seeded and mulched upon completion of backfilling operations. Seeding and mulching shall be in accordance with the requirements and recommendations of the Land Quality Section of the Division of Land Resources.

3.4.8 Termination of Water Mains

Water mains shall be terminated in accordance with the Standard Details. Provide either blow-offs or hydrants as required by Section 3.2.10 of the Manual.

3.4.9 Installation of Services

3.4.9.1 Services shall be provided to each lot or individual building unit as required by Section 3.2.9 of this Manual and as shown in the Standard Details. Meter boxes and brick for one-inch (1") services shall be provided by the Contractor as shown on the Standard Details. Meter boxes installed for multi-family developments and ganged together shall be marked with the unit number being served. Markings shall be permanently painted on the inside of the frame section and highly visible.

3.4.9.2 When service is available from two (2) or more water mains, the property shall be served by the main designated by the Commission.

3.4.9.3 Standard services are available utilizing 3/4", 1", 1 1/2", and 2" meters. Service tubing for 3/4", and 1" services shall be 1" diameter. Service pipe for 1-1/2" and 2" services shall be 2" diameter. For additional information, refer to the Standard Details. Larger services such as four-inch (4"), six-inch (6"), eight-inch (8"), etc., may be specified. Services larger than two-inch (2"), if used, shall be designed as a dead-end water main except that a permanent blow-off rather than a hydrant may be provided for flushing purposes.

3.4.9.4 Service connections for one-inch (1") services shall be installed by one of two (2) methods. These are as follows:

- 3.4.9.4.1 Service connections to PVC (C900) and ductile iron mains six inches (6") in diameter or larger may be accomplished by direct tapping of the main. Teflon tape or other approved pipe compound shall be applied to the corporation stop threads prior to installation.
- 3.4.9.4.2 Service connections for mains smaller than six-inches (6") and all sizes of pressure rated PVC require the use of a service clamp. A service clamp shall also be used as an alternative to tapping wherever required by the Commission.
- 3.4.9.5 One-inch (1") service tubing shall be installed with sufficient slack to prevent tension on the line. A maximum of three splices (couplings) per service shall be allowed. Tubing shall have a minimum cover of twenty-four inches (24"). See the Standard Details.
 - 3.4.9.5.1 Service tubing shall be installed with a minimum of six Inches (6") of vertical separation from an existing or proposed storm drain.
 - 3.4.9.5.2 If the service tubing is damaged during construction such that its flow capacity or its life expectancy is adversely affected, the damaged portion shall be replaced.
- 3.4.9.6 One and one-half inch (1-1/2") and two-inch (2") diameter services shall be installed in accordance with the Standard Details. The installation of the Class 200 PVC service pipe shall be in strict conformance with the requirements for mains, except that the service pipe shall have a minimum cover of twenty-four inches (24").

3.4.10 Setting of Valves and Valve Boxes

- 3.4.10.1 Valves shall be set at the locations directed in Section 3.2.7 of the Manual and as shown in the Standard Details.
- 3.4.10.2 All valves shall be installed with a cast iron valve box meeting the specifications of Section 7.3.4 of the Manual. The boxes shall be set plumb with the bottom of the box resting on compacted backfill. Valve boxes for two-inch (2") ball valves shall be supported by two (2) bricks. The box shall not contact the valve or water main.

The top of the box, when located in unpaved areas, shall be centered and set in a 24-inch X 24-inch X 6-inch depth concrete pad or precast concrete collar set flush with the finished grade. See Standard Details.

- 3.4.10.3 Valve boxes shall be installed so that a minimum of four inches (4") of upward and four inches (4") of downward [total of eight inches (8")] vertical adjustment is possible without disturbing the base or removal of any box sections. Valve box extensions shall be in accordance with Section 7.3.4 of the Manual.

3.4.11 Setting of Fittings

The specifications shall insure that care is taken in setting fittings so that the joints bell up properly. The fittings shall be properly supported and thrust blocked in accordance with Section 3.4.6.9 of the Manual.

3.4.12 Installation of Air Release Valves and Blow-offs

- 3.4.12.1 Blow-offs and drainage branches shall not be connected to any sewer, submerged in any stream, or be installed in any other manner which will permit back siphonage into the distribution system.
- 3.4.12.2 Automatic air release valves shall be installed in standard manholes free of infiltration. In cases where automatic air release valves are permitted or required by the Commission for use on a water main, such valves shall be equipped with a vacuum check device to prevent backflow in the event of main pressure loss.
- 3.4.12.3 Manual air release valves shall be installed in a standard meter box located outside of traffic areas where possible. The air release valve shall be provided by tapping the main and installing a standard service clamp, a corporation stop, one-inch (1") service tubing and an angle meter stop as shown in the Standard Details. The one-inch (1") tubing shall have a minimum cover of twenty-four inches (24").

3.4.13 Installation of Backflow Prevention Devices

- 3.4.13.1 Backflow prevention devices shall be located in accordance with Section 3.2.11.

3.4.13.1.1 Reduced Pressure Principle devices shall be installed such that they vent to the atmosphere and are not subject to submergence, or temperatures below freezing. Above ground installations shall meet the applicable requirements of the rights-of-way owner and city zoning setbacks. GUC will not be responsible for the operation and maintenance of the device and recommends to the owner a heating device be installed to prevent freezing.

3.4.13.1.2 Double Check Detector Check devices may be installed either in or above ground, but must have positive drainage away from the vault or enclosure. Installations that do not provide positive drainage away from the vault will require the installation of a sump pump. Above ground installations shall meet the applicable requirements of the rights-of-way owner and city zoning setbacks. GUC will not be responsible for the operation and maintenance of the device and recommends to the owner a heating device be installed to prevent freezing in an above ground installation.

3.4.14 Setting of Fire Hydrants

Fire hydrants shall be installed in accordance with the Standard Details. Restraint of the hydrant branch valve shall be accomplished by utilizing a locked hydrant tee meeting the requirements of Section 7.2.7.

3.4.15 Roadway, Street and Railway Crossings

3.4.15.1 Railway and NCDOT roadway crossings of water mains shall be performed in accordance with the requirements of the right-of-way owner and with the conditions set forth in the encroachment agreement. The materials as a minimum must meet the requirements of the Manual and must in addition meet or exceed the standards of the particular right-of-way owner.

3.4.15.2 The crossing of any street belonging to the City of Greenville, if installed by way of open-cut, requires the installer to obtain a permit from the City of Greenville Public Works Department.

The actual patching of City pavement shall be performed by the City at the expense of the permit holder. As a minimum, ABC stone shall be replaced beginning two inches (2") below the bottom of the existing stone and filled to the grade of the adjacent pavement and compacted. Upon completion of patching, the stone base shall be two inches (2") thicker than the existing stone base course.

3.4.15.3 All boring and jacking installations shall be accomplished with the use of encasement pipe which as a minimum, meets the specifications set forth in Section 7.9 of the Manual. The carrier pipe shall be DIP with "push-on" joints in conformance with the requirements of Section 7.2 of this Manual. The ends of the encasement pipe shall be as shown in the Standard Details.

3.5 CLEANING AND TESTING OF WATER SYSTEM EXTENSIONS

3.5.1 General

The Contract Documents for water system extensions shall provide written requirements for thorough cleaning, testing, and disinfection of the new extension. The following guidelines are intended to aid the Engineer in developing specifications which will insure sound and properly disinfected water lines.

The cleaning and testing of private fire service mains shall be coordinated with the Greenville Fire Prevention Bureau. A copy of their procedural requirements is included in the manual as Appendix H.

3.5.2 Test Sequence

The following test sequence shall be included in all water system extension specifications unless otherwise directed by the Commission.

- (1) Perform pretest inspection.
- (2) Clean the main.
- (3) Perform the hydrostatic tests.
- (4) Apply the proper dosage of chlorine.
- (5) Allow chlorine solution to remain in the water main a minimum of 24 hours.
- (6) Flush the main.
- (7) Assist the Commission in taking bacteriological samples.

3.5.3 Pretest Inspection

Prior to the commencement of hydrostatic testing and chlorination, the Commission shall be contacted to request scheduling of inspection and testing. A Commission's Representative shall visually inspect the completed installation prior to testing to insure that all fire hydrants, valves and other appurtenances have been installed and are operable. All defects disclosed by the inspection shall be corrected prior to testing.

3.5.4 Cleaning of The Main

Mains shall be cleaned only in the presence of a Commission Representative. No valves or hydrants owned by the Greenville Utilities Commission shall be operated without the express permission of the Commission.

3.5.4.1 Cleaning of Water Mains Smaller than 4" in Diameter

Mains shall be cleaned by flushing. Flushing velocity shall be adequate to remove all debris and other undesirable material and a minimum of 2-1/2 feet per second.

3.5.4.2 Cleaning of Water Mains 4" and Larger in Diameter

Mains shall be cleaned only in the presence of a Commission Representative. No valves or hydrants owned by the Greenville Utilities Commission shall be operated without the express permission of the Commission. Cleaning shall be accomplished by passing through the pipe a polyurethane "pig" of the appropriate size and density (as manufactured by Poly-Pig or approved equal). Pig(s) shall be furnished by the Contractor. The procedure shall be as follows:

- a. The Contractor shall prepare the main for the installation and removal of pig(s) as required:
 - (1) In general, this will consist of furnishing all equipment, material, and labor to satisfactorily install and remove the pig(s).
 - (2) Prior to scheduling a preconstruction conference, a "pigging" plan shall be submitted to the Commission for approval.

- (3) Where expulsion of the pig is required through a dead end main, the Contractor shall prevent the backflow of purged water into the main after expulsion of the pig. For pipe twelve inches (12") or less in diameter, purged water can be prevented from re-entering into the pipe by the temporary installation of pipe and fittings as required to provide a riser with an above ground discharge. On larger pipe, additional excavation of the trench may serve the same purpose.
- (4) After expulsion of the pig, completion of flushing, and at the direction of the Commission, the Contractor shall complete work at openings by plugging, blocking, backfilling and completion of all appurtenant work necessary to secure the system.
- b. Under supervision of the Inspector, pig(s) shall be propelled via water pressure through the main(s) from point of insertion to point of expulsion. Where mains are in the form of a loop, the Contractor shall "pig" the complete system.
- c. As an alternative to "pigging", dead end pipes of less than 100 feet in length which are difficult to "pig" may be cleaned by flushing. Flushing shall be accomplished in the same manner as that required for pipes less than four inches (4") in diameter in accordance with Section 3.5.4.1.

3.5.5 Hydrostatic Test

Unless otherwise permitted, testing shall be performed between each main line valve in accordance with AWWA C600. The Commission will, except when certain circumstances dictate otherwise, permit the lengths of test sections to be a maximum of 1500 feet in subdivisions or other areas where the new main has closely spaced valves. Testing shall be done only in the presence of a Commission's Representative, unless otherwise directed by the Commission. Testing shall be performed using a suitable pump and an accurate gauge graduated in 1.0 psi increments. The section of the main to be tested shall be subjected to a test pressure of 150 psi for a period of two (2) hours. The leakage of the test section shall be accurately determined and compared to the schedule shown below. All visible leaks shall be repaired regardless of the amount of leakage.

PIPE SIZE

ALLOWABLE LEAKAGE

(inches)	(Gallons per hour per 1000 feet of pipe)
2	0.16
4	0.33
6	0.50
8	0.66
10	0.83
12	0.99
14	1.29
16	1.47
18	1.66
20	1.84
24	2.21
30	2.76
36	3.31

If the leakage is greater than the allowable leakage as given by the above table, the Contractor shall replace any defective materials and perform all necessary work to insure that the installation is acceptable and a retest shall be performed subsequent to any repair work performed. Remedial repair work and retesting shall be repeated until the leakage occurring during the test period is less than or equal to the allowable leakage.

3.5.6 Chlorination

- 3.5.6.1 Chlorination shall be performed only in the presence of the Commission's Representative and shall be performed only after the line is complete and has tested satisfactorily for leakage.
- 3.5.6.2 Chlorination taps will be made within five (5) pipe diameters of the water main control valve at the upstream end of the line and at all extremities of the line.
- 3.5.6.3 Sufficient chlorine solution shall be applied to bring the concentration within the main to a minimum of 100 ppm free chlorine residual.
- 3.5.6.4 The chlorine solution shall be introduced to the main at a constant rate while regulating the flow of water through the main being chlorinated such that the required concentration of chlorine is achieved throughout.
- 3.5.6.5 All valves within the section of main being chlorinated shall be operated once during the contact period.
- 3.5.6.6 The chlorine solution shall remain in the lines for no less than twenty-four (24) hours, longer if so directed by the Commission.

- 3.5.6.7 Services shall be chlorinated at the same time and by the same method utilized for the main.
- 3.5.6.8 Extreme care shall be taken to prevent contamination of existing water mains during the test period. If, in the opinion of the Commission, an existing main is contaminated, the section of main subjected to the possible contamination shall be flushed and chlorinated in accordance with the requirements for new mains.
- 3.5.6.9 The Commission will advise the Contractor when a suitable period of time has elapsed for chlorine contact. The main shall be flushed thereafter in the presence of the Commission's Representative. The flushing of the main shall be considered complete when the chlorine concentration within the main is less than or equal to the lesser of the following values:
1. part per million (ppm)
 2. free chlorine
 3. free chlorine concentration within the existing main to which the extension has been connected.
- 3.5.6.10 The Contractor shall be responsible for insuring that high-strength chlorine solution is contained on-site and not allowed to make its way to any watercourse, stream, creek, lake, or other body of water.

3.5.7 Bacteriological Testing

- 3.5.7.1 After completion of chlorination and flushing, the Contractor shall assist the Commission as necessary in obtaining sufficient bacteriological samples for complete testing.
- 3.5.7.2 The Commission shall determine the location of samples and the number of samples necessary to provide a test group which is representative of the section of main being tested.
- 3.5.7.3 A failure of any sample of a test group shall constitute failure of the entire test group from which the sample was taken. Such failure shall require two (2) successive passing test groups to substantiate that the main has been satisfactorily chlorinated.

The second of the two successive test groups of samples will not be collected before nor unless the first group has passed. The Contractor may, at his option, rechlorinate and retest the section of water main upon failure of the test group.

3.5.7.4 If two (2) successive bacteriological test groups fail, the section of main from which the group was taken shall be rechlorinated and retested until the main is shown to be properly chlorinated in accordance with Section 3.5.6 above.

3.6 TEMPORARY WATER SERVICE

3.6.1 Temporary water service may be provided in accordance with the Terms and Conditions.