

33 11 00 – Water Utility Distribution Piping

1. Introduction

- A. Duke University owns and operates the water distribution system throughout the campus boundaries; however, water is supplied by the City of Durham. Durham has two main water supply sources to the distribution system, Lake Michie and the Little River.
- B. Campus water distribution systems will be designed in accordance with master plans developed by the Duke Utilities and Engineering Services (DUES) department.
- C. Planning for utility requirements to support projects must start in the programming stages to insure the work is coordinated with ongoing projects and there is adequate capacity to support the project.
- D. All proposed water system modifications and extensions shall be coordinated with the Duke Utilities and Engineering Services (DUES) department.

2. References

- A. Materials and operations shall comply with the latest revision of the Codes and Standards listed:
 - 1. AASHTO - American Association of State Highway Transportation Officials
 - 2. ANSI - American National Standards Institute
 - 3. AREA - American Railway Engineers Association
 - 4. ASTM - American Society for Testing and Materials
 - 5. AWWA - American Water Works Association
 - 6. CISPI - Cast Iron Soil Pipe Institute
 - 7. FS - Federal Specifications
 - 8. MSDS - Material Safety Data Sheets
 - 9. NFPA - National Fire Protection Association
 - 10. UL - Underwriter's Laboratories
 - 11. City of Durham: Water and Sewer Construction Specifications
 - 12. City of Durham: Reference Guide for Development

3. Water Distribution Piping Design

- A. Project team's civil engineer shall schedule an initial meeting with Duke Utilities and Engineering Services to review project utility requirements and design guidelines during the early stages of design.
- B. Refer to Section 5.0 of the City of Durham's "Reference guide for Development" for City requirements for pipe material and pressure requirements.
- C. Pressure
 - 1. Water mains shall be sized to provide a minimum system pressure of 20-pounds per square inch (psi) during peak system demands plus fire demand.
 - 2. A booster pump may be needed to assure adequate pressure.
 - 3. Peak system demands are described as follows:
 - a. The peak domestic demand plus
 - b. The Fire Protection System (sprinkler) demand plus
 - c. The fire flow demand (campus fire flow demand is 2000-gpm) is the demand for any hydrant on the project. Minimum residual pressure of 20-psi shall be available at all points in the distribution system during peak system demands.
 - 4. A Fire Flow Report is required by the City of Durham for all projects containing a proposed hydrant. Submit request to DUES for hydrant flow testing. Only qualified Duke Personnel are allowed to conduct hydrant flow testing.
 - 5. All water main, services and appurtenances shall be shown on the drawings and coordinated with all other proposed utilities, improvements (e.g., walls, handicap ramps) and proposed landscaping. All water main piping and components and services shall be accessible for operation and maintenance and eventual replacement.
 - 6. Encasements are required for bored crossings and railroad right of way. The pipe is required to have restrained joints under the road area. See City of Durham sizing table for carrier pipes and casing pipes for bored crossings.
 - 7. Water mains shall be flushed, pressure tested and disinfected prior to connection to the University's system, conforming to the City of Durham's specification. Pressure tests will be performed at 200 psi for duration of 3 hours.
- D. Alignment
 - 1. Water mains shall be designed with a minimum of 3 feet of cover to finished grade or 2 feet below subgrade, whichever is greater.
 - 2. Parallel Installations: 10-ft lateral separation (pipe edge to pipe edge) or minimum 3-ft lateral separation, and water line at least 18-inches above sanitary sewer line

measured vertically from top of sewer pipeline to bottom edge of water main. In some cases where the sanitary sewer and the water main are installed with at least 3-feet of lateral separation but less than 10-feet of horizontal separation, and less than 18-inches of vertical separation, both the water main and sanitary sewer shall be constructed of ductile iron pipe with joints in full compliance of these standards. Water mains shall have a minimum clearance of 2 feet horizontal from any other underground pipe.

3. Crossings (Water Main Over Sewer): At a minimum, 18-inches of clearance shall be maintained between the bottom edge of the water main and the top edge of the sewer main. If 18-inches of clearance are not maintained, the water main and sanitary sewer main shall both be constructed of ductile iron pipe with joints in conformance with water main construction standards. The sanitary sewer shall be ductile iron the entire run from manhole to manhole. When the separation between pipelines is 18-inches or less, the void space between the pipes shall be filled with minimum 500-psi, quick setting, non-excavatable, flowable fill extending 3-feet on both sides of the crossing. Regardless of pipe material, at least 12-inches of vertical separation is required for both sanitary and/or storm sewer crossings of potable water mains.
4. Gate or butterfly valves shall be installed to isolate each branch run from main supply run.
5. Air release/Vacuum relief valves will be installed at high points in water system profile.

4. Materials

- A. Distribution Mains shall be ductile iron pipe complying with requirements of ANSI / AWWA C-151. Thickness class shall be 51 for 4 inch to 6-inch diameter and Class 50 for 6 inch up to 24-inch diameter.
- B. Ductile Iron Pipe:
 1. Ductile Iron pipe shall be designed and manufactured in accordance with AWWA C150 and C151 and provided in nominal 18-foot or 20-foot lengths.
 2. Pipe joints shall be mechanical joint or push-on type as per AWWA C111. Pipe lining shall be cement mortar with a seal coat of bituminous material in accordance with AWWA C104. All buried ductile iron pipe shall have a bituminous exterior coating in accordance with AWWA C151.
- C. Ductile Iron Fittings:
 1. All ductile iron fittings shall be provided in conformance with AWWA C110 for standard ductile iron fittings and AWWA C153 for compact ductile iron fittings.
 2. All fittings shall be pressure rated for a minimum 350-psi through 24-inches in diameter and 250-psi for fittings greater than 24-inches in diameter.

3. All fittings for potable water service shall be provided with cement mortar linings and asphaltic seal coats in accordance with AWWA C104.
4. All ductile iron fittings shall have an asphaltic exterior coating in accordance with AWWA C151.
5. All DI fittings shall be provided with mechanical joint end connections and restrained with standard blocking and rodding or wedge action retainer glands.

D. Restrained Joint Ductile Iron Pipe:

1. Restrained joint ductile iron pipe unless otherwise specified shall be of the boltless restrained joint type as assembled with a steel flexible ring that locks into position inside the bell of the connecting pipe. The locking rings shall be one-piece construction. For installations requiring welded locking rings, the rings shall be factory welded. The restrained joints shall provide a minimum of 4-degrees of deflection for pipe sizes, 4-inches through 12-inches in diameter.
2. All proprietary pipe restraint systems shall be approved by DUES and provided in compliance with all standards for coatings, linings, pressure classes, etc. as required for ductile iron pipe. All restrained joint pipe shall be installed based on laying conditions, pressure class, etc. as required for typical ductile iron pipe.

5. Installation

- A. Ductile iron pipe shall be installed in accordance with the requirements of AWWA C600 and the Ductile Iron Pipe Handbook published by the Ductile Iron Pipe Research Association. Materials at all times shall be handled with mechanical equipment or in such a manner to protect them from damage. At no time shall pipe and fittings be dropped or pushed into ditches.
- B. Pipe and fitting interiors shall be protected from foreign matter and shall be inspected for damage and defects prior to installation. In the event foreign matter is present in pipe and fittings, it shall be removed before installation. Open ends of pipe shall be plugged or capped when pipe laying is not in progress.
- C. All water pipe shall be constructed with at least 36 inches of cover below the finished surface grade. Pipe shall be laid on true lines as directed by the Engineer. Trenches shall be sufficiently wide to adjust the alignment. Bell holes shall be dug at each joint to permit proper joint assembly. The pipe shall be laid and adjusted so that the alignment with the next succeeding joint will be centered in the joint and the entire pipeline will be in continuous alignment both horizontally and vertically. Pipe joints shall be fitted so that a thoroughly watertight joint will result. All joints will be made in conformance with the manufacturer's recommendations for the type of joint selected. All transition joints between different types of pipe shall be made with transition couplings approved on shop drawings showing the complete assembly to scale.

- D. Pipe shall be installed at laying conditions as specified by the plans. Laying conditions for ductile iron pipe shall be as described in AWWA C151 and the Ductile Iron Pipe Research Association. Laying conditions shall be defined as follows:
1. Type 1: Flat Bottom Trench with Pipe Resting on Stable Undisturbed Earth. Unstable conditions such as wet trench bottoms, intermediate rock layering, partially weathered rock, and other unsuitable soil conditions shall require utilizing more stringent laying conditions. At a minimum, Type 4 laying condition shall be utilized with a minimum of 4-inches of bedding to overcome unstable conditions. For severe unstable soil conditions, undercut excavation and an engineer designed foundation plan shall be provided prior to pipeline installation.
 2. Type 4: Pipe bedded in Class 1 material, No. 67 or No. 78 crushed stone to a depth of 1/8 pipe diameter or a minimum of 4-inches. Embedment material, consisting of Class 1, Class 2 or Class 3 materials, shall be compacted greater than 95% Proctor to the top of the pipe. Careful attention must be allocated to compacting embedment material under the bottom edges of the pipe.
 3. Type 5: Pipe bedded in Class 1 material, No. 67 or No. 78 crushed stone to the center of the pipe and extending a minimum of 4-inches under the pipe. Granular or select embedment, consisting of Class 1 or Class 2 materials, compacted to greater than 95% Proctor installed to the top of the pipe.
- E. Prior to beginning construction, the Contractor shall comply with all provisions set by the Duke University Excavation Program. Please refer to the following link for additional information: http://www.fmd.duke.edu/utilities/excavation_files/index.php
- F. Please contact Duke FMD prior to operating any waterline valves. All valves within campus proper shall be operated only by Duke Personnel. Contractor's personnel shall only be responsible for operating valves within new construction areas that are not directly connected with the existing distribution system.

6. Fire Protection

A. Fire Hydrants

1. Location

- a. Please refer to the North Carolina State Fire Prevention Code for additional provisions for Hydrants.
- b. Fire Hydrants shall be located so that they shall be installed on a 6-inch branch line and shall be equipped with a gate valve for isolation purposes. The hydrant isolation valve shall be located directly adjacent to the water main and shall be inside the pavement when possible.
- c. Hydrants shall be oriented so that large diameter connection faces fire apparatus access.

- d. Hydrants shall be no closer than 10-feet from the PC or PT of any intersection, including driveways.
- e. Hydrants are to be placed 18-inches to back of curb
- f. Fire hydrants shall be located at each street intersection
- g. Maximum spacing between hydrants shall not exceed 500-feet. The hydrant spacing distance shall be the horizontal distance as measured along the centerline of the street.
- h. Phased projects shall be designed such that there guidelines are met during each phase and after completion of the project.
- i. Hydrants shall be situated at locations which enable fire apparatus to pass other fire apparatus which have stopped to connect to the hydrant (driveway width 20-foot minimum).
- j. A hydrant shall be installed no less than 6-feet nor more than 50-feet (lineal) from any and all Fire Department Connections (FDC).
- k. Landscape plantings (when fully grown) or other vertical projections greater than 6-inches in height shall not encroach upon any fire hydrant within a 3-foot radius and not obscure view of hydrant upon approach.
- l. Hydrants shall be located a minimum of 40-feet from any building walls.
- m. Hydrants shall be situated to enable fire equipment to first pass a fire hydrant before reaching any structure or hazard associated with a site.

2. Materials

- a. All hydrants shall be of the City of Durham established standards.
- b. Fire Hydrants shall be of the safety flange, breakaway top type and shall meet requirements of AWWA C-502, "AWWA Standard for Dry - Barrel Fire Hydrants."
- c. Hydrants shall have a barrel diameter no smaller than 7 inches, a hydrant valve diameter no smaller than 5 inches, and shall be equipped with two 2 ½ inch hose nozzles and one 4 ½ inch pumper connection.
- d. Hose and pumper outlet threads shall match local fire department equipment.

B. Fire Department Connections (FDC)

1. The fittings, typically associated with a sprinkler/standpipe system within a building, shall be located no closer than 6-feet or greater than 50-lineal feet of a fire hydrant. In all instances, these fittings shall be located on the same side of the travel lane. Both hydrant and connection shall be accessible along the roadway fronting the building or along the roadway approaching the building.

2. Contact Fire Department for requirements for buildings with standpipe systems.

7. Valves

A. Type

1. Valves 8-inch and below require a valve box.
2. Valves 12-inch and 16-inch are required to be in 4-foot diameter manholes.
3. Gate valves
 - a. Shall be used up to and including 16-inch diameter water lines.
 - b. Gate valves sizes 3" through 12" shall have non-rising stem and shall meet requirements of AWWA C-500 or C-509.
 - c. Gate Valves shall be at least 200-psi working.
 - d. Valve ends shall be compatible with piping systems in which they are installed.
 - e. All valves shall have cast iron bodies and bronze stems.
 - f. Gate valves shall have O-ring seals and shall open counterclockwise.
4. Butterfly Valves
 - a. Butterfly valves 3" and larger shall meet requirements of AWWA C-504, AWWA Standard for Rubber - Seated Butterfly Valves.
 - b. Valves shall be for pressure class 150B and shall open counterclockwise.
 - c. Wafer type valves shall not be used for underground installation.
 - d. Valve bodies shall be constructed of close grain, high tensile strength cast iron.
 - e. Valve body ends shall conform to the requirements of connecting pipe.
 - f. The shaft shall have a minimum diameter specified for the size and class valve in Table 4 of AWWA C-504.
 - g. Discs shall be constructed of corrosion resistant alloy cast iron.
 - h. Seats shall be natural or approved synthetic rubber of the molded type, secured for lubricating sleeve type.
 - i. Valves with diameters larger than 20 inches shall have an adjustable, two-way thrust bearing to keep the valve disc centered, regardless of the valve position.

- j. Valve operators shall meet requirements of AWWA C-504, pressure class 150B.
 - k. Interior valves shall be hand wheel type and shall open counterclockwise.
 - l. Exterior valves for buried service shall have buried service gear actuated operators with 2 inch nut and shall open counterclockwise.
 - m. Valve operators shall be suitable for a minimum of 10,000 cycles of operation at the rated torque.
 - n. All valve operators shall be sized based on valve diameter as indicated on drawings, materials specified above, and the following system characteristics:
 - maximum non-shock shut off pressure across the valve of 150 psi
 - velocity through valve under normal conditions of 2 fps
 - velocity through valve under extreme maximum flow conditions of 20 fps
 - constant head source
 - o. Written certification of compliance with AWWA C-504, pressure class 150B, for each size valve and operator shall be required prior to installation. In addition, the maximum operating torque shall be stated, as defined in the Appendix of AWWA C-504, to which each size valve and its operator will be subjected based upon the above information and the torque output rating of each of the above operators.
5. Valves shall be in accordance with the North Carolina Fire Prevention Code. Post indicator valves (PIV), located 40-feet from building walls when possible, shall be installed unless other valve arrangements are approved by the Fire Official.
6. Valve Boxes:
- a. The valve box frames and covers shall conform to the City of Durham Standard.
 - b. Valve boxes shall be adjustable cast iron of the three - piece type, consisting of lid, two piece sliding extension, and base.
 - c. Base shall be proper type and size for the valve with which it is used.
 - d. The word "WATER" shall be cast or embossed on the valve box lid in letters not less than 1 inch high.

B. Locations

1. Each intersection of water mains shall have one less main line valve than the number of intersecting pipes.

C. Straight Runs

1. Main line valves located in straight runs of pipe shall be spaced as follows:

<i>Main Size</i>	<i>Maximum Spacing</i>
4-inch	400-feet
6-inch	600-feet
8-inch	900-feet
12-inch	1000-feet
16-inch	1000-feet

D. Tapping Sleeves

1. A City of Durham Engineering Division Inspector is to be present at all taps to water mains prior to the tap being made unless other arrangements have been made with the City Inspector.
2. Wet Taps/Saddle Taps are not permitted unless given written permission from Duke Utility and Engineering Services (DUES).
3. Same size taps are only allowed on an 8-inch line and smaller. Any larger same size connection requires installing a tee and valve(s).
4. If a tapping valve is 12-inch or larger, the valve and the tapping sleeve are to be located within one manhole. Cut in tees with sleeves are required for 12-inch by 12-inch same size taps or larger.

E. Terminating Lines

1. For 12-inch by 16-inch taps the valve and tapping sleeve are to be located in a 5-foot diameter manhole.
2. Piping 12-inch and greater shall extend 3 pipe joints beyond end line valve.

F. Blow-offs

1. Blow-offs shall be installed on all dead end mains and at elevated points along the water main. A 1-inch blow off assembly shall be installed on all dead end mains 8-inch or less in diameter and a 2-inch blow-off assembly shall be installed on all dead end mains greater than 8-inches in diameter. Fire hydrants are not considered as blow-offs.

G. Pressure Reducing Valves

H. Pressure-reducing valves for water services shall be installed in accordance with current City of Durham Plumbing Code.

I. Services and Meters

1. Services:
 - a. Service pipe 3/4" through 2" shall be type K wall soft drawn copper.

- b. Joints shall be made with flared type brass fittings.
 - c. Service pipe larger than 2" shall be ductile iron water main.
 - d. Service saddles shall be of double strap brass or bronze with tapered threads manufactured by Jones, Ford or Mueller.
 - e. Tapping saddles for service pipe larger than 2" shall be as for ductile iron water main.
2. Meters:
- a. Water meters shall be manufactured by Neptune with E-coder type technology.
 - b. Water meters shall be sized accordingly to flow variations. Positive Displacement Meters shall be installed at low flow levels. Compound Meters are preferred at high flow levels.
8. Accessories
- A. Flanged Adapters for joining plain end pipe to flanged items shall be Style 128 or 127.
 - B. Concrete for Reaction Anchors shall have 3,000-psi strength at twenty-eight days and shall meet requirements of ASTM C-94.
 - C. Sleeves through concrete or masonry walls or slabs shall be either cast iron or galvanized, schedule 40 steel.
 - D. Pipe to Sleeve Sealant shall be either grouting compound or mechanical type seal.
 - E. Grouting Compound shall have 80 psi tensile strength and 700 percent elongation in accordance with ASTM D-3574 Test E, and linear dimension change shall not exceed 18 percent when subject to wet and dry cycles in accordance with ASTM D756, G, and D-1042.
9. As-Built Requirements
- A. As-Built Requirements shall be consistent with Section 4.0 of the City of Durham "Reference Guide for Development"
 - B. Electronic files will be submitted to FMD in conjunction with City of Durham As-Built submittal.