

CHAPTER THREE

WATER DISTRIBUTION DESIGN GUIDELINES

I. GENERAL

A. LOCAL PERMITTING AUTHORITY

In December 2003, PWC initiated its delegated Local Permitting program. In accordance with applicable North Carolina State Statutes, PWC has been given the authority to issue permits for the construction of new water lines. This authority extends to those systems that will not be owned, operated, or maintained by PWC.

What Projects can PWC Permit?

For those water systems that have a master meter with PWC, and that system is owned, operated, and maintained by another entity, and that entity does not have its own Public Water Supply Identification number (PWS ID), PWC has the authority to permit any water extensions/expansions for that system. For example, under this scenario, PWC would be the permitting authority for Fayetteville State University, Methodist University, Goodyear, etc.

However, if the entity has a PWS ID number, owns, operates, and maintains its system; the water permit is reviewed and issued by the State. Therefore, PWC would not permit any water extensions/expansions by Brookwood-Lagrange, Spring Lake, Fort Bragg, the Eastover Sanitary District, or within the Town of Stedman. However, since PWC has an operation and maintenance (O&M) agreement with the Town of Stedman, PWC will review all plans for water extensions, prior to being sent to the State for permitting. In cases where PWC has an O & M Agreement, the water system shall be designed in accordance with the PWC Standards.

For those systems owned, operated, and maintained by PWC, PWC will be the permitting authority.

All other projects not meeting the above criteria need to be permitted through the State of North Carolina. For further information on permits issued by the State, please refer to: <http://www.ncwater.org/pws/>

- B. All public water distribution systems that are to be owned, operated, and maintained by the Public Works Commission shall be constructed in accordance with PWC requirements. All plans and subsequent revisions shall be reviewed and approved by PWC prior to beginning construction. The water distribution system shall adhere to all requirements of PWC's extension policy, unless otherwise approved by PWC. The public water distribution system shall be designed in accordance with the minimum requirements of Title 15A, Subchapter 18C of the North Carolina

Administrative Code, “Rules Governing Public Water Systems” (most recent edition), this Design Manual, PWC Standard Specifications, and PWC Standard Details. Where discrepancies occur, the more stringent shall apply.

- C. For those public water distribution systems that PWC will not own, operate, or maintain, but PWC is the permitting authority, the public water distribution systems shall be in accordance with the minimum requirements of Title 15A, Subchapter 18C of the North Carolina Administrative Code, “Rules Governing Public Water Systems” (most recent edition).
- D. Residential and commercial developments shall connect proposed water extensions to the PWC water system at the Developer’s expense. Construction shall be in accordance with PWC Standards, Details and Specifications and designed to provide adequate flow and pressure for both domestic supply and fire protection.
- E. Private community water supply systems or individual wells shall be in accordance with the minimum requirements of the North Carolina Division of Health Services, Environmental Management, or Department of Environment and Natural Resources, as applicable. Connections to the PWC water supply system, if approved, shall be subject to PWC requirements.
- F. PWC and the City of Fayetteville, North Carolina Cross Connection Control Ordinance (as amended) shall be adhered to and coordinated with the PWC System Protection Department. Please call 910-223-4699 for additional information regarding backflow requirements and cross-connection issues.
- G. All taps on a PWC water main shall be made by a licensed utility contractor. The Public Works Commission shall observe and approve all connections to PWC water mains. All taps shall be made in accordance with PWC requirements.

II. HYDRAULIC DESIGN AND DEMAND

- A. The Design Engineer shall perform an analysis of all proposed extensions, in order to verify the development meets the fire flow requirements. The design data shall include a sketch of the proposed system, pipe roughness coefficient, fixed nodes, elevations, supply, demand, hydrant flow test (usually provided by PWC) and all calculations for fire flow requirements and domestic water demands. Extended period analysis will not be required.
- B. The developer shall be responsible for ensuring that the development meets the minimum fire flow and pressure requirements. A flow test will be provided by PWC at the fire hydrant closest to the proposed development, upon request from the developer or their Design Engineer.
- C. Average daily flow may be estimated at 85 gallons per person per day with 2.77 persons per household. This estimate should be modified as necessary based on specific zoning and land use data. Maximum daily flow and peak hourly flow shall be determined as follows:

Maximum daily flow = Average daily flow times 1.5

Peak hourly flow = Average daily flow times 2.1

- D. Instantaneous demand for residential areas shall be based on the number of 1-inch service connections. Instantaneous demand for business and industrial development shall be based on detailed analysis of water volume and usage patterns for the particular type of development.
- E. The water distribution systems and any extensions shall be designed to supply for the demand of all customers while maintaining the following minimum pressure and velocity.
 - a. 40 psi for maximum daily flow
 - b. 30 psi for peak hourly flow
 - c. 20 psi for instantaneous flow plus fire flow.
 - d. 4 fps for flushing
 - e. 3 to 6 fps for normal working conditions
- F. The water distribution system and any extensions shall be designed to supply for at least the minimum fire flow required in Appendix B (Fire-flow Requirements for Buildings) of the North Carolina Fire Code (most recent edition).
- G. Mains 12 inches in diameter and larger shall be designed to deliver maximum daily design flow with a head loss not to exceed 5 feet per 1,000 feet. Lower head loss criteria may be established based on length of main and available system head. Distribution mains 8 inches in diameter and smaller shall meet the same criteria for maximum daily domestic demand, but head losses up to 10 feet per 1,000 feet are acceptable for fire flow design provided volume and residual pressure requirements are met. Designs shall be based on a Hazen-William "C" value of 120.

III. WATER DISTRIBUTION SYSTEM

A. MATERIALS

1. **WATER MAINS** - Water mains shall be constructed of polyvinyl chloride (PVC), high-density polyethylene, or ductile iron. Water mains which are 12 inches or less in diameter can be polyvinyl chloride (PVC), while any water mains greater than 12 inches in diameter shall be ductile iron.
2. **WATER LATERALS** - Water laterals shall be constructed of HDPE or copper. Other materials for laterals shall be approved by PWC prior to construction.
3. All materials for mains and laterals shall be in accordance with the technical specifications, details, and other requirements within this Manual.

B. LOCATION - WATER MAINS

1. Water mains shall be located within dedicated street right-of-ways, except if existing conditions, underground utility conflicts, or requirements of NCDOT do not permit. Location in a dedicated permanent easement may be required by PWC. Water mains located in an easement shall be centered within an adequate easement width to allow excavation, maintenance, and unrestricted access and free of obstruction. The minimum easement width acceptable to PWC is 20 feet.
2. Within streets maintained by the City of Fayetteville, the main shall be located 10 feet from the sewer main and under the proposed pavement or five (5) feet inside the back of the curb or asphalt. Within NCDOT maintained streets, an encroachment must be approved. Generally, along NCDOT roads, water mains are located outside of pavement, a fixed distance from the edge of pavement or back of curb. No water main shall be designed closer than six (6) feet to the edge of pavement of an NCDOT maintained highway. The alignment should be chosen so as to minimize conflicts with utilities and underground structures, and to minimize the need for additional easement outside of the right-of-way. However, PWC does reserve the right to require that new lines be installed in an easement outside of the NCDOT right of way.
3. Water mains shall not be located closer than 20 feet horizontally to buildings or substantial surface structures. Water mains located closer than 20 feet shall be approved by PWC. If it is necessary to have a water main closer than 20 feet, the water main shall be ductile iron. The Design Engineer shall provide adequate precautions and design considerations to protect existing structures from damage/undermining due to pipe failure (break, leakage, etc.).
4. Water mains should be designed to be located on the "higher" side of the right-of-way street cross section. Where one side of roadway has a fill slope the water main should be placed on the other side of the road to allow for protection of the roadway and main should a leak occur.
5. Main extensions in and/or along the street to serve a property or subdivision shall be extended in accordance with the current PWC policy.

C. LOCATION - WATER SERVICES

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 of the lateral shall be a minimum of 1 inch. The location of services and the size of the lateral shall be based upon the anticipated use of the lot and require PWC approval. PWC may agree to waive its requirement that water services be installed

to each lot within non-residential subdivisions if there is sufficient information available to permit proper sizing of services and they can be conveniently installed at the time service is requested.

2. PWC requires individual water and sewer services to each building, tenant space or customer. If the building is single use, only one (1) service is required. For those buildings with multiple uses, each tenant/space shall be served with an individual service, unless otherwise approved by PWC.
3. An individual water service shall be provided for each residential lot.
4. Water meter boxes shall be set in accordance with the PWC Standard Detail, located 18 inches inside the street right-of-way at the center of the lot for which service is installed, and located 18 inches away from the sanitary sewer cleanout, unless approved otherwise.
5. Water meter boxes shall not be located within driveways, sidewalks, or other paved areas subject to vehicular traffic unless approved otherwise.
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.
7. Easements dedicated for PWC maintenance shall be provided for all water meter boxes not located in existing rights-of-way.
8. Water services shall be located perpendicular to the main, unless otherwise approved by PWC.
9. Water services for commercial facilities should be designed in accordance with the following table:

Lateral Size	Meter Size
1-inch	1-inch or 5/8 inch
2-inch	1-1/2 inch or 2-inch
4-inch	3-inch or 4-inch
6-inch	6-inch
8-inch	6-inch or 8-inch
Note: 4-inch and larger laterals require the installation of a meter vault, in accordance with PWC standard detail W.20.	

10. All water meters shall be located outside of the building in accordance with PWC standards. All meters shall be located a minimum of five (5) feet from the building.
11. All existing services that are not to be used in the current development shall be killed out at the main by closing the corporation stop and cutting

the pipe off at the corporation.

D. LOCATION OF AIR RELEASE VALVES

1. Mains 12-inches or larger in diameter, which have a change in elevation of ten (10) feet or greater, shall have an air release valve installed at the highest elevation of such change, unless otherwise approved by PWC.
2. PWC may 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. Automatic air release valves shall be installed in accordance with PWC Standard Detail.

E. LOCATION OF BLOW-OFFS AND DEAD END HYDRANTS

1. Dead ends on mains shall be provided with a two-inch blow-off at the terminal end. Materials and installation shall be in accordance with PWC standards.
2. Banks of meters shall be provided with a one-inch blow-off or irrigation service as shown in the PWC Standard Detail.
3. All water lines shall be terminated with blow-offs located on property corners whenever possible.
4. Provide a hydrant in severe sags as directed by PWC.
5. The blow-off or fire hydrant shall be located as to provide proper drainage and minimize impacts to any adjacent property or structures.
6. Provide a fire hydrant near the end of mains 12-inches and larger to facilitate flushing.

F. MAINS

1. In the PWC system the minimum nominal pipe diameter for new installations of water supply distribution system mains providing fire flow shall be eight (8) inches. Two (2) inch diameter lines may be used within residential subdivisions only for a maximum length of 1,000 feet where fire flow requirements and minimum hydrant spacing is provided by eight (8) inch and larger mains. No more than 20 residential customers may be served from a dead end two (2) inch main and no more than 40 residential customers may be served from a looped two (2) inch main.

If in an area that is operated and maintained, but not owned by PWC the lines should be sized according to demand. Materials shall be in

accordance with PWC requirements.

There may be cases in which a line is being replaced, retrofitted, or rehabilitated in which it will be acceptable to replace the line with the same size main if there are no advantages to upsizing the main. PWC will review these scenarios and determine what is allowable on a case by case basis.

2. Parallel mains shall be used anytime a design involves a multilane (defined as four (4) lanes or more) road so that services and hydrant branches are not crossing all lanes of traffic unless otherwise approved by PWC. Parallel mains may be required on streets with less than three (3) lanes, as required by PWC.
3. Water mains shall be designed with a minimum cover of 3.5 feet, as measured to the top of main. If existing conditions warrant greater or lesser depths of cover than allowed, special design measures, such as using ductile iron pipe or using restrained joint ductile iron pipe, for installations or additional easement widths for deeper installations may be required by PWC. For large diameter transmission mains (16-inches and larger), the main shall be deep enough to allow for the gate valves to be installed upright. Placing the valves sideways and utilizing bevel gearing shall only be done with prior approval of PWC.
4. Water mains utilizing ductile iron restrained joint pipe shall be designed in accordance with the applicable AWWA standards and manufacturer's instructions. The use of factory restrained joint ductile iron pipe shall be in accordance with PWC technical specifications.
5. Valves shall be placed in a manner that will allow for future extension without interruptions of current services. The main shall be extended across the last lot which is served and shall have service connections which are perpendicular to the main. No service connections shall be allowed beyond the last valve on the line. Stub outs shall extend a minimum of five (5) feet beyond the pavement and shall be properly restrained. Existing stub-outs shall be shown on plan view with "As-Built" distances.
6. Fittings, including valves, shall be shown on the plan view for all intersecting water mains and at fire hydrants. Bends shall be labeled on the plan and profile views.
7. A method of restraint shall be labeled on the plan for each bend, fitting, plug and valve.
8. For water mains subject to extreme variations in temperature (i.e. attached to bridges, etc.), consideration shall be given to expansion and contraction of the pipe material and the potential freezing of the line's content. Aerial crossings shall incorporate expansion couplings in the

design.

9. Water distribution pipe shall be designed based upon a minimum soil weight of 120 lbs./cubic feet and an H2O loading condition with a minimum 3.5 feet of cover.
10. For pipe sizes 12-inches or less, ductile iron pipe shall be pressure class 350. For pipe sizes larger than 12-inches, pressure class 250 ductile iron pipe shall be used.
11. If the main alignment requires deflection in excess of the specified limitations or as determined by the Public Works Commission, bends shall be utilized. Joint deflection shall not exceed the limits recommended by the pipe manufacturer.
12. Ductile Iron River Crossing Pipe or "Ball Joint" pipe shall be a restrained joint. Pipe thickness class shall be as recommended by the manufacturer, and as approved by PWC. Pipe bell deflection per joint shall be as recommended by the manufacturer. Pipe end shall be tapered by manufacturer to ensure pipe end does not block flow when pipe is deflected. The use of ductile iron "River Crossing" or "Ball Joint" pipe shall only be utilized for underground crossings. The use of this pipe on aerial crossings is not allowed.

G. VALVES

1. Valves shall be installed at all pipeline intersections, changes in pipe diameter between mains, and on hydrant branches according to the following:
 - Crosses (4 intersecting mains) 3 valves
 - Tee Intersections (3 intersecting mains) 2 valves
 - Hydrant Branch (on branch line)1 valve
2. A proposed connection of a new water line to an existing water line may include provisions for the addition of sufficient valves to the existing water line to meet the requirement of a tee intersection, as deemed necessary by PWC.
3. Maximum valve spacing (in-line valves) shall be 1,500 feet in the distribution system and 2,500 feet for transmission mains 16 inches in diameter and larger.
4. Size and type of valves shall be shown on plan view. All two (2) inch valves shall be quarter turn ball valves, in accordance with PWC specifications. All other valves shall be resilient wedge gate valves, in accordance with PWC specifications. All valves shall be placed in the vertical position, unless otherwise approved by PWC. The use of bevel gearing is not allowed without prior approval from PWC.

5. Valves located within sections of restrained joint ductile iron pipe shall be restrained to the pipe. For valves on mains 12-inches and smaller, the use of a mechanical restraint system (i.e., mega-lugs) shall be utilized. For valves on mains 16-inch and larger, the use of factory restraint systems (i.e., Harness-Lok, etc.) shall be utilized.
6. All valves on transmission mains, 16-inches in diameter and larger, shall be restrained joint ductile iron gate valves. The restraint system shall be compatible with the factory restraint system utilized on the piping.
7. Valve boxes shall be installed to allow operation of all valves. Valve box protectors shall be installed in unpaved areas.
8. Street intersection valves shall be located at the tee, unless otherwise approved by PWC.
9. Where valves must be located away from street intersections, (such as along transmission main) valves should be located at hydrant branches and/or property lines.
10. Valves shall not be located in curb and gutter or in the flow line of wedge asphalt curb or in ditches and ditch slopes.
11. For one way feeds and dead end mains to be extended, valves shall be located on the dead end side of the hydrant branch with no service connection beyond the mainline valve.
12. When transitioning from a larger main to a smaller main (e.g., 8 inch to 2 inch), locate valve on the smaller diameter pipe.
13. Each fire hydrant shall have a six (6) inch hydrant branch valve. Valves on a hydrant branch shall not be located in curb and gutter or ditch.
14. Post indicator valves (PIV) and Fire Department Connections (FDC) are not regulated by PWC, but shall be installed in accordance with the local governing authority's rules and regulations.

H. FIRE HYDRANTS

1. Fire hydrants shall be installed on water mains eight (8) inches in diameter or larger and that are designed to provide adequate fire protection flows at the required residual pressure. Fire hydrants may be installed on six (6) inch mains when a larger main is not available; provided that the required fire flow can be met. The design engineer shall provide PWC with a design report, to include calculations, that indicates all hydrants can achieve the required fire protection flows as outlined in Appendix B of the North Carolina Fire Code (most recent edition), as approved by the local governing authority.

2. Fire hydrant spacing and location within the City of Fayetteville shall be in accordance with the most recent edition of the International Fire Code and shall be subject to review and approval of the Fire Marshal of the City of Fayetteville.
3. Fire hydrant spacing and location within the Town of Hope Mills shall be in accordance with Subdivision Ordinance of the Town of Hope Mills and shall be subject to review and approval of the Fire Marshal of the Town of Hope Mills.
4. Fire hydrant spacing and location outside of the City of Fayetteville and the Town of Hope Mills shall be subject to review and approval of the Cumberland County Fire Marshal.
5. For new subdivisions, where structures are not known, fire hydrant spacing shall be measured along street right-of-way and spaced as required by the local governing authority. Radial measurement and/or spacing (i.e. "as a bird flies") are not acceptable. Additionally, measurements across lots, which front different streets, will not be permitted for purposes of satisfying the spacing requirement.
6. In instances where structures front multiple public right-of-ways, fire hydrants shall be provided and spaced as defined above along each public right-of-way, as required by the local governing authority.
7. Structures located on multi-lane (4 lanes or more) roads or highways shall require fire hydrants located on the same side of the roadway as the structure. Staggering fire hydrants in relation to the opposite side of the roadway is recommended, however hydrant branches should not cross multiple lanes of traffic. Parallel mains shall be utilized on multi-lane facilities so that long hydrant branches will not be needed, unless otherwise approved by PWC.
8. Generally, fire hydrants should be located at street intersections and property corners. Intermediate fire hydrant placement shall be located at property corners. Consideration should be given to other utilities such as power, telephone, and cable locations. In all instances, hydrants should be placed to afford protection from vehicle collisions, etc.
9. Fire hydrant spacing along water transmission mains (16 inches and larger) located in undeveloped areas shall be a maximum of 2,500 feet.
10. Fire hydrants shall be installed 18 inches inside the right-of-way measured to the hydrant centerline. Hydrants shall not be located in the back slope of a roadside ditch.
11. Hydrant branches shall have a minimum of three and a half (3.5) feet of

cover unless local conditions dictate otherwise, such as ditch bottoms, but in no case less than two (2) feet of cover with prior approval by PWC. The bury depth of the hydrant shall be in accordance with PWC details and specifications.

12. New fire hydrants should not be located closer than 50 feet to a structure unless approved otherwise.
13. Fire hydrants shall be located on the same side of the roadway as the water main, unless otherwise approved.
14. No fire hydrant older than three (3) years shall be installed, as determined by the manufacture date stamped on the hydrant.
15. Fire hydrants older than 20 years shall be replaced as part of the new construction, retrofit, and/or rehabilitation.

I. FIRE LINES

1. General

- a. Fire lines are required by code to be installed at commercial developments as well as multi-family housing developments, unless otherwise approved by the local governing authority.
- b. Fire lines six (6) inches and larger must be permitted by PWC through the local permitting authority.

2. Materials

- a. Fire lines four (4) inches and larger shall be restrained joint ductile iron from the tap of the main to the right-of-way boundary or easement line. All two (2) inch fire lines shall be PVC, SDR-21, from the tap to the right-of-way or easement.
- b. Domestic services and irrigation services may be tapped off of fire lines which are greater than two (2) inches in diameter. Valves shall be placed to allow either the domestic or fire line to remain in service, as indicated on PWC standard details. When a two (2) inch fire line is used the domestic and irrigation services must be tapped off of the main. See PWC Standard Details for further illustration.

3. Ownership and Maintenance

- a. PWC will operate and maintain fire lines located at commercial facilities from the tap on the main to the right-of-way/easement line, whichever is applicable. The fire line shall be constructed and tested in accordance with PWC's standards and specifications to the right-of-way/easement line. The remainder of the fire line from the right-of-way/easement line to the building will be overseen by

the local governing authority.

- b. PWC will operate and maintain fire lines located at multifamily developments from the tap on the main to the closest point which is 10 feet from the face of the building, unless otherwise approved by PWC. The fire line shall be constructed and tested in accordance with PWC standards and specifications to the point which is 10 feet from the building. The remainder of the fire line from the above-mentioned point to the building will be overseen by the local governing authority.

4. Fire Department Connections

- a. All Fire Department connections (FDC) shall be located on the customer side (i.e., private) of the backflow preventer.
- b. The FDC shall be located in accordance with, and as approved by, the local governing authority.
- c. Fire lines with FDC shall have a reduced pressure detector assembly (RPDA) for the backflow device. Fire lines without a FDC shall have a double check detector assembly (DCDA) for the backflow device. All backflow devices shall be approved by PWC.

5. Testing and Disinfection

- a. If the fire line has a domestic or irrigation service, both the fire line and service shall be tested and disinfected, regardless of the length.
- b. If the fire line does not have any services connected to it, disinfection is only required if the total length of the fire line is greater than 20 linear feet (i.e., one (1) full joint of pipe).
- c. If the fire line is greater than 20 linear feet, then it shall be pressure tested.
- d. All testing and disinfection shall be done in accordance with PWC requirements.

J. WATER METER SIZING

1. General

- a. Water laterals greater than 1 inch with meters larger than 1.5 inches shall be sized in accordance with AWWA Manual M22, "Sizing Water Service Lines and Meters", and subject to PWC approval. The size of the proposed water meter shall be determined by the number of gallons per minute required for the facility, and this flow rate provided to PWC to verify the meter size. Documentation of how the flow rate was determined is required for all proposed meters greater than 1.5 inches. The Design Engineer shall be responsible to insure head loss through the meter meets the project requirements.
- b. Irrigation systems shall be metered separately and shall be sized based on the flow demand.

- c. The selection of the type and size of the meter should be based only on the flow requirements and the type of use, not on the pressure loss through the meter.
- d. If the flow demand is anticipated to increase in the future (i.e. project phasing/expansion), provisions should be made to install a meter box and connections for the future demand, but the meter shall be sized for current demands and changed, as future demands require.
- e. All improvements on the property side (outlet) of the meter shall be in accordance with the current Plumbing Codes. Properly sizing water service lines, backflow prevention devices, and pressure reducing valves to maintain adequate water flow and pressure from the meter to the structure and/or point of demand shall be the responsibilities of the property owner.

2. Single Family Residential Units

- a. Provide 1-inch copper, type K or polyethylene water lateral for each single-family dwelling unit with a 5/8 inch meter.

3. Residential and Commercial Facilities

- a. For meter sizing use AWWA manual M22 "Sizing Water Service Lines and Meters".
- b. Calculations shall be submitted by the Design Engineer to verify meter size selection for meters greater than 1-1/2 inches. The Design Engineer shall provide design calculations in accordance with AWWA M22 "Sizing Water Service Lines and Meters".

4. Master Meters

- a. Master meters are allowed on a case by case basis on multi family projects if the units are to be rented. There must be a master meter for each building if this form of metering is pursued. It will be the responsibility of the developer to manage each unit and correct any problems which may arise.
- b. In no case will master meters be allowed on multi family developments in which individual units are sold.
- c. Manufactured home developments shall be master metered unless otherwise approved by PWC.

K. STREAM CROSSINGS

- 1. Water mains crossing under streams shall be manufactured restrained joint ductile iron pipe. The pipe shall be buried at sufficient depth to provide a minimum of 42 inches of cover between the top of the pipe and the streambed. The pipe and joints shall be protected against streambed

erosion; unstable subsoil conditions and any other anticipated horizontal or vertical loading. Protection measures may include riprap and driven or drilled piers at each pipe joint or use of ball and socket pipe. For large stream crossings, PWC may require specific designs based on subsurface soil investigations.

2. When installing an aerial crossing it shall be the responsibility of the Developer to obtain all applicable regulatory permits. When the aerial crossing is accomplished by attachment to a bridge or drainage structure, the Developer must meet all the requirements of the agencies that own or have jurisdiction over such structures.
3. Water mains used for aerial crossings shall be designed in accordance with PWC technical specifications and standard details. Mega-lugs, field-lok, and gripper rings are not allowable means of restraint. Each aerial crossing shall have a site-specific design, to include: pile embedment length, geotechnical report, how pile refusal will be determined, lateral loading from wind, flood, ice, etc., pile spacing, and thrust restraint, as applicable.
4. Adequate support shall be provided for all joints of pipe utilized for aerial crossings. A licensed professional engineer must design and seal the supports. Expansion joints shall be incorporated into the design to address expansion and contraction of the pipe. Expansion joints shall be provided between the aerial and buried sections of the main. Calculations and design data shall be submitted by the Design Engineer to PWC for review.
5. On aerial crossings the bottom of the pipe shall not be placed any lower than one foot above the elevation of the bottom of the bridge or two feet above the 25 year flood elevation, whichever is greater.
6. Valves shall be installed at both ends of the aerial crossing on the buried main so that the aerial section may be isolated for testing or repair.
7. The ends of the aerial crossing shall be secured so that the public cannot access the main.
8. Railroad crossings shall be in accordance with the railroad's specifications and approved by PWC.

L. HORIZONTAL DIRECTIONAL DRILLING

1. Installation of water mains utilizing horizontal directional drilling is allowed on a case-by-case basis, with prior approval from PWC. Considerations to allow horizontal directional drilling shall include: location of work, future maintenance activities (including cost), traffic control, and environmental impacts. The Design Engineer shall provide supporting documentation to justify the use of horizontal directional

drilling with plan submission.

2. Directional drilling within NCDOT right-of-way shall be done in accordance with NCDOT's "Standard Specifications for Roads and Structures", most recent edition.
3. All horizontal directional drilling shall be completed in accordance with PWC standard technical specifications and the requirements of this Manual.
4. Installation of water mains utilizing horizontal directional drilling shall meet all separation requirements as outlined in this Manual, the NC DENR rules and regulations, and PWC standard specifications. Where the minimum separations cannot be met, installation of ductile iron pipe shall be made to a point 10 feet on either side of the crossing. Upon request, the contractor shall verify that the required separation requirements have been met, through "potholing" or other PWC approved methods.
5. Either high-density polyethylene (HDPE), fusible PVC, or restrained joint ductile iron pipe shall be utilized for horizontal directional drilling. No other materials are acceptable. The Design Engineer shall furnish the proposed pipe material to PWC for review and approval, prior to starting construction.
6. The depth of cover for water mains installed utilizing horizontal directional drilling shall be 3.5 feet, unless variations are required due to separation requirements. Variations shall be clearly noted on the plans submitted to PWC for approval, prior to construction.
7. HDPE shall be ductile iron pipe size (DIPS), unless otherwise approved by PWC. **The interior diameter of the new pipe shall closely match the interior diameter of the existing pipe, unless otherwise approved by PWC.**
8. Subsurface geotechnical investigations are strongly recommended to be completed, prior to selecting horizontal directional drilling as the method of installation. PWC reserves the right to request the geotechnical reports for their review, as part of their approval process.
9. It is the design engineer's responsibility to verify field conditions, including subsurface utilities and geotechnical information, prior to selecting an installation method.
10. PWC reserves the right to reject the installation of the water main utilizing horizontal directional drilling, and require an alternate method of installation.
11. Upon completion of the work, a copy of the drill log shall be furnished to

the Design Engineer and PWC that provides “as-built” information on the line and grade of the installed water main. The drill log shall include horizontal and vertical information on the location of the installed water main, so that the Design Engineer can prepare and submit an “as-built” plan and profile. The drill log shall report horizontal and vertical location a minimum of every 50 feet, or as necessary to accurately determine the location of the installed water main in relation to other utilities and conflicts. The drill log shall clearly provide the recorded information, and shall be submitted to PWC upon completion of the project.

M. THRUST RESTRAINTS

1. Thrust restraint for water mains shall be provided by concrete thrust blocks bearing on undisturbed soil or by approved restrained pipe joints for a specified distance. The bearing area for thrust blocks shall be based on the required test pressure of 200 psi, a Type 3 trench condition with a safety factor of 2, and a field determination of the load bearing capacity of the soil. The Design Engineer shall consider the restraint required for valves as a dead-end condition.
2. Acceptable restrained joint types shall be as outlined in the PWC Specifications or as approved by the PWC. Restrained lengths shall be calculated for each application. Calculations shall be based on a test pressure of 200 psi, 3.5 feet of cover and Type ML soil conditions with a safety factor of 2.0.
3. Design of restrained lengths of water distribution systems greater than or equal to 16 inches in diameter shall be performed in accordance with the AWWA standards. Ductile iron mains twelve (12) inches or less in diameter shall be restrained as indicated on PWC’s Standard Detail W.18 “Alternate Restraint Detail”. All water distribution mains twelve (12) inches or less in diameter that are not ductile iron shall be restrained by utilizing thrust blocking as indicated on PWC’s Standard Detail W.17 “Concrete Thrust Block Detail”. The Design Engineer is responsible to evaluate existing conditions, soils, cover requirements, calculate the required restraining lengths, and, upon request from PWC, provide documentation to support the resulting restrained lengths. The Design Engineer shall indicate the locations and lengths of the restrained joint ductile iron pipe on the plans.

N. RELATION OF WATER MAINS TO SEWERS

1. Lateral Separation of Sewers and Water Mains: Water mains shall be laid at least 10 feet laterally from existing or proposed sewer main and/or lateral, unless local conditions or barriers prevent a 10-foot lateral separation - in which case:
 - a. The water main is laid in a separate trench, with the elevation of the

bottom of the water main at least 18 inches above the top of the sewer main and/or lateral; or

- b. The water main is laid in the same trench as the sewer main and/or laterals with the water main located at one side on a bench of undisturbed earth and with the elevation of the bottom of the water main at least 18 inches above the top of the sewer main and/or lateral.
2. Crossing a Water Main Over a Sewer Main and/or Lateral: Whenever it is necessary for a water main to cross over a sewer main and/or lateral, the water main shall be laid at such an elevation that the bottom of the water main is at least 18 inches above the top of the sewer main and/or lateral, unless local conditions or barriers prevent an 18 inch vertical separation - in which case both the water main and sewer main and/or lateral shall be constructed of ferrous material and with joints that are equivalent to water main standards for a distance of 10 feet on each side of the point of crossing.
 3. Crossing Water Main Under a Sewer Main and/or Lateral: Whenever it is necessary for a water main to cross under a sewer main and/or lateral, ***both the water main and the sewer main and/or lateral shall be constructed of ductile iron material*** and with joints equivalent to water main standards for a distance of 10 feet on each side of the point of crossing. A section of water main pipe shall be centered at the point of crossing.
 4. Crossing Storm Drainage Lines: A minimum of 12-inches of vertical clearance shall be maintained between a water line crossing over a storm drainage line unless ductile iron pipe is used. In addition, three and a half (3.5) feet of cover must be maintained over the water main or it shall be ductile iron. If ductile iron pipe is used then two and a half (2.5) feet of cover must be maintained over the water main and a minimum of four (4) inches of vertical clearance shall be maintained between the water main and the storm drainage line. Where a water main crosses under a storm drainage line a minimum of twelve (12) inches of vertical separation shall be maintained and the water main shall be ductile iron for a distance of 10-feet on each side of the crossing.

O. CROSSING EXISTING OR PROPOSED UTILITIES

1. Relation To Other Utilities
 - a. Underground telephone, cable TV, and gas utilities or conduit banks shall be crossed maintaining a minimum of 12-inch separation or clearance.
 - b. Where possible, electrical crossings shall be performed while the conductor is de-energized and at all times in the presence of the service provider. Electrical primary conductor crossings shall be as follows:

- i Crossing over a conductor, maintain a minimum of 12 inches of undisturbed soil encasing the conductor.
- ii Crossing under a conductor shall be accomplished by boring maintaining 12 inches of undisturbed soil encasing the conductor.

Refer to PWC's standard specifications, the National Electric Code (NEC), and details on underground electrical crossings for additional requirements and information. In the event that there is a conflict between the PWC standard specifications and the National Electric Code (NEC), then the more stringent shall apply.

IV. CROSS CONNECTION PREVENTION

A. GENERAL

1. A copy of the City of Fayetteville's Cross Connection Control Ordinance is available by contacting the PWC System Protection Department at (910) 223-4699.
2. The System Protection Department can provide a list of backflow prevention assemblies, approved by the Public Works Commission for protection of its public water supply.
3. Lawn irrigation systems are required to have a split tap service or a designated lawn irrigation service tap. The connection of a lawn irrigation system to a domestic tap is prohibited.
4. Fire lines with Fire Department connections (FDC) shall have a reduced pressure detector assembly (RPDA) for the backflow device. Fire lines without a FDC shall have a double check detector assembly (DCDA) for the backflow device. All backflow devices shall be approved by PWC

B. LOCATION OF BACKFLOW PREVENTION ASSEMBLIES

1. All backflow prevention assemblies shall be installed in accordance with the requirements of the Cross Connection Control Program and shall be located before any branch connections to the private system. Backflow prevention assemblies shall also be located between the meter and the facility with not less than five (5) feet of horizontal separation between the meter and backflow enclosure/vault.
2. Backflow assemblies for fire protection systems shall be located within 100 feet of the tap at the water main, unless otherwise approved by PWC. In all cases fire hydrant branches more than 100 feet in length will require a backflow assembly. It is noted that some situations may require a backflow prevention device on fire hydrant branches that are less than 100 feet, as determined by PWC and the Design Engineer.

3. Backflow assemblies shall be required for any application in which possible pollution or contamination of the public water supply system could result from a cross-connection.
4. In accordance with the Terms and Conditions of the City of Fayetteville's Cross Connection Control Ordinances and the Rules Governing Public Water Supply Systems, the severity of the potential effects upon public health shall determine the minimum degree of protection required. PWC will review each case on an individual basis.
5. Backflow prevention assemblies shall be installed on non single family residential meters and on any privately owned and maintained fire lines, distribution systems, domestic services lines, irrigation systems, etc. (For example, an apartment complex that has a master meter will be required to have a BFP, but an apartment complex with individual meters for each unit does not, since these are considered single family residences. In a situation where a meter serves multiple units a BFP is required). The Design Engineer shall determine the type of backflow prevention assembly based on the type of connection to the public water supply, subject to PWC approval.

C. BACKFLOW PREVENTION ASSEMBLIES

1. The following should be considered before selecting a particular assembly:
 - a. All plumbing laws and regulations **must** be adhered to.
 - b. All backflow prevention assemblies **shall** be installed in accordance with specifications furnished by the Public Works Commission and the manufacturer's installation instruction. Note: PWC's installation instructions supersede the manufacturer's instructions, due to local requirements.
 - c. Reduced pressure principle assemblies **must** be installed in a horizontal position and in a location in which no portion of the assembly can become submerged under any circumstances (pit/below grade installations are prohibited).
 - d. All double check backflow prevention assemblies 2 ½" and larger shall be installed above ground in accordance with detailed specifications provided by the Public Works Commission unless approved differently by the PWC General Manager or designee.
2. The operations and performance of these assemblies may vary among manufacturers. Because of local pressure conditions, it is suggested that the PWC System Protection Supervisor be contacted at (910) 223-4699 to assist in selecting an assembly.

3. The Public Works Commission of the City of Fayetteville reserves the right to add to or remove any Reduced Pressure Backflow Prevention Assembly, Double Check Valve Assembly, or Pressure Vacuum Breaker Backflow Preventer from the approved list.
4. It is a requirement that backflow prevention assemblies be tested immediately after installation and at least once a year thereafter by a person approved by the Public Works Commission. A copy of the test results **must** be sent to the Public Works Commission System Protection Department immediately (within 10 days) after testing.
5. Any time that repairs to backflow prevention assemblies are deemed necessary, whether through initial, annual testing, or routine inspection by the owner or by the Public Works Commission, these repairs **must** be completed within a specified time in accordance with the degree of hazard. In no case **shall** this time period exceed 30 days. Should you have any questions concerning the above-mentioned testing requirements, contact the PWC System Protection Department at (910) 223-4699.
6. Personnel of the Public Works Commission will conduct testing of backflow prevention assemblies on a random basis to ensure that the assemblies are operating properly. The owner will be given adequate advance notification prior to the test.
7. By-pass piping is not permitted unless the by-pass piping is equipped with an approved backflow prevention assembly of the same type as the main line assembly. In many instances it will be necessary to install two approved backflow prevention assemblies in order that water service will not be interrupted during the testing/repair of the assembly.
8. When cross-connections are found to exist, the owner, his agent, occupant, or tenant will be notified in writing to disconnect the same within the time limit established by the Public Works Commission. The degree of protection required and maximum time allowed for compliance will be based upon the potential degree of hazard to the public water system. The maximum time limits are as follows:
 - a. Cross-connections with private wells or other unapproved auxiliary of water - immediate disconnection of unapproved source.
 - b. Cross-connections requiring correction through 1) elimination; 2) air gap separation; 3) reduced pressure zone backflow prevention assembly, double check valve assembly, or pressure vacuum breaker for sizes $\frac{3}{4}$ " through 2" - up to thirty (30) days.
 - c. Cross-connections requiring correction through reduced pressure zone backflow prevention assembly or double check valve assembly for sizes $2\frac{1}{2}$ " and larger - up to sixty (60) days.

D. LIST OF APPROVED BACKFLOW PREVENTION ASSEMBLIES

Note: A list of the approved backflow prevention assemblies is located on the PWC website (www.faypwc.com). Please contact the PWC System Protection Department for the most up to date list of approved assemblies. There is no implication of preference of assemblies. Assemblies are subject to revision as the devices are evaluated and approved by PWC.

Note: All assemblies approved for use in the PWC system must have prior approval by Foundation for Cross-Connection Control and Hydraulic Research, University of Southern California.

Note: Backflow Prevention Assemblies two (2) inches and smaller shall have one quarter ($\frac{1}{4}$) turn, full port, resilient seated, bronze ball valve shut-off.

Note: Assemblies two and one half ($2\frac{1}{2}$) inches and larger shall have resilient wedge shut-off valves. The backflow preventer and resilient wedge shut-off valves must be fusion bonded epoxy coated.