

CHAPTER 10

WATER MAIN DESIGN

1. GENERAL

- 1
2
3 A. This chapter covers the minimum design criteria to be used for designing water pipelines
4 and appurtenances including those portions of water service connections that lie in
5 public rights-of-way and in easements granted to Charlotte Water. All other systems are
6 the responsibility of the respective property owner unless otherwise documented via
7 agreement with Charlotte Water.
8
9 B. All engineering plans for water pipelines must meet the Charlotte Water design
10 standards as presented and the State standards as indicated in the most recent
11 amended *North Carolina Administrative Code, Title 15A, Subchapter 18C, Section .0900*
12 *Distribution Systems* administered by the North Carolina Department of Environmental
13 Quality (NCDEQ). In general, the Charlotte Water standards should be the primary
14 source for design guidance with the State standards as a supplement. In some cases,
15 the Charlotte Water standard is more stringent than the State standard.
16
17 C. All projects must be sealed by a North Carolina professional engineer.

2. HYDRAULIC DESIGN

A. General

- 21
22
23 1) In general, water distribution systems shall be designed to provide adequate flow
24 and pressure for both domestic supply and fire protection.
25
26 2) A North Carolina Professional Engineer shall submit calculations upon Charlotte
27 Water's request for all flow requirements including fire flow, average daily flow,
28 maximum daily flow, and peak hourly flow.
29
30 3) Available water pressure and capacity can be confirmed with the Charlotte Water
31 Planning Division.
32

B. Fire Flow and Residual Pressure

- 33
34
35 1) New water infrastructure shall meet a minimum fire flow of 1,000 gallons per minute
36 in an 8-inch main with a residual pressure of 20 pounds per square inch (psi), as
37 measured at the hydrant being tested.
38
39 2) It is the responsibility of the Engineer of Record to incorporate private booster
40 pumping if needed to meet flow and pressure criteria on the parcel. If booster
41 pumping is required, the Engineer of Record shall confirm the distribution main can
42 meet the required booster pumping and testing flows and pressures for the parcel
43 without affecting the domestic supply and fire protection for adjacent parcels.
44
45 3) Local fire district shall govern fire flow requirements for individual parcels.
46

- 1 4) Mixed-use developments, significant users, and large developments (developments
 2 with more than 100 parcels) shall provide redundant connections to the distribution
 3 system, maintain fire protection sizing throughout, and minimize dead ends. An
 4 outage analysis shall demonstrate less than 100 customers or residential units will
 5 be affected during an outage.
 6
 7 5) The bottom elevation of the elevated storage tanks in the distribution system to be
 8 used for consideration of fire flows is summarized in Table 10.1:
 9

Pressure Zone	Tank Bottom Elevation (ft)
882	847.0
960	922.0
978	939.0

10
 11 C. Demands
 12

- 13 1) Water distribution systems shall be sized to serve the foreseeable demands at full
 14 build-out of the service area or projected demands of at least 50 years.
 15
 16 2) Average Day Demand (ADD) shall be calculated from plumbing fixture counts,
 17 number of services, and Future Land Use (FLU). It is the average flow that a water
 18 main is expected to handle within an annual basis.
 19
 20 3) Maximum Day Demand (MDD) is the maximum volume expected to flow through a
 21 main in a single 24-hour period in a year.
 22
 23 4) Peak Hour Demand (PHD) is the maximum volume expected to flow through a main
 24 in a single hour period in a year.
 25
 26 5) The peaking factors to calculate MDD and PHD is summarized in Table 10.2.
 27

Demand	Peaking Factor
MDD	1.6 x ADD
PHD	1.7 x MDD

- 28
 29 6) Instantaneous demand for residential areas shall be based on the number of 5/8-inch
 30 service connections, based on Figure 4-1 *AWWA Manual M22 Sizing Water Service*
 31 *Lines and Meters*. Instantaneous demand for business and industrial development
 32 shall be based on detailed analysis of water volume and usage patterns for the given
 33 type of development.

1
2 D. Pressures
3

4 Water systems shall be designed to supply the demands of all customers while
5 maintaining the following minimum pressures, as measured at the meter or at the back
6 of curb of each parcel, shown in Table 10.3.
7

Table 10.3: Minimum Pressures	
Demand	Pressure (psi)
MDD	40 psi
PHD	30 psi
MDD + Fire Flow	20 psi

8
9 E. Velocities
10

- 11 1) Pipelines shall be designed to meet the following maximum velocities summarized in
12 Table 10.4.
13

Table 10.4: Maximum Velocity		
Demand	Pipe Size (in)	Maximum Velocity (ft/s)
PHD	All	5.0
MDD + Fire Flow	< 16	10.0
MDD + Fire Flow	≥ 16	7.0

- 14 2) Mains shall be designed to provide:
15
16 a. 5 feet per second (fps) for flushing mains 12-inches or less
17
18 b. 4 fps for flushing for mains 12-inches or greater
19
20

21 F. Head Loss Criteria
22

- 23 1) A Hazen-William C-factor of 120 shall be used for new pipes 16-inches and smaller,
24 to account for hydraulic degradation over the life expectancy of the pipe.
25
26 2) Pipes greater than 16 inches should be designed to meet the performance criteria in
27 Table 10.5 when velocities are 5.0 fps.
28

Table 10.5: Allowable Head Loss	
Size	Allowable Head Loss
> 16 to 36-inches	5.0 ft / 1,000 linear feet
> 36 to 54-inches	3.0 ft / 1,000 linear feet
> 54-inches	2.0 ft / 1,000 linear feet

- 3) A C-factor of no greater than 100 shall be used for the existing pipe between the fire hydrant tested and the new system tie-in connection. The C-factor of the existing pipe may be reduced from 100 down to a value of no less than 25 by Charlotte Water depending on the location within the distribution system.
- 4) All calculations and pipe sizes shall be based on actual internal diameter (ID) of the pipe, not the nominal pipe size.

G. Services

- 1) Services and meters, including irrigation meters, shall be sized and locations designed in accordance with the Water Standard Details and Water Meter Standard Details.
- 2) The minimum service size shall be a 3/4-inch service tube with a 5/8-inch meter.
- 3) Any water service customer which has a static water pressure greater than 80 psi is required by North Carolina State Building Code to install and maintain a pressure reducing valve (PRV), to be installed on the building service line after the meter. This installation is covered by the Plumbing Code and is not maintained by Charlotte Water.
- 4) Individual taps on lines 20-inches or greater are not permitted unless absolutely needed. Consideration by Charlotte Water will be given for isolated services and customers on a case-by-case basis. Both sides of the tap 8-inches and larger shall include mainline valves for isolation and parallel connection feeds to meet fire flow requirements.

H. Private Systems

- 1) Private distribution systems including potable and non-potable, shall meet the cross-connection control requirements of 15A NCAC 18C .0406(b) which requires installation of a testable backflow prevention assembly or air gap.
- 2) Looped private distribution systems are discouraged and will only be considered by Charlotte Water if it is needed to meet fire flow requirements.

1 I. Minimum Pipe Sizing and Limitations on Use of Small Diameter Mains
2

- 3 1) The minimum water main diameter when providing public fire flow shall be 8-inches.
4
5 2) 2-inch lines may be used within residential subdivisions on cul-de-sacs or dead end
6 right of way with no potential for future extension for a maximum length of 1,000 feet
7 where fire flow requirements and minimum hydrant spacing is provided by water
8 mains 8-inches and larger.
9
10 3) No more than 10 residential customers, or the equivalent of 10 residential customers,
11 with 5/8-inch services may be served from a dead-end 2-inch main.
12
13 4) No more than 20 residential customers, or the equivalent of 20 residential customers,
14 with 5/8-inch services, may be served from a looped 2-inch main. A looped 2-inch
15 main is connected to a minimum 6-inch main on each end.
16
17 5) The maximum service size on 2-inch mains shall be 1 ½-inch service.
18

19 J. Terminal Ends
20

- 21 1) The maximum length of a dead-end 8-inch water main is 2,000 feet.
22
23 2) The terminal end of 8-inch and larger water mains shall have a fire hydrant or a
24 permanent auto-flusher at Charlotte Water’s discretion.
25

26 **3. LOCATION AND DEPTH**
27

28 A. Location
29

- 30 1) In general, water mains shall be located only within the limits of public road rights-of-
31 way (ROW). Where this is not achievable, any water main location in an easement
32 outside of a public road ROW and not adjacent to a road must be approved by
33 Charlotte Water. Specific horizontal alignment shall be made with consideration to
34 property lines, construction conditions, underground conflicts, and property owner
35 requirements.
36
37 2) Water mains shall not be located in either public or private alleys.
38
39 3) When an existing water line is replaced with new pipe, the existing water services
40 along this section must be replaced from the main line to the angle valve on the front
41 side of the meter yoke bar. The existing tailpiece assembly is not replaced.
42
43 4) Any pipes requiring replacement due to upsizing and/or relocating shall be to
44 property lines unless otherwise approved by Charlotte Water.
45

46 B. Depth
47

- 48 1) Depth of water mains shall be set to minimize high and low points and shall be
49 measured from top of pipe.
50

1
2

2) Minimum cover depths per pipe size shall be as shown in Table 10.6.

Table 10.6: Minimum Cover Depth Allowable for Water Main Pipe Size		
Pipe Size (inches)	Minimum Depth* in Road Rights-of-Way (feet)	Minimum Depth in Cross- Country Easements (feet)
≤ 12	3	5
16	4	5
24	5	5
≥ 30	6	6
*Minimum depth of pipe shall ensure all applicable clearances are met, with consideration given for future utility locations.		

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Table 10.6 ensures pipe will be buried to a depth below the frost line in Mecklenburg County (approximately 12 inches). In no case shall any pipe be installed with less than 30 inches of cover.

3) Minimum cover depth requirements of water main located inside a road right-of-way shall be based on the top of pipe below the adjacent roadway pavement edge of pavement elevation or below the pipe centerline ground elevation, whichever is greater. Charlotte Water reserves the right to require more depth of cover if needed.

13 **4. PIPE MATERIAL AND THICKNESS DESIGN**

14
15
16
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The following pipe materials, displayed in Table 10.7, are approved for various applications. All pipe sizes shall be based on internal diameter (ID). Thickness requirements below are based on a minimum depth of cover of 3 feet. If depths are approved less than 3 feet or if depth of cover exceeds 10 feet, then the pipe thickness must be determined by AWWA standards or the Ductile Iron Pipe Research Association (DIPRA) thickness design calculator based on cover depth and type of bedding to be used.

Table 10.7: Water Main Materials and Thickness			
Pipe Size (inches)	Material	Thickness	Specifications
SERVICE LINES			
¾ - 2	Copper	Type K	ASTM B88
¾ - 1	HDPE	SDR 9 Copper Tube Size	ASTM D2737 AWWA C901
1 ½ - 3	HDPE	DR 9 IPS	ASTM D3035 AWWA C906
≥ 3	DIP, RJ	Pressure Class 350	AWWA C151
DISTRIBUTION LINES			
2	HDPE	SDR 9 IPS	ASTM D3035 AWWA C901
	PVC	SDR 13.5	ASTM D2241
6 - 12	HDPE	DR 9 IPS	AWWA D3035 AWWA C906
	PVC	SDR 14	AWWA C900
	DIP	Pressure Class 350	AWWA C151
TRANSMISSION MAINS			
16 - 30	DIP	Pressure Class 250 Minimum, Thickness design per AWWA C150	AWWA C151
16 - 32	HDPE	DR 9 IPS	AWWA D3035 AWWA C906
36 - 64	DIP	Pressure Class 250 Minimum, Thickness design per AWWA C150	AWWA C151
≥ 36	PCCP	Per Appendix C AWWA C301	AWWA C301
	Steel	Special Cases for Charlotte Water Review	AWWA M11

1
2 **5. THRUST RESTRAINT**

3
4 A. Thrust Blocks

- 5
6 1) Thrust blocks may be used on pipe 8 inches and smaller.
7
8 2) Thrust blocks shall be used on pipe greater than or equal 12 inches at all bends and
9 tees.
10
11 3) Thrust blocks shall bear on undisturbed soil.

12
13 B. Restrained Joints

- 14
15 1) Restrained joints shall be integrally cast at the factory. Field-installed restrained
16 joints will not be allowed. Push-on joint gripper gasket restraint may be used on 12
17 inch and smaller ductile iron pipe. Gripper gasket restraint shall not be used on larger
18 diameter ductile iron pipe or any size plastic pipe.

1
2 C. Thrust Restraint Criteria

3
4 Thrust restraint criteria is summarized in Table 10.8, per *AWWA Manual M41 Ductile*
5 *Iron Pipe and Fittings* and *DIPRA Thrust Restraint Design for Ductile Iron Pipe*, latest
6 editions, shall be used to calculate thrust and joint restraint length.
7

Table 10.8: Thrust Restraint Criteria per AWWA M41	
Variable	Criteria
Pressure (whichever is greater)	<ul style="list-style-type: none">• Working pressure plus surge pressure• Working pressure x 1.5• 200 psi
Soil Type for Bearing Strength	<ul style="list-style-type: none">• Actual soil type• Silt 1 (if soil type is unknown)
Safety Factor	<ul style="list-style-type: none">• Two (2)
Cover Depth	<ul style="list-style-type: none">• Table 10.6 or actual depth if shallower is approved
Trench Type or Laying Designation	<ul style="list-style-type: none">• Type 2 when Charlotte Water Type 1 bedding is used• Type 3 when Charlotte Water Type 1A bedding is used• Type 4 when Charlotte Water Type II bedding is used• Type 5 when Charlotte Water Type III or greater bedding is used

8
9 **6. VALVING REQUIREMENTS**

- 10
11 A. Main line valves shall be located at all pipeline intersections and at changes in pipe
12 diameters.
13
14 B. Isolation valves should be added to minimize the number of customers affected during
15 an outage.
16
17 C. Maximum valve spacing shall be 1,500 feet for distribution lines, 2- to 12-inch lines.
18
19 D. Maximum valve spacing shall be 3,000 feet for transmission mains, 16 inches and larger
20 mains.
21
22 E. Maximum valve spacing shall be 250 feet within the Central Business District (CBD)/
23 inside of the I-277 loop, Neighborhood 2-B Zoning District or greater, and Transient-
24 Oriented Development (TOD).
25
26 F. Intersecting pipe may utilize a cross-style connection up to a maximum diameter of 12-
27 inches. Round connections shall be used for pipe larger than 12-inches in diameter.
28
29 G. Three (3) valves shall be provided at all tees and four (4) valves shall be provided at all
30 crosses, with valves located at road intersection radius points or as close to the fittings
31 as possible.
32

- H. Isolation valves are required on both sides of a water line crossing a railroad, light rail, streetcar rails, major creek/stream, or major road (interstates, US or State numbered highways, roads with 6 or more travel lanes) .
- I. When valves must be located away from intersections due to conflicts, they shall be located at hydrant installations.
- J. If the line is a one-way feed, the valve shall be on the dead-end side of the hydrant branch. On looped mains, the valve should be located downstream from the water flow direction.
- K. Tie-in connections shall be made with tees and valves. Tapping sleeves and tapping valves shall not be allowed. Tapping sleeves and valves are only allowed for service connections. If a size on size service connection is to be installed, a mechanical joint tapping sleeve is required. Bolt-on sleeves are not allowed.
- L. Fire hydrants shall have a hydrant guard valve located at the hydrant tee per the Water Standard Detail on Distribution Mains.
- M. For transmission mains 30 inches and larger, fire hydrants shall have two (2) hydrant guard valves: one (1) at the hydrant tee and one (1) on the fire hydrant line.
- N. Allowable valve types of valves for various applications are summarized in Table 10.9.

Table 10.9: Allowable Valves for Water Mains	
Valve Type	Application and Installation
Butterfly Valves	<ul style="list-style-type: none"> • Water mains 36 inches and larger • Valve operators to be located within a vault
Resilient Seated Gate Valves	<ul style="list-style-type: none"> • Water mains 30 inches and smaller • All Pressure Zone Boundary Valves • ≤ 12 inches, valves direct buried with standard valve box • 16- to 30-inch valves with vertical orientation, direct buried, with 20.5-inch clear opening valve box • 16- to 30-inch valves with horizontal orientation, direct buried, shall have operator/nut located inside a manhole

25
26 **7. FIRE HYDRANTS**

- A. Standard fire hydrants shall be used on 8-inch water mains. For water mains 12 inches and larger, a high velocity fire hydrant shall be used. High velocity fire hydrants are not allowed on water mains less than 12 inches unless approved by Charlotte Water.
- B. Hydrant spacing between public hydrants shall be no greater than 1200 feet for residential purposes or 800 feet for commercial and multifamily purposes. These distances are measured along an improved public roadway.
 - 1) Charlotte Water’s practice is to limit the maximum distance between the public fire hydrant and the building set back line for residential dwelling units except multi-family

1 complexes (e.g., stacked multi-family) to 600 feet as measured along an improved
2 public roadway; this shall be reduced to 400 feet from the building set back line for
3 multi-family residences and commercial developments, measured along an improved
4 public roadway.

5
6 2) These distances are anticipated to assist with meeting NC Fire Prevention Code
7 507.5.1.

8
9 C. Fire hydrants shall be located within 600 feet of a subdivision entrance that includes a
10 public right-of-way.

11
12 D. Fire hydrants shall be located at every arterial, thoroughfare, boulevards, and collector
13 street intersection that include public road rights of way. This requirement is also
14 applicable to Uptown Street classifications as defined in the Charlotte UDO.

15
16 E. Where streets are designed with median dividers or four or more traffic lanes that cannot
17 be crossed by fire fighters pulling hose lines, including those streets incorporating light
18 rail systems, fire hydrants shall be spaced between 400 and 600 feet based on adjacent
19 land use, measured along public street centerlines on alternating sides of the roadway.

20
21 F. Where new water mains are extended along streets where hydrants are not needed for
22 protection of structures or similar fire problems, fire hydrants shall be provided at
23 spacing not to exceed 1200 feet.

24
25 G. Hydrants shall NOT be placed inside the radius points of intersections or commercial
26 driveway entrances.

27
28 H. Hydrants shall NOT be installed in ADA ramps nor impede ADA access requirements.

29
30 I. Hydrants shall be located within the public ROW.

31
32 J. Hydrants cannot be within 15 feet of on-street parking.

33
34 1) Accommodations may include removal of public parking spaces, installation of a
35 grass island, or others as approved by regulatory authority.

36
37 K. Terminal end of a water main 8 inches and larger shall have a fire hydrant or permanent
38 auto-flusher at Charlotte Water's discretion (within 10 feet prior to the last main line
39 valve).

40
41 L. When existing water mains are replaced, fire hydrants shall be spaced at distances
42 described above unless approved by Charlotte Water.

43
44 **8. AIR-RELEASE VALVES, VACUUM VALVES, AND BLOW-OFFS**

45
46 A. Manual air-release valves (ARVs) shall be provided at high points on water mains 12
47 inches and larger.

48
49 B. Manual ARVs shall be provided at high points on 6- and 8-inch water mains where air
50 cannot be adequately released through a service connection.

51

- 1 C. Manual 2-inch ARVs are required on both sides of transmission main line valves 16
2 inches and smaller. 6-inch manual ARV/standard hydrant shall be provided for 20-inch to
3 32-inch water mains and 8-inch manual ARV/high velocity hydrant shall be provided for
4 water mains 36-inches and larger.
5
- 6 D. The Engineer of Record shall evaluate the need for automatic ARV and air vacuum
7 valves (AVV) on pumped lines or any other application where the potential for water
8 column separation exists and supply the results of the surge analysis upon request by
9 Charlotte Water.
10
- 11 E. The Engineer of Record shall use AWWA M51 to determine recommended locations and
12 sizes of automatic ARVs.
13
- 14 F. Automatic ARV and AVV discharge piping shall include a downward-facing elbow with a
15 stainless-steel insect screen.
16
- 17 G. Automatic AVVs shall be located inside vaults.
18
- 19 H. Transmission mains 24 inches and larger shall be designed such that they can be
20 dewatered within 4 hours through blow-offs and fire hydrants.
21
- 22 I. Dead-end lines less than 24 inches shall be terminated with a 2-inch blow-off. Dead-end
23 lines 24 inches and larger shall be terminated with a 4-inch blow-off. Larger blowoffs
24 may be required by Charlotte Water as needed to provide adequate flushing velocities.
25
- 26 J. 12-inch blow-offs shall be installed at low point of 24-inch and larger water mains.
27 Tangential connections are not allowed.
28
- 29 K. Water quality appurtenances, i.e., auto flushers or sampling stations, may be required by
30 Charlotte Water based on the planned development and/or extension network and shall
31 be installed by the developer.
32

33 **9. UTILITY SETBACKS AND SEPARATIONS**

34

35 The minimum clearance requirements for conflicts with utilities and other features, in
36 accordance with NCAC 18C .0904 and .0906 and governing utility guidelines, is shown in
37 Tables 10.10 and 10.11. Depth of cover shall be defined from the top of the pipe. Charlotte
38 Water reserves the right to require increased separations.
39

Table 10.10: Minimum Separations for Water Mains per NCAC 18C .0904 & .0906	
Setback Parameter	Separation Requirements*
Storm Sewers and other utilities not listed below	
Vertical	1 foot
Horizontal	5 feet
Sewer Lines, existing or proposed	
Horizontal	10 feet*
<p>*If local conditions or barriers prevent a 10-foot lateral/horizontal separation, then:</p> <p>1) The water main shall be 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,</p> <p>or</p> <p>2) The water main shall be 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 18 inches above the top of the sewer.</p> <p>And the reasons for preventing the 10-foot separation shall be documented on the permitted plans.</p>	
Vertical, water over sewer including in shared benched trenches or crossings	18 inches
Crossings	Center one full pipe length over crossing to maximize joint distance from sewer
Reclaimed Water Lines	
Vertical, water main over reclaimed water line	18 inches
Horizontal, water main over reclaimed water line	10 feet
Crossings	Center one full pipe length over crossing to maximize joint distance from sewer

Final earth grade (vertical)	Below frost line of 12 inches or minimum 30 inches whichever is greater
Where it is impracticable to provide 30 inches of cover, a deviation may be approved on a case-by-case basis taking into consideration feasibility, cost, and supporting data from the design engineer including pipe material, cover material, land cover, land use, land slope, depth of the frost line, and location of other utilities.	
*At a minimum, 12 inches shall be maintained between the outside of the water main and the outside of other utilities to allow for construction and repair. If it is impractical to maintain the separation distances, a deviation may be approved on a case-by-case basis if supported by data and alternative construction criteria submitted by the design engineer. Data and alternative construction criteria to be provided per 15A NCAC 18C .0904 (c) and .0906 (f).	

1

Table 10.11: Minimum Separations for Water Mains to Other Features	
Parallel pipes in same trench	Minimum 10-foot separation or outside 1:1 slope whichever is greater at the discretion of Charlotte Water
Stormwater BMP	Water main trench remain outside 1:1 slope to the BMP easement
Retaining Wall	Water main to remain 5 feet from footings and outside of geogrid area/structural impact of retaining wall
Roadways	2 feet from edge of pavement and/or back of curb
Any other stream, lake, impoundment, or ground water lowering and surface drainage ditches	10 feet
Any building foundation	10 feet
Any basement	10 feet
Top slope of embankment or cut of 2 feet or more vertical height	10 feet
Drainage systems and interceptor drains	5 feet
Swimming pools	10 feet

2

3

A. Storm structures are not permitted in Charlotte Water easements. Stormwater BMPs are not allowed in Charlotte Water easements.

4

5

6

10. STREAM CROSSINGS

7

8

Stream crossings shall be minimized, and the following design standards shall be followed:

- 1
2 A. Streambanks shall be protected from erosion at all times and shall comply with all
3 requirements of the jurisdiction having authority.
4
5 B. When approved by Charlotte Water, water mains shall cross stream channels at a near-
6 perpendicular direction.
7
8 C. When possible, stream crossings shall be made with the top of pipe a minimum of 5 feet
9 below the stream bed. Pipe shall be protected from flotation by the use of piers, piles,
10 and/or concrete collars.
11
12 D. When necessary, as dictated by depth of cover, stream width, flow conditions, and soil
13 conditions, special anchorage shall be required to prevent flotation and/or washout.
14
15 E. Pipe for submerged stream crossings shall be factory installed restrained joint ductile
16 iron or Charlotte Water approved material.
17
18 F. Aerial stream crossings are not recommended and shall only be reviewed by Charlotte
19 Water in extreme circumstances.
20
21 G. Designers shall be responsible for compliance with floodplain regulations and any
22 approval(s) required by appropriate jurisdiction having authority.
23

24 **11. CORROSION PROTECTION**

- 25
26 A. Where ductile iron pipe may be installed in corrosive soils, polyethylene encasement of
27 the ductile iron pipe and fittings is required. Soil testing shall be required to be conducted
28 by an experienced technician as certified by The Association for Materials Protection
29 and Performance (AMPP) to determine if additional protective measures are required.
30
31 B. Where pipes are installed near impressed current utilities, such as gas pipelines, high
32 voltage power transmission lines, light rail, street cars, and railroads, a stray current field
33 analysis and soil testing shall be required to be conducted by an experienced technician
34 as certified by The Association for Materials Protection and Performance (AMPP) to
35 determine if additional protective measures are required. External protective measures
36 may include zinc coating, polyethylene encasement, or bonded joints and sacrificial
37 anodes as approved by Charlotte Water. PVC or HDPE pipe is preferred. At a minimum
38 ductile iron pipe and fittings shall be double-wrapped in polyethylene encasement. Upon
39 approval of controlling agency, restrained joint C900 PVC carrier pipe inside a casing or
40 open cut HDPE casing pipe may be allowed for 12-inch and smaller water mains.
41
42 C. Reference Chapter 18 Corrosion Control for specific requirements and details for
43 corrosion control and monitoring systems.
44

1 **12. DESIGN OF EROSION AND SEDIMENT CONTROL MEASURES**

2
3 Regardless of size, all water main projects shall include measures and/or devices to prevent
4 erosion and to contain sediment within the limits of the right-of-way and/or proposed
5 easements. Design and permitting of erosion and sediment control devices shall be in
6 accordance with Charlotte Land Development Standards including the City of Charlotte Soil
7 Erosion and Sedimentation Control Ordinance for Developer-Donated projects. Charlotte
8 Water designed projects shall meet NCDEQ requirements, as outlined in the North Carolina
9 Erosion and Sediment Control Planning and Design Manual. Projects outside of City limits
10 but within Mecklenburg County or outside of Mecklenburg County shall follow the
11 appropriate county, town, and/or state requirements.
12

13 **13. BORES AND TUNNELS**

- 14
- 15 A. Water main crossings of railroads, major city streets, secondary roads, hydrocarbon
16 transmission pipeline easements, and numbered highways must be encased in a steel
17 pipe installed by either auger boring, boring and jacking, hand tunneling lined with
18 prefabricated steel liner plates, or by another approved method by the controlling
19 agency.
20
 - 21 B. Minor city streets and secondary roads may be open cut with specific permission of the
22 controlling agency, CDOT, NCDOT, or respective governing agency and if detailed on
23 the construction drawings.
24
 - 25 C. The carrier pipe shall be restrained ductile iron pipe, restrained AWWA C900 DR 14
26 PVC pipe, HDPE SDR 9 pipe, or other controlling agency approved pipe material.
27 Carrier pipe thickness requirements must be calculated based on site conditions and
28 actual depth of cover.
29
 - 30 D. Encasement pipe shall be new and manufactured of Grade “B” steel with minimum yield
31 strength of 35,000 psi. Steel pipe shall have machine cut, bevel ends that are
32 perpendicular to the longitudinal axis of the casing and fully welded watertight or
33 Permalok brand jointed casing pipe. Pipe shall be designed in accordance with *AWWA*
34 *M11 Steel Pipe – A Guide for Design and Installation*.
35
 - 36 E. Casing spacers shall be used on all water pipes installed within a steel or HDPE casing
37 pipe or tunnel. A minimum of 3 casing spacers per joint shall be required. Casing
38 spacers shall be evenly spaced to support the same weight of the carrier pipe and
39 provide the necessary grade of the carrier pipe. Casing spacer manufacturer shall
40 provide the load carrying capacity of each spacer to determine when additional casing
41 spacers are required. Casing spacers shall not allow the carrier pipe to float no more
42 than 2 inches within the casing pipe.
43
 - 44 F. Within NCDOT encroachments, the annular space between the carrier and casing pipe
45 shall be filled if the casing pipe has a diameter of 24 inches or larger. Lightweight cellular
46 concrete grout shall be used to fill the annular space to allow future carrier pipe removal
47 if necessary. The Engineer of Record may certify the casing pipe durability and design
48 life of 100 years in lieu of filling the annular space when approved by NCDOT.
49
 - 50 G. Bores and tunnels shall be designed to meet specific encroachment permit
51 requirements, based on the governing agency (CDOT, NCDOT, CSX Corporation,

Norfolk Southern Railway, NC Railroad, hydrocarbon transmission pipeline, etc.) based on loadings, depths, and minimum separation and clearances. The minimum size and thickness standards for steel casing pipe, carrier pipe, and tunnels for various water pipe sizes shall be in accordance with the governing agencies and meet the minimum requirements in Table 10.12.

- H. The minimum thickness provided in Table 10.12 are provided by the controlling agencies. The actual thickness required must be calculated based on site conditions and actual depth of cover.

Table 10.12: Minimum Requirements for Steel Casing Pipe and Tunnels				
Carrier Pipe Size (inches)	Casing Pipe Minimum Thickness (inches)			Minimum Tunnel Size (inches)
	Casing Pipe Size (inches)	NCDOT	Railroads	
3 or 4	12	.250	---	36
6	12	.250	.250	36
8	18	.250	.312	48
10	20	.250	.344	48
12	24	.250	.375	48
16	30	.312	.469	48
24	36	.375	.532	54
30	48	.500	.750	60
36	54	.500	.781	72
42	60	.500	.844	84
48	66	.625	.938	90
54	72	.625	1.000	96

- I. When HDPE SDR9 casing pipe is used for open cut casing installations, the minimum casing pipe size shall be as shown in Table 10.13. Bedding shall be Charlotte Water Type IV Granular Stone Bedding.

Carrier Pipe Size (inches)	Casing Pipe Size (OD, inches)	Casing Pipe Minimum Thickness (inches)	Casing Pipe Average ID (inches)
6	18	2.000	13.760
8	22	2.444	16.819
12	28	3.111	21.405
16	34	3.778	25.991

1
2
3 **14. TESTING, DISINFECTION, AND DECHLORINATION**
4

- 5 A. All water main testing and disinfection shall be in accordance with *AWWA C651*
6 *Disinfection Water Mains*, latest edition.
7
8 B. All testing shall be performed by a state-approved and certified laboratory. Charlotte
9 Water is state-approved and the preferred laboratory; other laboratories may be
10 approved by the Chief Engineer in extenuating circumstances.
11
12 C. All new water mains and appurtenances shall be disinfected according to the continuous
13 feed method of chlorination unless otherwise approved by Charlotte Water. Chlorination
14 shall be with hypochlorite or other chlorine solution at least 25 parts per million (ppm) at
15 the time of injection and shall remain in contact with the interior surfaces for 24 hours. A
16 residual chlorine concentration at blow-offs and air release sample points shall be at
17 least 10 ppm at the end of the 24-hour period.
18
19 D. Sample points are required every 1,200 feet, at any dead-end line, blow-off, air release
20 or commercial sized water service.
21
22 E. Upon approval from the Inspector, the water mains shall be flushed to less than 2 ppm
23 chlorine residual whereby a Bac-T test can be taken.
24
25 F. A jumper connection with a certified reduced pressure backflow device shall be provided
26 to furnish the water for filling the main, flushing the main at a minimum of 3 feet per
27 second to remove air and particles, pressure and leakage testing, chlorination injection,
28 flushing, dichlorination, and sampling. No direct connections to existing waterlines is
29 permitted. The jumper connection must be inspected, approved, and tested by a
30 Charlotte Water approved third party backflow testing firm prior to use.
31
32 G. New water mains may be tied to the existing system with a backflow jumper connection
33 at one point only prior to filling, flushing, pressure testing and disinfection.
34
35 H. When the connection is such that the new main will be pressure tested against an
36 existing valve, the valve shall be pressure tested, prior to the connection, at the same
37 differential pressure that will be applied during testing of the new main. If the valve does
38 not hold constant pressure for a ten (10) minute test period, using a mechanical

1 pressure gauge, then the connection will not be permitted by Charlotte Water until the
2 new main is tested and disinfected.

- 3
- 4 I. Following testing against an active valve, the valve shall be opened, and the line
5 thoroughly flushed through the valve.
- 6
- 7 J. Access to flush points for Contractors and Charlotte Water staff shall be provided.
- 8
- 9 K. Where new mains are connected to the existing system by tapping sleeves and valves,
10 in cases where permitted as last available option due to field conditions, the valves shall
11 be hydrostatically tested after the sleeve and valve have been bolted on but prior to
12 when the tap is made.
- 13
- 14 L. Temporary taps and air release may be made to accommodate testing and disinfection
15 with the approval of the Charlotte Water. Where possible, blow-offs shall be located in
16 close proximity to sanitary sewer manholes for convenient disposal of de-chlorinated
17 water following disinfection.
- 18
- 19 M. Contractor shall provide 24-hour notice for request of Bac-T testing from Charlotte Water
20 Inspector. Charlotte Water laboratory only accepts 10 samples per day per job and
21 results typically take 24 hours, excluding weekends and City holidays.
- 22
- 23 N. Chlorinated water should be running at a low flow rate for a minimum of 2 hours prior to
24 scheduled water sample collection times by Charlotte Water Lab Services. The Charlotte
25 Water Inspector and Lab Services must be present at the time of sample collection.
- 26
- 27 O. If 1 sample fails, the entire project must be recollected. If the project fails 3 times, the
28 water main must be re-chlorinated.
- 29
- 30 P. Water mains shall be connected to the existing public water system and activated within
31 14 days after being approved by Charlotte Water Lab Services or shall be continually
32 flushed and chlorine residual monitored. Chlorine residual must be maintained above 1.5
33 ppm to avoid additional Bac-T testing by Charlotte Water Lab Services. Residual
34 monitoring shall be witnessed by the Charlotte Water Inspector. After 14 days of
35 inactivation, the main must be retested by Charlotte Water Lab Services.
- 36
- 37 Q. Dechlorination shall comply with *AWWA C655 Field Dechlorination*, latest edition.
38 Contractor shall request approval from Charlotte Water Inspector for dechlorination
39 agent and process to be used, and prior to discharge to the ground or storm drain once
40 the concentration is 0.0 ppm following dechlorination.
- 41
- 42 R. Chlorine residual shall be tested by the Contractor to confirm no elevated chlorine
43 readings in the discharge at any time.
- 44
- 45 S. Contractor shall provide additional required erosion control measure to prevent erosion
46 and migration of sediment during discharge process.
- 47

1 **15. ABANDONMENT AND DISMANTLEMENT**
2

3 A. Abandonment of existing pipes, structures, appurtenances, and limits of abandonment
4 shall be clearly indicated on the project plans and shall meet the minimum requirements
5 listed below. Abandonment procedures may be more stringent in accordance with the
6 appropriate governing agency's standards.
7

- 8 1) All water mains to be abandoned that are greater than 15 inches shall be filled with
9 excavatable flowable fill, lightweight cellular concrete, or removed.
10
11 2) All open ends of abandoned 15-inch and smaller pipe shall be plugged watertight.
12
13 3) Comply with current standards for water main to be abandoned inside NCDOT
14 rights-of-way.
15
16 4) All water main pipes with less than 3 feet of cover shall be filled with excavatable
17 flowable fill.
18
19 5) Water mains shall be dismantled and removed to the active main connection at both
20 ends and the pipe tee shall be replaced with new pipe; no dead-end stub-outs shall
21 remain.
22
23 6) Water mains shall be dismantled or cut out if a bad connection and replaced with new
24 pipe, at tees and tapping sleeves.
25
26 7) All above-ground features on an abandoned and dismantled water main shall be
27 removed and plugged watertight at the active main.
28
29 8) Valves shall be removed from valve boxes and boxes and covers shall be
30 demolished to 3 feet below grade, removed from the site, and remaining structure
31 filled with excavatable flowable fill or washed stone.
32
33 9) Fire hydrants, auto flushers, sampling stations, and above-ground appurtenances
34 shall be removed. If connected directly to the water main with a valve, the pipe tee
35 shall be removed to the valve, close the valve, install a restrained mechanical joint
36 plug to the valve, and restrain the plugged end. If there is no valve at the main, the
37 tee shall be removed from the main and replaced with a DIP short and restrained
38 mechanical joint long pattern solid sleeve.
39
40 10) Abandoned aerial crossings and piers shall be fully removed and plugged watertight
41 with thrust restraint at the active main.
42
43 11) Abandoned residential service lines and meters shall be removed to the corporation
44 stop at the water main. Close the corporation stop and install a brass plug or cap.
45
46 12) Large service lines shall be dismantled and removed as close to water main as
47 possible. If there is a restrained valve and tee connection, close the valve, install a
48 restrained mechanical plug to the valve, and restrain the plugged end. If there is no
49 restrained valve, remove all the service line piping and the water main connection
50 and install a DIP short and restrained mechanical joint long pattern solid sleeve on
51 the active main.

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13) When a water service dismantlement is requested, the water service and meter shall be dismantled to the corporation stop/tap at the water main.

14) Abandonment of existing asbestos concrete pipe shall be done in accordance with all federal and local laws and submitted for review and approval by Charlotte Water.

15) All abandonment work which requires temporary shut off of active water mains shall be scheduled with the Charlotte Water inspector and shall be witnessed by the inspector.

16) All disturbed areas shall be properly restored per Chapter 23 Restoration.

END OF SECTION