CHAPTER 10
WATER MAINS

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PART 1 - GENERAL

1.1 SUMMARY

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19. Stone and Brick
20. Clay Anti-Seep Collars

1.2 DEFINITIONS AND ABBREVIATIONS

A. See Sections iii and iv of the CHARLOTTE WATER Water and Sewer Design and Construction Standards for common abbreviations and definitions.

1.3 SUBMITTALS

A. Required submittals for product approval include, but are not limited to, the following:

1. Product brochures
2. Catalog cut sheets
3. Shop drawings including dimensions and part/material lists
4. Certification of compliance
5. Prior product acceptance test reports

6. Reference contact data
7. Shipping tickets and purchase invoices

B. Provide product data for the following:

1. Ductile Iron Pipe and Fittings
2. PVC Pipe and Fittings
3. Prestressed Concrete Pressure Pipe, Steel-Cylinder Pipe (PCCP)
4. Concrete Pressure Pipe, Bar Wrapped Steel Cylinder Pipe (BWP)
5. Steel Water Pipe
6. High Density Polyethylene Pipe (HDPE) (OD-Based Iron Pipe Size – IPS) and Fittings
7. Red Brass Pipe (Iron Pipe Size – IPS) and Fittings
8. Stainless Steel Pipe and Fittings
9. Copper Tubing (CTS – Copper Tubing Size)
10. Polyethylene (PE) Tubing – (Copper Tubing Size – CTS)
11. Copper Tracer/Locator Wire
12. Fire Hydrants
13. Valves
14. Water Main Taps
15. Repair/Tie-In Sleeves/Clamps
16. ¾ - 1-inch Water Services
17. 1-1/2 -inch and Larger Water Services
18. Ferrous Castings
19. Miscellaneous Steel
20. Concrete
21. Stone and Brick
22. Clay Anti-Seep Collars

C. Shop Drawings:

1. Required shop drawings shall include, but are not limited to, the following: Ductile Iron Pipe, PVC Pipe, PCCP Pipe, BWP Pipe, Steel Water Pipe, HDPE Pipe, Fire Hydrants, Valves, Tapping Sleeves, Tie-in Sleeves, Water Services, etc.
2. Pipeline laying schedule showing stations and elevations and identifying each piece by mark number. Each bend, bevel, or other special fitting shall be marked to clearly identify the centerline at the top of the piece.
3. Details of standard pipe, joints, specials, and fittings.

D. Design:

1. Design calculations for pipe, fittings, precast vaults, structures, reinforcement and/or test data.

2. Details of joint bonding and field welded joint restraint calculations when specified.

E. Pre-excavation Photographs or Videotape: Show existing conditions of adjoining construction and site improvements, including finish surfaces that might be misconstrued as damage caused by earth-moving operations. For Donated Projects, these requirements apply to existing road rights-of-way only. Submit before earth moving begins.

F. Product Certificates:

1. Required for all products furnished.

2. Comply with NSF 61 Annex G for materials for water service piping and specialties for domestic water.

G. Qualification Data: For qualified testing agency.

H. Material Test Reports: For each on-site and borrow soil material proposed for fill and backfill as follows:

1. Classification according to ASTM D 2487.

2. Laboratory compaction curve according to ASTM D 698.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Do not store plastic pipe and fittings in direct sunlight. All pipe must be in brand new factory condition, and no more than one year old from manufacturer date to installation. Pipe manufacturer must provide letter regarding exposure requirements.

B. Protect pipe, pipe fittings, and seals from dirt and damage.

C. All PVC and HDPE Pipe will be shipped, stored, and strung at the project in such a manner as to be protected from total accumulated exposure to sunlight and possible ultraviolet radiation of no more than four (4) weeks.

D. The Contractor shall be responsible for the safe storage of materials furnished by or to them, and accepted by them and intended for the work, until they have been incorporated in the completed project. Handling and storage of all project materials are to be in compliance with the manufacturer's recommendations for handling and storage. The interior of all pipe, fittings and other accessories shall be kept free from dirt and foreign materials at all times. Valves, meters and pressure gauges shall be protected from freezing at all times.

E. Transportation of Materials and Equipment: The Contractor and their Suppliers are directed to contact the North Carolina Department of Transportation to verify axle load limits on State maintained roads (and bridges) which would be used for hauling of equipment and materials for this project. The Contractor and their Suppliers shall do all that is necessary to satisfy the Department of Transportation requirements and will be responsible for any damage to said roads which may be attributed to this project. Unless otherwise specified, all materials required to construct this project shall be furnished by the Contractor and shall be delivered and distributed at the site by the Contractor or their material supplier.

F. Loading and Unloading Materials: Ductile iron pipe accessories shall be loaded and unloaded by lifting with hoists or skidding so as to avoid shock or damage. Pipe, fittings, and other accessories will be unloaded with hoists and/or as recommended by the respective manufacturers. Under no circumstances shall such materials be dropped. Pipe handled on skidways shall not be skidded or rolled against pipe already on the ground.

G. Responsibility for Materials on Site: In distributing the material at the site of the work, each piece shall be unloaded opposite or near the place where it is to be laid in the trench. Each piece shall be redundantly chocked at each end to prevent movement or rolling. Pedestrian or vehicular traffic shall not be unduly inconvenienced in placing of material along the streets or right-of-way, as applicable.

The Contractor will string in advance no more than the amount of pipe and material that can be installed within two (2) weeks unless approved by the Engineer. All the materials shall be placed in such a manner as not to hinder access, endanger or impede traffic, create a public nuisance or endanger the public.

Materials strung through residential areas (or any area with maintained lawns) shall be placed in such a manner as not to restrict normal lawn maintenance, and must either be installed within two (2) weeks or removed to an approved storage yard, as required by the Engineer.

H. Material and Equipment Storage Sites: Unless otherwise shown on the plans, the Contractor will be responsible for locating and providing storage areas for construction materials and equipment. Unless prior written consent from the owner of the proposed storage area is received by CHARLOTTE WATER, the Contractor will be required to store all equipment and materials within the limits of the project site or the limits of the right-of-way and temporary construction easement provided. The materials and equipment storage shall comply with all local and state ordinances throughout the construction period. Material and equipment may only be stored within road right-of-way if approved by the controlling agency. Bulk storage of stacked materials shall not be permitted in or along road rights-of-way.

Storage sites shall be fenced with adequate protection to reasonably prevent the public from entering the site. The Contractor shall be responsible for the safeguarding of materials and equipment against fire, theft, and vandalism and in a manner which does not place the public at risk, and shall not hold the City responsible in any way for the occurrence of same.

I. Care of Coatings and Linings: Pipe, fittings, and other accessories including frames and covers, steps, straps, etc., shall be so handled such that the coating or lining will not be damaged. If, however, any part of the coating or lining is damaged, the repair shall be made by the Contractor at their expense in a manner satisfactory to the Engineer and the coatings manufacturer.

1.5 FIELD CONDITIONS

A. Interruption of Existing Water Distribution Service: Do not interrupt service to facilities occupied by Owner or others unless permitted and then only after provisions for providing temporary service according to CHARLOTTE WATER requirements are in place.

PART 2 - PRODUCTS

2.1 PIPE, GENERAL

A. All materials furnished in accordance with these specifications shall be new and unused, unless otherwise specified in the project Special Provisions. Unless superseded or modified by a Special Provision; all materials, apparatus, supplies, methods of manufacture, or construction shall conform to the specifications for same contained in this Section. National material standards (ASTM, ANSI, AWWA, NSF (NSF International), etc.) referred to herein shall be considered to be the latest revisions only. All materials that come in contact with potable drinking water shall conform to the requirements of the Safe Drinking Water Act and NSF/ANSI 61 – Drinking Water System Components – Health Effects.

B. Quality Assurance and Quality Control:

1. Pipe smaller than 24-inch in diameter shall conform to the minimum thickness and pressure class/rating requirements for the individual pipe materials as indicated in the sections below, as shown on the construction drawings, or Standard Details.

2. 24-inch and larger diameter pipe shall conform to the minimum thickness and pressure class/rating requirements for the individual pipe materials as indicated in the sections below, as shown on the construction plans, as specified in the project Special Provisions, and shall also meet the following design and quality control/quality assurance requirements:

a. General: The 24-inch and larger pipe and fittings may be designed around ductile iron pipe, however, pre-stressed concrete pipe and steel water pipe may be considered as alternatives when indicated in the project Special Provisions or shown on the construction plans. In all cases, the pipe manufacturer and contractor shall submit a detailed design for review prior to an alternative pipe being approved.

The contractor/manufacturer shall notify the Engineer at least two weeks prior to the date production runs are scheduled. Full access shall be provided to the Engineer's Inspectors to all parts of the plant that concern production of the pipe and all reasonable facilities shall be provided to the Inspector to allow them to verify that the pipe is being furnished according to the applicable standards and the approved design. All such inspections shall be conducted so as not to interfere unnecessarily with the operation of the plant. All costs of the Inspector's transportation, meals, and lodging will be borne by CHARLOTTE WATER.

b. Design Criteria: The following criteria shall govern the design of the pipe regardless of the pipe materials.

1) Qualifications:

a) Manufacturers who are fully experienced, reputable, and qualified in the manufacture of the products to be furnished shall furnish all pipe and fittings. The pipe and fittings shall be designed, constructed, and installed in accordance with the best practices and methods and shall comply with these specifications as applicable.

b) Pipe cylinders, coating, lining, and fabrication of specials shall be the product of one manufacturer that has not less than 5 years successful experience manufacturing pipe of the particular type and size indicated. The pipe manufacturer must have a certified quality assurance program.

2) Markings:

a) The contractor/manufacturer shall legibly mark all pipes and specials in accordance with the laying schedule and marking diagram. Each pipe shall be numbered in sequence and said number shall appear on the laying schedule and marking diagram in its proper location for installation. All special pipe sections and fittings shall be marked at each end with top field centerline. The word “top” or other suitable markings shall be painted or marked on the outside top spigot end of each pipe section.

3) Depth of Cover:

a) A minimum depth of 12-feet or maximum depth as shown on plans plus 4-feet overburden, plus a HS20 live load shall be used in the calculation of the design of the pipe. When pipe is located within Railroad or NCDOT ROW, Contractor shall follow all loading requirements of the governing authority having jurisdiction of the ROW.

4) The ground water level for the design shall be 3-feet above the top of the pipe (minimum).

5) A soil weight of 120 pounds per cubic foot shall be used for calculation of the dead load.

c. Stone bedding shall be as specified in this document, or in the project Special Provisions or as shown on the construction plans. Where required due to existing soil conditions, additional bedding requirements may be required. The contractor shall be responsible for maintaining stable trench walls with the standard width shown on the bedding details, including any required sheeting or shoring.

d. Restrained joint design and details shall be submitted for approval. Submittal shall include calculations of the required length of restrained joint sections. Unless otherwise specified and in the absence of project specific requirements and/or site specific geotechnical information, these calculations shall be based on a minimum 200 PSI test pressure or 1.5 times the static pressure at the lowest point (whichever is greater), a factor of safety of 2.0, a soil weight of 120 pounds per cubic feet, a Silt 1 soil designation, a pipe bedding condition as specified in this document and on the actual depth of cover shown on the construction plans, excluding future fill by others, but including future cut by others.

e. Detectable Warning Tape:

1) Detectable warning tapes shall be 6-inch wide with 5-mil thickness, blue and black tape located 24 inches below finish grade.

2) Warning tape shall be brightly colored non-biodegradable plastic ribbon. The words “Warning Buried Water Line Below” shall be printed continuously along the length of the ribbon in large letters.

3) Approved Products:

a) Brady Underground Utility Marking Tape

b) Terra Tape

c) Seton Detectable Underground Warning Tape

d) Pre-Approved equal by CHARLOTTE WATER

C. Unless amended on the Construction Drawings, or approved by CHARLOTTE WATER, all piping shall be Ductile Iron, PVC, HDPE, Prestressed Concrete Pressure Pipe (Steel-Cylinder Pipe), Concrete Pressure Pipe (Bar Wrapped Steel Cylinder Pipe), Steel Water Pipe, Red Brass, Stainless Steel, Copper Tubing, or Polyethylene (PE) Tubing, as specified herein.

2.2 DUCTILE IRON PIPE AND FITTINGS

A. Pipe: At a minimum, ductile iron pipe shall conform to the requirements of AWWA Standard C-151, ASTM A-746 with thickness design conforming to the procedures outlined in AWWA C-150. Unless otherwise shown on the construction plans, all ductile iron pipe shall be furnished with push-on joints in accordance with AWWA C-111 and a cement mortar lining of standard or double thickness in accordance with AWWA C-104. The minimum cement mortar lining thickness shall be:

Standard Thickness Cement Mortar Lining	
Pipe and Fitting Diameter Inches	Thickness of Lining (Min.) Inches
3-12	1/16
16-24	3/32
30-64	1/8

1. Pipe (36-inch diameter through and including 64-inch diameter): AWWA C151/A21.51, ASTM A-746, minimum pressure class 200, with cement mortar lining in accordance with AWWA C104. The pipe class selection shall be based on the installation conditions. The pipe shall conform to the Quality Assurance/Quality Control and Design Criteria sections indicated above. See project Special Provisions and Construction Drawings for additional design requirements, standards and details. A higher pipe class may be shown on the construction plans and/or elsewhere in Special Provisions.

2. Pipe (16-inch diameter through and including 30-inch diameter): AWWA C151/A21.51, ASTM A-746, minimum pressure class 250, with cement mortar lining in accordance with AWWA C104. The pipe class selection shall be based on the installation conditions. 30-inch diameter pipe shall conform to the Quality Assurance/Quality Control and Design Criteria sections indicated above. A higher pipe class may be shown on the construction plans and/or elsewhere in Special Provisions.

3. Pipe (12-inch diameter and smaller): AWWA C151/A21.51, ASTM A-746, minimum pressure class 350, with cement mortar lining in accordance with AWWA C104. A higher pipe class may be required based on installation conditions and as shown on the construction plans and/or elsewhere in Special Provisions.

Ductile Iron Pipe Requirements	
Pipe Diameter Inches	Minimum Pressure Class
3 - 12	350
16 - 30	250
36 - 64	200

4. The pipe class selection for all diameters shall be based on the installation conditions and existing or proposed depth of cover. Special thickness class pipe up to and including thickness class 56 shall be required when specified, based on installation conditions and depth of cover/loading conditions.

5. The pipe shall contain all product markings required by ASTM A-746 and AWWA C-151. The minimum pipe markings shall include the weight, class or nominal thickness, casting date. The manufacturer's mark, the country where cast, the production year, and the letters "DI" or "DUCTILE" shall be cast or metal stamped on the pipe, and on pipe sizes 14-inch and larger shall not be less than ½-inch in height. All markings shall be clear and legible, and all cast or metal-stamped marks shall be on or near the bell.

6. DIP pipe shall be manufactured within the North American Continent by an approved manufacturer.

7. Manufacturers:

   a. DIP shall be as furnished by American Cast Iron Pipe, McWane Cast Iron Pipe, US Pipe Company.

B. Mechanical Joint Accessories: Mechanical joint glands shall be ductile iron. Glands, bolts, nuts, and gaskets for mechanical joint pipe and fittings shall be furnished by the pipe/fitting manufacturer and shall conform to ANSI Specifications A21.11 (AWWA C-111).

1. Rubber gaskets shall be made of vulcanized styrene butadiene rubber (SBR), unless otherwise shown on the plans or specified. Nitrile (NBR) rubber (acrylonitrile butadiene) gaskets shall be furnished when specified or shown on the construction plans and when water mains are located near contaminated soils or gasoline storage facilities.

2. Gasket lubricant shall be as recommended by the pipe manufacturer and shall conform to the requirements of the Safe Drinking Water Act and be NSF/ANSI 61 certified.

3. The gaskets shall contain all product markings required by the appropriate AWWA Standard. The minimum gasket markings shall include size, manufacturer's mark, country where molded, year, mold number, and "MJ".

4. Bolts shall be Tee Head or Stud Bolts where required. Bolts shall be provided with standard hexagonal cold pressed nuts unless otherwise specified. Bolts and nuts shall be made of the best quality refined iron or mill steel and shall have sound, well-fitting threads. Bolts and nuts shall be threaded according to ASME B1.1 and B1.2, coarse-thread series unified coarse (UNC), Class 2A, External, and Class 2B, Internal. Bolts and nuts shall be of high-strength, low alloy steel conforming to the chemical and mechanical requirements of AWWA C-111, minimum 45,000 PSI tensile strength.

5. If the pipe manufacturer furnishes third party accessories, the pipe manufacturer shall provide a written and notarized statement signed by a current officer of the pipe manufacturer accepting unit responsibility for both the fitting, pipe, and accessories for 30-inch and larger products.

C. Push-On Joint Material: Gaskets for push-on pipe shall be furnished by the pipe manufacturer. Joint type shall be Tyton or Fastite only. Gaskets and gasket lubricant shall conform to ANSI Specifications A21.11 (AWWA C-111).

1. Rubber gaskets shall be made of vulcanized styrene butadiene rubber (SBR), unless otherwise shown on the plans or specified. Nitrile (NBR) rubber (acrylonitrile butadiene) gaskets shall be furnished when specified or shown on the construction plans and when water mains are located near contaminated soils or gasoline storage facilities.

2. Gasket lubricant shall be as recommended by the pipe manufacturer and shall conform to the requirements of the Safe Drinking Water Act and be NSF/ANSI 61 certified.

3. If the pipe manufacturer furnishes third party accessories, the pipe manufacturer shall provide a written and notarized statement signed by a current officer of the pipe manufacturer accepting unit responsibility for both the fitting, pipe, and accessories for 30-inch and larger products.

D. Flange Joints and Accessories: Ductile iron flange joints shall be furnished in accordance with the requirements of ANSI Specifications A21.11 (AWWA C-111) and ANSI A21.15/AWWA C-115. The bolt circle and bolt holes of these flanges shall match those of ANSI/ASME B16.1, Class 125 flanges and can be joined with these class 125 flanges or with ANSI/ASME B16.5, class 150 flanges as required.

1. Flanges, stainless steel flange bolts and nuts, and gaskets shall conform to the dimensional requirements of ANSI/ASME B16.1, AWWA C-111 and C-115 for Class 125.

2. Bolts shall have standard hexagonal heads and shall be provided with standard hexagonal cold pressed nuts unless otherwise specified. Bolts and nuts shall be made of the best quality refined iron or mill steel and shall have sound, well-fitting threads. Bolts shall conform to the requirements of ASME B18.2.2. Bolts and nuts shall be threaded according to ASME B1.1, Unified Inch Screw Threads, UN and UNR Thread Form, Class 2A, External, and Class 2B, Internal. Bolts and nuts shall be stainless steel ASTM A240 Type 316 or Type 316L. Anti-seize compound shall be used on all bolts and nuts.

3. When screw-on flanges are approved, the flange shall contain all product markings required by the appropriate AWWA/ANSI/ASME Standard. The minimum markings

shall include the manufacturer's mark, size, and the letters "DI" cast or stamped on the back face of the flange.

4. Rubber gaskets shall be made of vulcanized styrene butadiene rubber (SBR), unless otherwise shown on the plans or specified. Nitrile (NBR) rubber (acrylonitrile butadiene) gaskets shall be furnished when specified or shown on the construction plans and when water mains are located near contaminated soils or gasoline storage facilities. Gaskets shall be ring or full-faces, and 1/8-inch thick. Gaskets using one or more annular rings molded into the gasket to improve the joint performance shall be acceptable.

5. If the pipe manufacturer furnishes third party accessories, the pipe manufacturer shall provide a written and notarized statement signed by a current officer of the pipe manufacturer accepting unit responsibility for both the fitting, pipe, and accessories for 30-inch and larger products.

E. Factory Restrained Joint Pipe Systems: Flexible restrained joint ductile iron pipe shall be as supplied by the pipe manufacturer. Joint type shall be restrained Mechanical Joint, Tyton, or Fastite only. Minimum rated working pressure shall be as shown on the table below.

1. Only designs using a welded retainer ring on the spigot will be allowed for 30-inch through 64-inch diameter pipe. Restrained push-on or mechanical joint designs may be used for the pipe and associated fittings. When 30-inch through 64-inch pipe/fittings are added during construction and are not shown on the construction plans, they shall be factory restrained joints, if available from the pipe manufacturer, or may be wedge action thrust restrained mechanical joints as specified, when approved by the Engineer.

2. Designs using a welded retainer ring on the spigot are approved for 16-inch through 24-inch diameter pipe. Factory restrained push-on or mechanical joint designs may be used for the pipe and associated fittings. When 16-inch through 24-inch pipe/fittings are added during construction and are not shown on the construction plans, they may be factory restrained joint pipe/fittings or wedge action thrust restrained mechanical joint/pipe fittings only.

3. Designs using a welded retainer ring on the spigot will be allowed for 4-inch through 12-inch diameter pipe. Factory restrained push-on or mechanical joint designs may be used for the pipe and associated fittings. When 4-inch through 12-inch pipe are added during construction and are not shown on the construction plans, they may be factory restrained joint pipe, wedge action thrust restrained mechanical joint pipe or push-on restrained joint pipe gasket systems, as specified below.

4. If the pipe manufacturer furnishes third party accessories, the pipe manufacturer shall provide a written and notarized statement signed by a current officer of the pipe manufacturer accepting unit responsibility for both the fitting, pipe, and accessories for 30-inch and larger products.

5. The following flexible factory restrained joint pipe system products are approved:

Manufacturer	Factory Restrained Joint Name	Pipe Size Range (inches)	Min. Rated Working Pressure (PSI)
American CIPC	FLEX-RING	4-24	350
	FLEX-RING	30-48	250
	LOK-RING	54-64	250
	SUPER LOCK	6-24	350
McWane Industries (Atlantic States CIPC, McWane CIPC, Pacific States CIPC)	SUPER LOCK	30	250
	THRUST-LOCK	6-24	350
	THRUST-LOCK	30-36	250
	TR FLEX	4-24	350
	TR FLEX	30-36	250
	TR FLEX	4-24	350
U. S. Pipe Co.	TR FLEX	30-36	250
	BOLT-LOK (MJ)	4-24	350
	BOLT-LOK (MJ)	30-48	250
	HP LOK	30-64	250

F. Push-On Restrained Joint Pipe Gasket System: For 3-inch through 12-inch ductile iron pipe only, push-on joint pipe may be made restrained joint pipe by replacing the standard pipe gasket with restrained joint gaskets that include internal stainless steel locking segments. The internal stainless steel locking segments shall be corrosion resistant hardened stainless steel, and shall be integrally molded and vulcanized into the gasket and shall grip the pipe spigot to prevent joint separation. The restraining system shall be UL Listed for 350 PSI working pressure and Factory Mutual approved for 250 PSI working pressure. Gasket restraining system shall be produced and tested in accordance with AWWA C-111 and shall have a 350 PSI pressure rating.

1. Gasket lubricant shall be as recommended by the pipe manufacturer and shall conform to the requirements of the Safe Drinking Water Act and be NSF/ANSI 61 certified.

2. Restrained joint pipe gasket products shall be furnished by the ductile iron pipe manufacturer. Third party restrained joint pipe gasket systems are NOT approved. If considered, third party restrained joint pipe gasket systems shall be pre-approved by the Engineer. Third party restrained joint pipe gasket systems will only be considered when the product submittals are accompanied by a certified statement from the ductile iron pipe manufacturer that they approve the restrained joint gasket system product for use with its pipe joint. Third party restrained joint gasket system products must be accompanied by Underwriters Laboratories and Factory Mutual approval. The pipe manufacturer shall accept unit responsibility for the pipe and gasket restrained joint system.

3. The following push-on restrained joint pipe gasket system products are approved:

Pipe Manufacturer	Push-On Restrained Joint Gasket System	Pipe Size Range (inches)	Min. Rated Working Pressure (PSI)
Gripper Gasket, LLC	Gripper Gasket	3-12	350
American CIPC	Fast Grip Gasket	4-12*	350
McWane Industries (Atlantic States CIPC, McWane CIPC, Pacific States CIPC)	SURE STOP 350 Gasket	4-12	350
U. S. Pipe Co.	FILED LOK 350 Gasket	4-12*	350

* Only 3-inch through 12-inch is approved as a standard product. 16-inch restrained joint pipe shown on the construction plans shall be Factory Restrained Joint Pipe System as specified. When 16-inch restrained joint pipe is added during construction and is not shown on the construction plan, factory restrained joint pipe shall be provided, if available from the pipe manufacturer, or may be restrained joint pipe gasket systems, when specifically approved by the Engineer in writing.

4. As stated in the pipe manufacturer's published literature, the restrained joint pipe gasket systems shall NOT be used in the following conditions or applications:

   a. Spray on lubricants shall not be used.

   b. Pipe coating system shall not exceed 6 mils on the plain end of the pipe.

   c. Gaskets shall not be reused, as they may have been damaged during any previous installation or during removal.

   d. Gaskets shall not be used as an electrical conductor. Use bonded joints where applicable.

   e. Gaskets shall not be used in above ground applications.

   f. Gaskets shall not be used in casing/tunnel applications, unless installed straight, by pulling, NOT pushing the pipe through the casing. Assembly of the joints must be controlled, such as come-a-longs or cable hoists, to prevent fully homing the spigot to the base of the socket.

   g. Gaskets shall not be used with gray iron pipe/fittings or with plastic pipe.

   h. Gaskets shall not be used with push-on plugs.

   i. Joint shall not be rotated after assembly.

G. Fittings: All fittings shall be cast from the standard grade 70-50-05 ductile iron with conformance values of 70,000 PSI minimum tensile strength, 50,000 PSI minimum yield strength and 5 percent minimum elongation.

1. 30-inch through 48-inch diameter: minimum Pressure Class 250, cast from ductile iron, in accordance with AWWA C-110 for full body fittings or AWWA C-153 for compact fittings.

2. 3-inch through 24-inch diameter: minimum Pressure Class 350, cast from ductile iron, in accordance with AWWA C-110 for full body fittings or AWWA C-153 for compact fittings.

3. All cast fittings shall have a cement mortar lining of standard or double thickness in accordance with AWWA C-104, or fusion bonded epoxy lining and coating of minimum thickness in accordance with AWWA C-116.

4. The fittings shall contain all product markings required by AWWA C-110 or C-153 as applicable. The minimum markings on each fitting shall include the identity of the AWWA standard, the pressure rating, nominal diameters, manufacturer's identification, the county where cast, the letters "DI" or "DUCTILE", and the angle of all bends. The markings shall be distinctly cast raised or in relief on the outside of the fitting body.

5. Manufacturers:

   a. All fittings, including gaskets, glands, and bolts, shall be furnished by one fittings manufacturer.

   b. 30-inch and larger fittings shall be manufactured within the North American Continent by an approved manufacturer (Note: See 2.2 B 5 for additional information):

      1) American Cast Iron Pipe Co
      2) U.S. Pipe Co
      3) McWane Cast Iron Pipe

   c. 24-inch and smaller fittings shall be manufactured within the North American Continent or imported by an approved manufacturer:

      1) American Cast Iron Pipe Co
      2) U.S. Pipe Co
      3) McWane Cast Iron Pipe
      4) Star Pipe Corporation
      5) Sigma Corporation
      6) SIP Industries
      7) Tyler/Union Foundry

H. Mechanical Joint Fittings: Fittings shall be furnished with mechanical joints as indicated on the construction plans. All mechanical joint fittings will be Bell and Bell unless otherwise indicated on the plans.

I. Wedge Action Thrust Restraint for Mechanical Joint Fittings:

1. Restrained joints shall be used where shown on the plan, standard details or as directed or approved by the Engineer.

2. Mechanical joint thrust restraints may be through the use of a follower gland with restraining device that imparts a wedging action against the pipe. The restraining device shall have twist off nuts to ensure proper contact with the pipe. Glands and restraining devices shall be manufactured of Ductile Iron conforming to ASTM A536. The restraining devices shall be heat treated to a hardness of 370BHN. Gland dimensions shall be compatible with the MJ fittings hereinbefore specified. The restrained joint shall be rated for a minimum 200 PSI working pressure for pipes with diameters greater than 48-inches, 250 PSI working pressure for pipes with diameters 18-inch through 48-inch, and 350 PSI for pipes with diameters 3-inch through 16-inch with a 2:1 safety factor.

3. Wedge action thrust restraint mechanical joint restraints may be through the use of a specially machined ductile iron ring and follower gland that is used with standard mechanical joint gaskets and T-bolts.

4. There shall be no additional tool required for installation other than the tools required to install standard sizes of hex nuts from 5/8-inch to 1 1/8-inch. The hex heads, bolts, and rods shall be designed to tighten clockwise. The hex heads, bolts, and rods shall be manufactured to allow for disassembly and re-installation of the restraint.

5. Retainer glands will NOT be permitted.

6. Wedge action thrust restraint shall not be used on plain end fittings.

7. 30-inch and larger wedge action thrust restraints for mechanical joint fittings shall only be used when specifically called out on the construction plans or special provisions. Where permitted, 30-inch and larger wedge action thrust restraints for mechanical joint fittings shall be:

    a. Megalug Series 1100 as manufactured by EBAA Iron, Inc.

    b. OneLoc Series SLDE as manufactured by Sigma Corporation

    c. StarGrip Series 3000 as manufactured by Star Pipe

    d. TufGrip Series 1000 as manufactured by Tyler Union Corp

    e. EZ Grip Series EZD as manufactured by SIP Industries

8. When 30-inch and larger fittings are added during construction and are not shown on the construction plans, they shall be factory restrained joint fittings if available from the pipe manufacturer, or may be wedge action thrust restrained mechanical joint fittings as specified above, when approved by the Engineer.

9. 24-inch and smaller wedge action thrust restraints for mechanical joint fittings shall be:

    a. Megalug Series 1100 as manufactured by EBAA Iron, Inc.

    b. OneLoc Series SLDE as manufactured by Sigma Corporation

    c. StarGrip Series 3000 as manufactured by Star Pipe

    d. TufGrip Series 1000 as manufactured by Tyler Union Corp.

10. When 24-inch and smaller fittings are added during construction and are not shown on the construction plans, they may be wedge action thrust restrained mechanical joint fittings as specified above, or factory restrained joint fittings as specified below.

J. Factory Restrained Joint Fittings:

1. For 30-inch and larger water mains, factory restrained joint fittings shall be supplied by the pipe manufacturer with Fast-Tite or Tyton gasket joints for fittings shown on the construction plans. Only designs using a welded retainer ring on the spigot will be allowed. The following manufacturer's factory restrained joint fittings products are approved:

Manufacturer	Factory Restrained Joint Name	Pipe Size Range (inches)	Min. Rated Working Pressure (PSI)
American CIPC	FLEX-RING	30	150
	FLEX-RING	30-48	250
	LOK-RING	54-64	250
McWane Industries (Atlantic States CIPC, McWane CIPC, Pacific States CIPC)			
	THRUST-LOCK	30-36	250
	TR FLEX	30-36	250
U. S. Pipe Co.	TR FLEX	30-36	250
Ford Meter Box	Uni-flange	30-48	250
SIP Industries	EZD	30-48	250
	EZDPTP	30-36	250
	EZDTP	30-48	300
	EZFADP	36	250

2. When 30-inch and larger fittings are added during construction and are not shown on the construction plans, they shall be factory restrained joint fittings if available from the pipe manufacturer, or may be wedge action thrust restrained mechanical joint fittings as specified above, when approved by the Engineer.

3. When 16-inch and smaller fittings are added during construction and are not shown on the construction plans, they may be factory restrained joint fittings or wedge action thrust restrained mechanical joint fittings as specified above.

4. Factory restrained joint fittings shall be manufactured in North America.

K. The Engineer reserves the right to witness any or all acceptance tests. Prior notice of testing schedules will be provided by the manufacturer to the Engineer to accommodate travel or independent third-party witness arrangements.

L. Quality Control/Quality Assurance: The manufacturer shall perform the standard acceptance tests required by AWWA C-151, Section 5.1.1.2 and shall keep test records on file for inspection by the Engineer. The manufacturer shall furnish an affidavit that the materials used in the making of the pipe meet all provisions of the applicable AWWA and ASTM standards and that the pipe, fittings, accessories, and rubber gaskets meet all applicable provisions of AWWA C-104, C-110, C-111 C-115, C-150, and C-153 respectively.

M. Corrosion Protection: When indicated on the plans, corrosion protection equipment and installation shall be in accordance CHARLOTTE WATER standard specifications for Corrosion Control.

2.3 PVC PIPE

A. Unless amended on the Construction Drawings or elsewhere in these specifications, all 2-inch and 6-inch through 12-inch diameter water main pipe may be Polyvinyl Chloride (PVC) Pipe as specified below.

B. Pipe: Pipe shall be made from blue (only) pigmented virgin materials and shall be furnished in lengths of 20 feet or longer. Lesser lengths will be accepted to allow the proper placement of fittings, valves, etc.

1. All PVC Water Pipe will be shipped, stored, and strung at the project in such a manner as to be protected from total accumulated exposure to sunlight and possible ultraviolet radiation of no more than four (4) weeks. Pipe shall be installed within 12 months of the manufacture date stamped on the pipe wall.

2. PVC pipe shall be manufactured within the North American Continent. An officer of the manufacturing company shall certify that all PVC pipe products were manufactured in North America.

3. Rubber gaskets shall be as furnished by the pipe manufacturer and shall be made of vulcanized ethylene propylene diene monomer rubber (EPDM) or styrene butadiene rubber (SBR), unless otherwise approved or specified. Gaskets shall meet the requirements of ASTM F-477 for high head applications. Gaskets shall conform to the requirements of the Safe Drinking Water Act and be NSF/ANSI 61 certified.

4. Gasket lubricant shall be as recommended by the pipe manufacturer and shall conform to the requirements of the Safe Drinking Water Act and be NSF/ANSI 61 certified.

5. Push-on Joint: Pipe jointing will be by elastomeric (gasket) joints only. Joints shall conform to AWWA C-900 for 6-inch, 8-inch, and 12-inch diameter pipe.

   Pipe bells, with gasket seats, shall be formed as the pipe is extruded. Sleeve couplings are not permitted.

6. Restrained Joint: When restrained joints are required, all restrained pipe and fittings shall conform to the requirements for restrained joint ductile iron pipe as specified above or to the requirements for restrained joint PVC pipe as specified later in this section.

C. IPS (Iron Pipe Size Equivalent) PVC Pipe: All 2-inch diameter water main shall be PVC 1120 in accordance with ASTM D-2241 with push-on joints. The pipe shall be water pressure rates at 315 PSI with a standard dimension ratio (SDR) of 13.5. The pipe shall be manufactured from white or blue pigmented virgin PVC compounds and shall equal or exceed PVC class 12454.

IPS PVC Pipe				
Nominal Pipe Size (Inches)	Outside Diameter (Inches)	Min Wall Thickness (Inches)	Standard Dimension Ratio (SDR)	Pressure Rating (PSI)
2	2.375	0.176	13.5	315

PVC pipe shall contain the product markings as required by ASTM D-2241. The pipe markings shall be spaced at intervals of not more that 5 feet. The minimum pipe markings shall include the nominal pipe size, the Standard Dimension Ration (SDR 13.5), the ASTM designation (ASTM D-2241), the manufacturer's name or trademark, a production code which allows the manufacturer to trace production and the seal or mark of the laboratory certifying the pipe for use with potable water.

D. CIOD (Cast Iron-equivalent Outside Diameter) PVC Pipe: All 6-inch through 12-inch diameter water main pipe may be PVC pipe conforming to the requirements of AWWA C-900 with push on joints, unless otherwise shown on the construction plans or specified. The pipe shall be minimum Pressure Class (PC) 305 PSI with a Dimension Ratio (DR) of 14 per AWWA C-900. The pipe shall be manufactured from blue (ONLY) pigmented virgin PVC resin compounds and shall equal or exceed PVC class 12545 as described in ASTM D-1748. The pipe shall also qualify for a minimum hydrostatic design basis (HDB) of 4000 PSI at 73.4-degree Fahrenheit in accordance with the requirements of PPI TR-3.

C-900 PVC PIPE - CIOD				
Nominal Pipe Size (inches)	Outside Diameter (inches)	Min Wall Thickness (inches)	Dimension Ratio (DR)	Pressure Class (PSI)
6	6.900	0.493	14	305
8	9.050	0.646	14	305
12	13.200	0.943	14	305

1. CIOD C-900 PVC pipe shall contain the product markings required by AWWA C-900. The pipe markings shall be spaced at intervals of not more than 5 feet. The minimum pipe markings shall include the nominal pipe size and outside diameter base (for example, “6 CI”), type of plastic (“PVC”), Dimension Ratio (“DR 14”), AWWA pressure class (“PC305”), AWWA designation (“AWWA C900”), manufacturer’s name or trademark, and the seal or mark of the testing agency certifying the pipe for use with potable water.

2. The manufacturer shall submit certification and test results that the pipe has been tested in accordance with AWWA-C-900 and has been found to meet all requirements. Test samples shall be as selected by the manufacturer or testing laboratory unless otherwise stipulated in the Special Provision Section of the contract.

3. The Engineer reserves the right to witness any or all appetence tests. Prior notice of testing schedules will be provided by the manufacturer to the Engineer to accommodate travel or independent third party witness arrangements.

4. Manufacturers: PVC pipe shall be as furnished by the following or pre-approved equal:

   a. Harco Fittings LLC
   b. Westlake Pipe & Fittings, formerly Lasco
   c. Westlake Pipe & Fittings, formerly NAPCO
   d. JM Eagle
   e. Diamond Plastics
   f. National Pipe
   g. Sanderson Pipe

E. Restrained Joint in Bell (RJIB): Unless amended on the Construction Drawings or elsewhere in these specifications, all 6-inch through 12-inch diameter restrained joint water main pipe may be Polyvinyl Chloride Pipe with restrained joints in bell as specified below.

1. Restrained joint PVC Water Pipe shall be made from blue (only) pigmented virgin materials and shall be furnished in lengths of 20 feet. Lesser lengths will be accepted to allow the proper placement of fittings, valves, etc.

2. All restrained joint PVC Water Pipe will be shipped, stored, and strung at the project in such a manner as to be protected from total accumulated exposure to sunlight and possible ultraviolet radiation of no more than four (4) weeks. Pipe shall be installed within 12 months of the manufacture date stamped on the pipe wall.

3. Restrained joint PVC pipe shall be manufactured within the North American Continent. An officer of the manufacturing company shall certify that all restrained joint PVC pipe products were manufactured in North America.

4. Rubber gaskets shall be as furnished by the pipe manufacturer and shall be made of vulcanized ethylene propylene diene monomer rubber (EPDM) or styrene butadiene rubber (SBR), unless otherwise approved or specified. Gaskets shall meet the requirements of ASTM F-477 for high head applications. Gaskets shall conform to the requirements of the Safe Drinking Water Act and be NSF/ANSI 61 certified.

5. Gasket lubricant shall be recommended by the pipe manufacturer and shall conform to the requirements of the Safe Drinking Water Act and be NSF/ANSI 61 certified.

6. Manufacturers: Restrained joint PVC pipe restraining system shall be:
   a. BullDog™ Restraint System – Eagle Loc 900™ as manufactured by JM Eagle, Lok-21® as manufactured by Diamond Plastics, or pre-approved equal.
   b. Spline/Groove Restraint System – Certa-Lok® as manufactured by Westlake Pipe and Fittings, or pre-approved equal.

7. All 6-inch through 12-inch diameter restrained joint water main pipe may be PVC pipe conforming to the requirements of AWWA-C900, unless otherwise shown on the construction plans or specified. The pipe shall be minimum Pressure Class (PC) 305 PSI with a Dimension Ratio (DR) of 14 per AWWA C-900. The pipe and coupling shall be manufactured from blue (only) pigmented virgin PVC resin compounds and shall equal or exceed PVC class 12454 as described in ASTM D-1748. The PVC compounds shall also qualify for a minimum hydrostatic design basis (HDB) of 4000 PSI at 73.4-degree Fahrenheit in accordance with the requirements of ASTM D-2837.

8. Pipe shall be made restrained joint by using a PVC coupling and high-strength flexible thermoplastic splines inserted into mating precision machined grooves in the pipe to provide full 360 degree evenly distributed restraint. Couplings shall be designed for use at or above the pressure class of the pipe, and shall incorporate twin elastomeric sealing gaskets meeting the requirements of ASTM F-477. Joints shall be designed to meet the zero leakage test requirements or ASTM D-3139.

9. Restrained Joint PVC pipe shall be C900/RJIB Certa-Lok PVC Pressure Pipe, or pre-approved equal.

C-900/RJ RESTRAINED JOINT PVC PIPE - CIOD						
Nominal Pipe Size - Inches	Pipe Outside Diameter - Inches	Pipe Min Wall Thickness - Inches	Dimension Ratio (DR)	Pressure Class - PSI	Restraint Spline Groove Width - Inches	Restraint Spline Groove Min. Depth - Inches
6	6.90	0.493	14	305	0.375	0.125
8	9.05	0.646	14	305	0.500	0.130
12	13.20	0.943	14	305	0.500	0.200

10. Restrained joint C-900 pipe shall contain the product markings required by AWWA C-900. The pipe markings shall be spaced at intervals of not more than 5 feet. The minimum pipe markings shall include the nominal pipe size and outside diameter base (for example, “6CI”), type of plastic (“PVC”), Dimension Ratio (“DR 14”), AWWA pressure class (“PC305”), AWWA designation (“AWWA C900”), manufacturer’s name or trademark, and the seal or mark of the testing agency certifying the pipe for use with potable water.

11. The manufacturer shall submit certification and test results that the pipe has been tested in accordance with AWWA C-900 and has been found to meet all requirements. Test samples shall be as selected by the manufacturer or testing laboratory unless otherwise stipulated in the Special Provision Section of the contract.

12. The Engineer reserves the right to witness any or all appetence tests. Prior notice of testing schedules will be provided by the manufacturer to the Engineer to accommodate travel or independent third party witness arrangements.

F. Ductile Iron Fittings For Use With PVC Pipe

1. For 6-inch, 8-inch, and 12-inch PVC Pipe:

   a. Minimum Pressure Class 350, cast from ductile iron, in accordance with AWWA C-110 for full body fittings or AWWA C-153 for compact fittings.

   b. All cast fittings shall have a cement mortar lining of standard or double thickness in accordance with AWWA C-104, or fusion bonded epoxy lining and coating of minimum thickness in accordance with AWWA C-116.

   c. Manufacturers:

      1) All fittings, including gaskets, glands, and bolts, shall be furnished by one fittings manufacturer.

      2) Fittings shall be manufactured within the North American Continent or imported by an approved manufacturer:

         a) U.S. Pipe Co

         b) McWane Cast Iron Pipe

         c) Tyler/Union Foundry

         d) Star Pipe Corporation

         e) Sigma Corporation

f) SIP Industries

G. Valve and Fitting Restraint Systems for PVC Pipe

1. Restraint at connection to mechanical joint valves and fittings shall be by the use of wedge action thrust restraint for mechanical joints as specified for use with restrained joint PVC pipe.

   a. EBAA Iron – 2000PV MEGALUG – Series 2000

   b. Star Pipe Products – PVC Stargrip – Series 4000

   c. Romac Industries – GripRing

   d. Tyler Union Corp – TufGrip – Series 2000

   e. SIP Industries – EZ Grip Ultra Joint Restraint

2.4 PRESTRESSED CONCRETE PRESSURE PIPE, STEEL-CYLINDER PIPE (PCCP)

A. All 30-inch through 144-inch diameter water main pipe may be PCCP pipe conforming to the requirements of the applicable AWWA Standards, unless otherwise shown on the construction plans or specified. All wire wrapped prestressed concrete steel-cylinder pipe furnished shall be either prestressed concrete lined-cylinder (LCP) pipe with rubber and steel joint, or prestressed concrete embedded-cylinder (ECP) pipe with rubber and steel joints all in compliance with AWWA C-301 and AWWA C-304. The pipe shall be designed and furnished to fit the profile and head conditions shown on the construction plans and hydrostatic tests herein specified, plus the standard allowance for water hammer.

B. The pipe shall conform to the Quality Assurance/Quality Control and Design Criteria Sections indicated above. See project Special Provisions and Construction Drawings for additional design requirements, standards and details.

C. All connections for main line valves shall be mechanical joint for 30-inch through 48-inch diameter pipe, unless otherwise shown on the construction plans or specified. Connections for main line valves shall be flange joint for 54-inch through 144-inch diameter pipe, unless otherwise shown on the construction plans or specified. Connections for side outlets will be flanged, mechanical joint, or factory restrained joint as indicated on the construction plans, or as specified.

D. The pipe shall be manufactured within the North American Continent. An officer of the manufacturing company shall certify that all PCCP was manufactured in North America.

E. Rubber gaskets shall be made of vulcanized styrene butadiene rubber (SBR), unless otherwise shown on the plans or specified. Nitrile (NBR) Rubber (Acrylonitrile Butadiene) gaskets shall be furnished when specified or shown on the construction plans and when water mains are located near contaminated soils or gasoline storage facilities.

F. Gasket lubricant shall be as recommended by the pipe manufacturer and shall conform to the requirements of the Safe Drinking Water Act and be NSF/ANSI 61 certified.

G. If the pipe manufacturer furnishes third party accessories, the pipe manufacturer shall provide a written and notarized statement signed by a current officer of the pipe manufacturer accepting unit responsibility for both the fitting, pipe, and accessories.

H. The pipe shall contain all product markings required by AWWA C-301. The product markings shall be marked on the inside of the bell or spigot ends and shall be a waterproof marking material. The minimum pipe markings shall include the

manufacturer's name or trademark, the production year, piece number per the laying schedule and the pressure rating or area of circumferential reinforcement per unit length of pipe wall. Beveled pipe shall be marked with the amount of bevel and the point of maximum pipe length shall be marked on the beveled end. All markings shall be clear and legible.

I. The Engineer reserves the right to witness any or all acceptance tests. Prior notice of testing schedules will be provided by the manufacturer to the Engineer to accommodate travel or independent third party witness arrangements.

J. Prestressed concrete cylinder pipe and fittings shall be manufactured according to AWWA C-301, AWWA C-304, and as modified below:

1. The pipe shall be designed for working pressure, surge pressure, as specified, and live and dead loads as directed in the AWWA C-304 and as required in Section 2.1B.

2. Concrete core thickness and the area, tension and spacing of pre-stressing wire shall be designed as outlined by Appendix A of AWWA C-304.

3. Testing: All materials used in the manufacture of the pipe shall be tested as outlined in the applicable ASTM standard for that material. Test reports shall be obtained by the manufacturer and held on file for inspection by the Engineer. Hydrostatic tests of the completed cylinders with joint rings and compression tests of concrete cylinders shall be made by the manufacturer during the production process and test reports shall be held on file for inspection by the Engineer. The manufacturer shall furnish an affidavit that the materials used in making the pipe meet all provisions of the applicable ASTM standard and that the pipe and fittings meet all applicable provisions of AWWA C-301.

4. Restrained joints shall be snap ring or approved equal.

5. Manufacturers: Thompson Pipe Group w/Snap Rings®, Forterra Precast or approved equal.

2.5 CONCRETE PRESSURE PIPE, BAR WRAPPED STEEL CYLINDER PIPE (BWP)

A. All 30-inch through 72-inch diameter water main pipe may be BWP pipe conforming to the requirements of the applicable AWWA Standards, unless otherwise shown on the construction plans or specified. All BWP pipe furnished shall be concrete pressure pipe with a bar wrapped steel-cylinder with rubber and steel joints all in compliance with AWWA C-303. The pipe shall be designed and furnished to fit the profile and head conditions shown on the construction plans and hydrostatic tests herein specified, plus the standard allowance for water hammer.

B. The pipe shall conform to the Quality Assurance/Quality Control and Design Criteria Sections indicated above. See project Special Provisions and Construction Drawings for additional design requirements, standards and details.

C. Connections for main line valves shall be mechanical joint for 30-inch through 48-inch diameter pipe, unless otherwise shown on the construction plans or specified. Connections for main line valves shall be flange joint for 54-inch through 72-inch diameter pipe, unless otherwise shown on the construction plans or specified. Connections for side outlets will be flanged, mechanical joint, or factory restrained joint as indicated on the construction plans, or as specified.

D. The pipe shall be manufactured within the North American Continent. An officer of the manufacturing company shall certify that all steel pipe was manufactured in North America.

E. Rubber gaskets shall be made of vulcanized styrene butadiene rubber (SBR) unless otherwise shown on the plans or specified. Nitrile (NBR) Rubber (Acrylonitrile Butadiene) gaskets shall be furnished when specified or shown on the construction plans and when water mains are located near contaminated soils or gasoline storage facilities.

F. Gasket lubricant shall be as recommended by the pipe manufacturer and shall conform to the requirements of the Safe Drinking Water Act and be NSF/ANSI 61 certified.

G. If the pipe manufacturer furnishes third party accessories, the pipe manufacturer shall provide a written and notarized statement signed by a current officer of the pipe manufacturer accepting unit responsibility for both the fitting, pipe, and accessories.

H. The pipe shall contain all product markings required by AWWA C-303. The product markings shall be marked on the inside of the bell or spigot ends and shall be a waterproof marking material. The minimum pipe markings shall include the manufacturer's name or trademark, the production year, piece number per the laying schedule and the pressure rating or area of circumferential reinforcement per unit length of pipe wall. Beveled pipe shall be marked with the amount of bevel and the point of maximum pipe length shall be marked on the beveled end. All markings shall be clear and legible.

I. The Engineer reserves the right to witness any or all acceptance tests. Prior notice of testing schedules will be provided by the manufacturer to the Engineer to accommodate travel or independent third party witness arrangements.

J. Bar Wrapped Pipe shall be manufactured according to AWWA C-303, and as modified below:

1. The pipe shall be designed for working pressure and surge pressure, as specified, and dead and live loads as directed in AWWA M9, Manual of Practice for Concrete Pressure Pipe, Chapter 7, and as required by Section 2.1B.

2. Concrete lining and coating thickness, steel cylinder thickness, and bar diameter and spacing shall conform to AWWA C-303 and M-9.

3. Restrained joints shall be snap ring or approved equal.

4. Manufacturers: Thompson Pipe Group w/Snap Rings®, Forterra Precast w/Snap Rings®, Northwest Pipe Company, or approved equal.

2.6 STEEL WATER PIPE

A. All 30-inch through 144-inch diameter water main pipe may be fabricated steel pipe conforming to the requirements of the applicable AWWA Standards, unless otherwise shown on the construction plans or specified. The pipe shall be designed and furnished to fit the profile and head conditions shown on the construction plans and hydrostatic tests herein specified, plus the standard allowance for water hammer.

B. The pipe shall conform to the Quality Assurance/Quality Control and Design Criteria Sections indicated above. See project Special Provisions and Construction Drawings for additional design requirements, standards and details.

C. Connections for main line valves shall be mechanical joint for 30-inch through 48-inch diameter pipe, unless otherwise shown on the construction plans or specified.

Connections for main line valves shall be flange joint for 54-inch through 144-inch diameter pipe, unless otherwise shown on the construction plans or specified. Connections for side outlets will be flanged, mechanical joint, or factory restrained joint as indicated on the construction plans, or as specified.

D. The pipe shall be manufactured within the North American Continent. An officer of the manufacturing company shall certify that all steel was manufactured in North America.

E. Rubber gaskets shall be made of vulcanized styrene butadiene rubber (SBR) unless otherwise shown on the plans or specified. Nitrile (NBR) Rubber (Acrylonitrile Butadiene) gaskets shall be furnished when specified or shown on the construction plans and when water mains are located near contaminated soils or gasoline storage facilities.

F. Gasket lubricant shall be as recommended by the pipe manufacturer and shall conform to the requirements of the Safe Drinking Water Act and be NSF/ANSI 61 certified.

G. If the pipe manufacturer furnishes third party accessories, the pipe manufacturer shall provide a written and notarized statement signed by a current officer of the pipe manufacturer accepting unit responsibility for both the fitting, pipe, and accessories.

H. The pipe shall contain all product markings required by AWWA C-200. The product markings shall be marked on the inside of the bell or spigot ends and shall be a waterproof marking material. The minimum pipe markings shall include the manufacturer's name or trademark, the production year, piece number per the laying schedule and the pressure rating. Beveled pipe shall be marked with the amount of bevel and the point of maximum pipe length shall be marked on the beveled end. All markings shall be clear and legible.

I. The Engineer reserves the right to witness any or all acceptance tests. Prior notice of testing schedules will be provided by the manufacturer to the Engineer to accommodate travel or independent third party witness arrangements.

J. Steel pipe shall conform to AWWA C-200 and as modified below:

1. Steel pipe shall conform to AWWA C200. Steel plate used in the manufacture and fabrication of steel pipe shall meet the requirements of ASTM A1011 or A1018. All longitudinal and girth seams, whether straight or spiral, shall be butt-welded using an approved electric-fusion-weld process.

2. Pipe is to be furnished principally in 50-feet net laying lengths with shorter lengths, field trim pieces and closure pieces as required by plan and profile for location of elbows, tees, reducers and other in-line fittings or as required for construction. The pipe fabricator shall prepare a pipe-laying schedule showing the location of each piece by mark number with station and invert elevation at each bell end.

3. Pipe cylinders, coating, lining, and fabrication of specials shall be the product of one manufacturer that has not less than 5 years successful experience manufacturing pipe of the particular type and size indicated. The Pipe Manufacturer much have a certified quality assurance program.

4. Unless otherwise shown on the plans, all specials and fittings shall conform to the dimensions of AWWA C208. Pipe material used in fittings shall be of the same material and pressure class as the adjoining pipe. The minimum radius of elbows shall be 2 ½ times the pipe diameter and the maximum miter angle on each section of the elbow shall not exceed 11 ¼ degrees (one cut elbow up to 22 ½ degrees). If elbow radius is less than 2 ½ times the pipe diameter, stresses shall be checked per AWWA M11 and the pressure class increased if necessary.

5. Fittings shall be equal in pressure class design as the adjoining pipe. Specials and fittings, unless otherwise shown on the plans, shall be made of segmentally welded sections from hydrostatically tested pipe, with ends compatible with the type of joint or coupling specified for the pipe. All welds made after hydrostatic testing of the straight sections of pipe shall be tested per the requirements of AWWA C200 Section 5.2.2.1.

6. The standard joint for 54-inch through 84-inch diameter pipe shall be a Carnegie bell and spigot rubber gasket joint unless otherwise noted on the plans. Rolled groove rubber gasket joints shall conform to AWWA C303 and AWWA M9. The O-ring gasket shall have sufficient volume to approximately fill the area of the groove. Restrained joints shall be lap-welded joints with a full penetration, full thickness weld performed on the pipe interior. All welds shall be tested utilizing ultrasonic, magnetic particle or radiographic (x-ray) testing methods as described in AWWA C206-17. After pushing on joints or welding restrained joints, the pipe exterior shall be wrapped with tape coat or shrink wrap.

7. The standard joint for 90-inch through 144-inch diameter pipe shall be a lap-welded joints with a full penetration, full thickness weld performed on the pipe interior. All welds shall be tested ultrasonically. After pushing on joints or welding restrained joints, the pipe exterior shall be wrapped with tape coat or shrink wrap.

8. Interior surface 30-inch through 84-inch diameter steel pipe, fittings and specials shall be lined in the shop with cement-mortar lining applied centrifugally and conforming with AWWA C205. All interior joint recesses shall be hand mortared.

9. Interior surface 90-inch through 144-inch diameter steel pipe, fittings and specials shall be lined with cement-mortar lining factory applied centrifugally and conforming with AWWA C205.

10. Fittings, including those specially made, shall be cement-mortar lined per AWWA C205.

11. Pipe shall be coated with a bonded tape system per AWWA C214 or cement mortar per AWWA C205.

12. Deflection of the backfilled pipe shall be limited to 3% of the outside diameter.

13. The manufacturer shall submit details for joint restraint, including calculations of the required length for restrained joint sections, for approval prior to shipment of the pipe. These calculations shall be based on the pressures specified, earth cover at the location in question, soil weight of 120 pcf, and a friction factory of 0.25. Bedding shall be in accordance with CHARLOTTE WATER standard bedding requirements or as specified.

2.7 HIGH DENSITY POLYETHYLENE (HDPE) PIPE (OD-BASED IRON PIPE SIZE – IPS) AND FITTINGS

A. The HDPE pipe shall be manufactured in accordance with AWWA C-901 or C-906 and ASTM D-3035, using PE 4710 resin (ASTM D-3350, Cell Classification PE 445574). Polyethylene pipe shall be 200 PSI pressure class, OD based Iron Pipe Size – IPS pipe and much meet the dimension ratio (DR) below. Each pipe nipple shall contain no more than two (2) butt fusion joints. Due to the pipe wall thickness of HDPE pipe and due to IPS OD-based pipe, the HDPE pipe size shall be based on ID dimensions of the HDPE

pipe (e.g. when 24-inch nominal pipe is called out on the plans, 32-inch HDPE is needed to provide the required 24-inch ID pipe).

Pipe Use	Outside Diameter (inch)	ASTM Test Method	AWWA Standard	Pressure Class (PSI)	Max Dimension Ratio
Water Mains	4 - 30	D2239, D2239, D2737, D3035, D3350, F714	C906	250	DR 9
Water Mains and Service Lines	1.5 - 2	D2239, D2737, D3035, D3350	C901	200	SDR 9

IPS HDPE Pipe Sizes based on DR9 (250 psi)				
Pipe Size (inch)	Outside Diameter (inch)	Min Wall Thick-ness (inch)	Inside Diameter (inch)	Weight (pounds/foot)
3	3.5	0.389	2.68	1.66
4	4.5	0.5	3.44	2.75
6	6.625	0.736	5.06	5.96
8	8.625	0.958	6.59	10.11
10	10.75	1.194	8.22	15.70
12	12.75	1.417	9.75	22.08
14	14.00	1.556	10.70	26.63
16	16.00	1.778	12.23	34.78
18	18.00	2.00	13.76	44.02
20	20.00	2.222	15.29	54.34
22	22.00	2.444	16.819	65.75
24	24.00	2.667	18.35	78.25
26	26.00	2.889	19.88	91.84
28	28.00	3.111	21.40	106.51
30	30.00	3.333	22.93	122.27

B. 1.5-inch and 2-inch pipe for use on services, blow-offs and air releases (only), may be furnished in high density polyethylene (HDPE) with stainless steel threaded end pieces.

C. The transition pieces at each end of the HDPE pipe shall be Series 710 Male NPT couplings as manufactured by Poly-Cam, Inc or approved equal, and shall be press fit onto the HDPE pipe. The HDPE shall extend through the full length of the transition piece with no metal exposed in the waterway. The transition piece shall be manufactured from 304 or 316 stainless steel.

D. The pipe shall be manufactured within the North American Continent. An officer of the manufacturing company shall certify that all HDPE was manufactured in North America.

E. Pipe shall be manufactured at a facility that has a Registered ISO 9001:2000 Quality Management System. Copy of current ISO 9001:2000 registration shall be submitted with product submittals.

F. Pipe markings shall be as required by AWWA C-901 and C-906 and/or ASTM D-3035. Product markings shall be at intervals of not more than 5 feet. The minimum pipe markings shall be as follows:

1. Manufacturer's Name or Trademark and product record.
2. Nominal pipe size.
3. IPS.
4. Dimension Ratio ("DR 9").
5. AWWA C-901 or C-906.
6. Seal of testing agency that verified the suitability of the pipe.
7. Resin type (PE4710).
8. Color identification requirements:
    a. 1.5-inch and 2-inch HDPE Pipe shall be blue exterior.
    b. Larger than 2-inch HDPE Pipe shall be identified by a blue stripe on exterior. Striping material shall be the same as piping material.
9. Manufacturers: Performance Pipe, GF Piping Systems, JM Eagle, Driscoplex, WL Plastics or approved equal.

G. Fittings:

1. Butt Fusion Fittings:
    a. Butt fusion fittings shall be made of HDPE material with a minimum material designation code of PE 4710 and with a minimum Cell Classification as required for HDPE Pipe.
    b. Butt fusion fittings shall meet the requirements of ASTM D3261. Molded and fabricated fittings shall have a pressure rating equal to or greater than the pipe unless otherwise specified on the plans.
        1) Fabricated Fittings shall be Equivalent Dimension Ratio to DR9.
        2) Pipe stock used to manufacture fabricated fittings shall meet requirements of AWWA C901 or C906 and meet the material designation code of PE4710.
        3) Fabricated Fittings typically require a lower DR rating than the pipe to meet or exceed the pipe pressure rating. Calculate the difference for a fabricated fitting based on a published rerating percentage.

4) Fabricated bend and tee fittings shall have a minimum of 3 segments.

5) Fabricated bend fittings over 45 degrees through 90 degrees shall have a minimum of four segments.

6) Field fabricated fittings are not allowed.

c. All fittings shall meet the requirements of AWWA C901 or C906.

d. Markings for molded fittings shall comply with the requirements of ASTM D3261.

1) Standard Designation (ASTM D 3261).

2) Manufacturer's name or trademark.

3) Material designation (PE4710).

4) Date of manufacture or manufacturing code.

5) Size.

6) Dimension Ratio (example: DR 9).

e. Fabricated fittings shall be marked in accordance with ASTM F 2206.

1) Standard Designation (ASTM F 2206).

2) Manufacturer's name or trademark.

3) Material designation (PE4710).

4) Date of manufacture or manufacturing code.

5) Size.

6) Equivalent Dimension Ratio.

7) Manufacturers: ISCO, IPEX, GF Piping Systems, or approved equal.

2. HDPE Electrofusion Fittings:

a. Electrofusion Fittings shall be made of HDPE material with a minimum material designation code of PE 4710 and with a minimum Cell Classification as noted for HDPE pipe.

b. Electrofusion Fittings shall have a manufacturing standard of ASTM F1055. Fittings shall have a pressure rating equal to the pipe unless otherwise specified on the plans.

c. All electrofusion fittings shall be suitable for use as pressure conduits, and have nominal burst values of four times the Working Pressure Rating (WPR) of the fitting.

d. Markings shall be according to ASTM F 1055.

1) Standard Designation (ASTM F 2206).

2) Manufacturer's name or trademark.

3) Material designation (PE4710).

4) Date of manufacture or manufacturing code.

5) Size.

6) Equivalent Dimension Ratio.

7) Manufacturers: Agru America, GF Piping Systems, Integrity Fusion Products, IPEX, MT Deason Company, NUPI Americas Inc, or approved equal.

3. Flanges and Mechanical Joint Adapters (MJ Adapters):

a. Flanges and Mechanical Joint Adapters shall have a material designation code of PE4710 or higher and a minimum Cell Classification as noted for HDPE pipe.

b. Flanged and Mechanical Joint Adapters can be made to ASTM D 3261 or if machined, must meet the requirements of ASTM F 2206.

c. The outside diameter of Flanges shall be based on Iron Pipe Size (IPS).

d. The MJ Adapters shall be based on Iron Pipe Size by Ductile Iron Pipe Size (IPS x DIPS).

e. Flanges and MJ Adapters shall have a pressure rating equal to the pipe unless otherwise specified on the plans.

f. Markings for molded or machined flange adapters or MJ Adapters shall be per ASTM D 3261.

1) Manufacturer's name or trademark

2) Material designation (PE4710)

3) Date of manufacture or manufacturing code

4) Size

5) Where recessed marking is used, take care not to reduce the wall thickness below the minimum specified.

g. Fabricated (including machined) flange adapters shall be per ASTM F 2206.

h. Metal gland for MJ Adapter may be either AWWA C110 (full body) or AWWA C153 (compact).

i. Low alloy steel bolts shall comply with AWWA C 111.4. Bolts, rods, and hex nuts shall be manufactured from 304 stainless steel as per ANSI/ AWWA C111/A21.11.

j. Van-Stone style, metallic (including stainless steel), convoluted, or flat-plate back-up rings and bolt materials shall follow the guidelines of Plastic Pipe Institute Technical Note # 38, and shall have the bolt-holes and bolt-circles conforming to one of these standards: ASME B-16.5 Class 150, ASME B-16.47 Series A Class 150, ASME B-16.1 Class 125, or AWWA C 207 Class 150 Series B, D, or E.

k. The back-up ring shall provide a long-term pressure rating equal to or greater than the pressure-class of the pipe with which the flange adapter assembly will be used, and such pressure rating shall be marked on the back-up ring. The back-up ring, bolts, and nuts shall be protected from corrosion by a system such as coal-tar epoxy, galvanization, polyether, or polyester fusion bonded epoxy coatings, anodes, or cathodic protection, as specified by the Engineer.

l. Stiffening insert required shall comply to Part 2.7.G.4.

m. Manufacturers: Georg Fisher, DriscoPlex, IPP, or approved equal.

4. Stiffening Insert (Stiffener):

a. Provide stiffeners at each MJ adapter and coupling per Standard Details.

b. Stiffening inserts shall be specially designed for use on the inside of HDPE pipe in conjunction with AWWA C111 mechanical joints.

c. Provide stainless steel per ASTM 240, type 304 or 316.

d. Stiffener shall be manufactured within the pipe or MJ adapter by the factory.

e. Field installed stiffeners may be allowed upon approval of CHARLOTTE WATER inspector. Wedge style stiffeners are allowed.

f. Stiffener length must be sufficient to fully encompass the area of the pipe being restrained.

g. Inserts must be designed for underground pressurized fluid service and are pressure rated to match the pipe DR pressure rating, derated as appropriate for service temperature. Maximum test pressure limited to pipe rated pressure.

h. Stiffener design shall prevent movement causing fitting to slide or rotate on the pipe.

i. Manufacturers: Georg Fisher, ROMAC, or approved equal.

5. Flex Coupling Restraint Device:

a. HDPE flex coupling restraint devices will be rated for minimum of 8,000 pounds of force.

b. Resin used to manufacture device shall meet requirements of ASTM 3350 with minimum cell classification of 445474C.

c. Device will include bar code and product label tag.

d. Device will install by electrofusion.

6. Stainless Steel Threaded Fitting: Stainless steel fittings, including bends, street tees, and couplings, used with HDPE pipe shall be type 304 or type 316 stainless steel with NPT threads. The minimum wall thickness shall be 0.130-inches. Fittings shall be Standard Weight 150# Stainless Fittings as manufactured/supplied by Smith-Cooper International, or pre-approved equal. The fittings may be import or domestic production and shall be manufactured in as IS0 9001:2000 manufacturing facility.

2.8 RED BRASS PIPE (OD BASED IRON PIPE SIZE) AND FITTINGS

A. 2-inch diameter and smaller red brass pipe, for use in water mains and water service laterals shall be seamless red brass pipe, when shown on the construction plans or when specified. Pipe shall conform to the requirements of ASTM B-43, annealed temper (O61), and AWWA C-800 Section A.3: Red Brass Pipe. Pipe shall be Regular Strength or Schedule 40. Red brass pipe shall contain 84-86% copper, max 0.05% lead, max 0.05% iron and remainder zinc in conformance with ASTM B-43.

B. The pipe shall come in standard twelve foot lengths and shall be threaded on each end. Shorter lengths may be used for placement of valves and fittings. Lengths less than 10 feet may not be used to make up straight sections of pipe in order to limit the number of couplings. All red brass pipe may be of domestic manufacture or import.

RED BRASS PIPE - IPS				
Nominal Pipe Size (inches)	Outside Diameter (inches)	Min Wall Thickness (inches)	Weight (pounds/foot)	Strength
¾	1.050	0.114	1.27	Regular
1	1.315	0.126	1.78	Regular
1 ½	1.900	0.150	3.13	Regular
2	2.375	0.156	4.12	Regular

C. Pipe markings shall be as required by ASTM B-43. The minimum product markings shall include the ASTM designation ("ASTM B-43"), the alloy number or designation, manufacturer's name or trademark, and the country where cast. All markings shall be clear and legible.

D. Red brass fittings and couplings shall conform to the requirements of ASTM B-584 and AWWA C-800. Components shall be made from Copper Alloy UNS No. C89520 or No. C89833. All red brass components may be of domestic manufacture or import.

RED BRASS CASTINGS - IPS							
Classification	Copper Alloy UNS No.	Commercial Designation	Normal Composition - %				
			Copper	Tin	Lead	Zinc	Bismuth
Bismuth Selenium Brass	C89520	Sebiloy II	86	5.5	-	5	1.9
Bismuth Red Brass	C895833	Bismuth Brass	89	5	-	3	2.2

E. Although the Normal Composition of Leaded Red Brass is 5% lead, the maximum lead content shall be 0.05% as specified above, for pipe in contact with potable water. The manufacturer shall provide test reports and certification that the pipe conforms to the stated standards.

F. Cast component markings shall be as required by ASTM B-584 and ASTM B-824. The minimum product markings shall include the ASTM designation ("ASTM B-854"), manufacturer's name or trademark, and the country where cast. All markings shall be clear and legible.

G. The piping shall be manufactured within the North American Continent. An officer of the manufacturing company shall certify that all piping was manufactured in North America, if not included in product markings.

H. Red Brass Fittings: Fittings for copper tubing, red brass pipe and polyethylene tubing shall be no lead or low lead red brass alloys containing not greater than 0.25 percent

lead (weighted average) and shall comply with NSF Standard 61, NSF Standard 372 and the Reduction of Lead in Drinking Water Act passed in 2011 (or most recent applicable amendments to the Safe Drinking Water Act). Fittings for tubing shall be compression, in accordance with AWWA C-800. Stab type fittings are not approved. Red brass fittings shall have threaded ends conforming to National Pipe Thread standards.

I. The minimum product markings shall include the manufacturer's name or trademark and lettering indicating no-lead or low-lead compliance on the fittings.

2.9 STAINLESS STEEL PIPE AND FITTINGS (OD BASED STAINLESS STEEL SIZE)

A. 1.5- and 2-inch diameter stainless steel pipe, for use in water mains and water service laterals shall be seamless stainless steel, when shown on the construction plans or when specified. Pipe shall conform to the requirements of ASTM A312. Piping less than 3 inches in nominal diameter shall have a minimum wall thickness not less than the Schedule 40S.

B. The piping shall be manufactured within the North American Continent. An officer of the manufacturing company shall certify that all piping was manufactured in North America, if not included in product markings.

C. The pipe shall come in standard twenty foot lengths and shall have threaded ends with NPT threads made up with Teflon tape. Shorter lengths may be used for placement of valves and fittings. Lengths less than 10 feet may not be used to make up straight sections of pipe in order to limit the number of couplings. All stainless steel pipe may be of domestic manufacture.

STAINLESS STEEL - SEAMLESS				
Nominal Pipe Size (inches)	Outside Diameter (inches)	Min Wall Thickness (inches)	Weight (pounds/foot)	Type
¾	1.050	0.113	1.131	Sch 40S
1	1.315	0.133	1.679	Sch 40S
1-1/2	1.900	0.145	2.718	Sch 40S
2	2.375	0.154	3.653	Sch 40S

D. Fittings: Threaded fittings with forged stainless steel shall conform to ASME B16.11. Unless otherwise indicated, fittings shall be in accordance with the pressure classes called for in the Piping Schedule. Where not indicated, fittings shall have the same pressure rating as the pipe.

E. Cleaning: Stainless steel pipe and fittings shall be pickled at the point of manufacture, scrubbed, and washed until all discoloration is removed in accordance with ASTM A380 or ASTM A967.

F. Manufacturers: As approved by CHARLOTTE WATER.

2.10 COPPER TUBING – (OD BASED COPPER TUBING SIZE)

A. Copper tubing shall conform to the requirements of ASTM B-88 and AWWA C-800, Section A.2: Copper Water Tube. Copper tubing shall be Type K seamless copper water tubing. Chemical composition of material shall be a minimum 99.9% copper, by weight,

and shall be copper UNS No. C10200, C12000 or C12200. End connections may be compression type connections unless otherwise approved.

COPPER TUBING - SEAMLESS				
Nominal Pipe Size (inches)	Outside Diameter (inches)	Min Wall Thickness (inches)	Weight (pounds/foot)	Type
3/4	0.875	0.065	0.641	K
1	1.125	0.065	0.839	K
1-1/2	1.625	0.072	1.360	K
2	2.125	0.083	2.060	K

B. The tubing shall be manufactured within the North American Continent. An officer of the manufacturing company shall certify that all copper tubing was manufactured in North America, if not included in product markings.

C. The tubing shall contain all product markings required by ASTM B-88. The minimum pipe markings shall include the following: the manufacturer's name or trademark, and the type ("TYPE K") shall be permanently marked (incised) on the tubing at intervals not greater than 1.5-feet. On tubing produced from C102000 and C12000 copper, the UNS copper designation shall be identified at intervals not greater than 3 feet. Country of origin is optional at no greater than 3-feet intervals. All markings shall be clear and legible.

D. Copper tubing shall be installed in a single segment between the corporation stop on the water main pipe and the water meter. No fittings shall be used on the tubing. Couplings may not be installed between the corporation stop and the meter box.

E. Required submittals for product approval include, but are not limited to, product brochure, catalog cuts, certification of compliance, prior product acceptance test reports, and reference contact data.

2.11 POLYETHYLENE (PE) TUBING – (OD BASED COPPER TUBING SIZE)

A. ¾-inch and 1-inch diameter water service tubing may be polyethylene tubing unless otherwise shown on the construction plans or specified. Polyethylene tubing shall conform to the requirements of AWWA C-901, and be manufactured in accordance with ASTM D2239, D2737, D3035, D3350, and F2769, using PE 4710 resin (ASTM D-3350, Cell Classification PE 445574). Polyethylene water service tubing shall be SDR-9, 200 PSI pressure class, and shall comply with AWWA C-901, NSF 61, and NSF 14.

POLYETHYLINE TUBING - CTS				
Nominal Pipe Size (inches)	Outside Diameter (inches)	Min Wall Thick-ness (inches)	Pressure Class (psi)	SDR – Standard Dimension Ratio - Outside Diameter Based
3/4	0.875	0.097	200	9
1	1.125	0.125	200	9

B. The tubing shall be manufactured within the North American Continent. An officer of the manufacturing company shall certify that all polyethylene tubing was manufactured in North America.

C. The pipe shall contain all product markings required by AWWA C-901. The product markings shall be at intervals of not more than 5 feet. The minimum pipe markings shall include the nominal pipe size, production record code, standard PE code designation ("PE 3408"), Dimension Ratio ("SDR 9"), AWWA pressure class ("PC 200" or "200 PSI"), AWWA designation ("AWWA C901") and/or ASTM designation ("ASTM D-2737"), the word "Tubing" or "CTS", manufacturer's name or trademark, and the seal or mark of the testing agency certifying the pipe for use with potable water. All markings shall be clear and legible.

D. PE tubing shall be installed in a single segment between the corporation stop on the water main pipe and the water meter. No fittings shall be used on the tubing.

E. Pipe Shall be Blue or Black with Blue Stripe in color.

2.12 COPPER TRACER/LOCATOR WIRE

A. All main line water main pipe and service line pipe or tubing shall be installed with copper tracer/locator wire, regardless of the pipe material.

B. Tracer/Locator Wire System: The tracer wire shall be a single conductor AWG No. 12 (gauge) solid copper wire with HDPE insulation. The insulation shall be blue and shall be 30 mils thick for open cut installation or 45 mils thick for Horizontal Directional Drill (HDD) installation. HDD installations shall require 2 conductors. The copper conductor wire shall conform to the requirements of ASTM B-3. Tracer wire shall be furnished in coiled rolls of 500-feet or greater length on distribution project with multiple water services. Tracer wire shall be furnished on coiled rolls of 2500-feet or greater lengths on transmission main projects (typically without services), to limit splices. Tracer wire will be secured to the pipe every 10' using an HDPE zip tie or Duct Tape. A 24" pigtail will be provided in any structure exposed to daylight.

1. The wire may be of domestic manufacture or import.

2. The product markings shall be at intervals of not more than 5 feet. The minimum product markings shall include the production record code, conductor average wire gauge ("AWG No. 12"), manufacturer's name or trademark, and the insulation rating. All markings shall be clear and legible.

C. Wire Splice System: Tracer wire shall be as continuous as possible to the greatest extent. When wire splices are required, they shall conform to the Standard Details and shall be made with a butt splice, and three layers of vinyl and rubber tapes. The butt splice shall be made with copper alloy split connector or copper crimp connector.

1. The splice system may be of domestic manufacture or import and shall be pre-approved by CHARLOTTE WATER.

2. The product packaging shall indicate approved conductor type and size, the manufacturer's name, product name or number, and that the product is designed for direct bury and submersible installations. All markings shall be clear and legible.

2.13 FIRE HYDRANTS

A. Standard Fire Hydrants (3-Way):

1. Fire hydrants shall conform to AWWA C-502, Underwriters Laboratories 246 Listed, Factory Mutual 1510 Approved, and shall be constructed for 3'-6" minimum depth of bury. See Standard Details for additional minimum bury depth

requirements, based on water main diameters. Fire hydrant bury depths shall be based on the actual depth and/or the plan profile depth, to avoid using hydrant extension kits.

2. Fire hydrants shall have a minimum working pressure of 250 PSI and a minimum test pressure of 500 PSI.

3. All fire hydrants shall be constructed with a bronze main valve seat which screws into a threaded bronze connection at the base of the hydrant. All fire hydrants shall be equipped with two 2 ½ -inch brass hose nozzles with National Standard Threads, and one 5-inch STORZ connection pumper nozzle. 2 ½-inch nozzle caps shall be retained to the hydrant with zinc plated chains.

4. Hydrants shall be traffic breakaway type. Hydrant drain valves shall force flush with each operation and shall include a minimum of 2 drain outlets. Hydrant main valve shall be constructed of EPDM rubber. Hydrant shoe interior and exterior shall be fusion bonded epoxy coated conforming to AWWA C550.

5. The pumper nozzle shall meet the NFPA – fire hose connection standard for 5-inch STORZ connection and shall be compatible with 5-inch coupled large diameter fire hose. The nozzle connection shall be brass, shall be of a one piece design, and shall be integral to the fire hydrant assembly. Add on adaptors shall not be permitted. The nozzle connection shall be resistant to tamper or removal by persons not familiar with fire hydrant construction. An aluminum STORZ compatible cap shall be provided and shall be attached to the hydrant by a vinyl coated 0.1875” (3/16”) diameter galvanized aircraft cable or a No. 6 Gauge (0.192) Single Jack Link zinc plated chain. Aluminum shall be 6061 – T6 aluminum and shall be anodized dark gray or bronze in color conforming to Mil-A8625f Type 3. Natural or bright aluminum finish will not be permitted. The Storz assembly (connection and cap) shall NOT be painted.

6. All hydrants shall open by turning to the right or clockwise, shall have a minimum valve opening size of 5 ¼ - inch and shall be furnished with a 6-inch or 8-inch mechanical joint inlet. A 6-inch or 8-inch vertical flange inlet may be used, when approved by the Engineer. Alpha end connections for American-Darling fire hydrants are also approved. Vertical flange hydrants shall have a 2’-6” bury depth. The operating nut shall be 1 ¼ -inch pentagon. Any extensions required for height adjustment shall be as recommended and supplied by the hydrant manufacturer. No more than one hydrant extension may used with new installations.

    a. Vertical flange shoes shall be manufactured by McWane Industries, Mueller Company or approved equal.

7. All fire hydrants and any portions of the hydrant assembly (excluding the STORZ connection and cap) exposed to view (above adjacent ground elevation) shall be painted with coating system consisting of two (2) or more evenly applied coats. The coating system shall include a primer coat and a color top coat, and may include a clear coat. The coating system may be a powder coat or wet coat system, industrial grade, exterior grade, full gloss coating system. Application and film thickness shall be according to the paint manufacturer’s published recommendations. The coating system may be Low VOC HAPs free two component exterior grade full gloss polyurethane enamel, polyurethane, fusion bonded epoxy or cross linked polyester powder coating system. Paint systems shall be Valspar TGIC (Triglycidyl Isocyamurate) cross linked polyester powder

coat, DuPont Imron 3.5HG Polyurethane, Sherwin Williams POLANE SP polyurethane enamel, or approved equal.

8. The standard fire hydrant shall be OSHA Safety Yellow. Fire Hydrants installed and intended exclusively for use as blow-off assemblies at major low points and creeks shall be OSHA Safety Blue. Fire Hydrants installed and intended exclusively for use as air releases assemblies at major high points in the main shall be OSHA Safety Blue.

9. Hydrants will be retouched/repainted as necessary after installation and prior to acceptance according to the fire hydrant manufacturer's recommendations. Touch up paint shall be a high quality industrial grade enamel intended for exterior use. Surface preparation and film thickness shall be as recommended by the paint manufacturer. Touch up color shall match the original paint color, or the fire hydrant shall be completely re-painted.

10. All standard fire hydrants shall be one of the following models:

Manufacturer	Model
American Flow Control (American Cast Iron Pipe Company)	5 ¼" B-84-B-5
McWane Industries (Clow Valve Company, Kennedy Valve Company)	5 ¼" Medallion
	5 ¼" Guardian K81A
Mueller Company (Mueller Water Products)	5 ¼" Super Centurion 250
EJ (East Jordan Iron Works)	WaterMaster 5CD250

11. Fire hydrant tees will be Swivel Hydrant tee, Tyler 5-125 swivel hydrant tee or approved equal with integral joint restraint. Swivel 90-degree bends will be Tyler 5-197 or approved equal with integral joint restraint. Hydrant guard valves shall be connected directly to the hydrant tee and shall be all MJ bell, with wedge action thrust restraint. When swivel tees are not available on large diameter pipe, the guard valve shall be directly connected to the MJ bell tee with a foster adaptor. Dependent on the distance between the main and the fire hydrant, and additional gate valve may be required to connect directly to the fire hydrant with a foster adaptor.

12. Pipe extensions from the main to the hydrant, shall be made with 6-inch or 8-inch ductile iron only. Fire hydrants shall be on 8-inch pipe extensions only. Air release hydrants shall be on 6-inch or 8-inch pipe extensions, depending on water main diameter. All pipe between the hydrant tee and the hydrant shall be fully restrained. PVC pipe shall NOT be permitted. Pipe restraint shall be as specified above or an approved factory restraint method. Vertical hydrant extension kits shall be from the hydrant manufacturer. Third party extension kits provided by manufacturers other than the original fire hydrant manufacturer are not allowed.

13. The hydrants shall contain all product markings required by AWWA C-502, UL 246, and FM 1510 as applicable. The minimum markings on each hydrant shall include AWWA C502 mark, UL Listed mark, FM Approved mark, manufacturer's name or

trademark, main valve size, and year of manufacture. The markings shall be distinctly cast raised or in relief on the outside hydrant and legible after hydrant installation.

14. Hydrants shall be manufactured within the North American Continent. An officer of the manufacturing company shall certify that all hydrants were manufactured in North America.

B. High Velocity Fire Hydrants (4-Way):

1. When high velocity fire hydrants are specified or shown on the plans, the following specification shall apply. High velocity fire hydrants shall conform to AWWA C-502, Underwriters Laboratories 246 Listed, Factory Mutual 1510 Approved and shall be constructed for 3'-6" minimum depth of bury. See Standard Details for additional minimum bury depth requirements, based on water main diameters. Fire hydrant bury depths shall be based on the actual depth and/or the plan profile depth, to avoid using hydrant extension kits.

2. Fire hydrants shall have a minimum working pressure of 250 PSI and a minimum test pressure of 500 PSI.

3. All fire hydrants shall be constructed with a bronze main valve seat which screws into a threaded bronze connection at the base of the hydrant. All fire hydrants shall be equipped with two 2 ½ -inch brass hose nozzles with National Standard Threads, and two 5-inch STORZ connection pumper nozzles. 2 ½-inch nozzle caps shall be retained to the hydrant with zinc plated chains.

4. Hydrants shall be traffic breakaway type. Hydrant drain valves shall force flush with each operation and shall include a minimum of 2 drain outlets. Hydrant main valve shall be constructed of EPDM rubber. Hydrant shoe interior and exterior shall be fusion bonded epoxy coated conforming to AWWA C550.

5. The pumper nozzles shall meet the NFPA – fire hose connection standard for 5-inch STORZ connection and shall be compatible with 5-inch coupled large diameter fire hose. The nozzle connection shall be brass, shall be of a one piece design, and shall be integral to the fire hydrant assembly. Add on adaptors shall not be permitted. The nozzle connection shall be resistant to tamper or removal by persons not familiar with fire hydrant construction. An aluminum STORZ compatible cap shall be provided and shall be attached to the hydrant by a vinyl coated 0.1875” (3/16”) diameter galvanized aircraft cable or a No. 6 Gauge (0.192) Single Jack Link zinc plated chain. Aluminum shall be 6061 – T6 aluminum and shall be anodized dark gray or bronze in color conforming to Mil-A8625f Type 3. Natural or bright aluminum finish will not be permitted. The Storz assembly (connection and cap) shall NOT be painted.

6. All hydrants shall open by turning to the right or clockwise, shall have a minimum valve opening size of 5 ¼ - inch or 6-inch depending on the manufacturer. Alpha end connections for American-Darling fire hydrants are also approved. The fire hydrant shall be furnished with an 8-inch mechanical joint inlet, or approved alternative. An 8-inch vertical flange inlet may be used, when approved by the Engineer. Vertical flange hydrants shall have a 2’-6” bury depth. The operating nut shall be 1 ¼ -inch pentagon. Any extensions required for height adjustment shall be as recommended and supplied by the hydrant manufacturer. No more than one hydrant extension may used with new installations.

a. Vertical flange shoes shall be manufactured by McWane Industries, Mueller Company or approved equal.

7. All fire hydrants and any portions of the hydrant assembly (excluding the STORZ connection and cap) exposed to view (above adjacent ground elevation) shall be painted with coating system consisting of two (2) or more evenly applied coats. The coating system shall include a primer coat and a color top coat, and may include a clear coat. The coating system may be a powder coat or wet coat system, industrial grade, exterior grade, full gloss coating system. Application and film thickness shall be according to the paint manufacturer's published recommendations. The coating system may be Low VOC HAPs free two component exterior grade full gloss polyurethane enamel, polyurethane, fusion bonded epoxy or cross linked polyester powder coating system. Paint systems shall be Valspar TGIC (Triglycidyl Isocyamurate) cross linked polyester powder coat, DuPont Imron 3.5HG Polyurethane, Sherwin Williams POLANE SP polyurethane enamel, or approved equal.

8. The fire hydrant shall be OSHA Safety Yellow. Fire Hydrants installed and intended exclusively for use as blow-off assemblies at major low points and creeks shall be OSHA Safety Blue. Fire Hydrants installed and intended exclusively for use as air releases assemblies at major high points in the main shall be OSHA Safety Blue.

9. Hydrants will be retouched/repainted as necessary after installation and prior to acceptance according to the fire hydrant manufacturer's recommendations. Touch up paint shall be a high quality industrial grade enamel intended for exterior use. Surface preparation and film thickness shall be as recommended by the paint manufacturer. Touch up color shall match the original paint color, or the fire hydrant shall be completely re-painted.

10. All high velocity fire hydrants shall be one of the following models:

MANUFACTURER	MODEL	INLET CONNEC-TION	5" PUMPER NOZZLES	2.5" HOSE NOZZLES
American Flow Control (American Cast Iron Pipe Company)	6" American-Darling B-84-B-5	8" MJ shoe or 8" Vertical Flange	Two	Two
Mueller Company (Mueller Water Products)	5 ¼" Super Centu-rion A-459 Urban Fire Hydrant	8" MJ shoe or 8" Vertical Flange	Two	Two

11. Fire hydrant tees shall be an 8" swivel outlet, or 8" MJ bell outlet with 8" foster adaptor, or approved equal with integral joint restraint. 90-degree bends shall be all MJ bell, with wedge action thrust restraint or approved equal with integral joint restraint. Hydrant guard valves shall be connected directly to the hydrant tee and shall be all MJ bell, with wedge action thrust restraint. Dependent on distance between the main and the fire hydrant, an additional gate valve may be required to connect directly to the fire hydrant with a foster adapter.

12. Pipe extensions from the main to the hydrant, shall be made with 8-inch ductile iron only. All pipe between the hydrant tee and the hydrant shall be fully restrained. PVC pipe shall NOT be permitted. Pipe restraint shall be as specified above or an approved factory restraint method. Vertical hydrant extension kits shall be from

the hydrant manufacturer. Third party extension kits provided by manufacturers other than the original fire hydrant manufacturer are not allowed.

13. The hydrants shall contain all product markings required by AWWA C-502, UL 246, and FM 1510 as applicable. The minimum markings on each hydrant shall include AWWA C502 mark, UL Listed mark, FM Approved mark, manufacturer's name or trademark, main valve size, and year of manufacture. The markings shall be distinctly cast raised or in relief on the outside hydrant and legible after hydrant installation.

14. Hydrants shall be manufactured within the North American Continent. An officer of the manufacturing company shall certify that all hydrants were manufactured in North America.

2.14 VALVES

A. Gate Valves

1. General

a. All valves 30-inch diameter and smaller shall be Resilient seat type gate valves in accordance with AWWA C-509 or C-515. Alpha end connections are approved for gate valves sizes from 4-inch to 12-inch diameter. Gate valves shall be furnished with non-rising stems only, and stem seals shall be of the "0" ring type only. Gate valves shall be furnished with two-inch square operating nuts, painted red, and shall open by turning to the right or clockwise. Valve ends shall normally be mechanical joint with necessary glands, gaskets and bolts furnished with the valve, or approved equal. Flange ends shall be furnished for special installations as shown on the construction plans or standard details. Tapping flange by mechanical joint ends shall be furnished for tapping sleeve & valve installations.

b. Gate valves shall be of the resilient wedge seat type in accordance with AWWA C-509 or AWWA C-515 with a minimum working pressure of 250 PSI. The resilient wedge seat shall be ethylene propylene diene monomer (EPDM) rubber. Resilient seated gate valves must be furnished with durable opaque end shields to prevent ultraviolet damage to the rubber discs.

c. The body and gate shall have guide surfaces to minimize wear of the gate seats during operation of the valve, to accurately position the gate throughout the travel distance to its seat, and to ensure the alignment of the gate and steam in all orientations without gate binding or galling. As a minimum, wedge guides and body guides shall be hard-faced and machined with appropriate tolerances and clearances to allow for proper valve operation in any orientation, including the effects of wear or galling.

d. Gate valves shall contain all product markings required by AWWA C-509, AWWA C-515, UL 262, and FM 1120/1130 as applicable. The minimum cast in markings on each C509 valve shall include the manufacturer's name or trademark, valve size, working pressure, and year of manufacture. The markings shall also include the UL Listed mark, FM Approved mark, when applicable. The markings shall be distinctly cast raised or in relief on the outside of the casting. C515 valves shall also include the letters "C515". C515 valve markings may be cast in as indicated above or may be stamped on a permanently affixed corrosion-resistant tag.

e. All hardware shall be 304 stainless steel. Operating stem shall be 304 stainless steel.

f. Valves 30-inch and larger shall have spur gear or bevel gear. All spur and bevel gears shall comply with AWWA C509 and AWWA C515.

g. Valve body shall consist of only two components: lower body and top bonnet. A three-component valve shall not be allowed. Valve body and bonnet shall be fully fusion bonded epoxy coated conforming to AWWA C550. Other exterior surfaces shall be epoxy coated or fusion bonded epoxy coated.

h. Bypass piping and valves shall not be required.

i. Valve waterways shall be full nominal diameter. Reduced waterway diameters shall not be allowed.

j. Number of turns to open a water valve shall be three times the valve diameter.

k. Valves shall be manufactured within the North American Continent. An officer of the manufacturing company shall certify that all valves were manufactured in North America.

l. Only valves which have been specifically approved by CHARLOTTE WATER may be furnished.

2. 2-inch Gate Valves: Gate valves smaller than three inches shall be iron bodied gate valves constructed with iron pipe thread (FNPT), screw ends, resilient wedge gates and non-rising stems, stem seals shall be of the "0" ring type only and shall open by turning to the right or clockwise, shall be furnished with a 2” square operating nut, painted red, and shall have a minimum working pressure of 250 PSI. Materials for such gate valves shall be in accordance with the most recent edition of AWWA C-509 or AWWA C-515 with a minimum working pressure of 250 PSI.

3. 2-inch Through 12-inch Gate Valves: Gate valves 12-inch and smaller in diameter shall be direct bury gate valves and shall be furnished with CHARLOTTE WATER Standard valve boxes set in concrete pads as specified and shown on the Standard Details

4. 16-inch Through 30-inch Gate Valves, Vertical Mount: Gate valves 16-inch through 30-inch in diameter, with a vertically mounted orientation, shall be direct bury gate valves and shall be furnished with CHARLOTTE WATER standard frame and cover with a 20.5” clear opening as specified and shown on the Standard Details.

5. 16-inch Through 30-inch Gate Valves, Horizontal Mount: Gate valves 16-inch through 30-inch in diameter, with a horizontally mounted orientation, shall be installed in a horizontal line with the main valve shaft horizontal and the operating nut assembly inside a frame and cover assembly as specified and shown on the Standard Details. A bevel gear operator with grease case shall be used so that the operator shaft and operating nut shall be aligned vertically to accept a valve key operated from the surface.

2” GATE VALVES		
Manufacturer	**C-515 Compact DI Body Valves (Thin Wall) Resilient Seat Valve**	**C-509 Full Body CI Valves (Thick Wall) Resilient Seat Valve**
Mueller (Mueller Water Products)	N/A	A-2362 RWGV
American Flow Control (ACIPCO)	2500 RW NRS Series	N/A
McWane Industries (Clow Valve Co.)	N/A	Clow 2639/2640
McWane Industries (Kennedy Valve)	Kennedy KS-RW 515	Kennedy KS FW 509
EJ (East Jordan Iron Works)	Flowmaster Series #2RW11 THD VLV OR	N/A

3”, 4”, 6", 8", 10”, 12" GATE VALVES		
Manufacturer	**C-515 Compact DI Body Valves (Thin Wall) Resilient Seat Valve**	**C-509 Full Body CI Valves (Thick Wall) Resilient Seat Valve**
Mueller (Mueller Water Products)	A-2361 RWGV	A-2362 RWGV
American Flow Control (ACIPCO)	2500 RW NRS Series	N/A
McWane Industries (Clow Valve Co.)	2638	2639/2640
McWane Industries (Kennedy Valve)	KS-RW-515	KS-FW-509
EJ (East Jordan Iron Works)	Flowmaster Series #RW12	N/A

16", 18", 20", 24", 30" GATE VALVES		
Manufacturer	**C-515 Compact DI Body Valves (Thin Wall) Resilient Seat Valve**	**C-509 Full Body CI Valves (Thick Wall) Resilient Seat Valve**
Mueller (Mueller Water Products)	A-2361 RWGV	N/A
American Flow Control (ACIPCO)	2500 RW NRS Series	N/A
McWane Industries (Clow Valve Company)	2638	N/A
McWane Industries (Kennedy)	KS-RW	N/A
EJ (East Jordan Iron Works)	Flowmaster Series #RW12 (16" – 24")	N/A

B. Butterfly Valves: When required due to depth of cover restrictions, 16-inch through 30-inch direct bury butterfly valves with mechanical joint ends may be used, when approved by CHARLOTTE WATER. All valves on water mains 36-inch through 48-inch in diameter shall be butterfly valves with flanged ends conforming to all requirements of AWWA C-504. All valves on water mains 54-inch through 72-inch in diameter shall be butterfly valves with flange ends conforming to all the requirements of AWWA C-504. All valves on water mains 78-inch and larger in diameter shall be butterfly valves with flange ends conforming to all the requirements of AWWA C-516. Unless otherwise shown on the construction plans, all butterfly valves shall be Class 250B, and installed in concrete vaults (for 36-inch and larger valves) per CHARLOTTE WATER Standard Details.

1. All hardware shall be series 300 Stainless Steel.
2. All valve bodies shall be gray iron or ductile iron. Valve discs shall be ductile iron.
3. Valve shafts shall be stainless steel.
4. Rubber seats shall be clamped or mechanically secured to the valve body or valve seat, and shall be designed to allow removal and replacement without removing the valve.
5. Mating surfaces for the rubber seat shall be stainless steel bar stock. Spray on surface methods are not allowed.
6. Shaft seals shall be O-ring type.
7. Interior and exterior surfaces shall be epoxy coated with a minimum dry film thickness of 8 mils. The epoxy coating system shall be NSF 61 approved.
8. Valves shall be manufactured in North America.
9. All valves and actuators shall be designed for submerged applications.
10. All actuators shall have an indicator showing the valve position as "open" and "close". All extension stems shall have a ground position indicators at the operating nut.

11. Manual actuators shall be a traveling nut design. Worm gear actuator designs may be considered on a case by case basis.

12. Valve markings shall be cast raised letters or provided on a stainless steel plate. Cast letters shall be ½ inch. Etched or engraved letters shall be ¼ inch. Valve markings shall include manufacturer, valve size, pressure class, year of manufacturer and seating direction for seat removal and replacement.

13. Each butterfly valve shall be furnished with a manual operator equipped with a two-inch square operating nut with open direction arrow and "open" painted red. The operator shall open the valve when the operating nut is turned to the right or clockwise. The valve and operator shall be assembled for installation in a horizontal line with the main valve shaft horizontal and the operator shaft and operating nut assembly inside a vault as specified and shown on the Standard Details.

14. Butterfly valves shall be shop painted for buried service in accordance with AWWA C-504 or C-516.

15. Each valve shall be factory leak tested. Tests shall include the required valve body test and closed disc tests in both directions. Each test shall be a minimum of 10 minutes.

16. Prior to shipping butterfly valves, the manufacturer shall submit shop drawings showing the principal dimensions, general construction, and materials used for all parts of the valves and operators. The manufacturer shall include in the submittal the dates the valves are to be tested. The testing shall be scheduled to allow a representative of the Engineer to be present at the discretion of the Engineer. The valves shall be furnished in accordance with these drawings after they have been approved by the Engineer. The manufacturer must submit written certification that the valves furnished comply with all applicable provisions of AWWA C-504 or C-516. Each valve must be identifiable through a separate serial number attached to the valve.

17. Valves shall be stored indoors when possible. Outdoor storage is subject to approval. If approved to be stored outside, valves shall be protected from freezing conditions, accumulation of dirt, rocks and debris, and from sunlight UV exposure.

18. Butterfly valves shall be manufactured by:

    a. Clow – Style 1450

    b. Kennedy – Style 1450

    c. M&H Valve Company – Style 1450

    d. ValMatic – 2000 series

    e. or Pre-approved equal

C. Fire Line – Detector Check Valve: Four-inch through ten-inch detector check valves shall be rated for 175 PSI minimum working pressure and 350 PSI hydrostatic test pressure with flanged ends per ANSI B16.1, Class 125 or 150. The valve body may be carbon steel, stainless steel, cast iron, or ductile iron. Carbon steel body valves shall be internally, and externally fusion bonded epoxy coated, 8 mils minimum thickness per AWWA C550. Stainless steel bodies shall be 300 Series stainless. Cast/ductile iron body valves shall be internally, and externally fusion bonded epoxy coated, 8 mils minimum thickness per AWWA C550. Operating mechanism shall be by internal weight or linkage

and spring and shall be all bronze or stainless steel. Valve shall have rubber faced clapper and bronze seat. Valves shall have two tapped bosses on each side to permit installation of a metered bypass. Valve shall be UL listed/FM approved. Name plate shall indicate: (1) manufacturer's name, model, (2) Size, (3) flow direction, (4) working pressure (PSI), (5) year of manufacture, and approval mark (UL, FM).

1. The following 4 through 10-inch fire line detector check valves are approved:

Manufacturer	Model
Ames Fire and Waterworks	1000 DCV
FEBCO	Series #800
Watts Regulator	Series SS 07F
Wilkins	Model 310

2. Bypass meter piping shall be 1-inch diameter, and the detector meter shall be a standard CHARLOTTE WATER 1-inch meter and yoke bar assembly. The one-inch detector meter shall include an angle single check valve in the meter box on the discharge side of the meter. The 1-inch angle single check valve shall be a Ford Model HA91444, Mueller H142 series, AY McDonald 702 series, or approved equal.

3. Fire Line - Detector Check Valve: Two-inch fire line detector check valves may be used on automatic fire sprinkler systems where fire hydrants are not required. Two-inch detector check valves shall be rated for 175 PSI working pressure and 350 PSI hydrostatic test pressure. The valve ends shall be 2 bolt meter flanges. The valve body shall be cast bronze with a bronze cover. Operating mechanism shall consist of an internally spring loaded check valve. Valve shall include a bronze replaceable bushing in the cover, a bronze replaceable seat ring, stainless steel spring and Delrin disc holder to insure positive check seating. Valve shall have two tapped bosses on each side of the check to permit installation of a metered bypass.

   a. Name plate shall indicate: (1) manufacturer's name, model, (2) Size, (3) flow direction, (4) working pressure (PSI), (5) year of manufacture.

   b. The following 2-inch fire line detector check valves are approved:

Manufacturer	Model
FEBCO	Series #406

   c. Bypass meter piping shall be ¾-inch diameter, and the detector meter shall be a standard CHARLOTTE WATER 5/8-inch meter and yoke bar assembly. The 5/8-inch detector meter shall include an angle single check valve in the meter box on the discharge side of the meter. The 5/8 x 3/4-inch angle single check valve shall be a Ford Model HA91323, Mueller H142 series, AY McDonald 702 series, or approved equal.

2.15 WATER MAIN TAPS

A. Tapping Sleeves for Cast Iron Pipe, Ductile Iron Pipe, or PVC Pipe:

1. Tapping sleeves may be ductile iron, mechanical joint, or stainless steel full gasket with wedge gasket around tap opening. All tapping sleeves shall be rated for a minimum of 200 PSI working pressure. Shop drawings shall be furnished that clearly indicate the minimum design working pressure and burst pressure. The maximum direct tap size shall be in accordance with AWWA C223.

2. Mechanical joint tapping sleeves shall be full body ductile iron furnished complete with joint accessories including split glands, split end gaskets, bolts, etc., and shall be compatible with the type and class of pipe being tapped. The outlet flange shall be Class 125 per ANSI B16.1 compatible with approved tapping valves. The sleeve shall include a brass or stainless steel test plug for pressure testing the installed sleeve prior to making the tap. DI full body MJ tapping sleeves shall be used for all same size on size taps and may be used on all size taps.

3. Stainless steel tapping sleeves shall be manufactured from 18-8, type 304 stainless steel. The outlet flange may be ductile iron or stainless steel. The gasket shall be a grid pattern design and shall provide full circumferential sealing around the pipe to be tapped. The sleeve shall include a stainless steel or brass test plug for pressure testing the installed sleeve prior to making the tap. All welds shall be passivated. The outlet flange shall be Class D per AWWA C-207-ANSI 150 lb. drilling compatible with approved tapping valves. Rubber or EPDM flange gaskets are required. Paper flange gaskets are not allowed.

4. Bolts, nuts, washers, etc. shall be manufactured from 18-8, type 316 stainless steel. Threads shall be coated with an anti-seize compound.

5. The following table lists approved tapping sleeves:

DI Mechanical Joint	Stainless Steel
Mueller - H615	Ford Meter Box – FTSS & FTSAS
American Flow Control – Series 2800-C	Romac - SST III & STS420
Kennedy – 957 / 960	Smith Blair/Rockwell - 665
	JCM Industries - 432 & 452
	PowerSeal – 3490 AS - 3460 AS-HP
	Mueller #H-304SS

6. Flange Isolation Kit

   a. Flange Isolation Kit: Full flange diameter, Type E, made of laminated phenolic with neoprene on each side of gasket with minimum total thickness of 1/8 inch.

1) Dielectric strength: Not less than 500 volts per mil.

2) Compressive strength: Not less than 24,000 psi.

3) Water absorption: Maximum 2.5%.

4) Approved manufacturers/suppliers:

a) Advance Products & Systems, Inc.

b) Central Plastics Company.

c) Pipeline Seal and Insulator, Inc. (PSI).

d) Or equal.

b. Isolation Flange Bolt Sleeves: High density polyethylene or spiral wrapped Mylar with dielectric strength not less than 1,200 volts per mil.

c. Isolation Flange Bolt Washers: High strength phenolic with minimum thickness of 1/8 inch, dielectric strength not less than 500 volts per mil, and compressive strength not less than 25,000 psi.

d. Steel Flange Bolt Washers for placement over insulating washers: Minimum thickness of 1/8 inch and cadmium plated.

e. One Piece Combination Sleeve and Washer, only when noted on Drawings.

1) One piece sleeve and washer of molded acetyl or nylon resin having minimum thickness of 1/8 inch.

a) Dielectric strength not less than 500 volts per mil.

b) Compressive strength not less than 15,000 psi.

B. Tapping Sleeves for HDPE Pipe:

1. Tapping sleeves to be of HDPE material with a minimum material designation code of PE4710 and installed with electrofusion conforming to ASTM F1055 and ASTM F1290. All tapping sleeves shall be rated for a minimum of 200 PSI working pressure. Shop drawings shall be furnished that clearly indicate the minimum design working pressure and burst pressure.

2. Tapping sleeves for HDPE pipe shall be as manufactured by Kinson, GF Piping Systems, or approved equal.

C. Mechanical Tapping Sleeves for HDPE Pipe:

1. Carbon Steel Tapping Sleeve:

a. Body and outlet nozzle shall be made of carbon steel, A-36 or equal.

b. Bolts and nuts shall be 5/8” corrosion resistant, high strength alloy oval neck track head bolt per ASTM A-242 / ANSI / AWWA C111 / A21.11 and heavy hex nut per A563 Electro Coated, Powercron 590-534. Stainless steel 18-8 type 316 is also acceptable.

c. Flange shall be AWWA C207 Class D, ANSI 150 lb. drilling, recessed for tapping valve MSS-SP60

d. Gaskets shall be NBR, Bunna-N, or SBR per ASTM D2000 MBA 710.

e. Coating shall be fusion bonded epoxy coating, minimum 12 mils thickness per ANSI / AWWA C213, and NSF 61 certified.

2. Stainless Steel Tapping Sleeve:

a. Shell and lugs shall be type 304 stainless steel per ASTM A240.

b. Bolts shall be UNC rolled thread, type 304 stainless steel.

c. Nuts shall be heavy hex, type 304 stainless steel per ASTM A194.

d. Washers shall be plastic lubricated flat washers. Spring washers shall be special "spring" grade stainless steel.

e. Flange shall be ductile iron per ASTM 536, Grade 65-45-12; or type 304 stainless steel per ASTM A240. Flange shall accommodate tapping flanges per MSS SP-60.

f. Gaskets shall be SBR per ASTM D2000 MAA 610, compounded for water service.

3. The following table lists approved mechanical tapping sleeves for HDPE pipe:

Carbon Steel Mechanical	**Stainless Steel**
Romac – FTS423-H	Romac – SST-H
JCM - 422	

D. Tapping Sleeves for Pre-Stressed Concrete Cylinder Pipe:

1. Tapping sleeves to be ASTM A-36 stainless steel conforming to the requirements of AWWA C-301, AWWA C-304, AWWA C-223 and as modified below:

a. The tapping sleeve shall be designed for 200 PSI working pressure, 40% surge pressure, live and dead loads as required in the AWWA C-304.

b. Factory Testing - all materials used in the manufacture of the tapping sleeve shall be tested as outlined in the applicable ASTM standard for that material. Test reports shall be obtained by the manufacturer and held on file for inspection by the Engineer. The manufacturer shall furnish an affidavit that the materials used in making the tapping sleeves meet all provisions of the applicable ASTM standard and that the fittings meet all applicable provisions of AWWA C-301.

2. Shop drawings (materials and dimensions) shall be furnished that clearly indicate the minimum design working pressure and burst pressure.

3. The outlet flange shall be Class 125 per ANSI B16.1 compatible with approved tapping valves.

4. The sleeve shall include a brass or stainless steel test plug for pressure testing the installed sleeve prior to making the tap.

5. Flanged Tapping Sleeves for PCCP:

a. Material:

1) Sleeve shall be designed for an operating pressure of 200 psi.

2) Saddle Plate to be ASTM A-36 stainless steel conforming to the requirements of AWWA C-301, AWWA C-304, and AWWA C-223.

3) Straps shall be manufactured from ASTM A36 steel or equal.

4) Gasket shall have a broad, flat sealing surface and shall be manufactured of a material suitable for the intended conveyed fluid.

5) Flange to be connected to valve shall be manufactured in accordance with AWWA C207 Class D. Flanges larger than 12" diameter shall have an alignment recess suitable for accepting the alignment lip of the tapping valve.

6) Bolts, studs and nuts shall be stainless steel with anti-seize compound coating.

7) Approved Manufacturers or approved equal:

Manufacturer	Model Number
Ford Meter Box	FRCTS, FRCTSC, FRCTS2
Romac Industries	FTS435
Smith-Blair	625 Tapping Sleeve
JCM Industries	JCM 415

b. The complete construction of the tapping sleeve and valve (including field assembly, installation, testing, tapping, etc.) shall be performed under the direct supervision and approval of a qualified field services technician working directly for and employed by a United States-based pre-stressed concrete cylinder pipe manufacturer. The technician shall witness and approve each step of the process. The technician shall have been trained in the construction and installation of like-sized or larger tapping sleeves and valves on pre-stressed concrete cylinder pipe. The manufacturer shall provide written proof of qualifications and a history of installations performed under the direction of the proposed technician. The field services technician proposed shall be reviewed by the Engineer as part of the shop drawing approval process.

E. Weld-on Tapping Sleeves for Steel Pipe

1. Tapping Sleeve Material

a. Tapping sleeve shall be high strength type made of a minimum material strength ASTM A36 or A516 GR 70 Steel or equal.

b. Sleeve shall be designed for a minimum operating pressure of 200 psi.

c. Outlet flange shall be AWWA C207 Class D, ANSI 150 lb. Drilling, recessed for approved tapping valve. Tapping Sleeves shall be ANSI/NSF Standard 61, Annex G and ANSI/AWWA 372 Certified.

d. Waterway shall be lined with fusion-bonded epoxy to a minimum thickness of l5 mils in accordance with AWWA C2l3. All other steel shall be coated

with a shop coat primer coating. Coatings shall be free of laminations and blister; not peel; and remain pliant and resistant to impact.

e. Tapping Sleeves: Provide with 3/4-inch NPT test opening for testing prior to tapping. Provide 3/4-inch bronze or stainless steel plug for opening.

f. Steel sleeves shall be shipped in wooden crates that provide protection from damage to epoxy coating during transport and storage.

g. Approved Manufacturers or Approved Equal:

Manufacturer	Model Number
Smith Blair	#626 type 2 or type 3
Power Seal	#3428
Ford Meter Box	FWS
JCM Industries	#416 & #417
ROMAC	FTS 445 Series

2. Flange Isolation Kit

a. Flange Isolation Gasket: Full flange diameter, Type E, made of laminated phenolic with neoprene on each side of gasket with minimum total thickness of 1/8 inch.

1) Dielectric strength: Not less than 500 volts per mil.

2) Compressive strength: Not less than 24,000 psi.

3) Water absorption: Maximum 2.5%.

4) Approved manufacturers/suppliers:

a) Advance Products & Systems, Inc.

b) Central Plastics Company.

c) Pipeline Seal and Insulator, Inc. (PSI).

d) Or equal.

b. Isolation Flange Bolt Sleeves: High density polyethylene or spiral wrapped Mylar with dielectric strength not less than 1,200 volts per mil.

c. Isolation Flange Bolt Washers: High strength phenolic with minimum thickness of 1/8 inch, dielectric strength not less than 500 volts per mil, and compressive strength not less than 25,000 psi.

d. Steel Flange Bolt Washers for placement over insulating washers: Minimum thickness of 1/8 inch and cadmium plated.

e. One Piece Combination Sleeve and Washer, only when noted on Drawings.

1) One piece sleeve and washer of molded acetyl or nylon resin having minimum thickness of 1/8 inch.

a) Dielectric strength not less than 500 volts per mil.

b) Compressive strength not less than 15,000 psi.

F. Service Saddles for PVC Pipe: All corporation stops for services or air releases shall be installed with service saddles having threads to accept standard AWWA Corporation valve inlet AWWA CC – Taper Thread. Service saddles will comply with the following:

1. The service saddle shall be rated at a minimum of 200 PSI working pressure.
2. Service Saddles for 2-inch PVC shall be brass.
3. Service saddles for 3-inch and larger pipe may be brass, ductile iron or stainless steel.
4. Unless otherwise approved, all service saddles shall be double bolt/double strap/band style.
5. Ductile iron bodies shall be fusion bonded epoxy coated.
6. Bolts, nuts, straps/bands shall be series 300 stainless steel.
7. Straps/bands must be pre-formed at the factory to the specified outside diameters of and designed specifically for use on PVC pipe.
8. The following manufacturers and models are approved:

a. All Brass Service Saddles:

Manufacturer	On 2" Pipe	On 6" Pipe	On 8" Pipe	On 12" Pipe
Ford	S-70	202BS	202BS	202BS
A.Y. McDonald	3895	N/A	N/A	N/A
Power Seal	3401	3403	3403	3403
Cambridge Brass	N/A	800-0690	800-0905	800-1320

b. Brass Service Saddles with Stainless Steel Double Straps:

Manufacturer	On 2" Pipe	On 6" Pipe	On 8" Pipe	On 12" Pipe
Ford	N/A	202BSD	202BSD	202BSD
A.Y. McDonald	N/A	3855	3855	3855
Power Seal	N/A	3409	3409	3409
Cambridge Brass	N/A	812-0750	812-0962	812-1438

G. Service Saddles for Ductile Iron Pipe: All corporation stops for services or air releases shall be installed with service saddles having threads to accept standard AWWA Corporation valve inlet AWWA CC – Taper Thread. Service saddles will comply with the following:

1. Ductile Iron Service Saddles (Epoxy Coated with SS Straps):

Manufacturer	Stainless Steel Double Strap
Ford	FC202 & FCD202
Mueller	DR2S
Smith Blair/Rockwell	317 & 397
JCM Industries	406
Romac	202NS
PowerSeal	3417 DI or 3417 DI SW
A Y McDonald	4845A

2. Stainless Steel Service Saddles:

Manufacturer	Saddle No.
Ford	FS323
PowerSeal	3417 AS, 3417 AS SW

H. Service Saddles for use on existing HDPE Pipe: Service saddles for use on new and existing HDPE pipe shall be electrofusion saddles. See HDPE specifications and standard details for additional requirements of HDPE saddles. If approved on a case-by-case by CHARLOTTE WATER, mechanical saddles may be used on existing HDPE pipe as specified below in lieu of HDPE fused saddles. All corporation stops for services or air releases shall be installed with service saddles having threads to accept standard AWWA Corporation valve inlet CC – Taper Thread. Service saddles for HDPE Pipe shall be ductile iron or stainless steel, manufactured with fusion applied epoxy coating to provide protection against corrosion. Service saddles must have two stainless steel straps preformed at the factory to the specified outside diameters of and designed specifically for use on HDPE Pipe.

1. Service saddles for 2-inch PVC must be brass.
2. Service saddles for 3-inch and larger pipe may be brass, ductile iron or stainless steel.
3. Unless otherwise approved, all service saddles shall be double bolt/double strap/band style.
4. Ductile iron bodies shall be fusion bonded epoxy coated.
5. Bolts, nuts, straps/bands shall be series 300 stainless steel.
6. Straps/bands must be pre-formed at the factory to the specified outside diameters of and designed specifically for use on IPS HDPE pipe.
7. The following manufacturers and models are approved:

a. Epoxy Coated Ductile Iron Service Saddles with Stainless Steel Straps:

Manufacturer	Stainless Steel Double Strap
Ford	FC202
JCM Industries	406
Romac	202 N - H
PowerSeal	3422 AS

I. Adapters for Tapping to the Water Mains:

1. HDPE Adapters

a. 2-inch valves connecting to HDPE water mains shall connect with a stainless steel or brass MIPT x CTS compression adaptor.

J. Slip-joint DI bell adaptors for PVC: A FBE lined and coated ductile iron MNPT x slip joint bell adaptor shall be installed at threaded 2-inch valves and fittings and bends. Approved manufacturers shall be Harco or approved equal.

K. Corporation Stops: Corporation stops shall be ball valve corporations and shall comply with AWWA C-800 and shall be high pressure rated at 300 PSI working pressure in accordance with Section 3.3 of the standard. Inlet threads shall be standard AWWA Corporation valve inlet thread (CC or Taper Thread). Outlet threads shall be according to the indicated connection. The valve port diameter shall be the full service size. Reduced port sizes are prohibited. All corporations installed on C-900 PVC pipe, HDPE pipe, and DIP shall require a tapping saddle/service clamp as hereinafter specified. Taps on HDPE pipe require electrofused HDPE tapping saddle connections unless mechanical tapping saddles are specifically approved on a case-by-case basis by CHARLOTTE WATER. See the service saddle specification above for additional information. Direct taps without a tapping saddle are prohibited.

1. The following manufacturers and models are currently approved:

a. Services:

Manufacturer	3/4 " Services	1 " Services	1 ½ " Services	2 " Services
	Ball Type			
	CC x Compression	CC x Compression	CC x Compression	CC x Compression
Ford – Grip Joint Compression	FB1000-03-G-NL	FB1000-04-G-NL	FB1000-06-G-NL	FB1000-07-G-NL
AY McDonald – CTS Compression	4701BT-NL	4701BT-NL	4701BT-NL	4701BT-NL
Mueller – Grip Compression Connection	B25008N	B25008N	B25008N	B25008N
Cambridge Brass – Grip Joint Compression	301NL	301NL	301NL	301NL

b. Air Release:

Manufacturer	2" Air Release
	CC x Female Iron Pipe
Ford	FB1600-07-NL
AY McDonald	73148B-NL
Mueller	B20045N

2.16 REPAIR/TIE-IN SLEEVES/CLAMPS

A. Long Pattern Solid Sleeves (2-inch through 64-inch): Solid cast ductile iron mechanical joint sleeves (long pattern) shall be used where required for tie-ins between new mains and existing mains and when replacing defective sections of pipe with new pipe. Special gasket sizing (oversize or undersize) may be required to conform to existing pipe outside diameters.

Approved Manufacturers: Tyler/Union, Star Pipe Products, Sigma Corp, SIP Industries, U.S. Pipe

B. Steel Couplings: Long Pattern steel sleeves may be used when necessary to conform to non-standard existing pipe outside diameters. Special gasket sizing (oversize or undersize) may be required to conform to existing pipe outside diameters. Steel sleeves may only be used when long pattern solid sleeves will not accept the odd pipe diameter, and have been specifically approved by the Engineer. Steel sleeves shall be designed for a minimum of 200 PSI working pressure, and shall be stainless steel or coated with a minimum of 12 mils of fusion bonded epoxy. Follower rings shall be ductile iron. Bolts, nuts, washers, etc. shall be manufactured from 18-8, type 316 stainless steel. Threads shall be coated with an anti-seize compound.

1. The following steel couplings are approved:

Manufacturer	24-inch and Smaller Epoxy Coated Steel Couplings
Smith Blair	411
JCM	202
Romac Industries	400

2. Shop drawings will be required from the manufacturer for 16-inch and larger steel couplings. Couplings shall meet the minimum requirements as indicated above, and shall be manufactured by Smith Blair, JMC, Romac, or approved equal.

C. Ductile Iron Restrained Joint Couplings: Long pattern ductile iron restrained joint couplings may be used when necessary to conform to non-standard existing pipe outside diameters. Gasket sizing shall be as required to conform to the existing pipe outside diameters. Ductile iron couplings may only be used when long pattern solid sleeves will not accept the OD size pipe diameter. Ductile iron couplings shall be designed for a minimum of 350 PSI working pressure and shall be fusion bonded epoxy coated inside and out with a minimum thickness of 12 mils. Bolts, nuts, washers, etc. shall be type 304 or 316 stainless steel. Threads shall be coated with an anti-seize compound.

1. The following Ductile Iron restrained joint couplings are approved in sizes 1.5-inch through 16-inch diameters:

    a. Romac Industries – Standard Alpha Coupling, Alpha XL, and Alpha Transition Coupling for 4-inch though 16-inch sizes.

2. Shop drawings shall be required from the manufacturer for 16-inch and larger ductile iron couplings.

Repair clamps or split sleeves will not be allowed on new construction. These may be used to repair existing mains (not installed as part of new construction projects) if specifically approved by the Engineer or Owner's representative.

2.17 FERROUS CASTINGS

A. Valve Boxes:

1. All valve boxes shall conform to the dimensions shown on the Standard Details. Valve boxes shall be of cast iron conforming to ASTM A-48, Class 35B and shall be manufactured in domestic foundries or may be import product manufactured at approved foundries. Approved import foundries are Star Pipe, SIP Industries, Sigma Corporation or approved equal.

2. Adjustment riser sections placed between the top section of the valve box and the cover are PROHIBITED on proposed construction. They may be used on resurfacing projects if designed specifically for use in the CHARLOTTE WATER standard valve box as detailed in the CHARLOTTE WATER Standard Detail and are approved by Charlotte Department of Transportation and/or NCDOT and CHARLOTTE WATER. Adjustment riser sections will be submitted for approval by the CHARLOTTE WATER Engineer.

3. Valve boxes shall use a plastic valve centering disk to keep the valve box aligned during back filling.

    a. Disks shall be Plastic Posi-Cap Valve Box Aligner Disk manufactured by Pollardwater or approved equal.

B. Manhole Frames and Covers:

1. All manhole frames and covers shall conform to the dimensions shown on the Standard Details. Manhole frames and covers shall be of cast iron conforming to ASTM-A-48, Class 35B and shall be manufactured in domestic foundries only. Frames and covers shall meet the minimum requirements established by and be approved for use in NCDOT rights-of-way. All covers shall have two non-penetrating lift holes, and two non-penetrating lifting bars, sized and shaped to facilitate the cover removal from the frame by use of a standard manhole hook and/or railroad pick. The manufacturer's name and model number shall be cast into the surface of the cover and into the frame. Frame and covers with a 21-, 24-, or 30-inch clear opening, conforming to the standard details, and shall have the following cast into the surface of the cover: "WARNING: DO NOT ENTER".

2. The following manufacturers and models are currently approved:

    a. US Foundry

    b. EJ Corp

c. Or, approved equal

3. Adjustment riser sections placed between the frame and the cover are PROHIBITED on proposed construction. They may be used on resurfacing projects if designed specifically for use in the CHARLOTTE WATER frame and cover, and are approved by Charlotte Department of Transportation and/or NC Department of Transportation and CHARLOTTE WATER. Adjustment riser sections will be submitted for approval by the Engineer.

2.18 MISCELLANEOUS STEEL

A. Steel Reinforcing for Concrete:

1. Bars: All reinforcement bars shall conform to the Standard Specifications for billet-steel bars for concrete reinforcement , ASTM A-615, or low alloy steel deformed and plain bars for concrete reinforcement, ASTM A-706. All bars shall be deformed and of structural Grade 60.

2. Wire: All reinforcement wire fabric shall conform to the Standard Specifications for welded steel wire fabric for concrete reinforcement, ASTM A-185 and steel wire, plain, for concrete reinforcement, ASTM A-82. Minimum yield strength shall be 65,000 psi and minimum tensile strength shall be 75,000 psi.

B. Stainless Steel Tie Rods: Tie rods used for thrust restraint of mechanical joints shall be fabricated from stainless steel type 304 or 316 conforming to the specifications of ASTM A193. Tie rods shall be threaded through the bolt holes in the flange and secured by nuts attached to the rod using spacers. The number and diameter of tie rods to be installed is dependent on the pipe diameter, flange size and maximum pipe pressure as shown below.

Pipe Diameter (inches)	Maximum Pressure (psi)		Tie-Rod Diameter Size (inches)
	200	275	
	Required Tie-Rod Quantity		
3	2	2	5/8
4	2	2	5/8
6	2	2	5/8
8	3	3	5/8
10	3	3	3/4
12	3	3	7/8
16	3	4	1
24	6	9	1
30	6	9	1 1/4
36	9	12	1 1/4
42	12	16	1 1/4
48	11	15	1 1/2
54	14	18	1 1/2
60	17	23	1 1/2
66	15	20	1 3/4
72	18	24	1 3/4

2.19 CONCRETE

A. Portland Cement: All concrete shall conform to the Standard Specifications for READY MIXED CONCRETE, ASTM C-94. An air-entraining admixture, conforming to ASTM C-260, shall be added to either Type II, or Type III Portland Cement. Fly Ash conforming to ASTM C-618 for Class F Fly Ash may be added to the concrete mix but shall not be considered as replacement for more than 25% of the cement therein (strengths shall not be less than hereinafter required). Type IL Portland-limestone cement meeting ASTM C-595, shall be allowed in lieu of Type II Portland-cement.

1. Types III and IIIA Portland Cement shall only be used for manhole inverts, concrete encasement, concrete blocking, and/or as directed by the Engineer and shall conform to ASTM C-150.

2. Types II and IIA Portland Cement shall be used in precast vaults, cast in place manhole structures, reinforced concrete pipe and reinforced concrete piers as directed by the Engineer, and shall conform to ASTM C-150 except that Tricalcium Aluminate content shall not exceed 8%. Portland-limestone cement Type IL(MS), conforming to ASTM C-595, shall be allowed in lieu of Types II and IIA.

B. Aggregates: All aggregates used for concreting shall conform to ASTM C-33 and shall be checked daily for any variances in moisture content. Said variances shall be corrected and/or taken into consideration for each batch.

1. Coarse Aggregates: Shall be uniformly and evenly graded for each application in accordance with A.C.I. Standard 318. Unless otherwise approved, aggregate shall be sound, crushed, angular granitic stone. Flat or elongated aggregate or smooth round stones shall not be acceptable.

2. Fine Aggregates: Shall consist of natural sand, manufactured sand or a combination thereof. Fine aggregates shall conform to the sieve analysis as specified in paragraph 4.1 of the ASTM C33 except that the percent passing a No. 50 sieve shall not exceed 5% and the percent passing a No. 100 sieve shall be 0% as provided for in paragraph 4.2 of the ASTM C33.

C. Mix Design: Concrete shall be watertight, resistant to freeze-thaw cycles and moderate sulfate attack, abrasion resistant, workable, and/or finishable. These qualities may be met through the use of admixtures (if and only if approved in the mix design as hereinafter specified) conforming to the appropriate ASTM with the exception of the use of calcium chloride, which shall be limited to no more than 1% by cement weight - thoroughly mixed to insure uniform distribution within the mix. If the concrete is used with reinforcing steel, no calcium chloride will be allowed. The Contractor shall assume responsibility for concrete mixture. When required by the Engineer, and prior to beginning construction, the Contractor, at their expense, shall obtain from an approved commercial certified testing laboratory a design for a suitable concrete mix and submit same with their list of materials and material suppliers for approval. The concrete shall be proportioned to meet the following requirements: (Note: This mix does not apply "in total" to precast manhole or reinforced concrete pipe).

1. Compressive Strength: Minimum 3,600 psi

2. Water-Cement Ratio By Weight: Maximum 0.50

3. Slump: Minimum 3”, Maximum 5”

4. Superplasticizer Slump: 6” – 8”

5. Air Content (Entrained and Entrapped): Minimum 4%, Maximum 6%

6. Coarse Aggregate: ¾" - 1 ½" (as required by the application)

D. Curing Compound: All concrete curing compounds shall conform to the standard specifications for LIQUID MEMBRANE - FORMING COMPOUNDS FOR CURING CONCRETE, ASTM C-309, Type 2. Curing compounds shall be applied if forms are stripped when concrete is to remain exposed to the atmosphere.

E. Grouts: All grouts shall be of a non-shrink nature (as may be achieved through additives or proportioning) and depending upon application range from plastic to flowable cement water paste. Testing as specified above for concrete may be required for acceptance of grouts to include frequent checks for consistency by a time- of-flow measurement. Expansion grouts shall be either MasterFlow 648 epoxy grout by BASF, or 1428HP Grout by W.R. Meadows, or approved equal. Grouts shall be mixed (if applicable) and placed in accordance with the manufacturer's current recommendations, for each specific application. Expansion grouts shall be used only as directed by the Engineer. Acceptable range of testing requirements:

1. Compressive Strength: 10,500 psi to 12,500 psi.

2. Bond Strength: 1,350 psi to 1,700 psi.

3. Percent Expansion: + 0.025% to + 0.75%

F. Mortar: Mortar used in water meter vaults and water valve vaults shall be Type M mortar in accordance with ASTM C-270.

G. Flowable/Excavatable Fill (CLSM): Contractor shall furnish and place flowable fill i.e. controlled low strength material (CLSM) backfill where shown in the drawings.

1. Cement: All cement used shall be Type II Portland cement which shall conform to the requirements of ASTM C150.

2. Fly Ash: ASTM C618, Class F.

3. Aggregates: Fine aggregate shall conform to the grading and quality requirements of ASTM C33. Coarse aggregate shall conform to the grading and quality requirements of ASTM C33 for size No. 476, No. 57, or No. 67.

4. Water: The batch mixing water and mixer washout water shall conform to the requirements of ASTM C94.

5. Flowable Fill Properties

   a. CLSM shall have a maximum fifty-six (56) day compressive strength of one hundred (150) psi when molded and cured as in conformance with ASTM D4832.

   b. CLSM shall have a minimum cement content of fifty (50) pounds per cubic yard. The water-cementitious materials ratio of the mix shall not exceed three and one-half to one (3.5:1).

   c. CLSM shall be air entrained to a total air content of approximately five percent (5%).

   d. The minimum slump shall be six (6) inches and the maximum slump shall be eight (8) inches when tested in accordance with ASTM D6103.

e. Fine aggregate shall be between fifty percent (50%) and sixty percent (60%) by volume of the total aggregates in the CLSM mix.

f. The consistency of the CLSM slurry shall be such that the material flows easily into all openings between the pipe and the lower portion of the trench. When trenches are on a steep slope, a stiffer mix of slurry may be required to prevent CLSM from flowing down the trench. When a stiffer mix is used, vibration shall be performed to ensure that the CLSM slurry completely fills all spaces between the pipe and the lower portion of the trench.

H. Lightweight Cellular Concrete Fill – For Use In Annular Spaces Inside Casing Pipe and Tunnel Pipes. See Chapter 21 “Tunneling and Encasement” of the CHARLOTTE WATER Standards.

I. Meter Vaults

1. Concrete meter vaults shall conform to the minimum requirements as indicated in the Standard Details. Vaults shall meet the minimum requirements established by and be approved for use in NCDOT road rights-of way as a minimum and as modified herein.

2. Structures shall be designed for a minimum of H/20/HS20 load rating and or a minimum of 3 feet of cover or the actual cover, whichever requires the stronger design.

3. Concrete shall be a minimum of 4000 psi compressive strength at 28 days. Cylinder test results shall be provided to CHARLOTTE WATER.

4. Design shall conform to ASTM C858 – Specifications for Underground Precast Concrete Utility Structures.

5. Steel reinforcement design shall conform to ASTM C857.

6. Rebars shall be grade 60 per ASTM A185.

7. Diagonal reinforcing shall be added at all openings.

8. Pipe penetrations shall be sealed with flexible connectors – Rubber manhole boots, or with 8-inches of brick and mortar, including ½ inch thick construction expansion material around the outside diameter of the pipe.

9. All joints shall be made watertight with two (2) rings of butyl rubber joint mastic.

10. All joints shall include a 6-inch wide external joint wrap made of butyl rubber mastic joint wrap.

11. Manufacturing shall be scheduled with CHARLOTTE WATER. CHARLOTTE WATER reserves the right to inspect all reinforcement placement prior to pouring concrete.

12. All steps shall pass a 1000-pound pullout test. Test results shall be provided to CHARLOTTE WATER.

13. All test equipment shall be calibrated at intervals not greater than one year. Calibration reports shall be provided to CHARLOTTE WATER.

14. Shop Drawings and Structural Design Calculations sealed by a North Carolina PE shall be submitted for review by CHARLOTTE WATER for each size and/or depth of structures.

15. Precast concrete vaults shall be as manufactured by Dellinger Precast, Precast Supply Co., Tindall Corp., Wellington-Hamrick Inc., or approved equal.

2.20 BEDDING MATERIALS - STONE AND BRICK/BLOCK

A. Granular Bedding Material: All bedding material shall be angular, clean washed crushed stone graded in accordance with Size #57, Size #67, or Size #78M in ASTM D-448 for "Standard Sizes of Coarse Aggregate" (NCDOT Standard size #57, #67 and #78). Bedding material will be used only as instructed in the Specifications and/or as specifically directed by the Engineer.

B. Stone Stabilization Material: All stone stabilization material shall be angular, clean washed crushed stone graded in accordance with standard sizes #467 in ASTM D- 448, (NCDOT Standard size #467M). Stabilization material will be used only as instructed in the specifications and/or as specifically directed by the Engineer. In conditions unsuitable for use of #467 stone, larger material conforming to NCDOT Class A, B, 1, and 2 stone and ASTM D-448 standard size #357 stone may be used as directed by the Engineer and shall meet the following class and size distribution.

Required Stone Sizes, Inches			
Class	Minimum	Midrange	Maximum
A	2	4	6
B	5	8	12
1	5	10	17
2	9	14	23

No more than 5% of the material furnished can be less than the minimum size specified nor no more than 10% of the material can exceed the maximum size specified.

Weight Percent Passing Each Sieve				
Size No.	Nominal Size Square Openings	2 ½ Inches	2 Inches	1 Inch
#357	2 inches to No. 4	100	95 to 100	35 to 70

C. Foundation Material: Foundation materials shall consist of field stone or rough unhewn quarry stone. The stone shall be sound, tough, dense, resistant to the action of air and water, and suitable in all other respects for the purpose intended. All stone shall meet the approval of the Engineer. While no specific gradation is required, there should be equal distribution of the various sixes of the stone within the require size range. The size of an individual stone will be determined by measuring its long dimension. No more than 5% of the material can be less than the minimum size specified and no more than 10% can exceed the maximum size specified. Foundation material will be used only as instructed in the specifications and/or as specifically directed by the Engineer.

D. Concrete Brick/Block: All concrete brick/block used to make vertical manhole and vault height adjustments shall be solid, of standard building size and meet the requirements of ASTM C55 for Grade S-II. Concrete brick shall conform to NCDOT requirements and shall be red tinted per NCDOT requirements. Concrete brick/block may be used in vertical manhole and vault height adjustments, as shown on the standard details, or when approved by the Engineer.

2.21 CLAY ANTI-SEEP COLLARS

A. Compacted clay for anti-seep collars shall have a specific discharge of 1 X 10–5 cm/sec or less. The clay source material shall be laboratory tested/verified prior to approval by the Engineer. Testing shall be performed by a materials testing laboratory and certified by a geotechnical Professional Engineer or Professional Geologist. Placement of clay anti-seep collars shall as be shown on the construction plans and/or where directed by the Engineer. The clay anti-seep collars shall conform to the Standard Detail. Clay shall be compacted to a minimum of 98% of maximum dry density. Compaction test results shall be required on each anti-seep collar.

PART 3 - EXECUTION

3.1 CONSTRUCTION LAYOUT

A. Construction Staking: Contractor is responsible for staking water main alignments, water main appurtenance structures, easements, rights-of-way, limits of disturbance, tree protection fence line, wetland boundaries, buffers, Project Control Points and other horizontal control reference points and benchmarks for the work shown on the Drawings. CHARLOTTE WATER (or the design engineer) will provide a drawing and/or staking plan files in electronic format to Contractor. Contractor shall confirm all drawing dimensions and elevations and establish elevations, lines, and levels from reference points, utilizing recognized engineering survey practices. During construction, Contractor shall provide competent helpers for checking elevations, lines, and levels deemed necessary by CHARLOTTE WATER. Contractor to establish horizontal and vertical control benchmarks and reference points on the site located in prominent and protected places as agreed upon by Contractor and CHARLOTTE WATER. All construction staking and survey work shall be performed by a North Carolina Professional Licensed Surveyor. The NC PLS shall be employed by the design engineer or a third party survey company.

1. Prior to construction, the Contractor will provide the following construction layout for each pipeline project:
    a. Centerline of proposed water main, water main appurtenance structures will be established and offset referenced.
    b. Begin and end point of proposed mainline dry bore with steel encasement or tunnel will be established and offset referenced centerline.
2. Permanent or temporary benchmarks will be established at or near:
    a. Connection to existing water mains,
    b. Proposed end of water mains,
    c. Approximate 1000-foot station,

d. Proposed water appurtenance structures

e. Proposed piers

f. Mainline bore with encasement or tunnel

3. The Contractor is responsible for protecting these control points until construction is complete. All other construction layout and surveying, which may be required for construction, shall be provided by the Contractor. The Contractor is responsible for determining the amount of additional construction layout and surveying that may be required to complete construction.

4. On developer donated projects, refer to the donated project general conditions for requirements.

3.2 CONNECTION TO EXISTING MAINS

A. Connections to the existing system shall be pre-scheduled with and made in the presence of CHARLOTTE WATER Inspection personnel. Valves, hydrants, blow offs, etc. will be operated by CHARLOTTE WATER personnel and/or the Contractor if specifically directed by CHARLOTTE WATER to do so in the presence of CHARLOTTE WATER Inspection personnel. The Contractor shall provide all labor, materials, and equipment required for connection to the existing system. Only one (1) connection between the existing system and the new extension will be allowed until testing, chlorination, and successful sampling of the new extension is complete. The one connection shall include a jumper assembly and backflow assembly. The backflow assembly shall be tested and certified by a CHARLOTTE WATER approved third party backflow tester. No water shall pass through the jumper assembly until the backflow assembly has been certified. Provide a copy of the backflow certification to CHARLOTTE WATER prior to filling the new water main.

B. If connection to existing mains will necessitate an interruption of service, the Contractor will schedule the connection for a time that is most convenient to the affected customers as determined by the Engineer. A minimum of seven (7) days notice shall be provided to those customers who will be put out of service by the connection. For commercial customers, a minimum of thirty (30) days notice shall be provided if an agreed upon shut down date cannot be agreed to by all impacted customers. When such interruption of service is approved, the Contractor will have all required labor, material and equipment at the site before beginning any work and the service interruption will be kept to an absolute minimum.

C. The Contractor shall verify blocking at existing valves prior to scheduling connections and will be required to block, rod, or restrain existing and new pipe, fittings and valves as necessary.

D. Connections

1. Direct connections to the existing water system, of any size or type, will not be allowed until:

a. chlorination is complete;

b. the new water main has passed all lab tests; and,

c. the new water main has been approved for connections and activation by the Engineer.

2. Only one temporary jumper connection to the existing water system, of any size or type, will be allowed until after chlorination is complete and the new water main has passed all lab tests and has been approved for connections and activation by the Engineer. The temporary jumper connection, for the purpose of filling, flushing, testing, disinfection and sampling shall be installed at an approved location and shall be sized to provide a minimum flushing velocity of 3.0 feet per second in all new main diameters.

3. The temporary jumper connection shall include a Reduced Pressure (RP) Principle Backflow Preventer as indicated on the Standard Details and as specified below. Chlorination of the new water main shall be performed through a tap on the new main side of the RP Backflow Preventer after the backflow device has been tested and certified by a certified tester. Temporary jumper connections will also be required where the only connection to existing water system is with a tapping sleeve (or saddle) and valve (or corporation). At these locations, the tap will be completed, and (1) on short side extensions, the jumper will be installed approximately 18-feet from the tapping sleeve and valve; and (2) on long side extensions, the jumper will be installed after crossing the road. At the time of pipe installation, the contractor will pressure test the new pipe segment. Then the Contractor will wash the inside of the new pipe, from the tapping sleeve and valve to the jumper, with 50 PPM free chlorine with 3 hours exposure, or 200 PPM with 30 minutes of exposure. The main shall be immediately flushed and samples pulled by CHARLOTTE WATER Lab Services. Only after the new main has passed all lab tests and has been approved for activation, the jumper can be removed and a long pattern solid sleeve connection will be completed.

E. Reduced Pressure (RP) Principle Backflow Preventer

1. The RP backflow preventer and jumper piping shall conform with the following size requirements and shall be sized to provide minimum flushing velocity of 3.0 feet per second in all new main pipe diameters:

   a. Proposed water mains will require a minimum 2-inch PR backflow preventer.

2. The RP backflow preventer shall be as indicated in the following table, or as approved by the Engineer, and must be included on the “APPROVED” list of RP backflow preventers as maintained by the Backflow Prevention Division of CHARLOTTE WATER:

Manufacturer	2-inch Diameter	4-inch Diameter	6-inch Diameter	8-inch Diameter	10-inch Diameter
Conbraco	RPLF40, 40A, 4A	PLF4A, RPLF4AN	PLF4A, RPLF4AN	PLF4A, RPLF4AN	-
Febco	LF825Y, YA, LF860, 860U	760, LF860, LF880V	760, LF860, LF880V	760, LF860, LF880V	760, LF860
Watts	LF909 M1QT, LF009 M2QT, LF919QT, LF919AQT, LFU919QT, LFU919AQT	957, 957N, 957Z, 994, LF909	957, 957N, 957Z, 994, LF909	957, 957N, 957Z, LF909M1	957, LF909M1
Wilkins	375XL, 375XLB, 975XL2, 975XL2MS, 975XL2BMS,975XL2SE, 375AR, 375AST, 375MS	375, 375A, 375AR, 375AST, 375MS, 475, 475MS, 475V, 475VMS, 475ST, 375ASTR	375, 375A, 375AR, 375AST, 375MS, 475, 475MS, 475V, 475VMS, 475ST, 375ASTR	375, 375A, 375AR, 375AST, 375MS, 475, 475MS, 475V, 475VMS, 475ST	375, 375A, 375AR, 375AST, 375MS, 475, 475MS, 475V, 475VMS, 475ST

3. A List of Companies with Approved Certified Testers is maintained by and available from the Backflow Prevention Division on CHARLOTTE WATER's web site. A Certified Tester will test the RP backflow preventer after each installation and prior to each use, in accordance with the requirements of the Backflow Prevention Division. If an RP jumper assembly is set-up at a location, and removed and re-installed at the same location, the RP backflow preventer shall be re-tested upon re-installation. Unless otherwise approved by the Engineer, the project Inspector shall witness the test(s). Whether witnessed or not, the Contractor will provide the Engineer with a copy of the Certified Tester's Test Reports. The Test Reports shall be in a format that is approved by the Backflow Prevention Division of CHARLOTTE WATER.

4. All RP jumper assembly piping and fittings shall be flanged, threaded, restrained or quick connect joints. The Contractor will install adequate thrust restraint on the proposed main at the jumper location to resist all thrust caused by the filling and flushing procedures. The Contractor will verify and improve the thrust restraint on the existing main at the jumper location as needed to resist thrust caused by existing pressures and surges, and by the filling and flushing procedures.

5. Adequate traffic control devices shall be in place prior to installation of the RP backflow preventer. Traffic control devices shall be properly maintained throughout the use of the RP backflow preventer. Placement of the RP backflow preventer may be restricted by the requirements of restricted work hour requirements of the NCDOT encroachment and/or CDOT thoroughfare requirements.

6. The RP backflow preventer shall not remain in the road right-of-way during non-work hours unless specifically addressed by the NCDOT or CDOT encroachment agreement, and/or approved by the controlling agency and CHARLOTTE WATER.

7. On non NCDOT maintained road rights-of-way, the location and work hour restrictions associated with the RP jumper shall be subject to approval of the controlling agency and CHARLOTTE WATER.

3.3 PIPING INSTALLATION GENERAL

A. General Locations and Arrangements: Drawing plans and details to indicate general location and arrangement of underground water piping. Location and arrangement of piping layout take into account design considerations. Install piping as indicated, to extent practical. Where specific installation is not indicated, follow piping manufacturer's written instructions.

B. In all instances pipe shall be laid in a workmanlike manner, true to line and grade, with bell ends facing up-grade in the direction of laying. The various pipes referred to herein shall be handled, belled up and laid in accordance with the manufacturer's requirements and good engineering practices as defined in the various publications referenced in this document. The following requirements and/or standards of the CHARLOTTE WATER shall govern this construction unless exceeded by other regulatory bodies.

C. When installing pipe under streets or other obstructions that cannot be disturbed, use dry bore with encasement, auger without encasement, dry punch/mole or horizontal directional drilling, as shown on the plans or as approved by the Engineer.

D. Pipe Bedding: Unless otherwise specified or noted on the Plans the following bedding classes are as commonly required by CHARLOTTE WATER. When filter fabric is required to be placed over the granular bedding and pipe the fabric shall be Mirafi 140N or approved equal. When granular material embedment is required, the Contractor will backfill above the granular bedding as specified for Type I bedding to an elevation one (1) foot above the top of the pipe bell.

1. Type I - Shaped Bottom Bedding: The trench bottom shall be shaped so the pipe bears uniformly upon undisturbed native earth. Soil shall then be placed by around the pipe and completely under the pipe haunches in uniform layers not exceeding six (6) inches in depth up to an elevation one (1) foot above the top of the pipe bell. Each layer shall be placed and then carefully and uniformly compacted, so that the pipe is not damaged nor the alignment disturbed.

2. Type IA – Granular Shaped Bottom Bedding: The trench bottom shall be shaped so the pipe bears uniformly upon undisturbed native earth. The pipe haunches shall be filled with an approved washed stone to a vertical height of one-fourth the outside diameter of the pipe bell for the pipe's entire length and for the entire width of the ditch. Type IA granular shaped bottom bedding may be used in lieu of Type I shaped bottom bedding. Soil shall then be placed by around the pipe and completely in uniform layers not exceeding six (6) inches in depth up to an elevation one (1) foot above the top of the pipe bell. Each layer shall be placed and then carefully and uniformly compacted, so that the pipe is not damaged nor the alignment disturbed.

3. Type II - Granular Material Embedment: The trench bottom shall be undercut a minimum of six (6) inches below the pipe barrel grade and filled with an approved washed stone to an elevation such that the pipe will be completely and uniformly bedded to a vertical height of one-third the outside diameter of the pipe bell for the pipe's entire length and for the entire width of the ditch. Depending upon soil and ground water conditions, greater depths (undercut) may be required to create a stable condition. Type II granular material embedment shall be used as directed by the Engineer. When groundwater or bedrock is encountered, a minimum bedding of Type II is required.

4. Type III - Granular Material Embedment: The trench bottom shall be undercut a minimum of six (6) inches below the pipe barrel grade and filled with an approved washed stone to an elevation such that the pipe will be completely and uniformly bedded to vertical height of one-half the outside diameter of the pipe bell for the pipe's entire length and for the entire width of the ditch. Depending upon soil and ground water conditions, greater depths (undercut) may be required to create a stable condition. Type III granular material embedment shall be used as directed by the Engineer.

5. Type IV – Granular Material Embedment: The trench bottom shall be undercut a minimum of six (6) inches below the pipe barrel grade and filled with an approved washed stone to an elevation such that the pipe will be completely and uniformly bedded to a vertical height equal to the outside diameter of the pipe bell for the pipe's entire length and for the entire width of the trench. Depending upon soil and ground water conditions, greater depths (undercut) may be required to create a stable condition. Type IV granular material embedment shall be used as directed by the Engineer.

6. Type V – Granular Material Embedment: The trench bottom shall be undercut a minimum of six (6) inches below the pipe barrel grade and filled with an approved washed stone to an elevation such that the pipe will be completely and uniformly bedded to a vertical height of twelve (12) inches above the outside diameter of the pipe bell for the pipe's entire length and for the entire width of the trench. Depending upon soil and ground water conditions, greater depths (undercut) may be required to create a stable condition. Type V granular material embedment shall be used as directed by the Engineer.

7. Type VI – Flowable Fill Embedment: The trench bottom shall be undercut a minimum of six (6) inches below the pipe barrel and shall be filled with excavatable flowable fill, for use adjacent to lakes and ponds, when the pipe is more than 6 feet below full pond, or when excavation occurs within 45 degree line sloping out and down from toe of a foundation slab. Depending upon soil and ground water conditions, wider trenches may be required to create a stable condition in poor soils that cannot brace the flowable fill. Type VI flowable fill embedment shall be used as directed by the Engineer.

8. Stone Stabilization: When the bottom of the trench is not sufficiently stable to prevent vertical or lateral displacement of the pipe after installation with Type II or Type III bedding, stone stabilization will be required to develop a non- yielding foundation for the bedding and pipe. When such conditions are encountered, the trench will be excavated to a depth as great as 2.5 feet below the pipe bell, or as determined by the Engineer, and #467 or #357 crushed stone, ballast stone or rip rap will be placed to an elevation six (6) inches below the bottom of the pipe. The pipe will then be laid with Type II, Type III, Type IV or Type V bedding as directed by the Engineer. Stabilization techniques utilizing a geotextile fabric may also be permitted or required by the Engineer.

9. Stone Foundation: When the bottom of the trench is not sufficiently stable to prevent vertical or lateral displacement of the pipe after installation of feet of stabilization stone material, stone foundation materials will be required to develop a non-yielding foundation for the stone stabilization, bedding and pipe. When such conditions are encountered, the trench will be excavated to a depth, as determined

by the Engineer. Class A, B, 1, or 2 stone foundation materials will be placed to an elevation determined by the Engineer. Layering of several classes of stone foundation materials may be required by the Engineer. Stabilization stone shall be used between the stone foundation materials and the bedding stone as determined by the Engineer. The pipe will then be laid with Type II through Type VI (6) bedding as directed by the Engineer. Should the Engineer determine that the stone foundation material is not capable of providing a non-yielding foundation, then concrete cradles or piers shall be required as specified below. Excavation and disposal of undercut materials necessary for installation of stone foundation material is included as part of stone foundation.

10. Concrete Encasement and Cradles: Shall be as designed for each individual case and will be noted on the Plans and in the Special Provisions when applicable.

E. Depth of Pipe Installation: Unless otherwise indicated on Plans, or required by existing utility location, all pipe will be installed with the top of the pipe at least 3.0' below the edge of adjacent roadway pavement or 3.0' below the ground at the pipe, whichever is greatest. The Contractor is instructed to check the construction plans and blow-up views for additional requirements.

1. The maximum depth of cover for the previously specified pressure classifications shall be as follows:

DIP maximum depth:

MAXIMUM DEPTH OF COVER - DIP				
Pipe Size	Pressure Class	BEDDING		
		Type I	Type II	Type III
8"	350	20’	34'	50'
10"	350	15’	28'	45'
12"	350	15’	28'	44'
14"	250	15’	23'	36'
16"	250	15’	24'	34'
18"	250	14’	22'	31'
20"	250	14’	22'	30'
24"	250	15’	20'	29'
30"	250	15’	19'	27'
36"	250	14’	18'	25'
42"	250	14’	17'	25'
48"	250	13’	17'	24'
54”	250		16’	24’
60”	250		16’	24’
64”	250		16’	24’

PVC maximum depth: PVC pipe shall be installed with a minimum of 3.0 feet of cover. The maximum depth of cover shall be as follows:

Type I Bedding: 10 feet

Type II Bedding: 15 feet

Type III Bedding: 20 feet

PCCP maximum depth: No maximum depth. Product shall be designed and selected on a per project basis between the Engineer and the Manufacturer.

BWP maximum depth: No maximum depth. Product shall be designed and selected on a per project basis between the Engineer and the Manufacturer.

Steel maximum depth: No specific maximum depth. Product shall be designed and selected on a per project basis between the Engineer and the Manufacturer.

HDPE maximum depth: Not applicable.

2. The Contractor may be required to vary the depth of pipe to achieve minimum clearance from existing utilities while maintaining the minimum cover specified whether or not the existing pipelines, conduits, cables, mains, etc. are shown on the Plans.

F. Alignment and Grade:

1. New Subdivision Streets: The water main shall be laid and maintained to the required lines and grades with fittings, valves and hydrants at the required locations; spigots centered in bells; and all valves and hydrant stems plumb. The curb must be in place and backfilled, and the area between the curb and the street right-of-way line graded smooth and to finished grade before water mains are installed. The water main shall be installed behind the curb or in the pavement as shown on approved plans or directed by the Engineer.

   a. In special circumstances, the Engineer may approve installation of water mains before the curb is installed. In such cases, the street must be graded to finish grade according to approved grading plans for the entire width of the street right-of-way, the water main staked per approved construction plans. In the absence of approved plans, the water main shall be staked five feet behind the proposed curb line with 90 degree offset stakes every 50 feet, and "cut sheets" provided showing the vertical distance between each offset stake and the trench bottom at that point. Such staking will be done only by a surveyor registered in the State of North Carolina.

   b. After the curb and gutter has been installed, the location and depth of the main, valves, fire hydrants, etc., will be checked for conformance with CHARLOTTE WATER standards and the construction drawings. Soft dig excavations shall be performed by the Contractor to verify compliance at

100-ft intervals. The compliance shall be witnessed by the CHARLOTTE WATER Inspector, or the pipe elevation, centerline, ground elevation and edge of pavement elevations shall be recorded by a third party NC-PLS. The survey data shall be provided to the design engineer and CHARLOTTE WATER. The survey data shall be used in the production of the record drawing profiles. Any deficiencies will be corrected to the satisfaction of the Engineer prior to testing, disinfection and activation of the mains.

2. Existing Streets: The water mains shall be installed as shown on the plans unless an obstruction prevents such alignment or grade. The Contractor will be required to adjust the location of the water main where possible to avoid such conflicts as specified and as directed by the Engineer.

   a. All construction layout and surveying which may be required for construction shall be provided by the Contractor and any costs associated shall be included in the various pay items of the proposal. The Contractor is responsible for determining the amount of construction layout and surveying that may be required to complete construction.

3.4 INSTALLATION AND ASSEMBLY, GENERAL

A. Proper implements, tools, and facilities satisfactory to the Engineer shall be provided and used by the Contractor for the safe and convenient prosecution of the work. All pipe, fittings, valves and hydrants shall be carefully lowered into the trench piece by piece by means of a backhoe or other suitable means, in such a manner as to prevent damage to protective coatings and linings. Under no circumstances shall water main materials be dropped or dumped into the trench. A tracer wire system shall be installed for all piping based on the standard details and specifications.

1. Inspection of Material: The pipe and fittings shall be inspected for defects.

2. Cleaning Pipe and Fittings: All lumps, blisters and excess coatings shall be removed from the bell and spigot ends of each pipe, and the outside of the spigot and the inside of the bell shall be wire-brushed, or wiped clean dry and free from oil and grease before the pipe is laid. A visual inspection shall be completed to determine if there is any foreign object is blocking the inside of pipe and shall be flushed with potable water to clear the opening, if there is any.

3.5 INSTALLATION AND ASSEMBLY OF DUCTILE IRON PIPE

A. DIP water main shall be installed in accordance with the Recommended Practice for the Installation by DIPRA and AWWA C-600 – Installation of DIP and Appurtenances.

B. Laying Pipe: Pipe shall be laid with bell ends facing in the direction of laying, unless otherwise approved by the Engineer. Every precaution shall be taken to prevent foreign material from entering the pipe while it is being placed.

1. If the pipe laying crew cannot put the pipe into the trench and in place without getting earth into it, the Engineer may require that before lowering the pipe into the trench, a heavy, tightly woven canvas bag of suitable size shall be placed over each end and left there until the connection is to be made to the adjacent pipe. During laying operations, no debris, tools, clothing or other materials shall be placed in the pipe.

2. After placing a length of pipe in the trench, the spigot end shall be centered in the bell and the pipe forced home and brought to correct line and grade. The pipe shall be secured in place with approved backfill material tamped under it. Precautions shall be taken to prevent dirt from entering the joint space.

3. At times when pipe laying is not in progress, the open ends of pipe shall be closed by a watertight plug or other means approved by the Engineer. This provision shall apply during the lunch hours as well as overnight. If water is in the trench, the seal shall remain in place until the trench is pumped completely dry.

C. Permissible Deflection of Joints: Wherever it is necessary to deflect pressure pipe from a straight line, either in the vertical or horizontal plane, to avoid obstruction or plumb valve stems, or where long radius curves are permitted, the amount of deflection allowed shall not exceed 50% of that which is required for satisfactory sealing of the joint as recommended by the manufacturer, and shall be approved by the Engineer.

Pipe Diameter (inches)	AWWA C600 Deflection Angle for push-on joint (degrees)	AWWA C600 Deflection Angle for mechanical joint (degrees)
3	5	8-18
4	5	8-18
6	5	7-07
8	5	5-21
10	5	5-21
12	5	5-21
14	3	3-35
16	3	3-35
18	3	3-00
20	3	3-00
24	3	2-23
30	3	-
36	3	-
42	3	-
48	3	-
54	3	-
60	3	-
64	3	-

D. Installation of Push-On Joint Pipe: The gasket groove and bell socket shall be cleaned and lubricated, and the gasket inserted as specified by the pipe manufacturer. Sterile lubricant, as furnished or specified by the manufacturer shall be applied to the gasket and beveled spigot end of the pipe. The beveled spigot end of pipe shall be pushed straight into bell using either a bar, jack, lever puller, or backhoe. A timber header will be placed between the jack or backhoe bucket and the pipe to prevent damage to the pipe. At no time will the joint be made by swinging the pipe. The pipe will be deflected, if required, after the joint is made.

E. Installing Factory Restrained Joint Pipe: For restrained joint pipe with a factory installed weldment, make conventional push-on joint assembly, fully homing the pipe until the first assembly stripe is in the bell. Insert right-hand and left-hand locking segments and slide segment in appropriate direction. Hold segments apart and wedge the rubber retainer into the slot between the two locking segments. Extend the joint to remove the slack in the locking segment cavity.

F. Installing Mechanical Joint Pipe and Fittings: All spigots shall be centrally located in the bell and adequate anchorage shall be provided where abrupt change in direction and dead ends occur. All pipe surfaces with which the rubber gasket seals come into contact will be brushed with a wire brush just prior to assembly in order to remove all loose rust or foreign material and to provide a clean surface for the installation of the gasket. The pipe surface with which the gasket comes into contact and the gasket will be brushed with soapy water just prior to the installation of the gasket and the making up of the joint. Torque loads shall be applied to the standard cast iron bolts used in making the joint as follows:

BOLT SIZE, INCHES	RANGE OF TORQUE, FT. POUNDS
5/8	40-60
¾	60-90
1	70-100
1-1/4	90-120

1. The above torque loads may be applied with torque measuring or indicating wrenches. Torque wrenches may be used to check the application of approximate torque loads applied by people trained to give an average pull on a definite length of regular socket wrench. The following lengths of wrenches should satisfactorily produce the above ranges of torques when used by the average person:

BOLT SIZE, INCHES	LENGTH OF WRENCH, INCHES
5/8	8
¾	10
1	12
1-1/4	14

2. When tightening bolts, the gland will be brought up toward the pipe flange evenly, maintaining approximately the same distance between the gland and the face of the flange at all points around the socket.

G. Installing Wedge Action Mechanical Joint: Clean and remove all loose materials and rust from the mating surfaces. Lubricate the gasket and plain end by brushing either soapy water or pipe lubricant. Slide the mechanical joint restraint on the plain end with the lip extension towards the plain end, followed by the mechanical joint gasket. Wedge action restraint shall be installed per the manufacturer's recommendations. Mechanical joint restraint shall require conventional tools and installation procedures per AWWA C600, while retaining full mechanical joint deflection during assembly as well as allowing joint deflection after assembly. Proper actuation of the gripping wedges shall be ensured with torque limiting twist off nuts. Torque loads are as follows:

Pipe Size (Inches)	Bolt Size (Inches)	Range of Torque (Ft - Lbs)
3	5/8	45 – 60
4 – 24	3/4	75 – 90
30 – 36	1	100 – 120
42 – 48	1 1/4	120 - 150

H. DI Pipe Gripper Gasket Joint Restraint: Gripper gasket joint restraint may be used on ductile iron pipe 12-inch and smaller only. Gripper gasket joint restraint shall be installed where shown on the plans, standard details or when approved by the Engineer. Restrained lengths on each side of the fittings shall be as shown on standard details or the plans, or as approved by the Engineer. Installation shall be as per the gripper gasket and pipe manufacturer's recommendations. Gripper gasket joint restraint is prohibited for use in above ground applications, such as bridge crossings. Gripper gasket joint restraint is prohibited for use in directional drilling applications. When used in conventional straight casings, gripper gasket joint restraint shall be installed per the manufacturer's recommendations by pulling, not pushing, the pipe through the casing. Gripper gasket joint restraint is prohibited for use at end of line plugs.

I. Bend and Fitting Location: The Contractor is advised that the bends and fittings indicated on the plans are for a guide only. The Contractor will be required to furnish additional bends and fittings as needed to complete all installations.

J. Cutting Pipe: The cutting of pipe for inserting valves, fittings, or closure pieces shall be done in a neat and workmanlike manner without damage to the pipe or cement lining and so as to leave a smooth end at right angles to the axis of the pipe. Cut ends of a pipe shall be beveled before installation in a push-on joint bell.

1. When making connections to existing mains which require water mains to be removed from service, automatic traveling pipe cutting machines will be required on pipe 16-inch and larger. At other times, hand-held pipe saws may be used provided the pipe is marked, prior to cutting, such as to provide a cut at right angles to the axis of the pipe. Handheld pipe saws may be used in all applications for cutting pipe smaller than 16-inch.

    a. Flame cutting of pipe with an acetylene torch will not be allowed.

K. Ductile Iron Pipe shall be installed when the minimum cover is less than 3.0 feet and in all crossings of other pipelines (storm drainage, gas, etc.) when the vertical distance between the water main and the other pipeline is less than 12-inches.

L. Tracer wire and warning tape shall be installed in accordance with the Standard Details and as specified in these specifications.

3.6 INSTALLATION AND ASSEMBLY OF PVC PIPE

A. PVC water main shall be installed in accordance with AWWA C-605 – Underground installation of PVC pressure pipe and fittings and with AWWA M23. Backfill shall be as specified elsewhere in these specifications.

B. Laying Pipe: Pipe shall be laid with bell ends facing in the direction of laying, unless otherwise approved by the Engineer. Every precaution shall be taken to prevent foreign material from entering the pipe while it is being placed.

1. If the pipe laying crew cannot put the pipe into the trench and in place without getting earth into it, the Engineer may require that before lowering the pipe into the trench, a heavy, tightly woven canvas bag of suitable size shall be placed over each end and left there until the connection is to be made to the adjacent pipe. During laying operations, no debris, tools, clothing or other materials shall be placed in the pipe.

2. After placing a length of pipe in the trench, the spigot end shall be centered and inserted into the pipe bell until the face of the bell is located between the bell homing lines on the pipe spigot and placed at the correct line and grade. Under no circumstance shall the pipe be over homed. The pipe shall be secured in place with approved backfill material tamped under it. Precautions shall be taken to prevent dirt from entering the joint space.

3. At times when pipe laying is not in progress, the open ends of pipe shall be closed by a watertight plug or other means approved by the Engineer. This provision shall apply during the lunch hours as well as overnight. If water is in the trench, the seal shall remain in place until the trench is pumped completely dry.

C. Permissible Bending Radius: Wherever it is necessary to deflect pressure pipe from a straight line, either in the vertical or horizontal plane, to avoid obstruction or plumb valve stems, or where long radius curves are permitted, the longitudinal bending radius of unrestrained gasket-joined pipe shall not exceed the values listed below or as recommended by the pipe manufacturer, and approved by the Engineer.

Pipe Diameter (inches)	AWWA C605 Minimum Bending Radius (feet)	CHARLOTTE WATER Minimum Bending Radius (feet)
2 (PVC)	--	75
6	144	150
8	--	200
10	--	250
12	--	300

D. Permissible Deflection of Joints: Wherever it is necessary to deflect pressure pipe from a straight line, either in the vertical or horizontal plane, to avoid obstruction or plumb valve stems, or where long radius curves are permitted, the maximum amount of angular joint deflection of unrestrained gasket-joined pipe shall not exceed 1% or as recommended by the manufacturer, and shall be approved by the Engineer.

E. Installation of Push-On Joint Pipe: Sterile lubricant, as furnished or specified by the manufacturer shall be applied to the gasket and beveled spigot end of the pipe. When inserting a PVC spigot into a ductile iron bell, the beveled end of the PVC spigot shall be removed, and the resulting outer edge shall be ground off. The beveled spigot end of pipe shall be pushed straight into bell using either a bar, jack, lever puller, or backhoe. When inserting a PVC spigot into a ductile iron bell, the insertion line shall be ignored and the PVC pipe will be bottomed in the ductile iron bell. A timber header will be placed between the jack or backhoe bucket and the pipe to prevent damage to the pipe. At no

time will the joint be made by swinging the pipe. The pipe will be deflected, if required, after the joint is made.

F. Installing Spline/Groove Restrained Joint Pipe and Fittings: The exposed gasket surface and pipe spigot shall be cleaned and lubricated and the spigot end inserted into the bell (restraint joint in bell (RJIB)) as specified by the pipe manufacturer. When the pipe end seats against the stop in the coupling, spline grooves are automatically aligned for spline insertion. The spline shall then be inserted through the insertion hole in the coupling and into the aligned grooves until it is fully seated around the circumference of the pipe. A timber header will be placed between the jack or backhoe bucket and the pipe to prevent damage to the pipe.

G. Installing Bull Dog Restrained Joint Pipe and Fittings: EBAA Iron Series 5000 Mega-Stop shall be installed at the pipe homing line after the pipe spigot is cleaned and lubricated ad before the spigot is inserted into the bell. Once the spigot is installed, the bell stop may be removed and reused in open cut installations. When bulldog restraint systems are used in casing pipe, tunnels or horizontal directional bores, the EBAA iron series 5000 Mega-Stop to be installed at the pipe homing line before the spigot is inserted into the bell. A permanent bell stop is required on all spigots in such installations.

H. Bend and Fitting Location: All bends and fittings on PVC pipe shall be DI mechanical joint. The Contractor is advised that the bends and fittings indicated on the plans are for a guide only. The Contractor will be required to furnish additional bends and fittings as needed to complete all installations.

I. Installing Restrained Joint Ductile Iron Fittings/Valves on PVC: Ductile iron fittings and valves shall be installed onto AWWA C900 pipe with mechanical joint glands and restraints. All spigots shall be centrally located in the bell and adequate anchorage shall be provided where abrupt change in direction and dead ends occur. The socket and the plain end shall be cleaned. Lubrication and additional cleaning shall be provided by brushing both the gasket and plain end with soapy water or an approved pipe lubricate meeting the requirements of ANSI/AWWA C111/A21.11 just prior to slipping the gasket onto the plain end for joint assembly. Place the gland on the plain end with the lip extension toward the plain end; follow by the gasket with the narrow edge of the gasket toward the plain end. Insert the pipe into the socket and press the gasket firmly and evenly into the gasket recess. Ensure the joint is kept straight during assembly. Push the gland toward the socket and center it around the pipe with the gland lip against the gasket. Insert bolts and hand-tighten nuts. Make deflection after joint assembly but before tightening bolts. Torque loads shall be applied to the standard cast iron bolts used in making the joint as follows:

Pipe Size (Inches)	Bolt Size (Inches)	Range of Torque (Ft - Lbs)
3	5/8	45 – 60
4 – 24	3/4	75 – 90
30 – 36	1	100 – 120
42 – 48	1 1/4	120 - 150

1. When tightening the bolts to the normal range of bolt torque, the gland will be brought up toward the pipe flange evenly, maintaining approximately the same distance between the gland and the face of the flange at all points around the socket.

J. Cutting Pipe: The cutting of pipe for inserting valves, fittings, or closure pieces shall be done in a neat and workmanlike manner without damage to the pipe so as to leave a smooth end at right angles to the axis of the pipe.

1. Hand-held pipe saws may be used provided the pipe is marked, prior to cutting, such as to provide a cut at right angles to the axis of the pipe. Handheld pipe saws may be used in all applications for cutting pipe smaller than 16-inch.

K. Unless otherwise indicated on the Plans, or required by existing utility locations, all PVC water pipe will be installed with a minimum cover of 3.0 feet.

L. Tracer wire and warning tape shall be installed in accordance with the Standard Details and as specified in these specifications.

3.7 INSTALLATION AND ASSEMBLY OF HDPE PIPE

A. HDPE water main shall be installed in accordance with AWWA M55 and ASTM D2774 and with the pipe manufacturer's recommendations. Backfill shall be as specified elsewhere in these specifications.

B. Service Installation: On new or existing HDPE water mains, mechanical service saddles and corporation stops shall not be allowed. HDPE service line shall be fused to the HDPE water main with a HDPE service saddle. The first mechanical connection shall be in the service box, at the angle valve on 1-inch and smaller services and shall be at the valve in front of the vault on 1.5-inch and larger services.

C. Joining Methods:

1. Socket Fusion: 4-inch and smaller diameter pipes may be joined by the socket fusion procedure as outlined in ASTM F2620, PPI TR-33 and PPI TN-42. All tools used in socket fusion shall be in accordance with ASTM F1056.

2. Butt Fusion: The pipe may be joined by the butt fusion procedure outlined in ASTM F2620 or PPI TR-33. All fusion joints shall be made in compliance with the pipe or fitting manufacturer's recommendations. Fusion joints shall be made by qualified fusion technicians per PPI TN-42. Butt fusion shall not be allowed on 1-inch and smaller HDPE pipe.

3. Saddle Fusion: Saddle fusion shall be done in accordance with ASTM F 2620 or TR-41 or the fitting manufacturer's recommendations and PPI TR-41.

4. Electrofusion: Electrofusion joining shall be done in accordance with the manufacturers recommended procedure. Other sources of electrofusion joining information are ASTM F 1290 and PPI TN 34. The process of electrofusion requires an electric source, a transformer, commonly called an electrofusion box that has wire leads, a method to read electronically (by laser) or otherwise input the barcode of the fitting, and a fitting that is compatible with the type of electrofusion box used. The electrofusion box must be capable of reading and storing the input parameters and the fusion results for later download to a record file.

5. Mechanical: Mechanical connection of HDPE pipe to auxiliary equipment such as valves shall use male HDPE mechanical joint adapters on 3-inch and larger HDPE

water mains and other devices in conformance with the PPI Handbook of Polyethylene Pipe, Chapter 9 and AWWA Manual of Practice M55, Chapter 6. On 2-inch water mains valves shall connect to the HDPE main with an HDPE adapter with a stainless steel or brass MNPT threaded end.

D. Minimum Bending Radius: Wherever it is necessary to deflect pressure pipe from a straight line, either in the vertical or horizontal plane, to avoid obstruction or plumb valve stems, or where long radius curves are permitted, the bending radius shall not be less than 31 times the pipe diameter (in feet) or as recommended by the manufacturer, and shall be approved by CHARLOTTE WATER.

Pipe Dia. (in)	SF	Minimum Bending Radius (ft)	Pipe Dia. (in)	SF	Minimum Bending Radius (ft)	Pipe Dia. (in)	SF	Minimum Bending Radius (ft)
2	31	6	12	31	32	24	31	62
3	31	8	14	31	38	26	31	68
4	31	12	16	31	42	28	31	74
6	31	16	18	31	48	30	31	78
8	31	22	20	31	52	32	31	84
10	31	26	22	31	58			

E. Ductile Iron Pipe shall be installed when the minimum cover is less than 3.0 feet and in all crossings of other pipelines (storm drainage, gas, etc.) when the vertical distance between the water main and the other pipeline is less than 12-inches.

F. Tracer wire and warning tape shall be installed in accordance with the Standard Details and as specified in these specifications.

3.8 INSTALLATION OF PCCP PIPES

A. PCCP water main shall be installed in accordance with AWWA C301 and with the pipe manufacturer's recommendations. Backfill shall be as specified elsewhere in these specifications.

B. Laying Pipe: Laying lengths shall be in accordance with AWWA C301. All pipe and fittings shall be carefully handled and protected against damage. No pipe shall be installed where interior or exterior surfaces show cracks. Before placement of pipe in the trench, each pipe or fitting shall be thoroughly cleaned of any foreign substance which may have collected thereon and shall be kept clean at all times thereafter. For this purpose, the openings of all pipes and fittings in the trench shall be closed during any interruption to the work. Pipe shall be laid directly on the bedding material. No blocking will be permitted, and the bedding shall be such that it forms a continuous, solid bearing for the full length of the pipe. Excavations shall be made as needed to facilitate removal of handling devices after the pipe is laid. Excavation shall be made as needed outside the normal trench section at field joints to permit adequate access to the joints for field connection operations.

C. Installation Tolerances: Each section of pipe shall be laid in the order and position shown on the laying diagram and in accordance with the following:

1. Each section of pipe having a nominal diameter less than 48-inches shall be laid to line and grade, within plus or minus 2-inches horizontal deviation and plus or minus 1-inch vertical deviation.

2. Each section of pipe having nominal diameter 48-inches and larger shall be laid to line and grade, within plus or minus 5 percent of diameter horizontal deviation and plus or minus 2.5 percent of diameter vertical deviation.

3. In addition to the horizontal and vertical tolerances above, lay the pipe so that no high or low points other than those on the laying diagram are introduced.

D. Where necessary to raise or lower the pipe due to unforeseen obstructions or other causes, the ENGINEER may change the alignment and/or the grades. Such change shall be made by the deflection of joints, by the use of bevel adapters, or by the use of additional fittings. However, in no case shall the deflection in the joint exceed 75 percent of the maximum deflection recommended by the pipe manufacturer. No joint shall be misfit any amount that will be detrimental to the strength and water tightness of the finished joint. In all cases the joint opening shall be the controlling factor.

E. Except for short runs that may be permitted by the ENGINEER, pipes shall be laid uphill on grades exceeding 10 percent. Pipe that is laid on a downhill grade shall be blocked and held in place until sufficient support is furnished by the following pipe to prevent movement. Bends shall be properly installed as indicated.

F. Pipe struts shall be left in place until backfilling operations have been completed for pipe 42-inches in diameter and larger. Struts shall remain the property of the CONTRACTOR. Struts in pipe smaller than 42-inches may be removed immediately after laying.

G. Cold Weather Protection: No pipe shall be installed upon a foundation into which frost has penetrated or at any time that there is a danger of the formation of ice or penetration of frost at the bottom of the excavation. No pipe shall be laid unless it can be established that the trench will be backfilled before the formation of ice and frost occurs.

H. Rubber Gasketed Joints: Immediately before jointing pipe, the spigot end of the pipe shall be thoroughly cleaned, and a clean rubber gasket lubricated with a non-toxic vegetable-based lubricant shall be placed in the spigot groove. The lubricant shall be a compound listed as in compliance with NSF Standard 61. The volume of the gasket shall be "equalized" by moving a metal rod between the gasket and the spigot ring around the full circumference of the spigot ring. The bell of the pipe already in place shall be carefully cleaned and lubricated with the vegetable-based lubricant. The spigot of the pipe section shall then be inserted into the bell of the previously laid joint and telescoped into its proper position. Tilting of the pipe to insert the spigot into the bell will not be permitted. After the pipe units have been joined, a feeler gage shall be inserted into the recess and moved around the periphery of the joint to detect any irregularity in the position of the rubber gasket. If the gasket cannot be felt all around, the joint shall be disassembled. The joint shall be reassembled with a new gasket.

I. Joint Coating and Lining: The interior and exterior joint recesses shall be thoroughly wiped clean and all water, loose scale, dirt and other foreign material shall be removed from the inside surface of the pipe. The grout for joint coating and lining shall be in accordance with AWWA C301

1. Joint Coating: After the pipe has been laid and after sufficient backfill has been placed between the joints to hold the pipe securely in place, the outside annular space between pipe sections shall be completely filled with grout formed by the

use of polyethylene foam-lined fabric bands. The grout space shall be flushed with water prior to filling so that the surface of the joint to be in contact with the grout will be thoroughly moistened when the grout is poured. The joint shall be filled with grout by pouring from one side only, and shall be rodded with a wire or other flexible rod or vibrated so that the grout completely fills the joint recess by moving down one side of the pipe, around the bottom of the pipe and up the opposite side. Care shall be taken to leave no unfilled space. Grouting of the outside joint spaces shall be kept as close behind the laying of the pipe as possible except that in no case shall grouting be closer than 3 joints of the pipe being laid.

2. Grout Bands (Diapers): The grout bands or heavy-duty diapers shall be polyethylene foam-lined fabric with steel strapping of sufficient strength to hold the fresh grout, resist rodding of the grout and allow excess water to escape. The foam plastic shall be 100 percent closed cell, chemically inert, insoluble in water, and resistant to acids, alkalies, and solvents, and shall be Dow Chemical Company, Ethafoam 222, or equal.

3. The fabric backing shall be cut and sewn into 9-inch wide strips with slots for the steel strapping on the outer edges. The polyethylene foam shall be cut into strips 6-inches wide and slit to a thickness of 1/4-inch that will expose a hollow or open cell surface on one side. The foam liner shall be attached to the fabric backing with the open or hollow cells facing towards the pipe. The foam strip shall cover the full interior circumference of the grout band with sufficient length to permit an 8-inch overlap of the foam at or near the top of the pipe joint. Splices to provide continuity of the material will be permitted. The polyethylene foam material shall be protected from direct sunlight.

4. The polyethylene foam-lined grout band shall be centered over the joint space with approximately equal widths extending over each pipe end and securely attached to the pipe with the steel straps. After filling the exterior joint space with grout, the flaps shall be closed and overlapped in a manner that fully encloses the grout with polyethylene foam. The grout band shall remain in position on the pipe joint.

5. Joint Lining: After the backfill has been completed to final grade, the interior joint recess shall be filled with grout. Grout shall be tightly packed in the joint recess and troweled flush with the interior surface. All excess shall be removed. At no point shall there be an indentation or projection of the grout exceeding 1/16-inch. With pipe smaller than 24-inches in diameter, before the spigot is inserted into the bell, the bell shall be daubed with grout; the joint shall be completed, and excess grout on the inside of the joint shall be swabbed out.

J. Installation of Valves: Valves shall be handled in a manner to prevent any injury or damage to any part of the valve. Joints shall be thoroughly cleaned and prepared prior to installation. The Contractor shall adjust stem packing and operate each valve prior to installation to insure proper operation.

1. Valves shall be installed so that the valve stems are plumb and in the location indicated.

K. Installation of Flanged Joints: Before the joint is assembled, the flange faces shall be thoroughly cleaned of all foreign material with a power wire brush. The gasket shall be centered and the connecting flanges drawn up watertight without unnecessarily stressing the flanges. Bolts shall be tightened in a progressive diametrically opposite sequence and torqued with a suitable, approved and calibrated torque wrench. Clamping torque

shall be applied to the nuts only. Full face reinforced rubber gaskets shall be applied to the inside face of blind flanges with adhesive.

L. Insulated Joints: Insulated joints and appurtenant features shall be provided as indicated. The Contractor shall exercise special care when installing these joints to prevent electrical conductivity across the joint. After the insulated joint is completed, an electrical resistance test shall be performed by the Contractor. Should the resistance test indicate a short circuit, the Contractor shall remove the insulating units to inspect for damages, replace all damaged portions, and reassemble the insulating joint. The insulated joint shall then be re-tested to assure proper insulation.

M. Flexible Coupled Joints: When installing flexible couplings, care shall be taken that the connecting pipe ends, couplings and gaskets are clean and free of all dirt and foreign matter with special attention being given to the contact surfaces of the pipe, gaskets and couplings. The couplings shall be assembled and installed in conformity with the recommendations and instruction of the coupling Manufacturer.

3.9 INSTALLATION OF BWP PIPES

A. Bar wired cylinder concrete pipes shall be installed in accordance with AWWA C303, M9 and with the pipe manufacturer's recommendations. Backfill shall be as specified elsewhere in these specifications.

B. Laying Pipe: Laying lengths of the BWP shall be in accordance with AWWA M9. Prior to installation, all piping shall be inspected to make sure it is free of defects. All piping shall be flush cleaned of any dust and foreign objects.

C. Joining Methods: All joining methods shall be based on AWWA M9 and with the pipe manufacturer's installation recommendations.

3.10 INSTALLATION OF STEEL PIPES

A. Steel pipes shall be installed in accordance with AWWA C604, M11 and with the pipe manufacturer's recommendations. Backfill shall be as specified elsewhere in these specifications.

B. Laying Pipe: Laying lengths of the steel pipe shall be in accordance with the AWWA M11. Prior to installation, all piping shall be inspected to make sure it is free of defects. All piping shall be flush cleaned of any dust and foreign objects.

C. Joining Methods: All joining methods shall be based on AWWA M11 and with the pipe manufacturer's installation recommendations.

3.11 INSTALLING VALVES, HYDRANTS, AND FITTINGS

A. Valves, hydrants and fittings shall be installed in the manner specified for installation and assembly of pipe. Valves and hydrants shall be installed according to the Standard Details at locations shown on the plans and/or as directed by the Engineer.

1. Valve Boxes: A valve box assembly conforming to the Standard Details shall be installed for every 12-inch and smaller gate valve and all service 1.5 and 2-inch ball valves. The valve box shall not transmit shock or stress to the valve and shall be centered and plumb over the operating nut, with the box cover flush with the surface of the pavement or other existing surface.

a. Where the box is not set in pavement, the top section shall be anchored by a 24” x 24” x 6" concrete pad, or an approved pre-cast concrete pad, set flush with the existing terrain. The top section will be grouted into the pre-cast concrete pad, the full depth of the concrete pad. The location of valves will be identified by the letter "V" cut/imprinted into the curb adjacent to mainline air release or hydrant valve. The “V” shall point directly toward the valve/box.

b. All 16” and larger valves shall be installed with operating nuts plumb and centered beneath a manhole frame and cover, valve box top section and riser pipe as shown in the Standard Details. Extension stems as shown on the standard detail will be required on valves where the operating nut is more than 3.0 feet below the top of the frame and cover. Operating nut of extension stem is to be 2-inch square. Extension stem shall be Type 316 stainless steel or carbon with ductile iron or stainless steel top nuts and bottom couplings. The extension stem operating nut and valve nut are pinned to the extension rod/bottom coupling which is drilled to receive stainless steel coil pins or set screws for attachment.

c. 12-inch and smaller valves shall require valve extension stems per the standard details when the valve operating nut is more than 3 feet below the top of the valve box assembly. The valve extension stem shall comply with the requirements above.

d. 12-inch and smaller valves shall require valve centering to keep valve box aligned during backfilling. Refer to the Standard Details for assembly.

2. Valve Blocking: All end of line valves 12-inch and smaller installed on PVC, DIP, or HDPE water mains shall be installed with end of line wall blocking per the standard detail. All 12-inch valves, and smaller, installed along PVC or HDPE water mains shall be securely wedge blocked with concrete bearing against, and cut into the excavated sides of the trench. All valves installed along HDPE water mains larger than 12” shall be restrained with thrust wall blocking according to the standard detail. Care shall be taken in forming and pouring the "wedge" blocking so the fitting joints will be accessible for repair and/or valve extraction. All valves shall be double wrapped with 2 layers of HDPE plastic film, high-density cross-laminated (HDCL) polyethylene per AWWA C-105. Each layer of film shall be a minimum of 4 mils thick. The film shall extend a minimum of 3 feet each side of the valve/fitting.

3. Fire Hydrants: Hydrants shall be manufactured with no less than three and one half (3.5’) foot bury on water mains 12" and smaller and with four and one half (4.5) foot or more for water mains 16" and larger. Because of varying topography, hydrants with greater bury shall be required based on the actual depth. Extensions kits will be manufactured by the hydrant manufacturer. No more than ONE extension kit shall be installed on a fire hydrant. Third party extension kits provided by manufacturers other than the original fire hydrant manufacturer are not allowed.

a. All hydrants and hydrant guard valves will be installed plumb and in accordance with the Standard Details. The appropriate plan view will be noted on the Plans or in the Special Provisions. Each hydrant installation will include a drainage bed of clean washed stone approximately one (1) cubic yard in size at the "weep hole" with filter fabric installed around the stone.

Piping from the main to the hydrant shall be 6-inch or 8-inch restrained joint DIP only, or may be HDPE on new HDPE water mains.

b. All hydrants shall have concrete collars installed on the barrel below the bury line as shown in the standard detail. Placement of hydrants and the hydrant guard valve(s) shall meet the requirements as indicated in the Standard Details. Hydrants shall not be installed within the radius points of streets or driveways, and shall not be installed within 15 feet of on street parking spaces.

4. Blocking Fittings: All plugs, caps, tees, and bends deflecting 11-1/4 degree or more on pressure mains 2-inch in diameter or larger shall be provided with thrust blocking, placed as shown on the Plans and/or as directed by the Engineer. Thrust blocking shall consist of ready mix concrete having a compressive strength of not less than 3,600 lbs per square inch at 28 days.

a. Bagged mix concrete may be used for blocking, anchorage, concrete valve pads, etc. on water mains and valves 12-inches and smaller, when less than 1/2 cubic yard is required. Bag mix concrete shall be properly mixed as recommended by the manufacturer, prior to placement in the trench.

b. Blocking shall be placed between solid/undisturbed ground and the fittings to be anchored. The area of bearing on the pipe and on the ground in each instance shall be that shown on the standard detail or directed by the Engineer. The blocking shall be so placed that the pipe and fittings will be accessible for repair. All fittings shall be double wrapped with 2 layers of HDPE plastic film, high-density cross-laminated (HDCL) polyethylene per AWWA C-105. Each layer of film shall be a minimum of 4 mils thick. The film shall extend a minimum of 3 feet each side of the valve/fitting.

5. Restrained Joints: Restrained joints shall be installed where shown on the plans, standard details or when approved by the Engineer, and may be installed in lieu of blocking. Installation shall be per manufacturer's recommendations, as shown on the plans, standard details, special provisions, and/or as directed by the Engineer.

6. Wedge Action Restrained Joints: Wedge action restrained joints shall be installed on mechanical joint valves and fittings where shown on the plans, standard details or when approved by the Engineer, and may be installed in lieu of blocking. Restrained lengths on each side of the fittings shall be as shown on the standard details, plans, or as approved by the Engineer. Installation shall be per manufacturer's recommendations, as shown on the plans, special provisions, and/or as directed by the Engineer.

3.12 WATER MAIN TAPS

A. Installation of Tapping Sleeves and Valves: Tapping sleeves and valves will be scheduled with and installed only under inspection by the Engineering Division of CHARLOTTE WATER and as recommended by the Manufacturer. No work will be done (including excavation of the existing main) except when CHARLOTTE WATER personnel are present.

1. Tapping valves shall be supported at all times to prevent the tapping sleeve from slipping on the main. Tapping sleeves and valves will be field pressure tested after installation on the pipe but before the tap is made.

2. First, the tapping valve will be opened and the sleeve and valve filled with water and placed under the rated pressure of the sleeve (200 PSI). The pressure gauge shall be observed for ten minutes with no loss of pressure. Then the pressure shall be released, the valve closed and procedure repeated with test pressure against the outside of the valve gate or wedge and with no water inside the tapping sleeve between the existing pipe and the tapping valve.

3. When tapping sleeves are furnished with test plugs, the test may be made in a single step with the valve closed and pressure applied through the test plug.

4. Thrust Blocking: All tapping sleeves shall be provided with thrust blocking, placed as shown on the standard details, the Plans and/or as directed by the Engineer. Thrust blocking shall consist of ready mix concrete having a compressive strength of not less than 3,600 lbs per square inch at 28 days.

   a. Bagged mix concrete may be used for blocking, anchorage, concrete valve pads, etc. on water mains and tapping sleeves 12-inches and smaller, when less than 1/2 cubic yard is required. Bag mix concrete shall be properly mixed as recommended by the manufacturer, prior to placement in the trench.

   b. Blocking shall be placed between solid/undisturbed ground and tapping sleeve to be anchored. The area of bearing on the pipe and on the ground in each instance shall be that shown on the standard details or directed by the Engineer. The blocking shall be so placed that the pipe and tapping sleeve will be accessible for repair. The tapping sleeve shall be double wrapped with 2 layers of HDPE plastic film, high-density cross-laminated (HDCL) polyethylene per AWWA C-105. Each layer of film shall be a minimum of 4 mils thick. The film shall extend a minimum of 3 feet each side of the tapping sleeve.

   c. The tapping valve shall be supported with poured in place concrete to prevent settlement of the valve or rotation of the tapping sleeve. The tapping sleeve shall be double wrapped with 2 layers of HDPE plastic film, high-density cross-laminated (HDCL) polyethylene per AWWA C-105. Each layer of film shall be a minimum of 4 mils thick. The film shall extend a minimum of 3 feet each side of the tapping sleeve.

B. Weld-on Tapping Sleeves for Steel Pipe

1. Welder Qualifications

   a. Welding shall be performed by skilled welders, welding operators, and tackers who have had adequate experience in the methods and materials to be used.

   b. Welders shall be qualified under the provisions of ANSI/AWS D1.1 or the ASME Boiler and Pressure Vessel Code, Section 9 by an independent local, approved testing agency not more than 6 months prior to commencing work on the project.

2. Repair of Welds

   a. Defective welds shall be repaired by the Contractor to meet the indicated requirements.

b. Defects in welds or defective welds shall be removed, and that section of the joint shall then be re-welded.

c. Only sufficient removal of defective material that is necessary to correct the defect shall be required.

d. After the repair is made, the joint shall be checked by repeating the original test procedure.

e. Welds deficient in size shall be repaired by adding weld metal.

3. Coating Repairs

a. Mortar-Coated Pipe: Perform coating repairs on mortar-coated pipe in accordance with the requirements of AWWA C205.

b. Tape-Coated Pipe

1) Perform coating repairs on tape-coated pipe tape and primer in accordance with the requirements of AWWA C209.

2) If the holiday re-test indicates a holiday still exists after re-testing, the inner wrap shall be exposed and the exposed area shall be wiped clean with xylol solvent or equal, and the area shall be coated with tape primer.

3) A patch of 35-mil thick cold-applied tape of sufficient size to cover the damaged area plus a minimum lap of 2-inches shall then be applied.

4) The patched area shall again be tested for holidays.

5) If none are detected, a second layer of 35-mil thick tape shall then be applied over the first patch, overlapping the first layer a minimum of 2 inches.

c. Epoxy-Coated Pipe:

1) For liquid-epoxy coated pipes, perform coating repairs on epoxy-coated pipe in accordance with the requirements of ANSI/AWWA C210-15

2) For fusion-bonded epoxy coated pipes, perform coating repairs in accordance with the requirements of AWWA C213.

4. Isolation Joints

a. Isolation joints and appurtenant features shall be provided as indicated in the cathodic protection specifications and standard details.

b. The Contractor shall exercise special care when installing these joints in order to prevent electrical conductivity across the joint.

c. After the isolation joint is completed, an electrical resistance test shall be performed by the Contractor.

d. If the resistance test indicates a short circuit, the Contractor shall remove the isolation units to inspect for damage, replace all damaged portions, and reassemble the isolation joint.

e. The isolation joint shall then be retested to assure proper isolation.

f. All isolation joints shall be tested during the Final Inspection process by an approved third party NACE certified testing firm and tester. Tests results for each isolation joint shall be provided in a report submitted to the Engineer.

C. Flanged Tapping Sleeves for PCCP

1. The cement pipe coating shall be removed from the steel pipe cylinder as recommended by the tapping sleeve manufacturer, without cutting or damaging the prestressing wires or steel pipe cylinder.

2. If a pipe cylinder weld is in the tapping area the weld shall be flattened as recommended by the pipe manufacturer or the tapping sleeve manufacturer. Grinding the weld flat shall not be allowed.

3. The sleeve shall have a separate gland, which allows the sleeve to be installed, and the annular space between the pipe and the sleeve to be grouted, prior to cutting the prestressed wires.

4. Foam or rubber grout gaskets and hard rubber spacers shall be used to provide an annular space between the pipe and the sleeve. Grout horns shall be furnished to facilitate grouting of the annular space.

5. The annular space shall be grouted with an approved Portland Cement grout. A minimum of 6 grout test cubes shall be made at the time the grouting is complete using the same grout. The grout shall be allowed to set prior to cutting any prestressing wires. The grout test cubes must confirm that the grout has completely set prior to tightening the bolts on the tapping sleeve straps. Tightening and torquing the strap bolts shall not be scheduled until a minimum of 30 minutes after the test cube grout test has been confirmed. Any accelerant used in the grout shall not be corrosive or deleterious to prestressing wire or the steel pipe cylinder.

6. The pressure plate shall be adequately braced to eliminate vibration & flexing of the plate while the tapping machine is operating.

7. The machined gasket groove on the pressure plate must be consistently positioned about throat of tapping gland waterway. However, ID of the gasket groove must be set back a minimum of 1" from the waterway to allow dispersal of forces generated by gasket compression. Gasket grooves machined in a circle and then rolled to an elliptical shape will not be allowed.

8. All waterway welds shall be dye-penetrant inspected or hydrostatically shop tested for water tightness.

9. The gland shall be equipped with load bearing set screws to transfer thrust loads from the branch piping to the sleeve.

10. A three-flange configuration shall be used on all outlets above twelve-inch to allow for valve bypass.

11. Welding the gland to the steel cylinder of the pipe to provide a watertight seal shall not be permitted.

12. The tapping sleeve shall be encased in a minimum of one inch of Portland cement mortar or concrete for corrosion protection after the tap.

3.13 WATER SERVICES

A. Services shall be installed prior to testing the proposed main. These services will be installed in a location determined by CHARLOTTE WATER after consultation with the Contractor (with Inspector present) and applicants.

B. 3/4" and 1" Water Service Connections: Applications shall be made to the Customer Service Section of CHARLOTTE WATER and will pay current fees for 3/4-inch and 1-inch meters prior to construction and installation of water service connections. Only those connections which have been applied for and approved will be made.

1. Service lines will be made perpendicular to the water main or road and shall, unless otherwise approved, terminate in the middle of the lot served. All taps will be made substantially as shown on the Standard Details. Services lines will be installed with a minimum depth of cover of 30 inches, 36 inches from the main to the meter box, and 30 inches at the tailpiece. Service connections must be installed prior to pressure testing and sterilization. Allowance for the joints in service connections will be included when computing the allowable leakage. The Contractor shall flush each connection prior to pressure testing and immediately after sterilization is complete.

2. Meter box locations shall be as shown on the standard details, construction plans or as approved by the Engineer. Meter boxes shall be plastic, unless otherwise approved or directed by the Engineer. In areas with sidewalks or proposed sidewalks, the meter boxes are to be set either totally in or totally out of the sidewalk. Meter boxes set in sidewalks shall be concrete with plastic lids. Meter boxes will not be set in driveway locations or within the radius point of roads or driveways.

3. Meters will be obtained through CHARLOTTE WATER and will be installed by CHARLOTTE WATER personnel after activation is approved by the Engineer, subject to receipt of turn-on order. The location of services will be identified by the letter "W" imprinted/cut into the curb directly in front of the service. Where a service is moved or removed, the "W" will be removed from the curb or grouted over.

4. On projects without curb, the Contractor will paint a "W" on the edge of pavement adjacent to the service. Markings will be made with blue paint conforming to the uniform color code established by the Utility Location And Coordination Council of the American Public Works Association.

5. Service connections:

   a. PVC and DIP shall be made by using tapping saddles threaded to accept corporation stops.

   b. Service connections to 30 inch and larger DIP mains may be made without tapping saddles as direct taps to the pipe.

   c. Service connections to HDPE pipe shall be made using fused HDPE Service saddles with integrated cutter heads.

   d. Mechanical tapping saddles and corporation stops shall NOT be used on HDPE water mains.

6. In new streets, piping beneath pavement on "long side" taps will be installed prior to paving. Backfill shall be compacted as specified with extreme care taken to prevent damage to the copper or HDPE service piping. All services shall be one

continuous piece from the tap to the angle valve in the meter box. Couplings shall not be allowed on service lines.

C. 1-1/2 Inch and 2-inch Services: 1-1/2-inch and 2-inch services may be installed by the Contractor. Such installation shall conform to the Standard Details, as applicable for the meter installations and to the applicable sections for service line piping. All portions of the installation, including property line valves, shall be contained within the street right-of-way. Where this is not feasible because of vault size or limited right-of-way width, or restrictions by the Controlling Agency, the service vault may be installed on private property served by the meter, and shall be located directly outside the road right of way. The Contractor shall consult with the project inspector to determine location of meter vaults before installation begins.

1. Service lines will be made perpendicular to the water main and shall, unless otherwise approved, terminate in the middle of the lot served. All taps will be made substantially as shown on the Standard Details. Services lines will be installed with a minimum depth of cover of 36 inches. Service connections must be installed prior to pressure testing and sterilization. Allowance for the joints in service connections will be included when computing the allowable leakage. The Contractor shall flush each connection prior to pressure testing and immediately after sterilization is complete.

2. Service vault locations shall be as shown on the standard details. In areas with sidewalks or proposed sidewalks, the meter vaults are to be set either totally in or totally out of the sidewalk. Meter vaults set in sidewalks shall be ADA compliant with the lid frame flush with the sidewalk, not on the vault or vault brickwork. Meter vaults shall not be set in driveway locations or within the radius point of roads or driveways.

3. Meters will be furnished and installed by the contractor. The location of services will be identified by the letter "W" imprinted/cut into the curb directly in front of the service vault. Where a service is moved or removed, the "W" will be removed from the curb or grouted over.

4. The letter “V” shall be imprinted into the curb, pointing directly to service valves that are not in direct alignment with the “W” specified above.

5. On projects without curb, the Contractor will paint a "W" on the edge of pavement adjacent to the service. Markings will be made with blue paint conforming to the uniform color code established by the Utility Location And Coordination Council of the American Public Works Association.

6. Service connections to PVC and DIP shall be made by using tapping saddles threaded to accept corporation stops. Service connections to 30 inch and larger DIP mains may be made without tapping saddles as direct taps to the pipe. Service connections to HDPE pipe shall be made using fused HDPE Service saddles with integrated cutter heads. Mechanical tapping saddles and corporation stops shall NOT be used on HDPE water mains.

7. In new streets, piping beneath pavement on "long side" taps will be installed prior to paving. Backfill shall be compacted as specified with extreme care taken to prevent damage to the service piping. All services shall be one continuous piece from the tap to the ball valve directly in front of the service vault. Couplings shall not be allowed on service lines.

D. 3-inch through 12-inch water services: 3-inch through 12-inch water services may be installed by the Contractor. Such installation shall conform to the Standard Details, as applicable for the meter installations and to the applicable sections for service line piping. All portions of the installation, including property line valves, shall be contained within the street right-of-way. Where this is not feasible because of vault size or limited right-of-way width, or restrictions by the Controlling Agency, the service vault may be installed on private property served by the meter, and shall be located directly outside the road right of way. The Contractor shall consult with the project inspector to determine location of meter vaults before installation begins.

1. Service lines will be made perpendicular to the water main and shall, unless otherwise approved, terminate in the middle of the lot served. All taps will be made substantially as shown on the Standard Details. Services lines will be installed with a minimum depth of cover of 36 inches. Service connections must be installed prior to pressure testing and sterilization. Allowance for the joints in service connections will be included when computing the allowable leakage. The Contractor shall flush each connection prior to pressure testing and immediately after sterilization is complete.

2. Service vault locations shall be as shown on the standard details. In areas with sidewalks or proposed sidewalks, the meter vaults are to be set either totally in or totally out of the sidewalk. Meter vaults set in sidewalks shall be ADA compliant with the lid frame flush with the sidewalk, not on the vault or vault brickwork. Meter vaults shall not be set in driveway locations or within the radius point of roads or driveways.

3. Meters will be furnished and installed by the contractor. The location of services will be identified by the letter "W" imprinted/cut into the curb directly in front of the service vault. Where a service is moved or removed, the "W" will be removed from the curb or grouted over.

4. The letter “V” shall be imprinted into the curb, pointing directly to service valves that are not in direct alignment with the “W” specified above.

5. On projects without curb, the Contractor will paint a "W" on the edge of pavement adjacent to the service. Markings will be made with blue paint conforming to the uniform color code established by the Utility Location And Coordination Council of the American Public Works Association.

6. Service connections to PVC and DIP shall be made by using tapping saddles threaded to accept corporation stops. Service connections to 30 inch and larger DIP mains may be made without tapping saddles as direct taps to the pipe. Service connections to HDPE pipe shall be made using fused HDPE Service saddles with integrated cutter heads. Mechanical tapping saddles and corporation stops shall NOT be used on HDPE water mains.

7. In new streets, piping beneath pavement on "long side" taps will be installed prior to paving. Backfill shall be compacted as specified with extreme care taken to prevent damage to the service piping. All services shall be one continuous piece from the tap to the ball valve directly in front of the service vault. Couplings shall not be allowed on service lines.

E. 4-inch through 12-inch fire services: 4-inch through 12-inch fire services may be installed by the Contractor. Such installation shall conform to the Standard Details, as applicable for the meter installations and to the applicable sections for service line piping. All

portions of the installation, including property line valves, shall be contained within the street right-of-way. Where this is not feasible because of vault size or limited right-of-way width, or restrictions by the Controlling Agency, the service vault may be installed on private property served by the meter, and shall be located directly outside the road right of way. The Contractor shall consult with the project inspector to determine location of meter vaults before installation begins.

1. Fire service lines will be made perpendicular to the water main and shall, unless otherwise approved, terminate in the middle of the lot served. All taps will be made substantially as shown on the Standard Details. Services lines will be installed with a minimum depth of cover of 36 inches. Service connections must be installed prior to pressure testing and sterilization. Allowance for the joints in service connections will be included when computing the allowable leakage. The Contractor shall flush each connection prior to pressure testing and immediately after sterilization is complete.

2. Meters will be furnished and installed by the contractor. Meters shall be located in appropriately sized meter boxes that allow access.

3. Service connections to PVC and DIP shall be made by using tapping saddles. Service connections to 30 inch and larger DIP mains may be made without tapping saddles as direct taps to the pipe. Service connections to HDPE pipe shall be made using fused HDPE Service saddles with integrated cutter heads. Mechanical tapping saddles and corporation stops shall NOT be used on HDPE water mains.

3.14 CONCRETE PLACEMENT

A. Ready mix concrete will not be accepted without the inspector receiving the plant dispatch ticket.

B. Before placing concrete, verify that installation of formwork, reinforcement, and embedded items is complete and that required inspections have been performed.

C. Do not add water to concrete during delivery, at Project site, or during placement unless approved by the Engineer.

D. Before test sampling and placing concrete, water may be added at Project site, subject to limitations of ACI 301. Do not add water to concrete after adding high-range water-reducing admixtures to mixture.

E. Deposit concrete continuously in one layer or in horizontal layers of such thickness that no new concrete will be placed on concrete that has hardened enough to cause seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as indicated. Deposit concrete to avoid segregation.

1. Deposit concrete in horizontal layers of depth to not exceed formwork design pressures and in a manner to avoid inclined construction joints.

2. Consolidate placed concrete with mechanical vibrating equipment according to ACI 301.

3. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations to rapidly penetrate placed layer and at least 6 inches into preceding layer. Do not insert vibrators into lower layers of concrete that have begun to lose plasticity. At each insertion, limit duration of vibration to time necessary to consolidate concrete and complete embedment of

reinforcement and other embedded items without causing mixture constituents to segregate.

F. Forms: Forms may be made of wood, plywood, metal, or any other material approved by the Engineer. Forms shall be mortar tight, of material strong enough to resist noticeable deflection or bulging between supports, and the interior dimensions of the forms shall be such that the finished concrete shall be of the form and dimensions shown on the Plans. The design of the forms shall take into account the effect of vibration of concrete as it is placed and also the rate of speed at which the forms will be filled. Forms shall be coated with a lubricant as approved by the Engineer. Mechanical vibrators, of an approved type, and continuous spading and/or rodding of concrete shall be used to produce proper contact of concrete with forms and reinforcing steel in piers and with forms and pipe in monolithic inverts insuring a compact, dense and impervious artificial stone of uniform texture.

G. Cold-Weather Placement: Comply with ACI 306.1 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.

1. When average high and low temperature is expected to fall below 40 deg F for three successive days Maximum temperature in concrete after placement shall not exceed 160°F (70°C). Maximum temperature difference between center and surface of placement shall not exceed 35°F (19°C).

2. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.

3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in mixture designs.

4. Do not place concrete until the foundation, the adequacy of the forms, the placing of reinforcement and other embedded items have been inspected and approved.

5. Place concrete in daylight unless an approved lighting system is provided.

6. Remove all debris from the interior of forms in preparation for placing concrete. Moisten earth or base course surfaces on which concrete is to be placed immediately before placing concrete. Do not place concrete on excessively wet or frozen surfaces.

7. Place concrete in its final position in the forms within the time stipulated in Sub article 1000-3(E) of NCDOT'S 2024 Standard Specifications for Roads and Structures, Table 1000-2. Elapsed time shall be measured as the time between adding the mixing water to the mix and placing the concrete. Maximum time in between placing the batches at the work site shall not exceed 20 minutes.

ELAPSED TIME FOR PLACING CONCRETE		
Air or Concrete Temperature, whichever is higher.	Maximum Elapsed Time	
	No Retarding Admixture Used	Retarding Admixture Used
90°F or above	30 minutes	1 hr. 15 minutes
80°F through 89°F	45 minutes	1 hr. 30 minutes
79°F or below[A]	60 minutes	1 hr. 45 minutes
70°F through 79°F[B]	60 minutes	1 hr. 45 minutes
69°F or below[B]	1 hr. 30 min	2 hr. 15 minutes

A. Applicable to Class AA, Class A and Drilled Pier concrete

B. Applicable to Class B concrete.

8. Place concrete to avoid segregation of the materials and the displacement of the reinforcement. Thoroughly work the concrete during placement. Bring mortar against the forms to produce a smooth finish, substantially free from water and air pockets or honeycombs.

9. Do not place concrete when the air temperature, measured at the location of the concrete operation in the shade away from artificial heat, is below 35°F unless permission is otherwise granted by the Engineer. When such permission is granted, uniformly heat the aggregates and water to a temperature no higher than 150°F. Place the heated concrete at a temperature of at least 55°F and no more than 80°F.

10. All concrete shall be prevented from freezing by the Contractor during the initial 7 days of curing. The Contractor shall submit an anti-freezing plan for review. Frozen concrete shall be removed and replaced at the Contractor's expense.

H. Hot-Weather Placement: Comply with ACI 301 and as follows:

1. Maintain concrete temperature below 90 deg F at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.

2. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade uniformly moist without standing water, soft spots, or dry areas.

I. Finishing: Provide the type of finish required by the contract directly applicable to the work being constructed

1. Ordinary Surface Finish: Remove all form ties or metal spacers to a depth of at least 1 inch below the surface of the concrete and clean and fill the resulting holes or depressions with grout. Metal devices with exposed cross-sectional area not exceeding approximately 0.05 sq. inches on surfaces permanently in contact with earth fill may be broken off flush with the surface of the concrete.

Remove all fins caused by form joints and other projections. Remove stains and discoloration. Clean all pockets and fill with grout as directed. Thoroughly soak the surface of all concrete with water before the application of a grout repair.

Use grout consisting of one part cement and two parts sand. Use cement from the same source as originally incorporated in work. Cure the grout for at least 3 days.

After the grout has thoroughly hardened, rub the patch with a carborundum stone as required to match the texture and color of the adjacent concrete.

On surfaces that are to be backfilled or surfaces that are enclosed, the removal of form marks, fins and pockets; the rubbing of grouted areas to uniform color; and the removal of stains and discoloration will not be required.

2. Sidewalk Finish: Strike off fresh concrete and compact until a layer of mortar is brought to the surface. Finish the surface to grade and cross section with a float, trowel smooth and finish with a broom.

3. Rubbed Finish: After the ordinary surface finish has been completed, thoroughly wet and rub the entire surface. Use a coarse carborundum stone or other equally good abrasive to bring the surface to a smooth texture and remove all form marks. Carefully stroke the surface with a clean brush to finish the paste formed by rubbing. Alternatively, spread the paste uniformly over the surface and allow it to take a reset. Finish by floating with a canvas, carpet-faced or cork float or rub down with dry burlap.

4. Float Finish: Finish the surface with a rough carpet float or other suitable device leaving the surface even but distinctly sandy or pebbled in texture.

J. Curing: Cure concrete according to ACI 308.1, by one or a combination of the following methods:

1. Moisture Curing: Keep surfaces continuously moist for not less than seven days with the following materials:

   a. Water.

   b. Continuous water-fog spray.

   c. Absorptive cover, water saturated, and kept continuously wet. Cover concrete surfaces and edges with 12-inch lap over adjacent absorptive covers.

2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive. Cure for not less than seven days. Immediately repair any holes or tears during curing period using cover material and waterproof tape.

   a. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive floor coverings.

   b. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive penetrating liquid floor treatments.

   c. Cure concrete surfaces to receive floor coverings with either a moisture-retaining cover or a curing compound that the manufacturer certifies will not interfere with bonding of floor covering used on Project.

3. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.

a. Removal: After curing period has elapsed, remove curing compound without damaging concrete surfaces by method recommended by curing compound manufacturer.

4. Curing and Sealing Compound: Apply uniformly to floors and slabs indicated in a continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Repeat process 24 hours later and apply a second coat. Maintain continuity of coating and repair damage during curing period.

K. Flowable Fill/Cellular Concrete:

1. Use straps, soil anchors or other approved means of restraint to ensure correct alignment when flowable fill is used as backfill for pipe or where flotation or misalignment may occur.

2. Protect flowable fill from freezing for a period of 36 hours after placement or until the fill is backfilled.

3. Place flowable fill to the designated fill line without vibration or other means of compaction.

4. Flowable fill may be placed during freezing conditions, provided measures are taken to prevent damage to the concrete until sufficient strength has been attained. Care should be taken to avoid freezing before initial set. Concrete must not be placed during heavy or prolonged precipitation.

5. Take all necessary precautions to prevent any damages caused by the hydraulic pressure of the fill during placement prior to hardening. Provide the means to confine the material within the designated space.

L. Testing: The following tests will be performed by a Testing Laboratory approved by CHARLOTTE WATER to ensure the concrete quality. The costs for performing the tests will be paid by for by CHARLOTTE WATER when the test results are in conformity with the specifications below. However, those which show no conformity or a failure will be paid for by the Contractor. It shall be the responsibility of the Contractor to properly inform the Testing Laboratory as to when the concrete will be placed into the forms. For developer projects, the testing laboratory shall be approved by the Engineer, and shall be a sub consultant to the developer's consulting engineer. All cost of testing shall be paid by the developer.

1. Compressive strength in accordance with ASTM C-31 and ASTM C-39. Test cylinders which are formed in the field will be left in the field until compression testing (7-day, 14-day, 28-day, and 56-day for flowable fill and cellular concrete) is completed thereby more closely approximately the curing conditions of the field placed concrete.

2. Slump Test in accordance with ASTM C-143.

3. Air Content Test in accordance with either ASTM C-173 or ASTM C-231.

4. A strength test shall be the average of the strengths of at least two 6 x 12 in. cylinders or at least three 4 x 8 in. cylinders made from the same sample of concrete and tested at 28 days, and 56 days for flowable fill and cellular concrete, or at test age designated for f'c.

5. Cellular concrete unit weight testing shall be in accordance with ASTM C495, ASTM C796 and ASTM C869.

6. The testing agency performing acceptance testing shall comply with ASTM C1077.

7. Samples for preparing strength test specimens of each concrete mixture placed each day shall be taken in accordance with (a) through (c):

   a. At least once a day.

   b. At least once for each 150 CY of concrete.

   c. At least once for each 5,000 SF of surface area for slabs or walls.

8. Engineer shall be consulted if exemption from testing is requested.

3.15 TRACER WIRE, PIPE MARKING, AND IDENTIFICATION

A. Tracer Wire System: A single conductor AWG No. 12 (12-gauge) solid copper wire with 30 mils blue HDPE insultation shall be laid on top of the pipe to aid in locating the pipe for maintenance purposes. For Horizontal Directional Drilling (HDD) installations, two conductor AWG No. 12 (12-gauge) solid copper wires with 45 mils blue HDPE insulation shall be laid on top of the pipe to aid in the locating the pipe for maintenance purposes. The copper conductor wire shall conform to ASTM B-3.

1. The wire shall be secured to the pipe with zip ties or duct tape (2-inches in width) near every bell and at the midpoint of each pipe joint, or at a maximum, every 10 feet. The wires shall **NOT** be fastened to valves, fire hydrants, service saddles, or to copper service tubing. The wire shall be a single continuous conductor from valve box to valve box. When the distance between valve boxes exceeds 500 feet, splices will be permitted at 500 feet (or greater) intervals, if needed. The splice shall be made watertight as indicated in the standard detail as approved by the Engineer. Splices shall be isolated from direct tension on the wires in accordance with the Standard Details.

2. When wire splices are required, the splices shall be securely bonded together with an approved industrial connector to provide electrical continuity. Connector shall be copper and insulation shall be repaired as detailed to seal out moisture and corrosion and shall be installed so as to prevent any uninsulated wire exposure. See Standard Details.

3. Valve boxes, for the purposes of this section, shall be defined as mainline valves, fire hydrant guard valves, air release valves, blow off valves, tracer wire termination valve boxes and /or service valves (1.5 inch and greater) which require a standard valve box. At valve boxes, the wire shall be installed along the outside of the valve box assembly from the pipe to the top section of the valve box. The wire shall enter the valve box assembly, directly below the top section of the valve box. The wire shall extend through the top section and shall terminate 24 inches above the top section. This excess wire shall be coiled and stored in the top section, directly below the valve box cover.

4. Contractor shall perform post installation testing of the tracer wire system to confirm conductivity from valve box to valve box on a daily basis during construction. Immediately prior to, or during the final inspection, the Contractor shall perform post installation testing of the tracer wire system to confirm conductivity from valve box to valve box. The test shall consist of applying an alternating High/Low tone voltage to the conductor at one valve box and testing the conductor at the next valve box or service box with Fluke Networks PRO3000 Tone Generator and Probe Kit, or approved equal. Every service line pipe segment

shall be tested in addition to all main line pipe segments. Alternate testing methods will be subject to approval by the Engineer. The testing shall be witnessed by the Engineer. The repair or replacement of any defective or improperly installed systems shall be the responsibility of the Contractor. Any and all repairs or replacement of defective or improperly installed tracer wire systems shall be performed by the Contractor and at no cost to the Engineer. Method of repairs or replacement shall be subject to approval of the Engineer. Upon acceptance by the Engineer, the wires in each valve box shall be connected together with a wire-nut wire connector, coiled and stored in the top section, directly below the valve box cover. The official Tracer Wire Conductivity test shall be performed by the contractor at the time of the Final inspection, or when approved by the Engineer, in presence of the Engineer.

B. Detectable Warning Tape: 6-inch wide blue and black water warning tape will be installed 12 inches above the top of the pipe and 24 inches below finish grade.

3.16 FILLING, FLUSHING, TESTING AND INSPECTION

A. Required testing of pipelines and valves shall be done under the direct supervision of the Project Inspector. Field testing shall not negate the requirements for material certifications as contained in the material specification section of this contract. Unless otherwise directed by the Engineer, all testing and disinfection will be completed prior to connection to any existing water main. The Contractor shall provide open ventilation of confined spaces. The Contractor shall be responsible for providing all equipment and personnel necessary to comply with OSHA confined spaces regulations.

1. Filling and Flushing: Upon completion of the installation of the jumper/backflow assembly, the new main may be slowly filled at up to 10 feet per minute to prevent pressure surges due to trapped air removal. Once trapped air has been removed from the pipe, then the new main can be properly flushed at higher velocities between 3 and 6 feet per second. All water usage shall be measured by the water meter required in the jumper assembly. Meter readings shall be documented and recorded daily. The document shall indicate the reason for the water usage each day. The readings shall be provided to the Engineer prior to removal of the jumper/meter assembly. All water usage shall pass through the approved reduced pressure backflow assemblies. The main shall be flushed at a minimum of 3 feet per second and the pipe water volume shall be turned over a minimum of 3 times. Flushing shall continue until all pipe joint/gasket soap/lubricant is removed from the pipe, and until all entrapped air in the pipe is removed. Flushing shall also continue until all visible evidence of dirty water, muddy water or debris is removed from the pipe. CHARLOTTE WATER shall provide water free of charge to the Contractor for the initial pipe filling volume and the 3 flushing volume turnovers, or a total of 4 pipe volumes. All additional water required until the hydrostatic test is approved, shall be billed to the Contractor at the commercial water billing rate.

2. Hydrostatic and Makeup Water Tests: On completion of the line or sections of the lines, connections and appurtenances, the line shall be filled and hydrostatically tested. All water services, air release assemblies, blow off assemblies and fire hydrants shall be complete prior to beginning testing procedures. Fire hydrants shall be rotated to the approved directions and shall be set to final approved finish grade. Hydrant extension kits are limited to one per fire hydrant. Any hydrostatic and makeup water tests shall not begin until all concrete thrust blocking has reached the required 28 compressive strength. The water for this purpose can be taken from existing lines

under the supervision of the Engineer's Inspector and makeup water will be measured by the Inspector with an ultrasonic water meter furnished by CHARLOTTE WATER. The Owner will provide water for the first two makeup water tests. If additional tests are needed, the Contractor is responsible for the cost of the water after the initial two tests and for any subsequent tests. All leaks and any defective material shall be repaired or replaced to the satisfaction of the Engineer and the tests repeated until the requirements of this specification are met. Any special equipment, pumps, etc. required to make the test shall be furnished and operated by the contractor as directed by the Inspector.

a. The Contractor shall use great care to be sure that all air is expelled from each section under test. If fire hydrants or other openings are not available for the purpose of expelling air, the Contractor shall provide air releases of sufficient size (as determined by the Engineer) in accordance with CHARLOTTE WATER Standard Drawings, at their expense. Specific procedures for testing mains are as follows:

1) The maximum length of pipe tested in one test shall be 5,000 feet or as close to 5,000 feet as approved by the Engineer, depending on valve spacing.

2) Test pressure will be 200 PSI or a minimum of 1.25 times the static pressure, whichever is higher, at the high point of the section under test. When testing against valves, the differential pressure at the valve must not exceed 250 PSI for valves rated at 250 PSI. The maximum water main test pressure shall be 350 PSI based on pipe and fitting ratings. The test pressure shall be rounded up to the next 25 psi pressure interval in the chart below.

3) Allowable makeup water is the volume of water that must be supplied to the water main to maintain a pressure with 5 PSI of the test pressure and will be determined by Table 6, AWWA C-600 (see below) or by the formula $L = SD(\sqrt{P})/148{,}000$ where S is the length of pipe under test in feet, D is the pipe diameter in inches, and P is the test pressure at the low point in the section of pipe being tested during the test (pounds per square inch). The following table lists the additional allowable makeup water for each service on the line being tested, based on the equation in this section and 30-foot average service line lengths at 200 psi testing pressure.

Allowable Makeup Water per Service Line (gal/hr)	Water Service Diameter (in)
.0021	¾
.0029	1
.0043	1.5
.0057	2 and manifold services
.0086	3
.0115	4
.0172	6
.0229	8
.0287	10
.0344	12

Allowable Makeup Water per 1000 ft. of Pipeline* - gph

Low Point Test Pressure	Nominal Pipe Diameter - *in.*																		
Pressure (psi)	2	3	4	6	8	10	12	14	16	18	20	24	30	36	42	48	54	60	64
350	0.25	0.38	0.51	0.76	1.01	1.26	1.52	1.77	2.02	2.28	2.53	3.03	3.79	4.55	5.31	6.07	6.83	7.58	8.10
300	0.23	0.35	0.47	0.70	0.94	1.17	1.40	1.64	1.87	2.11	2.34	2.81	3.51	4.21	4.92	5.62	6.32	7.02	7.49
275	0.22	0.34	0.45	0.67	0.90	1.12	1.34	1.57	1.79	2.02	2.24	2.69	3.36	4.03	4.71	5.38	6.05	6.72	7.17
250	0.21	0.32	0.43	0.64	0.85	1.07	1.28	1.50	1.71	1.92	2.14	2.56	3.21	3.85	4.49	5.13	5.77	6.41	6.83
225	0.20	0.30	0.41	0.61	0.81	1.01	1.22	1.42	1.62	1.82	2.03	2.43	3.04	3.65	4.26	4.86	5.47	6.08	6.48
200	0.19	0.29	0.38	0.57	0.76	0.96	1.15	1.34	1.53	1.72	1.91	2.29	2.87	3.44	4.01	4.59	5.16	5.73	6.11

* If the pipeline under test contains sections of various diameters, the allowable makeup water will be the sum of the computed leakage for each size.

4) Makeup water tests will be run for a duration of two hours plus the time required to complete all valve and service 10-minute testing requirements. For water mains 16 inch and larger, a continuous 8-hour pressure test at the required test pressure will be conducted, after the makeup water test, to provide proof of restrained joint assemblies and concrete thrust blocking installations.

5) The Contractor will pressurize the line and complete a pre-test to verify that it is within allowable makeup water before the official test is started. All makeup water shall be measured by a 5/8-inch ultrasonic water meter, furnished by CHARLOTTE WATER. Pressure gauges shall be furnished by the Contractor. The official test gauge shall be 4.5-inch dial with accuracy of ±0.5% of span per ASME B40.100, Grade 2A with liquid fill, throttle screw and pulsation damper, or 3-inch digital gauge with accuracy of ±0.25% of span. The gauge shall be 300 PSI or as approved by the Engineer. The gauge shall be calibrated within 90 days of the pressure test. Proof of calibration by a third party testing/lab company shall be provided prior to the testing. Other observation gauges may be 2.5-inch dials with accuracy of ±3-2-3% of span (ASME B40.100, Grade B).

6) When testing mains with Contractor installed water services, the Engineer shall require jumpers to be installed on a random basis on a minimum of 10 services, or a minimum of 10 percent, whichever is greater, of ¾ and 1 inch service meter yokes with full test pressure applied to the property line valve. The jumper locations shall be selected by the inspector. Such jumpers will be furnished and installed by the Contractor. During the 2-hour pressure test, the random jumper services shall be tested to the property line angle ball valve on the back side of the meter yoke. Front side angle ball valves shall be tested at the end of the water main test, with the jumpers removed. These front side angle ball valve test may be conducted as a single 10-minute test. Services without jumpers shall be tested to the front side angle valve during the 2-hour pressure test.

7) All water service lines shall be flushed to the service box/vault prior to beginning the pressure test. The Inspector will begin the test and remain at the job for the duration of the official test, making sure that the test pressure is maintained within 5 PSI. The Contractor is to maintain the pressure within 5 PSI for the duration of the test period. During the 2-hour test, the Contractor and the inspector shall inspect all exposed pipe, fittings, valves, hydrants, services, blow offs, and joints. Any defective, damaged or leaking components/joints, shall be repaired or replaced, and the test shall be repeated. Any visible leakage shall be repaired regardless of the allowable makeup water results.

8) If makeup water exceeds allowable during the first hour, the makeup water increases during the second hour, or the pressure drops more than 5 psi, the test has failed and will be terminated. All leaks shall be repaired and the test re-scheduled. If the total makeup water for the two-hour period does not exceed the allowable makeup water, the test has passed and will be terminated.

9) During the last stages of the test and without any reduction in pressure, first the hydrant guard valves will be closed. Then progressing in an orderly manner from the end opposite the test pump, each main line valve, fire hydrant valve, air release valve, blow off valve, and service line valve 1.5 inch and larger, will be closed and pressure released to determine if it is holding pressure (minimum 10 minutes per valve closing).

No visible change in pressure or visible leak is allowed during each valve test. All visible leaks shall be repaired in a manner approved by the Engineer.

10) All services larger than 1-inch shall be tested to the property line valve during the water main test. Each service control valve, including check valves, shall then be tested during the valve testing process after the water main test is complete.

3. Disinfection of Mains:

a. All of the water mains installed shall be thoroughly flushed and disinfected before being placed in service. This work shall be done under the direct supervision of the Engineer's Inspector and shall follow ANSI/AWWA C651 and NC Administrative Code. The AWWA continuous feed method shall be used, unless otherwise approved by the engineer. The specifications below are based on the continuous feed method and as modified to CHARLOTTE WATER Standards. The Contractor shall supply all labor, equipment and materials necessary for carrying out this work.

b. Filling and Flushing for Disinfection and Sampling: All water usage shall be measured by the water meter required in the jumper assembly. Meter readings shall be documented and recorded daily. The document shall indicate the reason for the water usage each day. The readings shall be provided to the Engineer prior to removal of the jumper/meter assembly. All water usage shall pass through the approved reduced pressure backflow assemblies. CHARLOTTE WATER shall provide water free of charge to the

Contractor for the chlorination, flushing and sampling processes one time or a total of 3 pipe water volumes. All additional water required for additional disinfection, flushing, and sampling shall be billed to the Contractor at the commercial water billing rate.

c. Flushing and cleaning is done prior to the pressure test. Sufficient hypochlorite or other chlorine compounds shall be introduced in the lines to produce a chlorine concentration of at least 50 parts per million and not greater than 150 parts per million. Where a direct connection to active water main is required, jumper assembly shall be used for the connection. The jumper shall be inspected by a representative of the Owner and tested by a third party certified backflow tester prior to use. The jumper shall be located no greater than 10 feet from the chlorination injection point.

d. The chlorine solution shall be retained in the lines for at least twenty-four (24) hours and no greater than 36 hours and tracked at each blow off sampling location. Sampling locations are required every 1200 feet of water main line and at any dead end line. Blow off standpipes used for sample points should be a minimum of 24-inches tall and include an extension at a 45- or 90-degree angle of at least 18 inches in length. The blow off should be constructed of rigid metal pipe and shall end without threads. Fire hydrants are not to be used as sampling points but should be chlorinated and flushed after 24 hours. At the end of the 24-hour chlorination period, the chlorine residual shall be at least 10 parts per million, prior to flushing. The inspector shall witness the chlorine residual tests at each blow off and sampling location, and record the results before the Contractor is approved to begin the flushing and dichlorination processes.

e. The water mains will then be flushed sufficiently to clear them of chlorine exceeding 0.80 ppm and return the turbidity to less than 1 TBU. Chlorine and turbidity testing shall be witnessed/verified by the CHARLOTTE WATER inspector. The flushing velocity shall be no less than 3.0 ft/s. All water services, regardless of size or type, shall be flushed to remove high chlorine concentrations once the water main has been flushed and tested to below 0.80 PPM. This flushing must be completed within 48-hours of the disinfection processes.

f. Samples of water from the mains will then be taken and analyzed for bacteriological purity. Water should be running at a low flow rate for a minimum of 2 hours prior to the sample collection. A representative of the Owner must be present at the time of sample collection. Sample collection shall be scheduled with the CHARLOTTE WATER Laboratory Services a minimum of 24 hours in advance of sample collection. Samples are not collected by the Laboratory on Friday or City of Charlotte holidays. Results typically take 24 hours and only the Owner may call the laboratory if there are questions regarding the testing. If one sample from the mains fail to meet the bacteriological standard for purity, additional samples will be collected and retested.

g. If the samples fail three times, disinfecting and flushing will be repeated until such standards have been met. The Contractor is responsible for the cost of the water required for the additional flushing, disinfection and sampling. The contractor shall also be responsible for the costs of all additional Laboratory

testing services. All analysis for chlorine and bacteriological purity will be by CHARLOTTE WATER Laboratory Services. All final connections to the CHARLOTTE WATER System shall be completed and the new water mains shall be activated within 14 days after being approved by the laboratory or continually flushed and monitored for chlorine residual. After 14 days of inactivation, the water main must be retested by the laboratory. The Contractor shall be billed for the water required for the additional flushing and monitoring.

h. If a third party laboratory is approved for use by CHARLOTTE WATER, the Contractor is responsible for all costs, and the Laboratory tests results and reports shall be submitted directly to CHARLOTTE WATER from the third party laboratory.

i. Water Main De-Chlorination and Residual Chlorine Disposal:

1) Water main de-chlorination shall comply with the requirements of AWWA C-655 Field Dechlorination, and as specified below.

2) The total residual chlorine standard set by the NC Department of Environmental Quality (NCDEQ) application to all surface waters of the State, including creeks, streams, ponds, lakes, etc., is 17 parts per billion. Any discharge to waters of the State that results in exceedance of this standard is considered a violation and is subject to enforcement action, including penalties/fines. The Contractor is responsible for reducing the total residual chlorine levels so that this standard is not exceeded in the nearest receiving waters during all water flushing processes.

3) The Contractor will be required to flush and remove the chlorine from the main 24 hours after initial chlorination. The primary disposal method shall be to de-chlorinate the water on site and discharge to the adjacent ground, nearby creek or the stormwater system. Testing water shall NOT be discharged into the sanitary sewer system. The Contractor shall provide necessary additional erosion control measures to prevent the migration of sediment and prevent erosion. The discharge shall be tested by the Contractor at 15- minute intervals to confirm the total residual chlorine level in the nearest receiving stream is less than 17 parts per billion. Discharge shall be immediately stopped if any elevated chlorine readings are observed by the Contractor or the Engineer. The de-chlorination agent and process shall be approved by the Engineer.

4) Be aware that the over application or miss use of dechlorination agents can deplete dissolved oxygen levels, alter the pH of the receiving stream or otherwise degrade water quality conditions in violation of State water quality standards. The Contractor is responsible for monitoring downstream conditions to ensure these violations do not occur. The table below indicates the minimum application rates – pounds per 1000 gallons of residual water, required to neutralize the chlorine, based on the residual chlorine concentration and the de-chlorination agent used:

De-Chlorination Agent					
Residual Chlorine Concentration ppm	Ascorbic Acid (Vitamin C) ($C_6O_8H_6$) lbs.	Sodium Thiosulfate ($Na_2S_2O_3$ $5H_2O$) lbs.	Sodium Sulfite (Na_2SO_3) lbs.	Sodium Bisulfite ($NaHSO_3$) lbs.	Sulfur Dioxide (SO_2) lbs.
10	20.9	12.0	14.6	12.5	8.3
50	104.0	60.0	73.0	62.6	41.7
100	208.0	120.0	146.0	125.2	83.4
200	416.0	240.0	292.0	250.4	166.8

4. Drainage of Mains: Drainage of mains and disposal of chlorinated water shall be in accordance with all Federal, State and local laws, ordinances and regulations. Drainage directly to surface waters (creeks, rivers, streams, lakes, ponds, etc.) shall not be allowed. Drainage branches, blowoffs, air release valves/hydrants and appurtenances shall be provided with valves and shall be located and installed as shown on the Plans and Standard Details. Drainage of mains will be accomplished in such a manner as to minimize erosion and siltation to adjoining properties. Water velocity from drainage and/or blow-off will be dissipated as necessary to prevent erosion. Temporary energy diffusers shall be used on all discharge ports larger than 2-inch in diameter. Under no circumstances shall discharge water be allowed to enter the sanitary sewer system.

   a. Drainage branches or blowoffs shall not be connected to any sewer, submerged in any streams, or installed in any other manner that will permit back siphonage into the distribution system.

   b. Metering Water Usage:

      1) All water used during the construction of proposed water mains shall be metered as approved by the Engineer. On projects where a jumper is used between the existing and proposed water mains, the Contractor shall furnish and install a 2 inch or larger water meter as part of the jumper assembly. The meter shall record usage in cubic feet or gallons. All water used, including filling, disinfection, and flushing, shall pass through the meter. The meter shall be read jointly by the contractor and the CHARLOTTE WATER inspector prior to installation and immediately prior to removal. See the testing and disinfection sections above for additional information on meter reading and recording requirements.

      2) The Contractor shall provide a water use report to the Engineer at the final inspection. All Cost shall be included in the cost of the pipe.

      3) The Owner will provide water at no charge to the Contractor for Initial main filling, initial flushing to remove air and joint lubricant foaming, flushing to clean the main prior to the pressure testing, the contractor's initial pressure pre-test, the official pressure test, flushing to inject chlorine, flushing to remove chlorine and de-chlorinate, and initial flushing to collect laboratory samples, or a total of 7 times the new main pipe volume. Any additional flushing and discharge of water for any reason shall be the responsibility of the contractor. If additional tests are

needed, the Contractor is responsible for the cost of the additional water required to complete the project. The Contractor shall be billed at the commercial water billing rate for all water used in excess of 7 times the new water pipe volume.

3.17 REPAIRS

A. The Contractor shall make any needed repairs to newly installed unactivated mains and shall notify the Owner and Engineer of the repairs. A representative of the Owner shall be on site during repairs. Repairs to existing and/or activated mains will be made by CHARLOTTE WATER unless the Contractor is otherwise directed by the CHARLOTTE WATER Engineer.

1. Repairs to New mains: Repairs shall be made by cutting out and removing the damaged/defective section and replacing those with new pipe using long pattern solid sleeves to connect plain ends. Bell clamps and repair clamps will not be allowed to repair newly installed water mains. The contractor is responsible for all repair costs to new water mains during the warranty period, regardless of who makes the repair.

2. Repairs to Existing Mains: The Contractor will not be required to repair existing mains unless specifically directed by the Engineer, or specified elsewhere in these specifications. Repair methods will be considered on a case by case basis.

3.18 CONTRACTOR RECORD DRAWINGS

A. The Engineer shall provide the Contractor a digital set of construction plans to use as the Contractor Record Drawing. The Record Drawings shall be annotated in Bluebeam, by the Contractor, to show all changes encountered or made during the construction of proposed facilities. Record Drawings should be submitted to the Owner upon completion of construction of facilities required by each sheet. Record Drawings shall be reviewed by the Engineer and CHARLOTTE WATER Inspector and subject to approval. Review and approval shall consist of a review for accuracy and completeness, based on the Inspector's knowledge of the project, and based on the minimum requirements indicated below. Record Drawings which are not approved by the Engineer shall be returned to the Contractor for explanation, revision, or correction as deemed necessary by the Engineer.

B. Record Drawings shall meet the following minimum requirements and standards:

1. General to all projects:

   a. Annotations shall be in red digital markups only.

   b. Annotations shall be neatly printed and legible.

   c. Add existing facilities encountered but not shown on plans.

   d. Revise existing facilities encountered differently from plans.

   e. Mark through changed stations, bearings, distances, slopes, etc., and print actual station, bearing, distance, slopes, etc.

   f. Mark through "proposed" for items that were actually installed.

   g. Mark completely through items that were proposed, but were not installed.

   h. Correct notes, sizes, diameters, dimensions, classes, types, etc to actual as installed.

i. Revise profile of proposed facilities to within 0.1 feet of actual vertical and within 1.0 feet of actual horizontal.

j. Revise plan view of proposed facilities to within 1.0 feet of actual.

k. The following sheets are excluded, and do not require updating by the Contractor:

l. Cover Sheet, Permit Sheet. Vicinity/Location Map Sheets

m. Traffic Control Sheets, Erosion Control Sheets, and other Temporary Facilities

n. Standard Detail Sheets unless changes are made on a project specific basis.

2. General to all new water main projects:

a. Indicate pipe manufacturer, type and class of pipe.

b. Indicate station for transition in pipe materials.

c. Indicate restraint type, manufacturer, and beginning and ending stations in profile, or on plan views without profiles.

d. Indicate bedding type and location in profile, or on plan views without profiles.

e. Indicate solid ledge rock in profile to within 0.1 feet of actual vertical and within 1.0 feet of actual horizontal, or on plan views without profiles.

f. All fittings, valves, fire hydrants, air releases, blow-offs, casings, tunnels, etc. shall be stationed.

g. At fire hydrants, a detail shall always be required with station numbers from the tee to the fire hydrant, including all fittings and valves.

h. At fire hydrant, indicate hydrant manufacturer, model, and actual number of turns to operate and direction of open operation (‘open right’ or ‘open left’).

i. At fire hydrant, indicate hydrant actual bury depth, and actual height of hydrant extensions installed, measured to 0.5 feet. Only ONE vertical extension per hydrant is allowed.

j. At air releases and blow-offs, a detail shall always be required with station numbers from the tee to the standpipe/fire hydrant, including all fittings and valves.

k. At ALL valves, indicate valve manufacturer, model, and actual number of turns to operate and direction of open operation (‘open right’ or ‘open left’).

l. At ALL valves, indicate if valve extension stem was installed, and actual height of extension stem, measured to closest 0.1 feet.

m. At services, indicate size, and location of tap, control valve(s), fittings, service box or vault, etc, as measured to closest 1.0 feet along the main and from the closest mainline valve. A detail shall be required with station numbers from the tap to the property line valve for all services other than ¾ and 1-inch residential services, including all fittings and valves.

3.19 FINAL INSPECTION

A. A final inspection will be held for each project once construction and complete restoration has been completed. The Contractor SHALL ATTEND the final inspection. During the final inspection, all fire hydrants, valves, air releases, blow-offs, and services shall be inspected and operated through one cycle of operation on water projects. All other features of the project, either constructed or reconstructed, shall also be inspected. The official tracer wire test shall be conducted during the Final Inspection process, unless otherwise approved by the Engineer. The Contractor shall be responsible for providing equipment and labor, as may be necessary, to conduct the final inspection and to provide a safe worksite. Deficiencies, if any, shall be noted for correction by the Contractor. The Contractor will schedule the work with the Inspector. Any and all corrective actions necessary to correct a deficiency noted at the final inspection shall be completed prior to final acceptance of the work and project.

3.20 WARRANTY PERIOD

A. A one-year warranty period is required. The project warranty period will be established from the date all deficiencies (if any) have been corrected, following the final inspection, and will extend for one year, unless extended as indicated below.

B. Should deficiencies develop during the warranty period, the Engineer shall determine the severity of the deficiency and advise the Contractor of its priority rating. The priority ratings shall be defined as Emergency, Major, Minor, or Routine. The Engineer reserves the sole right to determine the priority rating of a deficiency and to raise or lower the rating as needed. The Contractor shall respond to these deficiencies according to the following schedule:

1. Emergency: Once notified, the Contractor shall report to the project site within a maximum of 2 hours, and shall mobilize and take all actions necessary to make the site safe. The Contractor and the Engineer will agree on a course of required actions and timeline for completing those actions. All work necessary to correct the Emergency deficiency shall be completed as quickly as possible.

2. Major: Once notified, the Contractor shall mobilize to the project site within a maximum of 2 business days. The Contractor will schedule the work with the Inspector. All work necessary to correct the Major deficiency shall be completed within a maximum of 5 business days of mobilization, or according to timeline approved by the Engineer.

3. Minor: Once notified, the Contractor shall mobilize to the project site within a maximum of 10 business days. The Contractor will schedule the work with the Inspector. All work necessary to correct the Minor deficiency shall be completed within a maximum of 5 business days of mobilization, or according to timeline approved by the Engineer.

4. Routine: Once notified, the Contractor shall mobilize to the project site within a maximum of 25 business days. The Contractor will schedule the work with the Inspector. All work necessary to correct the Routine deficiency shall be completed within a maximum of 5 business days of mobilization, or according to timeline approved by the Engineer.

C. A warranty inspection will be scheduled for the project during the final month of the project warranty period. The Contractor SHALL ATTEND the warranty inspection. During the warranty inspection, all fire hydrants, valves, air releases, blow-offs, and services

shall be inspected and operated through one cycle of operation on water projects. All other features of the project, either constructed or reconstructed, shall also be inspected. The Contractor shall be responsible for providing equipment and labor, as may be necessary, to conduct the warranty inspection and to provide a safe worksite. Any deficiencies, if any, shall be noted for correction by the Contractor. The Contractor will schedule the work with the Inspector. The Engineer reserves the sole right to determine the priority rating of each deficiency noted at the warranty inspection. Any and all corrective actions necessary to correct a deficiency noted at the warranty inspection shall be completed within a maximum of 30 days following the warranty inspection.

D. Deficiencies noted and corrected during the warranty period will extend the project warranty period. The contractor shall warrant and guarantee the corrected work for one year from the date the deficiency is corrected. A warranty inspection will be conducted within the final month of the extended warranty period. The extended warranty inspection will be conducted as described above for a warranty inspection for the specific items that required warranty repairs during the warranty period.

3.21 PROPERTY OWNER RELEASES

A. The Contractor will contain their work activities within the public road rights-of-way, CHARLOTTE WATER public utility easements or restricted areas on CHARLOTTE WATER Property (where necessary) as shown on the plans. Any contractor activities outside these easements and rights-of-way will be considered work on private property. Work on private property may require the contractor to obtain from the impacted property owner, a release that holds the city harmless against claim for damages resulting from the contractor’s activities on private property. Any specific work or service performed by the contractor on behalf of the property owner shall be noted in the release document. The release shall be signed and dated by the legal owner of the property and shall be witnessed and dated by the Contractor’s representative. The contractor is responsible for retaining the original release. The Contractor shall provide a copy of the release to the Engineer prior to request for a final inspection.

END OF SECTION