

**WATER DISTRIBUTION CONSTRUCTION  
STANDARDS AND SPECIFICATIONS**

**CITY OF WILLIAMSBURG, VIRGINIA  
DEPARTMENT OF PUBLIC UTILITIES**

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City of Williamsburg, Virginia  
Department of Public Utilities

## STANDARD SPECIFICATIONS FOR WATER DISTRIBUTION SYSTEMS

### PART 1 - GENERAL

#### 1.1 GENERAL

The following Standard Specifications for Water Distribution Systems shall be followed for construction of all water distribution systems unless otherwise authorized by the Director of Public Utilities. The Director of Public Utilities reserves the right to waive any or all parts of the Standard Specifications in specific instances as he deems appropriate except where Virginia Department of Health regulations would be violated by such a waiver. The term "Director of Public Utilities" refers to the Director or authorized representative of the Department of Public Utilities.

References are made in these Standard Specifications to standards and other publications of the following associations and agencies and shall be of the latest revision at the time of construction.

AASHTO	American Association of State Highway and Transportation Officials
ANSI	American National Standards Institute
ASTM	American Society for Testing and Materials
AWWA	American Water Works Association
OSHA	Occupational Safety and Health Administration, U.S. Department of Labor
VDHT	Virginia Department of Highways and Transportation

The Owner/Developer shall be responsible for payment of permits and inspection services required by the City of Williamsburg and/or the Virginia Department of Highways and Transportation, unless otherwise directed. The Contractor shall satisfy himself as to the nature of the requirements of permits issued by the City and/or VDHT for the project.

#### 1.2 SYSTEMS DESCRIPTION

Water distribution systems shall consist of ductile iron, steel or copper pipe of the types, classes and sizes shown on the plans, together with the required fittings, valves, fire hydrants and other appurtenances shown on the plans and profiles or as authorized by the Department of Public Utilities. Water distribution systems and appurtenances shall be installed in accordance with these specifications and standards and shall conform to locations and grades shown on the plans.

### 1.3 SYSTEMS DESIGN

1.3.1 Minimum Residual Pressure - A minimum residual pressure of 20 psig shall be maintained throughout the water distribution system at all times. Flows required for fire protection shall be in accordance with applicable requirements of the National Fire Protection Agency, Insurance Services Office, State and local agencies.

1.3.2 Minimum Water Main Size - The minimum size of pipe where fire protection is to be provided or required shall be eight inches in diameter.

Pipe of lesser diameter may be used in the following instances where fire protection is not required:

- \* Six-inch pipe and lesser diameter pipe may be used if 20 psig minimum pressure and flow of three gallons per minute per connection can be maintained.
- \* Three-inch pipe may be used when the run is less than 600 feet but more than 300 feet.
- \* Two-inch pipe may be used when the run is less than 300 feet.

Use of the lesser diameter pipe must be justified by hydraulic analysis and projected future water use.

1.3.3 Minimum Service Connection Size - The minimum size of service connection shall be 3/4 inches.

1.3.4 Minimum Cover - The minimum depth of cover for water distribution systems pipe shall be 36 inches, measured from the top of the pipe to the established finished grade, unless otherwise noted.

1.3.5 Easements - Permanent easements of 10 feet width, minimum, shall be provided for water pipelines on all private property. Combined water and sewer easements shall be 20 feet minimum. Prior to considering an easement as permanent, all surface conditions must be restored to original or better condition. The easement shall be stabilized within 30 calendar days of the completion of construction. Easement plats and deeds suitable for recordation, and recordation fees, shall be provided to the Department of Public Utilities.

No building or permanent structures shall be constructed within easements. No trees, shrubs, structures, fences or obstacles shall be placed within an easement which would render the easement inaccessible to maintenance and repair equipment.

1.3.6 Dead Ends - Dead ends shall be minimized by looping pipelines where possible. Where dead-end pipelines occur, they shall be provided with a fire hydrant (8" pipe or larger), flushing hydrant, or blow-off for flushing purposes. The flushing device shall not be directly connected to any sewer.

1.3.7 As-Built Plans - A complete set of as-built plans (one set of mylar reproducibles and one set of blue line prints) shall be submitted to the Department of Public Utilities upon completion of the water system. As-built plans shall show the location of easements, pipelines, appurtenances, service connections, and other data necessary to operate and maintain the system. As-built plans shall be delivered within 30 calendar days of the final inspection. One complimentary set of the approved final plans shall be forwarded by the design engineer to the State Health Department. Water service will not be provided until as-built plans are received and approved by the City.

1.3.8 Dedication - The Developer/Owner shall formally dedicate the water distribution system, easements and/or property to the City of Williamsburg.

1.3.9 Extension Provisions - Provisions shall be made for logical future extensions at all proposed or existing street connections. Future extensions shall be provided with a gate valve and a full joint of pipe. This pipe shall be properly plugged, blocked, disinfected and pressure tested along with the rest of the water system. After passing inspection the gate valve shall be closed.

## PART 2 - SYSTEM COMPONENTS

### 2.1 PIPE AND FITTINGS

2.1.1 Ductile Iron Pipe - Ductile iron pipe shall be minimum thickness Class 52 and conform to ANSI A21.51/AWWA C151. The pipe shall have a cement-mortar lining in accordance with ANSI A21.4/AWWA C104.

Joints shall be rubber-gasket joints of the mechanical or push-on type in accordance with ANSI A21.11/AWWA C111.

Ductile iron fittings shall conform to ANSI A21.10/AWWA C110. Fittings shall have double thickness cement lining and be seal coated in accordance with ANSI A21.4/AWWA C104.

2.1.2 Steel Pipe - Steel pipe for air release and blow-off connections shall be galvanized, seamless, Schedule 40 (Standard Weight) conforming to ASTM A120.

2.1.3 Copper Pipe - Copper pipe shall be seamless copper water tube, Type K, conforming to ASTM B88. (Maximum size = 2")

2.1.4 Concrete Pipe - (16" diameter and larger) - Concrete pipe may be used only where approved by the Director of Public Utilities and shall be lock joint prestressed concrete embedded steel cylinder pipe with rubber and steel joints, conforming to AWWA C301.

2.1.5 Steel Casing Pipe - Casing pipe for water pipelines shall be welded joint seamless steel pipe conforming to ASTM A53 with a minimum yield strength of 36,000 psi. (Steel casing pipe which is installed under a railroad shall be coated on the exterior with a bituminous coating).

The following minimum casing pipe wall thickness shall be used:

<u>Casing Size</u>	<u>Wall Thickness (Inches)</u>	
	<u>Highway R/W</u>	<u>Railroad R/W</u>
8"	0.322	0.277
10"	0.365	0.279
12"	0.375	0.281
14"	0.375	0.281
16"	0.375	0.281
18"	0.375	0.344
20"	0.375	0.375
24"	0.375	0.438

## 2.2 VALVES

2.2.1 Gate Valves - (3" & Larger) - Gate valves 3" and larger shall be iron body, bronze trimmed, conforming to AWWA C500 with double disk parallel seat gate, non-rising stem, O-ring stem seals, mechanical joint end connections, 2" square operating nut, and open counter-clockwise. Minimum 150 psig working pressure. Gate valves used at tee connections shall be flanged by mechanical joint valves. Provide valves 16" and larger with bypass valves and gear operators. Provide the City with one valve wrench for every five valves installed (one minimum). As manufactured by Darling or Mueller. (\*) Kennedy "Ken-Seal" and Darling "CRS-80" resilient-seat gate valves are acceptable substitutions.

(Smaller than 3") - Gate valves smaller than 3" shall be bronze body, conforming to Federal Specifications WW-V-54c, Class A, Type 1, with screw-in bonnet, bronze solid wedge disc gate, inside screw non-rising stem, handwheel operated, and open counter-clockwise. Minimum 200 psi WOG pressure rated. Female standard pipe size threaded connections. NIBCO Inc. T-113 or equal.

(\*) Added August, 1990

2.2.2 Butterfly Valves - Butterfly valves shall conform to AWWA Standard C504, except as otherwise specified or approved. Body material shall be alloy cast iron conforming to ASTM A126. Cast iron disc material conforming to ASTM A436, Type 1 or Type 2; cast iron conforming to ASTM A48, Class 40; or ductile iron conforming to ASTM A536, Grade 65-45-12. Mating seat surface shall be 18-8 stainless steel or monel. Type 304 stainless steel valve shaft, retaining rings and internal hardware. Maximum 150 psig valve shutoff pressure. Counter-clockwise valve opening. Provide valves with sufficient length to assure proper operation. Shaft seals to have stuffing box and pull down packing gland. Design valves to operate satisfactorily at flows ranging from 10 mgd to 40 mgd when closing or opening. Design 16" valves to operate satisfactorily at flows up to 18 mgd when closing or opening. Test valves and furnish reports in accordance with AWWA C504. With the exception of finished and bearing surfaces and discs, coat interior ferrous surfaces with two coats of two-component coal tar epoxy suitable for use with potable water systems. Provide exterior surfaces with two coats of heavy coal tar coating. Provide the City with one valve wrench for every three valves installed (one minimum). As manufactured by Darling or Mueller.

2.2.3 Butterfly Valve Operators - Butterfly valve operators shall conform to AWWA Standard C504. Valve operators are to be approved by the Director of Public Utilities.

2.2.4 Tapping Valves and Sleeves - Tapping valves shall meet the same specifications as gate valves, except they shall have a full, unobstructed opening to receive a full size shell cutter. ANSI 125# flanged inlet end for attaching to tapping sleeve, standard mechanical joint outlet end. Minimum 150 psig working pressure, 300 psig test pressure. As manufactured by Darling or Mueller. Tapping sleeves and crosses shall be mechanical joint, complete with plain rubber gaskets, split gland mechanical joints, and duck-tipped end gaskets. ANSI 125# connection flange between sleeve and tapping valve.

2.2.5 Automatic Air Release Valves - Cast iron body and cover; stainless steel float, orifice seat, linkage mechanism, mountings and trim; Buna-N orifice seat. Valve orifice designed for maximum venting capacity under normal main pressure. Minimum 150 psig rated working pressure; 300 psig test pressure. Install in accordance with Standard Details where shown on the plans. Apco Valve & Primer Corp., Model #200A.

2.2.6 Backflow Prevention Devices - Conforming to AWWA C506. Complete assembly consisting of two independently acting swing check valves with an automatically operating pressure differential relief valve located between two check valves. The unit shall include tightly closing shut-off valves located at each end of the device, and shall be fitted with properly located test cocks. All parts must be removable or replaceable without removal of the unit from the line. Backflow prevention devices shall be approved by the Virginia Department of Health.

## 2.3 VALVE BOXES

Valve boxes shall consist of a cast iron frame and cover, as manufactured by Dewey Brothers Co., Norfolk, Va. Pattern B1200, and a 12" diameter piece of pipe.

The base shall be centered over the valve and shall rest on compacted backfill which has been tamped around the valve box for a distance of 4 feet on all sides of the valve box. The frame and cover shall not rest on the pipe but on compacted backfill. The entire assembly shall be plumb and adjusted flush with the finished grade. The valve operating nut shall be visible with the cover removed.

## 2.4 FIRE HYDRANTS

Dry-barrel break-away type conforming to AWWA C502, with full 360 degree revolving heads. 6" mechanical joint inlet connection, 4-1/2" hydrant valve, and equipped with two 2-1/2" hose nozzles and one 4-1/2" steamer nozzle. Hose and pumper outlet threads shall be National Standard Thread. Attach separate chains to nozzle caps. Corrosion resistant bolts and nuts. The hydrant shall open counter-clockwise and the direction of opening shall be cast on the head of the hydrant. Hydrants shall be painted with one coat of red lead paint and two finished coats of an approved paint. Mueller Company, Model A-421, or Kennedy Matthews Modernized Hydrant or Kennedy Guardian "K-81".

## 2.5 METER SETTINGS

Meter settings shall include corporation stops, copper tubing, adjustable meter box, meter box connections, and all appurtenances necessary for providing customer water service at the location designated on the plans or as directed by the Director of Public Utilities. The top section shall be adjustable for elevation and shall be set to allow equal movement above and below finished grade.

2.5.1 Corporation Stops - Corporation stops shall conform to AWWA C800 and shall be as manufactured for Ford, Mueller, or Hays, or approved equal.

2.5.2 Meter Boxes - Meter box assemblies shall be round and include a cast iron base casting with brass inverted key inlet valve, brass meter clamping device, and brass outlet connection; a rotating vertically adjustable 2-piece cast iron barrel; and a separate cast iron lid, providing a 10-1/2" opening, with the words "Water Meter" cast into the lid. Provide the City with one meter box valve wrench for every fifty or less meter boxes installed. Ford Meter Box Co. "Crescent Boxes", or equal.

2.5.3 Meter Vaults - Constructed in place where indicated on the plans in accordance with Standard Details W12.0, W12.1, W13.0, and W13.1 as applicable.

## 2.6 WATER METERS

Water meters shall be furnished and paid for by the Developer/Owner and installed by City of Williamsburg. All water meters shall be straight reading in U.S. gallons.



2.6.1 Meters (2" and Smaller) - Positive displacement nutating disc type, conforming to AWWA C700. Hermetically sealed register, magnetic drive, six digit straight reading in U.S. gallons. Bronze register case and cap. One-piece bronze main case, and measuring chamber with cast iron frost protection bottom cap. Internal stainless steel strainer.

(\*\*) Meters shall be guaranteed to operate at a working pressure of 150 psig without leakage or damage to any parts, and guaranteed against defects in material and workmanship for a period of one year from the date of installation. Water meters 2" and smaller shall be Neptune Water Meter Co., Model "Trident 10" (T-10) with Automatic Reading and Billing (ARB) registers.

2.6.2 (\*\*) Meters (Larger than 2") - Compound type. Use turbine type meter only where high constant water usage is present. Provide a strainer where turbine type meters are used. Water meters larger than 2" shall be Neptune Water Meter Co. with ARB registers.

2.6.3 (\*\*) Detector Meters - Detector meters are required at the following location: Master meters for water systems where both fire and domestic water is required. Detector meters shall be Neptune Protectus III Fire Service Meter or Hersey Model MFM II/MVR or MFM/MCT II with ARB registers.

2.6.4 (\*\*\*) Double Check Detector Check Valves - Double Check Detector Assemblies are required at the following location: Fire Service or automatic sprinkler services. 6" and 8" detector check with detector meter shall be Ames 3000 SE; 4" shall be Ames 3000 SS, or approved equal. Detector meter to be Neptune T-10 with ARB registers.

## 2.7 VALVE AND METER VAULTS

(\*\*) Install vaults in accordance with Standard Details W10.0, W11.0, W12.0, W12.1, as applicable. Meter vaults for Double Check Detector Assemblies including or without domestic meter service shall be designed by Developer's Engineer, approved by City and should be similar to Details 13.0 and 13.1 showing single check valve layout.

Cast iron access covers and frames. Contact surfaces machined and matched. Words "Water" cast into the cover. Dewey Brothers Co., Norfolk, Va Pattern #6007 or #6008.

In areas not subjected to traffic loading, meter vaults W13.0 and W13.1 shall use a Bilco Hatch Type "K-2" access cover.

## PART 3 - WATER MAIN CONSTRUCTION METHODS

### 3.1 GENERAL

3.1.1 Traffic Control - It shall be the responsibility of the Contractor to take any measures as may be necessary or as directed by the Virginia Department of Highways and Transportation and/or City of Williamsburg.

(\*\*) Added August, 1994

(\*\*\*) Added January, 1996

3.1.2 Erosion and Sediment Control - It shall be the responsibility of the Developer/Owner or Contractor to submit an Erosion and Sediment Control Plan for review and approval by the Department of Public Utilities. (See Appendix C)

3.1.3 Emergency Utilities - Emergency utilities such as fire hydrants and traffic signal control boxes shall not be obstructed at any time.

3.1.4 (\*\*) Site and road grading must be completed (within 6 inches of final grade) prior to the installation of any water system improvements.

3.1.5 The City of Williamsburg shall be notified at least 48 hours prior to commencement of construction.

### 3.2 EXCAVATION

3.2.1 Trench Width - The following table will serve as a guide for ordinary trench width (depths not exceeding six feet):

<u>Nominal Pipe Diameter</u>	<u>Maximum Trench Width</u>
3/4" - 6"	30"
8"	32"
10"	34"
12"	36"
14"	38"
16"	40"
18"	42"
20"	44"
24"	48"
30"	54"
42"	66"

3.2.2 Safety - All excavation shall conform to the latest regulations and safety practices specified by the Occupational Safety and Health Administration (OSHA).

3.2.3 Permits - No excavation shall be made until proper permits have been obtained from the City of Williamsburg and/or the Virginia Department of Highways and Transportation.

3.2.4 Length of Open Trench - On any day, no trench shall be opened to a greater length than can be reasonably expected to be closed on that day.

3.2.5 Dewatering - Trenches shall be kept free of water during construction. Pumps, dams, and/or under drains shall be maintained where required by the Director of Public Utilities. No excavation, installation, or backfilling shall be permitted as long as water remains in a trench.

(\*\*) Added August, 1994

3.2.6 Trenching - Pipe trenches shall be excavated to a depth that will insure a minimum of 36 inches of cover for water lines. Excavation shall be made for bells of all pipes, and shall be of sufficient depth to permit access to the joint for construction and inspection. In no case will the bells be used to support the body of pipe.

3.2.7 Unstable Subgrade - In the event that unsuitable materials are encountered at or below the level of the trench bottom, such material shall be removed and replaced with approved material as directed by the Department of Public Utilities. Stones or rock which are encountered shall be removed to a minimum depth of 6" below the pipe and replaced with approved material. Approved material for replacement shall be loose earth, sand, gravel, or crushed rock.

### 3.3 WATER MAIN INSTALLATION

The installation of water mains and appurtenances shall conform to AWWA C600, the manufacturer's recommendations, and the recommendation of the Engineer or Director of Public Utilities. Pipe delivered to the site shall be carefully inspected for defects. Any pipe found to be broken or defective prior to or after installation shall be removed and replaced at the Contractor's expense. Pipe and fittings may be strung out along the route of construction with the bells facing in the direction in which the work is to proceed. Pipe shall be placed where it will cause least interference with traffic, and shall be subject to Virginia Department of Highways and Transportation policies when placed within the state right-of-way. Pipe shall be carefully handled and lowered into the trench. Special care shall be taken to insure that each length shall abut against the next in such manner that there shall be no shoulder or unevenness of any kind along the inside of the bottom half of the pipe lines. The pipes shall be thoroughly cleaned before they are laid and shall be kept clean until acceptance of the completed work. The upper end of the pipelines shall be provided with a water tight stopper carefully fitted so as to keep dirt and other substances from entering. This stopper shall be kept in the line at all times when pipe laying is not in progress.

#### 3.3.1 Sewer and Water Main Separation:

Horizontal Separation - Water mains shall have a minimum horizontal separation of 10 feet from any existing or proposed sanitary sewer or storm drain line, measured edge to edge. Sewer manholes located within a horizontal distance of 10 feet from a water main must be of watertight construction. Conduct a manhole exfiltration test to ensure watertight construction. When local conditions prevent a horizontal separation of 10 feet, the water main may be laid closer to the sanitary sewer or storm drain line provided that it is in a separate trench and that the bottom of the water main is at least 18" above the top of sanitary sewer or storm drain line. Where this vertical separation cannot be obtained, the sanitary sewer or storm drain line shall be constructed of AWWA approved water pipe pressure tested in place to 50 psig with no leakage prior to backfilling.

Vertical Separation - Water lines crossing sewers shall be laid to provide a separation of at least 18" between the bottom of the water line and the top of the sewer whenever possible. When local conditions prevent this separation, the following construction shall be used:

- \* Sewers passing over or under the water lines shall be constructed of mechanical joint water pipe (minimum two joints), pressure-tested in place to 50 psi without leakage prior to backfilling.
- \* Water lines passing under sewers shall, in addition, be protected by providing: A vertical separation of at least 18" between the bottom of the sewer and the top of the water line; adequate structural support for the sewers to prevent excessive deflection of the joints and settling on and breaking water line; and the length of the water line shall be centered at the point of the crossing so that joints will be equidistant and as far as possible from the sewer.

Manholes - No water pipes shall pass through or come in contact with any part of a sewer or sewer manhole.

### 3.3.2 Appurtenances:

Valves - Valves shall be installed on all temporary dead-end lines, on branching mains and on loop networks. Valves shall also be placed on water mains so that a break or failure will not affect more than 800' of the main.

Valve Boxes - Valve boxes shall be installed plumb, directly over valves with fill carefully tamped around the valve box. Valve box covers shall be fully exposed and flush with the finished street or ground surface.

Hydrant Branch, Blow-offs, Future Connection Tees - Where a tee is installed and a valve is attached to the branch, the branch end of the tee shall be flanged and the water main ends shall be mechanical joint. Mechanical joints are to be restrained by the use of retainer rings.

Air Release and Blow-off Assemblies - Install air release assemblies in accordance with Standard Details W15.0 & W16.0 where shown on the plans. Install blow-off assemblies (or fire hydrants, where applicable) at the end of dead end pipelines and as shown on Standard Detail W17.0.

### 3.3.3 Fire Hydrants:

Fire hydrants shall be located at street intersections and at cul-de-sacs as necessary. The maximum distance between hydrants on the same water main shall be 1000 feet. In high-density residential areas, commercial areas, and industrial areas, the maximum hydrant spacing shall be 500 feet or as required by Insurance Services Office. Hydrants shall be set within the right-of-way a minimum of 18" above established finished grade; the setting height distance shall be measured from the established finished grade to the centerline of the pumper nozzle. Hydrants shall be placed on firm foundation with adequate drainage being provided by placing coarse gravel or crushed stone from the bottom of the trench to at least 6" above the drainage openings in the bowl of the hydrant. Each hydrant shall be braced and wedged as shown on the Standard Details.

All backfill shall be compacted to the established finished grade and the hydrant shall be checked to insure proper working order. No fire hydrants shall be connected directly to sanitary sewers or storm drains.

#### 3.3.4 Thrust Blocking:

All tees and bends shall be substantially braced, blocked, and/or anchored to prevent any movement by providing adequate thrust blocks of 3000 psi concrete. Blocking shall be placed between solid, undisturbed earth and the fitting to be anchored, and shall be placed so that pipe and fitting joints will be accessible for repair. Concrete shall be Class A3, General Use, as specified in Section 219, VDHT Road and Bridge Specifications. Caps, plugs and fire hydrants shall be provided with retainer rings and blocked with treated timber blocking.

### 3.4 BACKFILLING EXCAVATIONS

All trenches and excavation shall be backfilled on the same day that the trench or excavation was opened. Backfill shall consist of approved excavated materials free from large clods of earth or stone larger than 1" in diameter, deposited in 6" layers, thoroughly and carefully compacted by mechanical tampers. Backfill under areas to be paved shall be deposited in 6" layers and compacted to a density of at least 95% of the maximum dry density as determined by AASHTO Test Method T-99.

### 3.5 WATER MAIN TESTING

#### 3.5.1 Pressure Test:

New water mains shall be pressure tested in accordance with AWWA Standard C600, Section 4.1. Water mains shall be filled with clean water and subjected to a hydrostatic pressure of 120 psig, or not less than 1.25 times the working pressure at the highest point along the test section, whichever is greater. No noticeable drop in pressure shall occur. The pressure test shall be of at least a three-hour duration and any damaged or defective pipe, fittings, valves, or hydrants that are discovered following the pressure test shall be replaced by the Contractor and retested to the satisfaction of the Department of Public Utilities. The Contractor shall furnish all necessary equipment, materials and labor for making the tests as specified. Before applying the specified test pressure, air shall be expelled completely from the pipe, valves, and hydrants.

#### 3.5.2 Leakage Test:

New water mains shall be tested for leakage in accordance with AWWA C600, Section 4.2. The leakage test shall be conducted concurrently with the pressure test. Allowances for valves shall conform to the applicable AWWA specifications. No pipe installation will be accepted if the leakage is greater than the values listed in the following table:

## Allowage Leakage per 1000 Feet of Pipeline (\*) - gph

Avg. Test Pressure (psig)	Nominal Pipe Diameter - inches										
	<u>6</u>	<u>8</u>	<u>10</u>	<u>12</u>	<u>14</u>	<u>16</u>	<u>18</u>	<u>20</u>	<u>24</u>	<u>30</u>	<u>36</u>
120	0.49	0.65	0.82	0.99	1.15	1.32	1.48	1.64	1.97	2.47	2.96
125	0.50	0.67	0.84	1.01	1.18	1.34	1.51	1.68	2.01	2.52	3.02
150	0.55	0.74	0.92	1.10	1.29	1.47	1.66	1.84	2.21	2.76	3.31
175	0.59	0.79	0.99	1.19	1.39	1.59	1.79	1.98	2.38	2.98	3.58
200	0.64	0.85	1.06	1.28	1.48	1.70	1.91	2.12	2.55	3.19	3.82
225	0.68	0.90	1.13	1.35	1.58	1.80	2.03	2.25	2.70	3.38	4.05

(\*) For pipe with 18' nominal lengths. The allowable leakage values in the above table must be adjusted for nominal lengths other than 18' using the equation:

$$L = \frac{ND\sqrt{P}}{7400}$$

- Where L = Allowable leakage in gallons/hr  
 N = Number of joints in length of pipeline tested  
 D = Nominal diameter of the pipe in inches  
 P = Average test pressure during leakage test in psig

The Contractor shall, at his expense, locate and repair defective joints, fittings, pipe or valves and retest until leakage is within allowable limits. Repair visible leaks regardless of the amount of leakage.

### 3.6 DISINFECTION

New water mains shall be disinfected in accordance with AWWA Standard C601. The disinfection procedure shall be carried out after completion of satisfactory pressure and leakage testing and immediately before the mains are placed into service. During construction, precautions shall be taken to protect pipe interiors, fittings, and valves against contamination. Cleaning and swabbing of the interior of the pipe may be required if contamination will not be removed by ordinary flushing and disinfection procedures. The cleaning and swabbing shall be performed with a 5% hypochlorite disinfecting solution. Conduct water line disinfection in the following steps:

- Preliminary Flushing
- Chlorine Application
- Final Flushing
- Bacteriological Testing

## 3.6.1 Preliminary Flushing:

Prior to disinfection, except when the tablet method is used, fill the main to eliminate air pockets and flush to remove particulates. The flushing velocity shall be not less than 2.5 fps unless the Director of Public Utilities determines that conditions do not permit the required flow to be discharged to waste.

Required Flow and Openings to Flush Pipelines (\*)  
(40 psi Residual Pressure in Water Main)

Pipe Diameter (inches)	Flow Required to Produce 2.5 fps Velocity in Main (gpm)	Size of Tap on Main (**) (inches)	Hydrant Outlets Number	Size (inches)
4	100	15/16	1	2-1/2
6	220	1-3/8	1	2-1/2
8	390	1-7/8	1	2-1/2
10	610	2-5/16	1	2-1/2
12	880	2-13/16	1	2-1/2
14	1200	3-3/8	1	2-1/2
16	1565	3-5/8	2	2-1/2
18	1980	4-1/4	2	2-1/2

(\*) With 40 psi pressure in the main and the hydrant flowing to atmosphere, a 2-1/2" hydrant outlet will discharge approximately 1000 gpm; a 4-1/2" hydrant nozzle will discharge approximately 2500 gpm.

(\*\*) Size of tap on main, with no significant length of discharge piping.

## 3.6.2 Chlorine Form:

Approval of chlorine form is required from the Director of Public Utilities.

## 3.6.3 Chlorine Application:

Completely fill the main to remove all air pockets. Flush the completed main to remove particulates and fill the main with chlorinated potable water.

At a point not more than 10 feet downstream from the beginning of the new main, feed chlorine at a constant rate such that the water entering the new main will have not less than 50 mg/l free chlorine.

During the application of chlorine, position valves so that the strong chlorine solution in the main being treated will not flow into water mains in active service.

Retain the chlorinated water in the main for a 24-hour period. During the 24-hour treatment, operate valves, curb stops and hydrants in order to disinfect appurtenances and pipe branches. The chlorine residual after 24-hours must be a minimum of 10 mg/l.

#### 3.6.4 Final Flushing:

Flush the heavily chlorinated water from the system under treatment until the chlorine concentration in the water leaving the system is no higher than that generally prevailing in the system or is acceptable for domestic use.

#### 3.6.5 Bacteriological Testing:

After final flushing is completed and before the water main is placed in service, test the line for bacteriological quality. Conduct a second test 24 hours after the first test. Bacteriological tests shall be performed by a State Health Department approved laboratory.

Provide bacteriological test reports to the Director of Public Utilities. Failure to meet State Health Standard requirements will be cause for the Contractor to rechlorinate and retest the system.

#### 3.6.6 Supervision:

The testing and disinfection procedure shall be carried out by the Contractor under the supervision of the Department of Public Utilities. Water mains shall be placed in service only after final approval has been issued by the Director of Public Utilities contingent upon satisfactory test results.

### 3.7 PAVEMENT RESTORATION

The Contractor shall be responsible for the removal and replacement of any and all types of pavement disturbed or damaged during the course of and as a result of his construction activities. Pavement replacement including subbase, base, surface, and overlays shall conform to the applicable portions of VDHT Road and Bridge Specifications and the Standard Details.

Pavement shall be removed using appropriate methods. Edges shall be cut on straight lines and shall be as near to vertical as possible. Concrete saws or other similar equipment shall be used for this purpose. Jagged edges will not be acceptable. Settlement of pavement patches or final pavement replacement shall be corrected by the Contractor at his expense at any time during the one-year period following placement of same, in the manner prescribed by the Virginia Department of Highways and Transportation or the City of Williamsburg.



Unpaved Roadways - Roadways, shoulders of roads, alleys, and driveways that are not "paved" but constructed of shell, lime rock, base material, stabilized soil, or gravel, and that are traversed by the excavation work shall be restored to the condition existing prior to making the excavation. Backfill material shall be compacted to a minimum of 95% of the maximum dry density as determined by AASHTO T-99. Shoulders of state maintained highways shall be replaced to the satisfaction of the Virginia Department of Highways and Transportation.

Sidewalks, Curbs and Gutters, Drainage Structures - The Contractor shall remove and replace only those portions of sidewalk, curb and gutter and drainage structures as is absolutely necessary to complete work.

### 3.8 CLEANUP AND SITE RESTORATION

All areas utilized during the construction activities of the Contractor shall be cleaned to the satisfaction of the City. Undesirable material shall be disposed of off-site by the Contractor. All areas shall be restored to a condition equal to or better than that existing prior to construction.

All disturbed areas not designated for pavement and sidewalk replacement, structural use, and the like shall be stabilized in accordance with the "Virginia Erosion And Sediment Control Handbook, 1980" and Appendix C.

### 3.9 FINAL INSPECTION

A final inspection will be made when all items of water system work are complete. If any items of work remain incomplete at the time of final inspection, such as cleanup and minor soil stabilization, a "punch" list will be prepared and a date set for completion of punch list items. All items of work must be completed by the Contractor unless otherwise directed by the Director of Public Utilities.