

**UPDATE LOG FOR TECHNICAL PROVISIONS**

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07/2021	<p><b>TECHNICAL PROVISIONS</b>  <b>DIVISION 3 – PIPELINE SPECIFICATIONS</b></p> <p><b>The entire technical provisions document has been revised. Please replace the entire document dated 06/16 with the attached document dated 07/2021</b></p> <p>The font and format throughout the entire document has been revised to reflect that of the new branding.</p>	All
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07/2021	<p><b>DIVISION 3 – PIPELINE SPECIFICATIONS</b></p> <p><b>The following sections have been revised:</b></p> <p>3.1.2.1 <del>Asbestos Cement Pipe and</del> Polyvinyl Pipe</p> <p>3.1.2.2 Welded Steel Cylinder Pipe and Concrete Cylinder Pipe</p> <p>3.1.3 Construction Staking</p> <p>3.2.2 Limit of Excavation</p> <p>3.2.3 Width of Trench</p> <p>3.2.4 Excess Excavation</p> <p>3.2.6 Excavation in Poor Soil</p> <p>3.2.7 Excavation in Rock</p> <p>3.2.9 Blasting</p> <p>3.3.2 Backfill Adjacent to Pipe</p> <p>3.3.2.1 Asbestos Cement Pipe and Polyvinyl Chloride Pipe</p> <p>3.3.3 Backfill Above the Pipe</p> <p>3.3.4 Imported Backfill Material</p> <p>3.3.5 Slurry Backfill - <b>1 1/2</b> Sack</p> <p>3.3.7 Trench Compaction</p> <p>3.4.1.2 Pipeline Valves and Appurtenances</p> <p>3.4.1.4 Pipeline Alignment</p> <p>3.4.1.5 Pipeline Cover</p> <p>3.4.1.6 Thrust Protection</p> <p><del>3.5.2 — Asbestos Cement Pipe</del></p> <p><del>3.5.2.1 — Scope</del></p> <p><del>3.5.2.2 — Pipe and Couplings</del></p> <p><del>3.5.2.3 — Fittings</del></p> <p><del>3.5.2.4 — Testing</del></p> <p><b>3.5.3</b> Polyvinyl Chloride Pipe</p> <p>3.5.<del>3</del>.1 Scope</p> <p>3.5.<del>3</del>.2 Pipe</p> <p>3.5.<del>3</del>.3 Fittings</p> <p>3.5.<del>3</del>.4 Testing</p> <p>3.5.43 Welded Steel Cylinder Pipe (Cement Mortar Lined and <del>Either Outside Wrapped or Cement Mortar</del> Coated)</p> <p><del>3.5.4.1 — Scope</del></p> <p><b>3.5.43.21</b> Pipe and Fittings</p> <p><b>3.5.43.32</b> Pipe Joints</p> <p><b>3.5.43.43</b> Interior Coating (Cement Mortar Lining)</p> <p><b>3.5.43.54</b> Exterior Coating (Cement Mortar Lining)</p> <p><del>3.5.5 — Concrete Cylinder Pipe</del></p> <p><del>3.5.5.1 — Scope</del></p>	<p>3-1</p> <p>3-2</p> <p>3-3</p> <p>3-4</p> <p>3-5</p> <p>3-6</p> <p>3-7</p> <p>3-8</p> <p>3-9</p> <p>3-10</p> <p>3-11</p> <p>3-12</p> <p>3-14</p> <p>3-16</p> <p>3-17</p> <p>3-18</p>
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## **DIVISION 3**

### **PIPELINE SPECIFICATIONS**

#### **3.1 General**

##### **3.1.1 Scope**

Contractor shall furnish all pipe and fittings together with all material, equipment, and labor and perform all operations necessary to construct water mains and appurtenances as specified, unless otherwise indicated.

##### **3.1.2 Submittals**

###### **3.1.2.1 Polyvinyl Chloride Pipe**

Whenever specified by the Construction Drawings or by Owner, Contractor shall prepare detailed installation or laying drawings. Drawings for the pipe and fittings shall show fittings, appurtenances, station and elevation for each fitting, and each change in alignment or slope. The Contractor shall submit these to the Owner for approval in all cases in time sufficient to allow review and approval as hereinafter specified and to accommodate the rate of construction. The Contractor shall furnish copies of an Affidavit of Compliance, in accordance with Section 6.3, AWWA C-900 (latest). Contractor shall also furnish certified copies of test reports containing results of all physical and chemical tests on pipe and couplings to be furnished showing compliance with AWWA C-900 (latest), as modified herein.

###### **3.1.2.2 Welded Steel Cylinder Pipe and Concrete Cylinder Pipe**

Contractor shall prepare detailed shop fabrication drawings of the pipe, lining and coating, joints, details of reinforcement, fittings, appurtenances, station, and elevation for each outlet and fitting and each pipe joint where a change in pipe class, alignment, or slope occur and shall submit these to Owner for approval in all cases, as required in Article 8 of the General Provisions.

The following items shall be submitted to the District for review and approval prior to fabrication of steel pipe and specials:

1. An Affidavit of Compliance with the latest applicable standard (e.g., AWWA C200, C205, ASTM A53, ASME B16.9)
2. Tabulated layout schedule including:
  - a. Order of installation and closures.

- b. Pipe station and bottom of pipe (BOP) elevation at each change of grade and alignment.
  - c. Elements of curves and bends, both in horizontal and vertical alignment.
  - d. Pipe internal diameter, cylinder thickness, and internal design pressure.
  - e. Locations of bulkheads for field hydrostatic testing. (Testing against valves shall not be permitted).
  - f. Locations and types of closures, including cut-to-fit allowances, for length adjustment and for construction convenience.
  - g. Locations and types of valves, flanges, appurtenances and other mechanical equipment.
3. Details of all fittings, specials, closure pieces, and of the lining and coating.
  4. Calculations supporting the sizing of reinforcing collar plates, wrapper plates, or crotch plates.
  5. Calculations supporting selected wall thickness of pipe and specials.
  6. Calculations supporting welded joint design and joint welding details.
  7. Current shop and field welder certifications.
  8. Mill test reports on each heat from which steel is rolled, at the discretion of the District.
  9. Certification of dye penetrant shop-weld testing.

### 3.1.3 Construction Staking

Upon Contractor's request, the District will provide construction stakes along the pipeline alignment, in accordance with lay sheet(s), at maximum 50-foot intervals, including all angle points, grade breaks, fittings, and appurtenances and at the boring and receiving pits, as applicable.

Cut sheets will be prepared using flow line of pipe as shown on the Construction Drawings. Staking will be 1-inch x 2-inch hubs, or nails and tins, set along pipeline alignment at an offset determined by Contractor. Contractor will be furnished three (3) copies of cut sheets prior to trenching.

Contractor shall notify District a minimum of two (2) weeks prior to start of construction to allow ample time for preparation of cut sheets and construction staking. Contractor shall use the construction stakes and cut sheets for pipeline construction. District will use them for inspection of the work. Contractor shall protect all survey monuments and stakes and shall pay all costs to reestablish any monuments or stakes destroyed or disturbed during construction.

## **3.2 Excavation**

### **3.2.1 Trenches**

Excavation for pipelines and appurtenances shall be open trench to the depth and in the direction necessary for proper construction shown on the Construction Drawings or as otherwise directed by Owner. Excavation for trenches shall include the removal of all material of any nature at Contractor's expense for installation of the pipe or appurtenance and shall include either trench sloping or trench shoring, timbering as may be required, and all necessary dewatering. Contractor to obtain any necessary discharge permits required by regulating agencies.

### **3.2.2 Limit of Excavation**

Trenches shall be excavated not more than 500 feet in advance of pipe laying, unless otherwise permitted in writing by Owner. Trenches shall be adequately shored and braced so that the earth will not slide or settle and so that all existing improvements of any kind will be fully protected from damage. Any damage resulting from lack of adequate shoring and bracing shall be repaired or reconstructed at Contractor's expense and Contractor shall bear all other expense resulting from such damage. Trenches shall not be left open overnight without permission of Owner.

### **3.2.3 Width of Trench**

Unless otherwise shown, all pipeline trenches shall, wherever possible, have vertical sides and a minimum width as possible. Whenever the maximum allowable width of trench is exceeded for any reason, Owner may require, at its discretion, that Contractor, at his expense, cradle pipe in Controlled Low Strength Material (CLSM) with a minimum cement content of 50 pounds per cubic yard and minimum compressive strength of 50 psi (1/2 sack mix) conforming to Section 201-6 in the Standard Specifications for Public Works Construction (Greenbook).

### **3.2.4 Excess Excavation**

Should the excavation for the pipeline be carried below the designed grade without permission, it shall be refilled to proper grade at Contractor's expense for all labor and material with clean sand or sand and gravel tamped in place to 90 percent minimum compaction.

### **3.2.5 Excavation in Good Soil**

The trench shall have a flat or semi-circular bottom conforming to the grade to which the pipe is to be laid. The bottom of trench shall be graded and prepared to provide firm and uniform bearing throughout the entire length of each joint of pipe.

Pipe shall not be laid on earth mounds. It shall be laid so that pipe barrel will bear evenly on the bottom of the trench. Bell holes shall be excavated in the sides and bottom of the trench at pipe joints. They shall be of such size that the process of making joints and inspection can be performed satisfactorily.

#### 3.2.6 Excavation in Poor Soil

All soft, spongy, or unstable material shall be removed from the bottom of the trench to a depth determined in the field by Owner and shall be refilled to proper grade, at Contractor's expense, with clean sand, or sand and gravel, or other suitable material, as approved by Owner. Bedding material shall be tamped to 90 percent minimum compaction, graded, and prepared to provide a firm and uniform trench bottom.

#### 3.2.7 Excavation in Rock

Where rock is encountered, it shall be removed below-grade and the trench backfilled with clean sand, sand and gravel, or other suitable material, at Contractor's expense, as approved by Owner, to provide a compacted earth cushion with a thickness under the pipe of not less than four (4) inches. Bedding material shall be tamped to 90 percent minimum compaction, graded, and prepared to provide a firm and uniform trench bottom.

#### 3.2.8 Excavated Materials

All material excavated from the trench shall be placed as to offer a minimum of obstruction to traffic. Gutters shall be kept clear or other provisions shall be made for handling street or road drainage. Excess material and material that is not approved by Owner for use as backfill shall be disposed of elsewhere by Contractor entirely at his own expense, unless otherwise permitted by Owner.

If pipe or other material belonging to Owner is uncovered or removed from the excavation, all pipe or other material which is salvable in the opinion of Owner shall be disposed of, as directed by Owner. Material not considered to be salvable shall be disposed of with other excess excavated material at Contractor's expense.

### 3.2.9 Blasting

Blasting for excavation will be permitted only after securing approval of Owner and only when proper precautions are taken for the protection of persons and property. Contractor to provide District with copy of blasting permit. The hours of blasting will be fixed by the Owner. Any damage caused by blasting shall be repaired by Contractor at his expense. Contractor's methods of and procedures for blasting shall conform to State and local laws and municipal ordinances. Precautions shall be taken to post signs warning operators of radio equipment to stop transmitting in any area in which blasting operations are in progress. The costs for blasting shall be at Contractor's expense and shall be included in the bid price. Contractor may submit alternative methods for rock removal for review and approval by the District.

## 3.3 Backfill

### 3.3.1 Basic Requirements

Backfill shall be as specified by Owner or in accordance with permits issued by agency having jurisdiction (State, County, City) over rights-of-way in which construction is taking place. Backfill shall not commence without prior approval of Owner or of other aforementioned agency and in no event shall backfill be placed over pipelines until joints are properly made and inspected.

### 3.3.2 Backfill Adjacent to Pipe

Initial backfilling shall be performed as soon as possible after pipe has been laid. Selected backfill material shall be used and it shall consist of clean, loose earth, sand, or gravel free from stones, lumps, vegetable matter, or other unsatisfactory material. It shall have proper moisture content so that specified compaction can be achieved. Said material shall be  $\frac{3}{4}$ -inch maximum in size for polyvinyl chloride pipe (PVC) and asbestos cement pipe (ACP) and 1-inch maximum in size for CML&C pipe within six (6) inches of pipe, and it shall be placed in trench simultaneously on each side of pipe.

#### 3.3.2.1 Asbestos Cement Pipe and Polyvinyl Chloride Pipe

Selected backfill material of proper moisture content shall be placed in layers approximately four (4) to six (6) inches in depth, each layer being tamped, until the pipe has been covered by at least twelve (12) inches of well compacted material. Said selected backfill shall have a sand-equivalent (SE) value of SE 30 and be compacted to a relative density of 90 percent. Mechanical compacting or water consolidation shall not be used, unless permitted by Owner, until the pipe has been covered by a minimum of twelve (12) inches of well compacted hand-tamped backfill.

### 3.3.2.2 Welded Steel Cylinder Pipe and Concrete Cylinder Pipe

For pipe diameters sixteen (16) inches or less, selected backfill material of proper moisture content shall be placed simultaneously on each side of the pipe and to a minimum of twelve (12) inches over the top of the pipe and then it shall be thoroughly compacted by a combination of mechanical compaction and water settlement until the specified compaction has been achieved. For pipe diameters greater than sixteen (16) inches, the selected backfill material of proper moisture content shall be placed in two (2) lifts until a minimum 12-inch cover over the top of the pipe has been achieved. The first lift shall not exceed the springline of the pipe. The second lift shall cover the top of the pipe by a minimum of twelve (12) inches. Each lift shall be thoroughly compacted by a combination of mechanical compaction and water settlement until the specified compaction has been achieved. Care shall be exercised in backfilling to avoid any damage to the pipe coating. Whenever pipe is supplied with internal bracing, it shall be left in place until the pipe is installed and backfill operations are completed.

### 3.3.3 Backfill Above the Pipe

From the top of the selected backfill to ground surface, the material for backfill shall be free of brush, roots, or organic substances and it shall be free of material exceeding six (6) inches in greatest dimension and in quantity not exceeding 30 percent of the volume with said coarse materials being distributed throughout finer materials (well graded). All backfill material shall be compacted to a minimum relative compaction of 90 percent, as determined by field compaction tests, unless specified otherwise. Relative compaction shall be determined in accordance with ASTM D-1557 (latest) modified to 5-layer curve in lieu of 3-layer curve.

Compaction shall be obtained by means of water settlement or tamping, depending on the nature of the material. Sandy, granular soils may be compacted by means of water settlement. Trench to be backfilled by water settlement shall be diked at suitable intervals not to exceed 300 feet. Impounded water shall be of sufficient depth so that earth pushed or shoveled into trench will at all times be falling into water and will be completely saturated. Soils not having a sandy or granular nature shall be backfilled and compacted by either of the following methods:

- a. All material shall be placed in layers not exceeding eight (8) inches in thickness (loose measurement) and each layer compacted to the relative compaction specified by means of hand or pneumatic tampers.
- b. All material shall be placed in layers not exceeding eighteen (18) inches in thickness (loose measurement) and each layer compacted to the relative compaction specified by the use of a "HydraHammer-" tamper or similar equipment.



On steep slopes and other locations where compaction by flooding is not practicable, backfill material shall be compacted by means of either of the above tamping methods.

#### 3.3.4 Imported Backfill Material

Imported material shall be selected, clean, loose earth, sand, or gravel being 1-inch maximum in size. Said material shall be granular and it shall be free of organics, clay, silt, and fine sand. It shall be suitable for compaction with minimum effort. All material imported because of rock or poor soil conditions shall be provided at Contractor's expense.

#### 3.3.5 Slurry Backfill - 1/2 Sack

Where indicated on the plans, slurry backfill shall be placed in pipe trench conforming to the CLSM requirements in Section 3.2.3

#### 3.3.6 Finish Backfill

Where pavement is not required, trench backfill shall be brought to grade of existing surface and dressed to provide a firm, stable, and even surface without ruts or irregularities and which is in conformance with grades of existing surface. Where pavement is required, trench backfill shall be placed in accordance with paving requirements.

#### 3.3.7 Trench Compaction

Unless noted otherwise, trench backfill and pipe zone backfill shall be compacted pursuant to Standard Drawings RW-22 or RW-25, as applicable, after all sheeting, shoring, or shields have been removed.

Contractor shall notify District when any segment of backfill is complete and ready for compaction testing. After such notification, District will have all necessary tests made by a soils engineer of its choosing. District will pay for all passing tests. Contractor shall pay for all failing tests.

Compaction tests will be taken in the pipe zone, in the backfill above the pipe zone, and in the subgrade, as determined by the District. In addition, compaction tests may be taken along all pipeline appurtenances. Contractor shall assist, at no additional cost to District, soils engineer in taking all compaction tests. Contractor shall furnish all equipment (including shoring), labor, and materials needed for such assistance. Compaction testing shall be completed and accepted by District prior to hydrostatic/leakage testing of the pipeline.

### **3.4 Pipelines and Appurtenances**

#### 3.4.1 Pipeline Construction

##### 3.4.1.1 Pipelines and Appurtenances

Pipelines and appurtenances shall be constructed in accordance with Construction Drawings, Standard Drawings, Specifications, or as specified by Owner.

##### 3.4.1.2 Pipeline Valves and Appurtenances

Pipeline valves at pipeline intersections shall be connected directly to pipeline intersection fitting (cross, weld saddle, or tee) and all mainline or side outlet valves shall be located three (3) feet minimum from any curb facing, unless specified otherwise. Valves shall not be placed under curb or gutter or in parkway, unless approved by Owner. All valves located on steel pipe twelve (12) inches and less will be installed with victaulic couplings. All appurtenances, including, but not limited to, air valve installations, blowoff installations, and related facilities such as fire hydrants, fire services, and water services shall not be installed within one (1) foot of curb returns, five (5) feet of curb depressions, five (5) feet of driveway approaches, or in an inaccessible location or locations where interferences may restrict operation of facility, unless specified otherwise on the design drawings.

##### 3.4.1.3 Pipeline Length

All pipeline lengths noted by the Construction Drawings, or specified otherwise, or referenced shall mean net horizontal constructed length and said length shall extend through all fittings and appurtenances including bends, outlets, tees, flanges, and valves, unless otherwise specified. Contractor shall provide all pipe necessary to accommodate any vertical alignment of the pipeline and said pipe shall be represented by the net horizontal constructed length. Payment for pipeline shall be based on net horizontal length.

##### 3.4.1.4 Pipeline Alignment

All pipelines shall be constructed with no basic variation in horizontal alignment, as shown by the Construction Drawings. Pipelines shall be constructed parallel with centerlines of streets or rights-of-way and appurtenances shall be constructed perpendicular thereto, unless the Construction Drawings specify otherwise. Variations in the horizontal and vertical alignments from those shown on the Drawings will only be allowed after approval by the Engineer of Record and the District through the District's design change process.

#### 3.4.1.5 Pipeline Cover

Pipeline cover, as shown by the Construction Drawings, is hereby defined as design cover over the top of pipeline. Should field conditions, determined at time of construction staking, show that pipe grade changes are required to provide design cover, Owner reserves the right to direct said changes in pipeline grade and Contractor shall construct pipeline accordingly. Unless noted otherwise, pipeline cover shall not be less than 48 inches from top of pipe to ground surface over pipeline. Where ground surface elevation over pipeline has been established and where actual ground surface is greater, pipeline cover shall be referenced to the established ground surface elevation and not the actual ground surface.

#### 3.4.1.6 Thrust Protection

All tees, angles, reducers, dead ends, valves, etc. shall be protected from vertical and horizontal movement. The plans and specifications shall indicate the limits and type of thrust protection. Thrust protection shall consist of welded joints (steel pipe), or mechanical restraint fittings (PVC and ductile iron pipe), as approved by the Owner and/or design plans. If thrust restraint is not shown on the plans, the Contractor shall issue a request for information to identify appropriate thrust protection measures.

### **3.5 Pipe Materials**

#### 3.5.1 General

All pipe furnished shall be manufactured by an organization which has had not less than ten (10) years successful experience in the manufacture of the type of pipe specified. Owner shall, at all times, have the right to inspect all work and materials in the course of manufacture. Manufacturer shall furnish Owner reasonable facility for obtaining such information as he may desire regarding the progress and manner of the work and the character and quality of materials used.

#### 3.5.2 Polyvinyl Chloride Pipe

##### 3.5.2.1 Scope

PVC furnished under these Specifications shall conform to AWWA Standard Specification C-900 (latest), as modified herein, by the Construction Drawings, or by Owner.

### 3.5.2.2 Pipe

All 4- through 36-inch PVC pipe shall be rated at a minimum pressure rating of 235 psi with a minimum Dimension Ratio (DR) of 18 conforming to all dimensional requirements of AWWA C-900, Table 1A, or as specified on the approved drawings.

Standard lengths of pipe shall have a nominal length of 20 feet, 0 inches, plus or minus 1 inch. Random lengths of pipe shall not be less than 10 feet, 0 inches, plus or minus 1 inch. Special short lengths, minimum 4 feet, 0 inches, shall only be furnished where needed to accommodate specified fittings or deflections.

PVC pipe shall be marked for identification according to AWWA C900. In addition, PVC pipe shall be color-dyed for the following types of applications:

1. Potable Water: white or blue
2. Sewer Force Main: green
3. Reclaimed Water: purple

### 3.5.2.3 Fittings

All fittings shall be ductile iron and shall conform to AWWA C110 or C153. Fittings shall be designed and manufactured to fit cast iron pipe equivalent outside diameter and fittings shall be cement mortar-lined, per AWWA C104, standard thickness. Fittings to be included shall be as listed in the general catalog of the ductile iron fitting manufacturer.

Push-on joint rubber gaskets shall be per AWWA C111.

### 3.5.2.4 Testing

All pipe, including standard, random, and special short lengths, shall be tested in the United States, in accordance with Section 5, AWWA C-900 (latest).

### 3.5.3 Welded Steel Cylinder Pipe (Cement Mortar Lined and Coated)

### 3.5.3.1

#### Pipe and Fittings

##### Below-Grade Steel Pipe:

All below-grade pipe and fittings furnished shall conform to AWWA Standards C-200 and C-205 (latest), as modified herein, by the Construction Drawings, by Owner, applicable provisions of AWWA, C-206, C-207, and C-208, and applicable portions of AWWA M11. For pipe sizes twelve (12) inches and less, carbon steel pipe conforming to ASTM A 53, Type E or S, all grades or ASTM A 135, all grades, may be used. For pipe sizes larger than twelve (12) inches, alternative pipe materials other than AWWA steel pipe are not acceptable.

##### Above-Grade Steel Pipe:

Pipe shall be black carbon steel, conforming to ASTM A 53, Type E or S, all grades or ASTM A 135, all grades. Transitions between below-grade and above-grade pipe shall be made at the first flange above-grade.

The outside diameter of all below-grade Steel Cylinder Pipe shall conform to the following dimensions:

<u>Pipe Diameter</u> (Inches)	<u>Outside Diameter of Steel Cylinder</u> (Inches)
4	4 1/2
6	6 5/8
8	8 5/8
10	10 3/4
12	12 3/4
14	15 1/4
16	17 3/8
18	19 25/32
20	21 25/32
24	25 3/4
30	31 7/8
33	34 7/8
36	37 7/8
39	40 7/8
42	43 7/8

Below-Grade Steel Fittings:

All below-grade fittings shall be shop fabricated from individual sections of pipe, welded together, and the lining and coating of joints shall be hand-applied to provide a finished cement mortar-lined and finished outside coated joint comparable to mechanically-applied lining and coating detailed herein.

Above-Grade Steel Fittings:

All above-grade fittings shall be wrought steel conforming to ASME B16.9 and ASTM A-234.

Steel Cylinder Thickness:

- a. Minimum steel cylinder thickness shall be as designated on the construction drawings. Where no thickness is designated on construction drawings, it shall be computed using the following formula:

$$T_y = \frac{P D_y}{2(Y/S)}$$

T<sub>y</sub> = Minimum cylinder thickness, inches

D<sub>y</sub> = Outside cylinder diameter, inches

P = Minimum Design pressure, psi

Y = Specified yield point of steel, psi

S = Factor of safety = 2.0

In no case shall the design stress (Y/S) exceed 16,500 psi. Cylinder thickness shall be 10-gage minimum for all pipe diameters. In no case shall the cylinder thickness be less than D/288. For cylinder thicknesses proposed by the Contractor that are greater than what is shown on the plans, a substitution request shall be made and approved revisions shall be documented on the construction redlines, along with the beginning and ending station where the change was made.

- b. Specials are defined as bends, reducers, wyes, tees, crosses, outlets, manifolds, all above-ground piping, and all piping in structures. The cylinder thickness for specials shall be computed using the equation, as specified above, except the factor of safety (S) shall be equal to 2.5. In no case shall cylinders for specials have less than the following minimum thickness:

DESIGN  Nominal Pipe Diameter (in inches)	PRESSURE	
	150 psi	200 psi
under 14	3/16-inch (0.1875")	3/16-inch (0.1875")
14 to 24	3/16-inch (0.1875")	1/4-inch (0.250")
25 to 48	5/16-inch (0.3125")	1/2-inch (0.500")
over 48	3/8-inch (0.375")	5/8-inch (0.625")

- c. Pipe or specials shall be reinforced with reinforcing collars, reinforcing saddles, or plate reinforcement designed and constructed, in accordance with AWWA M11. The pipeline test pressure shall be used in the design of said reinforcement.

### 3.5.3.2 Pipe Joints

Unless specified otherwise, joints shall conform to the following types. Joints shall be as specified on the Construction Drawings or by Owner.

- a. Rubber Gasket Joints

All rubber gasket joints shall conform to AWWA Standard C-200.

- b. Flanged Joints

Gaskets shall be non-asbestos ring type, per AWWA Standard C-207. All steel welding flanges shall conform to the following:

Nominal Pipe Diameter	Standard
4-inch and larger	AWWA C-207, Class E, Maximum Design Pressure up to and including 250 psi
4-inch and larger	AWWA C-207, Class F, Maximum Design Pressure up to and including 300 psi

The Contractor shall verify flange compatibility between all connecting flanges prior to installation, and when applicable, prior to making a request to shut down the existing water system.

c. Swedged Lap Welded Joints

The bell end shall be formed integrally with the steel cylinder and shall be swedged out by machine to be circular in shape and so designed and fabricated to withstand design pressure of the class of pipe specified and to permit the spigot end (plain end) to enter the belled end approximately 1-inch with a clearance of approximately  $\frac{1}{32}$ -inch.

d. Banded Lap Welded Joints

Where lap welded joints are required and swedged lap welded joints cannot be fabricated, banded bell ends shall be formed by welding bands of steel to outside circumference of plain ends of pipe, resulting in circular shape, and so designed and fabricated to withstand design pressures stated herein and to permit spigot end (plain end) to enter belled end approximately 1-inch with a clearance of approximately  $\frac{1}{32}$  inch.

e. Coupled Joints

Pipe ends for sleeve-type couplings (Dresser or equal) shall have the weld bead ground flush. Mortar coating or wrapping shall terminate twelve (12) inches back from pipe end. Pipe ends for bolted, segmental, clamp-type couplings (Victaulic or equal) shall be equipped with shouldered grooved adapters or grooved pipe nipple transitions welded to pipe ends and appropriate for the coupling style designated on the construction drawings. Victaulic nipples shall be welded to the pipe with wedding bands.

f. Cut-to-Fit Joints

Where cut-to-fit joints with butt-straps are required, they shall be designed and fabricated to withstand design pressures of the class of pipe specified. For pipe diameters less than 24-inch, butt-straps shall be provided with 5-inch diameter hand holes to allow repair of pipe lining. Pipe coatings at cut-to-fit joints shall be held back, as required to permit construction of joint and thereafter added in the field.



g. Shop Testing of Joints and Joint Ends

Every pipe section, standard or special, shall be hydrostatically tested after joint ends have been completely shop formed and attached in place by welding, as applicable, or dye check tested provided pipe cylinders have been previously hydrostatically tested.

3.5.3.3 Interior Coating (Cement Mortar Lining)

a. General

Cement mortar lining for welded steel cylinder pipe shall conform to AWWA C-205 (latest), unless specified otherwise herein.

b. Preparation of Surfaces

Prior to lining, the pipe shall be cleaned of all loose mill scale, moisture, rust, sand, dust, oil, grease, and other objectionable matter both inside and outside.

c. Materials

The mortar shall consist of one (1) part Portland cement to two-and-one-half (2 1/2) parts by weight of clean, sharp sand. Cement used for cement mortar shall conform to ASTM Specification C150 (latest), Type II. Sand shall consist of clean, inert, sharp, durable material of a size so that 100 percent will pass a sieve having clear openings of the size nearest to one-half (1/2) the specified minimum thickness of the lining. Mortar shall be thoroughly mixed and made workable with a minimum quantity of clear, potable water. All cement mortar shall develop an ultimate compressive strength of 3,000-4,000 psi at twenty-eight (28) days, as determined by Paragraphs 19 and 20 of ASTM Specification C39 (latest).

d. Application and Treatment

The mortar shall be applied to the interior surface of the pipe by means of equipment specifically designed for that purpose using a retracting feed line in such a manner that uniform distribution throughout the length of pipe is achieved. The pipe shall be slowly rotated with its axis in a horizontal position while the mortar is being introduced to assist in uniformity of distribution. Both ends shall be provided with suitable end dams during the spinning operation. These dams shall assist in controlling the thickness of the mortar coating being applied and shall provide a square-finished end for the lining at the joint ends. After application of the mortar, the rate of rotation of the

pipe shall be uniformly increased to a speed that will compact the mortar. Said speed shall be maintained until all excess water has been forced to the surface. During the spinning operation, surplus water shall be expelled from the pipe by means of a blower or other suitable means. The peripheral speed and the length of spinning time shall be sufficient to obtain a dense, well-compacted lining with a smooth surface free from all defects. Minimum lining thickness shall be as follows:

Nominal Pipe Diameter (in.)	Lining Thickness (in.)
Under 14-inch	5/16
14- to 18-inch	3/8
20 to 42-inch	1/2
Over 42-inch	3/4

Immediately after completion of lining operation, pipe shall be water-cured without being disturbed for at least one (1) day in a manner that will prevent loss of moisture.

#### 3.5.3.4 Exterior Coating (Cement Mortar Coating)

##### a. Materials

Materials for the exterior cement mortar coating shall be the same as those specified in Section 3.5.3.3c of these Specifications except the cement shall conform to ASTM Specification C-150 (latest), Type II and mortar shall consist of one (1) part Portland cement to three (3) parts (by weight) of clean, sharp sand.

##### b. Application and Treatment

After the interior of the pipe has been lined, a cement mortar coating shall be applied to the outside of each section of pipe by means of nozzles or belts through which the mortar is forcibly expelled against the outside surface of the pipe in such a manner as to form an even, dense, and tightly adhering coating. The coating shall have a minimum thickness of 3/4-inch, unless designated otherwise on the construction drawings. The standard reinforcing for the cement mortar coating for welded steel cylinder pipe shall be spirally wound steel reinforcing wire embedded in the center of the coating. The wire shall be a bright basic wire of low carbon, open hearth steel, not annealed after the last draw, with an approximate ultimate tensile strength of 80,000 psi and shall be No. 14 gage at a pitch of 1-inch.

Immediately after coating has been completed, the outside of each end of each section shall be cleansed to bare metal and shall have the mortar trawled and shaped to suit the type of joint being used. All bare metal exposed at the ends of each section of pipe shall be cleansed and protected against corrosion as specified herein. The completed pipe shall then be water cured for at least seven (7) days without being disturbed.

Cement-mortar lined and coated steel pipe and specials for recycled water shall be identified with purple colored coating, purple polyethylene sleeves, identification labels, or signs

### **3.6 Installation**

#### **3.6.1 Construction Tolerances**

The pipeline shall be constructed so that actual (vertical) flow line elevations are within 0.1-foot of design flow line elevations. Pipeline, when installed, shall have continuous upgrade or downgrade, corresponding with design slope, without any high spots. Pipeline shall be constructed so that actual (horizontal) pipeline centerline is within 0.1foot of design pipeline centerline. Line and grade tolerances for steel casings pipe shall be within 3-inch. Said tolerances apply at all points along the alignment.

Pipeline construction shall conform with Construction Drawings in accordance with the above specified tolerances. Contractor shall assist District as required to confirm compliance with construction tolerances. Contractor shall make or assist in making all necessary measurements as determined by District.

#### **3.6.2 Loading, Transporting, and Unloading**

After the pipe has been manufactured and tested, it shall be loaded on rubber-tired vehicles, adequately supported and chocked to prevent any damage during transportation, and delivered job site. During the unloading and stringing operations, the pipe shall be moved in such a manner as to prevent injury to the pipe. Unloading shall be accomplished in a workmanlike manner, as directed by the District. The Contractor shall use double straps, placed equal distance from each other and the ends of the pipe, to unload the pipe. Under no circumstances are pipe sections to be dropped or bumped in handling.

### 3.6.3 Defective or Damaged Material

The pipe shall be carefully inspected for defects. Any pipe found to be defective in workmanship or materials or so damaged as to make repair and use impossible shall be rejected and removed from the job site. In the event a portion of a length of pipe is damaged, it shall be replaced with an undamaged section. Contractor shall be responsible for any and all damage to material and he shall stand the expense of repairing or replacing same. Proper precautions shall be taken to assure that the rubber rings are protected from oxidation or undue deterioration.

### 3.6.4 Polyvinyl Chloride Pipe

All pipe shall be laid true to line and grade and at the locations shown by the Construction Drawings. PVC pipe shall be installed in accordance with applicable provisions of AWWA C-900 or AWWA C-905 (latest), AWWA Manual No. M23, and manufacturer's directions, all as modified herein. Bell ends shall be placed uphill, unless otherwise permitted. Bell ends shall always be placed uphill on steep slopes (10 percent or more).

The trench bottom shall be constructed to provide a firm, stable uniform support for the full length of the pipe. The minimum clear width of unsheathed or unshored trench measured at the springline of the pipe shall be eighteen (18) inches or one (1) foot greater than the outside diameter of the pipe, whichever is greater. The maximum clear width of trench at top of the pipe shall not exceed the outside diameter of the pipe plus two (2) feet.

After pipe has been set in trench, exterior of spigot end and interior of bell end shall be thoroughly cleaned. A lubricant, as recommended by the pipe manufacturer and as approved by Owner, shall be applied to the rubber gasket. The lubricant shall be water soluble, nontoxic, shall impart no objectionable taste or odor to the water, shall have no deteriorating effects on the rubber gaskets, and shall not support growth of bacteria. Excess lubricant shall be removed. The ends shall be aligned and the spigot end of the pipe pushed into the bell.

A pipe locator wire shall be installed along the top of the pipe. The locator wire shall be No. 14-gage UF coated solid copper and shall be held in place by No. 14 AWS coated copper ties or duct tape with a minimum of two (2) ties per joint. Locator wire shall be color coded: white - potable water; purple - reclaimed water; green - sewer force main.

As the work progresses, a pipe cleaning tool, as approved by Owner, shall be drawn through the pipe to remove dirt, rocks, or other similar foreign material.

At the end of each day's work, all openings in the pipeline shall be plugged with watertight expandable plugs or approved equal.

Pipe manufacturer and fitting manufacturer shall have free access to the work during installation.

### 3.6.5 Welded Steel Cylinder Pipe and Concrete Cylinder Pipe

All pipe and fittings shall be laid true to line and grade and at the locations shown by the Construction Drawings or as specified. Welded steel cylinder pipe and fittings shall be installed in accordance with applicable sections of AWWA M11, *Steel Pipe Manual*. Concrete cylinder pipe and fittings shall be installed in accordance with applicable sections of manufacturer's installation handbook.

Special care shall be taken to avoid damaging lining or coating during lowering of pipe into trench and making of field joints. The Contractor shall use double straps, placed equal distance from each other and the ends of the pipe, during the lowering of the pipe into the trench. Field joints shall be bell and spigot rubber gasket joints, unless specified otherwise. Flanged joints, welded joints, and mechanical joints may be specified for particular applications; however, caulked joints, drive slip joints, and similar joints will not be specified and they will not be permitted.

#### a. Bell and Spigot Rubber Gasket Joints

Exterior of spigot and interior of bell shall be thoroughly cleaned and lubricants, as recommended by the pipe manufacturer and as approved by Owner, shall be applied to the rubber gasket. The gasket shall then be snapped into place and excess lubricant removed. The lubricant shall be water soluble, nontoxic, shall impart no objectionable taste or odor to the water, shall have no deteriorating effects on the rubber gaskets, and shall not support the growth of bacteria.

The bells shall be hand-mortared and the joints made by forcing spigots into bells. Joints shall be gauged to ensure that gaskets have been properly seated. Bell ends shall always be placed uphill, unless otherwise permitted by Owner (permission will be granted only under extenuating circumstances warranting change).

b. Joint Deflection

Curved alignment by use of pulled joints will be permitted. Maximum deflections shall be as specified by manufacturer. If deflection on design drawings exceed what is allowable by the manufacturer, a beveled angle shall be shop fabricated near the end of the pipe joint for the specified deflection.

c. Joint Interiors

For pipe less than twenty-four (24) inches in diameter, the interior joining ends of the pipe shall be mortared with cement mortar in sufficient quantities to completely fill the space between the respective mortar linings. Excess mortar shall be removed by drawing an approved pipe cleaning tool through the pipe after joints have been made (pipe sections have been joined).

For pipe twenty-four (24) inches in diameter and larger, the interior joint lining shall be hand mortared from inside pipe and pipe interior shall be cleaned of all excess mortar and debris by hand or by means acceptable to Owner.

Handholes on buttstraps shall only be used when admission to the inside of the pipe is not achievable due to pipe size or for closure pieces. For scenarios where inside joints are accessible, shop fabrication drawings for buttstraps shall omit the handholes referenced on standard drawings.

d. Continuity Bonds

All joints except field welded joints and insulated joints shall be continuity bonded. The bond shall be welded to both spring lines of the pipe joint and all major parts of any couplings. The bond shall be approved by the Owner before the joint exterior is coated. Upon completion of the project, the Contractor, at his own expense, shall hire a qualified testing firm to test the continuity of all bonds. All test data shall be submitted to the Owner for review and approval. Contractor, at his own expense, shall repair all bonds that fail the continuity test and shall retest those sections for continuity.

e. Joint Exteriors

The exposed steel between pipe joints shall be completely coated with cement mortar prior to backfilling. Said mortar joints shall be formed by the use of heavy-duty pipe diapers as furnished by the pipe manufacturer. Cement mortar shall be mixed and placed to completely fill the pipe diaper and completely coat all exposed steel. **Pipe joints shall not be backfilled until inspected by District.**

f. Cement Mortar Mix

Composition of mortar for caulking, buttering, or coating of joints shall be composed of cement, sand, and water well mixed and of such consistency as to produce a dense, homogeneous mortar that will adhere firmly to the pipe surface. Sufficient hand plastering of the joint prior to placing of the mortar is to be encouraged, to enhance the bond between the pipe and mortar.

- 1) Cement shall be Type V Portland Cement (sulfate resistant)
- 2) Water for mixing mortar shall be clean and free from mud, oil, organic material, or other deleterious substances.
- 3) Aggregate sand shall be silica sand passing at No. 16 mesh screen; or "plaster" sand at least 80 percent passing at No. 16 mesh screen; or other well graded inert, granular material produced from hard rock, with strong, durable, uncoated grains, upon prior approval of the District.

Proportions of cement and sand in joint mortar shall be 1 part of Portland cement to one-and-one-half (1<sup>1</sup>/<sub>2</sub>) parts of sand by volume. The exact proportion shall be determined by the characteristics of the sand used, and approved by the Engineer.

Water content shall be kept to the minimum allowing workability, as approved by the District, recognizing that better flow characteristics are required for placement in diapers around the pipe than for placement by caulking or buttering.

Mixing of the mortar should be long enough [approximately three (3) minutes in paddle-type mixers, or one (1) minute in turbine mixers] to obtain maximum plasticity. The mortar shall be used before initial set; therefore, only enough mortar shall be mixed at a time for immediate use even to the extent of discarding mortar already mixed in the event of delay in the pipelaying operation.

g. General Requirements

Joints shall be completed to provide continuous interior lining and exterior coating. Field lining and coating must be equal to or better than shop lining and coating when completed with respect to strength, uniformity, and density and there shall be no voids between lining or coating and steel cylinder.

At the end of each day's work, all openings in the pipeline shall be plugged with watertight, expandable plugs, or approved equal.

Pipe manufacturer and fitting manufacturer shall have free access to the work during installation. Contractor shall use assistance provided by either manufacturer where required for proper installation of either pipe or fittings; however, Contractor shall limit role of either manufacturer to advisory service.

3.6.6 Field Welding of Welded Steel Pipe

Whenever field welded joints or other field welding of welded steel cylinder pipe is specified on the Construction Drawings, Contractor shall attach welding machine ground to pipe only with "C" clamps or other means acceptable to Owner, unless an alternative means is specified. All joints within a distance specified on the design drawings from any standard or special fitting shall be fully welded. Full welds shall be made with pipe having ends belled for welding or with filler rods of proper diameter, length, and curvature furnished by pipe manufacturer; bell ends shall not be deformed to accomplish welding. All welders shall have 6G welding certification.

3.6.7 Joint Restraints for Polyvinyl Chloride Pipe

Whenever joint restraints for PVC Pipe is specified on the Construction Drawings, the Contractor shall install the joint restraints per manufacturer's specifications. All joints within the distance specified on the design drawings from any standard special fitting shall be fully restrained.

3.6.8 Field Coating of Flanges, Valves, Fittings, Couplings, and Fasteners

After installation and assembly of the pipe system, and prior to backfill on below-grade installations, field coating of steel, and/or iron appurtenant pipeline elements shall be performed as follows:



### 3.6.8.1 Steel Pipe Systems

Below-grade: steel and/or iron appurtenant pipeline elements (including flanges, bolts, nuts, and other fasteners) that are outside of the limits of cement mortar coating shall be field primed and coated with a 3-part cold-applied wax tape system meeting the requirements of AWWA C217. Factory-coated AWWA-style valves shall be polyethylene encased pursuant to Section 3.6.8.2, herein, unless indicated otherwise.

Above-grade: steel and/or iron appurtenant pipe elements (including flanges, bolts, nuts, and other fasteners) shall be primed and coated in accordance with Division 8 of the Technical Provisions, unless indicated otherwise.

### 3.6.8.2 Polyvinyl Chloride Pipe Systems

Below-grade: steel and/or iron appurtenant pipeline elements (including valves, flanges, fittings, bolts, nuts, and other fasteners) shall be wrapped/sleeved with 3-part cold-applied wax tape system meeting the requirements of AWWA C217. Prior to installation of wax tape, all damage to factory-applied coatings on the steel and/or iron appurtenant pipeline elements shall be repaired with a like coating system, in accordance with the manufacturer's requirements and as directed by the District. Also, a non-drying petrolatum grease type corrosion inhibitor shall be applied to all bolts, nuts, and other fasteners prior to installing wax tape encasement.

## 3.7. Interior Pipe Joint Inspection

### 3.7.1 General

Contractor shall furnish all equipment, labor, and material for performing interior pipe joint inspection. All mortar-lined pipe shall be inspected. Video inspection of appurtenances will not be required.

### 3.7.2 Video Inspection

For pipeline sizes 24-inch and smaller, the Contractor shall provide closed circuit television inspection (CCTV) as a post-construction method to determine if the pipeline has been installed as required and all interior pipe joints have been properly finished. CCTV system shall have a rotating lens camera with articulating head. Each joint will be scanned 360 degrees. The television camera shall be specifically designed and constructed for water pipe inspection. The camera shall be operative in 100 percent humidity conditions. Lighting for the camera shall minimize relative glare. Lighting and camera quality shall be suitable to provide a clear, in focus picture of the entire periphery of the water pipe for all conditions encountered during the

work. Focal distance shall be adjustable through a range of 6-inch to infinity. The remote reading footage counter shall be accurate to 1 percent over the length of the particular section being inspected. The camera, television monitor, and other components of the color video system shall be capable of producing a minimum of 350 line resolution. Documentation consisting of a color video tape and a written report detailing the condition of the mainline and joints shall be submitted to the District for approval prior to pressure testing.

Any defects in the pipe lining or joints, shall be repaired and another video taken of the repaired section and submitted for approval by the District prior to pressure testing. **For domestic water systems, all video equipment must be certified for DOMESTIC WATER LINE INSPECTION ONLY, and NEVER to have been utilized in a non-potable system.**

### 3.8 Testing

#### 3.8.1 General

Contractor shall furnish all equipment, labor, and material, exclusive of water, for testing and disinfecting the pipelines. Water used for testing will be furnished by Owner, but Contractor shall provide the necessary means to deliver water from the nearest available connection to the points of use. All tests of pressure piping shall be made in the presence of the Owner. All pipelines shall be thoroughly flushed with water prior to testing. Contractor shall test the pipelines in sections after backfilling operations are completed and prior to placement of permanent surfacing. Permanent surfacing at intersections may be done prior to testing.

#### 3.8.2 Filling

Cement mortar-lined pipe shall not be filled with water until a minimum period of eight (8) hours has elapsed after the last joint in any section has been made and the pipeline shall not be tested before the mortar lining and coating on all pipe lengths have attained an age of fourteen (14) days. The pipeline shall be isolated by placing temporary bulkheads in the pipe at the point of connection to the existing system. The pipeline shall slowly be filled with water. All air valves shall be open during the filling. After the line, or section thereof, has been completely filled, it shall be allowed to stand under a slight pressure for a minimum of forty-eight (48) hours to allow the mortar lining to absorb water and to allow the escape of air. During this period, bulkheads, valves, and connections shall be examined for leaks. If any are found, they shall be stopped or in case of leakage through valves in the main line or through bulkheads, provisions shall be made for measuring such leakage during the test.

### 3.8.3 Testing

The test shall consist of holding the test pressure on each section of line for a period of four hours. The test pressure at the lowest point in the line, or section of line, shall be 10 percent higher than the minimum pipeline design pressure. The water necessary to maintain this pressure shall be measured through a meter or by other means satisfactory to Owner. The leakage shall be considered the amount of water entering the pipeline during the test, less the measured leakage through valves and bulkheads. For PVC pipe, the leakage shall not exceed the quantity specified in AWWA Manual No. M23. For cement mortar-lined pipe, there shall be no water loss in 24 hours.

Any noticeable leaks shall be stopped and any defective pipe or equipment shall be replaced with new pipe or equipment until the leakage is reduced to the specified quantity. After the pipe has met all test requirements specified herein, the entire pipeline shall be filled with water and so maintained until the completion of the contract, unless otherwise ordered by Owner.

## 3.9 Disinfection of Pipelines and Neutralization of Testing Water Solution

### 3.9.1 General

Contractor shall furnish all equipment, labor, and materials for the proper disinfection of all pipelines and appurtenances and for the proper neutralization of the test water solution. Contractor may disinfect pipelines and appurtenances either before or after they are subjected to hydrostatic and leakage tests and Contractor shall be completely responsible for providing an adequately disinfected pipeline before it shall be accepted. If Contractor elects to disinfect before hydrostatic and leakage tests, he shall be required to again disinfect all or portions of tested pipeline if repairs or replacements are found necessary after said tests. Upon completion of the disinfection process, the Contractor shall neutralize the test water solution prior to its disposal.

### 3.9.2 Disinfection of Pipelines and Appurtenances

All new and repaired water mains shall be disinfected and sampled for bacteriological quality, per AWWA Standard C651 (latest). The following methods in Sections 3.9.2.1 and 3.9.2.2 are acceptable. Variations from these methods must be approved by the Water Quality Department of the District.

When mains are wholly or partially dewatered, the following procedures shall be implemented. If all the procedures have been correctly implemented, the existing mains may be placed back into service prior to completion of bacteriological testing in order to minimize the time customers are out of service. The main shall be valved in such a way as to create a dead end and shall remain so until results from the bacteriological sampling indicate the absence of coliform bacteria and heterotrophic plate counts (HPC) are less than 500 CFU/mL.

Following disinfection, new pipelines and appurtenances shall remain isolated from any operational water system facilities until evidence has been submitted to Owner demonstrating that said pipelines and appurtenances have been adequately and properly disinfected. Said evidence shall consist of the aforementioned Affidavits of Compliance together with said bacteriological test results. Normally, said pipelines and appurtenances shall be isolated for at least forty-eight (48) hours or longer, if so determined by the Owner.

Disinfection and dechlorination shall be at the sole expense of the Contractor. Chlorine residual and bacteriological analysis tests shall be arranged with the District and paid for by the District. If the initial tests fail, the Contractor shall pay for all additional tests.

- 3.9.2.1 If construction on new and existing mains is less than ten (10) feet and it can be determined that no foreign material has entered the pipeline:
1. The interior of all pipes, fittings, and the ends of the exposed main shall be swabbed or sprayed with 1 percent hypochlorite solution.
  2. Thoroughly flush pipelines to eliminate possible contamination. Flushing velocity in the main should be at least 3.0 ft/sec., and whenever feasible, flushing shall occur toward the work location from both directions. Flushing should begin upon completion of repairs and should continue until discolored water is eliminated and the chlorine residual inside the construction area matches that the residual of adjacent pipelines.
  3. The existing main may be placed back into service and shall be valved in such a way as to create a dead end and shall remain so until results from the bacteriological sampling indicates the absence of coliform bacteria, E. coli, and HPC are less than 500 CFU/mL.

### 3.9.2.2

If construction on new and existing mains is greater than ten (10) feet, or it is suspected or confirmed that foreign material has entered the pipeline:

1. The main shall be isolated and all meter services shut off.
2. Upon completion of construction, thoroughly flush pipelines to eliminate possible contamination. Flushing velocity in the main should be at least 3.0 ft/sec. and it is preferred that flushing occur toward the work location from both directions. Flushing should continue until discolored water is eliminated.
3. At a point upstream from the beginning of the repair, inject chlorinated water with a dose of 100 mg/L of free chlorine.
4. Chlorine shall be applied continuously and for sufficient period to develop a solid column of chlorinated water to achieve an exposure of 100 mg/L for at least three (3) hours.
5. The free chlorine residual shall be monitored in the slug as it moves through the main. If at any time it drops below 50 mg/L, flow shall be stopped and chlorine shall be applied to restore the free chlorine in the slug to not less than 100 mg/L [the dose may be increased to as much as 300 mg/L and contact time reduced to fifteen (15) minutes].
6. All valves and hydrants in the treated section shall be operated to ensure disinfection of appurtenances.
7. Flush the main using proper de-chlorinating equipment to eliminate heavily chlorinated water; flush from all fittings, valves, and branches. The chlorine residual shall be checked outside the work area and the flushing shall continue until the residual in the new section matches that outside the work area. The water shall be de-chlorinated, in accordance with Section 3.9.3.
8. The main may be placed back into service and shall be valved in such a way as to create a dead end and shall remain so valved until results from the bacteriological sampling indicate the absence of coliform bacteria, E. coli, and HPC are less than 500 CFU/mL.
9. Bacteriological samples shall be collected a minimum of fifteen (15) minutes apart after a sixteen (16) hour rest period and at least every 1,200 feet, or (1) upstream and (1) downstream of the repair site.

### 3.9.3

#### De-Chlorination During Flushing Operation

Upon acceptance of completed chlorine residual and bacteriological analysis testing, the Contractor shall flush the entire waterline system. Chlorinated water shall not be allowed to enter any drainage area until it is completely de-chlorinated which may require temporary impoundment. Chlorinated flush water shall be treated with one (1) of the chemicals listed in AWWA Section C655 (latest). Upon neutralization, the water can be disposed of as approved by the District's representative.

### **3.10 Connection to Existing Facilities**

Following the completion of pipeline pressure testing, disinfection, and acceptance by Owner, the Contractor shall connect the new facilities into the existing facilities. The connections shall be made by a "hot-tap" into the existing facilities, or by a system shutdown and connecting into a "dry" facility.

#### **3.10.1 Hot-tap Connection**

If shown on the design plans, the Contractor will be allowed to "hot-tap" connect into the fully pressurized District facility. "Hot-tap" connections will be allowed on PVC, ACP, and CML&C Steel Cylinder pipes with a maximum branch pipe diameter to trunk pipe diameter ratio of 75 percent. No "hot-tap" connections will be allowed on pre-tensioned, rod wrapped steel pipe. Approved, tees, tapping saddles, pipe flanged nipples, valves, etc. shall be in place prior to the "hot-tap" connection. The minimum distance between tapping locations is two (2) feet for connections two (2) inches in diameter and less with connections being made alternating between fifteen (15) and thirty (30) degrees above the horizontal plane. Connections greater than two (2) inches shall have a minimum separation of five (5) feet.. The Contractor or his subcontractor performing the "hot-tap" connection shall have a minimum five (5) years experience in making these types of connections. The tapping machine shall be in good working condition and all bits and cutters shall be sharpened prior to the "hot-tap". The Contractor shall supply all labor, materials, and equipment necessary to connect to the existing system including pumps, lights, barricades, and any other equipment required to complete the connection in a safe and timely manner.

#### **3.10.2 System Shutdown Connection**

Before a shutdown will be scheduled, all material required to complete the work being performed shall be on site prior to requesting shutdown. The Contractor shall supply the Owner with a 3-week written notice requesting a system shutdown according to the Plans and Specifications. All connections or tie-ins to the existing facilities requiring system shutdown and draining of the existing facilities shall be done at night or as approved by Owner. The Owner shall operate all valves required to shut the system down to drain the Owner's facilities. The Contractor is responsible to drain and de-water the existing pipeline after the Owner has shut the system down prior to making the tie-in. The Contractor shall supply all labor, materials, and equipment necessary to connect to the existing system including pumps, lights, barricades, and any other equipment required to complete the connection in a safe and timely manner. The Contractor shall be solely responsible for obtaining all de-watering permits and the cleanup associated with the de-watering operation. For PVC pipe, cut in tees are to be installed at a minimum distance of three (3) times the pipe diameter or 48 inches (whichever is longer) from the nearest adjacent pipe joint.

The Contractor shall disinfect the pipe, in accordance with Section 3.7.2 and shall assure adequate flushing has been conducted after completion of connection.

### **3.11 Conductor Casings and Carrier Pipes**

Wherever conductor casings are required, said casings shall be comprised of either welded steel cylinder pipe or reinforced concrete pipe, as specified. Conductor casing shall be bored, jacked, or bored and jacked into place, unless open trench installation is permitted; it shall not be sluiced or jetted into place. Conductor casing shall be bored or jacked into place from one direction only.

Conductor casing shall be installed to the lines, grades, and depths as specified. Contractor will be permitted a tolerance from exact grade of 1 percent or from exact alignment of 0.1 percent, unless specified otherwise. Unless specified otherwise, the methods and equipment used shall be as selected by Contractor and as approved by Owner. Said approval shall not relieve Contractor of any responsibility with regard to conductor casing construction. Conductor casing shall have an inside diameter at least 12 inches larger than outside diameter of carrier pipe.

Prior to any boring, jacking, or boring and jacking operations, Contractor shall submit to Owner a construction plan consisting of a schedule of operations, details of methods of construction, types of equipment to be used, details of boring or jacking pit including lengths, widths, and depths, and shoring and bracing required. Said construction plan shall be approved by Owner before any construction is commenced.

Contractor shall take all necessary precautions to prevent subsidence of or lifting of existing roadbeds, roadways, and pavements there on. Material excavated during boring, jacking, or boring and jacking operations shall be removed carefully so as to prevent caving. Voids created during construction shall be backpacted promptly to the extent practicable with soil cement or grout which shall consist of a slightly moistened mixture of one (1) part cement to five (5) parts granular material, unless specified otherwise.

After conductor casing has been constructed, casing spacers shall be placed around the carrier pipe according to manufacturer's specifications and then installed in conductor casing, in accordance with aforementioned construction plan as approved by Owner. The annulus between conductor casing and carrier pipe shall not be filled with sand, unless specified otherwise. Contractor shall install rubber end seals at each end of the conductor casing to prevent intrusion of water into the casing.

Contractor shall backfill boring or jacking pit with material specified for pipeline backfill. Said backfill material shall be compacted to the relative compaction specified which shall be not less than 90 percent. Contractor shall remove conductor casing and carrier pipe remnants, shoring materials, asphalt, concrete, and all other work-related debris. Contractor shall restore paved surfaces, unless directed otherwise.