SECTION 6

WATER MAIN CONSTRUCTION

CONSTRUCTION METHODS

1. SCOPE: This section shall include furnishing all labor, tools, equipment and other incidentals required for the construction of the water distribution system as shown on the drawings and as specified herein.

The work shall include laying pipe and setting fittings, valves, hydrants, and services, pressure testing and sterilization of the water distribution system.

Materials shall be as specified in previous sections of these specifications.

2. PIPE AND FITTINGS: Pipe and fittings shall be laid as directed by the District, and located as shown on the drawings.

A. Trenching: Trenches shall be excavated by open cut to the line and grade given by the Engineer. Vertical cuts shall be used whenever possible, but in unstable soils, trenches may be sloped from the top of the excavation to a point 3.0 feet above the top of the pipe with the width of the trench from this depth to the bottom of the ditch governed by 1' below. The bottom 4" of the excavation shall be excavated by hand. Bell holes shall be excavated by hand to insure that the pipe is properly supported for its entire length.

1. Trench Width: The maximum width of the trench shall be 24" plus the outside diameter of the pipe. This width shall also apply to sloped trenches for the last 3' above the top of the proposed pipe.

2. Excavated Material: Material excavated from the ditch shall be placed (whenever possible) in piles along the side of the trench. When it is necessary to stockpile excavated material, it shall be the Contractor' s responsibility to secure the stockpile areas. No excavated material shall be placed on private property without the consent of the property Owner.

3. Whenever the bottom of the trench is unstable and does not afford a good foundation, the Contractor shall remove such part as may be necessary and replace with suitable material from the surface to make a good foundation.

4. Under exceptional conditions where ground water and unstable soil are such that it is not possible to obtain a suitable foundation with material on the trench bank, the Engineer will determine the method to be followed.

5. Any unauthorized excavation below the pipe or structure shall be filled with sand, gravel, or concrete.

6. Pumping and well pointing shall be required if necessary.

B. Back-filling: Back-filling shall progress as rapidly as the pipe laying and testing permits. The trench shall be backfilled with approved material free from large clods, or stone, or other debris. The initial backfill shall be carefully placed on both sides of the pipe at the same time and thoroughly tamped around the barrel of the pipe until enough material has been placed to provide 2' of cover above the top of the pipe. The remainder of the backfill shall be placed in well compacted, one foot layers using approved mechanical tampers. In no case shall the backfill material be placed in unequal layers on one side of the pipe that might cause pipe displacement. In existing streets, roads or alleys, and under proposed pre-packaged water booster pump stations, the backfill shall be compacted to a density of 95% as determined by ASTM A-698 or AASHTO Method T-99 using approved mechanical tampers in 6" layers to the top of the trench. All other areas shall be compacted to a density of 90% as determined above. The District shall receive a copy of all compaction tests completed by an approved testing company. The top elevation of the trench shall be graded to the original grade that existed before excavation. In no case shall material such as old pavement, curbs, bricks or blocks be placed in the backfill.

1. De-watering: De-watering, when required, shall be continued during construction including the pipe laying and the backfilling process. Adequate equipment shall be used and maintained by the Contractor to insure a dry trench.

2. Sheeting: When sheeting is removed from the backfill, all cavities shall be properly filled.

C. Pipe Laying: Water pipe shall be laid in conformance with the standards set forth by AWWAC-600, latest revision. All water pipe shall be laid by experienced workers with straight lines, even grades, and all joints shall be perfectly fitted. All pipe fittings, valves, hydrants, and accessories shall be carefully lowered into the trench with suitable equipment in a manner that will prevent damage to pipe and fittings. Under no circumstances shall pipe or accessories be dropped or dumped into the trench. Pipe and accessories shall be inspected for defects prior to their being lowered into the trench. Any defective, damaged or unsound material shall be repaired or replaced as directed by the District. All foreign matter or dirt shall be removed from the interior and machined ends of pipe and accessories before it is lowered into position in the trench. Pipe shall be kept clean by means approved by the District, during and after laying. All water mains and services will have District approved 12 gauge coated tracing wire duct taped to the top of all in the trench. The tracer wire shall be extended into and to the top of all valve boxes, air release valve boxes, or any other structure the District requests.

1. Jointing Mechanical Joint Pipe:

(a) Joining Existing Bell and Spigot to New Mechanical Joint: Due to the difficulty that may be encountered in attempts to make such a connection of this type, an adapter having a fitting bell and a M.J. socket may be used by the Contractor.

(b) Cleaning and Assembling Joints: Clean last 8" outside the spigot, and the inside of the bell of mechanical joint pipe to remove oil, grit, tar (other than standard coating) and other foreign matter from the joint and then paint area clean with an approved non-toxic vegetable soap. The ductile iron gland shall then be slipped on the spigot end of the pipe with the extension of the gland toward the socket or bell end. The rubber gasket shall be painted with the soap solution and placed on the spigot end with thick edge toward the gland.

(c) Bolting of Joints: Push entire section of pipe forward to seat spigot end in the bell. Press gasket into place within the bell, being careful to have the gasket evenly located around the entire joint. Move ductile iron gland along the pipe into position for bolting, insert all bolts, and screw nuts up tightly with fingers. Tighten all nuts with a suitable (preferably torque-limiting) wrench. Tighten nuts that are spaced 180 degrees apart alternately in order to produce equal pressure on all parts of the gland.

2. Jointing Rubber Gasket Pipe (Bell Tite, Tyton, or Equivalent):

(a) Cleaning Joint and Gasket: Clean gasket and spigot and inside of bell thoroughly to remove all dirt and other foreign matter.

(b) Inserting Gasket: Insert gasket furnished by the pipe manufacturer into the gasket seat in the bell. Gasket shall be properly seated in the grooves provided in the pipe bell.

(c) Lubricating Gasket and Pipe Spigot: Using a non-toxic vegetable soap, apply a film by hand to the inside surface of the gasket that comes into contact with the entering pipe and to the first 1" of the spigot end of the entering pipe. Use only lubricant specified by the pipe manufacturer.

(d) Final Assembling of Joint: Align entering pipe with the bell to which it is to be joined. Enter the spigot end into the bell until it just makes contact with the gasket. Apply sufficient pressure to force the spigot end past the gasket as required by the pipe manufacturer.

(e) Field Cutting Pipe: When it is necessary to field cut pipe with rubber gaskets, chamfer the cut end 1/8 inch x 30 degrees before inserting into a rubber gasket bell.

(f) Fittings: Fittings shall be installed where and as shown on the plans or as directed by the Engineer. All bends (1/16 to 1/4), y-branches, plugs and all other fittings requiring such shall be sufficiently backed, blocked, or braced to preclude the possibility of their blowing off the main.

3. HDPE – Guided Boring Installation:

A. Scope: This section includes the installation of the water main by guided boring, including connecting to the new water main. The Contractor will furnish all labor, components, materials, tools and appurtenances necessary or proper for the performance and completion of the contract unless agreed upon before hand.

B. General Description of Method: Guided boring is a method of trenchless construction using a surface launched steerable drilling tool controlled from a mobile drilling frame, and includes a field power unit, mud mixing system and mobile spoils extraction system. The drilling frame is sited and aligned to bore a pilot borehole that conforms to the planned installation of the main. The drilling frame is set back from an access pit that has been dug (typically at the location of the proposed water main or other appurtenance) and a high-pressure fluidjet toolhead that uses a mixture of bentonite clay and water is launched. Pits are normally dug at the start point and endpoint of the proposed pipe installation and are used to align the toolhead, attach other equipment, and to collect and remove excess spoils. Using an electronic guidance system, the toolhead is guided through the soil to create a pilot borehole. Upon reaching the endpoint joint, the toolhead is removed and a reamer with the product pipe attached is joined to the drill string and pulled back through the borehole. In large diameter installations, pre-reaming of the borehole will usually be done prior to attaching the product pipe for the final pullback. A vacuum spoils extraction system removes any excess spoils generated during the installation. The connections, manholes or other appurtenances are then completed at both the start point and endpoint locations and the surface restored to its original condition.

C. Qualifications:

1. Guided boring contractors will have actively engaged in the installation of pipe using guided boring for a minimum of three years.

2. Field supervisory personnel employed by the Guided Boring Contractor will have at least three years experience in the performance of the work and tasks as stated in the contract document.

D. Submittals:

1. Submit documentation showing three years of guided boring experience. Information must include; but not be limited to, date and duration of work, location, pipe information (i.e., length, diameter, depth of installation, pipe material, etc.), project owner information, (i.e., name, address, telephone number, contact person), and the contents handled by the pipeline (water, wastewater, etc.).

2. Submit a list of field supervisory personnel and their experience with guided boring operations. At least one of the field supervisors listed must be at the site and be responsible for all work at all times when guided boring operations are in progress. Guided boring operations will not proceed until the resume(s) of the Contractor's field supervisory personnel have been received and reviewed by the Project Engineer.

3. Submit the following drawings and documents:

a. Working drawings and written procedure describing in detail the proposed method of installation. This will include; but not be limited to, size, capacity and setup requirements of equipment; location and siting of drilling and receiving pits; dewatering if applicable; method of fusion and type of equipment for joining pipe; type of cutting tool head; and method of monitoring and controlling line and depth. If the Contractor determines that modifications to the method and equipment as stated in the submittal is necessary during construction, the Contractor will submit a plan describing such modifications, including the reasons for the modification.

b. Bentonite drilling mud products information (MSDS); special precautions necessary; method of mixing and application; and method of removing spoils.

E. Site Conditions:

1. Drilling operations must not interfere with, interrupt or endanger surface and activity upon the surface.

2. Contractor must comply with all applicable jurisdictional codes and OSHA requirements.

3. The Contractor shall conduct pre-bid and pre-drill investigations of each individual site and make a determination as to the existing conditions.

4. When rock stratum, boulders, underground obstructions, or other soil conditions that impede the progress of drilling operations are encountered, the Contractor shall change from a conventional drilling bit to one suitable for drilling in rock formations. This change in equipment shall be at no additional cost to the District.

4. HDPE – Drilling Fluid:

A. Drilling fluid shall be a mixture of water and bentonite clay. The fluid will be inert. The fluid should remain in the tunnel to ensure the stability of the tunnel, reduce drag on the pulled pipe, and provide backfill with the annulus of the pipe and tunnel.

B. Disposal of excess drilling fluid and spoils shall be the responsibility of the Contractor who must comply with all relevant regulations, right-of-way, work space and permit agreements. Excess drilling fluid and spoils will be disposed at an approved location.

C. The Contractor is responsible for transporting all excess drilling fluid and spoils to the disposal site and paying any disposal costs. Excess drilling fluid and spoils will be transported in a manner that prevents accidental spillage onto roadways. Excess drilling fluid and spoils will not be discharged into sanitary or storm drain systems, ditches or waterways.

D. Drilling fluid returns (caused by fracturing of formations) at locations other than the entry and exit points will be minimized. The Contractor will immediately clean up any drilling fluid which surfaces through fracturing.

E. Mobile spoils removal equipment capable of quickly removing spoils from entry or exit pits and areas with returns caused by fracturing shall be present during drilling operations to fulfill the requirements of paragraphs b and c above.

F. The Contractor shall be responsible for making provisions for a clean water supply for the mixing of drilling fluid.

5. HDPE –Installation:

A. General:

1. The Engineer shall be notified immediately if any obstruction is encountered that stops the forward progress of drilling operations.

2. The type of dewatering method will be at the option of the Contractor. However, the dewatering of pits and excavations must meet all requirements of the general conditions, special provisions, and specifications. When water is encountered, the Contractor must provide a dewatering system of sufficient capacity to remove water, keeping any excavations free of water until the backfill operation is in progress. Dewatering shall be performed in a manner that removal of soil particles is held to a minimum.

B. Preparation:

1. Excavate required pits in accordance with the working drawings.

2. The drilling procedures and equipment shall provide protection of workers, particularly against electrical shock. As a minimum, grounding mats, grounded equipment, hot boots, hot gloves, safety glasses and hard hats shall be used by crew members. The drilling equipment shall have an audible alarm system capable of detecting electrical current.

3. Removal of trees, landscaping, pavement or concrete shall be performed as specified.

C. Guided Boring Operations:

1. Equipment.

a. The drilling equipment must be capable of placing the pipe within the limits indicated on the contract plans.

b. Guided boring equipment shall consist of a surface launched steerable drilling tool controlled from a mobile drilling frame, and include a field power unit, mud mixing system and mobile spoils extraction system.

c. The number of access pits shall be kept to a minimum and the equipment must be capable of boring the following lengths in a single bore. The guided boring system will have the capability of boring and installing a continuous run without intermediate pits of a minimum distance for the following pipe diameters:

Product Pipe Size	Minimum Boring Distance
1 – 1 ½ inches	500 feet
2 – 4 inches	450 feet
6 inches	400 feet
8 inches	350 feet
10 – 16 inches	300 feet

d. The guidance system shall have the capability of measuring vertical (depth) position, horizontal position and roll. The guidance system must meet the following specifications in soft homogenous soils:

	Accuracy		
Vertical position:	± 1 inch at	18-96	inches of depth
	± 2 inches at	97-144	inches of depth
	± 4 inches at	145-180	inches of depth
	± 6 inches at	181-300	inches of depth
	± 10 inches at	301-480	inches of depth
Horizontal position:	± 2 inches at	18-96	inches of depth
	± 4 inches at	97-144	inches of depth
	± 6 inches at	145-180	inches of depth
	± 12 inches at	181-300	inches of depth
	± 24 inches at	301-480	inches of depth

e. Equipment set-up requirements shall be prepared by the Contractor and submitted to the Engineer per the requirements as stated under "Submittals."

f. Required Safety Equipment: **During drilling operations all equipment shall be effectively grounded and incorporate a system that protects operating personnel from electrical hazards. The system shall be equipped with an audible alarm that can sense if contact is made with an energized electric cable. Proper operation of the alarm system will be confirmed prior to the drilling of each tunnel. All equipment will be connected to ground with a copper conductor capable of handling the maximum anticipated fault current. Crew members operating drilling equipment and handling rods will do so while standing on grounded wire mesh mats, ensuring that all equipment is grounded, and wearing hot boots, hot gloves, safety glasses and hard hats. Crew members operating handheld locating equipment will wear hot boots.**

g. Equipment set-up requirements and locations shall be determined by the Contractor and submitted to the Engineer per the requirements as stated under "Submittals."

2. Pilot Hole Boring.

a. The entry angle of the pilot hole and the boring process will maintain a curvature that does not exceed the allowable bending radii of the product pipe.

b. Alignment Adjustments and Restarts.

(1) The Contractor shall follow the pipeline alignment as shown on the Drawings, within the specifications stated. If adjustments are required, the Contractor shall notify the Engineer for approval prior to making the adjustments.

3. Installing Product Pipe

a. After the pilot hole is completed, the Contractor shall install a swivel to the reamer and commence pullback operations. Pre-reaming of the tunnel may be necessary and is at the option of the Contractor.

b. Reaming diameter will not exceed 1.5 times the diameter of the product pipe being installed.

c. The product pipe being pulled into the tunnel will be protected and supported so that it moves freely and is not damaged by stones and debris on the ground during installation.

d. Pullback forces will not exceed the allowable pulling forces for the product pipe.

e. The Contractor shall allow sufficient lengths of product pipe to extend past the termination point to allow connections to the diffuser assembly. Pulled pipe will be allowed 24 hours of stabilization prior to making tie-ins. The length of extra product pipe will be at the Contractor's discretion.

4. Clean-up: The Contractor shall maintain the work site in a neat and orderly condition throughout the period of work and after completing the work at each site, remove debris, surplus material and temporary structures erected by the Contractor. The site shall be restored to a condition equal to the existing condition prior to being disturbed.

6. FIRE HYDRANTS AND VALVES: Fire hydrants and valves shall be set as directed by the Engineer and located as shown on the drawings. The District and/or the Engineer may require concrete blocking behind all fire hydrants and valves.

A. Fire Hydrants: Fire hydrants shall be set where shown on the plans or as directed by the Engineer and/or District. The hydrants shall be set upon a bed of compacted crushed stone at least thirty (30) inches square by ten (10) inches in depth. There shall be furnished and installed concrete blocking and an approved ductile iron hydrant tee with approved megalugs or a gradelock to securely anchor the hydrant to the main line as shown on the detail contained in these specifications. The cost for the approved megalugs or gradelock and concrete blocking shall be included in the unit price for hydrants. When the hydrant is backfilled, crushed stone or gravel shall be placed around the hydrant to a point just above the weep holes of the hydrant.

B. Valves: Valves shall be set and anchored with steel bars and concrete as shown on the detail sheet contained in these specifications. All valves set by the Contractor shall include a cast iron or ductile iron valve box set to grade or as directed by the District. All valves boxes shall have a concrete protector ring installed around the box with a concrete marker pole installed with the letters "MV" pointing towards the valve location.

7. CONNECTIONS TO EXISTING MAINS: Only District personnel shall make connection to the existing water mains when and as directed by the District Inspector at the contractor's expense. In no case shall the Contractor shut off the water or operate the fire hydrants or gate valves of the existing distribution system without the expressed permission of the District Inspector. In case it becomes necessary to delay the cut-off, such instructions shall be given and obeyed without recourse.

In making connections to the old distribution system, valves shall be set as shown on the plan, or at such designated place as the Engineer may direct. If due to unforeseen conditions, these locations have to be changed or additional valves or fittings added, the Contractor shall install the valves or fittings at the new locations.

8. CONCRETE BLOCKING: All turns, fittings, fire hydrant connections, etc., that induce pressure which would cause separation of pipe, breakage, etc., shall be blocked with 3,000 lb. concrete. Blocking shall be formed and placed in such a manner that the pressure to be exerted at the point of blocking shall be transferred to firm, undisturbed earth at a maximum load of 2,000 lbs, per square foot. The Contractor shall insure that blocking at all tees, bends, plugs, etc., shall be sufficient to contain all pressure exerted by the pipe up to a pressure of 200 lbs. per square inch hydraulic pressure within the pipe, i.e. pressure at plug = 200 x (area of pipe in inches). The Contractor shall also be responsible for any damage or repairs caused by blowouts of any

insufficiently blocked pipe. The contractor shall wrap all fittings, fire hydrant connections, etc. with District approved plastic wrap before any and all concrete pouring is started.

9. PRESSURE TESTING: Hydrostatic pressure testing shall conform with AWWA C-600, latest revision. Pressure testing shall be performed on all pipe, valves, hydrants, and fittings. The test shall be conducted on line segments from shut valve to shut valve in segments not exceeding 5,000 linear feet. The Contractor shall provide a suitable pump for applying pressure and an accurate gauge for measuring the pressure.

The pipe shall be tested by applying one hundred fifty (150) pounds per square inch hydrostatic pressure or 50 lbs. over working pressure whichever is greater for a period of two (2) hours with the District inspector present and to the full satisfaction of the Engineer. Leakage shall not exceed 10 gallons per inch of pipe diameter per mile of pipe per 24 hours.

CONDUCTING A LEAK DETECTION SURVEY
Leak Losses for Circular Holes Under Different Pressures

Diameter of Hole in.	Area of Hole in.	Leak Losses- GPM									
		Water Pressure-psi									
		20	40	60	80	100	130	140	160	180	200
0.1	0.007	1.067	1.610	1.860	2.136	2.338	2.616	2.825	3.031	3.204	3.337
0.2	0.031	4.271	6.041	7.399	8.544	8.622	10.464	11.309	12.082	12.816	13.609
0.3	0.070	9.611	13.698	16.848	19.029	21.275	28.644	25.430	27.186	28.544	30.088
0.4	0.125	17.087	24.168	28.597	54.175	37.992	41.856	46.209	48.821	51.288	54.036
0.5	0.195	26.699	37.768	46.245	53.399	69.709	65.400	70.840	75.518	80.098	84.431
0.6	0.288	58.477	54.372	67.803	76.884	85.941	94.176	101.721	108.746	115.341	121.681
0.7	0.364	52.831	74.007	90.640	98.953	117.010	128.184	130.902	148.014	156.998	165.486
0.8	0.508	68.350	96.669	118.287	136.701	152.840	167.424	180.888	188.825	205.052	218.144
0.9	0.636	86.506	122.388	149.888	178.012	193.684	211.898	288.874	344.075	259.519	373.357
1.0	0.785	108.786	181.035	184.979	212.895	288.807	261.600	282.561	308.070	320.394	337.795
1.1	0.980	133.206	182.732	223.825	238.461	258.461	288.357	318.636	376.763	387.676	408.647
1.2	1.181	153.789	217.490	278.040	321.053	358.950	409.266	424.714	454.038	481.581	507.631
1.3	1.327	180.372	255.248	312.615	360.977	403.325	442.104	477.527	510.495	542.468	570.755
1.4	1.538	208.324	295.028	362.088	411.649	467.455	512.787	558.819	592.037	537.972	661.081
1.5	1.767	240.179	339.663	416.001	480.357	537.057	612.339	635.453	679.328	720.536	759.513
1.6	2.011	273.343	386.566	473.445	546.688	611.218	696.895	723.201	773.134	820.033	864.392
1.7	2.270	308.547	436.353	534.421	617.097	689.938	786.650	816.344	872.708	925.646	975.718
1.8	2.545	345.926	489.215	599.164	691.855	773.520	881.949	915.240	978.432	1037.784	1093.92
1.9	2.886	392.276	554.764	679.445	784.556	877.163	1000.120	1037.871	1109.531	1176.835	1240.495
2.0	3.142	424.626	603.974	739.714	854.149	954.971	1088.451	1129.935	1207.951	1281.225	1350.532

Calculation Method

This is the simplest method to perform in the field, but it requires calculations. This method is often helpful for large leaks where the flow is too great to measure and the main must be valved off. It requires that the size and shape of the hole be measured and that the line pressure be determined. A pressure gauge or a hand-held blade pitometer could be tested to determine the pressure of the water coming from the leak or a nearby fire hydrant. This method also uses some assumptions regarding the shape of the hole, which may introduce error.

For losses from such items as pipes or broken taps, assume an orifice coefficient of 0.80 and calculate flow in gallons per minute from the formula:

$$Q = (43{,}767/1440) \times A \times \sqrt{P}$$

Where:

Q = flow, in gallons per minute
A = the cross sectional area of the leak in square inches
P = pressure, in pounds per square inch

If a hole in a pipe was circular, then the area would be $A = 3.14 \sqrt{}^2$. You would measure the diameter of the hole (to get the radius) and ascertain the pressure in the pipe.

For relatively small holes, the leak rates were calculated, assuming a circular hole and several pressures. Tables 4-1 and 4-2 show the calculated leak rates for typical meter box leaks. Table 4-3 covers circular leaks, and Table 4-4 (see page 58) covers joints and cracks.

10. FLUSHING: The pipe segment shall be flushed by means of a fire hydrant, a post hydrant or a flush point for the purpose of removing debris from the pipe. The pipe shall be flushed at a velocity of 2.5 feet per second. All flushing shall be metered with a District approved and/or supplied meter. Contractor should coordinate with the District Inspector concerning any and all flushing so as to allow District Inspector to be present and issue any approval and regulation for flushing.

11. BLOW-OFF ASSEMBLY: A blow-off assembly may be required for all water mains under (6) inches in diameter. A blow-off assembly shall consist of a 2" or 2 ½" valve, a 90 degree elbow the same size as the valve, and a 2" or 2 ½" female adapter stubbed up for connection to a District approved stand pipe. The valve, 90 degree elbow, and female adapter shall be installed in a District approved concrete meter box. All blow-off assemblies shall have a concrete marker pole at each blow-off assembly. All blow-off assemblies shall be adequately blocked.

12. DISINFECTION: Disinfection of all new water mains shall be in accordance with current American Water Works Association (AWWA) Standard C651 for the disinfection of water mains. In general one approved method referred to as "continuous feed method" is as follows: Before being placed in service, all new mains shall be thoroughly flushed then chlorinated with not less than twenty-five (25) milligrams per liter of available chlorine. Water from the existing distribution system or other source of supply shall be controlled so as to flow slowly into the newly laid pipeline during the application of chlorine. The solution shall be retained in the pipeline for not less than twenty-four (24) hours and then flushed thoroughly with a potable water of satisfactory bacteriological quality before starting the sampling program. The District Inspector shall be present when all disinfection shall take place.

The contractor shall collect a minimum of two (2) samples from each sampling site for total coliform analysis. The number of sites depends on the amount of new construction but must include all dead-end lines and be representative of the water in the newly constructed mains. Prior to sampling, the chlorine residual must be reduced to South Carolina Department of Health and Environmental Control current regulations. These samples must be collected at least twenty-four

(24) hours apart and must show the water line to be absent of total coliform bacteria. The chlorine residual must also be measured and reported. If the membrane filter method of analysis is used for the coliform analysis, non-coliform growth must be reported. All samples must be analyzed by a certified laboratory at the contractor's expense with the District to receive a copy of all approved samples. DHEC may request that heterotrophic plate count analyses be conducted on a case-by-case basis where disinfection problems are suspected. If the presence of coliform bacteria is detected in the water samples, the section of pipe shall be disinfected and additional samples shall be taken.

The contractor shall provide a means by which the water used during the disinfection process can be de-chlorinated to a residual of less than 2 ppm prior to discharging into wetlands or other sensitive areas. The method for de-chlorination shall be submitted for approval.

The sampling location for this test shall be from a tap placed in the top or the pipe in locations approved by the engineer. No hoses or hydrants will be used in collecting samples.

13. METHOD OF MEASUREMENT: The cost of laying pipe including connection of existing mains, pressure testing, sterilization, and bacteriological testing shall be included in the unit price per foot of pipe measured as previously specified. The cost of setting valves, fittings, water services, etc. shall be included in the cost per unit of the respective item measured as specified.

Blocking for fittings shall be measured by the cubic yard of concrete. This item shall include all labor, materials, equipment, and incidentals necessary to properly block all fittings and bends according to the detailed drawings contained herein.