

SECTION 22 - WATER FACILITIES

22-1 SCOPE

These Standards are intended to describe the execution and Workmanship to be used in construction of a water system operated in the City of Madera. It is presumed that the developer or his engineer has prepared such general and special specifications as are necessary to define the nature and location of the Work, contractual arrangements, payment for Work, and any other matters concerning the owner or his Contractor. All street Work permits shall be obtained and fees shall be paid by the developer or Contractor.

22-2 GENERAL

22-2.1 Quality Control of Materials

The quality control of materials shall conform to the applicable sections of the Standard Specifications as published by the City of Madera.

22-2.2 Quality of Workmanship

All Work will be done by persons experienced in the specific Work, under competent supervision and in a first class manner to the Engineer's complete satisfaction. Every precaution shall be taken to prevent foreign material from entering the pipe while it is being placed in the trench. If the pipe-laying crew cannot put the pipe into the trench and in place without getting earth into it, the Engineer may require that before lowering the pipe into the trench a heavy tightly woven burlap bag of suitable size shall be placed over each end and left there until the connection is to be made to the adjacent pipe. During laying operations, no debris, tools, clothing or other materials shall be placed in the pipe. After placing a length of pipe in the trench and completing the jointing operation, in a method approved by the pipe manufacturer, the pipe shall be secured in place with approved backfill material placed under it. At times when pipe laying is not in progress, the open ends of the pipe shall be closed by a watertight plug or other means approved by the Engineer. This provision shall apply during any Work stoppage.

22-2.3 Connections to Existing Facilities

Connections shall be performed by Water Division personnel only. Three (3) days notice shall be given before any connection is to be made.

22-2.4 Defective Work

Any defective materials or Workmanship which shall become evident within one year after the City assumes responsibility for the completed Work shall be replaced or repaired without cost to the City. Refusal of the Contractor to correct defective Work which is his responsibility will be considered just cause for excluding him from performing future Work to be connected to the City's system. Such exclusion does not impair the City's right to bring legal action to correct the deficiencies.

22-2.5 Construction Staking and “Record-Drawings”

Construction stakes will be set parallel to the water main alignment at an offset distance and direction agreed upon with the Contractor but in no case shall construction stakes be offset more than 10 feet. Stakes will be set at no greater interval than 100 feet on straight alignments. For horizontally or vertically curved water mains, the stake intervals shall be 25 feet. For all street water mains, regardless of alignment or slope, the developer’s engineers shall determine “Record-Drawings” elevations at the top of pipe centerline at each change in pipe grade and shall provide a written record of such elevations to the inspector. The developers’ engineer shall also provide “Record-Drawings” of all main line valve locations and all service stop locations.

22-3 INSTALLATION OF PVC PRESSURE PIPE AND FITTINGS

22-3.1 Scope of Work

The Contractor performing the Work under this specification shall furnish all labor tools and equipment, which are necessary to install, complete, and ready for operation, the PVC pressure pipe water mains as herein specified and/or as indicated on the contract drawings.

22-3.2 Installation

Installation shall conform to Chapter 7, Installation, of AWWA Standard C 605 and AWWA Manual M23. Bending of PVC pipe barrels to accomplish horizontal or vertical curves is not permitted.

22-3.3 Tracer Wire

Tracer wire used with PVC **where called for on the plans** shall be bare copper wire, Type TW, Size AWG #10 and shall be placed on top of the PVC water main. Tracer tape is not allowed. All wire to wire connections shall be soldered to provide continuity and taped to prevent entry of moisture. Where tracer wire is called for, it shall be securely attached to each fire hydrant and each main line valve casing.

22-4 DUCTILE IRON PRESSURE PIPE AND FITTINGS INSTALLATION

22-4.1 Scope of Work

The Contractor performing the Work under this specification shall furnish all labor tools and equipment, which are necessary to install, complete, and ready for operation, the ductile iron pressure pipe water mains as herein specified and/or as indicated on the contract drawings.

22-4.2 Installation

Installation shall conform to AWWA C 600 and Installation of Ductile Iron Pipe and Fittings in AWWA Manual M41.

22-5 VALVE CASING AND LID INSTALLATION

When water mains are installed, casings and lids in street areas shall be installed in a lowered position below any sub-grade which may be removed or recompact.

Valves located in the sidewalk shall be marked with a 2" X 4" stake so that casings and lids may be brought to finished grade at the time concrete is poured.

Any excavation necessary for valve casing and lid Work shall be thoroughly recompact to the satisfaction of the Engineer. All casings shall be installed in a vertical position; all valve operating nuts shall be free of any dirt or debris and all valves shall be checked to insure that they are left in a wide open position.

It shall be the responsibility of the Contractor to do this Work exactly as specified.

22-6 EARTH WORK FOR DUCTILE IRON AND PVC PIPE INSTALLATION

22-6.1 Trench Excavation

The trench shall be constructed per Standard Plans. Unless shown otherwise on the plans a minimum cover of 3.0 feet is required for mains.

22-6.2 Trench Bottom

The trench bottom should be true and even so that the barrel of the pipe will have soil support for its full length. Earth mounds can be used to support the pipe with the Engineer's approval, see Section 22-7.

22-6.3 Bell Holes

Bell holes are required for push-on and mechanical joint pipe. While push-on joints require only a small depression beneath each bell to allow pipe to lay flat on the trench bottom, mechanical joints require additional space for operation of a ratchet wrench.

Minor excavations, which are necessary for removing the sling and for assembling the joints, should be made in advance of the laying crew and filled after these operations are completed.

22-6.4 Trench Width

The trench must be wide enough to permit proper installation of the pipe with room for assembling joints and tamping backfill around the pipe. The trench must be at least 12 inches wider than the outside diameter of the pipe to allow for proper placement, tamping, and compaction of the initial backfill. Per the City Standard Specifications, Section 16, the width of the trench at the top of the pipe shall not be greater than 16 inches more than the outside diameter of the barrel of the pipe to be laid therein. These requirements may be modified by the Engineer or as shown on the plans.

22-6.5 Rock or Hard Pan Excavation

Rock, hardpan and other debris shall be removed in accordance with the provisions of Section 16-3 of these Standard Specifications.

22-6.6 Barricades and Safety

The Contractor shall follow all the requirements in the City Standard Specifications in Section 7-10.3.

22-6.7 Shoring

In addition to, and consistent with public safety considerations, every precaution for safety must be provided for the workmen at the job site. Shoring must comply with Cal-OSHA Standards.

22-7 USING EARTH MOUNDS

With the Engineer's approval, earth mounds may be used for pipe support if the trench bottom is firm. Mounds can be built that will hold the pipe from settling during assembly and until backfilled. Do not use earth mounds in mucky soil or in wet, mushy trenches. Damp, loamy earth or sand is best. Locate four equally spaced mounds along each length of pipe. Construct mounds using soil free of rocks, large stones or lumps of clay. The mounds should run completely across the trench - and be at least 6" wide along the length of the pipe. The mound shall be firm and provide a clearance of at least 2" under the coupling.

22-8 BACKFILLING AND TAMPING

Backfilling usually follows pipe installation as closely as possible. This protects the pipe from falling materials, eliminates possibility of lifting the pipe due to flooding of open trench, and avoids shifting pipe out of line by cave-ins. The purpose of backfilling is not only to protect the pipe by covering it but to provide firm, continuous support that will prevent the pipe settling or resting on the couplings. The essentials of a first class backfilling job shall be as follows:

Provide continuous bedding or support by carefully consolidating approved material under pipe and couplings and between the run of pipe and the trench walls. Provide a cushion on top by hand - placing approved material to at least 12" over the pipe - the balance can then be backfilled by machine.

The first step in providing firm, continuous support for the pipe-line is to tamp soil solidly under the pipe and couplings. Tamping can be done with tamping bars to consolidate the backfill material. Hand tamping is best accomplished with damp loamy earth or sand.

The initial backfill material used should be slightly damp which will pack more solidly under the pipe. This initial backfill is always placed by hand. It should be shoveled in evenly along both sides of the pipe, making a layer about 4" thick. Then the tamping bar is used to tamp this soil firmly under the pipe. If more than 4" of soil is shoveled in before tamping, the soil can bridge and fail to go under the pipe. Next, another 4" layer is shoveled in and tamped. This is repeated until the pipe is firmly bedded in compact soil up to the top of the pipe. Two 6 inch lifts are then used to achieve a 12 inch cover over the pipe. This completes what is called the "initial" backfill, the thoroughly tamped soil which provides a continuous supporting bed for the pipeline. Where clay soil or unstable

soil is encountered, the pipe should be enveloped in a minimum of four inches of sand - then the backfill completed to at least 12" above the pipe with selected material, then dry sand or other suitable materials should be laid. The balance of the backfill which is usually placed by machine need not be as carefully selected as the initial material. If approved by the Engineer, jetting or water tamping will be allowed to achieve the required compaction. Cleanup shall be in accordance with the City's Standards.

22-9 TESTING AND STERILIZATION

22-9.1 General

The specifications constituting this section designate the requirements for the procedure, materials, performance, and payment for testing and sterilization of water mains and appurtenances intended for the conveyance of potable water under pressure. The Contractor shall furnish all labor, material, tools, and equipment, including all chemicals, necessary to perform all operations required to complete the testing and sterilization as herein specified.

22-9.2 Connections to Water Mains and Use of Construction Water

1. The contractor shall submit a connection sequence and plan including location of a Reduced Pressure Principal Backflow Prevention Device (R.P.) for approval by the City. If the connection location places the temporary R.P. device in the travel way, the City, during plan check will note an alternate location for the R.P. Size of temporary R.P. shall be no less than one-half ($\frac{1}{2}$) the diameter of the pipeline being installed. Smaller R.P.'s may be approved during plan check if two or more points of connection are to be employed. R.P.'s smaller than two inches shall not be allowed in any case.
2. Water sample points shall be installed every 350 feet. New water services intended for private use can be used for collecting water quality samples through a properly installed blow off assembly. It is not recommended that fire hydrants be used for sampling due to potential contamination within the hydrant.
1. All customers affected by shut down of an existing main must be properly notified in advance along with the Public Works Water Division and Fire Department. The contractor shall notify all affected water customers 48 hours prior to commencing installation of a new water main or connecting to an existing City pipeline.
2. Trenches shall be back filled and compacted immediately after pipe installation. Temporary trench patch shall be installed daily until permanent trench patch is installed.
3. The contractor is solely responsible for traffic control procedures and placing warning signs providing safe travel of vehicles around exposed or open trenches. A traffic control plan shall be submitted to the Engineering Division and designed according to the MUTD.

4. Water required to fill any pipeline for hydrostatic pressure testing, disinfection and flushing shall be supplied downstream of a University of Southern California (U.S.C.) Foundation for Cross Connection Control and Hydraulic Research approved and certified R.P. or Air Gap. Valves are not acceptable for protection during hydrostatic testing and may not be used in place of an R.P. (See Figure 3.)
5. Any fixture connecting to the new pipeline, which has not passed all testing procedures and makes water available to any person, must have a sign posted directly adjacent stating "not safe to drink". Such signs shall be supplied by the contractor and stay in place until all final bacteriological tests are confirmed negative by the City Inspector.
6. Work that involves required inspections, backflow testing work in the right-of-way, chlorination or chlorination testing shall NOT be conducted on holidays, weekends or after hours. If a normal workday extends after hours for justifiable reasons the contractor is responsible for all overtime expenses incurred by the city. The payment of overtime shall be submitted prior to final. Normal bacteriological testing should be scheduled on Tuesdays. Any change would require a 24-hour notification.

22–9.3 Hot Tap Methodology:

1. Hot taps are required for all connections to existing water mains. All necessary precautions including over excavation and pumping shall be taken to prevent contamination to the existing water main.
2. Contractor shall immediately take corrective action, under the direction of the City Inspector, if any water sample is found to be positive for the presence of Coliform Bacteria at any time during the process of installing a new water main or fire hydrant assembly. The Public Works Water Quality Division will determine Flushing and/or rechlorination procedure. In no case shall completion of corrective action take longer than 24-hours from notification to contractor of a positive sample.
3. Hot tap fittings, gate valve(s), R.P. (s) and other temporary plumbing shall be disinfected by swabbing with a 1% chlorine solution as required by ANSI/AWWA C651-92. (See Table 4.) The City Inspector must be present during the time of the hot tap procedure.
4. Precautions must be taken to protect the interior of pipes, fittings and valves against all forms of contamination. Pipes left unattended, such as during rest breaks, meal periods, or the end of the workday must be sealed off with watertight plugs to prevent contamination.

22–9.4 Hydrostatic Testing

1. Precautions must be taken to protect the interior of pipes, fittings and valves against all forms of contamination. Pipes left unattended, such as during rest breaks, meal periods, or the end of the workday must be sealed off with watertight plugs to prevent contamination.

2. When a water line is charged for hydrostatic testing a test plate or an R.P. must be in place to protect the City of Madera water systems. Valves or assemblies which are not approved by U.S.C. are unacceptable. Water being used for any hydrostatic test can only come from a source downstream of an air gap or U.S.C. approved R.P. assembly which has been tested and certified. Cases where there is no R.P. on a water pipeline to be hydrostatic tested, installation of a test plate is required so the water pipeline will be isolated and no water from the pipeline can backflow into the City water system. A temporary connection may be installed downstream of the test plate to facilitate hydrostatic testing, chlorine injection, flushing, etc. Temporary connection must be removed and properly plugged under direct observation of City Inspector prior to final inspection. Valves or assemblies which are not approved by U.S.C. are unacceptable, water sources are a hydrant with an R.P. and construction meter attached, water truck equipped with City of Madera approved air gap or R.P., or any source downstream of a U.S.C. approved backflow prevention assembly.
3. If water is obtained directly from an R.P. assembly to fill pipeline or feed the booster pump, the only acceptable point of connection is test cock #4 downstream of check valve #2. Water received from test cock #4 must pass through the booster pump and then be injected downstream of the closed #2 shutoff valve.

22-9.5 Disinfection with Temporary RP Backflow Prevention Device:

1. All chlorination disinfection procedures shall be in accordance with the current edition of the ANSI/AWWA C651-92 Standard of Disinfection Water Mains with the exception that the Slug Method shall not be allowed for use in the City. Only Tablet or Continuous Feed Methods are allowed for use in the City. It shall be the responsibility of the contractor to refer only to the current edition of these standards. Some of the most important and often overlooked procedures of these Standards which must be adhered to at all times are as follows: (See Tables 1 – 4). Tablets must be attached to the inside top of each length of pipe with food grade adhesive. Examples of food-grade adhesives accepted by the U.S. Drug Administration (USDA) are Permatex Form-A-Gasket No. 2 and Permatex Clear RTV Silicone Adhesive Sealant which are manufactured by Loctite Corporation, Kansas City, KS 66115. Other company products, such as Permatex Form-A- Gasket No. 1 are not allowed for use in the City.
2. Contractor shall install a USC approved R.P. between new and existing water mains. All water main extensions shall be connected with a gate valve immediately upstream of the appropriate sized and approved R.P. The temporary R.P. device shall be installed with a minimum of 12 inches above adjacent soil or surface. Testing will be provided by the Water Quality Division Monday through Friday, except holidays, between 7:00 a.m. and 2:30 p.m. A 24-hour notice is required to City Inspector requesting R.P. test and certification. The number 2-shutoff valve must remain fully closed and no water may be allowed to pass through the R.P. until Water Quality Division personnel have certified the device. A \$30.00 fee will be charged to the contractor each time a R.P. is tested or re-tested. The R.P. device is not to be moved, tampered with,

adjusted or modified after testing. If the R.P. device is tampered with, it will be removed from the project by City forces halting the project.

22–9.6 Chlorination Procedures:

1. The standards require that new water mains be filled at a “very slow” velocity of less than one foot per second to prevent flushing of the chlorine tablets or granules to the end of the pipeline.
2. Minimum chlorine dose for all water mains and piping shall be a minimum of 25 mg/L and shall not exceed 50 mg/L. See Tables 1,2 and 4 for dosage requirements for various pipe sizes. Water chlorinated at this level shall not be allowed to remain in contact with pipeline and fittings beyond the required 24-hour contact time. (See Tables).
1. The City Inspector shall test for chlorine residual in the new water main 24-hours after the high dosage was introduced to verify a minimum 10 mg/L. The contractor shall then flush the new main until the chlorine residual equals the existing system level and is verified by the City Inspector. See Table 3 and Figures 1 and 2. Chlorination shall not be permitted on **Fridays** or the day before a City holiday due to the corrosive potential of high concentrations of chlorine after 24-hours.
2. All new water mains shall sit for a minimum of 24-hours once normal City system chlorine residual has been achieved. The Water Quality Division will then collect water samples, which will be tested for Coliform Bacteria. All new water mains must remain isolated with all valves fully closed until all test results are returned from lab and confirmed negative by the City Inspector.
3. Upon approval of bacteriological test results, the contractor may remove the R.P. and complete connection to existing water mains. The City Inspector must be notified 24-hours in advance and shall be present during the connection procedure. All pipes and fittings used for final connection to an existing water main must be disinfected in accordance with the most current edition of ANSI/AWWA C651-92.
4. Contractor shall prevent water flowing from a disconnected pipe, R.P. assembly, test plate, coupling or other fixtures from coming in contact with new water main. This situation shall be controlled by over excavation of the trench where connection is being made. Water shall be pumped out of excavated area to prevent contaminated water from coming in contact with or infiltrating into water mains. If the water in the trench comes in contact with the new water main at any time or the trench fails and the water main is covered with soil, the main is contaminated and will require complete high dose disinfection and testing.
5. Throughout the testing and disinfection process if a sample returns positive for fecal coliform or 1.1 coliform or greater, the contractor shall stop all other work and commence another disinfection of the water main immediately. This second disinfection process shall be conducted as stated previously. This work shall be conducted regardless of weekends and holidays.

6. Contractor shall flush new water main through fire hydrants and or blow off assembly immediately after all connections have been made to existing water mains. See Table 3. This is to remove chlorine-swabbing residue. The City Inspector will then verify that chlorine residual is equal to the existing system level. The Water Quality Division will then sample for final bacteriological analysis after 24-hours. The contractor shall then close all valves, in the presence of the City Inspector, to achieve isolation of newly installed water system. All valves shall remain closed until approved by the City Inspector.
7. Contractor shall reimburse City for all costs incurred for all laboratory analysis prior to final project approval.
8. Upon completion of attachment "A" (Check List for Connection and Disinfection of New Water Main and/or Fire Hydrant Pipe Lines), contractor shall fully open all new mainline and fire hydrant valves in the presence of the City Inspector. The City Inspector must verify and approve this procedure prior to final project approval.

22-10 FIRE HYDRANT

22-10.1 General

All fire hydrant installation procedures shall strictly follow the guidelines provided below. If the current situation violates or deviates from the listed situations the installation of the fire hydrant will be considered a new water main and is required to follow the Testing and sterilization procedures explained in 22 – 9.

22-10.2 Fire Hydrants with Supply Line Shorter Than 18 feet:

These hydrants are generally attached to a short length of pipeline, which is connected to an existing water main by **hot tap method**. In such cases, it is imperative that all possible means be taken to protect the water system from potential contamination. The following special provisions shall govern such work:

22-10.3 Offsite Fire Hydrants Must Meet Following Criteria:

1. A single fire hydrant is being installed within the public right-of-way, which is being connected to an existing City water main.
2. No other connections may be made to the pipeline leading from the existing City water main to the fire hydrant.
1. All pipe, fittings and valves must be properly disinfected in accordance with ANSI/AWWA C651-92.
2. All work must be accomplished under the direct observation of a City Inspector and be completed in no more than one working day.
3. Hot tap valve at point of connection to existing City water main must remain fully closed until City Inspector has received written laboratory certification that all required water samples have been determined to be negative for the presence of

coliform bacteria. If water line to be installed is less than 18 feet or one pipe length and all components were swabbed with a 1% chlorine solution and flushed thoroughly in the presence of a City Inspector, the Bac-T sample will not be necessary.

22–10.4 Fire Hydrants must meet Following Criteria:

No other permanent connections may be made to the pipeline leading from the existing City water main to the fire hydrant(s). A test plate must be installed immediately downstream of the valve where fire hydrant pipeline connects to City water main. A temporary connection may be installed downstream of the test plate to facilitate hydrostatic testing, chlorine injection, flushing, etc. Temporary connections must be removed and properly plugged off under direct observation of City Inspector prior to final inspection. (See Figure 2.)

1. All pipe, fittings and valves must be properly disinfected in accordance with ANSI/AWWA C651-92.
2. All work must be accomplished under the direct supervision of a City Inspector and be completed in no more than one normal workday. This should not entail installation of more than 250 feet of pipeline and all hydrant(s). Fire hydrant(s) must only be served by a dead-end pipeline.
3. Precautions shall be taken to protect the interior of pipes, fittings and valves against all forms of contamination. Pipes left unattended, such as during rest breaks or meal periods must be sealed off with watertight plugs to prevent any form of contamination.
4. Hot tap valve at point of connection to existing City water main must remain fully closed until City Inspector has received written laboratory certification that all required water samples have been determined to be negative for the presence of coliform bacteria.
5. Bac-T must be performed after flushing of newly installed line.

22–10.5 Short Dead End “Off Site” Extensions to Existing Water Mains:

An R.P. may not be required if the pipeline extension is to be a “dead end”. In such case, authorization for not installing a R.P. must be with prior written approval of the City Engineer. A test plate must then be installed immediately downstream of valve where new pipeline connects to City water main. A temporary connection may be installed downstream of the test plate to facilitate hydrostatic testing, chlorine injection, flushing, etc. Temporary connections must be removed and properly plugged under direct observation of City Inspector prior to final inspection. (See Figure 2.)

If the City Engineer authorizes a short water main extension without the requirement for an R.P. all provisions listed above for onsite fire hydrant installations must be strictly adhered to.

All work must be accomplished under the direct supervision of a City Inspector and be completed in no more than one normal workday. This should not entail installation of more than 250 feet of pipeline and hydrant(s).

22-11 CONSTRUCTION WATER

All water trucks being filled from fire hydrants or from any other connection to the City water system must have an air gap between the receiving vessel and delivery pipe. Air gap must be at least two times the diameter of the delivery pipe. All delivery pipes must be externally mounted on the truck to facilitate visual inspection. Presence of an R.P. on the hydrant will not exempt trucks from the air gap requirement. No construction water may be taken from the water system through a hose unless it is downstream of the R.P. and meter.

22-12 PENALTY FOR VIOLATION OF THIS STANDARD

The purpose of this Standard is to maintain the integrity of the water system. This will help protect the public from all potential sources of cross-connection contamination.

The contractor under the direction of the City Inspector shall immediately correct violations of this policy. When necessary, applicable penalties shall be assessed as specified in the following:

1. City of Madera Code of Ordinances, Chapter 6: Water Cross-Connection Control, Section 5-6.07 Water Termination.
2. City of Madera Council Resolution No. 4369 Adopting the State of California Department of Health Services Manual of Cross-Connection Program in the City of Madera. Chapter IX Enforcement, Section A: Conditions Leading to Termination of Water Service.

22-13 Tables

Table 1 – Ounces of calcium hypochlorite granules to be placed at beginning of main and at each 500 foot interval

Pipe Diameter		Calcium Hypochlorite Granuels	
In.	mm.	Oz.	G
4	100	0.5	14
6	150	1	28
8	200	2	57
12	250	4	113
16 or larger	400 or larger	8	227

Table 2 – Number of 5-g calcium hypochlorite tablets required for dose of mg/L*

Legnth of Pipe Section, ft (m)

Pipe Diameter		13 (4.0) or less	18 (5.5)	20 (6.1)	30 (9.1)	40 (12.2)
In	mm.	Number of 5-g Calcium Hypochlorite Tablets				
4	100	1	1	1	1	1
6	150	1	1	1	2	2
8	200	1	2	2	3	4
10	250	2	3	3	4	5
12	300	3	4	4	6	7
16	400	4	6	7	10	13

* Based on 3.25g available chlorine per tablet; any portion of tablet to next higher integer.

Table 3 – Required flow openings to flush pipelines (40 psi [276-kPa] residual pressure in water main*

Pipe Diameter		Flow Required to produce 2.5 ft/s (aprox.) Velocity in Main		Size of Tap, in (mm)			Number of 2 ½ (64-mm) Hydrant Outlets
				1 (25)	1 ½ (38)	2 (51)	
In	(mm)	Gpm	(L/s)	Number of Taps on Pipe†			
4	(100)	100	(6.3)	1	-	-	1
6	(150)	200	(12.6)	-	1	-	1
8	(200)	400	(25.2)	-	2	1	1
10	(250)	600	(37.9)	-	3	2	1
12	(300)	900	(56.8)	-	-	2	2
16	(400)	1600	(100.9)	-	-	4	2

* With a 40-psi (276-kPa) pressure in the main and the hydrant flowing to atmosphere, a 2 ½ inch (64-mm) hydrant outlet will discharge approximately 100 gpm (63.1 L/s) and a 4 ½ inch (114-mm) hydrant outlet will discharge approximately 2500 gpm (160 L/s)

† Number of taps on pipe based on discharge through 5 feet (1.5 m) of galvanized iron (GI) pipe with on 90° elbow.

Table 4 – Chlorine required to produce 25-mg/L concentration in 100 ft (30.5m) of pipe by diameter

Pipe Diameter		100 percent Chlorine		1 % Chlorine Solution	
In	(mm)	Lb	G	Gal	(L)
4	100	0.013	5.9	0.16	0.6
6	150	0.03	13.6	0.36	1.4
8	200	0.054	24.5	0.65	2.5
10	250	0.085	38.6	1.02	3.9
12	300	1.12	54.4	1.44	5.4
16	400	0.217	98.4	2.6	9.8