

SECTION 02675 – FLUSHING, TESTING AND DISINFECTION OF WATER MAINS

PART 1 - GENERAL

1.01 SUMMARY

- A. This section provides the required procedure for water main flushing, testing, disinfection, and de-chlorination of water mains prior to placing the main in service.
- B. This section includes Corporation Cocks, Hydrostatic Testing, and Disinfection of Water mains.

1.02 SPECIFICATION MODIFICATIONS

- A. It is understood that throughout this section these Specifications may be modified by appropriate items in Section 01015 – Specific Project Requirements, or as otherwise indicated on the Contract Drawings.

1.03 RELATED SECTIONS

- A. Section 01000 – General Project Requirements.
- B. Section 01015 – Specific Project Requirements.
- C. Section 02645 – Hydrants and Flushing Assemblies.
- D. Section 02669 – Thrust Restraints.

1.04 CODES AND STANDARDS

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.
- B. American Water Works Association (AWWA):
AWWA C651 Standards for Disinfecting Water Mains.

1.05 PROVIDED BY CITY

- A. The City will perform bacteriological testing in accordance with paragraph BACTERIOLOGICAL TESTING.
- B. The City will provide Contractor with all sampling bottles for bacteriological testing.
- C. The City shall provide water for filling, flushing and testing water mains in accordance with Section 01000 – General Project Requirements.

1.06 SUBMITTALS

- A. Submit as specified in Section 01300 – Submittals.
- B. Other Submittals:
 - 1. Disinfection Report.
 - 2. Certification of Cleanliness.
 - 3. Product data for sodium hypochlorite or calcium hypochlorite.
 - 4. Product data for meters.
 - 5. Product data for backflow preventers.

1.07 QUALITY ASSURANCE

- A. The Contractor is responsible for the quality assurance and quality control of the Work.
- B. Work shall be performed in accordance with AWWA C651.
- C. Disinfection Plan:

1. Prior to the Preconstruction Conference, the Contractor shall submit for review and approval a Disinfection Plan which includes, but is not limited to, the following information:
 - (a) Information as required in Section 01015 – Specific Project Requirements.
 - (b) Type and form of disinfection to be used (sodium hypochlorite or calcium hypochlorite).
 - (c) Location of injection points.
 - (d) Location of sample points / corporation cocks. The maximum spacing of sample points shall be 1,200 feet or as directed by the City.
 - (e) Order of sampling.
 - (f) Location of required valve operations.
 - (g) Location of flushing points.
 - (h) Locations for disposal water.
 - (i) Product data pertaining to neutralizing chemicals.
 - (j) Procedures for final connection to existing mains.
 2. Locations of key features associated with the plan shall be provided on a marked-up set of Contract Drawings.
 3. Any modifications to the Disinfection Plan shall be resubmitted to the City for review and approval.
- D. Disinfection Report: Immediately following the completion of the disinfection procedures, Contractor shall prepare a Disinfection Report which shall include the following information:
1. Type and form of disinfectant used.
 2. Date and time of disinfectant injection start and time of completion.
 3. Test locations.
 4. Initial and 24-hour disinfectant residuals (quantity in treated water) in parts per million for each outlet tested.
 5. Date and time of post disinfectant flushing start and completion.
 6. Disinfectant residual after flushing in parts per million for each outlet tested.
- E. Certification of Cleanliness: The Contractor shall certify in writing that the cleanliness of the installed water distribution system meets or exceeds specified requirements.

1.08 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. See Section 01000 – General Project Requirements, paragraph PRODUCT DELIVERY, STORAGE AND HANDLING.

PART 2 - PRODUCTS

2.01 CORPORATION COCKS

- A. The Contractor, when needed, shall furnish and install a ¾-inch corporation cock to be used in the testing and disinfection of each new main. The location of these corporation cocks shall be as directed by the City.
- B. After the line has been tested and prior to placing the main in service, the Contractor shall remove the corporation cock and replace it with a tapered brass plug.

2.02 SODIUM HYPOCHLORITE

- A. Sodium hypochlorite shall conform to AWWA B300

2.03 CALCIUM HYPOCHLORITE

- A. Calcium hypochlorite shall conform to AWWA B300

2.04 WATER

- A. See Section 01000 – General Project Requirements, paragraph WATER.

PART 3 - EXECUTION

3.01 OPERATIONS OF EXISTING VALVES

- A. See Section 01000 – General Project Requirements, paragraph OPERATION OF EXISTING VALVES.

3.02 TEMPORARY CONNECTIONS

- A. The Contractor shall furnish and install all temporary flushing assemblies, fittings, thrust blocking, and restraining devices required for temporary connections for the filling, flushing, pressure testing, chlorination, de-chlorination and final flushing of the new water mains.
- B. See also the following sections:
 - 1. See Section 02645 – Hydrants and Flushing Assemblies.
 - 2. See Section 02669 – Thrust Restraints.

3.03 PREVENTIVE AND CORRECTIVE MEASURES DURING CONSTRUCTION

- A. General:
 - 1. Preventive and corrective measures to protect water mains during construction shall be in accordance with AWWA C651 which states the following:
 - (a) Heavy particulates generally contain bacteria and prevent even very high chlorine concentrations from contacting and killing these organisms. Therefore, the procedures of this section must be observed to ensure that a water main and its appurtenances have been thoroughly cleaned for the final disinfection by chlorination.
 - (b) Any connection of a new water main to the active distribution system before the receipt of satisfactory bacteriological samples may constitute a cross-connection. Therefore, the new main shall remain isolated until bacteriological tests are satisfactorily completed.
- B. Keep Pipe Clean and Dry:
 - 1. The interiors of pipes, fittings, and valves shall be protected from contamination.
 - (a) Openings in the pipeline shall be closed with watertight plugs when pipe laying is stopped at the close of the day's work or for other reasons, such as rest breaks or meal periods. Rodent-proof plugs may be used when watertight plugs are not practicable and when thorough cleaning will be performed by flushing or other means.
 - (b) Pipe delivered for construction shall be strung to minimize the entrance of foreign material.
 - (c) Delay in placement of delivered pipe invites contamination. The more closely the rate of delivery is correlated to the rate of pipe laying, the lower the risk of contamination.
- C. Joints:
 - 1. Joints of pipe in the trench shall be completed before work is stopped.
 - 2. If water accumulates in the trench, the plugs shall remain in place until the trench is free of standing water and mud that may enter the pipe.
- D. Packing Materials:
 - 1. Yarning or packing material shall consist of molded or tubular rubber rings, rope of treated paper, or other approved materials.
 - 2. Materials such as jute or hemp shall not be used.
 - 3. Packing material shall be handled in a manner that avoids contamination.

- E. Sealing Materials:
 1. No contaminated material or any material capable of supporting growth of microorganisms shall be used for sealing joints.
 2. Sealing material or gaskets shall be handled in a manner that avoids contamination.
 3. The lubricant used in the installation of sealing gaskets shall be suitable for use in potable water meeting the requirements of NSF/ANSI 61 and shall not contribute odors.
 4. It shall be delivered to the job in closed containers and shall be kept clean and applied with dedicated clean applicators.
- F. Cleaning and Swabbing:
 1. If dirt enters the pipe, it shall be removed and the interior pipe surface swabbed with a minimum 1 percent free chlorine disinfecting solution.
 2. If, in the opinion of the City, the dirt remaining in the pipe will not be removed using the flushing operation, the interior of the pipe shall be cleaned using mechanical means, such as a hydraulically propelled foam pig (or other suitable device acceptable to the purchaser) in conjunction with the application of a minimum 1 percent free chlorine disinfecting solution.
 3. For larger mains, pigging or other suitable method acceptable to the City is an option in place of high-velocity flushing. The cleaning method used shall not force mud or debris into the interior pipe-joint spaces.
- G. Wet-Trench Construction:
 1. Wet-trench construction is strictly prohibited. The trench shall be kept dry at all times and the end of the pipe plugged overnight.
- H. Chemical Contamination:
 1. If chemical contamination occurs, such as a hydraulic oil leak or petroleum product spill, the pipe sections exposed to the contamination shall be replaced at no additional cost to the City and not reused for potable water applications.
- I. Disinfection:
 1. After construction is completed, the main shall be filled, flushed, tested, chlorinated, de-chlorinated, final flushed and bacteriologically tested using the methods described herein.

3.04 TESTING

- A. General:
 1. The entire main shall be hydrostatically tested (pressure and allowable leakage test) after thoroughly flushing the new main. Flushing and testing shall be as directed by and witnessed by the City.
 2. The City will provide water for filling, preliminary flushing and testing of the new water mains as specified herein.
 3. The Contractor shall furnish and install all temporary flushing assemblies, fittings, thrust blocks and restraining devices required for temporary connections for filling, flushing and testing all new water mains.
 4. The Contractor shall furnish all pumps, piping, gauges, labor and other materials and services necessary to bring the main up to the specified test pressure.
 5. The contractor shall conduct the pressure test and leakage test simultaneously.
- B. Pressure and Allowable Leakage Test:
 1. Pressure and allowable leakage test may be conducted after all trenches have been backfilled, temporary connections made and the main is filled and flushed with water.
 2. Minimum test pressures:
 - (a) Mains 12-inches and smaller: a minimum pressure of not less than the normal operating pressure (for the lowest point on the line) plus 50% for surge, but in no case less than 160 psi at the lowest point in the line.

- (b) Mains larger than 12-inches: a minimum pressure of not less than the normal operating pressure (for the lowest point on the line) plus 50% for surge but in no case less than 225 psi.
- 3. Duration of test: pressure shall be maintained on the new water main for at least two (2) hours.
- 4. All pipe, fittings, valves, hydrants and joints shall be inspected by the Contractor and any evidence of moisture appearing on the surface of the ground during the test shall be investigated by the Contractor by excavation.
- 5. All defective pipe, fittings, valves or hydrants discovered during the pressure test shall be removed and replaced by the Contractor and the test shall be repeated until satisfactory to the City.
- 6. Leakage shall be defined as the quantity of water that must be supplied into the newly laid pipe to maintain the specified leakage test pressure.
- 7. No water main, or section thereof will be accepted if it has a leakage rate in excess of that determined by the following formula:

$$L = [.0000075 SD(P)^{1/2}] / 2$$
 Where:
 L = Maximum allowable leakage in gallons for two hours.
 S = Length of pipe tested, in feet.
 D = Nominal internal diameter of the water main being tested in inches.
 P = Test pressure in psi.
- 8. Should the leakage exceed the allowable leakage, the test pressure shall be maintained for an additional period of time so that the leakage location may be detected.

3.05 FLUSHING AND DISINFECTION OF WATER MAINS

A. General:

- 1. After completion of the pressure and leakage testing, the Contractor shall flush and disinfect the entire main and all branches. The Contractor shall coordinate with the City so that the City's representative is on-site for all flushing and disinfection activities.
- 2. The Contractor shall provide all labor, materials and equipment required to perform flushing and disinfection.
- 3. The Contractor shall prepare the main for disinfection by exposing the pipe at all entry points where the chlorine will be introduced into the pipe and installing temporary flushing assemblies at all discharge ends.
- 4. The continuous feed method of chlorination is required. The slug method of chlorination may be used only when approved or directed by the City.
- 5. The City will provide water for flushing, chlorinating, de-chlorinating and final flushing of new water mains as specified herein.
- 6. Temporary connections to the City's water distribution system shall have double valves installed to prevent backflow to the existing system.
- 7. Water supplied from the source approved by the City shall be used at a flow rate into the new water main so as not to disrupt service to existing customers

B. Flushing:

- 1. Under the supervision of the City, the Contractor shall flush the new mains to remove all particulates. The flushing velocity in the main shall not be less than 3.0 feet per second unless the City determines that conditions do not permit the required flow. Table 1 shows the rates of flow required to produce the minimum required velocity in commonly used sizes of pipe.

Table 1 – Required Flow to Flush Pipelines at 3.0 feet per second.

Pipe Diameter (inches)	Flow (gpm)
4	120
6	260
8	470
10	730
12	1,060
16	1,880

2. For 36-inch diameter mains and larger, prior to filling the main, the entire main is to be broom swept. Sweepings shall be thoroughly and carefully removed from the pipe.
- C. Continuous Feed Method:
1. The water main shall be filled with potable water a constant, measured flow rate. In that absence of a flow meter, the rate may be approximated using a Pitot gauge in the discharge, measuring time to fill a container of known volume, or measuring the trajectory of discharge and using the formula shown in Figure 2 of AWWA C651.
 2. At a point not more than 10 feet downstream from the beginning of the new main, water entering the new main shall receive a dose of chlorine fed at a constant rate such that the water will have not less than 60 mg/L free chlorine at the sampling points.
 3. To ensure that this concentration is achieved, the chlorine concentration should be measured at regular intervals in accordance with the procedures described in Standard Methods for the Examination of Water and Wastewater or AWWA Manual M12 or using an appropriate chlorine test kit. See Table 4 in AWWA C651 for the amount of chlorine required for various pipe diameters.
 4. As an optional procedure, water used to fill the new water main during the application of chlorine shall be supplied through a temporary connection. This temporary connection shall be installed with an appropriate cross-connection control device for backflow protection of the active distribution system. Chlorine application shall not cease until the entire main is filled with heavily chlorinated water.
 5. The chlorinated water shall be retained in the main for at least 24 hours, during which time all valves and hydrants shall be operated to ensure disinfection of all appurtenances.
 6. At the end of this 24-hour period, the treated water in all portions of the main shall have a residual of at least 45 mg/L free chlorine. Chlorine concentration shall be verified by sampling.
- D. Slug Method:
1. Use of the Slug Method requires pre-approval by the City. Submit justification and details of procedure in the Disinfection Plan (see paragraph QUALITY ASSURANCE).
 2. Water supplied from an approved source of supply shall be made to flow at a constant, measured rate into the new water main.
 3. At a point not more than 10 ft. downstream from the beginning of the new main, water entering the new main shall receive a dose of chlorine fed at a constant rate such that the water will have not less than 100 mg/L free chlorine. To ensure that this concentration is achieved, the chlorine concentration should be measured at regular intervals.
 4. The chlorine shall be applied continuously and for a sufficient period to develop a solid column, or “slug” of chlorinated water that will, as it moves through the main, expose all interior surfaces to a concentration of approximately 100 mg/L for at least 3 hours

5. If at any time chlorine residual drops below 50 mg/L, the flow shall be stopped. Then the chlorination equipment shall be relocated at the head of the slug, and, as flow is resumed, chlorine shall be applied to restore the free chlorine in the slug to not less than 100 mg/L.
 6. After the required retention period (at least 3 hours), the 3-hour residual chlorine sample shall be pulled, the heavily chlorinated water shall then be de-chlorinated to 0 mg/L chlorine. A reducing agent shall be applied to the water before discharging, to neutralize the chlorine residual in the water.
- E. De-chlorinating:
1. Clearing the Main of Heavily Chlorinated Water by De-chlorination:
 - (a) After the applicable retention period, the heavily chlorinated water shall be de-chlorinated.
 - (b) The heavily chlorinated water shall be de-chlorinated and flushed from the main and all branches achieving chlorine measurements at 0 mg/L chlorine.
 - (c) A neutralizing chemical shall be applied to the water to thoroughly neutralize the residual chlorine (see ANSI/AWWA C655 for neutralizing chemicals). Submit product data for neutralizing chemicals with the Disinfections Plan.
- F. After de-chlorinating, the new mains shall be final flushed to prepare for the bacteriological tests.

3.06 BACTERIOLOGICAL TESTING

1. The City will perform bacteriological testing, reporting and interpretation of testing results.
2. Contractor shall take water samples in accordance with the approved Disinfection Plan or as directed by the City.
3. City will provide bottles for sampling.
4. The Contractor shall take two (2) sets of Bac-T samples, one immediately after the final flush, the second taken 24 hours later.
5. Contractor shall coordinate disinfectant testing and bacteriological testing to demonstrate that the above requirements have been met.
6. A representative of the City shall be present to observe all sampling.
7. City will provide copies of all bacteriological testing reports to Contractor. Contractor shall submit reports in accordance with paragraph SUBMITTALS.

3.07 FINAL CONNECTION TO EXISTING MAINS

- A. New water mains must be disinfected and satisfactory bacteriological sample results received prior to permanent connections being made to the existing distribution system.
- B. Sanitary construction practices must be followed during installation of the final connection so that there is no contamination of the new or existing water main with foreign material or groundwater.
- C. The new pipe, fittings, and valves required for the connection shall be spray disinfected or swabbed with a minimum 1 percent solution of chlorine just before being installed, if the total length of the connection from the end of a new main to the existing main is equal to or less than 20 feet.
- D. If the total length of the connection from the end of a new main to the existing main is greater than 20 feet, the Contractor shall submit the procedures for disinfection as part of the Disinfection Plan. Procedures should comply with AWWA C651.
- E. Prior to placing new mains in service, the Contractor shall remove any corporation cocks used for testing or chlorination and replace them with tapered brass plugs.

END OF SECTION