



**SPECIAL PROVISIONS
FOR
TESTING AND DISINFECTION**

**Linn County
TAP-U-1187(792)--8I-57**

**Effective Date
November 16, 2021**

PART 1 – GENERAL

1.01 SECTION INCLUDES

- A. Testing and Quality Control
- B. Disinfection of Water Systems

1.02 DESCRIPTION OF WORK

- A. Testing and Quality Control – This item includes the furnishing of material samples and testing of the Work as set forth in the contract documents. This includes, but is not limited to, pipe leakage, turbidity and bacteriological tests for the water system including water mains, fire hydrants and appurtenances.
- B. Disinfection of Water Systems - Includes water mains, fire hydrants and appurtenances.

1.03 SUBMITTALS

Submit test results as noted in contract documents.

1.04 SCHEDULING AND CONFLICTS

- A. Notify the Engineer one working day in advance of testing or disinfection operations to coordinate the operations.
- B. The Engineer or his/her representative is required to be in attendance during testing or disinfection.

1.05 SPECIAL REQUIREMENTS

- A. The Contractor is responsible for water main flushing operations. This responsibility includes, but is not limited to, verifying procedures, providing adequate personnel and equipment, obtaining approval to discharge into storm or sanitary sewers, monitoring sewers for back-ups, monitoring flow and de-chlorination results.

- B. Testing performed by the Contractor or by the Engineer indicating acceptable results does not relieve the Contractor of the responsibility to construct the work in accordance with the contract documents or responsibility to correct any defects that are present.
- C. The test results submitted by the Contractor must meet the minimum requirement as established by the contract documents. If test results do not indicate compliance with the contract documents, additional tests in the area following the Contractor's re-work will be provided to the Engineer at the Contractor's expense.
- D. The Contractor shall give the Engineer 24 hours-notice prior to performing assurance testing.

1.06 MEASUREMENT AND PAYMENT

A. Disinfection and Hydrostatic Testing:

1. Measurement: Lump sum item: no measurement will be made.
2. Payment: Payment will be the contract lump sum price.
3. Includes: Lump sum price includes furnishing all material, labor and equipment to disinfect the water main, hydrants and appurtenances, to re-disinfect if required, and to perform the hydrostatic testing of the completed water main. Equipment includes, but is not limited to, corporation stops, copper tubing, hoses, pumps and gauges required for hydrostatic testing and all equipment and materials necessary to direct the chlorinated water to a proper disposal point.

PART 2 – PRODUCTS

2.01 DISINFECTION AGENT – CHLORINE

- A. Liquid Chlorine complying with AWWA B300 and AWWA B301, 100% available chlorine.
- B. Sodium Hypochlorite Solution complying with AWWA B300, approximately 5% to 15 % available chlorine by weight.
- C. Calcium Hypochlorite Granules complying with AWWA B300, approximately 65 % available chlorine by weight.
- D. All disinfecting agents to be NSF 60 D698. Supply and store in the original container with AWWA stamp.

PART 3 – EXECUTION

3.01 TESTING AND QUALITY CONTROL

- A. Perform quality assurance testing in accordance with the contract documents. The intent of the testing is to provide an indication of the effectiveness of the means and methods being employed by the Contractor.
- B. Test samples in a State Certified Laboratory.
- C. Operation of all valves and fire hydrants on watermain extensions or service lines 3 inch diameter or greater that are connected to the City of Cedar Rapids Water Distribution System to be by Water Division personnel. Coordination and direction with Water Division personnel of all flushing and filling operations to be by the Contractor.

3.02 WATER MAIN TESTING

- A. Coordination of tests to be by the Contractor. Collection of samples for testing to be by Water Division personnel.
- B. Regulatory Requirements: Comply with requirements of Iowa Environmental Protection Commission (IAC 567, Chapters 40 thru 43) and Recommended Standards for Water Works (Ten States).

3.03 SEQUENCE OF TESTING AND DISINFECTION

A. Sequence of Operations

1. Perform operations in the following sequence:
 - a. Remove any debris from within the pipe. Clean and swab out pipe if required.
 - b. Secure any unrestrained pipe ends against uncontrolled movement.
 - c. Fill the main and add chlorine.
 - d. Wait 24 hours to check the chlorine content. Must be over 25 mg/L.
 - e. Dispose of highly chlorinated water.
 - f. Wait 24 hours for bacteriological testing and turbidity testing.
 - g. Perform pressure and leak testing.
 - h. Make taps after passing all tests.
2. Successfully complete each operation before commencing to the next operation.
3. Contracting Authority will provide reasonable quantities of water for flushing and testing.

B. Method of Chlorination

1. Tablet Method (Concurrent with Water Main Installation): Perform chlorination in accordance with AWWA C651. The preferred method from AWWA C651 is the method utilizing calcium hypochlorite (HTH) granules placed in the water main as it is being installed and then filling the main with potable water when installation is complete.
 - a. To utilize this method, pipes and appurtenances must be kept clean and dry during construction.
 - b. During construction, place HTH at the upstream end of the first section of pipe, at the upstream end of the first pipe of each branch main and at approximately 60-foot intervals in all new pipes as they are laid. Refer to Table 1 for quantities of HTH granules to be used for various pipe sizes.

Table 1. Ounces of Calcium Hypochlorite Granules to be Placed at Beginning of Main, Beginning of Each Branch, and at Each 60-Foot Interval of Pipe.											
Pipe Diameter (inches)	6	8	10	12	16	20	24	30	36	42	48
HTH Granules (oz)	1	1.5	2.5	3.5	6	9	13	21	29	44	56

- c. When powder or tablet chlorine is deposited into the water main during installation, the main must be filled within 48 hours to prevent damage to the pipe lining and valve components.
- d. The quantities of calcium hypochlorite granules listed in Table 1 will result in initial chlorine concentrations of 45 to 55 mg/L.

- e. The sequence of testing and disinfection may be modified with approval of the Engineer.
 - 1) Perform disinfection.
 - 2) Flush after disinfection.
 - 3) Perform pressure and leak testing.

- 2. Continuous-Feed or Slug Method (After Water Main Installation):

Prepare a chlorine-water solution by dissolving granules of calcium hypochlorite in water in the proportion required for desired concentration. A 1% chlorine solution requires approximately 1 pound of calcium hypochlorite in 8 gallons of water.

 - a. Apply the chlorine solution to the water main with a pump suitable for pumping chlorine solutions and the head conditions at the point of application. Utilize a tap in the new main within 10 feet downstream of the valve to be used for turning water into the new pipe for the point of application. Turn water from the existing distribution system into the new pipe at a constant measured rate. The rate may be measured with a hydrant meter mounted on the discharge outlet. Feed the chlorine solution at a rate to produce a chlorine concentration in the pipe of at least 25 mg/L free chlorine. Table 2 shows the minimum rate of chlorine solution to feed to obtain a 25mg/L chlorine residual at various water flow rates. Feed rates may need to be adjusted upward to compensate for ammonia content of the water.

Table 2. Minimum Feed Rates for One Percent Chlorine Solutions to Obtain 25 mg/L Chlorine Concentration	
Water Flow Rate in Water Main (gpm)	1.0% Chlorine Solution Feed Rate (gpm)
100	0.25
200	0.50
300	0.75
400 (max. for meter)	1.00

- b. During application of the chlorine, position valves to prevent the strong chlorine solution from contacting water in the existing distribution system. Do not cease chlorine application until the main is completely filled with the chlorine solution. Maintain the chlorine solution in the main for at least 24 hours, and operate all valves and hydrants in the section being treated in order to disinfect the appurtenances. At the end of this 24 hour period, the treated water in all parts of the main shall have a residual of not less than 10 mg/L free chlorine.
- c. After the applicable retention period, flush the heavily chlorinated water from the main as specified in Article 3.04 of this specification.
- d. The sequence of testing and disinfection may be modified with approval of the Engineer.
 - 1) Perform initial flush.
 - 2) Perform disinfection.
 - 3) Flush after disinfection.
 - 4) Perform pressure and leak testing.

3.04 FILLING AND INITIAL FLUSHING

- A. When installation is completed, slowly fill the main by opening the inlet valve just enough turns to start the water running. Open air release valves and fire hydrants to release air pockets at the high points of the line. Check all interconnecting valves to the existing system to be sure they are completely closed. Valves which separate the existing City distribution system from the new main are to be operated only by Water Division personnel.

- B. Maintain the chlorine solution in the main for at least 24 hours, and operate all valves and hydrants in the section being treated in order to disinfect the appurtenances. At the end of this 24 hour period, the disinfecting solution shall have a residual of not less than 25 mg/L free chlorine.
- C. After the completion of the 24 hour period, flush the heavily chlorinated water from the main until the chlorine concentration is less than 4 mg/L. A chlorine residual determination shall be made to ascertain that the chlorine concentration of the water in the new main is compatible with that in the City distribution system.
- D. Do not allow heavily chlorinated water to remain in the pipeline for more than 48 hours. Thoroughly flush chlorinated water from the pipeline until the replacement water will be equal in quality to permanent source of supply throughout the length of the pipeline. Neutralize the chlorinated water by treating with sodium bisulfite, sodium sulfite, sodium thiosulfate or equal approved chemical before disposal.
- E. Provide and install all hoses, equipment, and appurtenances necessary to direct the flushing water to the proper discharge point.
- F. Discharge heavily chlorinated water to sanitary sewers. If sanitary sewers are not available in the area, truck the heavily chlorinated water to a sanitary sewer, or neutralize by treating with one of the chemicals listed in Table 3. Control the rate of discharge to sanitary sewers to prevent surcharging the sewer. Contact and coordinate operations with the Cedar Rapids Sewer Department a minimum of 48 hours prior to discharge into the sanitary sewer.

Table 3. Amounts of Chemicals Required to Neutralize Various Residual Chlorine Concentrations in 100,000 Gallons of Water					
Residual Chlorine Concentration mg/L	Sulfur Dioxide (SO₂) lb	Sodium Bisulfite (NaHSO₃) lb	Sodium Sulfite (Na₂SO₃) lb	Sodium Thiosulfate (Na₂S₂O₃ + 5H₂O) lb	Ascorbic Acid (C₆O₈H₆) lb
1	0.8	1.2	1.4	1.2	2.1
2	1.7	2.5	2.9	2.4	4.2
10	8.3	12.5	14.6	12.0	20.9
50	41.7	62.6	73.0	60.0	104

- G. Protect public and private property from damage during flushing operations.

3.05 FINAL FLUSHING

- A. Once the chlorine content of the flushing water has declined to less than 4 mg/L as determined by the Water Division, direct the water to natural waterways or storm sewer intakes. Direct the flushing water away from the site in a safe and non-destructive manner. Continue flushing to remove debris and sediment from the new main until preliminary grab samples indicate turbidity has been reduced sufficiently to warrant taking samples for laboratory testing. In addition to the end of the new main, open and flush hydrants at intermediate points along the main and all blow-offs on branches.
- B. For systems involving looped water mains, develop a plan for closing valves and flushing the loop to ensure that all parts of the loop are completely flushed. The plan is subject to approval of the Engineer prior to activation.
- C. Flush mains at a velocity of 3.0 feet per second for mains 16 inch diameter or smaller. For larger mains, consult with the Engineer. The rate of flow required to produce a velocity of

3.0 feet per second is shown in Table 4 along with required openings at 40 psi residual pressure to produce this flow.

Table 4. Required Openings to Flush Pipelines (40-psi residual pressure)					
Pipe Dia. (inches)	Flow Rate for Flushing (gpm)	Number of Taps ²			Number of 2 ½" Fire Hydrant Outlets
		1"	1 ½"	2"	
4	120	1	-	-	1
6	260	-	1	-	1
8	470	-	2	-	1
10	730	-	3	2	1
12	1060	-	-	3	2
16	1880	-	-	5	2

1. With 40 psi residual pressure in the main with the fire hydrant flowing to atmosphere, a 2 ½ inch fire hydrant outlet will discharge approximately 1000 gallons per minute. A 4 ½ inch fire hydrant outlet will discharge approximately 2500 gallons per minute.
2. Number of taps on pipe based on discharge through 5 feet of galvanized iron pipe with one 90 degree elbow.

D. Protect public and private property from damage during flushing operations.

3.06 PRESSURE AND LEAK TESTING

- A. Remove debris from within the pipe. Clean and swab out pipe, if required.
- B. Secure unrestrained pipe ends against uncontrolled environment.
- C. Isolate new piping from the existing water system.
- D. Fill and flush all new piping with potable water. Ensure that all trapped air is removed.
- E. Pressurize the new pipe to the test pressure at the highest point in the isolated system. Do not pressurize to more than 5 psi over the test pressure at the highest point in the isolated system.
- F. Test the completed piping system at 1 1/2 times the system working pressure or 150 psi, whichever is greater, for 2 hours.
- G. Monitor the pressure in the line for a period of not less than 2 hours.
- H. If at any time during the test the pressure drops to 5 psi below the test pressure, re-pressurize the pipe by pumping in potable water in sufficient quantity to bring the pressure back to the original test pressure.
- I. Accurately measure the amount of water required to re-pressurize the system to the test pressure.

The following table assumes an average test pressure (P) of 150 psi and 1000 feet of test section.

Table 5. Maximum Allowable Leakage Rate	
Pipe Diameter (inches)	Allowable Leakage Rate (gallons/hour/1000 feet of pipe)
4	0.33
6	0.50
8	0.66
10	0.83
12	0.99
14	1.16
16	1.32
18	1.49
20	1.66
24	1.99
30	2.48
36	2.98

NOTE: For unusual conditions or for waterlines shorter than 500 feet, consult Engineer for allowable leakage rate. The following formula shall apply:

$$L = \frac{(S)(D)(P)^{0.5}}{148,000}$$

Where: L = leakage, allowable, in gallons per hour
 S = length of pipe test section, in feet
 D = pipe diameter, in inches
 P = average test pressure, psig

- J. If the average measured leakage per hour exceeds the maximum allowable leakage rate, repair and retest the water line.
- K. Repair all visible leaks regardless of the amount of leakage.

3.07 BACTERIA SAMPLING

- A. Once preliminary samples indicate turbidity has been reduced sufficiently to warrant laboratory testing, collect samples from blow-offs and hydrants at the end of the main, and at intermediate branches and hydrants. In the case of looped mains, operate valves to ensure samples are drawn from all parts of the new main. Water Division personnel will collect samples in sterile bottles treated with sodium thiosulfate as required by Standard Methods for the Examination of Water and Wastewater (current edition). Do not use hoses in the collection of samples.
- B. After final flushing and before the water main is placed into service, collect two consecutive sets of acceptable samples, taken at least 24 hours apart, from the new water main. Collect a minimum of one set of samples for every 1200 feet of new main, plus one set from the end of the line and at least one set from each branch. Test all samples for bacteriological (chemical and physical) quality in accordance with Standard Methods for the Examination of Water and Wastewater (current edition).

3.08 SPECIAL CONDITIONS

If, during construction, trench water has entered the main, or if in the opinion of the Engineer, excessive quantities of dirt or debris have entered the main, bacteriological samples shall be taken at intervals of approximately 200 feet and shall be identified as to location. Take samples

from water that has stood in the main for at least 16 hours after final flushing has been completed.

3.09 TURBIDITY AND BACTERIOLOGICAL TESTING

- A. The Water Division will test samples for turbidity and bacteriological quality in accordance with Standard Methods for the Examination of Water and Wastewater (current edition) procedures. Turbidity shall be 1.0 NTU or less, and bacteriological tests shall show the absence of coliform organisms. A standard plate count may be required at the option of the Engineer.
- B. If satisfactory turbidity and bacteriological test results are obtained from the initial disinfection process, no further disinfection is required and the Contractor may proceed with pressure testing of the main.
- C. If the test results are not satisfactory, further flushing and testing of the main is required.

3.10 REDISINFECTION

If the initial disinfection fails to produce satisfactory bacteriological samples, re-flush and resample the main. If check samples show the presence of coliform organisms, re-chlorinate the main by the continuous feed or slug method of chlorination until satisfactory results are obtained.

3.11 DISINFECTION PROCEDURES WHEN CUTTING INTO OR REPAIRING EXISTING MAINS

- A. The following procedures apply primarily when mains are wholly or partially dewatered. After the appropriate procedures have been completed, the main may be returned to service prior to completion of bacteriological testing in order to minimize the time customers are out of water.
- B. Leaks or breaks repaired with clamping devices while the mains remain full of water under pressure present little danger of contamination and require no disinfection.
 - 1. Trench Treatment

When an old main is opened, either by accident or design, the excavation will likely be wet and may be badly contaminated from nearby sewers. Liberal quantities of hypochlorite applied to open trench areas will lessen the danger from such pollution. Tablets have the advantage in such a situation because they dissolve slowly and continue to release hypochlorite as water is pumped from the excavation.
 - 2. Swabbing with Hypochlorite Solution

Swab or spray the interior of all pipe and fittings used in making the repair (particularly couplings and sleeves) with a one percent hypochlorite solution before they are installed.
 - 3. Flushing

Thorough flushing is the most practical means of removing contamination introduced during repairs. If valve and hydrant locations permit, flushing toward the work location from both directions is recommended. Begin flushing as soon as the repairs are completed and continue until discolored water is eliminated.

3.12 PUTTING WATER MAIN IN SERVICE

Obtain Engineer's approval to put the completed water system in service.