

**Procedure for
Disinfecting Watermains**

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TS 7.30.01 SCOPE

This procedure covers the disinfection of watermain systems. This procedure applies to new mains, cleaned mains, cleaned and relined mains, repaired mains, temporary mains and mains that have been out of service for a significant period of time.

TS 7.30.02 REFERENCES

Contractors shall be familiar with and comply with the following acts, standards, specifications or publications:

Provincial Statute

Ontario Drinking Water Quality Standards

Ontario Regulation 128/04 Certification of Drinking – Water System Operators and Water Quality Analysts

Ontario Regulation 170/03 Drinking Water Systems
Safe Drinking Water Act, 2002

Ontario Ministry of the Environment and Climate Change

Watermain Disinfection Procedure November 2015

City of Toronto Standard Drawings

T-1104.03-3 Temporary Supply and Disinfection Connections

T-1104.03-4 Temporary Watermain Connection Detail from Watermain

Toronto Water

Practice No. 8 Watermain, Reservoir and Elevated Tank Disinfection

Municipal Drinking Water Licence Number 010-101

Drinking Water Works Permit #010-201

American Water Works Association

B300 Hypochlorites

B301 Liquid Chlorine

C651 Disinfecting Water Mains

C655 Field Dechlorination

M20 Water Chlorination Principle and Practice

AWWA RF Development of Disinfection Guidelines for the Installation and Replacement of Water Mains

NSF International

NSF/ANSI Standard 60 Drinking Water Treatment Chemicals – Health Effects

TS 7.30.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Certified Operator means a person who holds a Class I or higher certificate or license issued under the requirement of O. Reg. 128/04 and who conducts operational checks of or who adjusts, tests, or evaluates a process that controls the effectiveness or efficiency of a subsystem and includes a person who adjusts or directs the flow, pressure or quality of water within the subsystem, if that person works in a 'distribution subsystem' or a 'distribution and supply subsystem'. Note ¹: A person does not need to be certified to take a water sample, which is a different function than conducting a water test, that is to say analysis.

Water Quality Analyst means a person who holds a water quality analyst's certificate issued under section 16 of O. Reg. 128/04 or who holds a conditional water quality analyst's certificate issued under section 17 of O. Reg. 128/04. Note ²: A person does not need to be certified or hold a Water Quality Analyst Certificate to conduct water tests if they are being directly supervised by a certified operator or water quality analyst.

Backflow protected means the prevention of a reversal of normal flow that could introduce contamination to the potable water supply; accomplished by an air gap or a CSA approved backflow preventor selected, inserted and tested according to CSA B64.10, Selection and Installation of Backflow Preventors.

TS 7.30.04 DESIGN AND SUBMISSION REQUIREMENTS – Not Used

TS 7.30.05 MATERIALS

TS 7.30.05.01 Disinfectants

Use sodium hypochlorite that meets or exceeds AWWA B300 and is certified against standard ANSI/NSF 60.

Liquid chlorine (gas) according to AWWA B301 and packaged in steel containers.

Calcium Hypochlorite according to AWWA B300 in 5 gram tablets or granular form with approximately 65 per cent available chlorine by weight.

TS 7.30.05.02 De-chlorinating Agents

For more information on de-chlorinating agents, see AWWA C655.

TS 7.30.06 EQUIPMENT

TS 7.30.06.01 Chlorine Residual Testing

For chlorine residual testing use a DPD drop dilution method for field tests or high-range chlorine test kits according to AWWA C651, Appendix A.

TS 7.30.06.02 Backflow Preventor

Backflow preventor shall be a reduced pressure principle assembly backflow preventor according to CSA B64.10. The backflow prevention valve assembly shall be installed according to drawing T-1104.03-3 and T-1104.03-4.

TS 7.30.07 CONSTRUCTION

TS 7.30.07.01 During Watermain Construction and Rehabilitation

TS 7.30.07.01.01 *Installation of Pipes*

Keep pipes clean and dry. Take precautions to protect the interiors of pipes, fittings, and valves against contamination. Cap all openings with watertight plugs/seals. Remove plugs only when making connections. Complete joints of all pipes in trenches before any stoppage of work, such as at the end of the workday. Pipes shall not be laid in water.

TS 7.30.07.01.02 *Material Handling*

Handle all materials including sealing gaskets and lubricants in a manner to avoid damage and contamination.

TS 7.30.07.01.03 *Precautions before Disinfection*

Contractor shall adhere to the following requirements to ensure proper disinfection:

- a) Complete testing for leakage and allow only one backflow protected feed to the section to be disinfected. Always feed through a by-pass with two isolating valves and backflow preventor according to T-1104.03-3 or T-1104.03-4.
- b) Provide a 50 mm diameter tap with sampling cock and pressure gauge on the dead side of the isolating valve and a 25 mm diameter tap with sampling cock and pressure gauge on the live side of the isolating valve.
- c) Provide a minimum 50 mm diameter blow-off at the end of all pipe sections to be disinfected.
- d) Flush the source water as near the shut-off as possible.

TS 7.30.07.01.04 *Pressure Testing and Disinfection*

The Contractor shall pressure test and disinfect all newly installed water mains, hydrant leads and water services connections 100 mm in diameter and larger.

The large diameter water services 100 mm in diameter and greater shall be pressure tested and chlorinated at the same time as the pressure testing and disinfection of the new mainline water main.

TS 7.30.07.02 Supervision of Disinfection, Inspection, and Testing of Samples

TS 7.30.07.02.01 *Submission of Disinfection Proposal Plan*

Contractor performing the disinfection shall submit *Disinfection Proposal Plan* to the Contract Administrator. The Contract Administrator shall review and sign the proposal plan prepared by the Contractor prior to any work commencing. The proposal plan is to include the following:

- 1) Disinfection criteria, including; watermain dimensions, watermain material, disinfection method, contact time, concentration, receiving location and source of supply water.

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- 2) Disinfection site map and key map, including; location of mainline valves, sodium hypo-chlorite application, de-chlorination agent application, flushing, receiving, live side residual and pressure monitoring and sampling.
 - 3) Calculation sheets including; chemical volumes, watermain volume, flushing discharge rate and chemical application rates.
 - 4) Emergency response for spills and exfiltration to the distribution or transmission systems.
 - 5) Traffic protection plan—in accordance with the *Occupational Health and Safety Act* (OHSA).
 - 6) Confined space entry procedure—in accordance with the OHSA.

If the disinfection proposal is determined to be unsuitable by the Contract Administrator, the *Disinfection Proposal Plan* shall be returned to the Contractor for corrective work to be performed.

If the disinfection proposal is determined to be suitable by Contract Administrator, the *Disinfection Proposal Plan* shall be distributed to the applicable Toronto Water supervisor(s) to notify them of the scheduled disinfection before proceeding with the disinfection.

All valve or flushing operations on the distribution or transmission systems adjacent to the section of watermain to be disinfected will be suspended until the disinfection activity is completed.

TS 7.30.07.02.02 *Supervision, Testing and Records*

The inspector or Contract Administrator shall witness all swabbing and disinfection activities. The Contractor carrying out the disinfection shall take and record the readings on City approved forms. All such records shall be submitted to the inspector or Contract Administrator.

All microbiological samples shall be tested by an accredited laboratory that is licensed by the Ministry of the Environment and Climate Change (MOECC) to test drinking water.

The inspector or Contract Administrator shall witness, confirm and record all disinfection activities including:

- flushing discharge rate;
- sodium hypo-chlorite or chlorine application rate;
- turbidity checked;
- chlorination application time and residual;
- live side residual monitoring;
- 24-hour residual confirmation;
- flushing, to sanitary sewer, time and discharge residual or de-chlorination, to storm sewer, de-chlorination application rate, time and discharge residual;
- flushing residual confirmation;
- sampling time and locations; and
- approvals and notifications.

Forms and test results shall be submitted to the City and retained in the contract files for a period of seven years.

TS 7.30.07.02.03 *Valve Operation*

During the disinfection, a Toronto Water certified operator, certified under Ontario Regulation 128/04, will be on site to operate hydrants and valves on the active distribution system. The Contract Administrator shall notify Toronto Water operations section at least 2 Working Days in advance to make arrangements for the valve operation.

TS 7.30.07.03 *Connection of New Watermain to Watermain in Service*

TS 7.30.07.03.01 *Tapping*

Prior to performing wet taps of any size, the Contractor shall demonstrate that their tapping crews, or a person who will be directly supervising the tapping crews during the wet tapping process, have successfully completed a course on the performance of wet taps identified on the Ontario Water and Wastewater Certification Office director approved course listing. For a listing of director approved courses, go to www.owwco.ca .

Contract Administrator shall retain this documentation in the contract file for a period of seven years.

TS 7.30.07.03.02 *Tapping Sleeves*

For new watermain replacement projects, the Contractor shall use a tapping sleeve and valve to connect to the existing water distribution system along with a by-pass before starting to construct the new watermain.

The pipe surface at the location of the tap shall be cleaned and disinfected using a 5 per cent sodium hypochlorite solution. Where applicable, the drilling, cutting or tapping bits and all surfaces of main stops, service saddles, tapping sleeves and valves which will come into contact with drinking water shall likewise be cleaned and disinfected using a 5 per cent sodium hypochlorite solution immediately prior to installation. If any of the disinfected surfaces come into contact with the soil or water or both in the excavation prior to use, the cleaning and disinfection procedure shall be repeated.

Upon completion of the wet tapping, a coupon for connections 100 mm in diameter and larger shall be provided to the Contract Administrator.

TS 7.30.07.03.03 *Water Service Lines*

Water services less than 100 mm in diameter shall be installed by wet tapping. The Contractor shall only operate the water service main stop and curb stop. All other valve operations shall be completed by a Toronto Water certified operator. The Contact Administrator or inspector shall confirm all wet tapping activities according to this specification herein.

The pipe surface at the location of the tap shall be cleaned and disinfected using a 5 per cent sodium hypochlorite solution. Where applicable, the drilling, cutting or tapping bits and all surfaces of main stops, service saddles, tapping sleeves and valves which will come into contact with drinking water shall likewise be cleaned and disinfected using a 5 per cent sodium hypochlorite solution immediately prior to installation. If any of the disinfected surfaces come into contact with the soil or water or both in the excavation prior to use, the cleaning and disinfection procedure shall be repeated.

Prior to making the connection, the Contractor shall provide each affected customer with a copy of the City's standard notice *Notification to Customer*, advising the customer to flush all their taps prior to using the water.

TS 7.30.08 DISINFECTION PROCEDURE

Refer to MOECC, Watermain Disinfection Procedure and AWWA C651.

TS 7.30.08.01 General

A standard disinfection procedure shall ensure the following:

- a) Preventing contaminating material from entering the watermain during storage, construction, or repair.
- b) Removing, by flushing or other means, those materials that may have entered the watermain.
- c) Protecting the existing distribution system from backflow due to hydrostatic pressure and disinfection procedures.
- d) Chlorinating any residual contamination that may remain, and flushing the chlorinated water from the main.
- e) Following disinfection, determining the bacteriological quality of the water in the main by laboratory testing.
- f) Connecting the approved, disinfected watermain to the active distribution system.

TS 7.30.08.01.01 *Flushing and Swabbing*

Flush and swab new, replaced or relined watermains prior to the start of disinfection. Where achievable, flushing shall attain a scouring velocity of 0.9 m/s. A physical separation shall be maintained at all times between the active (potable) distribution system and the new (installed) watermain.

The physical separation shall consist of two 50 mm ball valves and approved reduced pressure assembly back flow preventer.

When a section of a new watermain is satisfactorily disinfected and the connection(s) to the active (potable) distribution system is completed, it is then considered part of the active (potable) distribution system.

The Contractor shall:

- 1) Confirm watermain is isolated. Blow-off pressure at highpoint of watermain.
- 2) Confirm isolating valve(s) are properly tagged or locked out on site.

Prior to disinfection, all new watermains, service connections, and side street connections 100 mm in diameter and greater shall be swabbed.

Swabbing outlets will connect to the new mains and connections using a 45 degree vertical bend and riser pipe that extends above the surrounding ground surface. Swabbing outlets shall be the same diameter as the pipe to which they are connected.

Swabbing outlets will be mechanically capped prior to and after swabbing to prevent entry of debris into watermains and service connections. During swabbing, discharge water shall be directed to a sanitary sewer inlet or storm sewer inlet, if not chlorinated. Contractor is to take all necessary measures to avoid flooding and erosion of adjacent properties, and build-up of ice during cold weather.

Swabs shall have a diameter 50 mm larger than the pipe that is going to be swabbed. The new watermain and service connections shall be filled with water a minimum of 24 hours in advance of the swabbing operation. Swabs shall be propelled using potable water with sufficient velocity to remove debris from the watermain. The swabbing operation should continue until the discharge water runs clear and the swab is clean. The Contractor shall demonstrate to the Contract Administrator that all swabs or parts thereof have been retrieved from the new watermain.

TS 7.30.08.01.02 *Valve Operation Sequence*

During flushing and disinfection, the new watermain shall be in isolation from the existing water distribution system.

A Toronto Water certified operator, certified under Ontario Regulation 128/04 will operate all distribution and transmission hydrants and valves.

TS 7.30.08.01.03 *Flush to Reduce Turbidity*

Flush the main at all hydrants and blow-offs to eliminate all air pockets and particulates, and to achieve and sustain a turbidity of less than one nephelometric turbidity units (NTU) or, at the City's discretion, no higher than that of the incoming water. Do not proceed with chlorination until these turbidity levels are achieved. Verify that the main to be disinfected is isolated from the system and not pressurized.

TS 7.30.08.02 *Standard Chlorination*

Before beginning chlorination, establish the proper flow rate in the main and adjust the flushing rate and dosage rate as required to achieve the proper chlorine dosage. During the chlorination procedure, perform ongoing residual chlorine checks on the live side of the watermain to ensure there is no leakage or contamination of super chlorinated water entering the active distribution system.

The following two methods of chlorination are acceptable for standard disinfection of watermains including temporary bypass systems.

TS 7.30.08.02.01 *Continuous Feed*

Refer to MOECC, Watermain Disinfection Procedure and AWWA C651.

The flow is adjusted to a constant known rate and sufficient chlorine is added to completely fill the main with chlorinated potable water to produce a homogeneous chlorine solution as specified in Table 1. Once this steady state is achieved the chlorinated water is left standing for a specified minimum contact time. For concentration and contact time see Table 1.

To assure that the desired concentration is achieved, the disinfection crew shall measure the chlorine concentration at regular intervals using the appropriate chlorine test kits. Chlorine application is to continue until the entire main is filled with heavily chlorinated water.

TS 7.30.08.02.01.01 *Free Chlorine Residual at the End of Contact Time*

Successful disinfection is achieved only when the free chlorine residual in the watermain is not allowed to decrease by 40 per cent of the initial chlorine concentration to a maximum of 50 mg/L at the end of the contact time. Perform residual checks on the live side of the watermain during the waiting period to ensure there is no leakage or contamination of super chlorinated water entering the active distribution system.

TS 7.30.08.02.02 *Slug Method*

Refer to MOECC, Watermain Disinfection Procedure and AWWA C651.

Chlorine and water are applied to the main at a constant measured rate so that a solid column of highly chlorinated water is achieved and moved intact along the watermain so that all interior surfaces have a minimum contact time as specified in Table 1.

The free chlorine residual must be monitored as the slug progresses along the main. If the chlorine concentration has decreased by more than 25 milligrams per litre, the flow shall be stopped, the chlorination equipment relocated to the head of the slug, and additional chlorine must be added at the head of the slug to restore the chlorine concentration in the slug to not less than 100 milligrams per litre. As the slug advances along the main, all valves, hydrants and side branches will be exposed to the disinfecting solution.

Table 1: Chlorine concentration and contact time for new watermains¹

Disinfection method	Minimum contact time	Initial chlorine concentration	Maximum allowable decrease in chlorine concentration
tablet or continuous feed	24 hours	≥ 25 mg/L	40% of the initial chlorine concentration to a maximum of 50 mg/L
slug	3 hours	≥ 100 mg/L	25 mg/L
spray	30 minutes	≥ 200 mg/L	Measurement not required

¹ At levels over 10 milligrams per litre, a measurement of total chlorine shall be deemed to be equivalent to a measurement of free chlorine.

TS 7.30.08.03 *Flushing after Disinfection*

Measure the free chlorine residual before beginning the process for final flushing. If after the prescribed minimum contact time the chlorine concentration has not exceeded the maximum allowable decrease in chlorine concentration at all sampling points, flush the heavily chlorinated water from the main through hydrants and blow-offs until the chlorine residual does not exceed 2.0 milligrams/litre or is the same as the chlorine residual level of the incoming water in the active water distribution system and the turbidity is less than one NTU or no higher than incoming water. Once these parameters are achieved, flushing should continue for at least an extra 30 minutes during which the total chlorine residual should consistently be less than 2.0 milligrams/litre. The maximum chlorine residual level in the watermain after final flushing shall be less than 2.0 milligrams/litre or the same as the chlorine residual level of the incoming water at the time of disinfection. Testing of the incoming water for chlorine residual level may be required if the residual chlorine level of the watermain after final flushing exceeds 2.0 milligrams/litre.

If the chlorine residual level is greater than 2.0 milligrams/litre or higher than the chlorinated mains, continue to flush for 30 minutes beyond the achievement of the correct levels.

TS 7.30.08.04 Short Filler Pieces and Appurtenances

Where normal disinfection methods are not possible or work is accomplished in manner that precludes the possibility of contamination of the main, clean short filler pieces—less than one pipe length—and appurtenances, remove dirt and debris and disinfect the entire interior surface area by spraying or swabbing the filler pieces, fittings and couplings with a minimum 5 per cent solution of freshly prepared sodium hypochlorite solution, and flush the affected section of main until the total chlorine residual is equal to the source water.

TS 7.30.08.05 Disposal of Chlorinated Water

After the retention period, discharge chlorinated water into a sanitary sewer. If a sanitary sewer is not available, do not discharge to a storm sewer, open ditch or watercourse unless the chlorinated water has been de-chlorinated. A list of de-chlorinating (neutralizing) agents may be found in AWWA C655. All discharges must comply with Toronto Municipal Code, Chapter 681 Sewers.

TS 7.30.09 BACTERIOLOGICAL AND WATER QUALITY SAMPLING

TS 7.30.09.01 Qualified Persons

All sampling and associated chlorine residual testing shall be performed by a certified operator or water quality analyst or by a person who is being directly supervised by a certified operator or water quality analyst.

TS 7.30.09.02 Water Sampling and Analytical Tests

Collect samples from points along the main, including both ends. At least one set of samples shall be collected from every 350 metres of the main and one set from each branch. In areas where the Contract Administrator suspects possible contamination, sampling shall be taken at intervals no greater than 60 metres.

After de-chlorination and flushing of the watermain and if the turbidity count is less than or equal to one NTU and the chlorine residual is less than 2.0 ppm (milligrams/litre), the first set of samples at all sampling points shall be collected according to AWWA C651. A second set of samples shall be collected from the new watermain that has stood for at least 16 hours after the first set of samples is collected.

All samples shall be collected in a manner as to avoid contamination from the environment surrounding the main. Collect samples for bacteriological analysis in sterile bottles treated with sodium thiosulfate according to Section 9060 *Standard Methods for the Examination of Water and Wastewater*. Do not obtain samples from a hose or fire hydrant unless there are no alternative sampling points available.

TS 7.30.09.03 Re-disinfection

If the initial disinfection fails to produce satisfactory results for all samples, re-flush and re-sample, or re-disinfect the main as required by the Contract Administrator. If check samples also fail to produce acceptable results, disinfect the main again until satisfactory results are obtained.

To confirm the source water parameter levels, take samples representative of the water in an unaffected part of the distribution system, upstream of the newly disinfected main (upstream samples).

TS 7.30.09.04 Sampling for Short Filler Pieces and Appurtenances

A Toronto Water Certified Operator shall obtain two samples from the filler piece for bacteriological testing using either Option A – samples taken 16 hours apart or Option B – samples taken 15 minutes apart after a 16 hour rest period according to AWWA C651, Section 5.10, as deemed appropriate by the Certified Operator.

TS 7.30.09.05 Water Quality Parameters for Disinfection Approval

Table 2 represents results deemed acceptable for placing the watermain back in service.

Table 2: Water quality parameters for disinfection approval

Parameter	Standard
Total Coliform	0/100 ml
E. Coli	0/100 ml
Background Colony Counts	≤ 20/100 ml
Heterotrophic Plate Counts	≤ 50/1 ml
Total Chlorine Residual	0.5 to 2.0 mg/L
pH Level	7.0 – 8.5
Turbidity	≤ 1.0 NTU

Match the chlorine residual levels of the incoming water of the water distribution system at the time of disinfection. If a chlorine residual level of 0.50 milligram/litre cannot be reached, continue to flush the main until the chlorine residual level is equal to the chlorine residual level in the existing water distribution system at the time of disinfection.

While samples meeting the above criteria are indicative of a satisfactory disinfection, Toronto Water – District Operations may apply discretion and approve disinfections where a certain non-health related parameter, like turbidity is not met due to incoming water quality.

TS 7.30.09.06 Test Results

Fax copies of all laboratory water quality test results to the Contract Administrator.

Upon receipt of the water quality test results, the Contract Administrator will determine if the test results are satisfactory. The Contract Administrator will provide a copy of the test results to Toronto Water. On receipt of confirmation of satisfactory results from the Contract Administrator, Toronto Water staff will put the new main into service.

TS 7.30.10**DISINFECTION OF WATERMAINS IN EMERGENCY SITUATIONS**

When an existing watermain develops a leak and repairs are required, upon completion of the excavation, a Certified Operator shall conduct a visual inspection to determine the nature of the break. The Certified Operator shall assess the evidence of contamination or potential contamination of the watermain before and during the repair procedure, and shall classify the break into one of two categories.

TS 7.30.10.01 Category 1

Watermain breaks with no evident or suspected contamination are classified as Category 1. Follow the steps described in section 3.2 and 3.3 according to MOECC Watermain Disinfection Procedure.

Contamination is typically not suspected for circumferential breaks or small leaks where flow is maintained from the break until an air gap is established and where the air gap is maintained during the repair procedure. If, at any time, contamination is evident or suspected, the break shall be reclassified as Category 2.

TS 7.30.10.02 Category 2

Watermain breaks with evident or suspected contamination are classified as Category 2. Watermain repairs involving more than six metres of replaced pipe are also classified as Category 2. Follow the steps described in section 3.2 and 3.4 according to MOECC Watermain Disinfection Procedure.