

**Construction Specification for the
Cleaning and Cement Mortar Lining
of Cast Iron and Ductile Iron Watermains**

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TS 7.10.01 SCOPE

The specification covers the cleaning and cement mortar lining of the various sizes of pipes and performing the following operations: cutting the pavement, excavation, cutting the pipe, dewatering, replacement of necessary valves or valve parts, replacement of hydrants, cleaning the pipe, disposal of water and waste products from cleaning operations, placing the cement-mortar lining, curing and protection of the lining, clearing of services, chlorination, flushing, back-filling of the excavation, permanent repairs to the pavement, permanent repairs to the boulevard, clean-up of the site of the work, the guarantee and all other incidental work and expenses.

The work involved requires special equipment to be handled by persons experienced in all phases of the work.

TS 7.10.01.01 Operation of Valves and Hydrants

The operation of all live valves and hydrants, in connection with cleaning and lining watermains, disinfection, shall be done by a crew certified under Ontario Regulation 128/04, or under the direct supervision of the Contract Administrator.

TS 7.10.01.02 Continuity of Work

The Contract Administrator reserves the right to limit or restrict the amount of work being carried out simultaneously in any area or on any street or adjacent street.

TS 7.10.02 REFERENCES

This specification refers to the following standards, specifications or publications:

City of Toronto Standard Specifications

TS 7.30 Procedure for Disinfecting Watermains

Provincial Statute

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

American Society of Testing and Materials

C10 Standard Specification for Natural Cement
C150 Standard Specification for Portland Cement

NSF International

NSF/ANSI Standard 61 Drinking Water System Components – Health Effects

TS 7.10.03 DEFINITIONS – Not Used

TS 7.10.04 DESIGN AND SUBMISSION REQUIREMENTS – Not Used

TS 7.10.05 MATERIALS – Not Used

TS 7.10.06 EQUIPMENT – Not Used

TS 7.10.07 CONSTRUCTION

TS 7.10.07.01 Temporary By-Pass Line

Temporary by-pass lines shall be supplied by connections at each end of the line where practical. Where the ends are at different pressure districts, a check valve shall also be installed. Valves shall be installed in the by-pass in the vicinity of existing main line valves on the line being cleaned and lined and also where 50 mm by-pass connects into 100 mm and by-pass line or at such other locations as the Contract Administrator may direct. The existing watermain shall not be removed from the service until the Contract Administrator has approved the installed by-pass line. Payment for the temporary by-pass watermain will be prorated based on the estimated quantity of watermain in the Pricing Form and length of existing watermain taken out of service and only paid when placed in service.

The Contractor shall maintain the temporary water service lines in a safe operative condition at all times and shall be responsible for the prevention of injury to persons and damage to property. The Contractor shall provide safeguards, but such provisions shall not relieve the Contractor of full responsibility for the adequacy of protection.

The Contractor must repair any leaks that are found or that may develop on any portion of the temporary by-pass pipe. If a leak is not repaired, the Contract Administrator may deduct from the Contractor's progress payment the cost of the water lost as a result of the leak. Moreover, should it be necessary for City forces to repair any portion of the by-pass system as a result of the Contractor not responding within a 2 hour period, any costs incurred by the City for such repairs will be deducted from the Contractor's progress payment.

TS 7.10.07.02 Temporary Service Connections

Twenty percent of all temporary service connection materials should conform to the NSF/ANSI 61 standard. All hose used for individual property connections, shall be minimum 20 mm internal diameter, designed for a working pressure of 860 kPa, free from defects in material and workmanship.

The pipe, hose and all other materials which are to be furnished by the Contractor for use in conjunction with the temporary service pipe and temporary connections to property services and branches shall be approved by the Contract Administrator, and shall be fully adequate to withstand the pressures and all other conditions of use and shall be of material which does not impart any taste or odour to the water in accordance with NSF/ANSI 61 standard.

The pipe and fittings shall provide adequate water tightness and care shall be exercised throughout the installation of any temporary pipe and service fittings to avoid the possible pollution of any City main or property services or contamination of the temporary service pipe proper. Flushing of the private service connections and chlorination of the by-pass line prior to their use will be required. The temporary service connections shall be valved near the point of connection to the by-pass and also to the private plumbing system so that both the by-pass line and private services may be chlorinated except for the final connection.

During freezing, stormy or inclement weather, no work shall be done except that which is incidental to cleaning or lining, unless otherwise directed by the Contract Administrator. No by-pass service pipe or property service connections shall be installed during freezing or inclement weather and pipes already in use shall be removed or drained and services restored when so directed by the Contract Administrator. Removal and re-installation of such pipes or services shall be done at the Contractor's expense.

Each home shall have its own temporary water service connection to the by-pass pipe and a connection to the private plumbing via a wye at an outside tap. The branching of wyes from a single spigot shall not be permitted; nor will connecting homes in series.

It shall be the responsibility of the Contractor to ensure an adequate water supply at all times. During the construction process, the Contractor will be responsible to restore a customer's water supply within a two hour time period upon notification from the Contract Administrator.

TS 7.10.07.03 Temporary Hydrants

The Contractor shall supply, install and maintain temporary fire hydrants and the necessary valves and fittings. These temporary hydrants shall be connected to 100 mm diameter by-pass pipe and placed in locations as instructed by the Contract Administrator. The temporary hydrants shall be 62 mm nozzles with 5-threads per 25 mm. The operating nuts shall be 32 mm square. The hydrants will be set in such a manner that the Toronto Fire Services will have no difficulty making a connection with a fire hose, and where they will cause least obstruction to vehicular and pedestrian traffic and will be least likely to be damaged. Temporary fabricated fire hydrants are acceptable. A sketch of the hydrant the Contractor proposes to use must be submitted prior to commencement of work.

All temporary hydrants, valves, fittings, and service pipe and all other material shall be adequate to withstand the pressures and conditions of use and shall provide adequate water-tightness. Before permanently shutting down the watermain that is to be cleaned and lined, the Contractor shall test all temporary hydrants and valves to be sure that they are in proper working order.

All temporary hydrants must have reflective tape on the barrel for increased visibility. The temporary hydrants must stand in an upright position at all times.

Once put into use, the temporary hydrants shall be maintained until the existing hydrants are restored to service. The hydrants which are out of service during construction operations shall be bagged and clearly marked with a "Hydrant Out of Service" tag.

TS 7.10.07.04 Burying By-Pass

The Contractor shall cut and remove asphalt across streets to permit burying the by-pass pipe without disturbing the concrete base, and shall replace the asphalt when the pipe is removed. Under no circumstance is a pipe road crossing to remain open and unprotected from vehicular and pedestrian traffic.

TS 7.10.07.05 Connection to Hydrants

All temporary by-pass service attachments to fire hydrants shall be made with an approved back-flow prevention device and shall be made in such a manner that if it becomes necessary they can be easily removed so that the hydrant can be used for fire fighting purposes.

TS 7.10.07.06 Disinfection of Temporary By-Pass/Service Connections

For more information see section TS 7.10.07.24.

TS 7.10.07.07 Operation of Service Box(es)

The Contractor shall locate inspect and ensure that all curb stops operate properly in advance of working on the street. During construction, if a curb box becomes inoperable, the Contractor may be required to repair the curb box by an approved method. The Contractor shall adjust curb boxes to grade where necessary. Before carrying out the repair of curb boxes the Contractor shall submit a list of defective curb boxes for inspection and approval by the Contract Administrator.

TS 7.10.07.08 Shut-off of Water Services

The Contractor shall make all shut-offs of property services and shall furnish water for the temporary by-pass service from a hydrant or other temporary source.

TS 7.10.07.09 Protection of Public

The Contractor shall be required, at no extra cost to the City, to mound over the by-pass pipe with asphalt or other acceptable material, wherever it crosses a street, driveway or sidewalk in order to prevent injury to pedestrians or damage to vehicles. The use of a polyethylene sheet shall be required as a barrier on concrete or interlocking driveways or both. If the work performed or the material used or both is not to the satisfaction of the Contract Administrator, action will be taken to rectify the problem to ensure the safety of the public. All costs incurred in the rectification shall be deducted from the Contractor's progress payment.

Safety flashers and barricades as may be required shall be furnished and maintained by the Contractor. In general, the temporary service pipe shall be laid where it will cause the least obstruction and is least liable to get damaged.

TS 7.10.07.10 Access Pits

The Contractor should use locations of existing tees, crosses, and reducers as access pits locations. When an access pit is excavated and a fitting is contained within it, the Contractor is to replace the fitting and the costs associated with this work must be included in the lining item. The Contractor shall note that the locations for all access pits shall be approved by the Contract Administrator prior to the beginning of construction.

All excavation and restoration of access pits for the purpose of watermain cleaning and lining shall be included in the applicable tender item. The Contractor shall use existing valve, bend and tee locations as access pits as often as possible. The excavation of additional access pits as a result of unforeseen or unknown pipe characteristics will be payable under the applicable tender item.

Valves or fittings or both in close proximity to access pits may require bracing. This work is to be carried out by the Contractor at no extra cost to the City.

TS 7.10.07.11 Cutting of Pipe

Pipes shall be cut by power operated pipe cutting machines, or other approved methods.

TS 7.10.07.12 Method of Cleaning

All rust, tubercles, deposits, loose or deteriorated remains of original coating and other foreign materials shall be removed from the inside of the pipe and valves by water-propelled cleaning devices, scrapers or other approved methods. The Contractor shall pass the cleaning device through the main as many times as is necessary to obtain results satisfactory to the Contract Administrator. To confirm satisfactory cleaning, the Contractor may be requested to undertake a video inspection of the watermain according to section TS 7.10.07.22.

Payment for closed circuit television inspection shall be made at the unit price of the applicable tender item.

Cleaning operations shall be carried out in a manner that will avoid the application of vertical or horizontal loads on the pipe.

Boxes of adequate size with compartments or other suitable and approved means shall be provided to function as settling tanks for the retention of solids removed during cleaning, flushing and pumping operations.

TS 7.10.07.13 Bulkheads on Open Pipe Ends

All pipes shall be bulkheaded using a mechanical joint plug/cap anytime there is no work being performed on the pipe. The bulkhead must be capable of preventing water from entering or exiting the watermain pipe, and should be equipped with a relief valve.

TS 7.10.07.14 Cement Mortar for Lining

All cement mortar for the lining shall be proportioned by volume and shall be of the proper consistency to provide a dense, homogeneous lining which will hold itself firmly against the pipe surface. The cement and sand for the mortar lining shall be mixed in the proportions of one part cement to one and one quarter (1¼) parts of screened sand by volume, the exact proportions to be determined by the characteristics of the sand available for the work.

Alternately the Contractor may submit for the approval of the Contract Administrator a proposed pre-mixed mortar.

Under no circumstances will the Contractor be permitted to use or introduce any chemical or additives of any kind unless written approval from the Contract Administrator has been obtained prior to its application.

TS 7.10.07.14.01 Cement

Portland cement shall meet the requirements of ASTM C150.

Natural cement shall meet the requirements of ASTM C10.

TS 7.10.07.14.02 *Sand*

Sand shall be manufactured sand and shall be well graded, having clean, hard, durable, uncoated grains, free from organic matter, shale, clay lumps, coal, soft or flaky particles and other unsound or deleterious substances, and shall be delivered to the site in sealed bags.

TS 7.10.07.14.03 *Water*

Water shall be clean and free from injurious ingredients.

TS 7.10.07.14.04 *Natural Cement*

Natural cement may be used in the proportion of up to one bag natural cement to five bags of Portland cement. No mortar which has attained its initial set shall be used.

TS 7.10.07.14.05 *Thickness and Placing of Cement-Mortar Lining*

The lining shall consist of a one-course application of pre-mixed cement mortar 5 mm thick and shall be placed by a machine propelling the mortar against the wall of the pipe and long radius bends, by centrifugal force, without injurious rebound and with sufficient velocity to cause the mortar to be densely packed and to adhere in place. The travel of the machine and the rate of discharge of mortar shall be controlled so as to produce a uniform thickness of lining around the perimeter and along the length of pipe.

TS 7.10.07.14.06 *Tolerance*

The permissible tolerance on the lining thickness shall be ± 1.5 mm.

TS 7.10.07.14.07 *Trowelling*

The cement mortar lining machine shall be provided with attachments for mechanically trowelling the mortar to produce a smooth surface finish and shall travel ahead of the lining, so that the freshly placed and trowelled mortar will not be touched until it has set. The design of the trowel attachment shall be such as to permit operations in pipes which may be out of round, as well as to permit trowelling through bends that deflect up to and including 22 ½ degrees. Mortar of improper consistency, that does not provide a dense, homogeneous lining which will hold itself firmly against the pipe surface, and all waste materials, spatter, etc., shall be removed from the pipe. Only mortar of suitable consistency and applied with sufficient velocity to adhere firmly to the surface of the pipe shall form the lining. The finished surface shall be smooth and shall not have a sand finish.

Untrowelled sections of watermain will not be permitted unless directed by the Contract Administrator. If any section of the lining fails or shows evidence of failure or unusual irregularity, the faulty section of lining shall be removed to the extent indicated by the Contract Administrator and the pipe re-cleaned and the lining replaced. When lining stub ends of a watermain, the maximum length of stub should not exceed 3 m.

TS 7.10.07.14.08 *Hand Work*

Edges of linings at openings or ends of lined sections shall be neatly finished. Edges shall be rounded or bevelled so as to avoid sharp angles or abrupt changes of sections which may tend to cause failure of the lining or offer resistance to flow. Surfaces of cement mortar lining to which additional mortar is to be placed shall be moistened just before the mortar is applied.

Hand finishing work in a section of the pipeline shall be completed within 24-hours after the machine application of the mortar lining to that particular section of the pipeline has been completed.

TS 7.10.07.15 *Closing of Pipe*

Immediately upon completion of the cement-mortar lining of a length of watermain, all openings in the main shall be closed to prevent circulation of air according to section TS 7.10.07.13. The Contractor must supply, install and remove bulkheads on all watermain openings when not performing parts of the work at such openings.

TS 7.10.07.16 *Mortar to be Kept Damp*

As soon as practicable, thereafter, water shall be introduced into the mortar-lined section between bulkheads or valves, in order to maintain a moist atmosphere.

TS 7.10.07.17 *Protection of Lining*

Should the lining be damaged as a result of negligence of the Contractor, or reveal evidence of defective work or materials prior to the completion of the Contract, such damaged or defective portions shall be removed and replaced at the Contractor's expense.

TS 7.10.07.18 *Service to be Back Flushed*

When the lining has achieved sufficient set, all services shall be back flushed by water or other approved method to remove any mortar deposited in them.

TS 7.10.07.19 *Cleaning of Valve Seats*

After placing the cement-mortar lining, mortar shall be removed from the seats and guides of valves that have been lined through and do not require replacement.

TS 7.10.07.20 *Water Service Cleaning*

TS 7.10.07.20.01 *Method A – Sandblasting from the Water Meter*

Small copper water services up to and including 25 mm in diameter are to be cleaned from the water meter to the watermain. Water meters removed for this operation by the Contractor must be resealed by the Contractor. The Contractor will be required to carry out this cleaning while the temporary bypass is operational. Any damage done to the private water system will be repaired by the Contractor at no extra cost to the City.

Sandblasting shall consist of the Contractor connecting a minimum 150 cfm air compressor and introduce one cup of silica sand into the water service. Compressed air must be sent through the water service for at least two minutes, at a minimum pressure of 480 kPa (70 psi).

Locations where the water services are galvanized or lead, or where the water meter is not accessible are to be provided to the Contract Administrator. The Contract Administrator will determine if further work is required. Payment will be made only for the water services successfully cleaned by sand blasting.

TS 7.10.07.20.02 *Method B – Air Blasting*

Air blasting shall consist of the Contractor connecting to the private plumbing system with a minimum 150 cfm air compressor. Compressed air must be sent through the water service for at least two minutes, at a minimum pressure of 480 Kpa (70 psi). During this procedure, arrangements must be in place to provide an exit point for air introduced via an opening in the watermain or an open hydrant.

Locations where the water services or portions of the internal plumbing are galvanized or lead are to be provided to the Contract Administrator. The Contract Administrator will determine if further work is required. Payment will be made only for the water services successfully cleaned by air blasting.

TS 7.10.07.21 **Obstruction in Water Services**

Should any services be partially or fully obstructed due to the ingress of foreign materials it shall be the Contractor's responsibility to remove such obstructions in a manner approved by the Contract Administrator. Where an excavation of a water service is required and not caused by the negligence of the Contractor, payment will be made at the Contract Price.

TS 7.10.07.22 **Closed Circuit Television Inspection**

Close circuit television (CCTV) inspections shall be carried out by the Contractor at the request of the Contract Administrator on cleaned or newly lined sections or both of watermain pipe to ensure proper cleaning or mortar application or both. All water shall be removed prior to the inspection of the main.

All CCTV inspections (video and report) shall conform to the following specifications:

- 1) Equipment shall be suitable for viewing the full perimeter of pipe with diameters ranging from 150 to 300 mm, using a suitable colour camera, with cables capable of inspecting a maximum watermain length of 200 m.
- 2) The inspection must be carried out at in the presence of the Contract Administrator's representative at such a speed to allow proper analysis of the lining condition, to a maximum of 10 m/min. The camera shall provide sufficient light and proper focus to enable clear viewing of the pipe surface. The video inspection equipment shall be disinfected prior to insertion into the watermain and care shall be taken to avoid contamination of the main during inspection.
- 3) All inspections must be recorded, in their entirety, on a brand name (high-grade) VHS T-120 videocassette tape. Only new tapes shall be used. The video image must be recorded on CD for submission to the City.

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- 4) The video inspection shall contain the street name, locations of point of exit/entry into the pipe (tied in to municipal addresses or valve chambers), and continuous chainage titles on video overlay.

The length of watermain to be video inspected following cleaning or lining or both is anticipated to amount to approximately 25 per cent of the total length of rehabilitated watermain. Additional testing and inspections necessitated by unsatisfactory results shall be carried out at no extra cost to the City.

TS 7.10.07.23 Repair of Pipe

Upon application of the cement-mortar lining, the openings in the main shall be closed as soon as possible using cast or ductile iron cement-lined pipe or PVC pipe and approved couplings, unless otherwise directed by the Contract Administrator. When using PVC pipe, approved restrainers shall be used to carry out the repair. In all cases a jumper wire must be thermite welded to either sides of the repair and an anode installed. This work shall be done before 24 hours has elapsed following the cement lining of the watermain.

TS 7.10.07.24 Disinfection

Disinfection shall be according to TS 7.30.

TS 7.10.07.25 Removal of By-Pass and Temporary Services

After the tests on all water samples have been approved, the watermain shall be flushed, water service connections restored, excavations backfilled, the watermain returned to service and the temporary service lines removed.

The contractor will be permitted to reuse temporary by-pass service connections previously disinfected without re-disinfecting provided that precautions are taken, to avoid the potential for contamination, that include: immediately capping each end of the temporary by-pass service prior to storage and reuse; and storing the temporary service lines in a manner that will lessen the likelihood of contamination.

Prior to the reconnection of the previously disinfected temporary service connection, the connection ends of the service pipe must be submerged in a 5 per cent sodium hypochlorite solution. The service pipe must then be flushed, the outside hose bib and “Y” connector sprayed with a 5 per cent sodium hypochlorite solution before final hook up of the temporary service pipe to provide service.

The Contractor shall satisfactorily restore the permanent property connections and leave streets, sidewalks and adjacent property in a neat and orderly condition.

Any valves, corporation stops or other appurtenances which have been damaged due to cleaning and lining operations shall be replaced at no extra cost to the City.

TS 7.10.08 QUALITY ASSURANCE – Not Used

TS 7.10.09 MEASUREMENT FOR PAYMENT

TS 7.10.10 BASIS OF PAYMENT

TS 7.10.10.01 Cleaning and Cement Mortar Lining of Cast Iron and Ductile Iron Watermains

Payment at the Contract Price shall be full compensation for all labour, Equipment and Material to do the work.

TS 7.10.10.02 Temporary By-Pass Line – Item

Payment at the Contract Price for the above tender item shall be full compensation for all labour, Equipment and Material to do the work.

The work includes the following operations: installing the temporary line, temporary fire hydrants and connections, valves and check valves where required, supply connections, chlorination, protection of the installation from damage, temporary shut-off of private services by operation of curb-stops or such other means as required, removal of temporary service connections and by-pass line and restoration of the site upon completion of the work.

TS 7.10.10.03 Obstructions in Water Services – Item

Payment at the Contract Price for the above tender item shall be full compensation for all labour, Equipment and Material to do the work.

The work includes cutting pavement, excavating and removing restrictions in main stops or services or replacing the main stop, reconnecting the service, backfilling and restoration.