



ONTARIO PROVINCIAL STANDARD SPECIFICATION

OPSS.PROV 441
APRIL 2025

(Replaces OPSS.PROV 441, April 2017, with minor formatting changes only.)

CONSTRUCTION SPECIFICATION FOR WATERMAIN INSTALLATION IN OPEN CUT

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441.01 SCOPE

This specification covers the requirements for the installation of watermains, service connections, and associated appurtenances in open cut.

441.02 REFERENCES

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

Ontario Provincial Standard Specifications, Construction

OPSS 206	Grading
OPSS 401	Trenching, Backfilling, and Compacting
OPSS 404	Support Systems
OPSS 490	Site Preparation for Pipeline, Utilities, and Associated Structures
OPSS 491	Preservation, Protection, and Reconstruction of Existing Facilities
OPSS 492	Site Restoration Following Installation of Pipelines, Utilities, and Associated Structures
OPSS 493	Temporary Potable Water Supply Services
OPSS 510	Removal

OPSS 517 Dewatering of Pipeline, Utility, and Associated Structure Excavation
OPSS 539 Temporary Protection Systems

Ontario Provincial Standard Specifications, Material

OPSS 1004 Aggregates - Miscellaneous
OPSS 1301 Cementing Materials
OPSS 1302 Water
OPSS 1350 Concrete - Materials and Production
OPSS 1842 Pressure Polyethylene Pipe Products

CSA Standards

B64.5-11 Double Check Valve (DCVA) Backflow Preventers [Part of B64 Series-11, Backflow Preventers and Vacuum Breakers Compendium]
B137.1-09 Polyethylene Pipe, Tubing and Fittings for Cold-Water Pressure Services [Part of B137-09, Thermoplastic Pressure Piping Compendium]
B137.2-09 Polyvinyl Chloride (PVC) Injection-Moulded Gasketed Fittings for Pressure Applications [Part of B137-09, Thermoplastic Pressure Piping Compendium]
B137.3-09 Rigid Polyvinyl Chloride (PVC) Pipe and Fittings for Pressure Applications [Part of B137-09, Thermoplastic Pressure Piping Compendium]
B137.3.1-09 Molecularly Oriented Polyvinyl Chloride (PVCO) Pipe and Fittings for Pressure Applications [Part of B137-09, Thermoplastic Pressure Piping Compendium]
B137.10-09 Crosslinked Polyethylene/Aluminum/Crosslinked Polyethylene Composite Pressure-Pipe Systems [Part of B137-09, Thermoplastic Pressure Piping Compendium]

ASTM International

A153M-09 Zinc Coating (Hot Dip) on Iron and Steel Hardware
A276-10 Stainless Steel Bars and Shapes
A307-10 Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength
B88-09 Seamless Copper Water Tube
B633-11 Electrodeposited Coatings of Zinc on Iron and Steel
B766-86 (2008) Electrodeposited Coatings of Cadmium
C361-11 Reinforced Concrete Low-Head Pressure Pipe
D3139-98 (2011) Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals

American Water Works Association (AWWA)

C104/A21.4-08 Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water
C110/A21.10-08 Ductile-Iron and Gray-Iron Fittings for Water
C111/A21.11-07 Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
C151/A21.51-02 Ductile-Iron Pipe, Centrifugally Cast, for Water
C153/A21.53-06 Ductile-Iron Compact Fittings for Water Service
C200-05 Steel Water Pipe - 6 In. (150 mm) and Larger
C205-07 Cement-Mortar Protective Lining and Coating for Steel Water Pipe - 4 in. (100 mm) and Larger
C206-11 Field Welding of Steel Water Pipe
C208-07 Dimensions for Fabricated Steel Water Pipe Fittings
C301-07 Prestressed Concrete Pressure Pipe, Steel-Cylinder Type, for Water and Other Liquids

C302-11	Reinforced Concrete Pressure Pipe, Non-Cylinder Type
C303-08	Concrete Pressure Pipe, Bar-Wrapped, Steel-Cylinder Type
C502-05	Dry-Barrel Fire Hydrants
C504-10	Rubber-Seated Butterfly Valves
C509-09	Resilient-Seated Gate Valves for Water Supply Service
C510-07	Double Check Valve Backflow Prevention Assembly
C800-05	Underground Service Line Valves and Fittings
C900-07	Polyvinyl Chloride (PVC) Pressure Pipe, and Fabricated Fittings, 4 in.-12 in. (100 mm - 300 mm), for Water Transmission and Distribution
C905-10	Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 350 mm Through 1,200 mm (14 in. Through 48 in.) for Water Transmission and Distribution
C907-12	Injection-Molded Polyvinyl Chloride (PVC) Pressure Fittings, 4 in.-12 in. (100 mm - 300 mm), for Water Distribution
C909-09	Molecularly Oriented Polyvinyl Chloride (PVCO) Pressure Pipe, 100 mm Through 600 mm (4 in. Through 24 in.), for Water Distribution

American Society of Mechanical Engineers (ASME)

B18.2.1-2010	Square, Hex, Heavy Hex, and Askew Head Bolts and Hex, Heavy Hex, Hex Flange, Lobed Head, and Lag Screws (Inch Series)
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NSF International

61-2008	Drinking Water System Components - Health Effects
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441.03 DEFINITIONS

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

Associated Appurtenance means structures, devices, and appliances, other than pipe and conduit, which are used in connection with a water distribution system, such as valves, hydrants, corporation cocks, services, and thrust restraints.

Backfilling means the operation of filling a trench with bedding, cover, and backfill material, or embedment and backfill material.

End Covers means temporary cover installed at the factory over both ends of uninstalled watermain pipe to prevent the entry of contaminants during shipping and storage.

Excavation, Earth and Rock means the excavation classified as earth and rock according to OPSS 206.

Fitting means connections, appliances, and adjuncts designed to be used in connection with pipe: for example, elbows and bends to alter the direction of a pipe; tees and crosses to connect a branch with a main; plugs and caps to close an end; and bushings, diminishers, or reducers to couple two pipes of different diameters.

Service Connection means the system used to supply water from the watermain to the property line.

Service Connection Appurtenance Set means the main stop, curb stop, couplings, service box, service box support, and service saddle used in the installation of a service connection.

Watermain means an installation designed for the conveyance of water under pressure using circular pipe.

441.05 MATERIALS

441.05.01 General

The pipe size shall be according to the size specified in the Contract Documents. Pipe type and class shall be as specified in the Contract Documents.

Fittings shall be suitable for and compatible with the pipe material and class with which they are used. All material for watermain shall be NSF/ANSI 61 compliant.

441.05.02 Ductile Iron Pipe

Ductile iron pipe shall be according to AWWA C151/A21.51.

Fittings shall be gray iron according to AWWA C110/A21.10 or ductile iron according to AWWA C110/A21.10 or AWWA C153.

Ductile iron pipe and fittings shall be cement lined according to AWWA C104/A21.4.

Rubber gaskets for push-on or mechanical joints shall be according to AWWA C111/A21.11.

441.05.03 Concrete Pressure Pipe

Concrete cylinder pipe including joints and fittings shall be according to AWWA C301 or AWWA C303.

Non-cylinder pipe and joints shall be according to AWWA C302 or ASTM C361. Fittings shall be according to AWWA C302.

441.05.04 Polyvinyl Chloride Pipe

441.05.04.01 General

Flexible elastomeric seals for bell and spigot joints shall be according to ASTM D3139.

Fittings for polyvinyl chloride (PVC) and molecularly oriented polyvinyl chloride (PVCO) pipe shall be either:

- a) Gray iron according to AWWA C110/A21.10.
- b) Ductile iron according to C110/A21.10 or AWWA C153 and shall be cement lined according to AWWA C104/A21.4.
- c) Injection moulded polyvinyl chloride, blue in colour and according to AWWA C907 and CSA B137.2.
- d) Prefabricated polyvinyl chloride, blue in colour and according to AWWA C905 and CSA B137.3.

441.05.04.02 Polyvinyl Chloride Pipe (PVC)

Polyvinyl chloride pipe shall be according to AWWA C900 or AWWA C905 and CSA B137.3, and shall be blue in colour and supplied complete with gaskets.

441.05.04.03 Molecularly Oriented Polyvinyl Chloride Pipe (PVCO)

Molecularly oriented polyvinyl chloride pipe shall be according to AWWA C909 and CSA B137.3.1, and shall be blue in colour and supplied complete with gaskets.

441.05.05 Polyethylene Pipe

Polyethylene pressure pipe shall be according to OPSS 1842.

Fittings shall be either:

- a) Flanged gray iron according to AWWA C110/A21.10.
- b) Flanged ductile iron according to AWWA C110/A21.10 or AWWA C153 and shall be cement lined according to AWWA C104/A21.4.
- c) Polyethylene according to OPSS 1842.
- d) Heat fusion or insert or compression type fittings according to CSA 137.1.

441.05.06 Steel Pipe

Steel pipe shall be according to AWWA C200. Fittings shall be according to AWWA C208. Steel pipe shall have a cement-mortar protective lining and coating according to AWWA C205.

441.05.07 Copper Pipe

Copper pipe for service connections shall be according to ASTM B88 and shall be type K soft copper.

441.05.08 Composite Pipe

Crosslink polyethylene/aluminum/crosslink polyethylene composite pressure pipe for service connections shall be according to CSA B137.10.

441.05.09 Valves

441.05.09.01 General

All valves shall open by operating in a counter clockwise direction.

Valves shall be designed for a minimum cold water working pressure of 1,035 kPa.

Valve types shall be one of the following:

- a) Valves less than 75 mm shall be brass or bronze gate valves.
- b) Valves greater than or equal to 75 mm, and less than or equal to 300 mm, shall be cast or ductile iron gate valves.
- c) Valves greater than 300 mm up to and including 500 mm shall be gate or butterfly valves.
- d) Valves greater than 500 mm shall be butterfly valves.

Fasteners shall be made from material meeting the strength requirements of ASTM A307 with dimensions according to ASME B18.2.1. Bolts, studs, and nuts shall be cadmium plated according to ASTM B766 or zinc coated according to ASTM A153 or ASTM B633. Fasteners for mechanical joints shall be ductile iron according to AWWA C111/A21.11.

441.05.09.02 Service Line Valves

Valves shall be according to AWWA C800. Type, pressure class, and end connections shall be as specified in the Contract Documents.

441.05.09.03 Gate Valves

Gate valves shall be according to AWWA C509.

Stem sealing on non-rising stem valves shall use O-ring type seals that do not require adjustment.

The gate valve end configuration shall be as specified in the Contract Documents.

441.05.09.04 Butterfly Valves

Butterfly valves shall be according to AWWA C504.

Valves shall be short body flanged or mechanical-joint, class 150B.

Valve shafts shall be stainless steel and, when they project through the body, shall have seals that do not require adjustment.

A vertical operating nut shall be provided. Valves shall be provided with an external indicator showing valve position by means of a pointer operating through a 90° arc from open to close.

441.05.09.05 Air Release and Air/Vacuum Valves

Air release and air/vacuum valves shall be single acting type.

441.05.10 Hydrants

Hydrants shall be according to AWWA C502. The type shall be as specified in the Contract Documents.

441.05.11 Double Check Valve Backflow Preventers

Double check valve backflow preventers shall be according to CSA B64.5 or AWWA C510.

441.05.12 Service Connection Fittings and Appurtenances

Main stops, curb stops, couplings, service boxes, and service saddles shall be as recommended by the manufacturer of the service connection pipe.

441.05.13 Concrete

Concrete for thrust blocks and fitting and appurtenance supports shall be according to OPSS 1350 with a nominal minimum 28-Day compressive strength of 20 MPa.

441.05.14 Mortar

Mortar for joints shall be composed of one part Portland cement and three parts mortar sand, wetted with sufficient water to make the mixture plastic.

The mortar sand shall be according to OPSS 1004, the Portland cement shall be according to OPSS 1301, and the water shall be according to OPSS 1302.

441.05.15 Straps, Tie-Rods, Angles, Nuts, and Bolts

Stainless steel straps, tie-rods, angles, nuts, and bolts used with concrete thrust blocks shall be according to ASTM A276, Type 316 stainless steel.

441.07 CONSTRUCTION

441.07.01 General

The work for the installation of watermain shall include all watermain pipe, bends, tees, fittings, and thrust restraints and the testing of the watermain system.

The interior of all pipe, fittings, and other accessories shall be kept clean and free from undesirable material at all times.

441.07.02 Site Preparation

Site preparation shall be according to OPSS 490.

441.07.03 Removals

Removals shall be according to OPSS 510.

441.07.04 Preservation and Protection of Existing Facilities

Preservation and protection of existing facilities shall be according to OPSS 491.

441.07.05 Protection Against Floatation

Damage to the pipeline due to floatation shall be prevented during construction and until completion of the works.

441.07.06 Cold Weather Work

All work shall be protected from freezing. Pipe and bedding material shall not be placed on frozen ground.

441.07.07 Transporting, Unloading, Storing, and Handling Pipe

All pipe, fittings, and gaskets that are unsound or damaged shall be rejected.

All pipe up to and including 600 mm diameter shall be delivered to the Work Area with end covers and a tamper evident seal on only the bell end. These components shall adhere sufficiently to withstand the stresses caused during shipment.

A waterproof seal is not required on the end covers.

Tamper evident seals shall display the manufacturers name or logo or both. Seals shall straddle the end cover and the pipe. Removal of the cover shall render the tamper evident seal unusable either by breaking the seal or by leaving a message such as "VOID" on the pipe. Tamper evident seals are not required for non-reusable heat shrink plastic covers or foam plugs with punch-out centres.

Pipe delivered to the construction site with damaged or missing end covers shall be field cleaned to remove all undesirable material along the entire length of the interior of the pipe and the end covers reinstalled.

Manufacturer's recommendations for transporting, unloading, storing, and handling of materials shall be followed.

441.07.08 Excavation

Excavation for the installation of watermain shall be according to OPSS 401.

441.07.09 Support Systems

Support systems shall be according to OPSS 404.

441.07.10 Dewatering

Dewatering shall be according to OPSS 517.

441.07.11 Temporary Protection Systems

The construction of temporary protection systems shall be according to OPSS 539.

When the stability, safety, or function of an existing roadway, railway, watercourse, other works, or proposed works may be impaired due to the method of operation, protection shall be provided. Protection may include sheathing, shoring, and piling when necessary to prevent damage to such works or proposed works.

441.07.12 Temporary Potable Water Supply Services

Temporary potable water supply services shall be according to OPSS 493.

441.07.13 Backfilling and Compacting

Backfilling and compacting shall be according to OPSS 401.

441.07.14 Installation of Pipe

Pipe shall be laid in a dry trench.

Pipe shall be laid within the alignment and grade tolerances specified in the Contract Documents. The barrel of each pipe shall be in contact with the shaped bed throughout its full length.

When the Owner raises or lowers the invert of a watermain by up to 150 mm, it shall not constitute a Change in the Work and no adjustment shall be made to the payment. When the invert of a watermain is raised or lowered by more than 150 mm, then this shall constitute a Change in the Work for the full extent of the change from the original grade.

Pipe shall be kept clean and dry as work progresses. A removable watertight bulkhead shall be installed at the open end of the last pipe laid whenever work is suspended.

Pipe shall not be laid until the preceding pipe joint has been completed and the pipe carefully embedded and secured in place.

441.07.15 Jointing

441.07.15.01 General

End covers shall be removed immediately prior to jointing. Joint surfaces shall be clean. Pipe ends shall be lubricated with material recommended by the pipe manufacturer.

Manufacturer's instructions for jointing pipe shall be followed.

Joints and all connections shall be made watertight.

All bolts, nuts, couplings, rubber rings, and connecting pieces shall be cleaned thoroughly before installation.

Pipe shall be aligned on centreline to previously laid pipe.

Pipe shall be pulled or pushed only by a hand-operated winch. A backhoe shall not be used for pushing pipe.

Joints shall be prevented from opening after the pipe has been laid.

441.07.15.02 Ductile Iron Pipe

Mechanical Joints:

The gland shall be positioned on the pipe with the lip extension toward the joint. The gasket shall be slipped on the pipe with the thick edge towards the gland. The spigot end shall be pushed to its seat in the bell. The gasket shall be pressed to seat it evenly around the joint.

The gland shall be positioned for bolting and the bolts shall be inserted. All nuts shall be hand tightened.

The nuts shall be tightened half a turn at a time with a calibrated torque wrench. All nuts shall be tightened uniformly to the torque specified in AWWA C111/A21.11.

Bell and Spigot Joints:

The gasket shall be placed in the groove of the bell making certain it is properly seated.

The gasket shall be lubricated.

Pipe to be joined shall be aligned and the spigot shall be carefully entered into the bell until the spigot end just makes contact with the gasket.

The entry of the spigot into the bell shall be completed by hand or by the use of a hand operated winch until the second reference mark is flush with the face of the bell.

441.07.15.03 Concrete Pressure Pipe

Bell and Spigot Joints:

A cotton or burlap diaper shall be placed around the bell end of the pipe already in place.

A rubber gasket shall be placed on the spigot end of the pipe to be laid ensuring that the stretch and volume of the gasket is equalized around the entire circumference of the pipe. The gasket and spigot shall be lubricated prior to the spigot end being inserted home into the bell end.

The pipe shall be aligned, and the spigot end shall be inserted into the bell of the pipe already in place.

Steel inserts shall be placed in the joints to prevent the spigot from entering the full depth of the bell. The location of the rubber gasket shall be checked around the entire circumference of the joint. The steel insert shall be removed, and the pipe pushed until the spigot enters the full depth of the socket and is retained in position.

Ensure that the diaper is carefully placed around the joint recess. Cement mortar shall be poured around the assembled joint.

441.07.15.04 Polyvinyl Chloride Pressure Pipe - PVC and PVCO

Joints shall be bell and spigot with rubber gaskets. If gaskets are supplied separately, they shall be inserted in the groove of the bell end of the pipe.

The spigot shall be lubricated. The spigot end shall be inserted and pushed into the bell up to but not beyond the depth of the stop reference mark.

441.07.15.05 Polyethylene Pressure Pipe

Polyethylene pipe 100 mm diameter and larger shall be joined by the thermal butt fusion process. Procedures recommended by the pipe manufacturer shall be followed.

Polyethylene pipe 75 mm diameter and smaller shall be joined with heat fusion or insert or compression type fittings that are recommended by the pipe manufacturer and that prevent pull-out and resist creep deformation at full test pressure.

Connections to non-polyethylene fittings and appurtenances 50 mm diameter and larger shall be made with flanged joints according to the manufacturer's recommendations. Bolts shall be tightened to the torque specified by the manufacturer for the particular size and type of stub end.

441.07.15.06 Steel Pipe

Steel pipe shall be jointed according to AWWA C200. Field welding for joints shall be according to AWWA C206.

441.07.15.07 Service Connection Pipe

Service connection pipe shall be jointed as recommended by the manufacturer.

441.07.16 Cutting of Pipe

Whenever cutting of pipe is required, the pipe shall be cut according to the recommendations of the pipe manufacturer. After cutting the pipe, the interior of the pipe shall be cleaned and the end cover replaced until the pipe is installed.

441.07.17 Change in Line and Grade

441.07.17.01 Ductile Iron Pipe

Fabricated bends shall be provided for changes in line and grade of 11.25° or more.

Deflections of less than 11.25° may be made using a series of pipe joint deflections. The manufacturer's recommendation in deflecting any single pipe joint shall not be exceeded.

441.07.17.02 Concrete Pressure Pipe

Fabricated bends, bevel adaptors, or elbows shall be used for changes in line or grade greater than 5°. Changes in line or grade less than 5° shall be made using a manufactured joint or bevel connection or may be made over several joints. The manufacturer's joint deflection recommendations shall not be exceeded.

441.07.17.03 Polyvinyl Chloride Pipe - PVC and PVCO

Polyvinyl chloride pipe joints may be deflected but shall not exceed the manufacturer's recommendations. Otherwise, fabricated bends shall be used.

441.07.17.04 Polyethylene Pipe

Use of pipe flexibility may be allowed but shall not exceed the manufacturer's recommendations.

441.07.17.05 Steel Pipe

Fabricated bends shall be used at all changes in line or grade, unless the change can be accomplished by deflections at pipe joints without exceeding the manufacturer's recommendation for deflection at pipe joints.

441.07.18 Installation of Valves and Fittings

441.07.18.01 General

The work for the installation of valves and fittings shall include the valves and couplings and valve boxes, when valve boxes are specified in the Contract Documents. Valves and fittings shall be installed in locations and be of the type specified in the Contract Documents. Valves and connecting pipe shall be aligned accurately and supported as specified in the Contract Documents. Valves and fittings do not require end covers but shall be field cleaned prior to installation.

441.07.18.02 Air Release and Air/Vacuum Valves

Air release and air/vacuum valves shall be installed at locations specified in the Contract Documents.

Each air release and air/vacuum valve shall be provided with an isolating valve.

441.07.19 Installation of Hydrant Sets

The work for the installation of hydrant sets shall include the placing of hydrants, hydrant isolating valves, hydrant leads, restraining devices, and support devices.

Hydrant sets shall be installed at locations specified in the Contract Documents.

The hydrant shall be plumb with the nozzles parallel to the edge of pavement or curb line and the pumper connection facing the roadway.

441.07.20 Installation of Service Connections

A service connection shall consist of a service connection pipe and a service connection appurtenance set and shall be installed at locations and be of the size specified in the Contract Documents.

Service connection pipe shall be installed by pressure tap connection or saddles. Service connections on plastic watermain shall be installed using service saddles or tapped couplings.

Curb stop valve boxes shall be installed vertically and flush with the final grade elevation.

441.07.21 Shutting Down or Charging Mains

At no time shall watermain be shut down or charged or valves operated without permission from the Contract Administrator.

441.07.22 Connections to Existing Watermain

The work of connecting to existing watermain shall include the removal of all plugs, caps, blow offs, and thrust blocks from an existing watermain or fitting, and the installation of the connection.

All connections to existing watermain shall be made under the supervision of the Contract Administrator.

441.07.23 Thrust Restraints

All connections, caps, and bends shall be restrained by concrete blocking and/or restrained joints as specified in the Contract Documents. Concrete for thrust blocks shall be placed against undisturbed ground. Joints and couplings shall remain free from concrete. Only restrained joint products specifically designed for use with the pipe material shall be used.

441.07.24 Hydrostatic Testing

441.07.24.01 General

Hydrostatic testing shall be conducted under the supervision of the Contract Administrator upon completion of the watermain, including services and backfilling.

A test section shall be either a section between valves or the completed watermain.

Test pressure shall be 1,035 kPa.

The test section shall be filled slowly with water and all air shall be removed from the pipeline. A 24-hour absorption period may be allowed before starting the test. The test section shall be subjected to the specified continuous test pressure for 2 hours.

441.07.24.02 Polyethylene Pipe

The test procedure shall consist of initial expansion and test phases.

During the initial expansion phase, the test section shall be pressurized to the test pressure and sufficient make-up water added each hour for 3 hours to return to test pressure. The test phase begins after the initial expansion phase.

The test phase shall be 2 hours after which a measured amount of make-up water is added to return the test pressure. If the amount of make-up water added does not exceed the value in Table 1, leakage is not indicated.

If the amount of make-up water exceeds the Table 1 value, all leaks shall be located and repaired, and the test section shall be retested until a satisfactory result is obtained.

The test duration should not exceed 8 hours. If the pressure test is not completed, the test section shall be depressurized and allowed to relax for at least 8 hours before bringing the test section up to pressure again.

441.07.24.03 Other Pipe

A period of 24 hours shall be allowed before starting the test.

The test section shall be subject to the specified continuous test pressure for 2 hours.

The leakage is the amount of water added to the test section to maintain the specified test pressure for the test duration. The measured leakage shall be compared with the allowable leakage as calculated for the test section. The allowable leakage is 0.082 litres per millimetre of pipe diameter per kilometre of pipe for the 2-hour test period.

If the measured leakage exceeds the allowable leakage, all leaks shall be located and repaired, and the test section shall be retested until a satisfactory result is obtained.

441.07.25 Flushing and Disinfecting Watermains

Flushing and disinfecting operations shall be conducted under the supervision of the Contract Administrator. The watermain shall be flushed to achieve a minimum velocity of 0.76 m/sec otherwise the watermain shall be swabbed. The Contract Administrator shall be notified at least 2 Business Days in advance of the proposed date on which flushing and disinfecting operations are to commence.

Watermains shall be flushed in a sequence approved by the Contract Administrator. The Contract Administrator may permit or require the flushing to be carried out in stages as sections of the system are completed. Flushed sections shall be protected from contamination.

After flushing is completed, water from the existing distribution system shall be allowed to flow at a controlled rate into the new pipeline. Liquid chlorine solution shall be introduced so that the chlorine is distributed throughout the section being disinfected. The chlorine shall be applied so that the chlorine concentration is 50 mg/litre minimum throughout the section. The system shall be left charged with the chlorine solution for 24 hours.

Sampling and testing for chlorine residual shall be carried out by the Contract Administrator. The chlorine residual shall be tested in the section after 24 hours. If tests indicate a chlorine residual of 25 mg/litre minimum, the section shall be flushed completely and recharged with water normal to the operation of the system. If the test does not meet the requirements, the chlorination procedure shall be repeated until satisfactory results are obtained.

Twenty-four hours after the system has been recharged, the Contract Administrator shall take samples for bacteriological tests. Samples shall be collected from every 350 m of the new watermain plus one sample from the end of each of the line and at least one sample from each branch. If there is indication of contamination, the disinfection procedure shall be repeated.

The system shall not be put into operation until approval has been given by the Contract Administrator.

441.07.26 Site Restoration

Site restoration shall be according to OPSS 492.

441.07.27 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

All chlorinated water used for testing, flushing, or disinfecting watermains shall be disposed of safely.

The method of disposal of chlorinated water is subject to the approval of the Contract Administrator.

441.09 MEASUREMENT FOR PAYMENT

441.09.01 Actual Measurement

441.09.01.01 Watermains

Measurement of watermains shall be by length in metres along the horizontal centreline of the pipe from the point of connection to a chamber, water treatment plant, or existing watermain to a point vertically above the end of the new watermain.

441.09.01.02 Valves

For measurement purposes, a count shall be made of the number of valves installed, regardless of the type and size.

441.09.01.03 Hydrant Sets

For measurement purposes, a count shall be made of the number of hydrant sets installed, regardless of the type.

441.09.01.04 Service Connection Pipe

Measurement of service connection pipe shall be by length in metres along the horizontal centreline of the pipe from the point of connection at the watermain to a point vertically above the end of the service connection.

441.09.01.05 Service Connection Appurtenance Sets

For measurement purposes, a count shall be made of the number of service connection appurtenance sets installed.

441.09.01.06 Connections to Existing Watermains

For measurement purposes, a count shall be made of the number of connections made to existing watermains.

441.09.02 Plan Quantity Measurement

When measurement is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

441.10 BASIS OF PAYMENT

- 441.10.01 Watermains - Item**
Valves - Item
Hydrant Sets - Item
Service Connection Pipe - Item
Service Connection Appurtenance Sets - Item
Connections to Existing Watermains - Item

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

TABLE 1
Test Phase Make-Up Amount for Pressure Polyethylene Pipe

Pipe Diameter (mm)	Make-Up Water (litre/km)
30	12.38
40	12.38
50	13.62
75	18.60
100	31.00
150	74.50
200	124.20
250	161.40
275	248.30
300	285.60
350	335.20
400	409.70
450	533.90
500	682.90
550	869.10
600	1,105.00
700	1,378.20
800	1,775.50
900	2,234.90
1,000	2,731.60
1,050	3,104.00
1,200	3,973.20
1,350	5,152.70
1,600	7,449.70