



**CONSTRUCTION SPECIFICATION FOR  
PIPE SEWER INSTALLATION IN OPEN CUT**

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**410.01 SCOPE**

This specification covers the requirements for the installation and inspection of storm and sanitary pipe sewers, laterals, service connections, and concrete appurtenances in open cut.

**410.01.01 Specification Significance and Use**

This specification is written as a provincial-oriented specification. Provincial-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of the Ontario Ministry of Transportation.

Use of this specification or any other specification shall be according to the Contract Documents.

## **410.01.02 Appendices Significance and Use**

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

## **410.02 REFERENCES**

When the Contract Documents indicate that provincial-oriented specifications are to be used and there is a provincial-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.PROV, unless use of a municipal-oriented specification is specified in the Contract Documents. When there is not a corresponding provincial-oriented specification, the references below shall be considered to be to the OPSS listed, unless use of a municipal-oriented specification is specified in the Contract Documents.

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 407	Maintenance Hole, Catch Basin, Ditch Inlet, and Valve Chamber Installation
OPSS 409	Closed-Circuit Television Inspection of Pipelines
OPSS 490	Site Preparation for Pipelines, 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 510	Removal
OPSS 517	Dewatering of Pipeline, Utility, and Associated Structure Excavation
OPSS 539	Temporary Protection Systems
OPSS 904	Concrete Structures
OPSS 905	Steel Reinforcement for Concrete

### **Ontario Provincial Standard Specifications, Material**

OPSS 1004	Aggregates - Miscellaneous
OPSS 1205	Clay Seal
OPSS 1301	Cementing Materials
OPSS 1302	Water
OPSS 1350	Concrete - Materials and Production
OPSS 1440	Steel Reinforcement for Concrete
OPSS 1801	Corrugated Steel Pipe Products
OPSS 1820	Circular Concrete Pipe
OPSS 1840	Non-Pressure Polyethylene Plastic Pipe Products
OPSS 1841	Non-Pressure Polyvinyl Chloride (PVC) Pipe Products

OPSS 1843 Non-Pressure Polypropylene (PP) Plastic Pipe Products  
OPSS 1860 Geotextiles

### CSA Standards

B182.1-11 Plastic Drain and Sewer Pipe and Pipe Fittings  
[Part of B1800-11, Plastic Non-Pressure Pipe Compendium]  
G401 Corrugated Steel Pipe Products

### ASTM International

B 746 Corrugated Aluminum Alloy Structural Plate for Field-Bolted Pipe, Pipe-Arches, and Arches;  
C 507-12 Reinforced Concrete Elliptical Culvert, Storm Drain, and Sewer Pipe

### Other

WRc Manual of Sewer Condition Classification (MSCC), Fourth and/or Third Edition

## 410.03 DEFINITIONS

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

**Acceptable Pipe Condition Status** means the assessment designation assigned to an installed gravity pipe installation that has no deficiencies.

**Aluminum Alloy** means a material made with two or more metals in which aluminum is the predominant metal.

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

**CCTV** means closed-circuit television used to inspect a gravity pipe installation.

**Certification Body** means an independent 3rd party agency accredited by the Standards Council of Canada that has the qualifications, skills, and expertise required to confirm that a pipe manufacturer produces pipe products to the quality and requirements of an accepted standard and that has the mandate to certify the pipe products produced.

**Certified** means pipe products that have been marked with a certification body's logo confirming that the production of the pipe product is in accordance with the quality and requirements of the manufacturing standard.

**Concrete Appurtenances** means concrete head walls, cut-off walls, stiffeners, aprons, collars, and any other concrete fixtures associated with the pipe sewer, excluding concrete bedding or concrete structures specified in the Contract Documents.

**Delivered Quality** means the pipe products' physical condition upon arrival at the construction site in terms of the extent and degree of dents, scratches, cracks, pipe coating integrity, etc., that appear on the pipe products delivered.

**Dimension Ratio** means the average specified outside diameter of a pipe divided by the minimum specified wall thickness.

**Drainage Structure** means a maintenance hole, catch basin, or ditch inlet.

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

**Flexible Pipe** means pipe that can deflect 2% or more without cracking, such as polyvinyl chloride or polyethylene or steel pipe.

**Gravity Pipe Installation** means a constructed pipe system conveying surface waters under the influences of gravity only and can be a pipe sewer or a pipe culvert.

**Inspection Assessment** means evaluating the findings of a post installation inspection and quantifying the pipe condition status of the gravity pipe installation.

**Laser Profiler** means an instrument that uses a light ring to survey, locate, measure and report profile, deflection and dimensional attributes, including anomalies, in a gravity pipe installation.

**Mandrel** means an instrument equipped with an odd number of arms that is pulled through a flexible gravity pipe installation to determine deflection anomalies.

**NASSCO** means the National Association of Sewer Service Companies which certifies inspectors to perform inspection of pipe sewers and culverts and code viewed pipe conditions.

**Pipe Class** means a pipe's physical material specification, such as load and pressure ratings, wall thickness, protective coatings, corrugation profiles, ring stiffness constants, and reinforcement.

**Pipe Condition Coding** means the assignment of code designations to pipe attributes such as pipe materials, walls, joints, service connections or any other physical pipe characteristics.

**Pipe Condition Status** means the designation assigned to the gravity pipe installation based on the assessment of the post installation inspection results.

**Pipe Condition Assessment Rating** means the final gravity pipe installations' acceptance rating that is given to the pipe based on the evaluation of the final post installation inspection results inclusive of both original and additional test segments from the post installation inspection, referee post installation inspection and follow up repair inspection.

**Pipe Run** means a section of a pipe sewer between two drainage structures or between a drainage structure and an outlet.

**Pipe Sewer** means an installation designed for the conveyance of sanitary sewage or storm water using preformed or precast pipe sections, circular or non-circular in cross-section, laid end to end using suitable jointing material and connected by maintenance holes for sanitary pipe sewers and by maintenance holes, catch basins, ditch inlets, or concrete appurtenances for storm pipe sewers.

**Pipe Type** means a pipe's inner wall design, which can be smooth or corrugated.

**Polypropylene Plastic** means a material made with virgin polymers in which propylene is essentially the sole monomer.

**Post Installation Inspection** means quantifying the final installed condition of gravity pipe installations using accepted surveillance and measuring methods.

**Reject Pipe Condition Status** means the designation assigned to an installed gravity pipe installation, pipe lengths, pipe fittings and/or pipe service connections that have deficiencies that cannot be repaired to maintain the structural integrity or design service life of the gravity pipe installation or has certain measurable pipe attributes that are beyond Owner acceptance limits.

**Repair Pipe Condition Status** means the designation assigned to an installed gravity pipe installation, pipe lengths, pipe fittings and/or pipe service connections that have deficiencies that can be repaired to maintain the structural integrity and design service life of the gravity pipe installation.

**Repaired Pipe Condition Status** means the designation assigned to installed gravity pipe installations, pipe lengths, pipe fittings and/or pipe service connections with a Repair Pipe Condition Status that have been repaired using acceptable intrusive repair measures.

**Replacing** means the removal of any gravity pipe installations, pipe lengths, pipe fittings and/or pipe service connections and reinstalling the gravity pipe installation, pipe lengths, pipe fittings and/or pipe service connections to contract specifications.

**Service Connection** means the pipe used to convey sanitary sewage or storm water from the property line to the main sanitary or storm pipe sewer respectively.

**Threshold Pipe Condition Status** means the designation assigned to an installed gravity pipe installation, pipe lengths, pipe fittings and/or pipe service connections that have certain measurable pipe attributes that are beyond accepted construction limitations but are still within Owner acceptance limits and requires no remediation actions.

**Test Segment** means an individual sewer pipe run or pipe culvert that has been selected to have a post installation inspection performed on it.

**Visual Observation Inspection** means coding and describing the profiles, deflection and dimensional features, including anomalies, in a gravity pipe installation using direct human entry into the pipe sewer run or pipe culvert.

**Zoom Camera** means a stationary video camera fitted with a tele-objective zoom lens and high-powered floodlights and used to inspect a gravity pipe installation.

## **410.05 MATERIALS**

### **410.05.01 Pipe Materials**

#### **410.05.01.01 General**

Pipe sewer size, type, and class shall be as specified in the Contract Documents.

Pipe sewer size and class shall be consistent throughout a pipe run as specified in the Contract Documents. Pipe type shall be consistent throughout a pipe sewer as specified in the Contract Documents.

Fittings shall be suitable for and compatible with the pipe type and class for which they will be used.

#### **410.05.01.02 Concrete Pipe**

Circular concrete pipe and joints shall be according to OPSS 1820.

Elliptical concrete pipe and joints shall be according to ASTM C 507.

#### **410.05.01.03 Corrugated Steel Pipe Products**

Corrugated steel pipe products shall be according to OPSS 1801.

Steel structural plate pipe with polymer coating shall be according to CSA G401.

#### **410.05.01.04 Polyethylene Pipe Products**

Polyethylene pipe products shall be according to OPSS 1840.

#### **410.05.01.05 Polyvinyl Chloride Pipe Products**

Polyvinyl chloride pipe products shall be according to OPSS 1841.

Polyvinyl chloride service connection pipe shall be according to CSA B182.1 and shall have bell and spigot joints with elastomeric gaskets.

#### **410.05.01.06 Polypropylene Plastic Pipe Products**

Polypropylene plastic pipe products shall be according to OPSS 1843.

#### **410.05.01.07 Aluminum Alloy Pipe Products**

Corrugated aluminum alloy structural plate pipe products shall be according to ASTM B746.

All corrugated aluminum alloy structural plate pipe products used on the Contract shall be certified and supplied from a manufacturer that produces the corrugated aluminum alloy structural plate pipe products according to ASTM B746. Only products with an accepted certification body logo marking as shown in Figure 1 shall be used.

Inspection, testing, and record keeping for corrugated aluminum alloy structural plate pipe products shall be according to ASTM B746.

Certified corrugated aluminum alloy structural plate pipe shall be marked according to ASTM B746, and shall include as a minimum the logo of the certification body and name of the pipe manufacturer.

When requested by the Owner, a copy of the certificate of compliance issued by the certification body confirming that the manufacturer produces certified corrugated aluminum alloy structural plate pipe products shall be submitted to the Contract Administrator.

The cost of all testing, except that performed in the Owner's laboratory, shall be included in the price.

Where the delivered quality of certified corrugated aluminum alloy structural plate pipe products is deemed to be unacceptable by the Contract Administrator, the products shall be rejected.

#### **410.05.02 Mortar**

Mortar for joints shall be composed of one part normal Portland cement and two parts mortar sand, wetted with only sufficient water to make the mixture plastic. The mortar sand shall be according to OPSS 1004, the normal Portland cement shall be according to OPSS 1301, and the water shall be according to OPSS 1302.

#### **410.05.03 Clay Seal**

Clay seal material shall be according to OPSS 1205.

#### **410.05.04 Concrete**

Concrete for concrete appurtenances shall be according to OPSS 1350 with a nominal minimum 28-Day compressive strength of 30 MPa.

**410.05.05 Steel Reinforcement**

Steel reinforcement shall be of the size and grade specified in the Contract Documents and shall be according to OPSS 1440.

**410.05.06 Geotextile**

Geotextile shall be according to OPSS 1860.

**410.07 CONSTRUCTION**

**410.07.01 Site Preparation**

Site preparation shall be according to OPSS 490.

**410.07.02 Removals**

Removals shall be according to OPSS 510.

**410.07.03 Preservation and Protection of Existing Facilities**

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

**410.07.04 Protection Against Floatation**

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

**410.07.05 Cold Weather Work**

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

**410.07.06 Transporting, Unloading, Storing, and Handling Pipe**

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

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

**410.07.07 Excavation**

Excavation for the placement of pipe sewers shall be according to OPSS 401.

**410.07.08 Support Systems**

Support systems shall be according to OPSS 404.

**410.07.09 Dewatering**

Dewatering shall be according to OPSS 517.

#### **410.07.10 Protection Systems**

The construction of all protection systems shall be according to OPSS 539. When the stability, safety, or function of an existing roadway, railway, other works, or proposed works may be impaired due to the method of operation, such protection as may be required shall be provided. Protection may include sheathing, shoring, and the driving of piles, when necessary, to prevent damage to such works or proposed works.

#### **410.07.11 Backfilling and Compacting**

Backfilling and compacting shall be according to OPSS 401.

#### **410.07.12 Pipe Installation**

##### **410.07.12.01 General**

If a universal dimple coupler or any other coupler does not follow the contour of the flexible pipe sections to be joined, polyethylene gaskets shall then be installed at all joints when such couplers are used. Polyethylene gaskets shall be installed symmetrically about the pipe joint, between the coupler and the pipe, and shall be of sufficient length to equal the circumference of the pipe plus a minimum overlap of 300 mm.

Pipe shall be laid within the alignment and grade tolerances specified in the Contract Documents. When bell and spigot pipe is laid, the bell end of the pipe shall be laid upgrade.

Pipe shall be kept clean and dry as work progresses. The trench shall be kept dry. 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 is carefully embedded and secured in place.

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

When installing gaskets, all pipe ends shall be thoroughly cleaned. For gaskets requiring field lubrication, a lubricant recommended by the pipe manufacturer shall be used.

When gaskets have been affixed, the pipe shall be handled in a way so that the gasket is not damaged, displaced, or contaminated with foreign matter. Any gasket displaced or contaminated shall be removed, cleaned, and lubricated, if required, and reinstalled before closure of the joint is attempted. When specified in the Contract Documents, nitrile gaskets shall be used.

The pipe shall be properly positioned by means of an appropriate mechanism. Sufficient pressure shall be applied in making the joint to ensure that the joint is in position. Sufficient restraint shall be applied to the line to ensure that joints are held in this position.

Once the pipe has been jointed, a test shall be made with a feeler gauge at intervals around the joint to ensure that the gasket has not been displaced from the spigot groove. If the gasket is found out of position, the joint shall be opened and the gasket placed in its proper position. If necessary, a new gasket shall be installed.



**410.07.12.02                      Circular Concrete Pipe**

All circular concrete pipe joints shall have elastomeric gaskets.

**410.07.12.03                      Non-Circular Concrete Pipe**

Elliptical concrete pipes and joints shall be used for storm pipe sewers only.

All non-circular concrete pipe joints shall be according to the procedures recommended by the manufacturer.

**410.07.12.04                      Corrugated Steel Pipe Products**

Corrugated steel pipe products shall be used for storm pipe sewers only.

Helical corrugated steel pipe without rerolled ends shall be installed so that the helix angle is constant for the total length of the installation. Each pipe section shall be installed next to the previous section so that the lockseam forms a continuous helix. For rerolled ends, the correct fit of the coupling system does not depend on the location of the helical lockseam and corrugation.

Corrugated steel pipe sections shall be joined by means of steel couplers. The couplers shall be installed to lap approximately equal portions of the pipes being connected so that the corrugations or projections of the coupler properly engage the pipe corrugations. As the coupler is being tightened, it shall be tapped with a mallet to take up the slack.

When joint seals are specified in the Contract Documents, they shall be installed immediately prior to the installation of steel couplers.

**410.07.12.05                      Polyethylene Pipe**

Polyethylene pipe shall be jointed by one of the following methods, as recommended by the manufacturer:

- a) Bell and Spigot
- b) Welded Joint
- c) Thermal Fusion Joint
- d) Screw-on Coupler
- e) Split Coupler
- f) Threaded Joint
- g) Mechanical Restrained Joint with Gasket

**410.07.12.06                      Polyvinyl Chloride Pipe**

Polyvinyl chloride pipe shall be jointed, as recommended by the manufacturer, using a bell and spigot joint with an elastomeric gasket.

At the end of a day's work, the last pipe shall be blocked as may be required to prevent movement.

#### **410.07.12.07 Polypropylene Pipe**

Polypropylene pipe shall be jointed by means of a bell and spigot joint with elastomeric gasket or a coupler joint as recommended by the manufacturer to satisfy the pipe joint specification.

#### **410.07.12.08 Corrugated Aluminum Alloy Structural Plate Pipe**

Corrugated aluminum alloy structural plate pipe shall be jointed by means of bolts as recommended by the manufacturer to satisfy the pipe joint specification.

#### **410.07.13 Service Connections**

Service connections to the main pipe sewer shall be made using factory made tees or wyes, strap-on-saddles, or other approved saddles. Factory made tees or wyes shall be used for all service connections when the diameter of the main pipe sewer is:

- a) less than 450 mm; or
- b) less than twice the diameter of the service connection.

Strap-on-saddles shall be installed before laying the pipe.

Holes in the main pipe sewer shall be cut with approved cutters and shall be the minimum diameter required to accept the service connection saddle. If mortar-on saddles are used, the inside of the pipe shall be mortared at the connection.

Service connections shall be plugged at the property line with watertight caps or plugs. Plugs or caps shall be braced sufficiently to withstand test pressures.

When existing service connections shall be connected to new pipe sewers or service connections, proper jointing procedures shall be used.

#### **410.07.14 Marking and Recording Service Connections**

A painted temporary location marker consisting of a 50 x 75 mm stake or two short sections of lumber connected by a piece of heavy gauge wire shall be placed at the end of the plugged or capped service connection. The marker shall be placed from 300 mm below the finished grade to a point 300 mm above the plugged end of the service pipe.

A painted surface stake, 50 x 75 x 450 mm long, shall be placed after trench restoration.

Service connections shall not be backfilled until they have been inspected and measurements of location have been taken by the Contract Administrator.

#### **410.07.15 Breaking into Maintenance Holes, Catch Basins, Ditch Inlets, Pipe Culverts, and Pipe Sewers**

Openings shall be made as necessary in an existing maintenance hole, catch basin, ditch inlet, pipe culvert, or pipe sewer to install the new pipe sewer and connect it to the structure according to OPSS 407. Benching in existing maintenance holes shall be altered to accommodate the flow in the new pipe sewer system.

When specified in the Contract Documents, the opening for the connection of a subdrain outlet shall be formed by coring. The subdrain outlet pipe shall be sealed into place using non-shrink grout. When specified in the Contract Documents, a 50 mm diameter weep hole shall be cored into the same wall as the subdrain connection and at the same invert elevation.

## **410.07.16 Field Testing**

### **410.07.16.01 General**

Field tests described in this subsection shall be conducted when specified in the Contract Documents and applied to sanitary and storm pipe sewers. All tests shall be carried out in the presence of and accepted by the Contract Administrator.

When specified in the Contract Documents, leakage tests shall be carried out on completed pipe sewers 1,200 mm in diameter and smaller. There shall be no visible leakage for pipe sewers larger than 1,200 mm diameter.

Testing shall be carried out from maintenance hole to maintenance hole, including house service connections as work progresses.

The construction of new mainline pipe sewers shall not proceed when three previously placed sections of the pipe sewer have not been tested or have been tested and are unsatisfactory.

Leakage up to 25% in excess of the calculated limits shall be approved in any test section provided that the excess is offset by lower leakage measurements in adjacent sections so that the total leakage is within the allowable limits for the combined sections.

Pipe sewers shall be repaired and retested, as required, until the test results are within the limits specified in this specification. Visible leaks shall be repaired regardless of the test results.

No part of the work shall be accepted until the pipe sewers are satisfactorily tested following completion of installation of service connections and backfilling.

### **410.07.16.02 Prequalification Leakage Tests**

Prequalification leakage tests shall be carried out as either infiltration or exfiltration tests, as required.

The test shall be performed on the first section of the pipe sewer of each size, not less than 100 m in length, installed by each crew in order to prequalify the crew and the material. Tests may be carried out prior to service connections being installed in the section being tested.

When tests are unsatisfactory, the test section shall be repaired and retested until satisfactory results are obtained.

### **410.07.16.03 Infiltration Test**

Dewatering operations shall be discontinued at least three days prior to conducting the test and allow for the groundwater level to stabilize. Infiltration tests shall be conducted when the groundwater level at the time of testing is 600 mm or more above the crown of the pipe for the entire length of the test section. The test section is normally between adjacent maintenance holes.

A watertight bulkhead shall be constructed at the upstream end of the test section. All service laterals, stubs, and fittings shall be plugged or capped to prevent water entering at these locations. A V-notch weir or other suitable measuring device shall be installed at the downstream end of the test section. Infiltrating water shall be allowed to build up behind the weir until the flow through the V-notch has stabilized. The rate of flow shall then be measured. The rate of flow shall not exceed the maximum allowable infiltration calculated for the test section. Allowable infiltration shall be calculated as 0.075 litres/millimetre diameter/100 metres of pipe sewer/hour.

#### **410.07.16.04 Exfiltration Test**

##### **410.07.16.04.01 General**

Exfiltration tests shall be conducted when the groundwater level is lower than 600 mm above the crown of the pipe or the highest point of the highest service connection included in the test section.

The test section is normally between adjacent maintenance holes. The test section of the pipe sewer shall be isolated by temporarily plugging the downstream end and all incoming pipes of the upstream maintenance hole. All service laterals, stubs, and fittings are plugged or capped to prevent water entering at these locations.

##### **410.07.16.04.02 Testing With Water**

The test section shall be slowly filled with water ensuring that all air is removed from the line. A period of 24 hours for absorption or expansion shall be allowed prior to starting the test, except if exfiltration requirements are met by a test carried out during the absorption period.

Water shall be added to the pipeline prior to testing until there is a head in the upstream maintenance hole of 600 mm minimum over the crown of the pipe or at least 600 mm above the existing groundwater level, whichever is greater. The maximum limit of the net internal head on the line is 8 m. In calculating the net internal head, allowance for groundwater head, if any, shall be made.

The distance from the maintenance hole frame to the surface of the water shall be measured. After allowing the water to stand for one hour, the distance from the frame to the surface of the water shall again be measured. The leakage shall be calculated using volumes.

The leakage at the end of the test period shall not exceed the maximum allowable calculated for the test section. Allowable leakage shall be calculated as 0.075 litres/millimetre diameter/100 metres of pipe sewer/hour.

An allowance of 3.0 litres per hour per metre of head above the invert for each maintenance hole included in the test section shall be made.

Maintenance holes shall be tested separately, if the test section fails.

##### **410.07.16.04.03 Low Pressure Air Testing**

The Contract Administrator may allow or require testing by use of air when water is not readily available or the differential head in the test section is greater than 8 m or freezing temperatures exist.

Air control equipment that includes a shut off valve, safety valve, pressure regulating valve, pressure reduction valve and monitoring pressure gauge with pressure range from 0 to 35 kPa with minimum divisions of 0.5 kPa and accuracy of approximately 0.25 kPa shall be provided.

Tests shall be conducted between two consecutive maintenance holes. The test section shall be plugged at each end. One plug shall be equipped with an air inlet connection to fill the pipe sewer system with air.

The test section shall be filled slowly until a constant pressure of 24 kPa is maintained. If the groundwater is above the pipe sewer being tested, the air pressure shall be increased by 3.0 kPa for each 300 mm that the groundwater level is above the invert of the pipe.

The air pressure shall be stabilized for five minutes and then regulated to maintain it to 20.5 kPa plus the allowance for groundwater, if any. After the stabilization period, the time taken for a pressure loss of 3.5 kPa shall be recorded.

The time taken for a pressure drop of 3.5 kPa shall not be less than the times shown in Table 1.

If the length of the test section is greater than the length for minimum time, the new testing time shall be a product of the length of test section multiplied by the time shown in Table 1 for the appropriate size pipe.

If the results of an air test are marginal, the Contract Administrator may require the section to be retested using water.

#### **410.07.16.05 Post Installation Inspection**

The post installation inspection of pipe sewers shall be carried out by the Contract Administrator as specified in the Quality Assurance section under the following conditions:

- a) When the total combined pipe sewer length of all pipe sewer tender items is greater than or equal to 500 m; or
- b) If the total pipe sewer length of all pipe sewer tender items is less than 500 m, when at least one sewer pipe run is constructed with a pipe diameter greater than or equal to 450 mm and is greater than or equal to 50 m in length.

A competent and authorized representative of the Contractor, by completing Form PH-CC-822PIC (Sewer Section), shall certify that all pipe sewer installations, within the highway section identified, have been installed and completed in general conformance with the Contract Documents and are ready for the post installation inspection. Submission of Form PH-CC-822PIC shall be deemed to be the request to the Contract Administrator to have the post installation inspection performed at the certification stage indicated on the form. A separate Form PH-CC-822PIC shall be submitted for each construction season of the Contract to have the post installation inspection apportioned by construction season.

The Contract Administrator, upon approving the Contractor's request, within five Business Days of receipt of Form PH-CC-822PIC, shall provide notification of the start date of the post installation inspection.

Upon commencement of the post installation inspection, construction work shall be discontinued temporarily in the vicinity of a pipe sewer being inspected until the inspection of that pipe sewer has been completed.

#### **410.07.17 Cleaning and Flushing of Pipe Sewers**

At least two Business Days prior to the commencement of the post installation inspection, pipe sewers shall be prepared for inspection by cleaning and flushing. The material from the cleaning and flushing operation shall be managed as specified elsewhere in the Contract.

#### **410.07.18 Clay Seals**

Clay seals shall be placed as specified in the Contract Documents and compacted to 95% of the maximum dry density.

#### **410.07.19 Concrete Appurtenances**

Concrete appurtenances shall be constructed as specified in the Contract Documents. Concrete in concrete appurtenances shall be placed according to OPSS 904. Steel reinforcement shall be placed according to OPSS 905. Steel grating shall be installed when specified in the Contract Documents.

#### **410.07.20 Site Restoration**

Site restoration shall be according to OPSS 492.

#### **410.07.21 Management of Excess Material**

Management of excess material shall be as specified in the Contract Documents.

### **410.08 QUALITY ASSURANCE**

#### **410.08.01 Acceptance**

Acceptance shall be according to this specification, including satisfactory completion of all replacement and remedial actions associated with identified deficiencies.

#### **410.08.02 Post Installation Inspection Procedures**

Notwithstanding that inspection for compliance with the Contract Documents will be performed during the Contractor's installation of the pipe sewers, the Contract Administrator shall carry out the post installation inspection on a number of test segments. The number of test segments per pipe sewer tender item shall account for a minimum of 25% of the total pipe sewer length on the Contract for the purpose of defining the quality of workmanship and acceptability of the pipe sewer installations.

On contracts with less than 4 pipe runs, a minimum of one test segment shall be inspected.

Selected test segments constructed with rigid pipe materials will be inspected using CCTV, zoom camera or by visual observations. Selected test segments constructed with flexible pipe materials will be inspected using CCTV, zoom camera or by visual observations and shall also be inspected for deflection using a mandrel, laser profiler or by direct measurement.

The Contract Administrator shall randomly select the test segments to be inspected on the Contract. If inspecting in a construction season, the number of test segments selected shall be apportioned across all construction seasons to comprise the total amount of test segments to be inspected.

Selected test segments shall be inspected throughout their entire length.

All CCTV, zoom camera or visual observation operations for a post installation inspection shall be performed by a certified NASSCO inspector. The certified NASSCO inspector shall also be responsible to carry out all mandrel, laser profiling or direct measurement operations on flexible test segments.

The Contractor may be present during inspection operations.

Pipe sewers that are to be installed in a preloaded or surcharged condition as specified in the Contract Documents will not be selected as a test segment and will not be subject to payment adjustments. However, these pipe sewers may be subject to a post installation inspection should poor performance and/or service arise after installation. Upon assessment of the post installation inspection submission, any repair or replacement issues shall be dealt with on a case by case basis.

#### **410.08.03 Post Installation Inspection Assessments**

The Contract Administrator shall assess the post installation inspection submissions for each test segment inspected quantifying the pipe condition statuses as per the pipe condition codes shown in Table 3.

Within 20 Business Days of receipt of Form PH-CC-822PIC, the Contract Administrator shall, for all test segments inspected, provide the Contractor, with copies of all test segment post installation inspection submissions and assessments. This will serve as notification to the Contractor if further action, based on the test segments' pipe condition statuses, is required.

#### **410.08.04 Replacement and Repair**

##### **410.08.04.01 Replacement**

All individual pipe lengths and/or joints in a test segment assessed with a "Reject" Pipe Condition status shall be replaced by the Contractor by installing new pipe lengths, service connections and/or joints as required.

The Contract Administrator shall, upon written notification from the Contractor that replacement operations have been completed, perform a replacement post installation inspection of all test segments where pipe lengths and/or joints have been replaced and shall assess the test segments' pipe condition statuses based on the replacement post installation inspection.

##### **410.08.04.02 Repair**

All individual pipe lengths and/or joints in a test segment assessed with a "Repair" Pipe Condition status shall be repaired by the Contractor.

Table 2 lists lists Owner accepted repair methods and pipe material application that may be used.

The Contractor shall submit a repair proposal to the Contract Administrator within five Business Days after receipt of the test segments' post installation inspection submissions and assessments. The Contract Administrator shall review the repair proposal within three Business Days.

Upon approval by the Contract Administrator, the Contractor shall carry out the repairs of the pipe lengths and/or joints in the test segment in accordance with the approved repair proposal.

All repair methods, measures and materials used shall be documented.

The Contract Administrator shall, upon written notification from the Contractor that repair operations have been completed, perform a follow up repair inspection on the pipe lengths and/or joints in the test segment that have been repaired to confirm that the repairs have been made by the Contractor as approved.

Notwithstanding where a test segment or portion of the test segment has been assessed by the Contract Administrator with a "Repair" Pipe Condition status and upon attempting to implement the approved repair proposal, the Contractor determines that the proposed repair measures cannot repair the test segment or portion of the test segment; the test segment or portion of the test segment shall be replaced by the Contractor.

The Contract Administrator shall, upon written notification from the Contractor that replacement operations have been completed, perform a replacement post installation inspection of the test segment in its entirety upon completion of the replacement of the test segment or portion of the test segment and shall assess the test segments' pipe condition statuses based on the replacement post installation inspection.

##### **410.08.05 Acceptance**

A pipe sewer tender item shall be accepted based on the post installation inspection assessment of selected test segments that comprise, at a minimum, 25% of the pipe quantity for that pipe sewer tender item. Additional test segments shall be added as described elsewhere in this specification.

Inspected test segments shall be assessed as follows:

Individual test segments or portions of a test segment and/or the joints in a test segment that received no Pipe Condition Code are assessed with an Acceptable Pipe Condition rating, and are not subject to price adjustment.

Individual test segments or portions of a test segment and/or the joints in a test segment that received a Repair Pipe Condition rating, and where the Contract Administrator has confirmed that the Contractor has performed the repairs using non-intrusive repair methods, are deemed acceptable and shall be upgraded to a final Acceptable Pipe Condition rating, and as such are not subject to a price adjustment.

If there are more than 2 repair deficiencies per linear metre or a common repair deficiency is found on 15% or more of the pipe lengths or joints in the test segments inspected where non-intrusive repair measures were used to perform the repairs, the Contract Administrator shall randomly select, at a minimum, an equivalent amount of additional test segments for the post installation inspection.

Individual test segments or portions of a test segment and/or the joints in a test segment that received a Threshold Pipe Condition rating are acceptable, however, are subject to a price adjustment.

If there are more than 2 threshold deficiencies per linear metre or a common threshold deficiency is found on 25% or more of the pipe lengths and/or joints in the test segments inspected, the Contract Administrator shall randomly select, at a minimum, an equivalent amount of additional test segments for the post installation inspection.

Individual test segments or portions of a test segment and/or the joints in a test segment that received a Repair Pipe Condition rating, and where the Contract Administrator has confirmed that the Contractor has performed the repairs using intrusive repair methods, are deemed to be adequate and the entire test segment shall be upgraded to a final Repaired Pipe Condition rating, however, is subject to a price adjustment.

If repair deficiencies were found and intrusive measures were used to repair an individual test segment or portions of test segments, the Contract Administrator shall randomly select, at a minimum, an equivalent amount of additional test segments for the post installation inspection.

Individual test segments or portions of a test segment and/or joints in a test segment that received a Reject Pipe Condition rating are not acceptable.

Of the individual test segments or portions of a test segment and/or the joints in the test segments inspected, if 10% or more of the test segments and/or joints received a Reject Pipe Condition rating, the Contract Administrator shall randomly select, at a minimum, an equivalent amount of additional test segments for the post installation inspection.

#### **410.08.06 Referee Testing**

The Contractor may request referee testing on individual test segments or portions of a test segment that received a "Repair", "Reject" or "Threshold" Pipe Condition Status.

Referee testing may only be invoked within five Business Days of the Contractor receiving copies of the test segments' post installation inspection submission and the assessment results.

Referee testing shall be done through the following procedure:

- a) The Contractor shall identify the assessments of individual test segments or portions of any test segments that they disagree with;
- b) The Contract Administrator shall arrange for a referee post installation inspection to be performed by an independent NASSCO certified, third party inspector using the same inspection criteria, type of



equipment and techniques as was used for the original post installation inspection on the test segments under disagreement;

- c) The Contract Administrator shall assess the referee post installation inspection submission, which replaces the original post installation inspection submission, for each test segment or portions of test segments under disagreement which will then be binding on both parties; and
- d) The Contract Administrator shall provide the Contractor with copies of the test segment referee post installation inspection submissions and assessments which will serve as notification to the Contractor if further action, based on the pipe condition statuses, is required.

#### **410.08.07 Final Pipe Condition Assessment Rating**

The Contract Administrator shall assign final Pipe Condition Assessment Ratings (PCAR) as follows:

A PCAR of "R" is assigned to those test segments that, either in part or in whole, initially received a Repair Pipe Condition Status and have been upgraded to a Repaired Pipe Condition Status;

and for the remaining test segments:

A PCAR of "A" is assigned to the portion of these remaining test segment lengths that received an Acceptable Pipe Condition Status; and

A PCAR of "T" is assigned to the portion of these remaining test segment lengths that received a Threshold Pipe Condition Status.

#### **410.09 MEASUREMENT FOR PAYMENT**

##### **410.09.01 Actual Measurement**

##### **410.09.01.01 Pipe Sewers**

Measurement of pipe sewers shall be by length in metres along the horizontal centreline length of the pipe from the centre of one drainage structure to the centre of another drainage structure or outlet end of the pipe sewer. When the grade of the pipe sewer is 10% or greater, the above measurement is then of the slope length.

##### **410.09.01.02 Service Connections**

Measurement of the service connections shall be by length in metres along its horizontal centreline from the centreline of the main pipe sewer to the end of the service connection.

##### **410.09.01.03 Breaking into Maintenance Holes, Catch Basins, Ditch Inlets, Pipe Culverts, and Pipe Sewers**

For measurement purposes, a count shall be made of the number of openings made in maintenance holes, catch basins, ditch inlets, pipe culverts and pipe sewers.

##### **410.09.01.04 Concrete Appurtenances**

Measurement for concrete appurtenances shall be by volume in cubic metres for the volume of concrete placed. Alternatively, concrete appurtenances may be a lump sum item.

**410.09.01.05 Clay Seal**

Measurement for clay seal shall be by volume in cubic metres for the volume of clay placed. Alternatively, clay seal may be a lump sum item.

**410.09.02 Plan Quantity Measurement**

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

**410.10 BASIS OF PAYMENT**

- 410.10.01 "size, type, class" Pipe Sewers - Item**
- Service Connections - Item**
- Breaking into Maintenance Holes, Catch Basins, Ditch Inlets, Culverts and Sewers - Item**
- Concrete Appurtenances - Item**
- Clay Seal – 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, subject to the payment adjustments as specified in this specification.

Costs for the replacement and/or repair of test segments including but not limited to the associated costs for the reinstatement of the highway structure and all ancillary features previously constructed above the test segments shall be at the Contractor's expense at no additional cost to the Owner. Costs for any delays associated with the repair and/or replacement of the test segments and the reinstatement of the highway structure and all ancillary features previously constructed above the test segments shall also be at the Contractor's expense at no additional cost to the Owner.

The cost of traffic control for the post installation inspection shall be at the Contractor's expense at no additional cost to the Owner.

The cost for inspection of additional test segments in the post installation inspection, follow up repair inspection and/or replacement post installation inspection, including traffic control, according to the Acceptance of Pipe Sewers clause shall be at the Contractor's expense at no additional cost to the Owner.

The cost for referee post installation inspection, including traffic control, according to the Referee Testing clause shall:

- a) Where the assessment of the referee post installation inspection confirms the original pipe condition status, be borne by the Contractor; or
- b) Where the assessment of the referee post installation inspection upgrades the original pipe condition status, be borne by the Owner; or
- c) Where the assessment of the referee post installation inspection upgrades a portion of the original pipe condition status, be apportioned between the Contractor and the Owner based on the final upgraded and confirmed pipe proportions respectively.

**410.10.02 Price Adjustment Factor**

Price Adjustment Factors (PAF) for each PCAR is noted as follows:

PCAR of "A" is subject to a PAF equal to 1;

PCAR of "R" is subject to a PAF equal to 0.75. and

PCAR of "T" is subject to a PAF equal to 0.85.

#### **410.10.02.01 Application to Pipe Sewer Tender Items**

A Weighted Price Adjustment Factor (WPAF) is calculated for each pipe sewer tender item that had test segments inspected and is applied against that pipe sewer tender item only. Each pipe sewer tender item that had test segments inspected will have a unique WPAF.

Any test segments with a PCAR of "R" are price adjusted separately as described in the Application to Repaired Test Segments clause.

The WPAF for a pipe sewer tender item is calculated using the total pipe length of those remaining test segments that have PCAR of "A" and "T" only.

The Contract Administrator shall calculate the WPAF for a pipe sewer tender item based on the "A" and "T" portions of the remaining test segments lengths, as follows:

WPAF =

$$\frac{\text{PAF (A) x "A" portion of remaining test segments' length} + \text{PAF (T) x "T" portion of remaining test segments' length}}{\text{Total pipe length of remaining test segments}}$$

This WPAF shall be applied to determine the payment adjustment for the tender item quantity minus the total quantity of test segments in that tender item that have a PCAR of "R".

#### **410.10.02.02 Application to Repaired Test Segments**

This individual WPAF is applied to all test segments that are rated "R". A separate WPAF is calculated for each test segment that is rated "R" within a pipe sewer tender item.

The Contract Administrator shall calculate the unique WPAF for each test segment with an "R" rating based on the applicable "A", "R" and "T" ratings as follows:

WPAF =

$$\frac{\text{PAF (A) x test segment length rated "A"} + \text{PAF (R) x test segment length rated "R"} + \text{PAF (T) x test segment length rated "T"}}{\text{Total repaired test segment length}}$$

This WPAF shall be applied to determine the payment adjustment for the repaired test segments in that tender item.

#### **410.10.02.03 Payment Adjustments for Pipe Sewers**

Tender item payment adjustments shall be applied only to inspected pipe sewer tender items and associated repaired test segments within the highway section as identified on Form PH-CC-822PIC.

Tender item payment adjustments in the current construction season are not subject to any WPAF as may have been determined through the post installation inspection or a referee post installation inspection carried out in previous construction seasons for the same tender item.

To calculate the payment adjustment for an inspected tender item excluding the repaired test segments in the tender item, the following formula using the unique WPAF applicable to the tender item shall be used:

$$\text{Pay. Adjust.} = (\text{Quantity Installed} - \text{Repaired Test Segments Quantity}) \times \text{Contract Price} \times (\text{WPAF} - 1.00)$$

A payment adjustment shall be calculated separately for each tender item that had test segments inspected.

To calculate the payment adjustment for repaired test segments in a tender item, the following formula using the unique WPAF applicable to the repaired test segment shall be used:

$$\text{Pay. Adjust.} = \text{Repaired Test Segment Quantity} \times \text{Contract Price} \times (\text{WPAF} - 1.00)$$

A payment adjustment shall be calculated separately for each repaired test segment that has been assessed with a different WPAF or is from a different tender item. Repaired test segments shall be grouped only if they are from the same tender item and have the same WPAF.

When the payment adjustment is zero, there is no payment change. When the payment adjustment is negative, it is a payment reduction.

**TABLE 1**  
**Exfiltration Test - Low Pressure Air Testing**

<b>Nominal Pipe Size mm</b>	<b>Minimum Time min:sec</b>	<b>Length for Minimum Time m</b>	<b>Time For Longer Length sec</b>
100	1:53	182	0.623
150	2:50	121	1.140
200	3:47	91	2.493
250	4:43	73	3.893
300	5:40	61	5.606
375	7:05	48	8.761
450	8:30	41	12.615
525	9:55	35	17.171
600	11:20	30	22.425
675	12:45	27	28.382
750	14:10	24	35.040
825	15:35	22	42.397
900	17:00	20	50.450

**Table 2  
Accepted Repair Methods**

<b>Repair Method Impact</b>	<b>Repair Method</b>	<b>Pipe Material Application</b>	<b>Repair Method Description</b>
Non-intrusive	Epoxy injection	Concrete	Filling entire fracture with epoxy material to seal against leakage
	High pressure chemical grout	Concrete	Pumping chemical grout into entire fracture to fill the void(s) behind the pipe wall to preserve the structural integrity of the pipe and seal against leakage
	Patching	Concrete	Filling spalled or chipped pipe wall areas with concrete material to prevent early exposure of reinforcing steel bars
	Re-rounding	Steel, HDPE or PVC	Reinstating a flexible pipe to the accepted construction tolerance or Owner acceptance limits
Intrusive	Fold and form	Concrete	Placement of a length of softened pipe material into a pipe installation and expanding to "fit" the inner dimensions of the deficient pipe in order to seal against leakage and maintaining 90% of original flow area.
	Lining	Concrete	Insertion of a short length of smaller pipe into a larger gravity pipe installation and sealing the area between the pipes with grout to provide structural integrity and seal against leakage and maintaining 90% of original flow area.
	Internal sleeve	Concrete	Insertion of a complete smaller gravity pipe installation into a larger gravity pipe installation and sealing the area between the pipes with grout to provide structural integrity seal against leakage and maintaining 90% of original flow area.

**Table 3  
Gravity Pipe Codes and Associated Pipe Condition Status**

Pipe Condition Status Assessment	Threshold □	Repair ◻	Reject ■	Not Applicable -			
Pipe Condition Codes	Pipe Code Description and Attributes	Rigid Pipe Applications			Flexible Pipe Applications		
		Water Tight (L*)	Fines Tight (F*)	Soil Tight (S*)	Water Tight (L*)	Fines Tight (F*)	Soil Tight (S*)
B	Broken pipe has noticeable displacement of cracked pipe wall segments where the breaks show half the pipe wall thickness or greater for thick walled pipe or there is clear visible separation between pipe wall segments for thin ( $\leq 8.0$ mm) walled pipe	■	■	■	■	■	■
CC	Circumferential crack is visible and apparent but crack edges are not visibly open and the crack spans more than 1 but less than 2 clock reference segments (i.e. between 1 to 3 o'clock)	□	□	□	-	-	-
	Circumferential crack is visible and apparent but crack edges are not visibly open and the crack spans 3 or more clock reference segments (i.e. greater than 1 to 4 o'clock)	■	■	■	-	-	-
	Circumferential crack is visible and apparent but crack edges are not visibly open	-	-	-	■	■	■
CL	Longitudinal crack is visible and apparent but crack edges are not visibly open and the crack is $\geq 1/3$ and $\leq 1/2$ of individual pipe length	□	□	□	-	-	-
	Longitudinal crack is visible and apparent but crack edges are not visibly open and the crack is $> 1/2$ of individual pipe length	■	■	■	-	-	-
	Longitudinal crack is visible and apparent but crack edges are not visibly open	-	-	-	■	■	■
CM	Multiple cracks (CC, CL and CS) are several cracks that are visible and apparent but crack edges are not visibly open	■	■	■	■	■	■

**Table 3  
Gravity Pipe Codes and Associated Pipe Condition Status**

Pipe Condition Status Assessment		Threshold □	Repair ◻	Reject ■	Not Applicable -		
Pipe Condition Codes	Pipe Code Description and Attributes	Rigid Pipe Applications			Flexible Pipe Applications		
		Water Tight (L*)	Fines Tight (F*)	Soil Tight (S*)	Water Tight (L*)	Fines Tight (F*)	Soil Tight (S*)
CS	Spiral crack is visible and apparent but crack edges are not visibly open and the crack is $\geq 1/3$ and $\leq 1/2$ of individual pipe length	□	□	□	-	-	-
	Spiral crack is visible and apparent but crack edges are not visibly open and the crack is $\geq 1/2$ of individual pipe length	■	■	■	-	-	-
	Spiral crack is visible and apparent but crack edges are not visibly open	-	-	-	■	■	■
FC	Circumferential fracture is a crack where the edges are visibly separated with an opening width that is $\leq 0.6$ mm and is $\leq 1$ clock reference segments (i.e. between 1 to 2 o'clock)	□	□	□	-	-	-
	Circumferential fracture is a crack where the edges are visibly separated with an opening width that is $\leq 0.6$ mm and is $> 1$ and $\leq 2$ clock reference segments (i.e. between 1 to 3 o'clock)	◻	◻	◻	-	-	-
	Circumferential fracture is a crack where the edges are visibly separated with an opening width that is $\leq 0.6$ mm and is more than 2 clock reference segments (i.e. greater than 1 to 3 o'clock)	■	■	■	-	-	-
	Circumferential fracture is a crack where the edges are visibly separated with an opening width that is $> 0.6$ mm and $> 1$ and $\leq 2$ clock reference segments (i.e. between 1 to 3 o'clock)	◻	◻	◻	-	-	-
	Circumferential fracture is a crack where the edges are visibly separated with an opening width that is $> 0.6$ mm and is more than 2 clock reference segments (i.e. greater than 1 to 3 o'clock)	■	■	■	-	-	-
	Circumferential fracture is a crack where the edges are visibly separated	-	-	-	■	■	■

**Table 3  
Gravity Pipe Codes and Associated Pipe Condition Status**

Pipe Condition Status Assessment		Threshold □	Repair ◻	Reject ■	Not Applicable -		
Pipe Condition Codes	Pipe Code Description and Attributes	Rigid Pipe Applications			Flexible Pipe Applications		
		Water Tight (L*)	Fines Tight (F*)	Soil Tight (S*)	Water Tight (L*)	Fines Tight (F*)	Soil Tight (S*)
FL	Longitudinal fracture is a crack where the edges are visibly separated with an opening width that is ≤ 0.6 mm and the crack is ≥ 1/3 and ≤ 1/2 of individual pipe length	□	□	□	-	-	-
	Longitudinal fracture is a crack where the edges are visibly separated with an opening width that is ≤ 0.6 mm and the crack is > 1/2 of individual pipe length	■	■	■	-	-	-
	Longitudinal fracture is a crack where the edges are visibly separated with an opening width that is > 0.6 mm and the crack is ≥ 1/3 and ≤ 1/2 of individual pipe length	◻	◻	◻	-	-	-
FL	Longitudinal fracture is a crack where the edges are visibly separated with an opening width that is > 0.6 mm and the crack is > 1/2 of individual pipe length	■	■	■	-	-	-
	Longitudinal fracture is a crack where the edges are visibly separated	-	-	-	■	■	■
FM	Multiple fracture (FC, FL and FS) are several cracks where the edges are visibly separated	■	■	■	■	■	■



**Table 3  
Gravity Pipe Codes and Associated Pipe Condition Status**

Pipe Condition Status Assessment		Threshold □	Repair ◻	Reject ■	Not Applicable -				
Pipe Condition Codes	Pipe Code Description and Attributes		Rigid Pipe Applications			Flexible Pipe Applications			
			Water Tight (L*)	Fines Tight (F*)	Soil Tight (S*)	Water Tight (L*)	Fines Tight (F*)	Soil Tight (S*)	
FS	Spiral fracture is a crack where the edges are visibly separated with an opening width that is ≤ 0.6 mm and the crack is ≥ 1/3 and ≤ 1/2 of individual pipe length		□	□	□	-	-	-	
	Spiral fracture is a crack where the edges are visibly separated with an opening width that is ≤ 0.6 mm and the crack is > 1/2 of individual pipe length		■	■	■	-	-	-	
	Spiral fracture is a crack where the edges are visibly separated with an opening width that is > 0.6 mm and the crack is ≥ 1/3 and ≤ 1/2 of individual pipe length		◻	◻	◻	-	-	-	
	Spiral fracture is a crack where the edges are visibly separated with an opening width that is > 0.6 mm and the crack is > 1/2 of individual pipe length		■	■	■	-	-	-	
	Spiral fracture is a crack where the edges are visibly separated		-	-	-	■	■	■	
H	Visible hole in the pipe sewer wall		■	■	■	■	■	■	
D	Deformed Pipe determined by visual techniques	right or left side only > 5% and ≥ 2 clock references (i.e. greater than 1 to 3 o'clock)	-	-	-	■	■	■	
		upper or lower left or right quadrants > 5% and ≥ 2 clock references (i.e. greater than 1 to 3 o'clock)	-	-	-	■	■	■	
D	Deformed Pipe determined by deflection measurements	≤ 750 mm	> 5% and ≤ 7.5%	-	-	-	□	□	□
			> 7.5% and ≤ 10%	-	-	-	◻	◻	◻
			> 10%	-	-	-	■	■	■
	> 750 mm	> 5% and ≤ 7.5%	-	-	-	◻	◻	◻	
		> 7.5%	-	-	-	■	■	■	

**Table 3  
Gravity Pipe Codes and Associated Pipe Condition Status**

Pipe Condition Status Assessment		Threshold <input type="checkbox"/>	Repair <input type="checkbox"/>	Reject <input checked="" type="checkbox"/>	Not Applicable -		
Pipe Condition Codes	Pipe Code Description and Attributes	Rigid Pipe Applications			Flexible Pipe Applications		
		Water Tight (L*)	Fines Tight (F*)	Soil Tight (S*)	Water Tight (L*)	Fines Tight (F*)	Soil Tight (S*)
DE	Settled deposits in the pipe blocking > 10% of cross sectional area, regardless of material composition	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
DI	Dropped invert of individual pipe lengths or at end of sewer run or culvert	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
JDM	Pipe lengths have slid apart at the joint with a separation distance between pipe length edges that is $\geq 50$ mm and $\leq 75$ mm, however, there is no opening where the pipe fill material is visible	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
JDL	Pipe lengths have slid apart at the joint with a separation distance between pipe length edges that is $> 75$ mm, however, there is no opening where the pipe fill material is visible	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
LL or LR	Line deviations left or right by $> 5$ and $\leq 10$ degrees as applied to straight pipe run installations	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Line deviations left or right by $> 10$ degrees and $\leq 20$ degrees as applied to straight pipe run installations	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Line deviations left or right by $> 20$ degrees as applied to straight pipe run installations	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
LD or LU	Line deviations up or down by $> 5$ and $\leq 10$ degrees as applied to straight pipe run installations	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Line deviations up or down by $> 10$ degrees as applied to straight pipe run installations	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
OB	An obstruction is apparent in the pipe and is not a feature that has been built into or inserted into the pipe	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
OJM	Pipe lengths have slid apart at the joint displaying an opening where pipe fill material is visible and the opening width is $\geq 50$ mm and $\leq 75$ mm	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

**Table 3  
Gravity Pipe Codes and Associated Pipe Condition Status**

Pipe Condition Status Assessment		Threshold <input type="checkbox"/>	Repair <input type="checkbox"/>	Reject <input checked="" type="checkbox"/>	Not Applicable -		
Pipe Condition Codes	Pipe Code Description and Attributes	Rigid Pipe Applications			Flexible Pipe Applications		
		Water Tight (L*)	Fines Tight (F*)	Soil Tight (S*)	Water Tight (L*)	Fines Tight (F*)	Soil Tight (S*)
OJL	Pipe lengths have slid apart at the joint displaying an opening where pipe fill material is visible and the opening width is > 75 mm	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
IS	Infiltration seeping is the slow ingress of water into the pipe through a fracture with crack width opening ≤ 0.6 mm but there are no visible drips	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	Infiltration seeping is the slow ingress of water into the pipe through a fracture with crack width opening > 0.6 mm but there are no visible drips	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	Infiltration seeping is the slow ingress of water into the pipe through a joint (JDM) but there are no visible drips	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Infiltration seeping is the slow ingress of water into the pipe through a joint (JDL) but there are no visible drips	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
ID	Infiltration dripping is water dripping into the pipe through a fracture with crack width opening ≤ 0.6 mm but not in a continuous flow	-	-	-	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	Infiltration dripping is water dripping into the pipe through a fracture with crack width opening > 0.6 mm but not in a continuous flow	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	Infiltration dripping is water dripping into the pipe through a joint (JDM) but not in a continuous flow	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
ID	Infiltration dripping is water dripping into the pipe through a joint (JDL) but not in a continuous flow	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
IR	Infiltration running is water running into the pipe through a fracture with crack width opening ≤ 0.6 mm and a continuous flow is visible	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>

**Table 3  
Gravity Pipe Codes and Associated Pipe Condition Status**

Pipe Condition Status Assessment		Threshold □	Repair ◻	Reject ■	Not Applicable -		
Pipe Condition Codes	Pipe Code Description and Attributes	Rigid Pipe Applications			Flexible Pipe Applications		
		Water Tight (L*)	Fines Tight (F*)	Soil Tight (S*)	Water Tight (L*)	Fines Tight (F*)	Soil Tight (S*)
IR	Infiltration running is water running into the pipe through a joint and a continuous flow is visible	◻	◻	◻	◻	◻	◻
IG	Infiltration gushing is water entering the pipe through a fracture or joint under pressure but may not necessarily be a heavy flow	■	■	■	■	■	■
SWM	Surface Damage to pipe coating by abrasion, wear or other installation related damages on galvanized, aluminized Type II and/or polymer laminated steel pipes where the damage area's linear measurement is ≤ 10% of individual pipe length and the damage area's widest width measurement is ≤ 2 clock segments (i.e. between 1 to 3 o'clock)	-	-	-	◻	◻	◻
SWL	Surface Damage to pipe coating damage by abrasion, wear or other installation related damages on galvanized, aluminized Type II and/or polymer laminated steel pipes where the damage area's linear measurement is > 10% of individual pipe length and the damage area's widest width measurement is > 2 clock segments(i.e. greater than 1 to 3 o'clock)	-	-	-	■	■	■
SWM	Surface wear in the context of abrasion, wear or other installation related damages to the inner surface of HDPE and PVC pipe products where the damage area's linear measurement is ≤ 10% of individual pipe length and the damage area's widest width measurement is ≤ 2 clock segments (i.e. between 1 to 3 o'clock)	-	-	-	◻	◻	◻
SWL	Surface wear in the context of abrasion, wear or other installation related damages to the inner surface of HDPE and PVC pipe products where the damage area's linear measurement is > 10% of individual pipe length and the damage area's widest width measurement is > 2 clock segments (i.e. greater than 1 to 3 o'clock)	-	-	-	■	■	■

**Table 3  
Gravity Pipe Codes and Associated Pipe Condition Status**

Pipe Condition Status Assessment		Threshold <input type="checkbox"/>	Repair <input type="checkbox"/>	Reject <input checked="" type="checkbox"/>	Not Applicable -		
Pipe Condition Codes	Pipe Code Description and Attributes	Rigid Pipe Applications			Flexible Pipe Applications		
		Water Tight (L*)	Fines Tight (F*)	Soil Tight (S*)	Water Tight (L*)	Fines Tight (F*)	Soil Tight (S*)
SSM	Surface Damage in the context of spalling where inner surface is splintered or chipped where total area coverage is $\geq 0.5$ and $\leq 1.0$ m in length and $\leq 2$ clock reference segments in width (i.e. between 1 to 3 o'clock)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	-	-	-
SSL	Surface Damage in the context of spalling where inner surface is splintered or chipped where total area coverage is $> 1.0$ m in length and $> 2$ clock reference segments in width (i.e. greater than 1 to 3 o'clock)	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	-	-	-
SR	Sealing ring at the pipe joint is displaced and intruding into the pipe	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
SRB	Sealing ring at the pipe joint is broken	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
X	Collapsed Pipe $> 50\%$ of cross sectional area lost	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
JX	Pipe junction defective means that the junction is damaged or incorrectly positioned	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
CNI	Service Connection intruding means that the connection is jutting into the drainage structure	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
CX	Service Connection defective means that the connection is damaged or incorrectly positioned	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
CXI	Service Connection defective and intruding means that the connection is damaged or incorrectly positioned and is jutting into the drainage structure	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>

**\* Note:**

Gravity pipe sewer requirements are as specified in the Pipe Joints column of the Quantities – Sewers contract sheets. The requirements are:

S for soil tight (replaces N);  
 F for silt or fines tight (replaces L); and  
 L for water or leak tight (replaces H).

Pipe Condition Codes are the standard condition classification codes as identified in the Manual of Sewer Condition Classification.



**Figure 1**  
**CSA Standards**  
**Certification Logo**

**Appendix 410-A, November 2015  
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS**

**Note:** This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

**Designer Action/Considerations**

No information provided here.

**Related Ontario Provincial Standard Drawings**

No information provided here.

