



THE CITY OF  
**CALGARY**  

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**WASTEWATER**

STANDARD  
SPECIFICATIONS

**SEWER CONSTRUCTION**

**2006**

## NOTICE

**You are asked to please take note of the following revisions within the 2006 Standard Specifications Sewer Construction:**

1. Section 401.03.00 City Roads Maintenance address changed (for Excavation Permits). Emergency numbers for Wastewater, Waterworks, and Calgary Roads changed to 3-1-1.
2. Section 401.04.00 Minor changes updating 'References' section. Add City Wastewater 'Design Guidelines for Subdivision Servicing' CAN/CSA-S6-00 (Bridge Design Code), ASTM Standards as follows: A496 (Deformed Steel Wire), A497 (Steel Welded Wire), C1417 (Manufacture of concrete pipe for Direct Design), D3350 (PE plastic pipe materials), F714 (PE plastic pipe), F794 (PVC plastic pipe), and ASCE Standard Practice 15 (Direct Design of precast concrete pipe).
3. Section 402.02.01 Paragraph re. Reinforced Concrete Pipe is revised to indicate that design by current methods or by ASCE Standard Practice #15 (Direct Design) are both acceptable. For Direct Design, pipe manufacturers are to certify design has been done according to the ASCE Standard Practice #15. Concrete Pipe manufacturers are to submit pre-certification certificates and copies of other reports under the Ontario Concrete Pipe Association Program.
4. Section 402.02.06 Add section HDPE (High Density Polyethylene) Pipe
5. Section 402.03.04 Sika Canada contact information updated.
6. Section 402.03.05 Clarify that Inserta Tees are approved for connecting to Profile PVC storm mains that are all 250 mm or greater
7. Section 402.04.01 Delete references to all Cast Iron Service leads and to non-reinforced concrete service leads that are 150, 200, and 250 mm.
8. Section 402.04.04 Section re-written for greater clarity.
9. Section 402.09.00 Add New Section: 'Embedment Material' as per UMA Recommendations. For pipe 375 mm and smaller minus 20 mm bedding material is specified.
10. Section 402.10.00 Add New Section: 'Foundation Stabilization Material'.
11. Section 403.02.01 Wording added to indicate that excavation material to be neatly deposited in a manner as not to "cause instability of the excavation slopes". Wording also added to provide different contact phone numbers for drainage permits required for subdivisions under development and for private sites and City projects.



This document can also be viewed and/or purchased online at [www.calgaryonlinestore.com](http://www.calgaryonlinestore.com) (click on 'Documents' then 'Manuals'), OR at [www.calgary.ca/wastewater](http://www.calgary.ca/wastewater) (click on 'Online Documents').

12. Section 403.03.02 Reinforced Concrete Pipe – Add rejection of pipe for non-conformance with SIDD #15 parameters.
13. Section 403.03.03 Add New Section: ‘Verification of Proposed Construction Method Consistent with Design Intent’.
14. Section 403.04.00 Rewrite and rename ‘Bedding Section’ to ‘Foundation and Embedment Installation’ as per UMA recommendations.
15. Section 403.05.03 Delete outdated references to mortar joints for storm sewer pipe.
16. Section 403.05.05 Reference to Section 403.13.04 added.
17. Section 403.05.06 Relocate “PE Pipe Bursting Procedures for Replacing Sanitary Services” from 406.00 to here and renumber following sections.
18. Section 403.05.07 Clarify that Polyvinyl Chloride (PVC) profile storm sewer pipe is not acceptable as a ‘carrier pipe’ in a carrier and encasement pipe installation.
19. Section 403.07.00 Remove subsection ‘Pipe Zone’.
20. Section 403.07.02 Revised to reference appropriate sections.
21. Section 403.08.02 Revise soil density requirements in the pipe embedment and final backfill. Also see Sheet #33.
22. Section 403.09.03 Details added regarding acceptable pipe protrusion where pipe enters a 5A manhole or a 1500 mm or 1800 mm large diameter manhole.
23. Section 403.10.07 Correct reference sections and terminology for backfilling and compaction of Catch Basin Leads. Revise bedding type.
24. Section 403.11.09 Phrase “accompanying plans” changed to “approved construction drawings”.
25. Section 403.13.01 For 2006, additional acceptance testing including visual inspection, CCTV video inspection, and deflection testing (PVC sewers) shall be successfully completed prior to the issuance of CCC and FAC.
26. Section 403.13.04 Revise the minimum distance between mandrel and CCTV camera to 2.5 pipe diameters.
27. Section 403.13.05
- Add CCTV Inspection as an option for pipe larger than 900 mm
  - Mounting of the CCTV camera on a float or skid is permitted if authorized by the Engineer.
  - Clarify that sewer inspection shall not proceed until all upstream sewers in the project/contract have been recently cleaned.
  - CCTV pictures shall be in focus for a minimum 2.5 pipe diameters ahead. Forward movement shall be stopped when panning and tilting the camera.
  
  - Magnetic inspection reports are to be in “Sewer.dat” format or approved alternate.

**402.00.00**     **MATERIALS**

**402.01.00**     **GENERAL**

Materials must conform to standards set out in this Standard Specification.

Materials not listed may be acceptable on a product by product basis, however, prior approval by the City will be required. **For a complete listing of approved products and materials please see the 'Wastewater Approved Products List' under separate cover.**

Upon request by Wastewater, evidence shall be provided that material complies with the Standard Specifications.

Access to manufacturing facilities for inspection purposes shall also be provided if requested by Wastewater.

**402.02.00**     **SEWER PIPE**

**402.02.01**     **Concrete Pipe**

Concrete sewer pipe used in sewer construction shall be manufactured from sulphate resistant cement Type HS (Type 50) in accordance with CSA A3001 or Type V in accordance with ASTM C150. All concrete structures shall be designed for CL-800 truck loading as per CSA-S6-00 (Canadian Highway Bridge Design Code).

Manufacturers who supply both concrete pipe and appurtenances (manhole and catch basin materials) shall be certified under the Ontario Concrete Pipe Association Program (OCPA) 'Prequalification Requirements for Precast Concrete Drainage Products'. Copies of Prequalification Certificates shall be submitted to City of Calgary Wastewater **annually starting 2005 March 1**, along with copies of all reports to the OCPA on a timely basis. City of Calgary Wastewater shall be notified within five business days of any change in status of the Prequalification Certificate.

Non-Reinforced Concrete Pipe

Shall conform to ASTM C14/C14M. All pipe shall be subject to such tests as outlined under ASTM Specifications and evidence shall be submitted to Wastewater.

Reinforced Concrete Pipe

Shall conform to ASTM C76/C76M. All pipe shall be subject to such tests as outlined under ASTM Specifications and evidence shall be submitted to Wastewater.

OR

Reinforced concrete pipe may be designed by direct design methods in accordance with the American Society of Civil Engineers (ASCE) Standard

Practice for Direct Design of Buried Precast Concrete Pipe using Standard Installations (SIDD) 15, and shall conform to ASTM C1417.

Reports shall be provided to the Engineer showing that the manufacturer of the concrete pipe has completed the reinforced concrete design by direct design methods in accordance with of ASCE SIDD No. 15. The manufacturer will also provide written certification that his product meets the design carried out by the original design engineer responsible for the project.

#### **402.02.02 Reinforced Concrete Box Conduit (Duct)**

Concrete box conduit shall be manufactured from sulphate resistant cement Type HS (Type 50) in accordance with CSA A3001 or Type V in accordance with ASTM C150.

Reinforced concrete box conduit shall conform to ASTM C1433 or ASTM C1433M. Physical properties testing shall be provided as specified in ASTM C1433 or ASTM C1433M and a certified copy of the test results shall be provided to Wastewater.

Coated supports and spacers shall be used as approved by the Engineer to minimize the potential for rust staining on the concrete surfaces on the inside of the box conduit.

Concrete box conduit shall be designed to resist all loads, including dead loads, earth loads including lateral pressures, internal and external hydrostatic loads, vehicle loads, and any other loads specified on the approved construction drawings. When requested by the Engineer, a copy of concrete box conduit designs stamped and signed by a Professional Engineer registered with APEGGA shall be submitted.

Concrete box conduit joints shall be sealed using Sikaflex products or an alternate product approved by Wastewater (see Section 402.03.04 Concrete Duct Joints).

#### **402.02.03 Poly Vinyl Chloride (PVC) Pipe**

All PVC pipe shall be CSA-approved. Materials used for pipe shall come from a single compound manufacturer and have a cell classification of 12454-B, 12454-C, or 12364-C as defined in ASTM D1784 (Rigid PVC Compounds and CPVC Compounds).

All pipe shall be subject to such tests as required in the CSA standards referenced below and results for a specific pipe date shall be submitted to Wastewater if requested. The following are the approved pipe sizes and suppliers:

PVC DR 35 Sewer Pipe (PSM Type)

*Conforming to CSA-B182.2-M - Min. Pipe Stiffness 320KPa*

<b>Size (mm)</b>	<b>IPEX</b>	<b>Royal Flex-Lox</b>	<b>Rehau</b>
100 mm (Perforated)	Yes	Yes	No
150 mm (Perforated)	Yes	Yes	No
150 mm	Yes	Yes	Yes
200 mm	Yes	Yes	Yes
250 mm	Yes	Yes	Yes
300 mm	Yes	Yes	Yes
375 mm	Yes	Yes	Yes
450 mm	Yes	Yes	Yes
525 mm	Yes	Yes	Yes
600 mm	Yes	Yes	Yes
675 mm	Yes	Yes	No
750 mm	Yes	No	No
900 mm	Yes	No	No
1050 mm	Yes	No	No

PVC DR 28 Sewer Pipe (PSM Type)

*Conforming to CSA-B182.2-M - Min. Pipe Stiffness 625KPa*

<b>Size (mm)</b>	<b>IPEX</b>	<b>Royal Flex-Lox</b>	<b>Rehau</b>
100 mm	Yes	Yes	Yes
150 mm	Yes	Yes	Yes

PVC Storm Sewer Service Pipe (PSM Type)

*Conforming to CSA-B182.1-M - Min. Pipe Stiffness 275KPa*

<b>Size (mm)</b>	<b>IPEX</b>	<b>Royal Flex-Lox</b>	<b>Rehau</b>
75 mm	Yes	Yes	No

**402.02.04 Corrugated Metal Pipe**

Shall conform to CSA G401 and shall be subject to such tests as outlined under the Specification.

**402.02.05 Polyvinyl Chloride (PVC) Profile Pipe**

Profile PVC storm sewer pipe shall be CSA certified, shall conform to CSA B182.4, and shall be subject to such tests as outlined under the standard. Materials used for pipe and fittings shall come from a single compound manufacturer and have a cell classification of 12454-B, 12454-C, or 12364-C as defined in ASTM D1784.

**Profile Pipe is to be used in storm system construction only.**

Profile PVC PS320

Conforming to CSA-B182.4M – Minimum Pipe Stiffness 320KPa

<b>Size (mm)</b>	<b>IPEX UltraRib</b>	<b>Rehau Raurib*</b>
200 mm	Yes	Yes
250 mm	Yes	Yes
300 mm	Yes	Yes
375 mm	Yes	Yes
450 mm	Yes	Yes
525 mm	Yes	Yes
600 mm	Yes	Yes

\*Manufactured by IPEX

**402.02.06 HDPE (High Density Polyethylene) Pipe**

These products are **not approved** for use except for service leads using pipe bursting (case by case only, see Section 403.05.06).

HDPE materials for pipe and fittings shall come from a single compound manufacturer and conform to ASTM D3350. Closed and open profile pipe products and fittings shall conform to sections 4 and 5 of CSA B182.6 and CSA B182.8 for manufactured quality and dimensional tolerances. Resin compounds shall be tested for slow crack growth resistance as per Appendix SP-NCTL in ASTM D5397 as modified in Clause 8.8 of CSA B182.8.

**402.03.00 SEWER PIPE JOINTS, FITTINGS AND CASING SPACER MATERIAL**

**402.03.01 Gaskets**

PVC Pipe

Gaskets shall be supplied by the manufacturer. All gaskets shall conform to ASTM F477 and shall be subject to such tests as outlined under the ASTM Specifications.

Concrete Pipe

All gaskets shall conform to CSA A257.3 or ASTM C443, and shall be subject to such tests as outlined under the specifications.

**402.03.02 Mortar**

Mortar, if specifically required for pipe joints, shall consist of one part sulphate resistant cement Type HS (Type 50) in accordance with CSA A3001 or Type V in accordance with ASTM C150 to two parts of clear sharp sand.

**402.03.03 Sewer Pipe Plugs**

Manufactured plugs shall be supplied by the pipe manufacturer or shall conform to the following and shall be as watertight as possible:

- for 100 mm - 600 mm diameter pipe, an 18 mm plywood plug cut to fit the inside of the pipe's bell

To conform to the strength requirements the average of all tests shall exceed the specified strength. When five or more tests of the same class of concrete are available, the average of any five consecutive tests shall be equal to, or greater than the specified strength. No three consecutive tests shall fall below the specified strength, and no strength test shall fall below 3.5 MPa of the specified strength.

If the above-noted criteria are not met, the Engineer shall have the right to require one or more of the following:

1. Changes in mix proportions for the remainder of the work.
2. The additional curing on those portions of the structure represented by the test specimen which failed.
3. That cores be drilled from the portion of the structure in question and tested in accordance with CSA A23.2. The result of this test will help ascertain whether or not the specimens previously tested were truly representative of the concrete in place.

If after carrying out the requirements mentioned above, the Engineer is not satisfied that the concrete in the structure is of the specified quality, he/she may demand a strengthening or replacement of those portions which failed to develop the required strength.

#### **402.08.05 Mix Design**

All concrete shall be proportioned according to mix designs prepared by a Professional Engineer employed by an independent engineering materials testing laboratory for the classes of concrete and nominal maximum size of coarse aggregate specified except where the concrete is to be supplied by a ready-mix plant. Where the Engineer so permits, mix designs may be prepared by a Professional Engineer who is in the employ of the plant.

Concrete shall be designed to produce minimum cement content for each class of concrete shown on the construction plans. The concrete mix shall be so designed that the material will not segregate and excessive bleeding will not occur. A copy of the mix design shall be made available to the Engineer upon request.

#### **402.09.00 EMBEDMENT MATERIAL**

##### **402.09.01 Bedding Material**

Bedding shall be of the type and class specified within the approved construction drawings, and if not so specified in the construction drawings, shall conform to the details shown on Drawing Sheet #33 and the following requirements:

Bedding material shall consist of hard durable particles free from clay lumps, cementation, organic material, frozen material and other deleterious materials.



Bedding material shall conform to the embankment materials specified in ASTM D2321.

The following tables must be used in conjunction with **Drawing Sheet #33**. The bedding materials listed are divided into Class 1A, 1B, II, and III consistent with ASTM D2321 (Flexible Pipe Installation Specification) and ASCE Standard Practice for Concrete Pipe Design (SIDD) 15. Minus 20 mm bedding material is specified for pipe sizes 375 mm and smaller for improved support underneath the haunches of the pipe.

Class IA – Manufactured Aggregate, open graded, clean

For Pipe 375mm and Smaller		For Pipe Larger than 375 mm	
Sieve Size	Percent Passing by Mass	Sieve Size	Percent Passing by Mass
20 mm	100%	40 mm	100%
4.75 mm (#4)	<10%	4.75 mm (#4)	<10%
2.5 mm (#8)	<5%	2.5 mm (#8)	<5%
0.075 mm (#200)	<5%	0.075 mm (#200)	<5%

Class IB – Manufactured, Processed Aggregates; dense graded, clean

For Pipe 375mm and Smaller		For Pipe Larger than 375 mm	
Sieve Size	Percent Passing by Mass	Sieve Size	Percent Passing by Mass
20 mm	100%	40 mm	100%
4.75 mm (#4)	10%-50%	4.75 mm (#4)	10%-50%
2.5 mm (#8)	<5%	2.5 mm (#8)	<5%
0.075 mm (#200)	<5%	0.075 mm (#200)	<5%

Class II - Coarse-Grained Soils; clean or borderline clean to w/fines

For Pipe 375mm and Smaller		For Pipe Larger than 375 mm	
Sieve Size	Percent Passing by Mass	Sieve Size	Percent Passing by Mass
20 mm	100%	40 mm	100%
4.75 mm (#4)	Varies	4.75 mm (#4)	Varies
0.075 mm (#200)	0%-12%	0.075 mm (#200)	0%-12%

Class III – Coarse-Grained soils with fines

For Pipe 375mm and Smaller	
Sieve Size	Percent Passing by Mass
20 mm	100%
4.75 mm (#4)	Varies
0.075 mm (#200)	12%-50%

For Pipe Larger than 375 mm	
Sieve Size	Percent Passing by Mass
40 mm	100%
4.75 mm (#4)	Varies
0.075 mm (#200)	12%-50%

Concrete Encasement – Concrete shall be minimum 13.6 MPa strength and shall be manufactured from sulphate resistant cement Type HS (Type 50) in accordance with CSA A3001 or Type V in accordance with ASTM C150. No air entrainment is required for encasement concrete with more than 2.0 m of earth cover.

Where groundwater flow is anticipated, material or products shall be used to mitigate the migration of fines into bedding material.

**402.10.00 FOUNDATION STABILIZATION MATERIAL**

Stabilizing foundation gravel shall consist of hard durable particles, free from clay lumps, cementation, organic material, frozen material and other deleterious materials.

The material shall be a Class 1A material as described above and in ASTM Specification D2321 with a maximum aggregate size of 40 mm. Subject to Wastewater approval, pit run gravel may be used on a project instead of Class IA material, provided a written request from a Specialist Geotechnical Engineer is received certifying the pit run material and there are less than 12% fines by mass passing the 0.075 mm (#200) sieve size.

Stabilizing foundation synthetic filter fabric shall consist of a durable, permeable, non-woven, polyester fabric composed of continuous synthetic filaments in a random arrangement with minimum properties as follows:

Fabric Weight	213 g/m <sup>2</sup>
Thickness	2.0 mm
Tensile Grab Strength	710 N
Tear Strength	310 N
Mullen Burst Strength	2,000 kPa

project. A sieve analysis of the material shall be carried out at the same time. The Engineer will have the ability to require further on-site testing (trial compaction demonstration and/or sieve analysis) for any questionable materials.

Using the previous example of a Type 2 installation, Class II material must also obtain 90% Standard Proctor Density after placement in the trench. If designers, contractors and aggregate suppliers wish to use Class II material without extra compaction they must ensure that dumped density tests are carried out prior to the start of a project. The Engineer will have the ability to require further on-site testing at any time. Class III material has more than 12% passing the No. 200 sieve and would require compaction to achieve 90% Standard Proctor Density.

Should the materials proposed for use in the embedment zone change during the course of the works, the installer shall notify the Engineer and carry out additional compaction trials sufficient to demonstrate that their proposed method of placement is consistent with achieving the specified requirements.

The trial compaction demonstration, whether or not it is carried out, shall in no way relieve the contractor from their contractual requirement of meeting the minimum performance criteria for completed installations as specified herein.

#### **403.04.00 FOUNDATION AND EMBEDMENT INSTALLATION**

##### Foundation Installation

The foundation soil shall be moderately firm to hard in-situ soil, stabilized soil, or compacted fill material.

When unsuitable or unstable material is encountered, the foundation shall be stabilized using Class IA material (40 mm maximum particle size) and filter fabric if required (see Section 402.09.00). Subject to Wastewater approval, pit run gravel may be used on a project instead of Class IA material, provided a written request from a Specialist Geotechnical Engineer is received certifying the pit run material and there are less than 12% fines by mass passing the 0.075 mm (#200) sieve size.

Where groundwater and soil characteristics may contribute to the migration of soil fines into or out of the foundation, embedment soils, sidefill, and/or backfill materials, methods to prevent migration shall be provided (see Section 402.10.00).

##### Embedment Installation

The installation of pipe embedment for both concrete pipe and flexible pipes (PVC pipes) shall be based on ASTM D2321 and the following modified ASCE 15 Standard Installation Types as shown in Drawing #33 (also see Section 402.09.00 Embedment Material).

**Type 1 Installation** – Embedment installation shall achieve a minimum of 95% Standard Proctor utilizing Class 1A or 1B material. **Type 1 installation requires that the material, density and method of installation be CERTIFIED by a Professional Engineer. The acceptance of a Type 1 installation will be approved only on a case by case basis.**

**Type 2 Installation** – Embedment installation shall achieve a minimum of 90% Standard Proctor utilizing Class 1A, 1B, or II material or shall be compacted to a minimum of 95% Standard Proctor utilizing Class III material.

**Type 3 Installation** – Embedment installation shall achieve a minimum of 85% Standard Proctor utilizing Class 1A, 1B, or II material or shall be compacted to a minimum of 90% Standard Proctor utilizing Class III material.

**Type 4 Installation** – Embedment installation with no extra compaction utilizing Class 1A, 1B, II or III material, or compacted to 85% Standard Proctor utilizing Native Materials. In a Type 4 installation no bedding is required except in a rock foundation where minimum bedding thickness shall be  $D_o/12$  (not less than 150 mm). **Type 4 installations shall be limited to appropriately designed concrete pipe.**

PVC Profile Pipe (Ultrarib and Raurib)

Embedment materials shall be as noted herein (see also Sheet 33 and 402.09.00) except that class 1A, 1B, II & III maximum aggregate size shall also be 20 mm for pipe larger than 375 mm up to 600 mm.

**Note: 20 mm is required in order for the aggregate to fit between the ribs. This will enhance pipe support and minimize voids.**

**403.04.01** **Bedding**

Bedding shall be constructed as required by the project specifications and in accordance with the contractors proposed construction method as verified in the compaction trial demonstration.

The bedding layer shall be placed as uniformly as possible to the required density, except that loose, un-compacted material shall be placed under the middle third of the pipe, prior to placement of the pipe.

Bell holes shall be excavated in the bedding when installing pipe with expanded bells such that the barrel and not the bell supports the pipe.

For large diameter pipe with  $D_o$  greater than 2400 mm, minimum bedding thickness shall be  $D_o/24$  (not less than 100 mm).

If there is a rock foundation then minimum bedding thickness shall be  $D_o/12$  (not less than 150 mm).

**403.04.02** **Haunch and Initial Backfill**

Placement of haunching and initial backfill embedment materials shall be carried out by methods that will not disturb or damage the pipe.

The haunching material shall be carefully worked in and tamped in the area between the bedding and the underside of the pipe before placement of the remainder of the material in the embedment zone.

If compaction is required, compaction equipment and methods shall be compatible with the materials used, the location in the trench, and the in-place densities required.

The primary purpose of initial backfill is to protect the pipe from any impact damage that may arise from the placement of overfill materials. Minimum thickness of cover over the top of the pipe shall be 300 mm as indicated on Sheet #33. Where final backfill contains large objects or is required to be deposited from very high heights, initial backfill shall be extended to such additional height above the pipe as is necessary to prevent damage from occurring to the pipe during backfilling operations.

Before using heavy compaction or construction equipment directly over the pipe, ensure that sufficient backfill has been placed over the pipe to prevent damaging either the pipe or the embedment zone materials.

In a flexible pipe installation (PVC - solid wall or profile), the material for initial backfill shall be the same as the embedment material.

For rigid (concrete) pipe the initial backfill shall be the specified embedment material or select native material, compacted to the specified density, that meets basic criteria for backfill/pipe overfill (see Sheet #33). Select material shall be devoid of boulders, organic matter, frozen material, lumps, debris or other material injurious to the pipe.

**403.04.03 Change in Native Soil Conditions**

Should a change in site conditions be observed that would impact either short or long-term pipe and/or embedment soil performance, the contractor shall notify the Engineer, so that the validity of the original design concept can be reviewed by the Engineer. If necessary, the design will be modified to suit the actual conditions encountered in the field.

**403.04.04 Final Backfill**

The final backfill (see Sheet #33) shall be approved material containing no debris, organic matter, frozen material, large stones or other objects that may be detrimental to the pipe or the embedment materials.

The contractor shall ensure there is sufficient cover over the pipe and the embedment zone materials to facilitate subsequent construction operations associated with the placement and compaction of final backfill.

**403.04.05 Manhole Bedding**

Precast Manholes

Precast manhole bases shall be bedded on granular material or acceptable undisturbed foundation material.

Cast-in-Place Manholes

Concrete bases shall be poured on granular material or acceptable undisturbed foundation material.

- (ii) Equipment shall conform to the applicable noise bylaws.

Provide continuous monitoring of water levels in upstream and downstream manholes. Ensure that there is no contamination of basements, ditches, roadways or sidewalks with raw sewage. In the event of such contamination, immediate action shall be taken to eliminate the source of contamination. Proper cleanup of the affected area shall be followed and no work shall recommence until a reevaluation of the complete process has been carried out by the City. No rehabilitation work shall be undertaken unless authorized by the City.

Where the Contractor has used a flow control procedure to limit flows during an inspection, the Contractor shall note on the inspection report the depth of normal flow and the duration the flow control was in effect.

After all sewer mains, manholes and related structures are constructed to the approved construction drawings and specifications, these structures shall be cleaned thoroughly ensuring no foreign material has entered the sewer facility. The sewer facility must be in a broom-clean state prior to the City taking over ownership of the facility.

**403.13.00**      **ACCEPTANCE TESTING**

**403.13.01**      **General**

After all sewer mains, manholes and related structures have been cleaned in accordance with Section 403.12.00 CLEAN UP, the system shall be tested to ensure that the sewer is free of defects and that the sewer was installed to the line and grade noted on the construction drawings. Acceptance testing must be carried out for both types of sewer systems and shall include the following:

- Visual inspection of surface features, manholes, and larger sewers
- CCTV video inspection of the smaller sewers (up to and including 900 mm diameter). Pipe larger than 900 mm shall be inspected and observations recorded during a walk-through by a NAAPI-certified operator or by CCTV video inspections where authorized by the Engineer (subject to obtaining acceptable data quality), and
- Deflection testing of PVC sewers in accordance with Section 403.13.04 Deflection Testing and Section 403.13.05 CCTV Video Inspection.
- The City may request that an Infiltration/Exfiltration test be performed if warranted.

**Acceptance testing (including visual inspection, CCTV video inspection, and deflection testing (PVC sewers)) shall be successfully completed prior to issuance of CCC and FAC. Testing for CCC shall occur no sooner than 30 days after installation and backfilling completion and for FAC, no sooner than one year. Portions of these testing requirements are new for 2006. Additional testing is being implemented in order to better identify and correct defects prior to FAC resulting in a lengthened service life for the infrastructure.**

**403.13.02 Vertical and Horizontal Alignment Tolerances**

The horizontal alignment of the facilities will be accepted by the Engineer only if the centre line of 900 mm and smaller diameter pipes shall not be more than 150 mm off the designated alignment. In addition, for pipe greater than 900 mm diameter, the center line shall not be off more than 50 mm per 300 mm of diameter from the designated alignment. For acceptance, where the pipeline alignment is supposed to be straight between manholes, a line of sight through the pipe shall exist from manhole to manhole.

For acceptance the vertical alignment of the sewer main shall not deviate from the designated grade by an amount greater than the total of 6 mm plus 20 mm per metre of diameter of sewer pipe.

For acceptance, no variance from grade vertically or horizontally shall be permitted that results in individual joint deflections in excess of the manufacturer's recommended value to maintain hydrostatic integrity to the limits specified herein.

**403.13.03 Infiltration / Exfiltration Limits**

The City will NOT accept any infiltration/exfiltration (I/E) in sanitary pipes and appurtenances, nor in storm pipes and appurtenances unless they are specifically designed to include that function.

Infiltration/Exfiltration (I/E) testing shall be carried out only when there is visible evidence of water entering the pipe or when environmental issues are a concern to the Engineer.

For acceptance testing, elastomeric gasket joints for pipe and fittings shall meet the requirements of ASTM D3212, except that the internal hydrostatic pressure shall be 100 kPa (15 psi).

**403.13.04 Deflection Testing**

Scope

All flexible thermoplastic pipe installed within the City of Calgary shall be tested for deflection. Deflection testing shall be carried out to confirm that installed pipe meets the requirements for either short or long term deflection limits. Deflection tests shall not be carried out sooner than 30 days after installation and backfilling completion to assess short-term deflection and not sooner than 1 year to assess long-term deflection.

Inspection Method

All pipe up to and including 900 mm diameter shall be inspected with "go/no-go" mandrel device as described herein. Pipe larger than 900 mm diameter shall be inspected with a suitable proving device to confirm that vertical deflection does not exceed either the maximum allowable short or long term deflection limits stipulated in the following table.

Short and Long Term Deflection Requirements

MAXIMUM ALLOWABLE DEFLECTION

Short Term  
5.0%

Long Term  
7.5%

**Short-term deflection** shall be deemed to be any deflection measured between one month and one year after backfilling.

**Long-term deflection** shall be deemed to be any deflection measured at least one year after backfilling.

The mandrel or proving device shall be pulled through the pipe in such a manner to ensure that excessive force is not used to advance the device through any deflected portion of the pipe.

Deflection testing shall be performed in conjunction with a closed circuit television (CCTV) inspection. The mandrel shall be located in front of, and in clear view of, the television camera. A minimum appropriate distance is 2.5 pipe diameters in front of the television camera.

The mandrel shall be cylindrical in shape, constructed with 9 evenly spaced arms and shall generally conform to the following.

Mandrel Dimensional Requirements

The minimum diameter of the circle scribed around the outside of the mandrel arms shall be equal to the values indicated on Sheet #63 for each specific pipe material, within a tolerance of +/- 0.25 millimetres. The contact length of the mandrel shall be measured between the points of contact on the mandrel arm as indicated on Sheet #63. The outside radius of the mandrel arms shall be checked for conformance with these specifications with a proving ring.

An oversized proving ring may be used, which shall be manufactured to a diameter equal to the outside diameter of the mandrel plus 1 millimetre, to facilitate undertaking measurements to confirm the size of the mandrel conforms to the dimensions and dimensional tolerances specified. The proving ring shall be manufactured to within 0.25 millimetres of the specified size. The proving ring shall be fabricated from 6 mm minimum thick steel.

As an alternative, a "go/no-go" proving ring device shall be permitted in which case the proving ring shall be sized up to 0.30 millimetres less than the circle that would be scribed by the specified mandrel size. If a "go/no-go" proving ring is utilized, an acceptable mandrel will not be able to pass through the proving ring. "Go/no-go" proving rings shall not be less than 0.1 mm of the specified dimension.



## **403.13.05 CCTV Video Inspection**

### General

Sewer inspections shall be performed to observe and record structural and service defects and construction features, to assess thoroughness of cleaning, and to verify new installation and rehabilitation work quality prior to acceptance. All observations shall be coded in accordance with WRc "Manual of Sewer Condition Classification" and the findings shall be submitted in an inspection report consisting of magnetic data file and video recording (in digital format on compact disc-recordable (CD-R) or DVD). Condition coding shall only be performed by operators who have successfully attained the North American Pipeline Inspectors (NAAPI) Level of Qualification for WRc Operators.

All pipe up to and including 900 mm diameter shall be inspected with CCTV Video inspection. Pipe larger than 900 mm diameter shall be inspected and observations recorded during a walk-through by a NAAPI-certified operator or by CCTV video inspection where authorized by the Engineer (subject to obtaining acceptable data quality).

### Equipment

#### a) Inspection unit

The inspection unit shall consist of a self-contained vehicle with separate areas for viewing and equipment storage. Each unit shall be equipped with a cellular telephone and a suitable communication system linking all crew members. Each inspection unit shall be equipped with fans and blowers to remove any fog, which may be present in the sewer at the time of the inspection.

#### b) Inspection Equipment

Inspection equipment shall consist of cameras, lighting, cables, power source, monitor, and digital video recorder (computer system with capture card or dedicated unit), and other related equipment. The camera employed for sewer and manhole inspections shall be pan and tilt type capable of panning 360° and tilting 270°. The adjustment of focus and iris shall allow optimum picture quality and the focal range shall be adjustable from 100 mm to infinity.

The light source shall be adjustable to allow an even distribution of light around the sewer perimeter without loss of contrast, flare out of picture, or shadowing. Video overlay equipment shall be capable of superimposing alpha-numeric information onto the video recording and shall be capable of providing a minimum of 15 lines of information, 30 characters per line. All digital video recordings shall be submitted on compact disc-recordables (CD-R) or DVD. Digital video recordings shall be captured from the live source (Digital videos to a hard-drive, and later transferred to CD-R or DVD for submission). Digital video shall not be captured from the video tape recordings.

For sewer inspections, the camera shall be transported through the sewer by means of a rubber tired or crawler tractor. The transport unit must be capable of passing over minor surface imperfections, including but not limited to, broken

joints and solid debris up to 40 mm in height. Mounting of the camera on a float or skid for tow through the sewer shall be permitted where authorized by the Engineer. If the camera is towed, the supporting equipment shall not impede the view of the camera and shall be stable to ensure steady and smooth progress.

The camera transport shall permit complete inspection of the sewer from the centre of the start manhole to the centre of the finish manhole. The camera transport and cable shall be capable of inspecting a minimum of 200 m of sewer from a single access point. A remote reading counter shall be used to measure distance traveled from the centre of the start manhole and measurements shall be recorded in metres to the nearest 100 mm.

The camera height shall be adjustable so as to position the centre of the lens in the centre of circular sewers and two thirds of the vertical dimension above the invert of egg shaped sewers.

#### Method of Inspection

The Contractor shall provide a minimum of 24 hours notice of the locations where the inspections will be performed to the Engineer.

Prior to beginning the inspection, the distance between the centres of the start and finish manhole shall be measured on the ground surface using a steel tape. Flow control measures shall be implemented to ensure a minimum of 80% of the height of the sewer is visible for the entire inspection. All fog shall be evacuated from the sewer. The camera lens shall be kept clean at all times and the sewer shall be kept clear of fog during the entire inspection.

All sewer inspections shall be conducted in the direction of flow unless a reverse set up is required. Inspections shall generally begin with the upstream sewer in the system and proceed downstream in a consecutive manner. Under no circumstances shall the inspection proceed for a length of sewer until that section and all upstream sewers in the project/contract have been recently cleaned.

The face of the start manhole shall be clearly visible at the start of the inspection and the inspection shall be performed from the centre of the start manhole to the centre of the finish manhole. At the start of the inspection, the length of sewer from the centre of the manhole to the cable calibration point shall be recorded and the distance reading at the cable calibration point shall be adjusted such that zero is at the centre of the start manhole.

During the inspection, automatic distance measurement shall be indicated on the screen and begin to move immediately as the camera moves. The distance measurement shall be accurate from the cable calibration point to the centre of the finish manhole. The camera speed shall not exceed 9 metres/minute.

During inspection, the picture shall be in focus from the point of observation to a minimum of 2.5 pipe diameters ahead. The camera shall be stopped for 2 seconds at major defects and connections, junctions, and major branches. Forward movement shall be stopped when panning and tilting the camera to observe defects and construction features. Major defects shall include but not be limited to deformed sewers, displaced bricks, holes, large displaced joints, missing bricks, totally missing mortar, obstructions, and large open joints. At major defects, connections, junctions, and major branches the camera shall be

positioned in order to provide a perpendicular view. The intent of this procedure is to permit a more detailed inspection of specific defects or construction features and reduce distortion during pausing of the video recording.

If inspection of an entire sewer cannot be completed due to a collapse, excessive deformation or solid debris, intruding connections, obstructions, or large displaced joints, the equipment shall be moved to the upstream manhole and inspection again attempted. If complete inspection still cannot be performed, the Engineer shall be immediately advised. Jointly, the Contractor and Engineer shall decide to:

- i. Abandon the inspection
- ii. Re-perform the inspection subsequent to:
  - performing solid debris cutting
  - removing intruding connections
  - modifying the camera setup (position and/or method of transport)
  - completion of emergency repairs

All locations where a complete inspection could not be obtained shall be noted in a log and reviewed with the Engineer on a weekly basis. The log shall note the sewer ID number, steel tape measurement, length inspected (up and downstream), length of missing video and the reason the inspection could not be completed.

If during the inspection the Contractor observes a flow disparity, clear water infiltration, hole, collapse, void, or deformation greater than 10%, they shall capture an image (photograph, videotape, or digital file) and notify the Engineer. Captured images shall be turned over to the Engineer at the end of each work day. If a void is visible or suspected outside of the pipe, the Contractor shall immediately place barricades around the location and notify the Engineer.

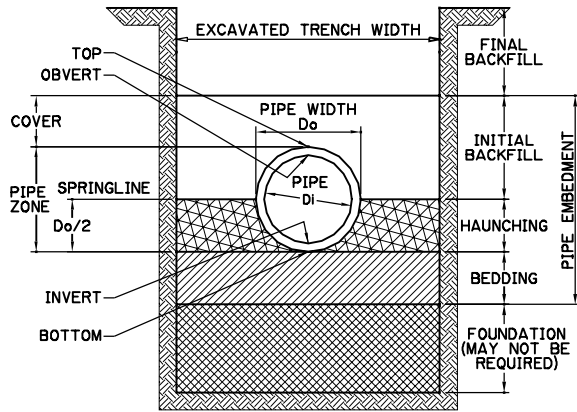
#### a) Sewer Inspection Reports

The sewer condition shall be coded in accordance with the requirements of the UK Water Industry, Engineering and Operations Committee, "Manual of Sewer Condition Classification" Third Edition, August 1993 and "Addendum" dated February 1996. The inspection reports shall consist of the original video recordings and magnetic data files of the sewer inspection reports on a CD or DVD. The magnetic inspection reports shall be in "sewer.dat" format corresponding to the WRC 'Manual of Sewer Condition Classification – 3<sup>rd</sup> Edition', or an approved alternate capable of direct downloading into to the City's Data Management System.

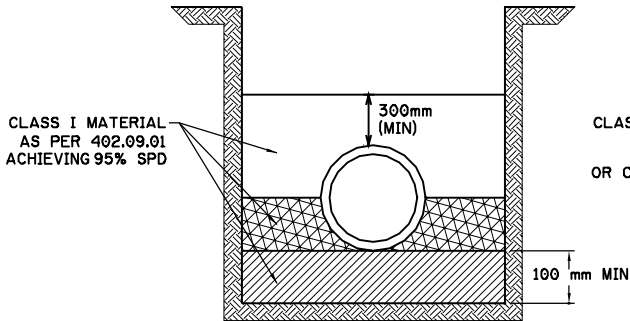
#### Digital Format

The inspections shall be captured in colour MPEG1 minimum format (HQ-VCD standard compliance) from the live video. All digital videos shall be first generation recordings. One complete single digital file shall be submitted for each inspection. The final file may be produced in one of three ways:

- 1) Using a computer system and capture card, the original recording may be captured continuously, regardless of the progress of the inspection. Where

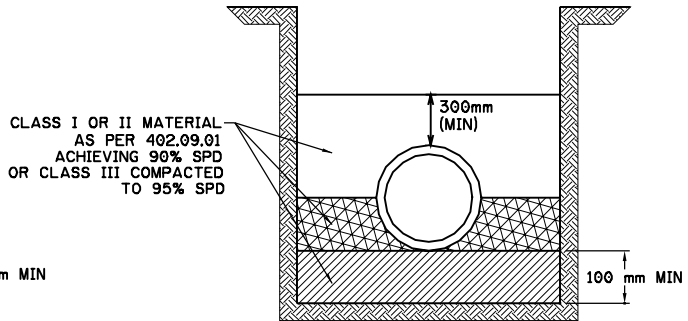


**TERMINOLOGY**

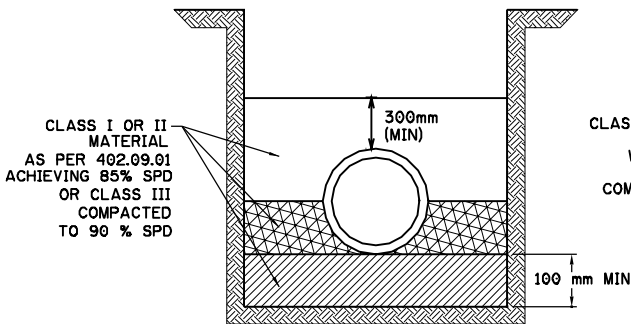


**TYPE 1  
INSTALLATION**

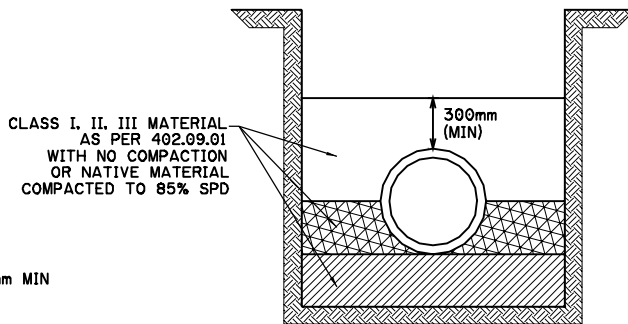
TYPE 1 INSTALLATION REQUIRES THAT THE MATERIAL, DENSITY AND METHOD OF INSTALLATION BE CERTIFIED BY PROFESSIONAL ENGINEER. PRIOR APPROVAL IS REQUIRED FROM MANAGER OF WASTEWATER ENGINEERING, CITY OF CALGARY



**TYPE 2  
INSTALLATION**



**TYPE 3 INSTALLATION**



**TYPE 4 INSTALLATION**

TYPE 4 INSTALLATION ONLY APPROVED FOR USE WITH RIGID (CONCRETE) PIPE

**NOTES:**

1. BEDDING UNDER THE MIDDLE THIRD OF THE PIPE SHALL BE LOOSE, UNCOMPACTED MATERIAL.
2. IF A ROCK FOUNDATION, THEN MINIMUM BEDDING THICKNESS IS  $D_o/12$  (NOT LESS THAN 150mm).
3. IF  $D_o$  IS GREATER THAN 2400mm, THEN MINIMUM BEDDING THICKNESS IS  $D_o/24$ .
4. FOR INITIAL BACKFILL MATERIAL OPTIONS IN A RIGID (CONCRETE) PIPE INSTALLATION, SEE SECTION 403.04.02.
5. SEE ALSO SECTION 403.04.00 FOUNDATION AND EMBEDMENT INSTALLATION.

DIMENSIONS ARE MILLIMETRES UNLESS OTHERWISE NOTED METRIC

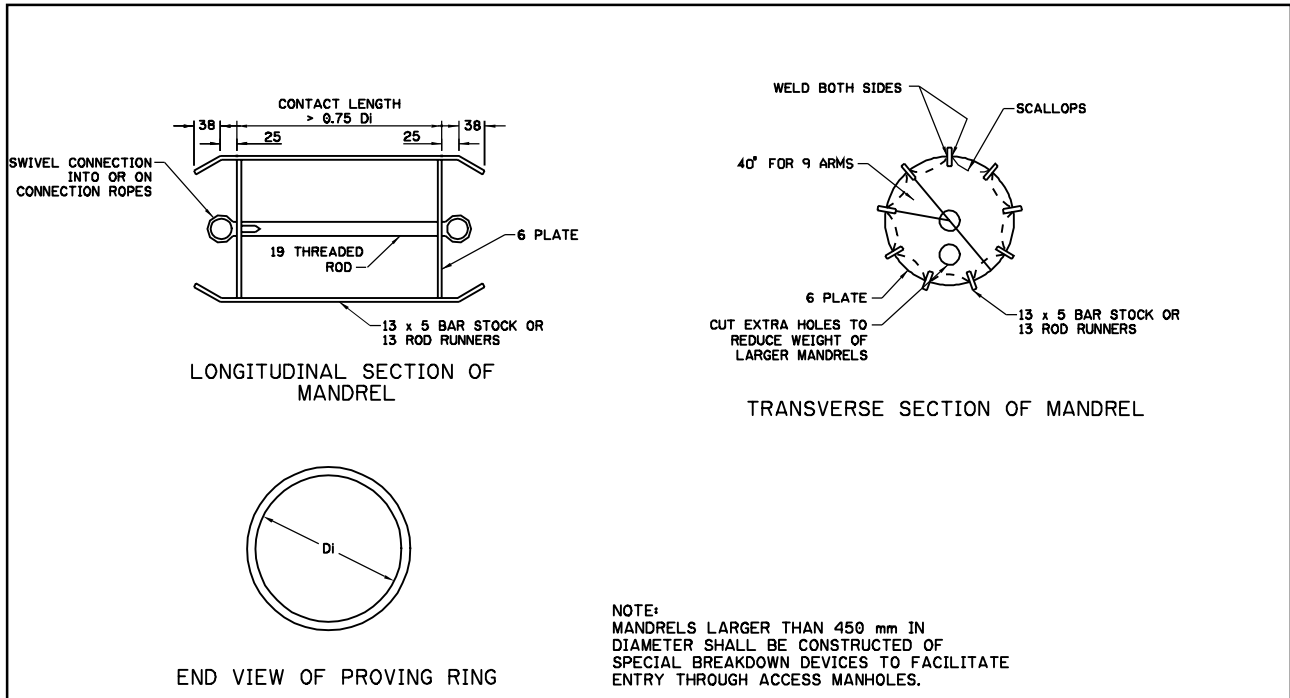
No.	Date	Revision	App'd
I	04/12/17	GENERAL REVISION	

Drawn	Date	Checked
LC	NOV15/04	
Scale	N.T.S.	
Approved by		
for City Engineer		

THE CITY OF CALGARY  
ENGINEERING AND ENVIRONMENTAL SERVICES DEPARTMENT

**BEDDING AND  
BACKFILL DETAILS  
(PIPE ZONE)**

Sheet	<b>33</b>
File Number	<b>452.1005.003</b>



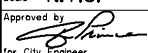
**MANDREL SIZING FOR SOLID WALL SDR35 PVC PIPE (CSA B182.2)**

NPS	AVERAGE INSIDE DIAMETER (mm)	BASE INSIDE DIAMETER (BID) (mm)	ALLOWABLE VERTICAL DEFLECTION (mm)		RADIUS OF MANDREL ARM (mm)	
			SHORT TERM	LONG TERM	SHORT TERM	LONG TERM
			5.00 %	7.50 %		
200	200.42	196.11	186.3	181.4	93.7	91.4
250	250.55	245.16	232.9	226.8	117.1	114.3
300	298.27	291.86	277.3	270.0	139.4	136.0
375	365.09	357.25	339.4	330.5	170.6	166.5
450	446.23	436.64	414.8	403.9	208.5	203.5
525	526.08	514.77	489.0	476.2	245.8	239.9
600	591.84	579.11	550.2	535.7	276.6	269.9
675	666.99	652.64	620.0	603.7	311.7	304.2
750	763.57	747.68	710.3	691.6	357.1	348.5
900	913.89	894.77	850.0	827.7	427.3	417.0
1050	1061.84	1039.51	987.5	961.5	496.4	484.5
1200	1212.14	1186.60	1127.3	1097.6	566.7	553.0

**PROFILE WALL PVC PIPE (CSA B182.4)**

NPS	AVERAGE INSIDE DIAMETER (mm)	BASE INSIDE DIAMETER (BID) (mm)	ALLOWABLE VERTICAL DEFLECTION (mm)		RADIUS OF MANDREL ARM (mm)	
			SHORT TERM	LONG TERM	SHORT TERM	LONG TERM
			5.00 %	7.50 %		
200	200.41	196.11	186.3	181.4	93.7	91.4
250	250.55	245.19	232.9	226.8	117.1	114.3
300	298.13	291.75	277.2	269.9	139.4	136.0
375	365.09	357.28	339.4	330.5	170.6	166.5
450	448.31	436.70	416.8	405.8	209.5	204.5
525	527.05	515.75	490.0	477.1	246.3	240.4
600	596.9	584.17	555.0	540.4	279.0	272.3
675	673.10	659.49	626.5	610.0	314.9	307.4
750	749.30	734.14	697.4	679.1	350.6	342.1
900	901.70	883.46	839.3	817.2	421.9	411.7
1050	1054.10	1032.79	981.2	955.3	493.2	481.3
1200	1206.50	1182.12	1123.0	1093.5	564.5	550.9

DIMENSIONS ARE MILLIMETRES UNLESS OTHERWISE NOTED METRIC

No.	Date	Revision	App'd	Drawn LC Date NOV15/04 Checked Scale N.T.S. Approved by  for City Engineer	THE CITY OF CALGARY ENGINEERING AND ENVIRONMENTAL SERVICES DEPARTMENT <b>MANDREL DESIGN &amp; SIZING</b>	Sheet <b>63</b> File Number <b>452.1016.002</b>
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