

1. General**1.1 Section Includes**

- 1.1.1 This section includes the materials references and the installation and testing procedures for sewage force mains.

1.2 Related Sections

- Section 01 33 00 – Submittal Procedures.
- Section 31 23 33 – Excavating, Trenching and Backfilling.
- Section 03 20 00 – Concrete Reinforcing.
- Section 03 30 00 – Cast-in-Place Concrete.
- Section 01 78 00 – Close Out Submittals.

1.3 References

- 1.3.1 Guidelines for the Design, Construction and Operation of Water and Sewerage Systems, Department of Environment and Conservation, Water Resources Management Division, Government of Newfoundland and Labrador, latest revision.
- 1.3.2 American National Standards Institute/American Water Works Association, (ANSI/AWWA).
- 1.3.3 American Society for Testing and Materials International, (ASTM).
- ASTM C117-95, Standard Test Method for Material Finer Than 75 μm (No. 200) Sieve in Mineral Aggregates by Washing.
 - ASTM C136-01, Standard Method for Sieve Analysis of Fine and Coarse Aggregates.
 - ASTM C478M-97, Standard Specification for Precast Reinforced Concrete Manhole Sections Metric.
 - ASTM D698-00a, Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³ (600 kN-m/m³)).
- 1.3.4 Canadian General Standards Board (CGSB):
- CAN/CGSB-8.1-88, Sieves, Testing, Woven Wire, Inch Series.
 - CAN/CGSB-8.2-M88, Sieves, Testing, Woven Wire, Metric.
- 1.3.5 Canadian Standards Association (CSA International):

- CAN/CSA-A3000-98(April 2001), Cementitious Materials Compendium (Consists of A5-98, A8-98, A23.5-98, A362-98, A363-98, A456.1-98, A456.2-98, A456.3-98).
- CAN/CSA-A8-98, Masonry Cement.
- CAN/CSA-G30.18-M92(R1998), Billet Steel Bars for Concrete Reinforcement.
- CAN/CSA-G164-M92(R1998), Hot Dip Galvanizing of Irregularly Shaped Articles.

1.4 Submittals

- 1.4.1 Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures.
- 1.4.2 Submit samples in accordance with Section 01 33 00 - Submittal Procedures.
- 1.4.3 Inform the Departmental Representative of proposed source of bedding materials and provide access for the Departmental Representative's sampling and testing prior to commencing work.
- 1.4.4 Submit manufacturer's test data and certification that pipe materials meet requirements of this section at least two (2) weeks prior to beginning work. Include manufacturer's drawings, information and shop drawings where pertinent.
- 1.4.5 Pipe certification to be marked on pipe.

1.5 Closeout Submittals

- 1.5.1 Provide data to produce record drawings, including details of pipe material, maintenance and operating instructions in accordance with Section 01 78 00 - Closeout Submittals.
 - Data shall include, but not be limited to, top of pipe elevation, horizontal location of fittings and type and bedrock profile.

1.6 Waste Management and Disposal

- 1.6.1 Separate waste materials for reuse and recycling.
- 1.6.2 Place materials defined as hazardous or toxic in designated containers.

2. Products

2.1 Pipe, Joints and Fittings

2.1.1 Polyvinyl Chloride Pressure Pipe:

- To AWWA C900-89, DR18 (pressure class 150), 1 MPa gasket bell end, cast iron outside diameter

- To CSA B137.3-M90, PVC series 160, 1.1 MPa elastomeric gasket coupling..

2.1.2 Pipe Joints and Fittings:

- Cast Iron fittings to AWWA C1110/ANSI A21.10.
- PVC fittings to CSA B137.2 M89 or AWWA C-907-91.

2.2 Pipe Bedding Material

2.2.1 Granular pipe bedding shall be Type 2.

2.2.2 Granular bedding in accordance with Section 31 23 33 – Excavating, Trenching and Backfilling and following requirements:

- Crushed or screened stone, gravel or sand.
- Gradations to be within limits specified when tested to ASTM C136 and ASTM C117. Sieve sizes to CAN/CGSB-8.2.

2.2.3 Concrete mixes and materials for bedding, cradles, encasement, and supports: In accordance with Section 03 30 00 - Cast-in-Place Concrete.

2.3 Backfill Material

2.3.1 Backfill material to Section 31 23 33 – Excavating, Trenching and Backfilling.

3. Execution

3.1 Preparation

3.1.1 Clean pipes, fittings,, and appurtenances of accumulated debris and water before installation:

- Inspect materials for defects to approval of the Departmental Representative.
- Remove defective materials from site as directed by the Departmental Representative.

3.2 Trenching

3.2.1 Do trenching work in accordance with Section 31 23 33 - Excavating Trenching and Backfilling.

3.2.2 Trench alignment and depth require the Departmental Representative's approval prior to placing bedding material and pipe.

3.3 Granular Bedding

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- 3.3.1 Place granular bedding material in uniform layers not exceeding 150 mm compacted thickness to depth of 150 mm below bottom of pipe unless otherwise indicated on the contract drawings.
- 3.3.2 Do not place material in frozen condition.
- 3.3.3 Shape bed true to grade to provide continuous uniform bearing surface for pipe.
- 3.3.4 Shape transverse depressions in bedding as required to suit joints.
- 3.3.5 Compact each layer full width of bed to at least 95 % of corrected maximum dry density, ASTM D698 – 78 Method D.
- 3.3.6 Fill authorized or unauthorized excavation below design elevation of bottom of specified bedding in accordance with Section 31 23 33 - Excavating Trenching and Backfilling.

3.4 Pipe Installation

- 3.4.1 Lay pipes to ANSI/AWWA C600 and manufacturer's standard instructions and specifications. Do not use blocks except as specified.
- 3.4.2 Join pipes in accordance with ANSI/AWWA C600 and manufacturer's recommendations.
- 3.4.3 Bevel or taper ends of PVC pipe to match fittings.
- 3.4.4 Handle pipe by methods approved by the Departmental Representative and as recommended by pipe manufacturer. Do not use chains or cables passed through pipe bore so that weight of pipe bears on pipe ends.
- 3.4.5 Lay pipes on prepared bed, true to line and grade:
- Ensure barrel of each pipe is in contact with shaped bed throughout its full length.
 - Take up and replace defective pipe.
 - Correct pipe which is not in true alignment or grade or pipe which shows differential settlement after installation greater than 10 mm in 3 m.
- 3.4.6 Face socket ends of pipe in direction of laying. For mains on grade of 2 % or greater, face socket ends up-grade.
- 3.4.7 Do not exceed permissible deflection at joints as recommended by pipe manufacturer.
- 3.4.8 Keep jointing materials and installed pipe free of dirt and water and other foreign materials:

- Whenever work is stopped, install a removable watertight bulkhead at open end of last pipe laid to prevent entry of foreign materials.
- 3.4.9 Position and join pipes with equipment and methods approved by the Departmental Representative.
- 3.4.10 Cut pipes in approved manner as recommended by pipe manufacturer, without damaging pipe or its coating and to leave smooth end at right angles to axis of pipe.
- 3.4.11 Align pipes before jointing.
- 3.4.12 Install gaskets to manufacturer's recommendations. Support pipes with hand slings or crane as required to minimize lateral pressure on gasket and maintain concentricity until gasket is properly positioned.
- 3.4.13 Avoid displacing gasket or contaminating with dirt or other foreign material:
- Remove disturbed or contaminated gaskets.
 - Clean, lubricate and replace before jointing is attempted again.
- 3.4.14 Complete each joint before laying next length of pipe.
- 3.4.15 Minimize deflection after joint has been made.
- 3.4.16 Apply sufficient pressure in making joints to ensure that joint is completed to manufacturer's recommendations.
- 3.4.17 Ensure completed joints are restrained by compacting bedding material alongside and over installed pipes or as otherwise approved by the Departmental Representative.
- 3.4.18 When stoppage of work occurs, block pipes in an approved manner to prevent creep during down time.
- 3.4.19 Recheck plastic pipe joints assembled above ground after placing in trench to ensure that no movement of joint has taken place.
- 3.4.20 Do not lay pipe on frozen bedding.
- 3.4.21 Upon completion of pipe laying and after the Departmental Representative has inspected the work in place, surround and cover pipes between joints with approval granular material placed to dimensions indicated on the contract drawings or as directed by the Departmental Representative.
- 3.4.22 Hand place granular material in uniform layers not exceeding 150 mm thickness to minimum 300 mm over top of pipe. Dumping of material directly on top of pipe is not permitted.

- 3.4.23 Place layers uniformly and simultaneously on each side of pipe to prevent lateral displacement of the pipe.
- 3.4.24 Compact each layer to at least 95 % maximum density. ASTM D698-78, Method D.
- 3.4.25 Surround and cover joints and fittings with granular material placed and compacted as specified herein. Backfill remainder of trench in accordance with Section 31 23 33 – Excavating, Trenching and Backfilling.
- 3.4.26 Install HDPE pipe to manufacturer's recommendations.
- 3.4.27 Install Forcemain warning tape 900 mm above the forcemain throughout its entire length.

3.5 Thrust Blocks and Restrained Joints

- 3.5.1 For thrust blocks: do concrete Work in accordance with Section 03 30 00 - Cast-in-Place Concrete.
- 3.5.2 Place concrete thrust blocks between valves, tees, plugs, caps, bends, changes in pipe diameter, reducers and fittings and undisturbed ground as indicated or as directed by the Departmental Representative.
- 3.5.3 Keep joints and couplings free of concrete.
- 3.5.4 Do not backfill over concrete within 24 hours after placing.
- 3.5.5 Install joint restraints with or without thrust blocks where indicated on the contract drawings and specifications or where required by the Departmental Representative. Joint restraints shall be of the same pressure rating as the pipe to be joined and restrained. Installation of joint restraints shall be in accordance with the manufacturer's instructions for the types of pipes to be joined and restrained. All components of joint restraint shall be corrosion resistant or suitably protected from corrosion and be approved by the Departmental Representative.

3.6 Pressure Test

- 3.6.1 After the pipe has been installed and backfilled, all newly installed pipe, or valved section thereof, shall be subjected to a hydrostatic pressure of 150 % of normal operating pressure based on the elevation at the lowest point in the main and corrected to elevation at test gauge location or a minimum of 1000 kPa, whichever is greater, for a period of 1 hour.
- 3.6.2 Each valved section of pipe shall be slowly filled with water and the test pressure shall be applied by means of a pump connected to the pipe in a manner satisfactory to the Departmental Representative. The pump, pipe connection and all necessary apparatus shall be furnished by the Contractor.

- 3.6.3 Before applying the test pressure, all air shall be expelled from the pipe. If permanent air vents are not located at all high points the Contractor shall install corporation stops at such points so that the air in the system can be expelled. After the air has been expelled, the corporation stops shall be closed and the required test pressure applied.
- 3.6.4 The pressure test shall be of a duration of at least one hour and the pressure shall not vary by more than ± 35 kPa.
- 3.6.5 Pressure testing of polyethylene pipe to be carried out as per the manufacturer's recommendations.
- 3.6.6 Pressure testing of HDPE Pipe:
- Water is to be used as the pressure medium. Testing can be done before or after the pipe is placed in the trench. If the pipe must be backfilled before it is tested the mechanical joints may be exposed for visual inspection during testing.
 - Pipe should be tested at a pressure 1.5 times the rated pressure of the pipe (1.5 times series number) at the lowest point in the system. To compensate for initial pipe stretch, a period of three hours is required to pressurize the pipe plus 1 hour during which time the required pressure is maintained before the next period is started. Unless a high volume, high pressure pump is used, it is sometimes difficult to raise the pressure within the allowable time.
 - After the completion of the initial expansion stage, i.e. a total of four hours, the pressure should be at the required level and the test period should commence. This period should not exceed 3 hours. After the test period, a measured amount of make-up water should not exceed the allowance given in the following table:

ALLOWANCE FOR EXPANSION TABLE

Allowance for Expansion (Litres/100 meters of pipe)

Nominal Pipe Size (mm)	1 – hour test	2 – hour test	3 – hour test
75	1	2	4
100	2	4	5
150	4	7	11
200	6	12	19
250	10	16	26
275	12	25	37
300	14	29	42
350	17	35	52
400	21	41	62
450	27	53	81
500	35	68	99
550	43	87	130
600	56	111	168

700	68	138	209
800	87	178	267
900	112	224	335
1000	137	273	410
1200	186	335	534

- Under no circumstances should the total time under test exceed more than 8 hours at 1 ½ times the pressure rating. If the test is not completed because of leakage or equipment failure, the test section should be permitted to “relax” for 8 hours prior to the next testing sequence.
- Testing for leakage can be done by developing the test pressure (described above) for a period of 4 hours and then dropping the pressure by 69 kPa (10 psi). If the pressure remains steady for 1 hour this indicates that there is no leakage in the system.

3.6.7 All faulty or leaking connections shall be corrected at the Contractor’s expense.

3.6.8 Notify the Departmental Representative at least 24 hours in advance of proposed tests.

3.6.9 Perform tests in the presence of the Departmental Representative.

3.7 Leakage Test

3.7.1 A leakage test shall be conducted concurrently with the pressure test. The Contractor shall supply all equipment necessary for the conducting of this test.

3.7.2 “Leakage” shall be defined as the quantity of water that must be supplied into the newly installed pipe or any valved section thereof, to maintain pressure within ± 35 kPa of the test pressure after the air in the pipeline has been expelled.

3.7.3 No pipe installation will be accepted if the leakage is greater than the allowable leakage for joints plus the allowable leakage for closed metal seated valves.

3.7.4 Allowable leakage for joints is calculated as follows:

$$L = N D (P)^{0.5} / 128$$

Where; L = the allowable leakage in l/h.

N = the number of joints in the length of pipeline tested.

D = the nominal diameter of the pipe in meters.

P = the average test pressure during the leakage test in kilopascals.

3.7.5 Allowable leakage for closed metal seated valves shall be 0.00121 l/h/mm of nominal valve size.

3.7.6 If any test of pipe discloses leakage greater than the allowable, the Contractor shall, at his own expense, locate and repair the defective joints until the leakage is within the specified allowance. All visible leaks are to be repaired regardless of the amount of leakage.

3.7.7 Notify the Departmental Representative at least 24 hours in advance of proposed tests.

3.7.8 Perform tests in the presence of the Departmental Representative.

3.8 Swabbing

3.8.1 Appropriately sized and designed force main swabs shall be inserted into the water main at as many locations as need be to ensure every section of force main is swept by a swab when the water is first charged into the system.

3.9 Surface Restoration

3.9.1 After installing and backfilling over force mains, restore surface to its original condition as directed by the Departmental Representative.

4. Measurement and Basis for Payment

4.1 Measurement for Payment

4.1.1 Trenching and backfilling will be measured as per Standard Specification 31 23 33 – Excavating, Trenching and Backfilling, Measurement for Payment.

4.1.2 Sewage force main will be measured in meters through fittings after the work is completed. Measurement will be horizontally in meters over the center line of the pipe when the grade of the pipe is less than 10% and in meters along the slope length of the pipe when the grade of the pipe is 10% or greater, for each size pipe and depth class supplied and installed.

4.1.3 Concrete bedding, encasement of pipes, supports and thrust blocks shall be measured in cubic meters as per, Standard Specification 03 33 00 – Cast-in-Place Concrete, Measurement for Payment.

4.1.4 Granular bedding material will be measured in cubic meters as per, Standard Specification 31 23 33 – Excavating, Trenching and Backfilling. No deduction for pipe volume up to and including nominal diameter of 300 mm will be made. Calculation of pipe volume deduction will be made based on the nominal diameter for pipes in excess of 300 mm nominal diameter.

4.1.5 Fittings will be considered incidental to the installation of pipe and will be included in the measurement for pipe.

4.1.6 Swabbing of force main will be measured in meters of pipe swabbed for each size of pipe swabbed.

- 4.1.7 Locating and connecting to existing sewer line will be considered incidental to the installation of pipe and will be included in the measurement for pipe.

4.2 Basis for Payment

- 4.2.1 All costs associated with work specified in this section shall be deemed to be included in the appropriate unit and lump sum prices quoted in the Schedule of Quantities and Prices.
- 4.2.2 Payment shall be made to the maximum of 90% of the value of force mains, fittings and appurtenances until the system, or sections of the system if payment approved by the Departmental Representative, has passed all hydrostatic and leakage tests. The 10% retained shall be called the force main testing allowance.