

Part 1 General

1.1 RELATED REQUIREMENTS

- .1 Section 22 10 10 – Pumps.
- .2 Section 44 41 13.1 – Water Treatment Equipment.

1.2 REFERENCES

- .1 American National Standards Institute/American Water Works Association (ANSI/AWWA)
 - .1 ANSI/AWWA B300-10, Standard for Hypochlorites.
 - .2 ANSI/AWWA B301-10, Standard for Liquid Chlorine.
 - .3 ANSI/AWWA B303-10, Standard for Sodium Chlorite.
 - .4 ANSI/AWWA C111/A21.11-07, American National Standard for Rubber-Gasket Joints for Ductile-Iron and Fittings.
 - .5 ANSI/AWWA C110/A21.10-08, American National Standard for Ductile-Iron and Gray Iron Fittings for Water.
 - .6 ANSI/AWWA C150/A21.50-08, Standard for Thickness Design of Ductile-Iron Pipe.
 - .7 ANSI/AWWA C151/A21.51-09, Standard for Ductile-Iron Pipe, Centrifugally Cast.
 - .8 ANSI/AWWA C153/A21.53-11, Standard for Ductile-Iron Compact Fittings.
 - .9 ANSI/AWWA C206-11, Standard for Field Welding of Steel Water Pipe.
 - .10 ANSI/AWWA C207-07, Standard for Steel Pipe Flanges for Waterworks Service, 4 Inch through 144 Inch (100 mm through 3,600 mm).
 - .11 ANSI/AWWA C208-07, Standard for Dimensions for Fabricated Steel Water Pipe Fittings.
 - .12 ANSI/AWWA C500-09, Standard for Metal-Seated Gate Valves for Water Supply Service.
 - .13 ANSI/AWWA C504-10, Standard for Rubber-Seated Butterfly Valves.
 - .14 ANSI/AWWA C600-10, Standard for Installation of Ductile-Iron Water Mains, and Their Appurtenances.
 - .15 ANSI/AWWA C651-05, Standard for Disinfecting Water Mains.
 - .16 ANSI/AWWA C800-05, Standard for Underground Service Line Valves and Fittings.
 - .17 ANSI/AWWA C900-07, Standard for Polyvinyl Chloride (PVC) Pressure Pipe, and Fabricated Fittings, 4 Inch through 12 Inch (100 mm - 300 mm), for Water Transmission and Distribution.
- .2 ASTM International
 - .1 ASTM A53/A53M-10, Standard Specification for Pipe, Steel, Black and Hot Dipped, Zinc Coated, Welded and Seamless.

- .2 ASTM A123/A123M-09, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
- .3 ASTM A307-10, Standard Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile.
- .4 ASTM B88M-05(2011), Standard Specification for Seamless Copper Water Tube Metric.
- .5 ASTM C117-04, Standard Test Methods for Material Finer Than 0.075 mm (No. 200) Sieve in Mineral Aggregates by Washing.
- .6 ASTM C136-06, Standard Method for Sieve Analysis of Fine and Coarse Aggregates.
- .7 ASTM C478M-11, Standard Specification for Precast Reinforced Concrete Manhole Sections Metric.
- .8 ASTM F714-10, Standard Specification for Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter.
- .3 CSA International
 - .1 CAN/CSA-B137 Series-09, Thermoplastic Pressure Piping Compendium. (Consists of B137.0, B137.1, B137.2, B137.3, B137.4, B137.4.1, B137.5, B137.6, B137.8, B137.9, B137.10, B137.11 and B137.12).
 - .1 CAN/CSA-B137.1-09, Polyethylene Pipe, Tubing, and Fittings for Cold-Water Pressure Services.
 - .2 CAN/CSA-B137.3-09, Rigid Polyvinyl Chloride (PVC) Pipe for Pressure Applications.

1.3 CLOSEOUT SUBMITTALS

- .1 Submit in accordance with Section 01 78 30 - Closeout Submittals.

1.4 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 61 10 - Product Requirements and with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials in accordance with manufacturer's recommendations.
 - .2 Replace defective or damaged materials with new.

1.5 SCHEDULING OF WORK

- .1 Schedule Work to minimize interruptions to existing services.

Part 2 Products

2.1 PIPE, JOINTS AND FITTINGS

- .1 Polyvinyl chloride pressure pipe: to ANSI/AWWA C900, pressure class 150, DR 18.

- .1 Cast iron fittings: to ANSI/AWWA C110/A21.10, and for pipe diameters larger than NPS 4 cement mortar lined to ANSI/AWWA C104/A21.4.
- .2 Polyethylene pressure pipe:
 - .1 To AWWA C906 pressure class as specified.
 - .2 Polyethylene to polyethylene joints: to be thermal butt fusion joined, to ASTM D2657 or flanged with ductile iron backing flanges.
 - .3 Polyethylene fittings: to AWWA C906 for pressure class as specified.

2.2 VALVES AND VALVE BOXES

- .1 Valves to open counter clockwise.
- .2 Gate valves: to ANSI/AWWA C500, standard iron body.
- .3 Butterfly valves: to ANSI/AWWA C504.

2.3 PIPE DISINFECTION

- .1 Disinfect water mains in accordance with ANSI/AWWA C651.

2.4 RAINWATER HARVEST AND STORAGE

- .1 Acceptable products include:
 - .1 First-flush diverter:
 - .1 Rain Harvesting Pty First Flush Diverter for post or wall mounting WDPW99 – painted to match exterior surfaces.
 - .2 Storage tank and filter:
 - .1 ‘Barr™ Carat S’ below-ground tanks with telescopic dome shaft. Each tank is to be accessible for maintenance
 - .2 ‘Optimax Pro’ self-cleaning filter, c/w cleaning unit Opticlean ® Internal without hose (Order #340040). Install filter on first receiving tank, only.
- .2 Follow all of the Manufacturers’ installation requirements.
- .3 All access hatches are to be insulated:
 - .1 With extruded polystyrene to CAN/CGSB-51.20-M87, Type 4,
 - .2 In thickness appropriate to obtain effective RSI 3.87 (R22).
- .4 Provide two spare sets of any media/filters that, as a function of regular maintenance, require replacement.

2.5 ULTRASONIC LEVEL MEASUREMENT

- .1 Provide ultrasonic transmitter in exterior rainwater storage facility which measures water level in the storage tanks. Transmitter is to be installed so that there is no interference from other components inside the tank.
- .2 Measuring range to accommodate the range between a full and an empty storage tank.
- .3 Receiver panel mounted in mechanical room is to include visual indicator of water level.

2.6 HEAT TRACING CABLE

.1 Self-Regulating Heating Cables

The decision between self-regulating heating cable and power-limiting heating cable shall be made considering the need for a T-rating that is not dependent on the specific application (this is provided by self-regulating heating cables) and the number of runs of heat tracing required for the application. In some applications power-limiting heaters can use fewer runs due to higher power output at higher temperatures.

- .1 Self-regulating heating cable shall vary its power output relative to the temperature of the surface of the pipe or the vessel. The cable shall be designed such that it can be crossed over itself and cut to length in the field.
- .2 Self-regulating heating cable shall be designed for a useful life of 20 years or more with "power on" continuously, based on the following useful life criteria:
 - .1 Retention of at least 75 percent of rated power after 20 years of operation at the maximum published continuous exposure (maintain) temperature.
 - .2 Retention of at least 90 percent of rated power after 1000 hours of operation at the maximum published intermittent exposure temperature. The testing shall conform to UL 7468, IEC 216-1 Part 1.
- .3 A warranty against manufacturing defects for a period of 10 years shall be available.
- .4 All cables shall be capable of passing a 2.5 kV dielectric test for one minute (ASTM 2633) after undergoing a 0.5 kg-m impact (BS 6351, Part 1, 8.1.10).

.2 Freeze-Protection Systems

- .1 The heating cable shall consist of two 16 AWG or larger nickel-plated copper bus wires, embedded in a self-regulating polymeric core that controls power output so that the cable can be used directly on plastic or metallic pipes. Cables shall have a temperature identification number (T-rating) of T6 (185°F or 85°C) without use of thermostats.
- .2 A ground-fault protection device set at 30 mA, with a nominal 100-ms response time, shall be used to protect each circuit.
- .3 The heating cable shall have a tinned copper braid with a resistance less than the heating cable bus wire resistance as determined in type test (ASTM, B193, Sec. 5). The braid shall be protected from chemical attack and mechanical abuse by a modified polyolefin or fluoropolymer outer jacket.
- .4 In order to provide rapid heat-up, to conserve energy, and to prevent overheating of fluids and plastic pipe, the heating cable shall have the following minimum self-regulating indices:

Table G.1 Minimum Self-Regulating Indices

Heating Cable	S.R. Index (W/°F)	S.R. Index (W/°C)
3 W/ft	0.038	0.068
5 W/ft	0.060	0.108
8 W/ft	0.074	0.133
10 W/ft	0.100	0.180

The self-regulating index is the rate of change of power output in watts per degree Fahrenheit or watts per degree Celsius, as measured between the temperatures of 50°F (10°C) and 100°F (38°C) and confirmed by the type test and published data sheets.

- .5 In order to ensure that the self-regulating heating cable does not increase power output when accidentally exposed to high temperatures, resulting in thermal runaway and self-ignition, the cable shall produce less than 0.5 watts per foot (1.64 watts per meter) when energized and heated to 350°F (177°C) for 30 minutes. After this test, if the cable is reenergized, it must not have an increasing power output leading to thermal runaway.
- .6 In order to confirm 2.5.1.1, the self-regulating heating cable shall retain at least 90 percent of its original power output after having been cycled 300 times between 50°F (10°C) and 210°F (99°C), allowing at least six minutes of swell time at each temperature.
- .7 An acceptable heating cable is Raychem BTV-CT or BTV-CR self-regulating heater, with continuous exposure (maintain) capability up to 150°F (65°C) and intermittent exposure capability up to 185°F (85°C).

Part 3 Execution

3.1 EXAMINATION

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for distribution piping installation in accordance with manufacturer's written instructions.
 - .1 Visually inspect substrate.
 - .2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
 - .3 Proceed with installation only after unacceptable conditions have been remedied.

3.2 PREPARATION

- .1 Clean pipes, fittings, valves, hydrants, and appurtenances of accumulated debris and water before installation.
 - .1 Inspect materials for defects.
 - .2 Remove defective materials from site as directed by Departmental Representative.

3.3 TRENCHING

- .1 Do trenching work in accordance with Section 31 23 33.01 - Excavating, Trenching and Backfilling.
- .2 Ensure trench depth allows coverage over pipe of 1.0 m minimum from finished grade or as indicated.

3.4 GRANULAR BEDDING

- .1 Place granular bedding material in uniform layers not exceeding 150 mm compacted thickness to depth as indicated.

- .2 Do not place material in frozen condition.
- .3 Shape bed true to grade to provide continuous uniform bearing surface for pipe.
- .4 Shape transverse depressions in bedding as required to suit joints.
- .5 Compact each layer full width of bed to 95% maximum density to ASTM D698.
- .6 Fill authorized or unauthorized excavation below design elevation of bottom of specified bedding in accordance with Section 31 23 33.01 - Excavating, Trenching and Backfilling with compacted bedding material.

3.5 PIPE INSTALLATION

- .1 Lay pipes to ANSI/AWWA C600 and manufacturer's standard instructions and specifications.
 - .1 Do not use blocks except as specified.
- .2 Bevel or taper ends of PVC pipe to match fittings.
- .3 Handle pipe by methods recommended by pipe manufacturer. Do not use chains or cables passed through pipe bore so that weight of pipe bears on pipe ends.
- .4 Lay pipes on prepared bed, true to line and grade.
 - .1 Ensure barrel of each pipe is in contact with shaped bed throughout its full length.
 - .2 Take up and replace defective pipe.
 - .3 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.
- .5 Face socket ends of pipe in direction of laying.
- .6 Do not exceed permissible deflection at joints as recommended by pipe manufacturer.
- .7 Keep jointing materials and installed pipe free of dirt and water and other foreign materials.
 - .1 Whenever work is stopped, install a removable watertight bulkhead at open end of last pipe laid to prevent entry of foreign materials.
- .8 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.
- .9 Align pipes before jointing.
- .10 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.
- .11 Avoid displacing gasket or contaminating with dirt or other foreign material.
 - .1 Remove disturbed or contaminated gaskets.
 - .2 Clean, lubricate and replace before jointing is attempted again.
- .12 Complete each joint before laying next length of pipe.
- .13 Minimize deflection after joint has been made.

- .14 Apply sufficient pressure in making joints to ensure that joint is completed to manufacturer's recommendations.
- .15 Ensure completed joints are restrained by compacting bedding material alongside and over installed pipes or as otherwise approved by Departmental Representative.
- .16 When stoppage of work occurs, block pipes in an approved manner to prevent creep during down time.
- .17 Recheck plastic pipe joints assembled above ground after placing in trench to ensure that no movement of joint has taken place.
- .18 Do not lay pipe on frozen bedding.
- .19 Do hydrostatic and leakage test and have results approved by Departmental Representative before surrounding and covering joints and fittings with granular material.
- .20 Backfill remainder of trench.

3.6 RAIN WATER COLLECTION AND STORAGE

- .1 Storage:
 - .1 Prior to storage, treat sediments and other contaminants by diverting the first-flush of each rain event away from the storage system. All downspouts to drain to diverters.
 - .2 A minimum of 52,000 litres of underground storage is to be provided in the location shown on the drawings. Following leaf and debris removal (at each downspout) but prior to storage, water is to be filtered a second time using a self-cleaning system and minimum 0.35mm mesh filter.
 - .3 Tanks are to be installed with minimum 1.0m of ground cover.
 - .4 Ensure that tanks do not displace during backfilling procedures. This may require filling the tanks with water to a prescribed level. If available, refer to Manufacturer's installation guidelines, otherwise undertake buoyancy calculations and determine the methodology to use to ensure that tanks do not displace.
 - .5 Tanks are to be disinfected to applicable AWWA Standards and filled to capacity with potable water prior to being commissioned for use.
- .2 Collection:
 - .1 Provide minimum two roof drains to each building. Each roof drain to be outfitted with a box-screen as shown on contract drawings. All water shall be diverted to First Flush Diverters located in mechanical room and/or at the corner of the Primary Inspection Lane. Calculate size of First-Flush Diverter based on size of drainage area. Install shutoff valve/bypass to First-Flush Diverters.
 - .2 One Rainwater First-Flush Diverter assembly to be located in each of:
 - .1 Mechanical Room for office building roof harvest
 - .2 Mounted on the wall of the inside of the south east corner of the Primary Inspection Lane.

3.7 VALVE INSTALLATION

- .1 Install valves to manufacturer's recommendations at locations as indicated.

- .2 Support valves located in valve boxes or valve chambers by means of concrete located between valve and solid ground. Valves not to be supported by pipe.

3.8 HARVESTING AND STORAGE INSTALLATION

- .1 Install per manufacturer's recommendations and specifications
- .2 Install first-flush diverters and filters on downspouts approximately 2.7 m from ground level.

3.9 HARVESTING AND STORAGE INSTALLATION

- .1 Install per manufacturer's recommendations and specifications.

3.10 HYDROSTATIC AND LEAKAGE TESTING

- .1 For pressure pipes
 - .1 Testing shall be scheduled during a site visit by the Departmental Representative.
 - .2 Do tests in accordance with ANSI/AWWA C600.
 - .3 Provide labour, equipment and materials required to perform hydrostatic and leakage tests hereinafter described.
 - .4 Notify Departmental Representative at least 24 hours in advance of proposed tests.
 - .5 Where section of system is provided with concrete thrust blocks, conduct tests at least 5 days after placing concrete or 2 days if high early strength concrete is used.
 - .6 Upon completion of pipe laying surround and cover pipes between joints with approved granular material placed [to dimensions indicated.
 - .7 When testing is done during freezing weather, protect hydrants, valves, joints and fittings from freezing.
 - .8 Strut and brace caps, bends, tees, and valves, to prevent movement when test pressure is applied.
 - .9 Open valves.
 - .10 Expel air from main by slowly filling main with potable water.
 - .11 Apply leakage / hydrostatic test pressure of 14.0 kPa minimum after complete backfilling of trench, based on elevation of lowest point in main and corrected to elevation of gauge, for period of 1 hour.
 - .12 Do not exceed allowable leakage of 0.0 L/mm of pipe.
 - .13 Locate and repair defects if leakage is greater than amount specified.
 - .14 Repeat test until leakage is within specified allowance for full length of water main.
- .2 For water storage tanks and connecting pump chamber:
 - .1 Testing shall be scheduled during a site visit by the Departmental Representative.
 - .2 Upon completion of installation and backfilling, fill tanks with clean water so that a minimum of 500mm depth of water is in all tanks.
 - .3 Record water depth at start of test and at 2 hours after the start of the test.
 - .4 Do not exceed allowable leakage of 0mm of water depth after 2 hours.

- .5 Locate and repair defects if leakage is greater than amount specified.
- .6 Repeat test until leakage is within specified limits.

3.11 FLUSHING AND DISINFECTING

- .1 Flush water mains through available outlets with a sufficient flow of potable water to produce velocity of 1.5 m/s, within pipe for minimum 10 minutes, or until foreign materials have been removed and flushed water is clear.
- .2 Flushing flows as follows:

Pipe Size NPS	Flow (L/s) Minimum
6 and below	38
8	75
10	115
12	150
- .3 Provide connections and pumps for flushing as required.
- .4 Open and close valves, hydrants and service connections to ensure thorough flushing.
- .5 Perform bacteriological tests on water main, after chlorine solution has been flushed out.
 - .1 Take sample.
 - .2 Should contamination remain or recur, repeat disinfecting procedure.
- .6 After adequate chlorine residual not less than 50 ppm has been obtained leave system charged with chlorine solution for 24 hours.
 - .1 After 24 hours, take further samples and submit to lab to ensure that there is still not less than 10 ppm of chlorine residual remaining throughout system.

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 American National Standards Institute/American Water Works Association (ANSI/AWWA)
 - .1 ANSI/AWWA C111/A21.11-07, Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
- .2 ASTM International
 - .1 ASTM C12-09, Standard Practice for Installing Vitrified Clay Pipe Lines.
 - .2 ASTM C14M-07, Standard Specification for Nonreinforced Concrete Sewer, Storm Drain and Culvert Pipe (Metric).
 - .3 ASTM C76M-10a, Standard Specification for Reinforced Concrete Culvert, Storm Drain and Sewer Pipe (Metric).
 - .4 ASTM C117-04, Standard Test Method for Material Finer Than 75 [MU] m (No. 200) Sieve in Mineral Aggregates by Washing.
 - .5 ASTM C136-06, Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
 - .6 ASTM C425-09, Standard Specification for Compression Joints for Vitrified Clay Pipe and Fittings.
 - .7 ASTM C428-05(2006), Standard Specification for Asbestos-Cement Nonpressure Sewer Pipe.
 - .8 ASTM C443M-07, Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets (Metric).
 - .9 ASTM C663-98(2008), Standard Specification for Asbestos Cement Storm Drain Pipe.
 - .10 ASTM C700-09, Standard Specification for Vitrified Clay Pipe, Extra Strength, Standard Strength, and Perforated.
 - .11 ASTM C828-06, Standard Test Method for Low-pressure Air Test of Vitrified Clay Pipe Lines.
 - .12 ASTM D698-07e1, Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft⁴-lbf/ft³ (600 kN-m/m³)).
 - .13 ASTM D1869-95(2005)e1, Standard Specification for Rubber Rings for Asbestos Cement Pipe.
 - .14 ASTM D2680-01(2009), Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) and Poly (Vinyl Chloride) (PVC) Composite Sewer Piping.
 - .15 ASTM D3034-08, Standard Specification for Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
 - .16 ASTM D3350-10, Standard Specification for Polyethylene Plastics Pipe and Fittings Materials.
- .3 CSA International
 - .1 CSA A3000-08, Cementitious Materials Compendium.

- .2 CSA A257 Series-09, Standards for Concrete Pipe and Manhole Sections.
- .3 CAN/CSA-B70-06, Cast Iron Soil Pipe, Fittings, and Means of Joining.
- .4 CSA B1800-11, Thermoplastic Non-pressure Pipe Compendium.
 - .1 CSA B182.1-11, Plastic Drain and Sewer Pipe and Pipe Fittings.
 - .2 CSA B182.2-11, PSM Type Polyvinylchloride PVC Sewer Pipe and Fittings.
 - .3 CSA B182.6-11, Profile Polyethylene (PE) Sewer Pipe and Fittings for Leak-Proof Sewer Applications.
 - .4 CSA B182.11-11, Standard Practice for the Installation of Thermoplastic Drain, Storm, and Sewer Pipe and Fittings.
- .4 U.S. Environmental Protection Agency (EPA) / Office of Water
 - .1 EPA 832/R-92-005, Storm Water Management for Construction Activities: Developing Pollution Prevention Plans and Best Management Practices.

1.2 ADMINISTRATIVE REQUIREMENTS

- .1 Scheduling:
 - .1 Schedule Work to minimize interruptions to existing services and maintain existing sewage flows during construction.
 - .2 Notify Departmental Representative and building superintendent 24 hours minimum in advance of any interruption in service.

1.3 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials in accordance with manufacturer's recommendations.
 - .2 Store and protect from damage.
 - .3 Replace defective or damaged materials with new.

1.4 SEWAGE TREATMENT

- .1 The existing sanitary sewer service between the building and the septic tank is to be located and elevations verified prior to construction. A new connection for the proposed building is to be installed without disruption to the existing service.
- .2 A sewage treatment system is to be installed directly downstream of the existing septic tank, using existing pipe elevations. The treatment system is to be capable of treating residential grade sewage as defined in CSA B65 standard, to 'Type 3' standards as defined by the BC sewage system regulation.
- .3 Design average-day flow rate is 285 litres/day.
- .4 An acceptable system is:

- .1 'Microfast ® 0.375' installed in a 2,725 litre (600 imperial gallon) underground tank
- .2 1/3 HP 'Gast' air blower mounted in the mechanical room
- .3 Nema 4 enclosure for controller and alarm, mounted in the mechanical room.
- .5 Follow all of the manufacturers' installation requirements.
- .6 Provide two spare sets of any media/filters that, as a function of regular maintenance, require replacement.
- .7 The area of the existing ground disposal field is to be cleared, without grubbing, pursuant to contract specifications.

1.5 HEAT TRACING CABLE

.1 Self-Regulating Heating Cables

The decision between self-regulating heating cable and power-limiting heating cable shall be made considering the need for a T-rating that is not dependent on the specific application (this is provided by self-regulating heating cables) and the number of runs of heat tracing required for the application. In some applications power-limiting heaters can use fewer runs due to higher power output at higher temperatures.

- .1 Self-regulating heating cable shall vary its power output relative to the temperature of the surface of the pipe or the vessel. The cable shall be designed such that it can be crossed over itself and cut to length in the field.
- .2 Self-regulating heating cable shall be designed for a useful life of 20 years or more with "power on" continuously, based on the following useful life criteria:
 - .1 Retention of at least 75 percent of rated power after 20 years of operation at the maximum published continuous exposure (maintain) temperature.
 - .2 Retention of at least 90 percent of rated power after 1000 hours of operation at the maximum published intermittent exposure temperature. The testing shall conform to UL 7468, IEC 216-1 Part 1.
- .3 A warranty against manufacturing defects for a period of 10 years shall be available.
- .4 All cables shall be capable of passing a 2.5 kV dielectric test for one minute (ASTM 2633) after undergoing a 0.5 kg-m impact (BS 6351, Part 1, 8.1.10).

.2 Freeze-Protection Systems

- .1 The heating cable shall consist of two 16 AWG or larger nickel-plated copper bus wires, embedded in a self-regulating polymeric core that controls power output so that the cable can be used directly on plastic or metallic pipes. Cables shall have a temperature identification number (T-rating) of T6 (185°F or 85°C) without use of thermostats.
- .2 A ground-fault protection device set at 30 mA, with a nominal 100-ms response time, shall be used to protect each circuit.
- .3 The heating cable shall have a tinned copper braid with a resistance less than the heating cable bus wire resistance as determined in type test (ASTM, B193, Sec. 5). The braid shall be protected from chemical attack and mechanical abuse by a modified polyolefin or fluoropolymer outer jacket.

- .4 In order to provide rapid heat-up, to conserve energy, and to prevent overheating of fluids and plastic pipe, the heating cable shall have the following minimum self-regulating indices:

Table G.1 Minimum Self-Regulating Indices

Heating Cable	S.R. Index (W/°F)	S.R. Index (W/°C)
3 W/ft	0.038	0.068
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8 W/ft	0.074	0.133
10 W/ft	0.100	0.180

The self-regulating index is the rate of change of power output in watts per degree Fahrenheit or watts per degree Celsius, as measured between the temperatures of 50°F (10°C) and 100°F (38°C) and confirmed by the type test and published data sheets.

- .5 In order to ensure that the self-regulating heating cable does not increase power output when accidentally exposed to high temperatures, resulting in thermal runaway and self-ignition, the cable shall produce less than 0.5 watts per foot (1.64 watts per meter) when energized and heated to 350°F (177°C) for 30 minutes. After this test, if the cable is reenergized, it must not have an increasing power output leading to thermal runaway.
- .6 In order to confirm 2.5.1.1, the self-regulating heating cable shall retain at least 90 percent of its original power output after having been cycled 300 times between 50°F (10°C) and 210°F (99°C), allowing at least six minutes of swell time at each temperature.
- .7 The heating cable shall be Raychem BTV-CT or BTV-CR self-regulating heater, with continuous exposure (maintain) capability up to 150°F (65°C) and intermittent exposure capability up to 185°F (85°C).

Part 2 Products

2.1 PLASTIC PIPE

- .1 Type PSM Polyvinyl Chloride (PVC): to CSA B182.2.
- .1 Standard Dimensional Ratio (SDR): 28.

2.2 PIPE BEDDING AND SURROUND MATERIALS

- .1 Granular material to Section 31 05 16 - Aggregate Materials and following requirements:
- .1 Crushed or screened stone, gravel or sand.
- .2 Gradations to be within limits specified when tested to ASTM C136 and ASTM C117.

.2 Table:

Sieve Designation	% Passing Stone/Gravel	% Passing Gravel/Sand
200 mm	-	-
75 mm	-	-
50 mm	-	-
38.1 mm	-	-
25 mm	[100]	-
19 mm	-	-
12.5 mm	[65-90]	[100]
9.5 mm	-	-
4.75 mm	[35-55]	[50-100]
2.00 mm	-	[30-90]
0.425 mm	[10-25]	[10-50]
0.180 mm	-	-
0.075 mm	[0-8]	[0-10]

2.3 BACKFILL MATERIAL

- .1 As indicated.

Part 3 Execution

3.1 EXAMINATION

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for sewer pipe installation in accordance with manufacturer's written instructions.
- .1 Visually inspect substrate.
- .2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
- .3 Proceed with installation only after unacceptable conditions have been remedied.

3.2 PREPARATION

- .1 Temporary Erosion and Sedimentation Control:
- .1 Provide temporary erosion and sedimentation control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, according to requirements of authorities having jurisdiction and sediment and erosion control drawings.
- .2 Inspect, repair, and maintain erosion and sedimentation control measures during construction until permanent vegetation has been established.
- .3 Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.
- .2 Clean pipes and fittings of debris and water before installation, and remove defective materials from site.
- .3 Clean and dry pipes and fittings before installation.

3.3 TRENCHING

- .1 Do trenching Work in accordance with Section 31 23 33.01 - Excavating, Trenching and Backfilling.
- .2 Protect trench from contents of sewer or sewer connection.

3.4 CONCRETE BEDDING AND ENCASEMENT

- .1 Do concrete Work in accordance with Section 03 30 00 - Cast-in-Place Concrete.
- .2 Do not backfill over concrete within 24 hours after placing.

3.5 GRANULAR BEDDING

- .1 Place bedding in unfrozen condition.
- .2 Place granular bedding materials in uniform layers not exceeding 150 mm compacted thickness to depth as indicated.
- .3 Shape bed true to grade and to provide continuous, uniform bearing surface for pipe.
 - .1 Do not use blocks when bedding pipe.
- .4 Shape transverse depressions as required to suit joints.
- .5 Compact each layer full width of bed to at least 95% maximum density to ASTM D698.
- .6 Fill excavation below bottom of specified bedding adjacent to manholes or structures with compacted bedding material.

3.6 INSTALLATION

- .1 Lay and join pipes to: ASTM C12.
- .2 Lay pipes on prepared bed, true to line and grade, with pipe invert smooth and free of sags or high points.
 - .1 Ensure barrel of each pipe is in contact with shaped bed throughout its full length.
- .3 Begin laying at outlet and proceed in upstream direction with socket ends of pipe facing upgrade.
- .4 Joint deflection permitted within limits recommended by pipe manufacturer.
- .5 Whenever Work is suspended, install removable watertight bulkhead at open end of last pipe laid to prevent entry of foreign materials.
- .6 Install plastic pipe and fittings in accordance with CSA B182.11.
- .7 Pipe jointing:
 - .1 Install gaskets in accordance with manufacturer's written recommendations.
 - .2 Support pipes with hand slings or crane as required to minimize lateral pressure on gasket and maintain concentricity until gasket is properly positioned.
 - .3 Align pipes before joining.
 - .4 Maintain pipe joints free from mud, silt, gravel and foreign material.

- .5 Avoid displacing gasket or contaminating with dirt or foreign material. Gaskets so disturbed to be removed, cleaned and lubricated and replaced before joining is attempted.
- .6 Complete each joint before laying next length of pipe.
- .7 Minimize joint deflection after joint has been made to avoid joint damage.
- .8 Apply sufficient pressure in making joints to ensure that joint is complete as outlined in manufacturer's recommendations.
- .8 Cut pipes as required for special inserts, fittings or closure pieces as recommended by pipe manufacturer, without damaging pipe or its coating and to leave smooth end at right angles to axis of pipe.
- .9 Make watertight connections to manholes.
 - .1 Use shrinkage compensating grout when suitable gaskets are not available.
- .10 Use prefabricated saddles or field for connecting pipes to existing sewer pipes.
 - .1 Joints to be structurally sound and watertight.

3.7 PIPE SURROUND

- .1 Place gravel/sand surround material in unfrozen condition.
- .2 Hand place surround material in uniform layers not exceeding 150 mm compacted thickness as indicated.
- .3 Place layers uniformly and simultaneously on each side of pipe.
- .4 Compact each layer from pipe invert to mid height of pipe to at least 95% maximum density to ASTM D698.
- .5 Compact each layer from mid height of pipe to underside of backfill to at least 90% maximum density to ASTM D698.

3.8 BACKFILL

- .1 Place backfill material in unfrozen condition.
- .2 Place backfill material, above pipe surround in uniform layers not exceeding 150 mm compacted thickness up to grades as indicated.
- .3 Under paving and walks, compact backfill to at least 95% maximum density to ASTM D698.
 - .1 In other areas, compact to at least 90% maximum density to ASTM D698.

3.9 FIELD TESTING

- .1 Perform a low-pressure air test of pipe in accordance with the latest edition of "Uni Bell Plastic Pipe Association Recommended Practice for Low Pressure Air Testing of Installed Sewer Pipe".
- .2 Repair or replace pipe, pipe joint or bedding found defective or which does not pass the air test.

3.10 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.
 - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 ASTM International
 - .1 ASTM D698-07e1, Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³ (600 kN-m/m³)).
- .2 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB-34.22-94, Asbestos-Cement Drain Pipe.
- .3 CSA International
 - .1 CSA A23.1/A23.2-09, Concrete Materials and Methods of Concrete Construction/Test Methods and Standard Practices for Concrete.
 - .2 CSA B1800-11, Thermoplastic Non-Pressure Pipe Compendium (Consists of B181.1, B181.2, B181.3, B181.5, B182.1, B182.2, B182.4, B182.6, B182.7, B182.8, B182.11 and B182.13).
 - .1 CSA B182.2-11, PSM Type Polyvinylchloride (PVC) Sewer Pipe and Fittings.
 - .3 CAN/CSA-G401-07, Corrugated Steel Pipe Products.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section 01 33 00 – Shop Drawings, Product Data and Samples.

1.3 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Product Requirements.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store and protect drainage material from nicks, scratches, and blemishes.
 - .2 Replace defective or damaged materials with new.

1.4 SITE CONDITIONS

- .1 Examine sub-surface investigation report which is bound in Appendix B.
- .2 Known underground utility lines and buried objects are as indicated on plans.

Part 2 Products

2.1 BEDDING AND SURROUND MATERIALS

- .1 Coarse filter aggregate: to in accordance with Section 31 05 16 - Aggregate Materials.

- .2 Fine filter aggregate: in accordance with Section 31 05 16 - Aggregate Materials.
- .3 Flexible plastic tubing and fittings: corrugated, perforated, non-perforated, nominal inside diameter 150 mm.
- .4 Rigid plastic pipe and fittings: to CSA B182.2, complete with fittings.
- .5 Perforated, Non-perforated, Corrugated, steel pipe, couplers and fittings: to CAN/CSA-G401.
- .6 Geotextile filter: see Section 31 32 19.01 - Geotextiles.

2.2 BACKFILL MATERIAL

- .1 Type 2, in accordance with Section 31 23 33.01 - Excavating, Trenching and Backfilling.
- .2 Excavated or graded material existing on site may be suitable to use if approved by Departmental Representative.

Part 3 Execution

3.1 EXAMINATION

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for drainage materials installation in accordance with manufacturer's written instructions.
 - .1 Visually inspect substrate.
 - .2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
 - .3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Departmental Representative.
- .2 Make sure graded subgrade conforms with required drainage pattern before placing bedding material.
- .3 Make sure improper slopes, unstable areas, areas requiring additional compaction or other unsatisfactory conditions are corrected to approval of Departmental Representative.
- .4 Make sure foundation wall has been installed and approved by Departmental Representative before placing bedding material.

3.2 BEDDING PREPARATION

- .1 Cut trenches and place bedding materials in uniform layers not exceeding 150 mm compacted thickness to depth as indicated.
- .2 Shape bed true to grade and to provide continuous, uniform bearing surface for pipe.
- .3 Shape transverse depressions, as required, to suit joints.
- .4 Compact each layer full width of bed to at least 95% of corrected maximum dry density.
- .5 Fill excavation below design elevation of bottom of specified bedding with compacted bedding material.

3.3 PIPE OR TUBING INSTALLATION

- .1 Make sure pipe interior and coupling surfaces are clean before laying.
- .2 Lay perforated pipe to slope of 1:100. For pipe face perforations and coupling slots downward.
- .3 Lay non-perforated pipe as indicated from perforated pipe to disposal area. Make joints watertight.
- .4 Grade bedding to establish pipe slope.
- .5 Install end plugs at ends of collector drains to protect pipe ends from damage and ingress of foreign material.
- .6 Connect non-perforated pipe to drain by appropriate adapters manufactured for this purpose.
- .7 Provide cleanouts on non-perforated pipe at changes of pipe direction and in runs greater than 15 m.
- .8 Provide flush cleanouts where directed by Departmental Representative.
- .9 Connect drainage system to building sewers, as indicated.

3.4 PIPE OR TUBING SURROUND MATERIAL

- .1 Upon completion of pipe laying and after Departmental Representative has approved Work in place, surround and cover pipe and install geotextile filter as indicated.
- .2 Hand place surround material in uniform layers not exceeding 150 mm compacted thickness, as indicated.
- .3 Place layers uniformly and simultaneously on each side of pipe.
- .4 Compact each layer from pipe invert to mid-height of pipe to at least 95% of corrected maximum dry density.
- .5 Compact each layer from mid-height of pipe to underside of backfill to at least 90% maximum density to ASTM D698.
- .6 Place low strength unshrinkable fill where compaction cannot be achieved using mechanical methods.

3.5 BACKFILL MATERIAL

- .1 Place backfill material above pipe surround in uniform layers not exceeding 150 mm compacted thickness up to grades as indicated.
- .2 Under paving and walks, compact backfill to at least 95% maximum density to ASTM D698. In other areas, compact to at least 90% maximum density to ASTM D698.
- .3 Use appropriate compaction equipment.
 - .1 Conduct hand tamping around confined areas of pipe.
 - .2 Do not use water or other hydraulic means to place or consolidate backfill material.

3.6 FOUNDATION

- .1 Make penetrations through foundation structures only after receipt of written approval from Departmental Representative.

3.7 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.
 - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.
- .3 Waste Management: separate waste materials for recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
 - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 CSA C22.2 No. 211.2 Rigid PVC (unplasticized conduit).

1.2 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Provide submittals in accordance with Section 01 33 00 – Shop Drawings, Product Data and Samples.
- .2 Product Data:
 - .1 Submit manufacturer's printed product literature, specifications and datasheet and include product characteristics, performance criteria, physical size, finish and limitations.

1.3 QUALITY ASSURANCE

- .1 Quality assurance submittals: submit following in accordance with Section 01 45 00 - Quality Control.
 - .1 Certificates: signed by manufacturer certifying materials comply with specified performance characteristics and physical properties.
 - .2 Manufacturer's Instructions: for installation and special handling criteria, installation sequence and cleaning procedures.

1.4 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 61 10 Product Requirements and with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements:
 - .1 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.
- .3 Packaging Waste Management: in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

Part 2 Products

2.1 PVC DUCTS AND FITTINGS

- .1 Rigid PVC duct: Thickwall Rigid PVC (DB 2 not permitted), with factory fittings, for direct burial, Trade size as indicated.
 - .1 Nominal length: 3 m plus or minus 12 mm.
- .2 Rigid PVC split ducts.
- .3 Rigid PVC bends, couplings, reducers, bell end fittings, plugs, caps, adaptors same product material as duct, to make a complete installation.
- .4 Rigid PVC factory bends as required.

2.2 SOLVENT WELD COMPOUND

- .1 Solvent cement for PVC duct joints.

2.3 CABLE PULLING EQUIPMENT

- .1 6 mm stranded nylon pull rope tensile strength 5 kN.

2.4 WARNING TAPE

- .1 Standard 4-mil polyethylene 76 mm wide tape, yellow with black letters, imprinted with "CAUTION BURIED ELECTRIC CABLE BELOW ".

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

- .1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheets.

3.2 INSTALLATION

- .1 Install duct in accordance with manufacturer's instructions and at elevations as indicated.
- .2 Clean inside of ducts before laying.
- .3 Install plugs and cap both ends of ducts to prevent entrance of foreign materials during and after construction.
- .4 Pull through each duct wooden mandrel not less than 300 mm long and of diameter 6 mm less than internal diameter of duct, followed by stiff bristle brush to remove sand, earth and other foreign material.
 - .1 Pull stiff bristle brush through each duct immediately before pulling-in cables.
- .5 Install a pull rope continuous throughout each duct run with 3 m spare rope at each end.
- .6 Place continuous strip of warning tape 300 mm above duct before backfilling trenches.
- .7 Install markers as required.
- .8 Notify the Departmental Representative for field review upon completion of direct buried ducts and obtain acceptance prior to backfill.

3.3 CLEANING

- .1 Clean in accordance with Section 01 74 11 - Cleaning.
 - .1 Remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION