

Approved: 2013-12-31

**Part 1            General**

**1.1                RELATED REQUIREMENTS**

- .1        Section 33 31 13 – Public Sanitary Utility Sewerage Piping

**1.2                REFERENCE STANDARDS**

- .1        ASTM International
  - .1        ASTM A48, Standard Specification for Grey Iron Castings.
  - .2        ASTM A123, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
  - .3        ASTM C139, Standard Specification for Concrete Masonry Units for Construction of Catch Basins and Manholes.
  - .4        ASTM C478, Standard Specification for Precast Reinforced Concrete Manhole Sections (Metric).
- .2        CSA Group
  - .1        CSA A23.1, Concrete Materials and Methods of Concrete Construction/Test Methods and Standard Practices for Concrete.
  - .2        CAN/CSA-A3000-08, Cementitious Materials Compendium (Consists of A3001, A3002, A3003, A3004 and A3005).

**Part 2            Products**

**2.1                MATERIALS**

- .1        Cast-in-place concrete:
  - .1        In accordance with Section 03 30 00- Cast-in-Place Concrete.
  - .2        Concrete reinforcement: in accordance with Section 03 20 00- Concrete Reinforcing.
- .2        Precast maintenance hole units: to ASTM C478M, circular.
  - .1        Top sections eccentric cone or flat slab top type with opening offset for vertical ladder installation.
  - .2        Monolithic bases to be approved by Departmental Representative and set on concrete slabs cast in place.
  - .3        All 1050 manhole barrel sections shall be manufactured with a minimum thickness of 89 mm (ASTM Class “A” Wall). All 1200 mm manhole barrel sections shall be manufactured with minimum wall thickness of 127 mm (ASTM Class “B” Wall).
- .3        Joints: made watertight using rubber rings, bituminous compound, epoxy resin cement or cement mortar .
- .4        Mortar:

- .1 Aggregate: to CSA-A82
- .2 Masonry Cement: to CAN/CSA-A3002.
- .5 Ladder rungs: to CSA G30.18, No.25M billet steel deformed bars, hot dipped galvanized to ASTM A123/A123M.
  - .1 Rungs to be safety pattern (drop step type).
- .6 Adjusting rings: to ASTM C478M.
- .7 Drop maintenance hole pipe: same as sewer pipe.
- .8 Frames, gratings, covers to dimensions as indicated and following requirements:
  - .1 Metal gratings and covers to bear evenly on frames.
    - .1 Frame with grating or cover to constitute one unit.
    - .2 Assemble and mark unit components before shipment.
  - .2 Gray iron castings: to ASTM A48/A48M.

### **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 maintenance holes and catch basin structures installation in accordance with manufacturer's written instructions.
  - .1 Visually inspect substrate in presence of Departmental Representative.
  - .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.

#### **3.2 EXCAVATION AND BACKFILL**

- .1 Excavate and backfill in accordance with Section 31 23 33.01- Excavating Trenching and Backfilling and as indicated.
- .2 Obtain approval of Departmental Representative before installing maintenance holes.

#### **3.3 CONCRETE WORK**

- .1 Do concrete work in accordance with Section 03 30 00- Cast-in-Place Concrete.
- .2 Place concrete reinforcement in accordance with Section 03 20 00- Concrete Reinforcing.

#### **3.4 INSTALLATION**

- .1 Construct units in accordance with details indicated, plumb and true to alignment and grade.
- .2 Complete units as pipe laying progresses.
  - .1 Maximum of 3 units behind point of pipe laying will be allowed.

- .3 Dewater excavation to approval of Departmental Representative and remove soft and foreign material before placing concrete base.
- .4 Cast bottom slabs directly on undisturbed ground.
- .5 Set precast concrete base on 150 mm minimum of granular bedding compacted to 100 % corrected maximum dry density.
- .6 Precast units:
  - .1 Set bottom section of precast unit in bed of cement mortar and bond to concrete slab or base.
  - .2 Make each successive joint watertight with Departmental Representative's approved rubber ring gaskets, bituminous compound, cement mortar, epoxy resin cement, or combination of these materials.
  - .3 Clean surplus mortar and joint compounds from interior surface of unit as work progresses.
  - .4 Plug lifting holes with precast concrete plugs set in cement mortar or mastic compound.
- .7 For sewers:
  - .1 Place stub outlets and bulkheads at elevations and in positions indicated.
  - .2 Bench to provide smooth U-shaped channel.
    - .1 Side height of channel to be 0.75 times diameter of sewer.
    - .2 Slope adjacent floor at 1 in 10.
    - .3 Curve channels smoothly.
    - .4 Slope invert to establish sewer grade.
    - .5 For pipes smaller than 250 mm use standard fittings, breaking out upper half of fitting upon completion of maintenance hole.
- .8 Compact granular backfill to 98 % maximum density to ASTM D698.
- .9 Installing units in existing systems:
  - .1 Where new unit is installed in existing run of pipe, ensure full support of existing pipe during installation, and carefully remove that portion of existing pipe to dimensions required and install new unit as specified.
  - .2 Make joints watertight between new unit and existing pipe.
  - .3 Where deemed expedient to maintain service around existing pipes and when systems constructed under this project are ready for operation, complete installation with appropriate break-outs, removals, redirection of flows, blocking unused pipes or other necessary work.
- .10 Set frame and cover to required elevation using adjustment rings.
  - .1 Make brick joints and join brick to frame with cement mortar.
  - .2 Parge and make smooth and watertight.
- .11 Place frame and cover on top section to elevation as indicated.
  - .1 If adjustment required use concrete ring.
- .12 Clean units of debris and foreign materials.

- .1 Remove fins and sharp projections.
- .2 Prevent debris from entering system.

**3.5 CLEANING**

- .1 Progress Cleaning: clean in accordance with Section 01 74 00- 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 00- Cleaning.

**END OF SECTION**

**Part 1      General**

**1.1      REFERENCE STANDARDS**

- .1 American National Standards Institute/American Water Works Association (ANSI/AWWA)
  - .1 ANSI/AWWA B300, Standard for Hypochlorites.
  - .2 ANSI/AWWA B301, Standard for Liquid Chlorine.
  - .3 ANSI/AWWA B303, Standard for Sodium Chlorite.
  - .4 ANSI/AWWA C104/A21.4, Standard for Cement-Mortar Lining for Ductile-Iron Pipe and Fittings.
  - .5 ANSI/AWWA C111/A21.11, American National Standard for Rubber-Gasket Joints for Ductile-Iron and Fittings.
  - .6 ANSI/AWWA C110/A21.10, American National Standard for Ductile-Iron and Grey Iron Fittings for Water.
  - .7 ANSI/AWWA C153/A21.53, Standard for Ductile-Iron Compact Fittings.
  - .8 ANSI/AWWA C500, Standard for Metal-Seated Gate Valves for Water Supply Service.
  - .9 ANSI/AWWA C651, Standard for Disinfecting Water Mains.
  - .10 ANSI/AWWA C900, 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 A307, Standard Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile.
  - .2 ASTM B88M, Standard Specification for Seamless Copper Water Tube Metric.
  - .3 ASTM C117, Standard Test Methods for Material Finer Than 0.075 mm (No. 200) Sieve in Mineral Aggregates by Washing.
  - .4 ASTM C136, Standard Method for Sieve Analysis of Fine and Coarse Aggregates.
  - .5 ASTM D698, Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft<sup>3</sup>(600 kN-m/m<sup>3</sup>)).
  - .6 ASTM D2657, Standard Practice for Heat Fusion Joining of Polyolefin Pipe and Fittings.
  - .7 ASTM F714, Standard Specification for Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter.
- .3 American Water Works Association (AWWA)/Manual of Practice
- .4 CSA International
  - .1 CAN/CSA-B137 Series, 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, Polyethylene Pipe, Tubing, and Fittings for Cold-Water Pressure Services.
    - .2 CAN/CSA-B137.3, Rigid Polyvinyl Chloride (PVC) Pipe for Pressure Applications.

- .2 CSA G30.18, Carbon and Steel Bars for Concrete Reinforcement.
- .5 Underwriters' Laboratories of Canada (ULC)
  - .1 CAN/ULC-S520, Standard for Fire Hydrants.
  - .2 CAN/ULC-S543, Standard for Internal-Lug, Quick Connect Couplings for Fire Hose.

## **1.2 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures
- .2 Product Data:
  - .1 Submit manufacturer's instructions, printed product literature and data sheets for distribution piping materials and include product characteristics, performance criteria, physical size, finish and limitations.
  - .2 Pipe certification to be on pipe.
- .3 Samples:
  - .1 Inform Departmental Representative of proposed source of bedding materials and provide access for sampling at least 4 weeks prior to commencing work.
  - .2 Submit for testing 4 weeks minimum prior to beginning work, samples of materials proposed for use as follows:
    - .1 Bedding Material.
  - .3 Submit manufacturer's test data and certification that pipe materials meet requirements of this section 4 weeks minimum prior to beginning work. Include manufacturer's drawings, information and shop drawings where pertinent.

## **1.3 CLOSEOUT SUBMITTALS**

- .1 Submit in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Submit data to produce record drawings, including directions for operating valves, list of equipment required to operate valves, details of pipe material, location of air and vacuum release valves, hydrant details.
  - .1 Include top of pipe, horizontal location of fittings and type, valves, valve boxes, valve chambers and hydrants.

## **1.4 DELIVERY, STORAGE AND HANDLING**

- .1 Deliver, store and handle materials in accordance with Section 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 pipes from damage.
  - .3 Replace defective or damaged materials with new.

## **1.5 ADMINISTRATIVE REQUIREMENTS**

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

- .2 Submit schedule of expected interruptions for approval and adhere to interruption schedule as approved by Departmental Representative.
- .3 Notify Departmental Representative minimum of 72 hours in advance of interruption in service.
- .4 Notify fire department of planned or accidental interruption of water supply to hydrants.
- .5 Provide and post "Out of Service" sign on hydrant not in use.

## **Part 2 Products**

### **2.1 PIPE, JOINTS AND FITTINGS**

- .1 Polyvinyl chloride pressure pipe: to AWWA C900, pressure class 150, DR 18.
  - .1 Fabricated fittings shall be thermally butt-welded segments, with overwrapped reinforcement, conforming with AWWA C900 and CSA B137.3. Where non-standard fittings and bend angles are required, fittings shall be constructed in every way to conform to the nearest CSA certified standard.
  - .2 PVC fitting joint restraints shall be constructed of ductile iron to ASTM A536 Grade 65-45-12.

### **2.2 VALVES AND VALVE BOXES**

- .1 Design
  - .1 Design as per latest version of AWWA C515 or AWWA C509
  - .2 Working Pressure of 1,724 kPa (250 psi)
- .2 Epoxy coated interior surfaces to AWWA C550.
- .3 External coatings shall be two (2) or more layers (5 mils minimum each coat) Polyamide Epoxy. Application as per manufacturer's recommendations.
- .4 Repair coatings shall be as per manufacturer's recommendations.
- .5 Fully restrained flanged end or mechanical joint end shall suit connecting pipe material according to the details for direct bury valves.
- .6 Ductile iron gate with mechanically attached resilient seat on disc.
- .7 Flanged valve ends shall be drilled to ANSI B16.1 standard for cast iron flanges, Class 125 and rated for 1,724 kPa (250 psi) working pressure.
- .8 Cast iron valve boxes: bituminous coated screw type adjustable over minimum of 450 mm complete with valve operating extension rod, 30 mm below cover.
  - .1 Base to be large round type with minimum diameter of 300 mm.
  - .2 Top of box to be marked "WATER"/"EAU".

### **2.3 SERVICE CONNECTIONS**

- .1 Polyethylene pressure pipe:
  - .1 Polyethylene (PE) tubing shall have a SDR of 9 (working pressure 1035 kPa) and shall be manufactured in accordance with ASTM D2737, AWWA C901, using materials designated PE 2306, PE 3306 or 3406.

- .2 Brass corporation stops: Shall be standard brass with tapping thread suitable for compression type connection to piping.
- .3 Brass inverted key-type curb stops: red brass to ASTM B62, compression type without drains.
- .4 Curb Boxes: Curb boxes to accommodate service connections less than 50 mm in diameter shall have a cast iron base and lid. Vertical riser piping shall consist of telescoping top section complete with set screw and galvanized Schedule 40 piping. The service lid shall have a threaded five sided brass plug opening. The operating spindle shall be 15 mm steel rod complete with brass pin. For cathodic protection, an 800 gm Zinc Protecto-Collar is required on the bottom section of the steel casing.

## 2.4 PIPE COUPLERS

- .1 Pipe couplers for pipe connections for AWWA C301 PCC and AWWA C905 PVC piping shall be to the latest revision of AWWA C-219 for bolted, Sleeve Type Couplers for Plain End Pipe. Minimum requirements are:
  - .1 Minimum sleeve length 175 mm
  - .2 Minimum centre sleeve thickness 10 mm
  - .3 Couplings capable of accommodating up to 2 degrees deflection
  - .4 Bolts and nuts to be 316 Stainless Steel
  - .5 Design pressure 150 psi
  - .6 Restrained couplers shall be provided where indicated on the Drawings
- .2 Pipe couplers for Victaulic Style 44 (Shouldered) End Connections to be to the latest revision of AWWA C606 for Grooved and Shouldered Joints. Minimum requirements are:
  - .1 Bolts and nuts to be 316 stainless steel
- .3 Couplings to be fusion bonded epoxy coated to AWWA C210.
- .4 Buried pipe couplers and flange connections shall be protected against corrosion by wrapping with petrolatum tape system, in accordance with AWWA C217.

## 2.5 PAINT

- .1 Paint for exposed metal surfaces shall be in accordance with AWWA C213.
- .2 Coating shall be two (2) or more layers (5 mils dry film thickness minimum each coat) Polyamide Epoxy.

## 2.6 FITTINGS FOR 200 MM AND SMALLER PIPE

- .1 Fittings shall be PVC fittings for AWWA C-900 pipe manufactured in one piece of injection molded PVC compound conforming to AWWA C-905.

## 2.7 FITTINGS FOR 250 MM AND LARGER PIPE

- .1 Flanged ends shall conform to AWWA C110.

- .2 Push-On type ends shall conform to AWWA C111.

## **2.8 HYDRANTS**

- .1 Hydrants shall be compression type shut off with cast iron body bronze mounted, 150 mm barrel diameter, O-Ring stem seals, and shall open with a counter-clockwise rotation conforming to AWWA Specification C502. The barrel shall be flanged at ground line and the barrel length shall be suitable for cover as indicated on drawings from flange at ground surface to crown of inlet pipe.
- .2 Hydrants shall have one 125 mm storz connection pumper nozzle and 2-65 mm hose connections conforming to AWWA C-502 and threads shall conform to Sask. Mutual Aid Standards.
- .3 All hydrants are to be certified by Underwriters' Laboratory of Canada (ULC).
- .4 The operating nut shall be Pentagonal shaped. Hydrants shall be flanged 100 mm above ground line. The colour of the hydrant above the ground shall be red.
- .5 Joints between hydrant and water main shall conform to the type of pipe supplied.
- .6 All nuts and bolts below grade shall be stainless steel AISI Type 316. Hydrant barrels and elbows shall be coated with Denso paste and tape.
- .7 Hydrants shall be brand name approved by the Department Representative

## **2.9 PIPE BEDDING AND SURROUND MATERIAL**

- .1 Granular material to: Section 31 05 16 - Aggregate Materials and following requirements:

## **2.10 BACKFILL MATERIAL**

- .1 In accordance with Section 31 23 33.01 - Excavating, Trenching and Backfilling

## **2.11 PIPE DISINFECTION**

- .1 Sodium hypochlorite to AWWA B300 to disinfect water mains.
- .2 Disinfect water mains in accordance with ANSI/AWWA C651.

## **2.12 SACRIFICIAL ANODE MATERIAL**

- .1 Cadweld to be 25 gram. A #6 copper sleeve crimped to anode lead is required prior to cadwelding.
- .2 Eyelets to be 16 mm (5/8") or 20 mm (3/4") copper stud #6 cable eyelet.

## **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 in presence of Departmental Representative.
  - .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.

### **3.2 PREPARATION**

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

### **3.3 TRENCHING**

- .1 Do PVC C900 water main trenching and backfill work in accordance with ASTM D2321-04 – Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications except as modified in 31 23 33.01 - Excavating, Trenching and Backfilling, and herein.
- .2 Trench depth to provide minimum cover over pipe of 3.2 m below the finished grades or graded as indicated on the drawings or as required to by the Department Representative.
- .3 Confirm trench line, grade and depth meet design requirements prior to placing bedding material and pipe.
- .4 Do not backfill trenches until pipe grade and alignment have been reviewed by the Department Representative.

### **3.4 GRANULAR BEDDING**

- .1 Construct embedment zone for open trench PVC water mains in accordance with ASTM D2321 Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications except as noted herein.
- .2 If required and approved by the Department Representative, replace unsuitable material in the foundation zone with granular backfill or bedding stone according to Section 02223.
- .3 Place granular bedding, haunch and initial backfill materials to details indicated in Section 31 23 33.01 and as indicated on the drawings.
- .4 Shape bed true to grade to provide continuous uniform bearing surface for pipe exterior. Do not use blocks in bedding pipe.
- .5 Shape transverse depressions as required to make joints.
- .6 Compact a bedding material that conforms to the gradation specification of Section 31 23 33.01 or ASTM D2321 Class II material to at least 95% standard proctor maximum dry density with the exception of the middle 1/3 of pipe diameter. Do not compact middle 1/3 of pipe diameter but allow uniform support with no voids in the bedding material. If the bedding material conforms to an ASTM D2321 Class III material, the material shall be compacted to at least 95% standard proctor maximum dry density with the exception of the middle 1/3 of pipe diameter.
- .7 Place haunch and initial backfill to 200 millimeters above the crown of the pipe over the trench width. Compact the haunch and initial backfill material that conforms to the gradation specification of Section 31 23 33.01 or ASTM D2321 Class II material to at least 95% standard proctor maximum dry density. If the bedding material conforms to an

ASTM D2321 Class III material, the material shall be compacted to at least 95% standard proctor maximum dry density.

- .8 Exercise caution and place and compact material for haunch and initial backfill area in such a manner that adverse vertical and horizontal deflection does not occur.
- .9 Place bedding stone in lieu of pipe embedment material when requested by the Department Representative.
- .10 Fill any unauthorized over-excavation with bedding stone or granular backfill at Contractor's expense.

### **3.5 PIPE INSTALLATION**

- .1 Lay and join pipes in accordance with manufacturer's recommendations.
- .2 Handle pipe with approved equipment. Do not use chains or cables passed through pipe bore so that weight of pipe bears upon pipe ends.
- .3 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.
- .4 Commence laying and proceed in upstream direction with socket ends of pipe facing upgrade.
- .5 Do not exceed permissible deflection at joints recommended by pipe manufacturer.
- .6 Do not allow water to flow through pipe during construction, except as may be permitted by Department Representative.
- .7 Whenever work is suspended, install a removable watertight bulkhead at open ends of last pipe laid to prevent entry of foreign materials.
- .8 Position and join pipes with approved equipment. Do not use excavating equipment to force pipe sections together.
- .9 Pipe Jointing:
  - .1 Install gaskets in accordance with manufacturer's 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 carefully before joining.
  - .4 Maintain pipe joints free from mud, silt, gravel or other foreign material.
  - .5 Avoid displacing gasket or contaminating with dirt or other foreign material. Gaskets so disturbed shall 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 assure that joint is complete as outlined in manufacturer's recommendations.

- .9 Ensure completed joints are restrained by compacting bedding material alongside and over installed pipe or as otherwise approved by Department Representative.
- .10 Block pipes when any stoppage of work occurs in such a manner as required by Department Representative to prevent creep during down time.
- .11 Cut pipes as required for special inserts, fittings or closure pieces in a neat manner as recommended by pipe manufacturer, without damaging pipe or its coating and to leave a smooth end at right angles to axis of pipe.
- .12 Upon completion of pipe laying place specified granular material to dimensions indicated or directed.
- .13 Hand place granular material in uniform layers of 150 mm thick or less. Dumping of material directly on top of pipe is not permitted.
- .14 Place layers uniformly and simultaneously on each side of pipe to prevent lateral displacement of pipe.
- .15 Haul and dispose of all surplus excavated material at an approved location. Place in 200 mm lifts to grades indicated by the Department Representative and track compact.

**3.6 VALVE INSTALLATION**

- .1 Valves shall be set accurately at the positions shown on the plans and properly jointed into the main. The valve box shall be set plumb over the valve bonnet. The bottom nut of the extension rod shall be securely fitted on the valve operating nut. On paved streets, the top of the valve box on main and hydrant valves shall be set flush with the finished paved surface. On gravelled streets and lanes, the top of the valve box on main and hydrant valves shall be set 150 mm below the finished gravelled surface. The top of the extension rod shall not be more than 600 mm or less than 300 mm below the top of the valve box.
- .2 The Contractor shall mark the location of each valve with a 38 mm x 89 mm x 750 mm stake with letters M.V. painted in red on a white background.

**3.7 SERVICE CONNECTIONS**

- .1 Terminate building water service 1 m outside building wall opposite point of connection to main.
  - .1 Install coupling necessary for connection to building plumbing.
  - .2 If plumbing is already installed, make connection, otherwise cap or seal end of pipe and place temporary marker to locate pipe end.
- .2 Do not install service connections until satisfactory completion of hydrostatic and leakage tests of water main.
- .3 Construct service connections at right angles to water main unless otherwise directed. Locate curb stops as directed by Departmental Representative.
- .4 Tappings on PVC-C900 pipe, may be threaded without service clamps.
  - .1 Double strap service connections with galvanized malleable iron body and neoprene gasket cemented in place may be used.
  - .2 Tappings for PVC-C900 pipe to conform to following:

Pipe Diameter (mm)	Maximum Tap Without Clamp (mm)	Maximum Tap With Clamp (mm)
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100	20	25
150	20	40
200	25	50
250	25	50
300	40	75

- .5 Tappings on PVC pipe to be PVC valve tees.
- .6 Employ only competent workmen equipped with suitable tools to carry out tapping of mains, cutting and flaring of pipes.
- .7 Install single and multiple tap service connections on top half of main, between 45 degrees and 90 degrees measured from apex of pipe.
- .8 Install multiple corporation stops, 30 degrees apart around circumference of pipe and minimum of 300 mm apart along pipe.
- .9 Tap main at 2:00 o'clock or 10:00 o'clock position only; not closer to joint nor closer to adjacent service connections than recommended by manufacturer, or 1 m minimum, whichever is greater.
- .10 Leave corporation stop valves fully open.
- .11 In order to relieve strain on connections, install service pipe in "Goose Neck" form "laid over" into horizontal position.
- .12 Install rigid stainless steel liners in small diameter plastic pipes with compression fittings.
- .13 Install curb stop with corporation box on services NPS 2 or less in diameter.
  - .1 Equip larger services with gate valve and cast iron box.
  - .2 Set box plumb over stop and adjust top flush with final grade elevation.
  - .3 Leave curb stop valves fully closed.

**3.8 HYDRANTS**

- .1 Install hydrants at locations as indicated.
- .2 Install hydrants in accordance with AWWA M17.
- .3 Install 150 mm gate valve and cast iron valve box on hydrant service leads as indicated.
- .4 Set hydrants plumb, with hose outlets parallel with edge of pavement or curb line, with pumper connection facing roadway and with body flange set at elevation of 50 mm above final grade.
- .5 Place concrete thrust blocks as indicated and specified ensuring that drain holes are unobstructed.
- .6 To provide proper draining for each hydrant, excavate pit measuring not less than 1 x 1 x 0.5 m deep and backfill with coarse gravel or crushed stone to level 150 mm above drain holes.

**3.9 THRUST BLOCKS AND RESTRAINED JOINTS**

- .1 For thrust blocks: do concrete Work in accordance with Section 03 30 00 - Cast-in-Place Concrete.
- .2 Place concrete thrust blocks between valves, tees, plugs, caps, bends, changes in pipe diameter, reducers, hydrants and fittings and undisturbed ground as indicated or as directed by Departmental Representative.

- .3 Keep joints and couplings free of concrete.
- .4 Do not backfill over concrete within 24 hours after placing.
- .5 The thrust block shall bear against undisturbed soil and the soil shall be cut smooth and at the proper angle to the pipe. No horizontal struts or braces required for trench bracing shall remain in the concrete thrust block. A bond breaker consisting of 0.20 millimetre (8 mil) polyethylene sheeting shall be installed between fittings, valves or plugs and the concrete of the thrust block to allow future removal of the thrust block without disturbing the fitting, valve or plug. Before any concrete is placed, all thrust block formwork shall be inspected and approved by the Department Representative.

**3.10 HYDROSTATIC AND LEAKAGE TESTING**

- .1 Do tests in accordance with AWWA C605.
- .2 Test Procedure

After backfilling is completed, a pressure test shall be carried out in the presence of the Department Representative on all lines at the maximum rated operating pressure for the class of pipe installed. Hydrostatic leakage testing, cleaning and flushing of pressure mains shall not be conducted when the ambient air temperature is less than + 10° C. The Contractor shall supply sufficient water for filling, flushing, swabbing, testing and disinfection.

The test section of the pipeline shall be filled with water at a velocity not exceeding 0.3 metres per second, taking care to expel all air from the high points. If air valves, service connections, or other means of venting are not provided, the Contractor shall at his own expense drill and tap small holes at high points. He shall also provide a suitable cock to vent air during tests. The hole shall be sealed by means of a tight fitting plug at the conclusion of the test. The pressure shall be maintained for not less than one hour by pumping additional water into the test section from a measuring tank with suitable accessibility and dimensions so that the necessary measurements can be obtained to calculate a water volume. The test section will not be accepted if the make-up water volume in litres per hour measured by the above method exceeds the allowable quantity determined by the following tables.

<b>PVC Pipe - Allowable Leakage in Litre/Hr. Per 100 Joints Based on AWWA C605 Test Pressure (kPa)</b>							
Pipe Diameter	350	500	700	850	1000	1400	1550
150 mm	2.2	2.6	3.0	3.4	3.6	4.3	4.5
200 mm	2.9	3.4	4.1	4.5	4.9	5.7	6.0
250 mm	3.6	4.3	5.1	5.6	6.1	7.2	7.6
300 mm	4.3	5.1	6.1	6.7	7.3	8.6	9.1
350 mm	5.0	6.0	7.1	7.8	8.5	10.0	10.6

If the make-up water volume exceeds the allowable, the Contractor shall locate and repair leaks and other defects and repeat the test until the make-up water volume does not exceed the allowable.

The Contractor shall provide all necessary labour, materials and equipment for the test including a suitable pump and measuring tank, pressure hoses and connection plugs, caps, gauges and all other apparatus necessary for filling the main, pumping to the required test pressure and recording the pressure and leakage losses. If requested by the

Department Representative, the Contractor shall provide evidence that the gauges used are accurate.

### **3.11 PIPE SURROUND**

- .1 Upon completion of pipe laying and after Departmental Representative has inspected Work in place, surround and cover pipes 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 Do not place material in frozen condition.
- .5 Compact each layer from pipe invert to mid height of pipe to at least 95 % of maximum density to ASTM D698.
- .6 Compact each layer from mid height of pipe to underside of backfill to at least 95 % maximum density to ASTM D698

### **3.12 BACKFILL**

- .1 Place backfill material, above pipe surround, in uniform layers not exceeding 150 mm compacted thickness up to grades as indicated.
- .2 Do not place backfill in frozen condition.
- .3 Under paving and walks, compact backfill to at least 98% maximum density to ASTM D698.
  - .1 In other areas, compact to at least 90% maximum density to ASTM D698.

### **3.13 HYDROSTATIC AND LEAKAGE TESTING**

- .1 Do tests in accordance with AWWA C605.
- .2 Test Procedure

After backfilling is completed, a pressure test shall be carried out in the presence of the Department Representative on all lines at the maximum rated operating pressure for the class of pipe installed. Hydrostatic leakage testing, cleaning and flushing of pressure mains shall not be conducted when the ambient air temperature is less than + 10° C. The Contractor shall supply sufficient water for filling, flushing, swabbing, testing and disinfection.

The test section of the pipeline shall be filled with water at a velocity not exceeding 0.3 metres per second, taking care to expel all air from the high points. If air valves, service connections, or other means of venting are not provided, the Contractor shall at his own expense drill and tap small holes at high points. He shall also provide a suitable cock to vent air during tests. The hole shall be sealed by means of a tight fitting plug at the conclusion of the test. The pressure shall be maintained for not less than one hour by pumping additional water into the test section from a measuring tank with suitable accessibility and dimensions so that the necessary measurements can be obtained to calculate a water volume. The test section will not be accepted if the make-up water volume in litres per hour measured by the above method exceeds the allowable quantity determined by the following tables.

<b>PVC Pipe - Allowable Leakage in Litre/Hr. Per 100 Joints Based on AWWA C605 Test Pressure (kPa)</b>							
Pipe Diameter	350	500	700	850	1000	1400	1550
150 mm	2.2	2.6	3.0	3.4	3.6	4.3	4.5
200 mm	2.9	3.4	4.1	4.5	4.9	5.7	6.0
250 mm	3.6	4.3	5.1	5.6	6.1	7.2	7.6
300 mm	4.3	5.1	6.1	6.7	7.3	8.6	9.1
350 mm	5.0	6.0	7.1	7.8	8.5	10.0	10.6

If the make-up water volume exceeds the allowable, the Contractor shall locate and repair leaks and other defects and repeat the test until the make-up water volume does not exceed the allowable.

The Contractor shall provide all necessary labor, materials and equipment for the test including a suitable pump and measuring tank, pressure hoses and connection plugs, caps, gauges and all other apparatus necessary for filling the main, pumping to the required test pressure and recording the pressure and leakage losses. If requested by the Department Representative, the Contractor shall provide evidence that the gauges used are accurate.

**3.14 CATHODIC PROTECTION**

- .1 The Contractor shall supply and install sacrificial zinc anodes to provide cathodic protection for all valves, hydrants and cast iron fittings installed under this Contract.
- .2 The Contractor shall connect a 24 lb. anode to each hydrant and each valve. Where the anode is connected to a valve, the anode wire shall also be connected to the valve box.
- .3 The Contractor shall connect a 12 lb. anode to each cast iron fitting, each robar coupling and to each copper water service line where the existing service lines are being reconnected into the new water main.
- .4 The Contractor shall install the anodes one metre away from the fitting/valve at water main depth and shall connect the anode wire to the cast iron using the "Cadweld" method. The Contractor shall provide experienced personnel who shall make these connections in accordance with the manufacturer's recommendations.
- .5 Following welding, the Contractor shall remove all slag from the weld, file off all sharp edges and coat all exposed cast iron surfaces, steel surfaces and "Cadweld" locations with "Denso" tape and paste.
- .6 When the installation is complete, the Contractor shall pour 10 litres of water over the anode and backfill uniformly around the anode

**3.15 SWABBING**

- .1 After the hydrostatic leakage testing and before flushing and disinfection have been completed, pipe 100 mm in diameter and greater shall be swabbed with swabs as supplied by manufacturer.

**3.16 FLUSHING**

- .1 Flushing operations to be under direct control of Department Representative. Notify Department Representative at least 4 days in advance of proposed date when flushing and disinfection operations are to commence.
- .2 Flush water mains until foreign materials have been removed and flushed water is clear. Ensure flushed water drains to a suitable location at an appropriate flow and appropriate measures are employed to prevent erosion and flooding.
- .3 Flushing flows to be as follows:

<u>Pipe Size (mm) =</u>	<u>Flow (L/s)</u>	
	<u>Minimum</u>	<u>Maximum</u>
150	16	32
200	28	56
250	44	88

- .4 Provide all connections, pipes and pumps as required. Employ backflow prevention measures as required to protect existing water systems from contamination.

**3.17 DISINFECTION**

- .1 Disinfect all water mains, tie-ins and connections according to AWWA C651 except as specified herein.
- .2 If the tablet method of chlorination is utilized, the Department Representative shall be informed and approve at least 15 days in advance of any leakage testing, flushing and swabbing.
- .3 When flushing, swabbing and pressure testing have been completed to satisfaction of Department Representative, introduce a solution of chlorine into the water main utilizing the continuous feed method. Ensure the chlorine is distributed evenly throughout the entire test section.
- .4 Protect the remaining distribution system that is in use for potable water distribution or existing potable water systems from backflow from pipes undergoing disinfection.
- .5 Chlorine application to be within 3 m of filling water main and occur at same time. When application is complete, the free chlorine concentration shall be not less than 25 mg/L throughout the test section. The Contractor shall arrange for field testing and submit test results, time of sample and test locations.
- .6 Chlorinated water shall be retained in the line for at least 24 hours. All appurtenances shall be operated during this time to ensure disinfection.
- .7 At the end of 24 hour period, the water shall be tested to ensure a free chlorine concentration of not less than 10 mg/L throughout the test section. The Contractor shall perform the chlorine field testing and report the test section, test results, test sample locations, sample time and test time to the Department Representative.
- .8 Repeat disinfection processes until tests meet the criteria.
- .9 Flush pipes and appurtenances of chlorine solution after satisfactory disinfection. Flushing is complete when the total chlorine concentration is suitable for potable water use. Apply a neutralizing chemical to the chlorinated water being disposed as required to neutralize the chlorine to a level suitable so as to not adversely affect vegetation, adjacent infrastructure or water bodies in contact with the disposed water.

- .10 Take water samples at end of test section and submit to an accredited lab to test for chlorine concentration and the presence of bacteria. Submit two copies of the test results to the Department Representative.

**3.18 SURFACE RESTORATION**

- .1 After installing and backfilling over water mains, restore surface to original condition as directed by Departmental Representative.

**3.19 CLEANING**

- .1 Progress Cleaning: clean in accordance with Section 01 74 00 - 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 00 - Cleaning.

**END OF SECTION**

**Part 1 General**

**1.1 REFERENCE STANDARDS**

- .1 American National Standards Institute/American Water Works Association (ANSI/AWWA)
  - .1 ANSI/AWWA C111/A21.11 Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
  - .2 ASTM International
    - .1 ASTM C117, Standard Test Method for Material Finer Than 75  $\mu$ m (No. 200) Sieve in Mineral Aggregates by Washing.
    - .2 ASTM C136, Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
    - .3 ASTM D698, Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft<sup>3</sup>-lb/ft<sup>3</sup> (600 kN-m/m<sup>3</sup>)).
    - .4 ASTM D2680 Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) and Poly (Vinyl Chloride) (PVC) Composite Sewer Piping.
    - .5 ASTM D3034, Standard Specification for Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
  - .3 CSA International
    - .1 CSA A3000, Cementitious Materials Compendium.
    - .2 CSA B1800, Thermoplastic Non-pressure Pipe Compendium.
      - .1 CSA B182.1, Plastic Drain and Sewer Pipe and Pipe Fittings.
      - .2 CSA B182.2, PSM Type Polyvinylchloride PVC Sewer Pipe and Fittings.
      - .3 CSA B182.6, Profile Polyethylene (PE) Sewer Pipe and Fittings for Leak-Proof Sewer Applications.
      - .4 CSA B182.11, Standard Practice for the Installation of Thermoplastic Drain, Storm, and Sewer Pipe and Fittings.

**1.2 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
  - .1 Submit manufacturer's instructions, printed product literature and data sheets for pipes, and backfill and include product characteristics, performance criteria, physical size, finish and limitations.
  - .2 Pipe certification to be on pipe.
- .3 Samples:
  - .1 Inform Departmental Representative at least 4 weeks prior to beginning Work, of proposed source of bedding materials and provide access for sampling.
  - .2 Submit for testing 4 weeks minimum prior to beginning work, samples of materials proposed for use as follows:

.1 Bedding Material.

.3 Submit manufacturer's test data and certification that pipe materials meet requirements of this section 4 weeks minimum prior to beginning work. Include manufacturer's drawings, information and shop drawings where pertinent.

### **1.3 CLOSEOUT SUBMITTALS**

.1 Submit in accordance with Section 01 78 00 - Closeout Submittals.

.2 Submit data to produce record drawings, including directions for operating valves, list of equipment required to operate valves, details of pipe material, location of air and vacuum release valves, hydrant details.

.1 Include top of pipe, horizontal location of fittings and type, valves, valve boxes, valve chambers and hydrants.

### **1.4 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 pipes from damage.

.3 Replace defective or damaged materials with new.

### **1.5 ADMINISTRATIVE REQUIREMENTS**

.1 Scheduling:

.1 Schedule Work to minimize interruptions to existing services and maintain existing sewage flows during construction.

.2 Submit schedule of expected interruptions for approval and adhere to approved schedule.

.3 Notify Departmental Representative 24 hours minimum in advance of any interruption in service.

## **Part 2 Products**

### **2.1 PLASTIC PIPE**

.1 Type PSM Polyvinyl Chloride (PVC): to CSA B182.2.

.1 Standard Dimensional Ratio (SDR): 35.

.2 Locked-in gasket and integral bell system.

### **2.2 SERVICE CONNECTIONS**

.1 Type PSM Poly (Vinyl) Chloride: to CSA B182.2.

- .2 Plastic pipe: to CSA B182.1, with push-on joints.

### **2.3 PIPE BEDDING AND SURROUND MATERIALS**

- .1 Granular material to Section 31 23 33.01 - Excavating, Trenching and Backfilling:

### **2.4 BACKFILL MATERIAL**

- .1 As indicated.
- .2 In accordance with Section 31 23 33.01 - Excavating, Trenching and Backfilling.

## **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 in presence of Departmental Representative.
  - .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.

### **3.2 PREPARATION**

- .1 Clean pipes and fittings of debris and water before installation, and remove defective materials from site to approval of Departmental Representative.
- .2 Clean and dry pipes and fittings before installation.
- .3 Obtain Departmental Representative approval of pipes and fittings prior to 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 Trench alignment and depth require approval of Departmental Representative prior to placing bedding material and pipe.

### **3.4 CONCRETE BEDDING AND ENCASEMENT**

- .1 Do concrete Work in accordance with Section 03 30 00 - Cast-in-Place Concrete.
  - .1 Place concrete to details as indicated.
- .2 Position pipe on concrete blocks to facilitate placing of concrete.
  - .1 When necessary, rigidly anchor or weight pipe to prevent flotation when concrete is placed.

- .3 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 in accordance with ASTM D2321 Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications and manufacturer's recommendations except as noted herein.
- .2 Handle pipe with approved equipment. Do not use chains or cables passed through pipe bore so that weight of pipe bears upon pipe ends.
- .3 Lay pipes on prepared bed, true to line and grade, with pipe invert smooth and free of sags or high points. Ensure barrel of each pipe is in contact with shaped bed throughout its full length.
- .4 Commence laying at outlet and proceed in upstream direction with socket ends of pipe facing upgrade.
- .5 Do not exceed permissible deflection at joints recommended by pipe manufacturer unless directed in writing.
- .6 Do not allow water to flow through pipe during construction that adversely affect the installation.
- .7 Whenever work is suspended, install a removable watertight bulkhead at open ends of last pipe laid to prevent entry of foreign materials.
- .8 Position and join pipes with approved equipment. Do not use excavation equipment to force pipe sections together.
- .9 Variance from grade shall not exceed 0.03mm per mm of pipe diameter or 10 mm whichever is greater. Provided in all cases that such variation does not result in a reverse sloping invert.
- .10 Variance from alignment shall not exceed two (2) times the variance allowed for grade.
- .11 Pipe Jointing:

- .1 Install pipe joints in accordance with manufacturer's recommendations or as specified by the Departmental Representative.
- .2 Support pipes with hand slings or crane as required to minimize lateral pressure on gasket and maintain concentricity until pipes are properly joined.
- .3 Align pipes carefully before joining.
- .4 Maintain pipe joints free from mud, silt, gravel or other foreign material.
- .5 Avoid displacing gasket or contaminating with dirt or other foreign material. Gaskets so disturbed shall 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 At rigid structures, install a pipe joint not more than 1.2 m from side of structure.
- .9 Apply sufficient pressure in making joints to assure that joint is complete as outlined in manufacturer's recommendations.
- .10 Ensure completed joints are restrained by compacting bedding material alongside and over installed pipes or as otherwise approved by Departmental Representative.
- .11 Block pipes when any stoppage of work occurs in such a manner as required by Departmental Representative to prevent creep during down time.
- .12 Cut pipes as required for special inserts, fittings or closure pieces in a neat manner as recommended by pipe manufacturer, without damaging pipe or its coating and to leave a smooth end at right angles to axis of pipe.
- .13 Make watertight connections to manholes with manufacturer's factory installed rubber gaskets.
- .14 Upon completion of pipe laying, and after Departmental Representative has inspected pipe joints, place specified granular material to dimensions indicated or directed.
- .15 Hand place granular material in uniform layers of 150 mm thick or less. Dumping of material directly on top of pipe is not permitted.
- .16 Place layers uniformly and simultaneously on each side of pipe to prevent lateral displacement of pipe.

### **3.7 PIPE SURROUND**

- .1 Place surround material in unfrozen condition.

- .2 Upon completion of pipe laying, and after Departmental Representative has inspected pipe joints, surround and cover pipes as indicated.
  - .1 Leave joints and fittings exposed until field testing is completed.
- .3 Hand place surround material in uniform layers not exceeding 150 mm compacted thickness as indicated.
- .4 Place layers uniformly and simultaneously on each side of pipe.
- .5 Compact each layer from pipe invert to mid height of pipe to at least 95 % maximum density to ASTM D698.
- .6 Compact each layer from mid height of pipe to underside of backfill to at least 95 % maximum density to ASTM D698.
- .7 When field test results are acceptable to Departmental Representative, place surround material at pipe joints.

### **3.8 BACKFILL**

- .1 Place backfill in accordance with Section 31 23 33.01 - Excavating, Trenching and Backfilling.
- .2 Place backfill material in unfrozen condition.
- .3 Place backfill material, above pipe surround in uniform layers not exceeding 150 mm compacted thickness up to grades as indicated.
- .4 Under paving and walks, compact backfill to at least 98 % maximum density to ASTM D698.
  - .1 In other areas, compact to at least 98 % maximum density to ASTM D698.

### **3.9 SERVICE CONNECTIONS**

- .1 Install pipe to CSA B182.11 manufacturer's instructions and specifications.
- .2 Maintain grade for 100 and 125 mm diameter sewers at 1 vertical to 50 horizontal unless directed otherwise by Departmental Representative.
- .3 Service connections to main sewer: standard fittings Tee.
  - .1 Do not use break-in and mortar patch-type joints.
- .4 Service connection pipe: not to extend into interior of main sewer.
- .5 Make up required horizontal and vertical bends from 45 degrees bends or less, separated by straight section of pipe with minimum length of 4 pipe diameters.
  - .1 Use long sweep bends where applicable.
- .6 Plug service laterals with water tight caps or plugs as approved by Departmental Representative.

### **3.10 FIELD TESTING**

- .1 Repair or replace pipe, pipe joint or bedding found defective.
- .2 Remove foreign material from sewers and related appurtenances by flushing with water.

- .3 Television and photographic inspections:
  - .1 Carry out inspection of installed sewers by video camera, digital camera or by other related means.
  - .2 Provide means of access to permit Departmental Representative to do inspections.

**3.11 CLEANING**

- .1 Progress Cleaning: clean in accordance with Section 01 74 00 - 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 00 - Cleaning.

**END OF SECTION**

**Part 1 General**

**1.1 REFERENCE STANDARDS**

- .1 ASTM International (ASTM)
  - .1 ASTM C136-06, Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
  - .2 ASTM D698-10, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft<sup>3</sup>(600 kN-m/m<sup>3</sup>)).
- .2 CSA Group (CSA)
  - .1 CAN/CSA-B1800-06, Thermoplastic Non-pressure Pipe Compendium.

**1.2 ADMINISTRATIVE REQUIREMENTS**

- .1 Inform Departmental Representative of proposed source of bedding and filter materials and provide access for sampling at least 4 weeks prior to commencing work.

**1.3 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Submit in accordance with Section 01 33 00- Submittal Procedures.
- .2 Product Data:
  - .1 Submit manufacturer's instructions, printed product literature and data sheets for pipes, pipe fittings, tiles, and aggregate and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Certificates:
  - .1 Certification to be marked on pipe.
- .4 Test and Evaluation Reports:
  - .1 Submit manufacturer's test data that drain pipe materials meet requirements of this Section.

**1.4 DELIVERY, STORAGE AND HANDLING**

- .1 Deliver, store and handle materials in accordance with Section 01 61 00- Common Product Requirements and/or 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 pipes from damage.
  - .3 Replace defective or damaged materials with new.

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**Part 2            Products**

**2.1                MATERIALS**

- .1      Perforated plastic pipe and fittings: to CAN/CSA-B1800. Nominal pipe sizes 100 mm.
- .2      PVC pipe shall be SDR 35.
- .3      Subdrain shall have perforated 10 mm diameter holes on three parallel rows at 120°, 100°, and 240° locations spaced at 75 mm o.c. along the pipe.
- .4      Pipe shall be supplied complete with drainage sock.
- .5      The subdrainage pipe shall be surrounded by a minimum 200 mm thick layer of crushed granular drainage aggregate.
- .6      Bedding gravel or crushed granular drainage aggregate; hard, durable particles, graded evenly in size from 16 to 8 mm.

**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 sub-drainage piping installation in accordance with manufacturer's written instructions.
  - .1      Visually inspect substrate in presence of Departmental Representative.
  - .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.

**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 sediment and erosion control plan, specific to site, that complies with EPA 832/R-92-005 or requirements of authorities having jurisdiction, whichever is more stringent.
  - .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.

**3.3                TRENCHING**

- .1      Do trenching and backfilling in accordance with Section 31 23 33.01- Excavating, Trenching and Backfilling.

- .2 Place bedding material after approval of trench by Departmental Representative.

### **3.4 BEDDING**

- .1 Place 200 mm layer of bedding material as indicated and compact to minimum 95% of corrected maximum dry density.

### **3.5 INSTALLATION OF PIPE SUB-DRAINS**

- .1 Lay pipe drains on prepared bed, true to line and grade with inverts smooth and free of sags or high points.
  - .1 Ensure barrel of each pipe is in contact with bed throughout full length.
- .2 Begin laying at outlet and proceed in upstream direction.
- .3 Lay perforated pipes with perforations downwards at 4 o'clock and 8 o'clock positions.
- .4 Lay bell and spigot pipe with bell ends facing upstream.
  - .1 Do not mortar joints.
- .5 Make joints tight in accordance with manufacturer's instructions.
- .6 Make watertight connections to existing drains, new or existing manholes and catch basins where indicated or as directed by Departmental Representative.
- .7 Plug open upstream ends of pipes.
- .8 Surround pipe with bedding gravel and compact as directed by Departmental Representative.
- .9 Surround and cover drain with filter material in uniform 150 mm layers as indicated and compact to at least 95% of corrected maximum dry density.
- .10 Backfill remainder of trench as indicated.
- .11 Do not place bedding surround and backfill materials in frozen condition.
- .12 Protect sub-drains against flotation during installation.

### **3.6 CONNECTIONS TO STORM FACILITIES**

- .1 Connect pipe sub-drains to storm sewer system where indicated.

### **3.7 CLEANING**

- .1 Progress Cleaning: clean in accordance with Section 01 74 00- 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 00- Cleaning.

**END OF SECTION**

**Part 1            General**

**1.1                RELATED REQUIREMENTS**

- .1            Section 26 05 00 Common Work Results for Electrical

**1.2                REFERENCE STANDARDS**

- .1            American Society for Testing and Materials International (ASTM), Latest Editions
  - .1            ASTM A82/A82M, Standard Specification for Steel Wire, Plain, for Concrete Reinforcement.
  - .2            ASTM A185/A185M, Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete.
  - .3            ASTM C139, Standard Specification for Concrete Masonry Units for Construction of Catch Basins and Manholes.
  - .4            ASTM C 478/C478M, Standard Specification for Precast Reinforced Concrete Manhole Sections.
  - .5            ASTM D1056, Standard Specification for Flexible Cellular Materials - Sponge or Expanded Rubber.
- .2            CSA Group (CSA), Latest Editions
  - .1            CAN/CSA-A3000, Cementitious Materials Compendium (Consists of A3001, A3002, A3003, A3004 and A3005).
    - .1            CSA-A3001, Cementitious Materials for Use in Concrete.
  - .2            CSA A23.1/A23.2, Concrete Materials and Methods of Concrete Construction/Methods of Test and Standard Practices for Concrete.
  - .3            CAN/CSA-G30.18, Billet-Steel Bars for Concrete Reinforcement.
  - .4            CSA C22.2 No. 211.1
- .3            Health Canada/Workplace Hazardous Materials Information System (WHMIS)
  - .1            Material Safety Data Sheets (MSDS).

**1.3                ACTION AND INFORMATIONAL SUBMITTALS**

- .1            Provide submittals in accordance with Section 01 33 00- Submittal Procedures.
- .2            Product Data:
  - .1            Submit manufacturer's printed product literature, specifications and datasheet and include product characteristics, performance criteria, physical size, finish and limitations.
  - .2            Submit two copies WHMIS MSDS - Material Safety Data Sheets in accordance with Section 02 81 01- Hazardous Materials.
- .3            Shop Drawings:
  - .1            Submit shop drawings for precast manholes.

- .4 Quality assurance submittals: submit following in accordance with Section 01 45 00- Quality Control.
  - .1 Test reports: submit certified test reports for specified materials from approved independent testing laboratories, indicating compliance with specifications for specified performance characteristics and physical properties.
  - .2 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

#### **1.4 QUALITY ASSURANCE**

- .1 Pre-Installation Meetings: convene pre-installation meeting one week prior to beginning on-site installation, with Departmental Representative in accordance with Section 01 32 16.07- Construction Progress Schedule - Bar (GANTT) Chart to:
  - .1 Verify project requirements.
  - .2 Review installation and substrate conditions.
  - .3 Co-ordination with other building subtrades.
  - .4 Review manufacturer's installation instructions and warranty requirements.

#### **1.5 DELIVERY, STORAGE AND HANDLING**

- .1 Packing, shipping, handling and unloading:
  - .1 Deliver, store and handle materials in accordance with Section 01 61 00- Common Product Requirements.
  - .2 Deliver, store and handle materials in accordance with manufacturer's written instructions.
- .2 Waste Management and Disposal:
  - .1 Separate waste materials for recycling or reuse in accordance with Section 01 74 19- Waste Management and Disposal.

### **Part 2 Products**

#### **2.1 SUSTAINABLE REQUIREMENTS**

- .1 Materials and products in accordance with Section 01 47 15- Sustainable Requirements: Construction.
- .2 Do verification requirements in accordance with Section 01 47 17- Sustainable Requirements: Contractor's Verification.

#### **2.2 PVC DUCTS**

- .1 PVC ducts, type EB1, encased in reinforced concrete.

#### **2.3 PVC DUCT FITTINGS**

- .1 Rigid PVC translucent pushfit or opaque solvent welded type couplings, bell end fittings, plugs, caps, adaptors as required to make complete installation.
- .2 Expansion joints.

- .3 Rigid PVC 5 degree angle couplings.

## **2.4 MANHOLES**

- .1 Provide type indicated.
- .2 Top, walls, and bottom: reinforced concrete.
- .3 Walls and bottom: monolithic concrete construction.
- .4 Locate duct entrances and windows near corners of structures to facilitate cable racking.
- .5 Covers: fit frames without play.
- .6 Form steel and iron to shape and size with sharp lines and angles.
- .7 Castings: warp and blow hole free.
- .8 Exposed metal: smooth finish without sharp lines and arises.
- .9 Provide lugs, rabbets, and brackets.
- .10 Set pulling-in irons and other built-in items in place before depositing concrete.
- .11 Install pulling-in iron in wall opposite each duct line entrance.
- .12 Cable racks, including rack arms and insulators: sized to accommodate cable.

## **2.5 PRECAST CONCRETE MANHOLES**

- .1 Precast concrete manholes and auxiliary sections fabricated in steel forms.
- .2 Aggregates: to CSA A23.1/A23.2.
- .3 Cement: CAN/CSA-A3001, Type GU.
- .4 Steel welded wire fabric mesh reinforcing: to ASTM A82/A82M, ASTM A185/A185M
- .5 Neoprene gasket seals between manhole sections: to ASTM D1056.
- .6 Size: 762 mm clear diameter.
- .7 Precast Concrete Manholes: to ASTM C478/C478M
  - .1 Manhole step and ladder rung spacing: 405.

## **2.6 CAST-IN-PLACE CONCRETE MANHOLES**

- .1 Smooth trowel finish for floors and horizontal surfaces.
- .2 Concrete: in accordance with Section 03 30 00- Cast-in-Place Concrete.
- .3 Construct walls on cast-in-place concrete footing except that precast concrete base sections are used for precast concrete manhole risers.
- .4 Concrete block: to ASTM C139 and in accordance with Section 04 22 00- Concrete Unit Masonry.

## **2.7 DRAINAGE**

- .1 Floor drain fittings: consisting of floor drain, back water valve, trap and pipe connection to drainage system or dry sump, as indicated.

**2.8 MANHOLE NECKS**

- .1 Concrete brick and mortar.

**2.9 MANHOLE FRAMES AND COVERS**

- .1 Cast iron manhole frames and covers.

**2.10 GROUNDING**

- .1 Ground rods: in accordance with Section 26 05 28- Grounding - Secondary for cable rack grounding.

**2.11 CABLE RACKS**

- .1 Hot dipped galvanized cable racks and supports.
- .2 12 x 100 mm preset inserts for rack mounting.

**2.12 CABLE PULLING EQUIPMENT**

- .1 Pulling iron: galvanized steel rods, size and shape as indicated.
- .2 Pull rope: 6 mm stranded polypropylene, tensile strength 5 kN, continuous throughout each duct run with 3 m spare rope at each end.

**2.13 MARKERS**

- .1 Concrete type cable markers: 600 x 600 x 100 mm, with words: "Cable", "Joint", "Conduit" impressed in top surface, with arrows to indicate change in direction of duct runs.

**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 GENERAL**

- .1 Install underground duct banks and manholes including formwork.
- .2 Build manholes and duct bank on undisturbed soil or on well compacted granular fill not less than 150 mm thick, compacted to 95% of maximum proctor dry density.
- .3 Open trench completely between manholes before ducts are laid and ensure that no obstructions will necessitate change in grade of ducts.
- .4 Install ducts at elevations and with slope as indicated and minimum slope of 1 to 400.
- .5 Install base spacers at maximum intervals of 1.5 m levelled to grades indicated for bottom layer of ducts.

- .6 Lay PVC ducts with configuration and reinforcing as indicated with preformed interlocking, rigid plastic intermediate spacers to maintain spacing between ducts at not less than 75 mm horizontally and vertically.
  - .1 Stagger joints in adjacent layers at least 150 mm and make joints watertight.
  - .2 Encase duct bank with 75 mm thick concrete cover.
  - .3 Use galvanized steel conduit for sections extending above finished grade level.
- .7 Make transpositions, offsets and changes in direction using 5 degree bend sections, do not exceed a total of 20 degree with duct offset.
- .8 Use bell ends at duct terminations in manholes or buildings.
- .9 Use conduit to duct adapters when connecting to conduits.
- .10 Terminate duct runs with duct coupling set flush with end of concrete envelope when dead ending duct bank for future extension.
- .11 Cut, ream and taper end of ducts in field in accordance with manufacturer's recommendations, so that duct ends are fully equal to factory-made ends.
- .12 Allow concrete to attain 50% of its specified strength before backfilling.
- .13 Use anchors, ties and trench jacks as required to secure ducts and prevent moving during placing of concrete.
  - .1 Tie ducts to spacers with twine or other non-metallic material.
  - .2 Remove weights or wood braces before concrete has set and fill voids.
- .14 Clean ducts before laying:
  - .1 Cap ends of ducts during construction and after installation to prevent entrance of foreign materials.
- .15 Duct cleaning:
  - .1 Pull 300 mm long x diameter 6 mm less than internal diameter of duct steel mandrel through each duct, immediately after placing of concrete.
  - .2 Then pull stiff bristle brush through duct; avoid disturbing or damaging ducts where concrete has not set completely.
  - .3 Pull stiff bristle brush through each duct immediately before pulling-in cables.
- .16 Install four 3 m lengths of 10M reinforcing rods, one in each corner of duct bank when connecting duct to manholes or buildings.
  - .1 Wire rods to 10M dowels at manhole or building and support from duct spacers.
  - .2 Protect existing cables and equipment when breaking into existing manholes.
  - .3 Place concrete down sides of duct bank filling space under and around ducts.
  - .4 Rod concrete with flat bar between vertical rows filling voids.
- .17 Install pull rope continuous throughout each duct run with 3 m spare rope at each end.

### 3.3 MANHOLES

- .1 Build cast-in-place manholes.
- .2 Concrete Placement:

- .1 Place concrete in two lifts with slab and sump in first, walls, roof and neck in second lift.
- .2 Provide key in walls to slab.
- .3 Place 100 x 6 mm PVC water bar vertically in key.
- .4 Install ground rod before placing slab and place reinforcing steel, inserts for cable rack, pulling irons, drain, duct outlets, duct run dowels before casting walls. Make manhole to duct connection as indicated.
- .3 Provide 115 mm deep window to facilitate cable bends in wall at each duct connection.
  - .1 Terminate ducts in bell-end fitting flush with window face.
  - .2 Provide four 10M steel dowels at each duct run connection to anchor duct run.
- .4 Alternately connect large duct runs by leaving square opening in wall, later pouring duct run and wall opening in one pour, and install 10M x 3m reinforcing rods in duct run at manhole connection.
- .5 Build up concrete manhole neck to bring cover flush with finished grade in paved areas and 40 mm above grade in unpaved areas.
- .6 Install manhole frames and covers for each manhole:
  - .1 Set frames in concrete grout onto manhole neck.
- .7 Drain floor towards sump with 1 to 48 slope minimum and install drainage fittings as indicated.
- .8 Install cable racks, anchor bolts and pulling irons as indicated.
- .9 Grout frames of manholes:
  - .1 Cement grout to consist of two parts sand and one part cement and sufficient water to form a plastic slurry.
- .10 Ensure filling of voids in joint being sealed.
  - .1 Plaster with cement grout, walls, ceiling and neck.
- .11 Spray paint "X" on ceiling of manhole above floor drain or sump pit.

### **3.4 MARKERS**

- .1 Mark location of duct runs under hard surfaced areas not terminating in manhole with railway spike driven flush in edge of pavement, directly over run.
  - .1 Place concrete duct marker at ends of such duct runs.
  - .2 Construct markers and install flush with grade.
- .2 Mark ducts every 150 m along straight runs and changes in direction.
- .3 Where markers are removed to permit installation of additional duct, reinstall existing markers.
- .4 Lay concrete markers flat and centered over duct with top 25 mm above earth surface.
- .5 Submit drawings showing locations of markers.

**3.5 FIELD QUALITY CONTROL**

- .1 Site Tests/Inspections:
  - .1 Inspection of duct will be carried out by Departmental Representative prior to placing.
  - .2 Placement of concrete and duct cleanout to be done when Departmental Representative present.

**3.6 CLEANING**

- .1 Proceed in accordance with Section 01 74 11- Cleaning.
- .2 On completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

**END OF SECTION**

**Part 1            General**

**1.1                RELATED REQUIREMENTS**

- .1            Section 26 05 00 Common Work Results for Electrical

**1.2                ACTION AND INFORMATIONAL SUBMITTALS**

- .1            Provide submittals in accordance with Section 01 33 00- Submittal Procedures.
- .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.

**1.4                DELIVERY, STORAGE AND HANDLING**

- .1            Deliver, store and handle materials in accordance with Section 01 61 00- Common Product Requirements.
- .2            Delivery and Acceptance Requirements:
  - .1            Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.
- .3            Packaging Waste Management: remove for reuse or recycle in accordance with Section 01 74 19- Waste Management and Disposal.

**Part 2            Products**

**2.1                PVC DUCTS AND FITTINGS**

- .1            Rigid PVC duct: Type DB2/ES2, with moulded fittings, for direct burial
- .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 90 degrees, 45 degrees bends and 5 degrees angle couplings as required.

**2.2                SOLVENT WELD COMPOUND**

- .1            Solvent cement for PVC duct joints.

### **2.3 PLASTIC POLYETHYLENE PIPE**

- .1 Flexible or rigid plastic polyethylene pipe with approved couplings and fittings required to make complete installation for duct drainage.

### **2.4 CABLE PULLING EQUIPMENT**

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

### **2.5 MARKERS**

- .1 Concrete type cable markers: as indicated, with words: "Cable", "Joint" or "Conduit" impressed in top surface, with arrows to indicate change in direction of duct runs.

### **2.6 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 pipe and duct in accordance with manufacturer's instructions and at elevations as indicated.
- .2 Clean inside of ducts before laying.
- .3 Install plastic duct spacers and ensure full, even support every 1.5 m and smooth transition throughout duct length.
- .4 Slope ducts with 1 to 400 minimum slope.
- .5 Install plugs and cap both ends of ducts to prevent entrance of foreign materials during and after construction.
- .6 Pull through each duct steel 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.
- .7 Install a pull rope continuous throughout each duct run with 3 m spare rope at each end.
- .8 Place continuous strip of warning tape 300 mm above duct before backfilling trenches.
- .9 Install markers as required.
- .10 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.
- .2 Waste Management: separate waste materials for reuse or recycling in accordance with Section 01 74 19- Waste Management and Disposal.

**END OF SECTION**

**Part 1            General**

**1.1                RELATED REQUIREMENTS**

- .1        Section 26 05 00 Common Work Results for Electrical
- .2        Section 26 05 21 Wires and Cables (0-1000V)
- .3        Section 26 05 43.01- Installation of Cables in Trenches and in Ducts
- .4        Section 26 05 28- Grounding - Secondary

**1.2                REFERENCE STANDARDS**

- .1        CSA Group (CSA), Latest Edition
  - .1        CSA A23.1/A23.2, Concrete Materials and Methods of Concrete Construction/Methods of Test and Standard Practices for Concrete.

**1.3                ACTION AND INFORMATIONAL SUBMITTALS**

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

**1.4                QUALITY ASSURANCE**

- .1        Quality assurance submittals: submit following in accordance with Section 01 45 00- Quality Control.
- .2        Regulatory Requirements:
  - .1        Perform Work to comply with applicable Provincial regulations.
  - .2        Co-ordinate and meet requirements of power supply authority.
    - .1        Ensure availability of power when required.
- .3        Certificates: submit certificates signed by manufacturer certifying materials comply with specified performance characteristics and physical properties.

**1.5                DELIVERY, STORAGE AND HANDLING**

- .1        Deliver, store and handle materials in accordance with Section 01 61 00- Common Product Requirements.
- .2        Delivery and Acceptance Requirements:
  - .1        Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.
- .3        Packaging Waste Management: remove for reuse or recycle in accordance with Section 01 74 19- Waste Management and Disposal.

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**Part 2 Products**

**2.1 MATERIALS**

- .1 Underground ducts: rigid type DB2, size as indicated.
- .2 Rigid steel galvanized conduit and fittings: size as indicated.
- .3 Conductors: as per Section 26 05 21 Wires and Cables (0-1000V), size and number of conductors as indicated.
- .4 Meter socket: weatherproof, and approval of supply authority.
- .5 Concrete: to CSA A23.1/A23.2.
- .6 Backfill: clean and free of debris.
- .7 Pulling Iron:
  - .1 22 mm diameter hot dipped galvanized steel bar with exposed triangular shaped opening.

**Part 3 Execution**

**3.1 APPLICATION**

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

**3.2 INSTALLATION**

- .1 Install cables in accordance with Section 26 05 43.01- Installation of Cables in Trenches and in Ducts.
- .2 Allow adequate conductor length for connection to supply by power supply authority.
- .3 Install metre socket and conduit.
- .4 Allow adequate conductor length for connection to service equipment.
- .5 Make grounding connections in accordance with Section 26 05 28- Grounding - Secondary.
- .6 Install concrete encased ducts for electrical systems as indicated and in accordance with CSA A23.1.
- .7 Install pulling irons as required.
- .8 Seal ducts and conduits at building entrance location after installation of cable.

**3.3 FIELD QUALITY CONTROL**

- .1 Site Tests:
  - .1 Perform tests in accordance with Section 26 05 00- Common Work Results for Electrical.
  - .2 Perform additional tests if required by authority having jurisdiction.

- .2 Submit written test results to Departmental Representative review.

**3.4 CLEANING**

- .1 Clean in accordance with Section 01 74 11- Cleaning.
  - .1 Remove surplus materials, excess materials, rubbish, tools and equipment.
- .2 Waste Management: separate waste materials for recycling or reuse in accordance with Section 01 74 19- Waste Management and Disposal.

**END OF SECTION**