Part 1 General

1.1 SUMMARY

1.1.1 This section shall govern the products and installation of underground ducts and raceways for communications systems.

1.2 RELATED DOCUMENTS

1.2.1 The latest versions of the following codes, standards, and guidelines shall be followed. Bring to the immediate attention of CCS if construction documents or conditions differ from requirements in codes, standards, guidelines and specifications.

1.2.2 The following codes, acts and regulations, as required by law:

Ontario Electrical Safety Code (OESC)

Ontario Building Code (OBC)

National Electrical Safety Code (NESC)

CSA C22.3 No.1 Overhead Systems

CSA C22.3 No. 7 Underground Systems

Occupational health and Safety Act

Ontario Regulation for Construction Projects 213/91

Utility Work Protection Code

1.2.3 The following Construction/Safety Guidelines, Policies and Practices:

Guidelines for Safe Excavation in the Vicinity of the Bell Network

Third Party Requirements in the Vicinity of Natural Gas Facilities

Guideline for Excavation in the Vicinity of Utility Lines

EUSA Rule Book

Ontario Traffic Manual – Book 7

Tree Protection Policy and Specifications for Construction Near Trees – City of Toronto Urban Forestry

Municipal Consent Requirements for the Installation of Plant within City of Toronto Streets

1.2.4 The following standards:

TIA-758-B Customer-Owned Outside Plant Telecommunications Infrastructure Standard

TIA-569-D Commercial Building Standard for Telecommunications Pathways and Spaces

TIA-607-C Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises

1.2.5 The following civil construction standards:

.1 Reinforcement

CSA G.30.18 – Carbon steel bars for concrete reinforcement

CSA S-16 – Design of Steel Structures

CSA G40.20/G40.21 General Requirements for Rolled or Welded Structural Quality Steel / Structural Quality Steel

ACI 301: Structural Concrete for Buildings

ACI SP-66: American Concrete Institute - Detailing Manual

ANSI/ASTM A82: Cold Drawn Steel Wire for Concrete Reinforcement

ANSI/AWS D1.4: Structural Welding Code for Reinforcing Steel

ANSI/AWS D12.1: Reinforcing Steel Welding Code

ASTM A615: Deformed and Plain Billet Steel Bars for Concrete Reinforcement

AWS D12: Welding Reinforcement Steel, Metal Inserts and Connections in Reinforced Concrete Construction

.2 Cast-in-Place

CSA A23.1 – Concrete materials and methods of concrete construction

CSA A23.2 – Test methods and standard practices for concrete

CSA A23.3 – Design of concrete structures

ASTM C33: Concrete Aggregates

ASTM C39: Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens

ASTM C94: Ready-Mixed Concrete

ASTM C150: Portland Cement

ASTM C143: Standard Test Method for Slump of Hydraulic Cement Concrete

ASTM C173: Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method

ASTM C231: Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method

ASTM C260: Air Entraining Admixtures for Concrete

ASTM C309: Standard Specifications for Liquid Membrane Forming Compound for Curing Concrete

ASTM C494: Chemical Admixtures for Concrete

.3 Pre-cast

CSA A23.4 – Precast concrete – Materials and Construction

ASTM C 478, Standard Specification for Precast Reinforced Concrete manhole Sections
ASTM C 789, Standard Specification for Precast Reinforced Concrete Box Sections for Culverts, Storm Drains, and Sewers

ASTM C 850, Standard Specification for Precast Reinforced Concrete Box Sections for Culverts, Storm Drains, and Sewers with Less Than 2 Ft of Cover Subjected to Highway Loadings
ASTM C 857, Standard Practice for Minimum Structural Design Loading for Underground Precast Utility Structures
ASTM C 858, Standard Specification for Underground Precast Concrete Utility Structures
ASTM C 890, Standard Practice for Minimum Structural Design Loading for Monolithic or Sectional Precast Concrete Water and Wastewater Structures
ASTM C 891, Standard Practice for Installation of Underground Precast Concrete Utility Structures
ASTM C 913, Standard Specification for Precast Concrete Water and Wastewater Structures
ASTM C 1037, Standard Practice for Inspection of Underground Precast Concrete Utility Structures

.4 Trenching and Backfill

ASTM D1557: Test Method for Laboratory Compaction Characteristics Using Modified Effort

1.2.6 The following best practices:

BICSI, Telecommunications Distribution Methods Manual (TDMM) 13th Edition

BICSI, Information Transport Systems Installation Methods Manual (ITSIMM) 7th Edition

BICSI, Outside Plant Design Reference Manual, 6th Edition

1.3 DEFINITIONS

Aggregate: Mineral materials such as sand or stone used in making concrete

Backfill: Earth material used specifically for filling and grading excavations back to a finished state. Backfill is placed on top of the bedding surrounding encased ductbanks and direct-buried conduits.

Base: Earth material used specifically to level and grade an excavation's subgrade for the subsequent placement of encased ductbanks, direct-buried conduit, maintenance holes and handholes. Base material is placed on top of the subgrade and beneath the bedding surrounding encased ductbanks, conduits, maintenance holes or handholes.

Bedding: Earth material used specifically for filling excavations. Bedding is placed around encased ductbank, conduits, maintenance holes or handholes. Bedding is placed on top of the base and beneath the backfill.

Building Entrance Pathway: A building entrance pathway is two to six underground conduit or duct extended from a maintenance hole (MH) or service box, directly into a building's entrance facility space (EFS) or main telecommunications room (MTR).

Fill: The collective term for base, bedding, and backfill.

Handhole (HH): A structure similar to a small maintenance hole through which cable can be pulled, but not large enough for a person to fully enter to perform work.

Lateral Underground Pathway: A lateral underground pathway is a branch off the main underground pathway that supports communication cables serving one or more buildings or service locations in a service area. It contains a small number of multiple underground conduit or duct that extends from a main underground pathway to

succeeding maintenance holes (MH), service boxes (SB) or hand holes (HH) along the lateral run.

Main Underground Pathway: A main underground pathway supports communication cables that serve all buildings or service locations in a service route area. Main Underground Pathways typically begin at an Electronic Communication Hub (ECH) Building and radiate out along streets to serve buildings and service locations along the route or to connect to another ECH Building. It contains a large number of underground multiple conduit or duct, installed between maintenance holes (MH's) and Service Boxes (SB's) along the route.

Maintenance Hole or Manhole (MH): A vault located in the ground or earth as part of an underground conduit system and used to facilitate placing, connectorization, and maintenance of cables as well as the placing of associated equipment, in which it is expected that a person will enter to perform work.

RNC: Rigid Non-Metallic Conduit (PVC)

1.4 SYSTEM DESCRIPTION

1.4.1 Furnish, install, and place into satisfactory and successful operation all materials, devices, and necessary appurtenances to provide a complete Outside Plant pathway system as hereinafter specified and/or shown on the Contract Documents. The Pathway system shall support an ANSI/TIA/EIA and lSO/IEC compliant communications Structured Cabling System (SCS). A minimum 1x2 (2 duct) structure is required.

1.4.2 The work shall include materials, equipment and apparatus not specifically mentioned herein or noted on the plans but which are necessary to make a complete working ANSI/TIA/EIA and ISO/IEC compliant pathway system.

1.5 SUBMITTAL INFORMATION

1.5.1 Product Data Submittals: Provide submittal information for review before materials are delivered to the job site. Provide product data submittals for all products at the same time.

1. Submit a letter stating that the materials will be provided as specified, and specifically listing any items that will not be provided as specified. The letter shall also state that the Contractor has reviewed the specified items and agrees that they are applicable to this project in all respects.

2. For those items noted as allowing "or equal," and which are not being provided as specifically named, submit standard manufacturer's cut sheets or other descriptive information, along with a written description detailing the reason for the substitution.

3. Provide standard manufacturer's cut sheets and the operating and maintenance (O&M) instructions at the time of submittal review for each device in the system, regardless of whether it is submitted as specified or as an approved equal. These instructions shall detail how to install and service the equipment and shall include information necessary for rough-in and preparation of the building facilities to receive the materials.

1.5.2 Quality Assurance/Control Submittals: Provide submittal information for review as follows:

1. Submit a copy of the delivery receipt for each concrete delivery. Include date, strength ordered, and location used.

1.5.3 Closeout Submittals: Provide submittal information for review as follows:

1. O&M Manual for Communications - At the completion of the project, submit O&M information from product data submittals (above), updated to reflect any changes during the course of construction, to the Designer in the telecommunications-specific O&M Manual for Communications binder labeled with the project name and description.

2. Records - Maintain at the job site a minimum of one set of Record Drawings, Specification, and Addenda. Record Drawings shall consist of redline markups of drawings, specifications and spreadsheets, including maintenance hole/handhole butterfly drawings.

a. Document changes to the system from that originally shown on the Contract Documents and clearly identify system component labels and identifiers on Record Drawings.

b. Keep Record Drawings at the job site and make available to the Owner and Designer at any time.

c. Keep Record Drawings current throughout the course of construction. (“Current” is defined as not more than one week behind actual construction).

d. Show identifiers for major infrastructure components on Record Drawings.

1.6 CONTRACTOR WARRANTY

1.6.1 Provide a Contractor-endorsed two-year service warranty against defects in materials and workmanship.

1. Provide labor attributable to the fulfillment of this warranty at no cost to the Owner.

a. The Contractor Warranty period shall commence upon Owner acceptance of the work.

Part 2 Product

2.1 General

2.1.1 Materials shall consist of fill, topsoil, concrete formwork, concrete, raceway, maintenance holes, handholes and other incidentals and accessories as required.

2.2 Base, Bedding and Backfill

2.2.1 Use of on-site soils for base, bedding, and backfill is not acceptable.

2.2.2 Base: Readily compactable and meet the following gradation requirements.

1. For Maintenance Holes and Handholes (provide gravel):

Sieve Size Percent Passing

1” Square 100

¼” Square 25 - 80

U.S. No. 200 15 max

Sand Equivalent 30 min

2. For Trenches (provide sand):

Sieve Size Percent Passing

U.S. No. 10 35 - 100

U.S. No. 20 20 - 80

U.S. No. 40 10 - 55

U.S. No. 100 0 - 10

U.S. No. 200 0 - 3

2.2.3 Bedding: Same as Base - For Trenches, above.

2.2.4 Backfill:

1. For Maintenance Holes and Handholes - Same as Base - For Maintenance Holes and Handholes, above.

2. For Trenches

Sieve Size Percent Passing

½" Square 100

¼" Square 65 - 100

U.S. No. 10 40 - 100

U.S. No. 50 3 - 50

U.S. No. 100 0 – 4

U.S. No. 200 0 – 3

2.3 Cast-in-Place Concrete

2.3.1 Formwork:

1. Forms: Metal or plywood in good condition

a. Form Release Agent: Burke Form Coating (or equal)

2. Gypsum board

2.3.2 Reinforcement:

1. Reinforcing Steel: ASTM A615, Grade 40. Uncoated, free from rust, dirt, and loose scale.

2. Tie Wire: 18 gauge 40 or heavier black annealed wire.

3. Embedded Anchor Bolts: Mild galvanized steel, cold bent.

2.3.3 Concrete:

1. Cement: Different types of cement, including the same type of cement provided by more than one manufacturer, are not acceptable: Cement shall conform to:

a. ASTM C150-7, type 1.

b. 2500 psi. minimum compressive at 28 days per ASTM C39.

c. 4 inches maximum slump per ASTM C-143.

2. Aggregate:

a. Course: ASTM C33-71 with a maximum size of 1-¼".

b. Fine: ASTM C33-71.

3. Water: Fresh, clean, potable and not detrimental to concrete.

4. Admixtures:

a. Air Entrainment: Conform to ASTM C260 and ASTM C173 or C231 with 5% to 7% air entrainment.

b. Other: Not allowed without prior approval from the Designer.

5. Curing Compound: Conform to ASTM C309. Free from petroleum resins or waxes. Formulated for sealing, surface hardening, and curing concrete.

2.4 Conduits and Ductbanks

2.4.1 General:

CCS will specify the conduit/duct route, the number and size of conduit/ducts, and the size and location of MH/SB's.

Conduit/duct pathway locations shall be reviewed and approved via the Facilities Operations Plans Review process.

2.4.2 Clearance from other utilities:

Conduit/duct shall not be placed in parallel, directly above or below, other utility lines (allow for maintenance access).

Minimum required horizontal and vertical clearances to all adjacent utilities shall meet the Municipal Consent Requirements for the Installation of Plant within City of Toronto Streets and CSA C22.3 No. 7 Underground Systems

2.4.3 Concurrently installed joint duct systems (communication & power):

Minimum required horizontal and vertical clearances to all adjacent utilities shall meet the Municipal Consent Requirements for the Installation of Plant within City of Toronto Streets and CSA C22.3 No. 7 Underground Systems

2.4.4 Size and number of conduit/ducts:

CCS will specify the number and size of conduit/ducts.

Minimum size of main conduit(s) is four-inch (4") diameter. Five-inch (5") diameter conduits may be specified by CCS when bend radius specification allowances are exceeded.

Minimum size of lateral conduit(s) is 4" diameter to serve buildings (MH > MH, MH > SB, SB > SB). Five-inch (5") diameter conduits may be specified by CCS when bend radius specification allowances are exceeded.

Minimum size of a single lateral conduit to a blue tower, pay phones, other single use facility is generally a 2" diameter conduit (SB > HH, HH > HH, HH > utility base.

2.4.5 Conduit/duct route:

First choice is immediately adjacent to the curb and gutter in the street pavement if clear of other parallel utility lines.

Second choice is out into the street pavement area clear of parallel utility lines.

Third choice is behind the sidewalk / planter area if clear of trees or other major obstructions.

Last Choice is in the sidewalk / planter area if clear of trees or other major obstructions.

2.4.6 Conduit Material:

PVC Schedule 40 type conduit. Fittings shall be the same manufacturer as conduit. All plastic conduit and fittings shall have solvent-weld connections and shall provide a watertight joint.

Rigid galvanized steel conduit (wrapped or PVC coated) may be specified in special requirements, e.g. shallow depth, exposed structures, etc.

2.4.7 Multiple conduit/duct formations – duct bank configurations:

Two to three - four-inch (4") diameter" conduits = one layer

Four – four-inch (4") diameter conduits = two layers x two conduits wide

Six – four-inch (4") diameter conduits = two layers x three conduits wide (1st choice) or three layers x 2 conduits wde (2nd choice).

Eight – four-inch (4") diameter conduits = two layers x 3 conduits wide and one layer x 2 conduits wide

More than eight = N layers x 3 conduits wide.

2.4.8 Conduit/duct Cover, Separation & Encasement:

Unless future conditions require greater depth, the minimum cover over conduit/duct shall meet CSA C22.3 No.7.

Install conduit/duct with a minimum downward slope of three (3) inches in each one hundred (100) feet away from building towards MH's, SB's and other necessary drainage facilities. Unless otherwise noted on the drawings, conduit/duct shall be run in a straight line except where a change in direction is necessary.

Conduit shall be supported in the trench with Carlon Snap-Lock Spacers and Rebar Holders or equivalent. The Carlon Snap-Loc Spacer support assemblies or equivalent shall not exceed eight feet (8') between support assemblies. Maintain no less that two inches (2") clearance between conduit/duct and earth on all sides and bottom. Conduits shall be separated by a minimum of two inches (2") clearance. In joint trench, power and communication conduit/ducts shall be separated by a minimum three inches (3") of concrete. Separation shall be maintained to enable conduit/ducts to be fully bedded and encased, as required, in a flowable cement sand slurry (1-1/2 sack cement-sand slurry mix) or concrete (5 sack cement mix, 3/4" maximum aggregate). The conduit/duct structure shall be tied together at the separators with wire and rebar and securely anchored to the bottom of the trench to prevent any movement or floating while pouring encasement.

Conduit shall be encased in flowable 1-½ sack cement – sand slurry mix, or if required by design specifications, concrete encased (5-sack cement mix, ½" maximum aggregate) to a minimum 3" above the conduit structure. A concrete vibration tool must be used to ensure that voids are not created around duct structures.

In asphalt street and walkway pavement areas, the remainder of the trench shall be backfilled with Class II aggregate base @ 95% compaction to the bottom level of the existing pavement. The trench shall be final paved to match the existing pavement material (minimum 3" asphalt)

In landscaped areas, the remainder of the trench shall be backfilled with native material @ 90% compaction and planting topsoil mix, to existing landscape grade (removed sod, plants and/or decorative materials shall be replaced in kind).

All bends and sweeps less than eighty feet (80") radius and all shallow depth conduit/ducts shall be concrete encased (5-sack cement mix, ¾" maximum aggregate).

2.4.9 Bends & Sweeps:

Changes in direction of conduit/duct runs, exceeding a total of 10 degrees, shall be accomplished by long sweep bends.

No more than two (2) 90 degree bends (180 degrees total) are allowed in a conduit/duct section without some form of pull-point (e.g. MH or SB as applicable).

The minimum inside radius of long sweep conduit/duct bends shall not be less than 25 feet. All bends and sweeps less than eighty feet (80') radius shall be concrete encased (5-sack cement mix, ¾" maximum aggregate). Nothing less than 25' shall be used unless pre-approved in writing by CCS.

Straight sections of single bore PVC Schedule 40 conduit can be manually bent to form curves with a radius 40 feet or greater. All field formed long radius bends must be able to pass a 12" long by 3 5/8" wide solid 'slug' mandrel.

All bends and sweeps less than eighty feet (80") radius shall be concrete encased (5-sack cement mix, ¾" maximum aggregate).

2.4.10 Mandreling, Brushing, Pull Tapes, Plugging:

Each conduit shall be mandreled immediately following backfill and compaction. The mandrel shall be pulled in both directions. It shall be preceded by a stiff brush pulled in both directions or until the conduit is clear of all material particles (earth, sand, gravel). The brush shall be sized to match the diameter of the conduit. A bend radius of 60" or less shall pass a rigid mandrel not less than 6" long with a diameter 3/8" less than the interior size of the conduit (4" diameter conduit requires a 3-5/8" diameter mandrel). A bend radius greater that 60" shall pass a 12" long rigid mandrel with a diameter 3/8" less than the interior size of the conduit. Conduit though which the mandrel cannot pass will be judged defective and shall be repaired immediately. CCS shall witness the mandrel proving process.

Install a ¾" polyester woven pre-lubed measuring / pull-tape (2500 lbs tensile strength, flat design with footage measurements, Neptco WP2500P or equivalent) in each conduit. The pull tape shall be new and free of splices. The wall-to-wall footage length, for each section, shall be provided to CCS and noted on the "as-built" drawings. The pull tape shall be securely fastened at both conduit ends to compression conduit plug fittings. Install one (1) #18 AWG, stranded, jacketed copper wire, with the pull-tape, in one upper conduit of each duct structure, to enable future electronic locating and marking of the conduit/duct structure.

Upon completion of mandreling, brushing and pull tape placement; each conduit shall be plugged at both ends, using compression type conduit plug fittings.

2.5 Underground Spaces - Maintenance Hole (MH), Service Box (SB), Hand Hole (HH) Design Standards.

2.5.1 General Specifications:

CCS will specify the size and location of MH's, SB's and HH's.

MH/SB's shall be sized to meet the ultimate number of conduit/ducts required in the pathway route.

Locations shall be based on the optimum use of associated main, lateral and reviewed and approved via the Facilities Operations Plans Review process.

Precast MH's, SB's and HH's shall be used whenever possible. Field-cast shall only be used when precast does not meet requirements.

CCS has adopted the general specifications for MH's and SB's as used by the Bell System. These standardized vaults are commonly available from multiple manufacturers.

2.5.2 MH Types & Sizes:

The following precast MH products are used in various landscape, pedestrian, incidental traffic and full traffic areas e.g. Oldcastle, Jensen Precast or equivalent manufacturer:

4.5'W x 8.5'L x 6.5'HR (e.g. Jensen PTS-65). Maximum 8-4" main conduit/ducts in/out and a maximum of 2-4" lateral conduit/ducts out.

6.0'W x 12.0'L x 7.0'HR (e.g. Jensen 38Y-4046-1). Maximum 18-4" main conduit/ducts in/out (27-4" when equipped with 38Y-4049 extension) and a maximum of 6-4" lateral conduit/ducts out.

7.0'W x 16.0'L x 10.0'HR (e.g. Jensen 38Y-4048). Maximum 24-4" main conduit/ducts in/out (33-4" when equipped with 38Y-4051 extension) and a maximum of 8-4" lateral conduit/ducts out.

2.5.3 CCS will have the final decision on MH type and configuration based on location, future growth needs, and configuration of the conduit structures being installed.

2.5.4 SB Types & Sizes:

The following precast SB products are used in pedestrian and incidental traffic areas e.g. Oldcastle, Jensen Precast or equivalent manufacturer:

3.0'W x 5.0'L x 4.0'D (e.g. Jensen PTS-3660). Maximum 2-4" conduit/ducts in/out.

4'.0"W x 6'-6"L x 3'-7"D (e.g. Jensen PTS-4878). Maximum 4-4" conduit/ducts in/out.

2.5.5 HH Types & Sizes:

The following precast HH products are used in pedestrian or landscaped areas only e.g. Christy Concrete Products or equivalent manufacturer:

17-3/4"W x 30"L x 24"D (PTS1730). Maximum 1-2" conduit/duct in/out. Use as a pull box only, no planned splicing.

30-1/4"W x 48-1/4"L x 34"D (PTS3048). Maximum 1-4" conduit/duct in/out. Use as a pull box only, no planned splicing.

NOTE: HH's shall not be installed in full or incidental traffic areas.

2.5.6 MH/SB in street areas, which are subject to vehicular traffic, shall be constructed to withstand a minimum of highway loading. The strength of concrete used for MH/SB's shall be at least 4,500 psi within 28 days.

2.5.7 The MH roof shall be a minimum 24" depth-of-cover in traffic areas to a maximum of 60" depth-of-cover. If greater depth-of-cover is required, use MH extensions or a Structural Engineer's certified custom design.

2.5.8 MH's shall be set on a graded level and compacted base of three (3) to six (6) inches of sand, gravel, drain rock or base rock. An approved flowable compactable mix shall be delivered by read-mix truck and backfill placed around the outside of the MH to the top of the roof slab (Do not use concrete above possible future bottom duct runs).

2.5.9 MH's shall be fully equipped as follows:

MH interior painted white.

All hardware shall be galvanized steel metal.

Term-A-Duct terminators that accept PVC Schedule 40 conduit, minimum 4" inside diameter unless otherwise specified. The pathway designer must specify the location and spacing of terminators (minimum 8" horizontal and 10" vertical separation between conduits, measured centerline to centerline of conduits). It is recommended that the pathway designer specify additional row(s) of terminators, above and below those intended for use, to facilitate duct grade changes if conflicting utility crossings are in close proximity to the MH.

Ground rod installed into earth through the provided knockouts in the floor of the enclosure. Copper, ¾" x 6' in length.

Bonding and grounding attachments and bonding ribbons installed.

Uni-strut racking installed for cable support hanger attachments.

A minimum of four 7/8" diameter pulling irons shall be installed. On each duct entrance wall, install one pulling eye on the floor or lower wall and one on the upper wall. A Type 'A' MH with wall-centered duct banks shall be equipped with a minimum of 4 pulling irons. A Type 'A' MH with splayed duct banks shall be equipped with a minimum of 8 pulling irons.

A 12" diameter by 4" depth sump located below each entry opening.

An entry ladder in each entry opening. Ladder to be placed so that entry and exit is facing oncoming traffic (MH's with centered access hole). MH's that are between 12 feet and 20 feet long or between 6 feet and 12 feet width shall have two entry openings with covers. MH's over 20 feet long must use three entry openings with covers.

MH's entry openings shall be thirty-six inch (36") diameter clear opening at the center of the ceiling slab with thirty-six inch (36") diameter extension rings installed as required for grade.

MH Frame, Ring and Covers shall meet AASHTO HS-20-44 standards. The Frame shall be marked with the maintenance hole identification number on the top surface, facing North, with stamped letters not less than ½" high. The cover shall be a 30' diameter labeled "Communications" in letters not less than two inches (2") high, cast into the cover. The first MH step shall be placed on the top surface of the roof. Additional intermediate steps shall be placed at 12" intervals. The top step, just below the maintenance hole cover, shall be placed not less that six inches (6") or not more than seventeen inches (17") below the cover. Steps shall be ¾" galvanized steel and grouted between joints.

All extension ring and collar seams in the MH neck shall be grouted smooth (prevention of water intrusion, debris collection, and snags) and painted white (increase light).

2.5.10 SB's shall be set on a graded level and compacted base of three (3) to six (6) inches of sand, gravel, drain rock or base rock.

2.5.11 SB's shall be fully equipped as follows:

All metal hardware shall be galvanized steel.

Term-A-Duct terminators that accept PVC Schedule 40 conduit, minimum 4" inside diameter unless otherwise specified. The pathway designer must specify the location and spacing of terminators (minimum 8" separation between conduits, measured centerline to centerline of conduits).

Ground rod installed into earth through the provided knockouts in the floor of the enclosure. Copper, ¾" x 6' in length.

Bonding and grounding attachments and bonding ribbons installed.

Uni-strut racking installed for cable support hanger attachments

A minimum of two 7/8" diameter pulling irons shall be installed. On each duct entrance wall, install one pulling eye on the floor or lower wall. A Type 'A' SB with wall-centered duct banks shall be equipped with a minimum of 2 pulling irons. A Type 'A' SB with splayed duct banks shall be equipped with a minimum of 4 pulling irons.

A 12" diameter by 2" depth sump located in the center of the floor.

An adjustable frame and two-piece hinged cover assembly equipped with torsion assist opening and a slip-resistant steel cover. Cover to be furnished with a welded nameplate labeled "Communications" in letters not less than two inches (2") high. Covers shall meet the design load criteria as applicable for the site location as follows:

Incidental traffic Loading: AASHTO H-20 (sidewalks & shared walkways).

Full Traffic Loading: AASHTO H-20 with 30% increase for impact (driveways, parking lots).

2.5.12 HH's shall be set on a graded level and compacted base of three (3) to six (6) inches of sand, gravel, drain rock or base rock

2.5.13 HH's shall be fully equipped as follows:

Extensions to meet depth requirements (conduit/ducts shall enter the sides of HH, not bottom).

Slab bottoms (unless otherwise noted).

End knockouts for conduit/duct entries.

Inserts and uni-strut racks for cable support hanger attachments.

A slip-resistant cover. Cover to be embossed labeled "Communications" in letters not less than two inches (2") high. Covers shall meet the pedestrian loading design criteria (300 lbs/sq.ft.)

2.5.14 Building Entry Boxes shall be Screw Cover Type 3R Enclosures, minimum sixteen (16) gauge galvanized steel (Hoffman or approved equivalent). The Enclosure shall provide protection in outdoor installations against rain, sleet, and snow and indoors against dripping water. The Contractor shall provide galvanized or cadmium plated nails, screws, clips or other means of securely anchoring boxes to buildings or other structures as required for a complete installation. Adequate provisions shall be taken to prevent dielectric action between dissimilar metals. Building entry boxes shall be painted to match existing building walls and/or trim where applicable.

The building entry box shall be sized based on the number and size of conduits entering and exiting the box and the size, number and type of cables to be installed thru the box.

2.5.15 Conduit penetrations into existing MH's, SB's or HH's shall be by core drill hole or preformed breakout. Seal penetrations with waterproof grout. Conduits ends shall be placed flush to the inside surface of the wall.

2.6 Building entrance Pathway – conduit/duct design standards

CCS will specify the conduit/duct route, the number and size of conduit/ducts, and the size and location of MH/SB's (if required), to connect new or remodeled buildings with the existing underground pathway system.

Buildings shall require dual building entrance facilities (separate entrance structures). If required the number of entrance conduit/ducts shall be duplicated in each separate entrance structure.

2.6.2 Clearance from other utilities:

Conduit/duct shall not be placed in parallel, directly above or below, other utility lines (allow for maintenance access).

Minimum required horizontal and vertical clearances to all adjacent utilities shall meet the Municipal Consent Requirements for the Installation of Plant within City of Toronto Streets and CSA C22.3 No. 7 Underground Systems

2.6.3 Concurrently installed joint duct systems (communication & power):

Communication conduit/duct can be concurrently installed in joint trench with rigid power conduit/ducts if separated by a minimum 300 mm (12") of concrete.

Communication conduit/duct(s), in a joint trench configuration, shall be installed in a separate top layer(s) or a side-by-side configuration separated by a minimum 300mm (12)" of concrete between communications and power conduit/ducts.

2.6.4 Size and number of conduit/ducts:

A minimum of two (2) four inch (4" diameter), to a maximum of six (6) four inch (4" diameter) entrance conduit/ducts shall be placed (CCS will specify the required size and number). 5" conduits may be specified, at the discretion of the CCS, if the radius into the structure is 60" or less.

2.6.5 Underground Conduit Material:

PVC Schedule 40 type conduit. Fittings shall be the same manufacturer as conduit. All plastic conduit and fittings shall have solvent-weld connections and shall provide a watertight joint.

Rigid galvanized steel conduit (wrapped or PVC coated) may be specified in special requirements, e.g. shallow depth, exposed structures, etc.

2.6.6 Above Grade Communication Conduit Material:

All exposed conduit rising more than one foot (1') above the adjacent grade shall be rigid steel conduit, full weight, pipe size, finished inside and outside by a hot dipped galvanized method. The weight of zinc coating on the interior and exterior surfaces shall not be less than 2.0 ounces per square foot of total coated surface. The interior of the conduit shall be free of blisters, projections, and other defects. The conduit shall have threaded type couplings and fittings with insulated end bushings. Rigid steel conduit shall extend a minimum of 600 mm (24") below grade before transition to PVC conduit.

The Contractor shall provide galvanized or cadmium plated nails, screws, clips, or other means of securely anchoring the conduit to buildings or other structures as required for a complete installation. Adequate provisions shall be made to prevent dielectric action between dissimilar metals.

2.6.7 Multiple conduit/duct formations – duct bank configurations:

Two to three (3) – four-inch (4") diameter" conduits = one layer

Four – four-inch (4") diameter conduits = two layers x two conduits wide.

Six – four-inch (4") diameter conduits = two layers x three conduits wide (or three layers x 2 conduits wide)

2.6.8 Conduit/duct Cover, Separation & Encasement:

Unless future conditions require greater depth the minimum required horizontal and vertical clearances to all adjacent utilities shall meet the Municipal Consent Requirements for the Installation of Plant within City of Toronto Streets and CSA C22.3 No. 7 Underground Systems

Install conduit/duct with a minimum downward slope of three (3) inches in each one hundred (100) feet away from building towards MH's, SB's and other necessary drainage facilities. Unless otherwise noted on the drawings, conduit/duct shall be run in a straight line except where a change in direction is necessary.

Conduit shall be supported in the trench with Carlon Snap-Lock Spacers and Rebar Holders or equivalent. The Carlon Snap-Loc Spacer support assemblies or equivalent shall not exceed eight feet (8') between support assemblies. Maintain no less that two inches (2") clearance between conduit/duct and earth on all sides and bottom. Conduits shall be separated by a minimum of two inches (2") clearance. In joint trench, power and communication conduit/ducts shall be separated by a minimum three 300mm (12") of concrete. Separation shall be maintained to enable conduit/ducts to be fully bedded and encased, as required, in a flowable cement sand slurry (1-1/2 sack cement-sand slurry mix) or concrete (5 sack cement mix, 3/4" maximum aggregate). The conduit/duct structure shall be tied together at the separators with wire and rebar and securely anchored to the bottom of the trench to prevent any movement or floating while pouring encasement.

Conduit shall be encased in flowable 1-½ sack cement - sand slurry mix, or if required by design specifications, concrete encased (5-sack cement mix, ½" maximum aggregate) to a minimum 3" above the conduit structure. A concrete vibration tool must be used to ensure that voids are not created around duct structures.

- In asphalt street and walkway pavement areas, the remainder of the trench shall be backfilled with Class II aggregate base @ 95% compaction to the bottom level of the existing pavement. The trench shall be final paved to match the existing pavement material (minimum 3" asphalt
- In landscaped areas, the remainder of the trench shall be backfilled with native material @ 90% compaction and planting topsoil mix, to existing landscape grade (removed sod, plants and/or decorative materials shall be replaced in kind).

All bends and sweeps less than eighty feet (80") radius shall be concrete encased (5-sack cement mix, 3/4" maximum aggregate).

2.6.9 Bends & Sweeps (if required):

Changes in direction of conduit/duct runs, exceeding a total of 10 degrees, shall be accomplished by long sweep bends.

No more than two (2) 90 degree bends (180 degrees total) are allowed in a conduit/duct section without some form of pull-point (e.g. MH, SB, etc).

The minimum inside radius of building entrance long sweep conduit/duct bends shall not be less than 60". CCSshall specify longer sweep bends, greater than 60" radius, or 5" conduits, if large pair-count copper cables are planned for placement.

Straight sections of single bore PVC Schedule 40 conduit can be manually bent to form curves with a radius 40 feet or greater.

All bends and sweeps shall be concrete encased (5-sack cement mix, 3/4" maximum aggregate).

2.6.10 Mandreling, Pull Tapes, Plugging:

Each conduit shall be mandreled immediately following backfill and compaction. The mandrel shall be pulled in both directions. It shall be preceded by a stiff brush pulled in both directions until the conduit is clear of all material particles (earth, sand, gravel). The brush shall be sized to match the diameter of the conduit. A bend radius of 60" or less shall pass a rigid mandrel not less than 6" long with a diameter 3/8" less than the interior size of the conduit (4" diameter conduit requires a 3-5/8" diameter mandrel). A bend radius greater that 60" shall pass a 12" long rigid mandrel with a diameter 3/8" less than the interior size of the conduit. Conduit though which the mandrel cannot pass will be judged defective and shall be repaired immediately. CCS shall witness the mandrel proving process.

Install a 3/4" polyester woven pre-lubed measuring / pull-tape (2500 lbs tensile strength, flat design with footage measurements, Neptco WP2500Polor equivalent) in each conduit. The pull tape shall be new and free of splices. The wall-to-wall footage length, for each section, shall be provided to CCS and noted on the "as-built" drawings. The pull tape shall be securely fastened at both conduit ends to compression conduit plug fittings. Install one (1) #18 AWG, stranded, jacketed copper wire, with the pull-tape, in one upper conduit of each duct structure, to enable future electronic locating and marking of the conduit/duct structure.

Upon completion of mandreling, brushing and pull tape placement; each conduit shall be plugged at both ends, using compression type conduit plug fittings. Blank conduit plugs shall be removable, reusable, corrosion proof, water/air/gas-tight, and equipped with an attachment to secure the pull tape inside the conduit.

2.7 Firestopping Material

Conform to both Flame (F) and Temperature (T) ratings as required by local building codes and as tested by nationally accepted test agencies per ASTM E814 or UL 1479 fire test in a configuration that is representative of the actual field conditions.

2.8 Labels

2.8.1 As recommended in ANSI/TIA/EIA 606. Permanent (i.e. suitable for an outdoor environment), permanently affixed, typed, and created by a hand-carried label maker or an approved equivalent software-based label making system. Handwritten labels are not acceptable.

1. Hand-carried label maker:

a. RHINO M1011 Metal Tape Embosser (or approved equal).

2. Labels:

a. Aluminum non adhesive/adhesive label 1/2" (or approved equal)

2.9 Landscaping

Topsoil: Imported from off construction site.

Part 3 Execution

3.1 General

3.1.1 The Contractor is solely responsible for the safety of the public and workers in accordance with all applicable rules, regulations, building codes and ordinances.

3.1.2 All work shall comply with applicable safety rules and regulations. All work shall comply with the requirements of the National Electrical Safety Code (NESC), Canadian Electrical Code (Part III) and the Ontario Electrical Safety Code (OESC) except where local codes and/or regulations are more stringent, in which case the local codes and/or regulations shall govern.

3.1.3 All work shall comply with the standards, references and codes listed in PART 1 -- REFERENCES above. Where questions arise regarding which standards, references, or codes apply, the more stringent shall prevail.

3.1.4 All work shall comply with the requirements and recommendations of the product manufacturers. Where questions arise regarding which requirements and recommendations apply, the more stringent shall prevail.

3.1.5 Replace and/or repair to original (or better) condition any existing structures, materials, equipment, etc. inadvertently demolished or damaged by the Contractor during the course of construction at no additional cost to the Owner.

3.1.6 Remove surplus material and debris from the job site and dispose of legally.

3.2 Excavating, Trenching and Fill

3.2.1 Excavation:

1. Do not excavate when the outside temperature is less than 1.7° C or when there is standing water or snow on the subgrade.

2. Where crossing of concrete or asphalt is required, saw cut and remove surface material prior to excavating. Remove concrete in complete sections from control joint to control joint regardless of the width of the excavation. Restore concrete and asphalt surfaces following excavation to match existing depth, strength, color, and type of material.

3. If an adjacent structure may be compromised or damaged by excavation work, underpin the structure as required. If the structural integrity is in question, obtain an evaluation and recommendation from a registered structural Designer employed by the Contractor prior to proceeding with the work.

4. Maintain adequate separation between the excavation and adjacent underground utilities. Locate excavations such that ductbanks, maintenance holes, and handholes have a minimum separation of 300 mm (12”) between the ductbank and/or MH/HH and the nearest underground utility after installation. For gas lines a minimum separation of eighteen (18) inches is required. For water a minimum separation of thirty-six (36) inches is required. Contact the Designer prior to proceeding if minimum separation distances cannot be achieved.

5. Protect excavations at the end of the work shift. Cover with steel sheets and barricade prior to leaving the job site, in accordance with all applicable rules, regulations, building codes, and ordinances.

6. Install, operate and maintain pump or dewatering equipment as necessary to

prevent water from accumulating in the excavation.

7. Excavation Depth/Width

a. For MH/HH: Excavate to a sufficient depth to cover the overall assembled height of the vault plus the added height of risers, covers and bedding material consisting of a minimum 6"-12" of base. Excavate to a sufficient width to provide a minimum of 6" clearance around each side of the MH/HH.

b. For trenches: Excavate to a sufficient depth to provide a minimum cover as required by the Canadian Electrical Code Part III/ and/or the City of Toronto over the conduit or ductbank formation and to allow for the proper alignment of conduits into the MH/HH. Excavate to a sufficient width to provide a minimum of 6" to each side of the ductbank formation.

8. Over-excavate, fill, and compact any soft spots in the subgrade.

9. Run trench excavation true and as straight as possible. Clear trenches of stones and soft spots.

10. Slope trench grade to fall 3" per 100 feet in general and ¼" per foot where possible.

a. Slope trench toward lower MH/HH or from high points toward MH/HH at both ends.

b. Slope trench away from building entrances.

3.2.2 Fill:

1. Drain and/or pump groundwater and surface water from the recipient area prior to the placement of fill.

2. Do not place frozen fill.

3. Base:

a. Scarify and moisture-condition the subgrade bed to receive fill prior to placing materials.

b. Moisture-condition base material to within three (3) percent of optimum moisture content and place in loose, horizontal layers.

c. Level the subgrade bed using sand for trenches and gravel for MH/HH as necessary to form an even base.

4. Bedding: Do not exceed 4" depth of bedding lifts/layers before compacting

5. Backfill: Do not exceed 6" depth of backfill lifts/layers before compacting.

6. Compaction: Compact using a vibratory plate or roller or other mechanical device. Compaction through jetting and/or pounding is not acceptable. Compact per APWA Standard Specification Paragraph 7-10.3 (11).

a. Bedding: Compact material to a dense state equaling at least 95% of the maximum dry density per ASTM D1557.

b. Backfill: Compact material up to two (2) feet below the finished grade with a minimum relative compaction of 90% of the maximum dry density per ASTM D1557. Compact material from two (2) feet below the finished grade up to the finished grade with a minimum relative compaction of 95% of the maximum dry density per ASTM D1557.

3.2.3 Waste Disposal: Remove excavation materials and other construction debris from the site in a timely manner and dispose of legally.

3.3 Cast-in-Place Concrete

3.3.1 Construct concrete in accordance with the applicable portions of the specifications, standards, codes and regulations (latest editions and/or amendments) listed in Section 1, References.

3.3.2 Formwork:

1. Construction:

a. Forms: Use the most advantageous panel sizes and panel joint locations. Neat patches and minor surface imperfections will be permitted. Form surfaces in true planes within ¼" in 10 feet. Clean forms and remove debris prior to pouring concrete. Make braces unyielding and tight to prevent leakage. Maintain formwork construction tolerances complying with ACI 347. Formwork shall be readily removable without impact, shock, or damage to concrete surfaces and adjacent materials. Use chamfer strips fabricated to produce uniform smooth lines and tight edge joints for exposed corners and edges. Note: chamfer strips are not required for concrete encased ductbank corners and edges. Gypsum board shall not be used for forms except to form concrete encased ductbank.

b. Reinforcement: Construct reinforcement in accordance with ACI SP-6. Weld reinforcement in accordance with ANSI/AWS D1.4 or ANSI/AWS D12.1. Accurately position, support, and secure reinforcement against displacement. Support reinforcement by metal/plastic chairs, runners, bolsters, spacers, hangers, or other incidental materials as required.

c. Where metal or plywood forms are used, coat the forms with a form release agent prior to placement of concrete. Coat faces and edges of forms applied at a rate of 500 to 550 square feet per unit.

d. Curved Surfaces: Use only curved forms for constructing curved structures and surfaces.

2. Slope: For flatwork, construct forms with 1% side slope to both south and east sides.

3. Joints:

a. Control: Build into form.

b. Expansion: Build expansion joints into form, premolded ½" thick, and conforming to ASTM D1751. Seal the top ½" of expansion joints with an approved joint sealer.

4. Removal: Remove forms after concrete has cured (see Curing below) for 7 days or after concrete has attained a compressive strength of 4000 psi.

a. Where gypsum board forms are used to form concrete encased ductbank they can be left in place and backfilled after the specified curing period.

3.3.3 Concrete:

1. Transport: Comply with ACI 304. Transport concrete from the mixer to the construction location via methods preventing separation of materials.

2. Application:

a. Prior to placement, inspect and complete formwork construction, reinforcement, and items to be embedded or cast-in.

b. Deposit concrete in forms in layers not deeper than 24" and in a manner toavoid inclined construction joints. Where placement consists of several layers, place each layer

on the preceding layer while the preceding layer is still plastic. Cold joints are not acceptable.

c. Deposit concrete in a plastic condition and uniformly work around reinforcements.

d. Consolidate concrete using internal machine vibration (stinger) during pouring.

e. Once concrete work has commenced, work continuously until the work segment and/or section has been completed.

f. Cold Weather: Protect concrete from damage caused by frost, freezing, or low temperatures in compliance with ACI 306R. When temperature is below 4.4° C, heat water and aggregates before mixing to obtain a concrete mixture of not less than 10° C and not more than 26.7° C.

g. Hot Weather: Protect concrete from damage caused by hot weather in compliance with ACI 305R. When temperature is above 32.2° C chill water before mixing to obtain a concrete mixture of not more than 32.2° C. Cover reinforcing steel with water-soaked burlap if it becomes too hot immediately before placement of concrete. Temperature of steel shall not exceed the ambient air temperature.

3. Curing:

a. Curing method and rate of application shall be according to manufacturer's recommendations.

b. Protect concrete from premature drying, rain, excessive temperatures, and mechanical injury during the curing period.

c. Cure concrete for 7 days in accordance with ACI 301 and keep continuously moist during this time. Maintain concrete temperature between 10° C and 32.2° C during the curing period.

d. Provide curing and sealing compound to exposed slabs, sidewalks, curbs, etc. as soon as final finishing operations are complete (within 2 hours). Re-coat areas subjected to heavy rainfall within 3 hours of the initial application.

4. Finish:

a. Consolidate, level and screen surfaces for evenness and uniformity. Remove excess concrete. Fill low spots. Float the surface after water sheen has disappeared from surface.

b. Finish flatwork with a special tool to match patterned finish of adjacent existing concrete.

c. Tool edges, control, and expansion joints to make finish work straight and even.

3.3.4 Ductbanks:

a. Reinforce ductbanks along full length with formed sides. Install reinforcement at each corner of the conduit spacers/supports.

b. Do not pour concrete against trench walls. Consolidate concrete during placement using an internal concrete vibrator.

c. Provide each MH/HH penetration with reinforcing bars tied to MH/HH reinforcement. Dowel reinforcement in foundation wall of building penetrations.

d. Secure conduit spacers/supports and reinforcing to prevent movement during concrete placement. Use stakes and/or tie wire to minimize floating and spreading.

6. Protection for exposed concrete: Cover exposed concrete (i.e. sidewalk, driveway, etc.) with plywood, weighted with concrete blocks or similar heavy object in order to prevent surface damage.

7. Bond and ground reinforcement bars to the nearest approved ground.

3.4 Conduits and Ductbanks

3.4.1 Conduits:

1. Outdoor underground: Provide RNC Schedule 40 (Type 1), concrete encased.

2. Outdoor exposed: Provide RGC.

3. Sweeps:

a. Shallow curves comprised of continuous lengths of individual straight RNC conduit are permissible with a minimum sweep radius of 40 feet.

b. Where the conduit sweep radius is less than 40 feet, sweeps shall be factory-manufactured bends with a minimum of 48 inch radius. Bending conduit in the field using manual or mechanical methods is not acceptable.

c. Do not exceed 90 degrees for an individual sweep.

d. Where unique construction requirements for bend radius or arc length do not permit the use of factory-manufactured sweeps, sweeps shall be field manufactured using factory-recommended equipment. The internal diameter of the sweep shall not be changed during the sweep field manufacturing process.

e. A conduit section shall have not more than the equivalent of two 90-degree sweeps (a total of 180 degrees) between pull points. The 180-degree maximum shall include kicks and offsets. Where it is not possible to construct a section of conduit within the 180-degree sweep maximum, an intermediate MH/HH shall be installed.

f. Two 90-degree sweeps separated by less than 10 feet is not permissible.

g. Construct sweeps for conduits within a common ductbank parallel, measured from the same center-point.

h. Do not install LB's, condulets, or 90 degree electrical elbows.

4. Fittings:

a. Cut conduit ends square and ream to remove burrs and sharp ends. Extend conduits the maximum distance into fittings, couplings, and/or connectors. Tighten fittings securely and seal watertight (see below).

b. End Caps (Plugs): Provide end caps on conduit ends throughout construction to prevent the intrusion of water or debris. Install end caps on conduit that is not directly being worked on during the work day and on conduits at night. Leave end caps in place upon final completion of the work.

c. End Bells: Provide end bells for terminating conduit in maintenance holes and handholes. Install protective end bells on conduits flush with MH/HH walls. Do not use TERM-A-DUCT.

5. Sealing: Apply a solvent-type cement (for RNC) to make conduit connections waterproof. Seal and grout conduit terminations in maintenance holes and handholes to ensure that voids in the joints are filled. Seal conduit terminations in buildings until used for cable.

6. Cleaning: After installation, and within five days prior to releasing conduit for cabling installation, clean each conduit with a wire brush and swab. Clean each conduit a minimum of two times in the same direction and swab with clean rags until the rag comes out of the conduit clean and dry. Swab away from buildings for conduit sections connected to buildings.

7. Test Mandrels: Prove out each conduit with a minimum 16 inch long test mandrel that is ¼ inch smaller than the inside diameter of the conduit. Pull the test mandrel after backfilling but prior to the replacement of landscaping. Repair or replace any conduit that does not prove out at no cost to the Owner.

8. Conduit Entrances:

a. MH/HH: Conduit entrances at opposite ends of a maintenance hole or handhole shall be at the same level and in the same position with respect to the side walls. Ensure that each conduit leaving a MH/HH in any position enters the next MH/HH in the same relative position.

b. Buildings: Terminate conduits a minimum of 6-inches above the finished floor.

9. Length: Unless otherwise shown on the Drawings, do not exceed 183 metres (600 feet) of ductbank between pulling points. Contact the Designer prior to proceeding if a ductbank section will exceed 183 metres (600 feet).

10. Pull Ropes: Install in each conduit immediately after the conduit has been cleaned and mandreled. Leave a minimum of 10 feet looped and tied off at each end of the conduit.

11. Protection: Insure that after installation the conduit coatings and finishes are without damage. Repair any Rigid Non-metallic Conduit damage with matching touchup coating recommended by the manufacturer.

3.4.2 Ductbanks:

1. Unless otherwise noted on the Contract Documents or required for sweep radius, construct ductbanks in a concrete encasement. Use concrete encased RNC (see CAST-IN-PLACE CONCRETE, above).

2. Encased in Concrete:

a. See CAST-IN-PLACE CONCRETE, above.

3. Conduit Spacers/Supports: Place supports on eight (8) foot centers if encased in concrete and five (5) foot centers otherwise. Interlock spacers horizontally only. Stagger spacers encased in concrete at least six (6) inches vertically.

4. Warning Tape: Install metallic warning tape half the distance between the top of the ductbank and finished grade.

5. Grounding/Bonding: Install ground wire along length of ductbank. Bond to grounding electrodes of MH/HH and to building service grounds.

6. Slope ductbank grade to fall 3 inches per 100 feet in general and ¼" per foot where possible.

a. Slope ductbank toward lower MH/HH or from high points toward MH/HH at both ends.

b. Slope ductbank away from building entrances.

3.5 Underground Spaces

3.5.1 Provide maintenance holes and handholes in the sizes and locations shown on the Drawings.

3.5.2 Precast maintenance holes and handholes shall be free from damaged joint surfaces, cracks, or other damage that would permit infiltration. Repair of defects is not acceptable. MH/HH and incidental and miscellaneous equipment (such as cable racking brackets and supports) shall be supplied by a single manufacturer.

3.5.3 Install MH/HH according to manufacturer's instructions.

3.5.4 Covers and Frames: Provide 30" wide x 10" high circular frames/covers and provide with minimum 4" and maximum 12" high circular maintenance hole entrance riser sections as required. Use the riser sections to maintain the top of the cover 1" above the existing ground line or finished grade. Taper pavement surfaces up to the top of the maintenance cover. Provide lock-down bolts for HH covers. Covers and frames shall be of uniform quality, free from blowholes, porosity, shrinkage, distortion, cracks and other defects. Repair of defects is not acceptable. Mating surfaces between covers and frames shall be machine-finished to ensure a non-rocking fit.

3.5.5 Setting and Placement: Remove water from excavation and properly install bedding material prior to setting the MH/HH. Clean MH/HH section seal surfaces so that they are free from dirt or other material.

1. Set MH/HH in place by lowering each section into the excavation, ensuring that the section is level, plumb, and firmly positioned, and ensuring that the section gasket/seal is properly installed and watertight prior to setting the next section.

2. Carefully set the MH/HH to ensure that the rim or lid elevation is set one inch above finished grade. For vaults located in paved areas, taper pavement up to the MH/HH rim.

3.5.6 Knockouts: Open conduit entry knockouts with care preserving the TERM-A-DUCT sidewalls. Glue conduits entering the vault to the opened TERM-A-DUCTs with PVC cement. Preserve intact the conduit entry knockouts that are not intended for current use.

3.5.7 Grouting: Apply grout in a manner to insure filling of voids in the joints being sealed. Apply grouting to conduit entrances, risers, and covers in addition to any other voids.

3.5.8 Racking and Hardware: Install racking and hardware and incidental materials. Provide three (3) cable racks per longitudinal side (six (6) racks total) per maintenance hole. Provide eight (8) 7-½" cable support arms per manhole. Provide additional incidental hardware for mounting racks and cable support arms.

3.5.9 Risers: Provide riser sections that are a minimum of 4" high and a maximum 12" high, sized for the MH entrance. Provide riser sections in quantities sufficient to meet the minimum and maximum height requirements discussed above.

3.5.10 Grounding/Bonding: Provide a minimum of one ¾" x 10' copperclad steel ground rods, and one #4/0 pigtail for connection to interior ground conductors. Bond metallic hardware in the vault to the pre-cast bonding tabs. Bond the bonding tabs to the ground rod.

3.5.11 Cleaning: Clean and dry the MH/HH after construction activity is complete and prior to releasing the MH/HH to the Owner for the Owner's use.

End of Section 27 05 43