

APPENDIX 3R
CPPS TECHNICAL SPECIFICATIONS

Please see attached.

Table of Contents

Part 1.	GENERAL	2
1.	System Overview	2
2.	Related Documents and Sections	2
3.	Applicable Standards and References	2
4.	Quality Assurance	3
5.	Submittals and As-Builts	4
Part 2.	PRODUCTS	6
1.	Duct.....	6
2.	Pre-Cast Manholes	6
3.	Concrete Extension Rings.....	8
4.	Warning Tape	8
Part 3.	EXECUTION	8
1.	General.....	8
2.	Excavation, Backfill and Trench Restoration	10
3.	Duct Installation.....	14
4.	Service Entrance Facilities.....	16
5.	Pre-Cast Manholes	17
6.	Labeling and Marking.....	19

PART 1. GENERAL

1. System Overview

- .1 The Campus Perimeter Pathway System (CPPS) will:
 - .1 Provide the distribution system around the Burnaby Hospital (BH) campus for all inter-building fiber and copper cabling systems.
 - .2 Connect to third party carrier structures to enable cabling infrastructure and telecommunications services from third parties to be brought into and distributed throughout the BH Campus.
- .2 Project Co will undertake the Design and Construction of a dedicated concrete encased underground Perimeter Pathway System around the existing BH Campus. Concrete encased ducts from manholes will be run into Service Entrance Facilities during the construction of the project as indicate on the CPPS drawings herein.
- .3 The CPPS will be designed and installed to enable the Authority to deploy a physical fiber optic ring topology around the perimeter of the BH Campus that will connect to new and existing buildings.
- .4 It is Project Co's responsibility to coordinate and work with the AHJ as required to construct the CPPS.
- .5 The Authority will be responsible for coordinating and paying for connections to 3rd party communications utility infrastructure to the BH Campus property line. Extension of 3rd party communications utility infrastructure from the property line to the point where that infrastructure ties into the CPPS will be the responsibility of Project Co.
- .6 The Authority will be responsible for the installation, splicing, termination and testing of all inter-building fiber optic and copper cabling.
- .7 The CPPS will be completed by the Target CPPS Substantial Completion Date.

2. Related Documents and Sections

- .1 The Campus Perimeter Pathway System will be designed and constructed in accordance with the drawings and written specifications contained herein and in Schedule 3 – Design and Construction Specifications.

3. Applicable Standards and References

- .1 All materials supplied and construction performed will be in accordance with the latest edition of the Canadian Electrical Code.
- .2 Other standards applicable to the design and construction of the Campus Perimeter Pathway System are:
 - MMCD Standard Documents, Current Edition (Technical Content Only, not Commercial)
 - MMCD Design Guidelines, Current Edition
 - BICSI Outside Plant Design Reference Manual, Current Edition.
 - ANSI/BICSI 002-2014, Data Center Design and Implementation Best Practices
 - BICSI Telecommunications Distribution Methods Manual, Current Edition (Volume 1 and 2)

- ANSI/TIA-758-B, Customer Owned Outside Plant Telecommunications Infrastructure Standard,
 - ANSI/TIA-568.1-E, Commercial Building Telecommunications Infrastructure Standard
 - ANSI/TIA-569-E, Telecommunications Pathways and Spaces
 - ANSI/TIA-606-C, Administration Standard for the Telecommunications Infrastructure of Commercial Buildings
 - ANSI/TIA-607-D, B-1 and B-2 Telecommunications Bonding and Grounding (Earthing) for Customer Premises.
 - ANSI/TIA-942-B, Telecommunications Infrastructure Standard for Data Centers
 - ANSI/TIA-1179-A, Healthcare Facility Telecommunications Infrastructure Standards.
 - CSA 22.1, Safety Standard for Electrical Installations
 - CSA 22.2, Canadian Electrical Code, General Requirements
 - CSA 22.3, Canadian Electrical Code Outside Wiring
 - CSA A-22.4, Precast Concrete Materials and Construction Standard
 - CSA A-23.3, The Design of Plain or Reinforced Concrete Structures
- .3 Utilize the latest version of the applicable standard or code adopted by the AHJ in affect at the Effective Date of the Agreement.
- .4 In the event there is a conflict between the standards identified in this Section and Schedule 3 [Design and Construction Specifications] and it associated appendices, the more stringent standard or requirement will apply.
4. Quality Assurance
- .1 All installation work for the Campus Perimeter Pathway System will be performed in a neat and workmanlike manner.
- .2 Equipment and materials will be of the quality and manufacture indicated. They will be installed to manufacturers best practice guidelines and as laid out in the project documents. No equipment material substitution will be permitted after shop drawings have been reviewed by the Authority pursuant to Appendix 2C [User Consultation and Review Procedure].
- .3 Any change and or revision to the Issued for Construction (IFC) permit drawings will be reviewed by the Authority through Appendix 2C [User Consultation and Review Procedure].
- .4 The Authority will inspect the installation in progress. It is the responsibility of Project Co to schedule regular and milestone inspection times with the Authority's designated Inspector. It is incumbent upon Project Co to verify that the installation and material used has been inspected by the Authority before it is enclosed within building features, encased in concrete, buried, or otherwise hidden from view. Project Co will bear costs associated with uncovering or exposing installations or features that have not been inspected.
- .5 Project Co will be responsible for submitting regular progress reports during the construction. Progress reports will be submitted weekly and will contain at a minimum:
- .1 Description of work completed; and
 - .2 Minimum one photo of every stage of installation and backfill that was completed.
- .6 Video scoping
- .1 Project Co will engage a 3rd party that specializes in the performance and provision of underground video scoping. Video scoping will be conducted for all duct installations as duct runs are completed and the scoping reports will be submitted to the Authority for review

through Appendix 2C [User Consultation and Review Procedure]. The full cost of the video scoping is to be borne by Project Co.

- .2 Project Co will provide video scoping equipment complete with the latest technologies and as part of the scoping review will provide:
 - .1 Scope with a minimum length range to scope the entire conduit run from one end.
 - .2 Unit will have suitable accessories for scoping the duct in question. Machines converted for mechanical duct scoping will not be used.
 - .3 Unit will provide the length from manhole that the break or obstruction has been identified at
 - .4 Scope will capture video of the run with sufficient resolution and frames per second to enable identification of blockage/breakages.
 - .5 Pictures of any identified obstructions will be included with the summary report of findings.

The information in the above listed points will be summarized in a report provided to the Authority at the conclusion of each section of duct scoping. The report format will include at minimum:

- .1 Inspection Summary
 - .2 Index of Defects
 - .3 Detailed Inspection Report for each conduit
 - .4 Catalogue of each video
 - .5 Catalogue of pictures showing each individual defect identified during the inspection which will include date/time stamp, project title, and individual duct identifier on each picture
- .3 Project Co will correct any deficiencies revealed by the video scoping. Correction of deficiencies will be verified by additional video scoping undertaken at Project Co's expense following the completion of remedial action.
- .7 All material testing will be done in accordance with the MMCD; testing to be carried out by qualified material testing firm and paid for by Project Co. Project Co is to provide copies of all test results to the Authority.

5. Submittals and As-Builts

- .1 Quality Assurance and Control Submittals
 - .1 Provide submittal information for review by the Authority through Appendix 2C [User Consultation and Review Procedure] before materials are ordered and construction commences. Refer to Schedule 3 for submittal requirements.
 - .2 In addition to the items identified in Schedule 3, Section 2.4.12, Project Co will also provide submittals for the following:
 - .1 Rebar specifications
 - .2 Sieve analysis for granular materials
 - .3 Video scoping of the ducts
 - .4 Concrete test results
 - .5 Compaction test results
 - .6 Asphalt test results
 - .7 Mandrel test results
 - .8 GPS data
 - .9 Progress reports with photos (Refer to Schedule 3, Section 2.4.12.7(3))

- .10 Weekly as-built updates reflecting the progress of construction
- .2 Maintain at the job site a minimum of one set of Record Drawings and Specifications. Record Drawings will consist of redline markups of drawings, specifications and spreadsheets, including manhole butterfly drawings.
 - .1 Document changes to the system from that originally shown on the IFC permit documents and clearly identify system component labels and identifiers on Record Drawings.
 - .2 Keep Record Drawings at the job site and make available to the Authority at any time.
 - .3 Keep Record Drawings current throughout the course of construction. ("Current" is defined as not more than one week behind actual construction).
 - .4 Show identifiers for major infrastructure components on Record Drawings.
 - .5 Project Co to record legible images of working as-built drawings on a once per-week basis. Transmit electronically to the Authority on a weekly basis to facilitate construction reviews and ensure vital records are maintained.
- .3 Closeout Submittals and As-Built
 - .1 At the completion of the CPPS, submit information from product data submittals (above), updated to reflect any changes during the course of construction, to the Authority in a telecommunications-specific Operations and Maintenance (O&M) Manual.
 - .1 O&M Manual will be in a suitably labelled, hard back, D-Ring type commercial binders each complete with an index and tabbed title sheets for each section. All binder pages will have self-adhesive reinforcing rings at each binder ring.
 - .2 All O&M data will be printed on 8 1/2" x 11" heavy bond, indexed, tabbed, punched and bound in the binders. Drawings will be printed on 11" x 17". Each manual will have a title sheet which is labelled "Operation & Maintenance Manual", and will list the Project name, Contractor's & Communications Consultant's names, date submitted, and a Table of Contents for each volume. If a manual exceeds 75 mm in thickness, provide additional manuals as required.
 - .3 Soft copy of the O&M Manual in PDF format on a separate USB Memory Key.
 - .2 As-Built drawings will:
 - .1 Identify the location and elevation of all new and existing works and underground routes encountered on the project.
 - .2 Identify duct lengths (measured by marked pull string), wheeled distance from the center of manhole lid to center of next manhole lid, center of manhole lid to center of bend, center of manhole lid and center of bend to stubbed ducts.
 - .3 All changes to approved IFC permit drawings including but not limited to duct trench details, offset adjustments, duct window assignments and locations of stubs and bends and any other change that is different than permitted.
 - .4 GPS location of center for start of bends, end of bends, and each stubbed out duct end, as well as each corner of every manhole are to be noted on the as-built drawing. GPS readings will be to a certainty of 10cm or better.
 - .5 Project Co. will provide GPS locations for each section of ducts between manholes, Service Entrance Facilities, and stubs indicating the location and elevation of all high and low points recorded to the top of each section of duct bank

- .3 As-Built drawings are to be provided in the latest version of AutoCAD (bind all x-Ref files) and in PDF format.
- .4 Provide hard and digital copies of the As-Built drawings in accordance with section 6.25 of Schedule 2.
- .5 Provide three (3) USB Memory Keys of As-Built Drawings.

PART 2. PRODUCTS

1. Duct

- .1 The number, size, raceway duct material and arrangement are as indicated on the CPPS drawings contained herein.
- .2 All telecommunication ducts will be 103mm (metric designator) (4 inch) PVC, DB2, orange in color
- .3 For all duct bank runs, bends will be factory sweeps with a minimum of 10 times the internal diameter of the duct.
- .4 Provide bell ends on all duct terminations.
- .5 Splice ducts with fittings approved by the conduit manufacturer for the specified applications.
- .6 Spacers will provide a 25mm (1") separation between ducts to allow for concrete to totally encase each duct as well as allow for a 50mm encasement of the system.
 - .1 Spacers will be of a type that allows for re-enforcing bar to be part of the system.
 - .2 Spacers will be interlocking or strapped.
 - .3 Material: High density polyethylene
- .7 PVC duct fittings, terminators and end caps will accommodate 103mm DB2 ducts.
- .8 Place a traceable mule tape with length markings in all ducts, rated for minimum 5.5kN (12,500 lbs) pull strength. Mule tape will be locatable Dura-Line: Bull-Line 20000059 or approved alternate as reviewed by the Authority through the review process in Appendix 2C [User Consultation and Review Procedure].
- .9 Watertight expandable duct plugs that seals the duct against water, gas, litter and vermin will be installed at both ends of every Service Entrance Facility duct.

2. Pre-Cast Manholes

- .1 Provide manholes as specified in the CPPS drawings and as specified herein.
- .2 The manholes and accessories such as risers, grade rings and lids will be rated for exposure to all climatic conditions and soil conditions that may exist through the Province of British Columbia. The range of temperatures the manholes will be exposed to is -40 Celsius to +40 Celsius.
- .3 Manholes are to be precast concrete chamber type PLMH 2102 (inside dimensions: length 1.925m x width 1.0m x height 2.02m) or approved equivalent and will be constructed and or placed as shown on the plans.

- .1 The internal dimensions of the manholes will be held within plus or minus 1% of the designated dimension.
- .2 The space in each joint will be uniform to a maximum tolerance of 2mm.
- .4 The manhole will be designed to withstand a maximum cover of 1.5m measured from final grade to the outer surface of the manhole roof.
- .5 The openings will be designed to accept precast extension rings.
- .6 The structural design of the manholes and their lids will meet the following:
 - .1 The design will be in accordance with the provisions of S6-1978 CSA A-23.3, The Design of Plain or Reinforced Concrete Structures, latest revision.
 - .2 The effect of the precast windows and knockout sections in the end walls will be taken into account, together with all possible loads or combinations thereof.
 - .3 Wheel loading will be MS200 (H20).
 - .4 The design will allow for a soil pressure equivalent to a fluid pressure of liquid of 800 kg/cubic meter unit mass.
- .7 Knockouts will be provided in each end wall. The remaining parallel walls are to remain free of conduit entrances.
- .8 Knockouts will be utilized from the bottom up, with remaining/spare knockouts on top.
- .9 Reinforcing bars will not protrude into the knockouts in the end walls unless a tie bar is required at the joining section for shipping.
- .10 The bottom inside edge of the circular openings in the roof will have a minimum chamfer of 25mm at 45 degrees.
- .11 The floor will be sloped towards the sump a minimum of 25mm over the length of the manhole.
- .12 Pulling eye inserts will be 32mm (1 1/4") in diameter and have a minimum allowable pull out strength of 29 kN and ultimate pull out strength of 67 kN and be complete with dust caps. Eight (8) pulling eyes will be supplied with each manhole by the precast vendor.
- .13 Inside walls, ceiling and roof openings to be painted with two coats of Emcrete or equivalent.
- .14 A knockout will be provided in the floor for a sump. It will be centered at one end of the structure.
- .15 A sump, backwater valve and "p" trap will be provided for all precast manholes. Allow for knocking/modification of manhole in order to fit required p-trap and drainage.
- .16 Floor channel inserts in the base unit will be tied to the reinforcing cage to provide an electrical ground.
- .17 An electrical ground symbol will be set in the concrete at the top of the structure.
- .18 Provide and install all hardware in precast manholes such as pulling irons, pulling eyes, ground rods and cable racks suitable for the support of cables and splice cases.
 - .1 All manhole hardware will have a hot dipped galvanized finish.

- .2 Cable racks are to be manufactured from 38-mm x 14-mm x 5-mm hot-rolled steel channel, T-slots spaced at 38-mm and provided with cable supports.
 - .19 Manhole covers will have permanent markings as per Part 3, Section 6.
 - .20 Manhole lids will be secured with a cam lock mechanism.
 - .21 Each manhole lid will be openable using standard lifting equipment.
 - .22 Furnish and install manhole signage as per labeling requirements in Section 3.8 Labeling and Marking.
3. Concrete Extension Rings
- .1 Steel reinforced concrete extension rings will be provided as required.
 - .2 The measured differences between major and minor axis will not exceed 1% for any cross section, based on the inside diameter.
 - .3 The major axis is defined as the maximum inside diameter.
 - .4 The minor axis is defined as the minimum inside diameter.
4. Warning Tape
- .1 A 152mm wide yellow warning marker tape will be placed in the trench on centerline of each duct bank approximately 300mm below final grade.

PART 3. EXECUTION

1. General

- .1 Any conflicts in the requirements of these specifications will be communicated to the Authority.
- .2 Prior to the start of construction, Project Co will locate and expose all existing utilities at all tie-in and crossing points, at all points where a conflict may arise during the construction of the proposed works, and to confirm design elevations. Project Co will assume all costs and expenses that may occur for damages, support of and repair to such plant.
- .3 When excavating near existing underground utilities, excavation will be by hydrovac. Project Co will allow to scan and/or conduct test hole investigation as required to determine presence and location of existing underground utilities to avoid damage.
- .4 Project Co will:
 - .1 Provide all services, labor, materials, tools, and equipment required for the complete and proper installation of the Campus Perimeter Pathway System.
 - .2 Have complete control of the work and will effectively direct and supervise the work so as to ensure conformance with the contract documents, subject to the Authority's rights as specifically set out in the contract documents to give directions regarding work.
 - .3 Be solely responsible for construction means, methods, techniques, sequences and procedures and for coordinating the various parts of the work under the contract.

- .4 Comply with all requirements of the AHJ as to the manner in which the work is done.
 - .5 Be responsible for security deposits, permit fees and any other payments required to allow for construction to commence.
 - .6 Maintain the work in a tidy condition and free from the accumulation of waste, debris, and waste products, other than that caused by the Authority or its employees.
 - .7 Be familiar with B.C. Gas Safety Regulations, Provincial Blasting Regulations and all AHJ specifications.
 - .8 Be solely responsible for construction safety at the place of work as and to the extent required by applicable construction safety legislation, regulations and codes, including the Workers' Compensation Act and applicable regulations, and by good construction practice.
 - .9 Take all necessary means to prevent damage to property or injury to persons.
 - .10 Be responsible in providing traffic control, signage, delineators, barricades, and other miscellaneous warning devices as required to maintain vehicle and pedestrian flow and for emergency vehicle access. A traffic management plan will be provided as required.
 - .11 Be solely responsible for providing the necessary field surveys by a qualified surveyor to permit the layout and construction of the work. No additional payment will be made for this field survey, which is deemed to be included in contract.
 - .12 Engage a geotechnical consultant for recommendations regarding the subsurface conditions, site preparation, and the proposed road structure prior to the start of construction.
 - .13 Be held responsible for the repair of any damage caused to existing street or services by construction equipment and/or trucks hauling material to the site. This may include daily cleaning or sweeping existing roads of dirt and debris caused by construction activities.
 - .14 Use extreme caution when working near existing services and any services disturbed are to be replaced to the satisfaction of the City of Burnaby, the Authority or other approving agencies.
 - .15 Obtain written permission prior to the start of construction from adjacent property owners for a temporary encroachment on private property and a registered document for a permanent encroachment if required.
- .5 When vehicles and/or machines (rubber tired backhoes, track backhoes, trucks etc.) are used in the construction of underground conduit systems and have a hydraulic oil capacity of ninety-one liters or more, an environmental spill kit will be required for each of these.
 - .6 All survey monuments, benchmarks, and legal pins will be protected and any damage caused by Project Co will be repaired at Project Co's expense.
 - .7 All existing improvements will be restored to the satisfaction of the City of Burnaby and the Authority. In special cases, the City of Burnaby may require written acceptance by the affected property owners for restoration works performed by Project Co.
 - .8 All pavement markings, line painting, directional lines/arrows etc. will be restored to original condition or better to the satisfaction of the City of Burnaby standards and the Authority.

- .9 In locations where underground construction is in landscaped areas, it is the responsibility of Project Co to minimize damage and will restore all damaged pavement, curbs, gutters, boulevards and landscaped areas to the satisfaction of the property owner, the City of Burnaby and the Authority.
- .10 Junction boxes, valve covers, manhole frames & covers within the paved roadway to be left low at base level at the time of base lift asphalt and raised just prior to the final lift of paving.
- .11 Notification and Coordination:
 - .1 Provide notification and coordination as stipulated in the Agreement and as required by the AHJ.
 - .2 Project Co is to notify the Authority at the following stages of the construction schedule for the purpose of review by the Authority:
 - .1 Delivery of materials to site.
 - .2 Prior to concrete encasement of ducts
 - .3 Prior to backfilling
 - .4 Grading of road surfaces prior to paving.
 - .3 The notifications for the Authority's review will be made sufficiently ahead of time to allow planning of logistics for review and independent photo documentation by the Authority, as well as rectification of any deficiencies found. Specifically, notification will be given:
 - .1 24 hours prior to inspection for work being conducted inside normal working hours
 - .2 48 hours prior to inspection for work being conducted outside of normal working hours
 - .4 Worksafe B.C. is to be notified prior to the start of CPPS construction.

2. Excavation, Backfill and Trench Restoration

.1 Excavation

- .1 Excavation is to be coordinated with the Authority, the AHJ, other trades, and disciplines and with other Landscaping, Civil, Architectural, Mechanical, Plumbing and Electrical drawings, requirements and specifications associated with the Burnaby Hospital Redevelopment Project.
- .2 Depth of excavation will be such that the required minimum one (1) meter and maximum two (2) meters bury depth (top of concrete encasement) is met. Report to the Authority any locations where the depth of planned burial to top of duct bank will exceed two (2) meters. Any deviations between the min. and max. burial depth will be reported to the Authority prior to any excavation or installation taking place. The Authority will approve or reject any request for deviation from required depths in writing.
- .3 Project Co will:
 - .1 Saw cut the existing pavement.
 - .1 All asphalt cuts will be straight with vertical clean edges so that the asphalt surface may break evenly and cleanly. The edge of pavement will be saw cut and keyed to form a minimum 0.20-meter-wide x 40mm deep lap joint.
 - .2 Sidewalks, curbs and gutters will be cut square and to regular panel lines. Pavement will be cut with a concrete saw.
 - .2 Excavate and remove all loose and organic material from the roadway.
 - .3 Make all machine, hydrovac, and hand excavations necessary for placing ducts, manholes, service boxes and other above surface supporting structures as may be required.
 - .4 Keep all excavations to a minimum size and protect the pavement and other structures adjacent to the work location by appropriate means.

- .5 Without extra charge, construct temporary drains or dewatering or well pointing as necessary to keep water away from the work operations.
- .6 Maintain access to driveways opened by excavation by means of adequate and safe bridging.
- .7 Without extra charge, provide and place shoring, as required by the Worksafe B.C. and as required to protect adjacent paving and structures and to prevent any sloughing in of material that is under adjacent sections of sidewalk or pavement.
- .8 Protect existing underground utility trenches adjacent to the proposed underground utility installation from sloughing in order to prevent over-width excavation.
- .9 Prove the trench grade far enough along the route so that any relocation or redesign necessitated by unforeseen obstacles may be carried out.
- .10 Open entire length of trench and establish proper grades before beginning installation of any portion of connecting duct runs.

.2 Adjacent Structures

- .1 Prior to excavation, Project Co will consult with owners of buildings, retaining walls, poles, lamp standards or any other structures, including gardens, shrubs and trees, which may be endangered.
- .2 Project Co will provide or arrange at its own expense, adequate support or take other precautions as is necessary to protect the structure, garden or shrubs to the satisfaction of the owner.
- .3 To avoid future dispute and or litigation, Project Co will establish with the owner the condition of the structure, garden or shrub prior to excavation.
- .4 Under no circumstances will Project Co permit its forces, materials and or equipment to encroach on private properties adjacent to the work, without express permission of the property owners.

.3 Protection of Foreign Underground Utilities

- .1 Project Co will contact each agency and arrange for the support of wood, steel or concrete poles necessary to continue the excavation work. The cost of such work will be included in the contract price and in no way will the Authority be held liable for costs incurred by reason of delays caused by said agency.
- .2 Protection of foreign utilities is the responsibility of Project Co and any damage caused to structures of any kind will be paid for by Project Co
- .3 Project Co will build around, under over pipes, culverts, sewers, catch basins, or other support structures encountered in the line of the work, and will supply such materials and make such alterations, substitutions and repairs as may be required for such work.
- .4 If Project Co desires to temporarily remove, disconnect or relocate service pipes crossing the excavation, it will make its own arrangements with the owners of the service pipes and will bear all costs for such temporary work.

.4 Blasting

- .1 In all cases of blasting, Project Co will take such measures that are necessary to prevent damage to property or injury to persons.
- .2 Project Co will observe all Federal, Provincial, City and Municipal regulations relative to the use, storage, transportation and hauling

- .3 If the AHJ or the Authority will not permit rock to be blasted, or if blasting would create a hazard to property or persons, Project Co will employ other approved means to remove the rock at no additional cost to the Authority.

.5 Test Holes

- .1 The depth of the buried utilities, determined by test holes, will determine the final grade of the bottom of the trench.
- .2 Project Co will dig all test holes by way of hydrovac before commencing construction.
- .3 Upon exposure by test hole, should any public utility pipes or other structures be at an elevation or offset that requires a revision to the proposed construction, the expense of any change will be borne by Project Co.
- .4 Project Co will have no charge against Authority by reason of delay, nor will Authority be held responsible for any delay in completion of the work due solely to the above clause.
- .5 Any duct or manhole installation constructed by Project Co which has to be relocated or redesigned because of a known obstacle which had not been exposed by a test hole prior to construction, will be relocated or demolished and removed from the site by Project Co at its own expense.

.6 Backfill

- .1 No backfilling of manholes, encasement of duct banks or backfilling of trenches will occur until the Authority has completed its inspection.
- .2 In all locations, a 150mm layer of sand will be placed in the bottom of the trench sloped in such a way that allows for all duct spacer assemblies to rest on the base and not float suspended between the adjoining spacer units. All duct slopes will provide required drainage as identified in the project documents.
- .3 Sand will be added and hand tamped for compaction to give a minimum 150mm cover over the conduit, backfilled to grade and compacted in accordance with and to the satisfaction of the Authority's specifications.
- .4 Imported granular backfill will be used for all trenches. No waste or contaminated material or soil will be used
- .5 Subgrade, granular subbase, and granular base materials will be compacted to at least 95% of their modified proctor dry density unless noted otherwise. Compaction testing results will be provided to the Authority as indicated in the submissions section.
- .6 The crushed granular base course will be tested in an approved manner prior to the placement of the proposed concrete curb and gutter and road pavement.
- .7 Only hand tamping will be permitted between the trench bed and 150mm above the duct bank in maximum lifts of 150mm; the remainder of the trench will be backfilled in lifts not to exceed 450mm unless otherwise approved by the Authority.
- .8 Power tamping will not be permitted unless there is a minimum of 600mm of cover over the duct bank and or structure.
- .9 No waste or contaminated material or soil will be permitted for use as backfill.

.7 Site Maintenance Prior to Permanent Repaving

- .1 Project Co will, at its own expense, maintain all backfilled excavations, including temporary patching in road or sidewalk areas until all settlement has ceased or permanent repaving/reconstruction has been completed.
- .2 Maintenance is defined as the placing and compaction of whatever additional fill and/or temporary patch that may be required from time to time.
- .3 Project Co will be fully responsible for any damage or accident to persons and/or property resulting from the condition of the backfilled excavation, until permanent restoration of pavement and/or sidewalk has been completed or until the Authority, in writing, relieves Project Co of the responsibility.
- .4 When in the opinion of the Authority any portion of the worksite constitutes a hazard to patients, staff, visitors or the general public, Project Co will immediately take whatever action is required to rectify the situation.

.8 Road Restoration

- .1 Project Co will restore to the satisfaction of the Authority and the AHJ the existing road pavement, sidewalks and driveways across all trench excavations to original condition or better.
- .2 Open trench operations in existing pavement will be vertical and replaced with hot mix asphaltic concrete after backfill and compaction within 48 hours of trench work. No trenches in existing roadway will be left uncovered overnight without approval of the AHJ and the Authority and fulfillment of any conditions of that approval.
- .3 No pavement repairs, other than temporary repairs, will be done when the temperature is below zero degrees Celsius or the sub-grade is frozen.
- .4 The road base will extend a minimum of 0.3 meters beyond the sidewalk and/or curb and gutter, whichever is greater and filled to the level of the sidewalk or curb for support.
- .5 Tie-in to existing pavement will be made by cutting back the existing pavement to sound material as per section 2.1.3.
- .6 The restored pavement structure will meet or exceed the following minimum standard:

Minimum 100mm thick – asphalt concrete
 Minimum 100mm thick – 19mm minus crushed granular base course
 Minimum 200mm thick – 75mm minus select granular subbase course
 Approved fill material on approved subgrade

- .7 All valve boxes, manholes, junction boxes, etc. within the road right of way will be adjusted to finished grade unless noted otherwise.
- .8 Catch basin rim elevations will be set 30mm below the finished gutter line grades. The gutter and road surface area to be shaped to form a dish around the inlet.
- .9 Driveway crossings will be installed as per the MMCD standard C7 unless noted otherwise.

.10 Changes in grade will be formed with smooth curves.

3. Duct Installation

.1 General Duct Bank Requirements

.1 In all instances, the minimum separation from other utilities that will be maintained are as follows:

- .1 CSA C22.3 No.7-94 underground systems, requires that the separation from a duct bank and other underground structures running parallel, be a minimum of 300mm. Crossing at 90 degrees cannot be less than 150mm, and when dealing with gas pipelines, the minimum crossing separation is also 300mm.
- .2 Maintain minimum 50 mm (2") separation from power ducts encased in concrete or 300 mm (12") in well tamped earth.
- .3 Maintain all other minimum required separations as required by the AHJ.

.2 The number, size, location and arrangement of conduits within the duct bank will be as indicated on the CPPS drawings contained herein.

.3 The duct bank configurations will be bundled together in ordered rows and columns, separated by spacers, and encased in re-enforced concrete.

.4 No section of duct will have more than 180° of bends without a manhole installed for an access point.

.5 No duct runs between manholes will extend more than 183 meters without a manhole installed as an access point.

.6 No hard 90° bends or elbow bends are permitted. All bends will be minimum 10 times the internal diameter of the conduit or sweeps.

.7 Duct spacers will be placed between the ducts at 1.5m intervals. The saddles will maintain a horizontal and vertical separation of 25 mm between the ducts then polypropylene strapping will then be placed over the point of the duct saddle support. The belled ends will be staggered and each duct will be in contact with adjacent ducts.

.8 Ducts will enter and exit manholes in a straight-line method for a minimum distance of 1 meter before the introduction of a manufactured bend or being formed into the trench configuration.

.9 The ducts will enter the manhole ends only. The sides of the manholes will not be cored and will remain free of conduit entrances to allow for cable support and splicing operations.

.10 Where factory set duct knockouts are utilized with conduits terminated inside, the duct terminations will be designed such that grouting is not required. Where building walls have been core-drilled to allow conduits to enter, conduit will come with bell end and be grouted in place flush with the wall.

.11 The ends of each duct are to be temporarily capped with manufactured plastic duct caps while being handled or stored on site and while being maneuvered into place within the trench. Uncap only when connecting to other ducts.

.2 Marking

.1 Install warning marker tape in trench on centerline of each duct bank.

- .2 Where possible, the stub out locations of all duct ends will be marked with a 50mm x 100mm x 1.5m post, painted orange and placed vertically against the capped conduit. In all cases, the ends of the stubbed out ducts will be GPS'ed and recorded according to the submission and as-built drawing requirements.
- .3 Place a traceable mule tape in all ducts, including Service Entrance Facility ducts, ducts between manholes and interior conduit runs between Service Entrance Facilities and MERs. Leave a minimum of 3 meters at each end of conduit run, tied off to the cable support bar.
- .4 Place a traceable mule tape in all ducts stubbed out for future connection. Leave a minimum of 3 meters at each end of conduit run. At conduit stub end, knot mule tape end, push excess into conduit, and place mule tape under cap with knot outside duct. At manhole end, tie off mule tape to cable support bar.

.3 Cleaning and Joining

- .1 All dirt, mud, sand, chips, etc. will be removed on the ends of the ducts prior to being joined.
- .2 It is mandatory that a primer be used on all PVC duct prior to placing the PVC cement.
- .3 Cleaning solvent and PVC joining cement will be placed on the bell end, spigot, and all other fittings as per manufacturer's instructions, pushed together and the duct twisted a quarter turn to ensure that the cement has even distribution around the joint and that all air pockets are removed.
- .4 The duct terminator diaphragm will only be removed if duct is to be placed in the terminator.
- .5 The duct terminator diaphragm will be removed and the rough edges of the terminator made smooth before cementing the duct in place.
- .6 Project Co will ensure all ducts are water tight.

.4 Mandrelling

- .1 After each duct bank between individual manholes or manhole and Service Entrance Facility has been assembled and adhesive has thoroughly set, but before concrete has been poured, Project Co. will test conduit with a mandrel. The diameter of the mandrel will be at least 6.35mm smaller than the inside diameter of the conduit. Any damage or obstructions found will be addressed by Project Co. prior to concrete pour.
- .2 As soon as every duct section with associated manhole and Service Entrance Facility duct is completed and the concrete is poured and thoroughly set, a test mandrel of the same size as previously specified will be drawn through each conduit in the presence of the Authority's Inspector.
- .3 Project Co will correct any discrepancies in the duct configuration between manholes, stub-out locations, and/or Service Entrance Facilities at its own expense.
- .4 Ducts will be clean and free from any water, obstructions or debris prior to mandrelling. All water, obstructions and debris inside ducts will be removed using the following procedure:
 - a. Send rubber cone projectile through duct with a string to prove the integrity of the duct (Opti-com Inc. rubber cone projectile or approved equal).

- b. Clean duct by pulling a wire brush mandrel through with a heavy pull rope connected to both ends of the mandrel.

.5 Concrete Encasement

- .1 All ducts will be re-enforced concrete encased.
- .2 For concrete encased duct banks the grade will be established by placing 75mm of sand. Under wet conditions, 20mm clear drain gravel will be used instead of sand.
- .3 All concrete encased duct banks will be properly formed to facilitate a minimum 50mm on the outer edge of the duct bank profile. Earth cuts will not be used as forms for vertical surfaces unless prior written approval is granted. Forms will be substantial and braced as required to prevent bowing or buckling and sufficiently tight to prevent leakage of concrete. All forms will be removed prior to backfilling.
- .4 All concrete encased duct banks will be reinforced with minimum 10M rebar. Longitudinal rebar will be tied to the spacers so as to provide as much space between the duct and the rebar as possible. Transverse rebar will be tied to the longitudinal steel on centers. Project Co. will provide to the Authority for Review, a signed and sealed design from their civil engineering drawings detailing the reinforcement of each duct section.
- .5 Concrete encased conduit which will be extended in the future will have each row staggered and will extend a minimum of 300mm beyond the end of the concrete and the open end of the conduit will be capped and cemented with an approved plastic cap. The end of the concrete duct bank will also have epoxy coted rebar protruding minimum 300mm from the concrete for future concrete extension. The duct bank will be backfilled with sand from the end of the concrete pour to the end of the furthest duct or rebar stub.
- .6 Concrete placement in the trench or forms will be undertaken such that the chute is less than 60cm from the top of the duct bank and where a plank is used to direct concrete down sides of the ductbank. Spade concrete carefully to prevent voids and do not allow heavy masses of concrete to fall directly on the ducts. Where this requirement cannot be met, Project Co will provide a pump truck or long chute. Concrete dumping from height will be assumed to have caused movement of spacers or ducts and will not be accepted. This will result in removal and replacement of duct sections at Project Co's expense.

4. Service Entrance Facilities

- .1 Project Co will undertake the Design and Construction of multiple separate Service Entrance Facilities as indicated on the CPPS drawings contained herein. This includes
 - .1 Three diverse and separate Service Entrance Facilities into the Nursing Tower from separate manholes.
 - .2 Two diverse and separate Service Entrance Facilities into the Phase 1A building from separate manholes.
 - .3 Two diverse and separate Service Entrance Facilities into the Phase 1B/Support Facilities Building (SFB) from separate manholes noting that from the perspective of the CPPS design Phase 1B and the Support Facilities Building are considered a single building.
 - .4 A single (non-diverse) Service Entrance Facility into the Energy Centre.
- .2 Where diverse Service Entrance Facilities are specified, the entrance points into a building will be distant from each other and enter from two different streets or opposite sides of the building and connect to two different manholes. Minimum distance between Service

Entrance Facility pathways into a building will be 20m and this minimum separation shall be maintained at all points along the route between the manholes and the Communications Rooms where the diverse Service Entrance Facilities terminate.

- .3 Each Service Entrance Facility will consist of three (3) Type DB2 PVC orange 103mm ducts unless otherwise indicated on the CPPS drawings contained herein.
 - .4 Each Service Entrance Facility will:
 - .1 Not have more than two 90-degree sweeping bends.
 - .2 Be concrete encased. Coordinate the duct bank with the structural design of the building to support the duct bank at the wall without reducing structural or the watertight integrity of the building wall.
 - .3 Be properly drained in accordance with building and electrical codes.
 - .4 Be reamed and bushed and have a smooth bell-shaped finish.
 - .5 Be equipped with watertight expandable duct plugs that seal the duct against water, gas, litter and vermin. Watertight expandable duct plugs shall be installed at both ends of every Service Entrance Facility duct.
 - .6 The maximum pulling lengths will not exceed 100m on any Service Entrance Facility duct or 60m if there are 2 - 90-degree bends.
 - .5 Where the underground Service Entrance Facility ducts banks enter a building, Project Co will supply and install a 1219 mm x 1219 mm x 610 mm pull box that is lockable and equipped with hinged lids.
 - .6 If these initial pull boxes or any other pull boxes that are part of the interior portion of each Service Entrance Facility are located in publicly accessible areas, Project Co will supply and install additional electronic security measures that will alert security in the event of unauthorized access to these boxes.
 - .7 For the interior portion of each Service Entrance Facility, Project Co will supply and install four (4) 103 mm EMT conduits from initial pull box located at the point entry into the Facility to the designated Communications Rooms identified on the CPPS drawings contained herein..
 - .8 If the EMT conduits associated with each Service Entrance Facility rise vertically for 30 m or more, Project Co will supply and install cable supports in each pull box just prior to and along the vertical portion of the route as well as at the top of the riser for each individual cable to be installed. The cable support system to be used is the NVENT Caddy Strut Mount Vertical Cable Support Kit that is appropriate for the cable sizes being installed.
 - .9 Mule tape must be run continuous through the Service Entrance Facilities from the manhole to the Communications Room.
5. Pre-Cast Manholes
- .1 General
 - .1 The number and approximate location of precast manholes are identified on the CPPS drawings contained herein.
 - .2 CPPS manholes will be for CPPS communication services only and will not be shared with electrical or any other services.

- .3 Project Co will not place a manhole until the sections of the route to all adjacent manholes have been proven feasible. Any manholes placed such that the route to adjacent manholes is not feasible will be relocated at Project Co's expense.
 - .4 The base preparation will have a minimum of 150mm of 20mm crushed aggregate with screeds set level to within 10mm and compacted to 95% modified proctor density and struck off to grade.
 - .5 Under wet conditions the manhole will be placed on a minimum of 150mm thick bed of 20mm clear drain gravel set level to within 10mm and compacted to 95% modified proctor density and struck off to grade.
 - .6 There will be a collar of precast concrete rings complete with a sand and cement render inside and out, extending from the manhole roof to the underside of the cast iron ring to provide a water tight neck.
 - .7 Interior manhole equipment will be installed neatly and aligned to facilitate future work and enhance worker's safety. This will include but not be limited to:
 - .1 Alignment of cable racks
 - .2 Permanently mounted ladder
 - .8 The inside of the manhole will be free of all debris accumulated during the construction process and swept clean.
- .2 Location and access
- .1 When determining manhole locations, Project Co will consider ground topography, soil conditions, location of manholes relative to surrounding structures, personnel access, pedestrian risk and the difficulty in using the manhole for placing and splicing cable.
 - .1 Manholes will be placed in locations that allow for safe access and that are at least 1.5 m clear of any structure or impediment that will compromise working space around the manhole. This includes buildings, retaining walls, monuments, landscaping structures, and shrubs, bushes, trees or other woody vegetation.
 - .2 Manholes will not be placed in the travelled portion of roadways, in lanes, in driveways, or in the street in front of or immediately adjacent to a driveway.
 - .3 If in the non-travelled portion of the roadway, manholes will not be placed within 15.2 m (50 ft.) of the curb radius or right of way line of the intersecting road.
 - .4 Where existing pathway widths allow, Manhole locations in pedestrian pathways will be sited to allow 1.5 m clear and level area around manhole in addition to travel space for pedestrians to avoid conflict with assisted mobility devices such as wheelchairs, scooters or similar during servicing.
 - .2 Project Co will ensure that that a splicing vehicle can be parked safely beside each manhole without impacting access to or the operation of any of the functional areas associated with the BH Campus or impeding the flow of vehicular traffic. Minimum splicing vehicle size assumption 5.5 meters x 2.5 meters. Install laybys where required to meet this access requirement.
 - .3 To accommodate the sustainable removal, servicing, and replacement of the manhole lid, the surface for 1.5 m radius around manhole lid will be level and solid and be covered in concrete, pavement or flag stones with minimal gaps such that a uniform hard surface is formed to prevent damage to the surface or dirt ingress to the manhole from movement of the manhole lid.

- .4 Where existing pathway widths allow, the top of the manhole casting will be set by Project Co to conform to the finished grade of the concrete, pavement or flag stones surrounding the manhole opening.
- .5 Precast manholes being set where the terrain slopes will have the sump end of the manhole located toward the lower direction of the slope while being set level in the excavation.
- .6 Manhole sections will be placed in order to avoid damage to the concrete edges of the bottom section by using the four 112mm pulling eyes as lifting points.
- .7 Manhole sections will be placed so that the male and female joints are properly engaged and sealed with a grout and a butyl rubber seal rated for underground use with precast concrete products. A water-proof seal will be provided for each manhole.

.3 Drainage

- .1 Project Co. will provide drainage for each manhole. The drainage will be coordinated in advance of manhole installation to ensure that all required preparatory work has been conducted before the manhole is installed.
- .2 Drainage from manholes will be achieved by constructing an expanded sump beneath the manhole sump area. The expanded sump will be composed of a concrete pipe or box dimensioned to fit the p-trap and backwater valve. The base of the expanded sump will be grouted and the assembly will rest on the compacted backfill. The expanded sump will house the backwater valve and p-trap and will drain using minimum 78mm PVC drain pipe SDR 30 or better. All joints will be caulked and/or cemented or use an "O" ring seal. Allow to modify the bottom of the manhole to align with the expanded sump and provide grouting to join the expanded sump to the manhole bottom. Provide a removable grate on top of the expanded sump to provide solid footing and capture large debris from traveling from the interior of the manhole into the expanded sump.
- .3 Connection of manholes and duct drains to drainage system will be made in order of descending preference. Any alternate solutions will be submitted for review by the Authority through Appendix 2C [User Consultation and Review Procedure]:
 - .1 Storm drains
 - .2 Building perimeter drain
- .4 The location and elevation of drainage connections will be proven, by means of a test hole, before placing a precast manhole.
- .5 Drains for each duct will be provided at every point where duct banks enter a building.

6. Labeling and Marking

.1 Manholes

- .1 Each manhole lid to be furnished with factory cast-in logo and pattern that is unique from other existing or new lids that will be used on the Burnaby Hospital site. The manhole label format will include "FHA", the Site ID and "COMMS". The specific manhole ID is to be arc welded onto the lid. Prior to production, provide shop drawings of the lid for review by the Authority through Appendix 2C [User Consultation and Review Procedure].
- .2 Signage will be provided and mounted in the wall of each manhole above the associated duct. Signage will include:

- .1 Manhole ID in bold
 - .2 Duct ID and destination manhole or Service Entrance Facility identifier
 - .3 Measured distance to the destination manhole, terminus of a duct or Service Entrance Facility Identifier
- .3 Prior to production, a proof of each manhole sign along with a detail showing the location and elevation of where the signage will be installed will be submitted to the Authority for Review. Allow to provide sample sign if requested by the Authority.
- .4 Signage will be reverse engraved plastic of minimum 0.06" thickness or color tuff aluminum of min 0.04" thickness engraved metal with a yellow background and black letters attached to the wall above the duct bank knockouts.
- .5 Means of attachment for signage will be permanent. Project Co. to submit method of attachment and product information as part of the shop drawing submission for review by the Authority through Appendix 2C [User Consultation and Review Procedure].