

City of Bloomington Fiber/Conduit Standards

Division 27 Specifications for Underground Ducts and Raceways for Communications Systems - BDU

Part 1 - Overview

1.1 SUMMARY

- A. Products and installation of all necessary parts, pieces and accessories of an underground duct and raceway system for communications cabling including manholes and hand-holes that compromise the Bloomington Digital Underground (BDU).
- B. All pathways shall be underground or directly buried. Ariel pathways will be prohibited without prior consent granted by ITS.
- C. Four (4) 4-inch ducts shall be installed in all primary, core, or trunk duct banks. Two (2) 4-inch, 3-cell textile innerducts shall be installed in two (2) of the four (4) ducts. One (1) of the four (4) textile innerducts shall be detectable. Each of the textile innerducts shall have a different color identifier.
- D. At minimum, two (2) 4-inch ducts shall be installed in all secondary, lateral, or branch duct banks, including those duct banks which feed buildings. Two (2) 4-inch, 3-cell (manufacturer?) textile innerducts shall be installed in one (1) of the two (2) ducts. One (1) of the two(2) textile innerducts shall be detectable with 12 AWG locate wire. Each of the textile innerducts shall have a different color identifier.
- E. Any exception, deviations or alternative build-outs shall be implicitly denied without prior consultation & approval from ITS.

1.2 SUBMITTALS

- A. The following submittals are required prior to construction:
 - 1. Product Information: For the following:
 - a. Maintenance Hole and Hardware.
 - b. Duct-bank materials, including spacers and miscellaneous components.
 - c. Warning tape.
 - d. Grounding and bonding.
 - e. Cost of all related material
 - 2. Provide manufacturer's product information cut sheet or specifications sheet with the specific product number identified.
- B. The following submittals are due prior to final payment or release of escrow.
 - 1. Record Drawings

- a. Provide scaled drawings indicating routing of pathway and cable as well as locations of telecommunications spaces such as maintenance holes or hand-holes in a digital format agreed upon by ITS. Design drawings, shop drawings, & other physical documents modified in the field will not be accepted.
2. Manufacturer and Maintenance Manuals for all installed equipment.
 - a. Provide manufacturer's product information cut sheet or specifications sheet with the specific product number identified or filled out.
 - b. List of bill of materials, including all parts, pieces, connectors, & labor required for installation of the underground duct and raceway including manholes and handholes.
3. Inform & deliver to CoB any special tools produced by the manufacturer required to install, uninstall, or maintain any component of the system.

1.3 QUALITY ASSURANCE

- A. Devices and Accessories (including conduits for communications): Listed and labeled as defined in [NFPA 70, Article 100](#), by a testing agency acceptable to authorities having jurisdiction and marked for intended use.
- B. Comply with [ANSI C2](#).
- C. Comply with NFPA 70.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Deliver conduits to Project site with ends capped. Store non metallic conduits with supports to prevent bending, warping, and deforming.
- B. Store precast concrete units at Project site as recommended by manufacturer to prevent physical damage. Arrange so identification markings are visible.
- C. Lift and support precast concrete units only at designated lifting or supporting points.

1.5 COORDINATION

- A. The contractor shall coordinate with ITS the location and installation of all conduits and manholes. All field adjustments of the proposed outside plant due to conflicts with grading and existing utilities shall be approved by ITS.

PART 2 – Products

2.1 GENERAL

- A. All Ducts/Raceway:

1. The number, size, raceway duct material and arrangement shall be as indicated on Drawings and or as specified herein.
2. Shall be non-metallic Schedule 40 PVC (heavy wall), galvanized rigid conduit (GRC) or Smoothwall HDPE as indicated on Drawings and/or as specified herein.
3. Installed conduits shall be capped with manufactured caps (duct plugs) until needed.
4. Shall be 4-inch nominal trade size, unless otherwise noted and approved in writing by CoB ITS Representatives.
5. Shall be checked by pulling a round wood or steel test mandrel, sized for each duct from both directions to remove obstructions. The mandrel shall be pulled through with consistent force. If additional force is required for a section the location shall be documented and checked with a second pass of the mandrel. If additional force is required on the second pass in the same location the conduit shall be excavated and repaired.
6. Shall be cleaned by passing a wire brush mandrel and/or rubber duct swab (or approved alternative) of appropriate size back and forth until all foreign materials and water are removed.
7. Shall be encased by a concrete envelope in road crossings or heavy traffic areas only, minimum 3" cover on all sides or flowable backfill as specified on the drawings.
8. Shall be installed using long radius sweeps to minimize pulling tensions, unless otherwise noted on Drawings or in specifications. No more than 45 degrees of total bends in any one section of conduit.
9. Shall be installed with a minimum of 3-inches fall per 100-foot run toward manholes and away from CoB buildings/facilities.
10. Each conduit shall have a one-half inch pre-lubricated, woven, 1130lb. minimum polyester tape made from low friction, high abrasion resistant yarns placed with in the conduit and secured at each end. Tape shall be printed with sequential footage markings for accurate measurements.
11. Provide a minimum of 12" separation between all utilities, including but not limited to electric power and telecommunications ducts where possible (if deviation is required, an CoB ITS representative must be contacted & sanction said deviation).
12. A minimum of 36-inches bury depth (measured from top of duct to finished grade) is required. Exceptions may be granted with approval of CoB ITS Representatives.
13. The distance between telecommunications manholes shall be no greater than 500-feet (where possible).

2.2 CONDUIT

A. Non-Metallic Raceways

1. **Manufacturers:** Subject to compliance with requirements, provide products by the following or an approved equal.
2. **Product:** Shall be PVC Schedule 40 Conduit for application underground, encased or exposed applications in accordance with NFPA 70.
3. Requirements:

- a. Conduit shall be rated for use with 90°C conductors, UL Listed or approved equal. Material shall comply with NEMA Specification TC-2 (Conduit), TC-3 (Fittings) and UL 651 (Conduit) and 514b (Fittings).
 - b. Conduit and fittings shall carry a UL label (Conduit – on each 10 foot length; Fittings – stamped or molded on each fitting).
 - c. Conduit and fittings shall be identified for type and manufacturer and shall be traceable to location of plant and date manufactured. The marking shall be legible and permanent.
 - d. The Conduit shall be made from polyvinyl chloride compound (recognized by UL) which includes inert modifiers to improve longevity and resist heat distortion. Clean rework material, generated by the manufacturer’s own conduit production, may be used by the same manufacturer, provided the end products meet the requirements of this specification.
 - e. The conduit and fittings shall be homogeneous plastic material free from visible cracks, holes or foreign inclusions/intrusion. The conduit bore shall be smooth and free of blisters, nicks or other imperfections which could mar conductors or cables.
 - f. Conduit, fittings and cement shall be produced by the same manufacturer to assure system integrity (were applicable)
4. All underground conduits shall be at minimum, 4-inch nominal trade size, unless otherwise noted and approved in writing as per section 1.1 E.
 5. All bends shall be factory made and be ten (10) times the diameter of the conduit.
 6. Provide bushings on all conduit terminations.
 7. Splice conduits with fittings approved by the conduit manufacturer for the specified applications.
- B. High Density Polyethylene (HDPE)
1. HDPE may be used if given prior approval by CoB ITS Representatives.
 2. HDPE shall be at minimum 4-inch nominal trade size, unless otherwise noted and approved in writing by CoB ITS Representatives.
 3. HDPE shall be smooth-walled interior and exterior configuration with call construction of SDR 13.5. (Note: Directional drilling installations shall utilize SDR 11).

2.3 TEXTILE/FABRIC INNERDUCT

- A. Manufacturer shall be MaxCell Group/TVC Communications, or approved equal
- B. Standard Outdoor Textile Innerduct: 4-inch, 3-cell polyester/nylon textile innerduct, each cell containing 250-pound polyester flat woven pull tape printed with accurate sequential footage marks and color coded.
- C. Detectable Outdoor Textile Innerduct: 4-inch, 3-cell polyester/nylon textile innerduct containing 1250lb polyester flat woven pull tape, and a solid copper, polyvinyl color coated conductor (12 AWG minimum) for tracing and rated for a minimum of 6 amps and 600 volts. Conductor shall be placed in the sidewall edge fold of the textile sleeve.
- D. Size and cell count may vary depending upon duct size. 4-inch, 3-cell shall be the default standard. Any variances from this standard shall require prior written approval by CoB ITS Representatives.

2.4 TEXTILE/FABRIC INNERDUCT FITTINGS

- A. Conduit Plugs: Compression-type conduit plugs with locking nuts for sealing and securing one or more textile innerducts within a 4-inch inside diameter conduit. e.g:
 - 4-inch plug with nine holes for cables in a 3 pack (9-cell) configuration
- B. Termination Bags: Inflation-type bags for sealing and securing around one or more textile innerducts and cables within 2-inch outside diameter or larger conduit.

2.5 COMMUNICATIONS MAINTENANCE HOLES

- A. Manufacturers: Subject to compliance with requirements, shop drawings shall be provided for approval
Description:
 - 1. Precast Units: ASTM 478, with interlocking mating sections, complete with accessories, hardware, and features as indicated. Include concrete knockout panels for conduit entrance, 19" wide by 5" tall all sides, sleeve for ground rod and 5" by 5" drain hole in the base. The size shall be at minimum 6-feet wide x 8-feet long by 7-feet high (interior dimensions) with a 30-inch manhole.
 - 2. The lid (cover) for all maintenance holes shall be rated to support heavy vehicular traffic (e.g. Type B, SB). Lid shall be lettered "BDU Communications" and number as assigned by CoB ITS Representatives. All covers shall be installed flush to final grade.
 - 3. Maintenance holes shall be constructed of reinforced precast concrete, 4500 psi and designed for truck loading.
 - 4. Manholes shall be used to accommodate cable, splice closures and racking systems. Maintenance holes shall contain a French drain and be installed on a gravel base of sufficient depth to allow for drainage and stability (where applicable).
 - 5. Maintenance holes shall be used to facilitate placing and splicing of cables. New maintenance holes shall be equipped with: corrosion-resistant cable racks and permanent ladders, which are grounded; pulling irons; and a sump pit and floor drainage system to drain water. (where applicable)
 - 6. Telecommunications maintenance holes shall not be shared with electrical installations.
 - 7. Maintenance holes shall meet the following requirements of this section unless otherwise approved by section 1.1.E.
 - 8. Conduits shall enter and exit the maintenance hole in a straight line or 90-degree up-turn method. The remaining parallel shall remain free of conduit entrances to allow cable support and splicing operations.
 - 9. Pulling irons shall be provided on opposite sides of the ducts, rated at 10,000 pounds pulling tension.
 - 10. Cable racks shall be installed into the walls, arms and insulators must be provided with cable supports.
 - 11. All additional manhole hardware shall have rubberized or hot dipped galvanized finish.
 - 12. Provide manhole signage within collar/chimney: to include manhole/hand-hole designator, measured distance to the next manhole/hand-hole, access point or building, cardinal direction

- designation and direction to adjoining maintenance holes and building entrance points. Signage shall be stamped metal attached to the chimney.
13. Identify the next destination of installed conduits. i.e.; "To MH 17I"

2.6 COMMUNICATIONS HANDHOLES

- A. Manufacturers: Subject to compliance with requirements, shop drawing shall be provided for approval. Description:
1. Hand-hole enclosures shall be at minimum, Quazite Precast Polymer Concrete 30-inch wide x 48-inch long x 24-inch deep PG style (Stackable) assembly with no base, Quazite P/N PG3048BA24 and cover PG3048HA00 or as specified on drawings. Larger dimensions may be required depending upon quantity and size of incoming ducts, outgoing ducts, and for locations housing splices.
 2. Boxes and hand-holes for use in underground systems shall be designed and identified as defined in NFPA 70, for intended location and application.
 3. Boxes installed in wet areas shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 4. Comply with [TIA-569-C](#).
 5. Polymer-Concrete Hand-holes and Boxes with Polymer-Concrete Cover: Molded of sand and aggregate, bound together with polymer resin, and reinforced with steel, fiberglass, or a combination of the two.
 6. **Standard:** Comply with SCTE 77
 7. **Configuration:** Designed for flush burial with open bottom unless otherwise indicated.
 8. **Cover:** Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with the enclosure and hand-hole location. Hand-hole covers shall be heavy-duty type, suitable for occasional heavy vehicles. All covers shall be installed flush to final grade.
 9. **Cover Finish:** Non-skid finish.
 10. **Cover Legend:** Molded lettering, "BDU COMMUNICATIONS."
 11. Hand-holes 12 inches wide by 24 inches long and larger shall have inserts for cable racks and pulling-in irons installed before concrete is poured.
 12. Fiberglass Hand-holes and Boxes are prohibited.

2.7 ACCESSORIES

- A. Conduit Spacers: Rigid PVC interlocking spaces, selected to provide minimum conduit spacing and cover depths indicated while supporting conduits during concreting and backfilling; produced by the same manufacturer as the conduits.
- B. Manhole Frames and Covers: Rated for Heavy Vehicular Traffic.
1. Provide cast iron covers with the engraved word "Communications" and number as assigned by CoB ITS Representatives, as required.
 2. Manhole Frames: [ASTM A 48](#), Class 30B gray cast iron, 30-inch size with pick holes, machine-finished with flat bearing surfaces.

- C. Sump Frame and Grate: ASTM A 48
- D. Pulling Eyes in Walls: Eyebolt with reinforcing-bar fastening insert 2-inch- diameter eye and 1-1/4-inch bolt.
 - 1. Working Load Embedded in 6-inch, 4000-psi Concrete: 13,000-lbf minimum tension.
- E. Pulling and Lifting Irons in Floor: 7/8-inch diameter, hot-dip-galvanized, bent steel rod; stress relieved after forming; and fastened to reinforced rod. Exposed triangular opening.
 - 1. Ultimate Yield Strength: 40,000-lbf shear and 60,000-lbf tension.
- F. Bolting Inserts for Cable Stanchions: Flared, threaded inserts of noncorrosive, chemical-resistant, non conductive thermoplastic material; 1/2-inch ID by 2-3/4-inches deep, flared to 1-1/4-inches minimum at base.
 - 1. Tested Ultimate Pullout Strength; 12,000 lbf. minimum.
- G. Cable Stanchions: Hot-rolled, hot-dip-galvanized, T-section steel; 2-1/4-inch size; punched with 14 holes on 1-1/2-inch centers for cable-arm attachment.
- H. Cable Arms: 3/16-inch thick, hot-rolled, hot-dip-galvanized, steel sheet pressed to channel shape; 12-inches wide by 14-inches long and arranged for secure mounting in horizontal position at any location on cable stanchions.
- I. Cable-Support Insulators: High-glaze, wet-process porcelain arranged for mounting on cable arms.
- J. Grounding Materials shall comply with INDOT Standard Specifications section 807.
- K. Ladder: UL-listed, hot-rolled, hot-dip galvanized steel ladder specifically designed for manhole use. Minimum length equal to the distance from the manhole floor to grade. Each manhole shall contain its own ladder.
- L. Conduit-Sealing Compound: Non-hardening, safe for contact with human skin, not deleterious to cable insulation, and workable at temperatures as low as 35 deg. F. Capable of withstanding temperatures of 300 deg. F without slump and of adhering to clean surfaces of plastic conduits, metallic conduits, conduit coatings, concrete, masonry, lead cable sheaths, cable jackets, insulation materials, and common metals. M. Conduit Duct Plugs:
 - 1. Duct plugs shall be manufactured from high impact plastic components and shall be corrosion proof.
 - 2. Duct plugs shall contain a durable elastic compressible gasket which will make it effective as a long term seal. They shall be removable and reusable.
 - 3. They shall meet or exceed the following mechanical requirements:
 - a. Air Pressure: 7.5 psi
 - b. Water Head: 15 ft.
 - c. Pull Out: 100 Kgf.
 - 4. Duct plugs shall be equipped with a rope tie device on the back compression plate to allow the securing of a pull rope. This will allow excess rope slack to be stored within the conduit.
 - 5. Refer to 2.4 for textile Innerduct, duct plug requirements.

PART 3 – Execution

3.1 GENERAL

- A. The exact number of building entrance conduits shall be determined by the Design Engineer after considering the site and building requirements and approved in writing/email by CoB ITS Representatives. Provide typically two (2) 4-inch Schedule 40 PVC building entrance conduits from the building entrance facility to the nearest telecommunications manhole or connection point, with the exception of boring applications. One (1) of the 4-inch conduits shall contain two (2) 4-inch, 3-cell MaxCell Textile Innerducts, or approved equal, of which, one (1) of the two (2) shall be detectable. Exact building entrance conduit requirements shall be approved in writing by CoB ITS Representatives prior to installation.
- B. The exact backbone conduit requirements shall be determined by Design Engineer and approved in writing/email by CoB ITS Representatives. Outside plant backbone pathways shall typically comprise four (4) 4-inch Schedule 40 PVC conduits. Two (2) of the 4-inch conduits shall contain two (2) 4-inch, 3-cell MaxCell Textile Innerducts, or approved equal, for a total of four (4). One (1) of the four (4) shall be detectable. Exact backbone conduit requirements shall be approved in writing/email by CoB ITS Representatives prior to installation.
- C. In underground raceways, angle couplings and bends alone or in combination with straight sections shall be used for direction changes. Direction changes made by skewing straight sections of conduits will not be permitted. Direction changes made in manholes or handholes will not be permitted.
- D. Orange caution tape shall be installed 12-inches above all underground conduits.
- E. Conduits shall be Schedule 40 PVC. Use of HDPE may be allowed but shall require prior written approval from CoB ITS Representatives.
- F. Conduits shall be capped with manufactured caps (duct plugs) until needed.
- G. Conduits shall be cleaned by passing a wire brush mandrel and/or rubber duct swab of appropriate size back and forth until all foreign materials and water are removed.
- H. Conduits shall be checked by pulling a round test mandrel, 1/4-inch less than the conduit's size for each duct from both directions to remove obstructions.
- I. Conduits shall be provided with continuous 1250 pound tensile strength conduit measuring pull tape in each duct terminated to prevent pullout.
- J. Installed underground conduit or HDPE pathways shall contain an un-spliced length of green-jacketed, #12 THHN copper locate wire.
- K. No section of conduit shall have more than 45 degrees of bends without a manhole or hand-hole installed for an access point.
- L. No conduit run shall extend more than 500 feet without a manhole or hand-hole installed as an access point.
- M. Conduit connections from buildings to manholes shall be installed with a minimum of 3 inch fall per 100 feet of conduit towards the manhole and sloping away from the building
- N. Conduits shall be inspected and approved for correct formations and tied to prevent ducts from floating when concrete is poured.
- O. The minimum separation from other utilities is as follows
 - 1. Power up to one KVA:
 - a. 12 inches of well- packed earth

- b. 4 inches of masonry
 - c. 3 inches of concrete
- 2. Gas, Oil, Water, etc.:
 - a. 12 inches when parallel
 - b. 6 in. when crossing
- P. A minimum of 36-inches of bury depth (measured from top of conduit or concrete encasement to finished grade) is required.
 1. Install a 6" orange warning tape labeled fiber optics. Install tape 12 inches above the entire conduit or duct bank.
- Q. Requirements for Non-metallic Raceways
 1. Install for all raceways except where rigid conduit is required.
 2. Install only manufacturer approved system components and methods.
 3. Typical nonmetallic conduits installation consists of a minimum of PVC Type Schedule 40.
 4. Provide a minimum of 36-inches bury depth measured from the top conduit to finished grade (where applicable).
 5. Bond PVC duct with couplings using manufacturer approved adhesives.
 6. Install metallic threaded adapter when attached to rigid conduit.
 7. Protect from deformation during stockpiling. Maintain a cylindrical shape. Other configurations will not be permitted unless vetted by Section 1.1 E.
 8. Comply with the manufacturers requirements for bending and cutting.
 9. All joints shall be wrapped with 1.5" or larger Scotch #88 tape as temporary concrete seal.
 10. Provide end bells flush with the inside wall of the manhole or vault.
 11. Install a 6" orange warning tape labeled "BDU Communications". Install tape 12-inches above the entire conduit or duct bank.
 12. Cover with select compactable soil, free of stones and debris.

3.2 CONDUIT INSTALLATION

- A. **Slope:** As referenced in other parts of this document.
- B. **Curves and Bends:** Use manufactured long sweep bends with a minimum radius of 24".
- C. Use solvent-cement joints in conduits and fittings and make watertight according to manufacturer's written instructions. Stagger couplings so those of adjacent conduits do not lie in the same plane.
- D. **Conduit Entrances to Manholes:** Space end bells approximately 8-inches on center for 4-inch conduits and vary proportionately for other conduit sizes. Change from regular spacing to end-bell spacing 10-feet from the end bell without reducing conduit line slope and without forming a trap in the line. Grout end bells into manhole walls from both sides to provide watertight entrances.
- E. **Building Entrances:** Make a transition from underground PVC to rigid galvanized steel conduit 5-feet from exterior wall of the building. Use fittings manufactured for this purpose. Follow the appropriate installation instructions below:

1. **Concrete-Encased Conduit:** Install reinforcement in conduit banks passing through disturbed earth near buildings and other excavations. Coordinate duct bank with structural design to support duct bank at wall without reducing structural or watertight integrity of building wall.
 2. **Waterproofed Wall and Floor Penetrations:** Install a watertight entrance sealing device with sealing gland assembly on the inside. Anchor device into masonry construction with one or more integral flanges. Secure membrane waterproofing to the device to make it permanently watertight.
- F. **Concrete-Encased, Nonmetallic conduits:** Support conduits on spacers, spaced as recommended by manufacturer and coordinated with conduit size, conduit spacing, and outdoor temperature. Install as follows:
1. Excavate trench bottom to provide firm and uniform support for conduit. Prepare trench bottom as specified in Section 312000 "Earth Moving" for pipes less than 6-inches in nominal diameter.
 2. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrance through floor.
 - a. Couple steel conduits to duct with adapters designed for this purpose, and encase coupling with 3-inches of concrete for a minimum of 12 inches on each side of the coupling.
 - b. For stub-ups at equipment mounted on outdoor concrete bases and where conduits penetrate building foundations, extend steel conduit horizontally a minimum of 60-inches from edge of foundation or equipment base. Install insulated grounding bushings on terminations at equipment.
 3. **Underground Warning Tape:** Bury detectable warning tape labeled "FIBER OPTIC" OR "BDU TELECOMMUNICATIONS" 12-inches to 18-inches above direct buried conduits, but at minimum of 6-inches below grade. Align warning tape along the centerline of conduit.
 4. **Separator installation:** Space separators close enough to prevent sagging and deforming of conduits and secure separators to earth and to conduits to prevent floating during backfilling. Stagger spacers approximately 6-inches between tiers. Tie the entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around conduits or conduit groups.
 5. **Concreting:** Space concrete carefully during pours to prevent voids under and between conduits and at the exterior surface of the envelope. Do not allow a heavy mass of concrete to fall directly onto conduits. Use a plank to direct concrete down the sides of the bank assembly to the trench bottom. Allow concrete to flow to the center of the bank and rise up in the middle, uniformly filling all open spaces. Do not use power-driven agitating equipment unless specifically designed for duct-bank application. Pour each run of envelope between manholes or other terminations in one continuous operation. If more than one pour is necessary, terminate each pour in a vertical plan and install 3/4-inch reinforcing rod dowels extending 18-inches into concrete on both sides of the joint near corners of the envelope.
 6. **Reinforcement:** Reinforce duct banks where they cross disturbed earth and where indicated.
 7. **Forms:** use walls of trench to form side walls of duct bank where soil is self-supporting and concrete envelope can be poured without soil inclusions; otherwise use forms.

8. **Minimum Clearances between Conduits:** 3-inches between conduits and exterior envelope wall, 3-inches between conduits for like services, and 4-inches between power and signal conduits.
9. **Depth:** Install top of duct bank at least 36-inches below finished grade in non-traffic areas and at least 36-inches below finished grade in vehicular traffic areas, unless otherwise indicated. If depth cannot be met, contact the Design Engineer and CoB ITS Representative for variance before proceeding.
- G. **Non-Metallic Conduits – No Encasement:** Support conduits on spacers, spaced as recommended by manufacturer and coordinated with conduit size, conduit spacing, and outdoor temperature. Install as follows:
 1. Excavate trench bottom to provide firm and uniform support for conduit. Prepare trench bottom as specified in INDOT Standard Specifications section 807”.
 2. Install backfill as specified in INDOT Standard Specifications section 807.
 3. After installing conduit, backfill and compact. Start at the tie-in point and work toward the end of the conduit run, leaving the conduit at the end of the run free to move with expansion and contraction as temperature changes during this process. Firmly hand tamp backfill around conduit to provide maximum supporting strength. After placing controlled backfill to within 12-inches of finished grade make final conduit connect at end of run and complete backfilling with normal compaction as specified in INDOT Standard Specifications section 807
 4. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrance through floor.
 - a. Couple steel conduits to duct with adapters designed for this purpose, and encase coupling with 3” of concrete for a minimum of 12”s on each side of the coupling.
 - b. For stub-ups at equipment mounted on outdoor concrete bases and where conduits penetrate building foundations, extend steel conduit horizontally a minimum of 60” from the edge of foundation or equipment base. Install insulated grounding bushing on terminations at equipment.
 6. **Underground Warning Tape:** Bury detectable warning tape labeled “FIBER OPTIC” OR “BDU TELECOMMUNICATIONS” 12-inches to 18-inches above direct buried conduits, but a minimum of 6-inches below grade. Align warning tape along the centerline of the conduit.
 7. **Separator installation:** Space separators close enough to prevent sagging and deforming of conduits and secure separators to earth and to conduits to prevent floating during backfilling. Stagger spacers approximately 6-inches between tiers. Continue...

Tie the entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around conduits or conduit groups.
 8. **Backfilling:** Spade backfill carefully to prevent voids under and between conduits and exterior surface of envelope. Do not allow a heavy mass of backfill to fall directly onto conduits. Comply with INDOT Standard Specifications section 807.05 or as indicated on the plans.
 9. **Reinforcement:** Reinforce duct banks where they cross disturbed earth and where indicated.
 10. **Forms:** use walls of trench to form side walls of duct bank where soil is self-supporting and concrete envelope can be poured without soil inclusions; otherwise use forms.

11. **Minimum Clearances between Conduits:** 3-inches between conduits and exterior envelope wall, 3-inches between conduits for like services, and 4-inches between power and signal conduits.
 12. **Depth:** Install top of duct bank at least 36-inches below finished grade in non-traffic areas and at least 36-inches below finished grade in vehicular traffic areas, unless otherwise indicated. If depth cannot be met, contact the Design Engineer and CoB ITS Representative for variance before proceeding.
- H. **Sealing:** Provide temporary closure at terminations of conduits and innerducts that have cables pulled. Seal spare conduits and innerducts at terminations. Use sealing compound and plugs to withstand at least 15-psig hydrostatic pressure.

3.3 TEXTILE INNERDUCT INSTALLATION

- A. Provide textile innerduct in conduit and wire ways using continuous non-spliced lengths of textile innerduct between maintenance holes, pull boxes, and/or termination points as indicated on the drawings.
- B. Make a 2" incision, approximately 18" from the end of the textile innerduct. Pull out and cut off approximately 2 feet of pull-tape. Thus allowing the pull tape ends to retract back into the cells.
- C. Using approximately 6 feet of pull tape, tie a non-slip knot to the incision. Then tie 3 to 6 half-hitch knots down to the end of the textile innerduct. Apply black vinyl tape over all knots and the end of the textile innerduct. Using a BowLine knot, tie a SWIVEL to the end of 3 feet pull tape. For multi-pack installations one swivel is sufficient, but stagger each textile innerduct.
- D. Using a BowLine knot, attach the pull rope located in the rigid conduit to the other end of the swivel. Install textile innerduct – ensuring that no twist is introduced to the innerduct.
- E. Provide suitable textile innerduct slack in the maintenance holes, hand holes, pull boxes, and at turns to ensure there is no kinking or binding of the product.
- F. Textile Innerduct Mountings, Hangers and Attachments: When exposed indoors or in maintenance holes, hold firmly in place using independent support.
 1. Design & install hangers and other similar fittings adequate to support loads and so as to not damage innerduct.
 2. Do not fasten textile innerduct to steam, water, or other piping, ductwork, mechanical equipment, electrical equipment, electrical raceways, or wires
 3. When appropriate, use the following cable ties to secure textile innerduct through previously created incisions:
 - a. Plenum areas: plenum-rated plastic or stainless steel
 - b. Non plenum areas: Conventional flame-retardant nylon ties
 - c. Underground locations : Conventional plastic cable ties
- G. Maintenance Hole and Hand Hole Installation:
 1. At locations where the textile innerduct will be continuous through a manhole or hand hole, allow sufficient slack so that the innerduct may be secured to the side of the vault maintaining the minimum bend radius.

2. At maintenance holes serving as the junction location, pull the exposed end of the innerduct to the far end of the vault, install termination bag, and secure to the vault.

H. Penetrations

1. Seal all conduit and textile innerduct entering structures at the first box or outlet to prevent entrance into the structure of gasses, liquids, insects or rodents.
2. Inspect fire stopping installation by others between building structure and conduit, wire way, and cable tray to verify integrity of installation.
3. **Exposed Textile Innerduct Penetrations:** Install conduit sleeves or fire barrier sealing systems in all openings where open and exposed textile innerduct passes through fire rated walls and floors. After installation, install intumescent fire barrier penetration sealing material (Hilti system) between textile innerduct and sleeves or fire barrier system.
4. **Raceway Penetrations:** After textile innerduct installation, install intumescent fire barrier penetration sealing material (Hilti system) between textile innerduct and conduit or wire way at all exposed penetration locations.
5. Inflation bags for 4" Plug kit shall be used to seal conduits in maintenance holes or hand-holes.
6. Protect adjacent surfaces from damage during water seal or firestop installation. Repair any damage.
7. Document entire installation process for future referral.

3.4 MAINTENANCE HOLE INSTALLATION

- A. **Elevation:** Install manholes with rooftop at least 13-inches below finished grade.
- B. **Drainage:** Install drains in the bottom of all units unless indicated otherwise on the plans. Drains shall consist of coarse aggregate, no. 8 or larger, one foot deep for the entire foot print of the unit.
- C. **Access:** Install cast-iron frame and cover.
 1. Install precast collars and rings to support frame and cover and to connect cover with roof opening. Provide moisture-tight masonry joints and waterproof grouting for cast-iron frame to collar.
 2. Set frames in paved areas and traffic ways flush with finished grade. Set other frames 1" above finished grade.
- D. **Damp Proofing:** Apply damp proofing to exterior surfaces of units after concrete has cured at least three days. Apply bituminous damp proofing. After conduits have been connected and grouted, and before backfilling, damp proof joints and connections and touch up abrasions and scrapes. Damp proof exterior of manhole and hand-hole chimneys after mortar has cured at least three days.
- E. **Hardware:** Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables, conductors and as indicated.
- F. **Field-Installed Bolting Anchors:** Do not drill deeper than 3"-7"/8" for anchor bolts installed in the field. Use a minimum of two anchors for each cable stanchion.
- G. **Grounding:** Install an 8ft copper ground rod through the floor in each structure with top protruding a minimum of 4" above MH floor. Seal floor opening against water penetration with waterproof non-shrink grout. Ground exposed metal components and hardware with #36-inches bare-copper

ground conductors. Train conductors neatly around corners. Use appropriate sized copper cable clamps secured with expansion anchors to attach ground conductors.

- H. **Precast Concrete Manhole Installation:** Unless otherwise indicated, comply with [ASTM C 891](#).
1. Install units level and plumb and with orientation and depth coordinated with connecting conduits to minimize bends and deflections required for proper entrances.
 2. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1" sieve to No. 4 sieve and compacted to the same density as undisturbed earth.

3.5 UNDERGROUND HANDHOLE AND BOX INSTALLATION

- A. Install hand-holes and boxes level and plumb with orientation and depth coordinated with connecting conduits to minimize bends and deflections required for proper entrances.
- B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from ½" sieve to No. 4 sieve and compacted to the same density as adjacent undisturbed earth.
- C. Elevation: In paved areas, the cover surface will be flush with finished grade. Set covers of other enclosures 1" above finished grade.
- D. Install hand-holes with bottom below frost line.
- E. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables, but short enough to preserve adequate clearance in enclosure.
- F. Field cut openings for conduits according to enclosure manufacturer's written instructions. Cut the wall of the enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.
- G. Install a 4 ft., 5/8" Diameter, copper bonded steel ground rod, connecting conduit locate wires with NVENT ERICO CP58 or equivalent 5/8" ground rod clamps.

3.6 CONCRETE ENCASEMENT

- A. Provide as shown on drawing and in accordance with these specifications. Duct banks shall not receive less than 3 inches of concrete cover all around and 1-1/2-inches between raceways.
- B. Conduits entering or leaving maintenance holes shall be encased in concrete or flowable fill 5-feet beyond maintenance holes. The concrete or flowable fill shall be pinned to the side of the maintenance holes to keep the ducts from shearing.
- C. Provide with a fine sand cover for initial curing except where waived by a CoB ITS Representative in writing/email.
- D. Rebar reinforcement is required where duct banks will cross roadways, railways or similar heavily traffic areas.
- E. Install a 6" orange warning tape labeled fiber optics. Install tape 12" above the entire conduit or duct bank.
- F. Protect against rain, flooding, freezing, etc., during curing.

- G. Ensure no honeycombing occurs and be properly vibrated with a small vibrator. Do not vibrate between ducts.
- H. Concrete for the duct bank shall be placed in such a way that the duct bank will not be disturbed and that the sides of the trench do not crumble, using splash boards, proper placement, etc. The vertical drop of concrete from the chute shall not exceed 36-inches.
- I. Concrete shall be poured continuously from manhole to manhole. No pours shall originate between manholes.
- J. Interval between base or intermediate spacers shall not exceed 8 feet with a minimum of two supports per length of duct.
- K. Make provisions, such as nylon ties, to prevent the ducts from floating when concrete is poured.
- L. Color top layer of concrete encasement by using "ORANGE" (for telecommunications) chalk dust while still wet, or dye the concrete.

3.7 BACKFILL

- A. Per INDOT Standard Specifications section 807.

3.8 DIRECTIONAL BORING

- A. **Boring Depths:** Coil-able duct shall be directionally bored at standard burial depths of 36" of cover for ducts housing primary cables and 24"-36" of cover for ducts housing secondary cables. CoB ITS Representatives shall approve any exceptions in writing to the specified burial depths, up to a maximum 60" of cover from final grade.
- B. **Duct Joining:** Sections of coil-able duct shall be joined using fusion couplings. Where the coil-able duct is to be joined with PVC conduit, the Contractor is to fuse a 24" straight piece of matching size PVC conduit to the coil-able duct. Prior to fusing, the Contractor shall make circumferential scores around the outside of the PVC conduit at the end that is to be installed into the fusion coupling. This will allow the fusion coupling to adhere to the... dissimilar PVC conduit. A special epoxy is also available that joins the coil-able duct with standard PVC couplings. The epoxy and its application shall be approved with CoB ITS prior to installation.
- C. **Connections into Vaults and Manholes:** Bored coil-able duct shall end 4'-5' from a new vault or manhole. This coil-able duct shall then be transitioned to the same size PVC before connecting into the structure. The transition to PVC shall be made using the techniques described in duct joining.
- D. Contractor shall be responsible for marking location and depth on the surface for City of Bloomington Engineering Department use. Contractor shall contact the Engineering Department (812) 349-3913, prior to commencement of work to allow them the opportunity to be present while work is being completed. And, to survey and establish locations and depths of directionally bored utilities.

3.9 MAINTENANCE HOLE CABLE SUPPORT

- A. The cable supports described on the drawings or herein are intended to assist the Contractor in obtaining a satisfactory job and shall be altered to fit job conditions.
- B. In general, all cables in manholes shall be supported on 4 feet maximum centers for straight runs, on each side of splices, and within 2 feet of cable entering or exiting a duct or termination.
- C. Do not install supports so that cables will block or cross ducts.

3.10 EXCAVATION

- A. Coordinate excavation with other trades, disciplines, specifications and drawing before starting work.
- B. Verify all elevations and arrangements are correct and there are no conflicts with other utilities. Verify that the entryways into manholes, buildings and other structures meet CoB Standards. It will be the responsibility of the Contractor and Design Team to ensure CoB ITS requirements are met. All corrections needed to meet CoB Standards are the responsibility of the Contractor.
- C. Verify all utilities have been located. Contractor shall call 811, to request a utility locate ticket prior to beginning any excavation work, for onsite assistance in locating known underground utilities in the area of work. Complete all requirements of 811 before excavating. Report any conflicts or omitted utility locates to CoB ITS.
- D. If soil conditions are such that because of the depth or any other reasons the trench/excavation cannot conform to the size of the duct bank, provide forms and bracing as required.
- E. Contractor shall open the entire length of trench and establish proper grades before beginning installation of any portion of connecting duct runs.
- F. Coordinate and comply with the requirements of INDOT Standard Specifications section 807 and all related sections of the project specifications for Excavation, Backfill, Concrete, Asphalt Repairs and Related Work.
- G. Depth of excavation shall be such that the required bury depths (top of concrete encasement) are met. CoB prior to installation shall approve any deviation from required depths. It is the responsibility of the contractor to call for a CoB ITS inspection before closing any work.
- H. Using GPS equipment, record depths of open-trench conduit pathways at 20ft intervals; where other utilities cross over or under; at angle points and change of elevation.
- I. Contractor is responsible for obtaining all required permits and comply with Federal, State and Local ordinances.

3.11 REINFORCING

- A. Reinforcing shall be installed when the following conditions are present and as specified in the project documents and References listed with this section.
 - 1. Where noted on drawings and /or as specified herein.
 - 2. Where connected to buildings and manhole walls, anchor there using projecting re-bars.
 - 3. Where crossing trenches for other work.

4. At conduit joints.
5. If continuous pour is impractical, provide (4) #4 reinforcing bars extending 6 feet into the first and second pour.
6. Where trenches cross roadways and railways.
7. Reinforcing shall be supported from the bottom of the trench at least one inch and is not required if conduits are supported by saddles.

3.12 BACKFILL

- A. Contractor shall contact City of Bloomington Engineering Department, (812) 349-3913 prior to backfilling any underground utility lines and shall allow adequate time during normal business hours for personnel to observe depths of all lines.
- B. Shall not be installed until after concrete has reached the initial set.
- C. Cover with select fill void of stones and debris.
- D. Meet all requirements of the University Standards for excavation, backfill, compaction, and restoration.
- E. The Contractor shall restore the landscape to its original condition or as specified by the project documents.
- F. The Contractor shall restore the original surface to like or better condition, or as specified in the plans, specifications or standards.

3.13 WARRANTY & AS-BUILTS

- A. The Contractor shall provide a 5 year warranty on materials and labor for all work associated with duct banks, manholes, hand-holes, associated apparatus and all other infrastructure components associated with this section. A certificate of warranty shall be provided to CoB ITS as part of closeout prior to final invoice.
- B. The Contractor shall provide as-built drawings and documentation to CoB ITS prior to final payment for this work.
- C. As-built information shall be in electronic form; (AutoCAD) drawing and .csv file. Indicate location of all underground routes within the work area.
- D. If construction drawings are not utilized, Contractor shall provide all telecommunications location information on an accurately scaled AutoCAD formatted site plans.

