

270543 – UNDERGROUND DUCTS AND RACEWAYS FOR COMMUNICATIONS SYSTEMS

PART 1 GENERAL

1.1 RELATED SECTIONS

- A. Section 31 81 26 - Communications Underground Ducts, Manholes, and Handholes
- B. This Section includes earthwork information in the absence of Division 31 specifications. Conflicts between this section and Division 31 specifications shall be resolved by the architect/engineer / designer in consultation with Owner.

1.2 REFERENCES

- A. NFPA 70 - National Electrical Code.
- B. IEEE C2 - National Electric Safety Code.

1.3 DEFINITIONS

- A. See Section 27 00 00: Communications General.

1.4 SAFETY AND RESTRICTIONS

- A. See specific elements within this document for safety and restrictions information. Contractors shall bear all responsibility and cost to locate existing underground utilities including, but not limited to, electricity, natural gas, domestic water, steam and condensate, chilled water, sewer, storm drainage, and telecommunications. Most of these utilities are owned and maintained by the Owner. In many cases, utilities have been plastic pipe without metallic (detectable) elements. Contractors shall have all underground utilities clearly marked prior to any excavation.
- B. Maryland's Underground Facilities Protection Organization, or Miss Utility, shall locate utilities within the boundaries of the Owner. Locate contractors shall be pre-approved by the Owner.
- C. Contractors shall contact the Owner immediately if unmarked utilities are discovered. Contractors shall stop all work in the area until the utility can be identified by the Owner. Contractors may be required to recall the originally pre-approved locator to trace the utility to an identifiable point. Contractors shall contact the Owner immediately if a utility is damaged in any way. Contractors shall stop all work in the area until directed by the Owner.
- D. Areas of the campus are restricted from heavy equipment, including but not limited to backhoes, concrete trucks, utility and work trucks, and other full-size vehicles. Contractors shall contact the Owner's Personnel for specific restrictions based on the location of the work area.
- E. During construction of all pathways, the Owner's Security shall determine if closures of the Owner's-controlled roads or spaces are possible at proposed dates and times. When on the Owner's property, Contractors shall coordinate all activities with interested parties.
- F. Locating done by another trade or a general contractor in the same work area and for the same overall project does not need to be repeated by the Contractors, provided 1) the entire cabling work area was recently covered, 2) the markings are bold and undisturbed, and 3) the geographic scope of the work area can be confirmed by the locating company.
- G. Information on underground utility placement does not waive Contractors from confirming the

- presence and location of all underground utilities in the work area.
- H. There are no specific safety information or restrictions for direct-buried pathways.
 - I. Contractors shall provide all necessary equipment to safely excavate and construct conduit/duct pathways. Contractor shall comply with all federal, state, and the Owner's regulations regarding working in this environment. Appropriate personal protective equipment is required and shall be the responsibility of the Contractors.
 - J. Contractors shall provide all necessary equipment to safely excavate and construct tunnel penetrations. Contractor shall comply with all federal, state, and the Owner's regulations regarding excavation and working in this environment. Personal protective equipment is required and shall be the responsibility of the Contractors.
 - K. See Section 27 00 00: Communications General.

1.5 DESIGN REQUIREMENTS

- A. New construction or other circumstances may require the relocation of existing OSP elements. Relocating OSP elements requires improving those elements to meet current codes, standards, methods, and specifications.
- B. During the relocation of OSP elements, services provided by or through the elements shall be minimally impacted. Service outages are to be minimal and during off-hours. Extra effort may be required to accommodate the service users (e.g. using half-taps on a replacement voice backbone cable). All service outages must be pre-approved by the Owner's Personnel.
- C. The location of pathways shall be coordinated with the Owner's Personnel early in the design process. Pathways should anticipate future campus growth with respect to placement and sizing. Pathways are likely to be oversized for a given project where the pathway is in a growth area or may have a foreseeable additional use.
- D. Pathway design shall avoid older, established trees. In very rare cases, small ornamental trees that can be moved or replaced may be so treated with prior approval. Planting beds and shrubs can be disrupted as needed, provided they are fully restored to original condition.
- E. Walkways and roadways can be crossed as needed, provided there is full restoration. Empty conduits have been placed under newer brick walkways to minimize walkway disruption. Designers should consult with the Office of Facilities Management to review existing site plans to locate these conduits.
- F. Where possible, new conduits installed along the same pathway as an existing pathway shall be installed as part of the existing ductbank. This physical arrangement minimizes the campus area occupied by network ductbanks. Designers may design intercepting and accessing these existing pathway elements. Designers may expose the existing ductbank and use its vertical side to frame the space for the new conduits.
- G. Security devices (alarms, sensors, cameras, etc.) may require dedicated cabling to specific, non-standard locations. These devices will be designed as required and may run independent of other pathways and requirements for this document. The Owner's Personnel shall approve all pathway designs involving security or life-safety cabling.
- H. Underground Pathways
 - 1. Underground conduit structures are pathways used for placing network cable between access points such as MHs, HHs, HBs, and building entrances. Cable pathways should be underground, where possible. Underground pathways should be concrete-encased

conduit, where possible. Special pathways may use conduits without concrete encasement or with the installation of a concrete cap. Clearances as required by NESC.

2. The conduits and fittings shall be a 4" ID PVC SCH 40. The conduits shall have bell ends and shall be joined with the appropriate adhesive for this type of conduit providing a permanent and watertight seal.
3. The diameter of a duct shall be at least 1.15 times the diameter of the cable, or one-half trade size larger in diameter than the diameter of the largest anticipated cable (whichever provides the greater clearance).
4. Underground pathways shall be designed for as minimal depth of 30" to the top of the pathway elements, where possible. Deviations from this shall be pre-approved by the Owner's Personnel. Pathways may gradually slope up to 30" deep to enter HBs or HHs.
5. Design underground conduit elevations so that a slope exists at all points of the run to allow drainage. A drain slope toward the MH of no less than one percent grade is desirable.
6. Design for an aggregate bed of a minimum of 12 inches of compacted aggregate, under the same guidelines as MH installation, for the first 6 feet of any ductbank exiting a MH.
7. Design for conduit spacers beneath each conduit three times for every 20 linear feet of conduit with an additional support at the end. The spacers shall be evenly distributed over each 20 foot segment (e.g. one at each 20 foot joint and two evenly spaced over the middle). Each horizontal row of spacers (in cross-section) shall be designed with a 6" minimum horizontal distance from any other row of spacers so as to eliminate weak vertical shear planes.
8. Design conduit formations to facilitate orderly cable racking within the MH and ensure minimal change in the formation when entering a MH. The following recommendations allow for the design of the most efficient cable formation.
 - a. The main conduit formations should enter the end walls of the MH at a point approximately halfway between the floor and roof.
 - b. For wall racking considerations, design splayed ductbank entrances at the end walls rather than center placement.
 - c. If the total number of conduits being places is significantly less than the capacity of the terminating MH or cable entrance, conduits should enter at the lower level. The upper space should be reserved for future conduit additions.
 - d. The conduit entrance into the MH should be sized for the ultimate number of conduits to prevent the need for future wall breakouts.
9. Refer to the current BICSI CO-OSP manual for conduit bend radii. Curved sections shall be pre-manufactured. Curved segments shall have minimum of 15 ft radii. Sweeps to enter utility tunnels may be less. Any sweep below 15 ft radius shall be pre-approved by the Owner's Personnel.
10. Ductbank configuration shall vary, depending on the spaces into which the conduits end.
11. All buildings shall have a minimum of four 4-inch conduits accessing the entrance facility. Two shall include multi-cell pathway with a minimum of three factory-manufactured inner cells.

12. Compacted aggregate to be used to backfill may be crushed stone or gravel fill provided the percent composition by dry weight as determined by laboratory sieves (U.S. series) conforms to the following grading when measured in accordance with ASTM C136-01 (Test Method C136-01 Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates):
13. Lesser-grade material to be used to backfill. This backfill material may be material removed from the original excavation. All backfill materials shall be free from boulders, large rock, asphalt, concrete, bricks, wood blocks or roots, and other debris. High quality top-soil shall be used.
14. Match sod of the same origin as the surrounding area.
15. Design for all materials to prevent erosion of seeded areas.
16. The Owner shall approve materials necessary to minimize erosion and soil run-off.
17. Design for a level layer of compacted aggregate over each encased ductbank. The bed shall extend 1 foot above the surface of the ductbank. The first 6 inches of the aggregate bed shall be compacted to not less than 95% density compared to maximum laboratory tests by weight per ASTM D1557-64T method. A. The second six inches of the aggregate bed shall be compacted to not less than 85% density compared to maximum laboratory tests by weight per ASTM D1557-64T, method A.
18. Horizontal conduits shall end flush with the interior surface of the wall. Vertical conduits ending in eaves shall be designed such that they extend a minimum of 4" above the final floor. Cut the conduits square with the conduit and not necessarily level to the floor. Bushings shall be installed on conduit ends.
19. 4" compression-type duct plugs (Condux, Nonmetallic Eye Nut Plug- 08067840), or equivalent., Universal or "push-in" type plugs (e.g. Condux, Universal Plug- 08047601) are not an acceptable substitute.
20. Provide 1¼" OD nonmetallic flexible raceway (innerduct) with smooth exterior surface. Provide 1¼" OD corrugated nonmetallic flexible raceway (innerduct). All innerduct shall be orange.
21. Install warning tape to be provided by the Owner (Empire Level Mfg. Corp. 25 071 Orange FO cable MegaStretch Underground Marking Tape) or equivalent.
22. Provide #10 copper, green insulated tracer wire.
23. Specify the installation of 3/8" or greater Neptco Polyester Muletape pull strings.
24. Once built, the conduit system should remain usable for 75 to 100 years and fulfill design specifications.

I. Encasement

1. When fully encasing in concrete, 4" ID PVC type EB-35 conduits and fittings are acceptable. The conduits shall have bell ends and shall be joined with the appropriate adhesive for this type of conduit providing a permanent and watertight seal.
2. Ductbanks shall be designed to be encased in concrete. All interbuilding pathways shall be encased. The concrete shall be 3/8" aggregate with a nominal compressive strength of 3000 PSI. Concrete surrounding the conduits shall be at least 3 inches around all sides of the conduit for complete encasement.

3. Fully encase any ductbanks that penetrate a MH or building for the first 6 feet beyond the structure.
4. When transitioning from an encased ductbank to a capped ductbank, it is not necessary to frame the transition in cross-section, provided the required area is encased to a minimum of 3 inches. The concrete may slope down into the area to be capped. If framing a transition point, the frame shall be removed prior to installing aggregate around the conduits and installing the cap.
5. Shape the top of the concrete in such a way as to slope water away from the ductbank-structure seams.
6. Design for steel reinforcing bars, vertically and horizontally, to form a vertical box framing the conduits. The vertical bars shall be driven a minimum of 6 inches deep to prevent the conduits from floating during concrete pouring. The horizontal bars shall be secured to the vertical bars to prevent movement. The vertical bars shall extend 3 inches above the top conduit row. Alternately, the bars may be less than 3 inches above the top conduit row, if an inverted spacer is placed on the top row to provide a 3 inches depth gauge for pouring concrete.
7. The design may use "U"-shaped bars to straddle the conduits, if driven into the trench as specified above. The design may use a single horizontal bar or an upward pointing "U"-shaped bar in this configuration. The upward pointing "U"-shaped bar shall extend 3 inches over the top conduit or use an inverted spacer to provide a 3 inch depth gauge for pouring concrete.
8. Design for reinforcing bars, longitudinally. The bars shall be secured to each vertical reinforcing bar box. The longitudinal bars shall overlap 12 inches, unless welded together, and shall be secured to each other in a way to prevent movement.

J. Capping

1. Designers may propose a "capped" ductbank for certain pathways. These pathways may include parking lift gate cable or other low count cables to specific field devices. When capping a ductbank, install filler sand around the conduits providing at least 3 inches of sand below and to the side of all conduits. Filler sand above the top of the conduit ductbank shall not be allowed.
2. Design the filler sand to fill to the side walls of the trench. Compact filler sand to the sides of the conduits.
3. The design may allow for framing on the compacted surface of the sand for pouring the concrete cap.
4. Design for a 3 inch thick concrete cap over the conduits.
5. Extend the cap horizontally to a minimum of 3" beyond the outer most conduits.
6. If the cap is framed, the design may show lesser-grade backfill material to cover the sand beyond the cap once the framing is removed.

K. Non-encasement

1. In special circumstances, the design may plan for conduits installed without concrete. These installations may include parking lift gates, information kiosks, and other non-critical devices as determined by the Owner's Personnel.

L. Existing Ductbanks

1. The designers may use conduits and/or innerducts within existing ductbanks as directed by the Owner's Personnel. Where possible, used conduits with available innerducts or space shall be used.

M. Existing Ductbanks

1. The designers may use conduits and/or innerducts within existing ductbanks as directed by the Owner's Personnel. Where possible, used conduits with available innerducts or space shall be used.
2. When designing optical fiber into a 4" conduit without existing innerduct or cable, design for three 1-1/4" OD innerducts.
3. When designing for a 200 pr. copper cable, or less, design for two 1 - 1/4" OD innerducts with the cable. Design for one 1 - 1/4" OD innerduct for larger copper cables, if possible.
4. The design shall specify ribbed innerduct. Corrugated innerduct may be used only when necessary to make tight bends and then only as much as needed before making a transition to ribbed innerduct.
5. Specify Muletape in all innerducts.
6. Specify pre-formed duct plugs around innerducts and smaller compression-type duct plugs in the innerducts.
7. Seal used conduits (when pre-formed plugs are not feasible) with a non-hardening, removable sealant (PT Tech DuckSeal Sealant). Expanding foam products designed specifically for duct sealing (e.g. 3M Part #4416 Duct Sealant Kit) may only be used on conduits considered to be at capacity by the Owner's Personnel. Innerducts shall not extend beyond six inches from the end of the conduit.

N. Direct-buried

1. Direct-buried pathways shall not be used. All pathways shall include the use of conduit.

1.6 DELIVERY, STORAGE, AND PROTECTION

- A. Store all materials under cover and elevated above grade. Prevent water, dirt, and debris from entering conduits and tubing.

PART 2 PRODUCTS

2.1 MATERIALS

A. Conduits

1. Manufacturers
 - a. IPEX, Inc.: TerraCon PVC raceway for directional boring and open trenching
 - b. Carlon: PVC Bore-Gard for directional boring and open trenching
2. PVC SCH 40
 - a. Manufactured to NEMA TC2 (Electrical Polyvinyl Chloride (PVC) Tubing and Conduit) specifications

- b. Bell ends
 - c. Appropriate adhesive for this type of conduit providing a permanent and watertight seal
- 3. PVC SCH 40 Fittings
 - a. Manufactured to NEMA TC3 (PVC Fittings for Use with Rigid PVC Conduit and Tubing) specifications.
 - b. Appropriate adhesive for this type of fitting providing a permanent and watertight seal
- 4. PVC SCH 40 Pre-Manufactured Sweeps
 - a. 6 ft radius, 90 degree sweeps
 - b. 45 degree sweeps of >6 ft radius
- 5. PVC type EB-35
 - a. For use only when fully encased in concrete
 - b. Manufactured to NEMA TC8 (PVC Plastic Utilities Duct for Underground Installations) specifications
 - c. Bell ends
 - d. Appropriate adhesive for this type of fitting providing a permanent and watertight seal
- 6. PVC type EB-35 Fittings
 - a. For use only when fully encased in concrete
 - b. Manufactured to NEMA TC9 Fittings for PVC Plastic Utilities Duct for Underground) specifications
 - c. Appropriate adhesive for this type of fitting providing a permanent and watertight seal
- B. Conduit Spacers
 - 1. Manufacturers
 - a. Underground Devices, WUNPEECE spacers- 4W20-2
 - b. Other acceptable manufacturers offering equivalent products
- C. Conduit plugs
 - 1. Compression-type plug
 - 2. Manufacturers
 - a. Condux, Nonmetallic Eye Nut Plug- 08067840
 - b. Other acceptable manufacturers offering equivalent products
 - 3. Universal or "push-in" type plugs (e.g. Condux, Universal Plug- 08047601) not acceptable
- D. Conduit Seals

1. Non-hardening, removable sealant- PT Tech DuckSeal Sealant, or equivalent
 2. Expandable sealing bags, Tyco T-DUX
 3. Expanding foam, 3M Part #4416 Duct Sealant Kit, or equivalent product designed specifically for duct sealing (expanding foam for insulation (e.g. Great Stuff) is not acceptable)
- E. Innerduct conduits
1. Manufacturers
 - a. Carlon, Ribbed Wall High Density Polyethylene, 1 ¼" OD, orange
 - b. Carlon, Corrugated High Density Polyethylene, 1 ¼" OD, orange
 - c. Endot, EDOCOR corrugated, 1 ¼" OD, orange
- F. Pull tape
1. 3/8" or larger
 2. Manufacturers
 - a. Neptco
 - 1) Polyester Muletape, 2500 lbs minimum
 - 2) Detectable Muletape, 22 AWG, 2500 lbs minimum
 - b. Other acceptable manufacturers offering equivalent products
- G. Warning tape
1. High stretch polymer, orange tape, blank print
 2. Marked "Optic Fiber" or "Communications"
 3. Manufacturers
 - a. Empire Level Mfg., 25-071, Orange FO Cable MegaStretch
 - b. Other acceptable manufacturers offering equivalent products
- H. Tracer Wire
1. Green, insulated wire
 2. #10 copper conductor
- I. Concrete
1. 3/8" maximum size
 2. Nominal compressive strength: 3000 PSI at 28 days
- J. Steel reinforcing bars
1. Size- standard size #5

K. Sand for filler

1. Clean and graded
2. All passing a #4 U.S. sieve
3. Conforming to ASTM C33-01a (Standard Specification for Concrete Aggregates) for fine aggregates.

PART 3 EXECUTION

3.1 INSTALLATION

A. Digging and Trenching

1. In general, underground pathways shall be at a minimal depth of 30" to the top of the pathway elements, where possible. Deviations from this specification must be pre-approved by the Owner's Personnel. Pathways may gradually slope up to under 30" deep to enter handboxes or handholes.
2. Digging and trenching shall be in accordance with codes and requirements established by all applicable local, state, and federal agencies and departments.
3. All trenching and digging shall be done in a neat and workmanlike manner. All methods of construction and details of workmanship shall be subject to the control and approval of the Owner.
4. Contractors shall protect from direct damage during construction and damage resulting from construction all surrounding environments, including, but not limited to, existing roadways, sidewalks, curbing, trees and shrubs, open grass areas, and planting beds. Contractors shall use planking and ramps as needed to protect these areas.
5. Contractors shall provide and install all necessary barriers to prevent unauthorized entry into the construction area. Contractors shall provide temporary walkways to divert pedestrian traffic safely around the construction area. Contractors shall contact the Owner's Personnel for approval of all temporary walkway locations.
6. Contractors shall provide traffic control, signage, plating, etc. as necessary to maintain the safe flow of vehicular traffic as deemed necessary by the Owner's Personnel. Contractors shall contact the Owner's Personnel for approval of any changes to normal flow of vehicular traffic in and around the construction area and to arrange road closures, if necessary.
7. Contractors shall restore, repair, rebuild, or replace any items including, but not limited to, adjacent property, existing fences, trees and shrubs, roadways and curbs, sidewalks, and surface utilities and parts damaged during construction. Damaged items shall restore, repair, rebuild, or replace to their original condition and to the satisfaction of the Owner's Personnel. The Owner's Personnel may waive this requirement for specific items if within the construction area and/or if scheduled for eventual demolition or replacement and at the Owner's Personnel discretion.
8. Contractors shall secure all necessary permits, as required. Contractors shall contact the Owner's Personnel to ascertain the existence of established permits covering this work.
9. Contractors shall coordinate construction schedules and all work on the construction site with the Owner's Personnel. Other Contractors may be working in the area. Contractors shall coordinate construction schedules with any general contractor or construction

manager hired by the Owner's Personnel when working as a subcontractor or when required by the Owner's Personnel.

10. Contractors shall provide a detailed photographic survey of all pathways and areas to be disturbed prior to construction. Contractors shall deliver a set of these photographs to the Owner's Personnel prior to construction.
11. Contractors shall locate and stake all pathways and spaces to be installed. Contractors shall confirm with the Owner's Personnel and the project engineers all staked pathways and spaces. Contractors shall notify the Owner's Personnel of any discrepancies in the site plan and the existing conditions.
12. Contractors shall protect, support, and maintain all existing utilities in the work area as they are encountered during excavation. Shallow utilities to light posts or other devices may be temporarily re-routed or disconnected if pre-approved by the Owner's Personnel.
13. Contractors shall install erosion control measures as needed to minimize erosion and to prevent soil run-off from the construction area.
14. Contractors shall provide and install bracing, shoring, and sheathing as necessary to protect personnel and surrounding conditions. Contractors shall adhere to all local, state, and federal requirements for safe excavations.
15. Contractors shall hand remove and stack all paving bricks and marble pavers in the construction pathway for re-installation later. Contractors shall remove granite or other stone or brick curbing pavers in the construction pathway for re-installation later.
16. Contractors shall saw cut all paved area encountered during excavations. Cuts shall be neat and straight.
17. Contractors shall remove all material excavated including soil, rubble, debris, or other materials encountered during excavation. Contractors may store excavated material on site at the discretion of the Owner's Personnel and at the location designated by the Owner's Personnel. Contractors shall not anticipate storing excavated material on site. Excavated material from ductbank trenches may be left near the trench to be used as backfill, if adhering to later backfilling specifications. Contractors shall properly dispose of any material taken from the construction area per local disposal requirements.
18. Contractors shall remove only the material necessary to safely install ductbanks as specified. Contractors shall contact the Owner's Personnel immediately if the trench or hole bottom is wet, unstable, or otherwise unable to support the infrastructure to be installed.
19. Contractors shall provide pumps, as necessary, to keep water out of the excavation. Contractors shall direct effluent towards the nearest storm drain only if the effluent is free from dirt and debris. Otherwise, the effluent shall be diverted to an area free from vehicular and pedestrian traffic and other construction areas.
20. Contractors shall notify the Owner's Personnel of any rock that cannot be excavated by a $\frac{3}{4}$ cubic yard power shovel or broken sufficiently by an air hammer to clear the space required for infrastructure installation. the Owner's Personnel shall determine the appropriate course of action.

B. Restoration

1. Contractors shall contact the Owner's Personnel prior to any backfilling which will conceal an installed pathway element to enable the Owner's Personnel to document and

photograph the pathway.

2. Contractors may backfill in stages, when necessary to complete trenching and ductbank installation.
3. Contractors shall use pre-excavation photographs to restore the existing conditions, including brick walkway placement and pattern. Contractors shall restore brick walkways in the same pattern and arrangement as originally installed.
4. Contractors shall provide and install a level layer of compacted aggregate over each encased ductbank. The bed shall extend 1 foot above the surface of the ductbank. The first 6 inches of the aggregate bed shall be compacted to not less than 95% density compared to maximum laboratory tests by weight per ASTM D1557-64T, method A. The second six inches of the aggregate bed shall be compacted to not less than 85% density compared to maximum laboratory tests by weight per ASTM D1557-64T, method A.
5. Contractors shall remove all remaining excavated material from the construction area.
6. Contractors shall remove any erosion control devices no longer needed, not including those in and around seeded areas.
7. Restoration of disturbed landscaping shall be to the satisfaction of the Owner's Personnel.

C. Conduit/Duct Pathways

1. During construction, Contractors shall use appropriate personal protective equipment to work safely within trenches and excavated areas. Contractor shall provide all appropriate safety equipment as needed to extract disabled workers or as otherwise needed to provide a safe work environment and to provide immediate support in emergency situations.
2. Contractors shall store all conduits and fittings in a manner to prevent dirt, rain, and other debris from entering the conduits. All conduits and fittings shall be free from dirt, water, and debris before installation.
3. Contractors shall locate each ductbank as specified by this document and subsequent documentation provided by the Owner's Personnel.
4. Contractors shall install an aggregate bed of a minimum of 12 inches of compacted aggregate under the same specifications as maintenance hold installation (Section 7.3.2) for the first 6 feet of any ductbank exiting a maintenance hole.
5. Contractors shall mechanically tamp the bottom of all trenches to provide a firm surface. If a solid base is not achievable given soil or other conditions, the Contractors shall install a minimum 4" bed of compacted aggregate under the same specifications as maintenance hole installation (Section 7.3.2). Contractors shall excavate as needed to install this aggregate bed while maintaining 30" of minimal cover over the final ductbank. the Owner's Personnel shall determine the need for an aggregate base prior to the placement of any framing and laying of conduit in place.
6. Contractors shall obtain the Owner's Personnel permission to proceed prior to the laying of conduits into the trench.
7. When possible, the vertical trench walls shall be used as the vertical frame for pouring concrete. When necessary, the sides of trenches shall be framed to maintain a straight and neat cross-section for areas completely encased by concrete. Contractors shall not

use framing in areas to be filled with sand.

8. Contractors shall use exterior maintenance hole walls, utility tunnel walls or roof, and/or building structure as framing into which the concrete is to be poured where possible.
9. When penetrating a MH or building, Contractors shall core-drill, shall use a pre-manufactured knock-out window, or shall sawcut a window to penetrate the structure. Contractors shall confirm with the MH manufacturer or a structural engineer that the proposed method to access a structure and the final configuration of conduits per J the Owner's Personnel shall not compromise the structural integrity of the structure. Contractors shall provide the Owner's Personnel with written documentation to this effect.
10. Contractors shall provide and install framing as necessary to prevent the penetration of concrete into the interior space of a structure. Contractors shall remove this framing when the concrete has properly set and after backfilling is complete.
11. Contractors shall install horizontal conduits ending in structures flush with the interior surface of the wall. Contractors shall install vertical conduits ending in entrance facilities such that they extend a minimum of 4" above the final floor. Contractors shall cut the conduits square with the conduit and not necessarily level to the floor. Contractors shall provide and install bushings on conduit ends.
12. Contractors shall provide and install conduit spacers beneath each conduit three times for every 20 linear feet of conduit. The spacers shall be evenly distributed over each 20 segment (e.g. one at each 20 foot joint and two evenly spaced over the middle). Each horizontal row of spacers shall be installed with a 6" minimum horizontal distance from any other row of spacers so as to eliminate weak vertical shear planes.
13. Contractors shall provide and install steel reinforcing bars, vertically and horizontally, to form a vertical box framing the conduits. The vertical bars shall be driven a minimum of 6 inches deep to prevent the conduits from floating during concrete pouring. The horizontal bars shall be secured to the vertical bars to prevent movement. The vertical bars shall extend 3 inches above the top conduit row. Alternately, the bars may be less than 3 inches above the top conduit row, if an inverted spacer is placed on the top row to provide a 3 inches depth gauge for pouring concrete.
14. Contractors may use "U"-shaped bars to straddle the conduits, if driven into the trench as specified above. Contractors may use a single horizontal bar or an upward pointing "U"-shaped bar in this configuration. The upward pointing "U"-shaped bar shall extend 3 inches over the top conduit or the Contractors shall use an inverted spacer to provide a 3 inch depth gauge for pouring concrete.
15. Contractors shall provide and install reinforcing bars, longitudinally, as detailed in the drawings. The bars shall be secured to each vertical reinforcing bar box. The longitudinal bars shall overlap 12 inches, unless welded together, and shall be secured to each other in a way to prevent movement.
16. When abutting a MH or building. Contractors shall provide dowel holes in each structure to enable the longitudinal reinforcing rods to penetrate the structure far enough as to prevent vertical and horizontal shearing of the ductbanks from the structure. Contractors shall not penetrate the wall with these holes. Contractors may need to provide and install additional reinforcing rods to provide this type of anchoring around MH window knock-outs.

D. Concrete Encasement

1. When encasing a ductbank, Contractors shall provide and install concrete around the

conduits providing at least 3 inches of concrete around all sides of the conduit ductbank for the areas indicated on the drawing for complete encasement.

2. Contractors shall use appropriate methods to remove air pockets from the concrete and to provide 100% fill around all conduits and spacers.
3. Contractors shall fully encase any ductbanks that penetrate a MH or building for the first 6 feet beyond the structure.
4. When transitioning from an encased ductbank to a capped ductbank, Contractors do not have to frame the transition in cross-section, provided the required area is encased to a minimum of 3 inches. The concrete may slope down into the area to be capped. If the Contractors frame a transition point, the frame must be removed prior to installing aggregate around the conduits and installing the cap.
5. Contractors shall shape the top of the concrete in such a way as to slope water away from the ductbank-structure seams.

E. Cap Preparation and Installation

1. When capping a ductbank, Contractors shall provide and install filler sand around the conduits providing at least 3 inches of sand below and to the side of all conduits. Contractors shall not install filler sand above the top of the conduit ductbank.
2. Contractors shall use appropriate methods to remove air pockets from the sand and to provide 100% fill around all conduits and spacers.
3. Contractors may provide and install framing on the compacted surface of the sand for pouring the concrete cap.
4. Contractors shall provide and install a 3 inch thick concrete cap over the conduits for the areas indicated on the drawing. Contractors shall use appropriate methods to remove air pockets from the concrete.
5. Contractors shall extend the cap horizontally to a minimum of 3" beyond the outer most conduits.
6. If the cap is framed, Contractors may use lesser-grade backfill material to cover the sand beyond the cap once the framing is removed.

F. Final Installation of New Pathway

1. Contractors shall clean all conduits by pulling cylindrical brushes until all dirt is removed. Contractors shall blow all conduits dry.
2. Contractors shall install Muletape pull strings into all conduits.
3. Contractors shall install a tracer wire in one of the conduits of a new pathway. In maintenance holes, handboxes, and entrance facilities, the tracer wire shall be bonded to ground. The wire shall be clearly labeled.
4. In maintenance holes, the tracer wire shall loop up to the neck such that it can be reached without entering the hole. The wire shall be securely anchored along the neck, ceiling and wall.
5. Contractors shall install duct plugs at both ends of all conduits.

G. Existing Ductbanks

1. Contractors may use conduits and/or innerducts within existing ductbanks as directed by the Owner's Personnel. Where possible, used conduits with available innerducts or space shall be used.
2. When installing optical fiber into a 4" conduit without existing innerduct or cable, Contractors shall install three 1 - 1/4" OD innerducts or three MaxCell 3-cell products.
3. When installing a 200 pr. copper cable, or less, Contractors shall install two 1 - 1/4" OD innerducts with the cable. When installing larger copper cables, Contractors shall install one 1 - 1/4" OD innerduct, if possible.
4. Contractors shall use ribbed innerduct. Contractors may use corrugated innerduct only when necessary to make tight bends and then only as much as needed before making a transition to ribbed innerduct.
5. Contractors shall install Muletape pull strings in all innerducts.
6. Contractors shall install pre-formed duct plugs around innerducts and smaller compression-type duct plugs in the innerducts.
7. Contractors shall seal used conduits (when pre-formed plugs are not feasible) with a non-hardening, removable sealant (PT Tech DuckSeal Sealant) or with an expandable sealing bag (Tyco T-DUX). Expanding foam products designed specifically for duct sealing (e.g. 3M Part #4416 Duct Sealant Kit) may only be used on conduits considered to be at capacity by the Owner's Personnel.
8. Innerducts shall not extend beyond six inches from the end of the conduit.
9. Contractors shall replace any Muletape pull strings installed in conduits subsequently removed during installation, including outside of newly installed innerducts. Muletape pull strings in innerducts used to pull a cable does not need to be replaced.

H. Tunnel Pathways

1. Tunnel pathways are considered spaces under this specification. Refer to the latter section for specifications.

I. Direct-buried Pathways

1. Direct-buried pathways shall not be used for permanent installations.

END OF SECTION 270543