Appendix D

Project Construction Specifications

Appendix D.1

Long Haul Running LIne Construction Specifications

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Long Haul Running Line Construction Specifications

1. Depths of Cover

(a) The Conduit System shall be placed with a minimum cover of forty-two inches (42") except where:

(i) otherwise specified in the Drawings;

(ii) accepted by Contractor;

(iii) governing authorities or ROW owners dictate a greater depth;

(iv) required to be eight inches (8") below the frost line; or

(v) where greater Conduit System depth will be required at the following locations:

(b) At road crossings, the Conduit System shall be placed with a minimum cover of forty-eight inches (48") below the top of pavement.

(c) In drainage ditches, the Conduit System shall be placed with a minimum cover of forty-two inches (42") below the clean out elevation; unless the controlling authority requires additional depth in which case the greatest depth will be maintained.

(d) Where the Conduit System crosses railroads, the Conduit System shall be placed at a minimum depth of sixty inches (60") below the base of rail or sixty inches (60") below the paralleling drainage ditches, whichever is greater.

(e) Where the Conduit System crosses Existing Facilities, including pipes, cables, or other structures, the Conduit System will be placed to maintain a minimum of twelve inches (12") clearance under the Existing Facility or a minimum clearance as required by the governing authorities or facility owner, whichever is greater. In the event that the top of sub-surface Existing Facility is greater than seventy-two inches (72") below grade, the Conduit System may be placed over the object while maintaining the twelve-inch (12") clearance if such action is not in conflict with permits and in accordance with the requirements of governing authorities and ROW owners. In all cases, the Conduit System shall be placed a minimum of forty-two inches (42") below grade.

(f) Unless otherwise specified, where the Conduit System crosses gullies, ditches, streams, rivers, creeks, canals, and washes, the Conduit System will be placed at a minimum cover of forty-eight inches (48") below the bottom of the waterway unless the controlling authority requires additional depth in which case the greatest depth will be maintained. In navigable waterways, the Conduit System shall be placed a minimum of twenty feet (20') below the bottom of the waterway, or as detailed on the Drawings or directed by the Contractor.

(g) In areas of rock as defined in Section 11, the cover shall be as follows and as shown on the drawings:

(i) When rock is encountered at grade, the rock shall be excavated to

provide duct system cover of eighteen inches (18"). The Conduit System shall be installed by one of the following methods:

- The Conduit System shall be installed on a two-inch (2") bed of select backfill and covered in a one and one-half (1-1/2) sack concrete mix eight inches (8") thick. The remaining of the trench shall be backfilled per the requirements of Section 13.

- The Conduit System shall be installed on a two-inch (2") bed of select backfill and then covered by select backfill to two inches (2") above the Conduit System. A one-quarter-inch (1/4") steel plate will cap the select backfill and the remainder of the trench backfilled per the requirements of Section 13.

- The Conduit System shall be installed in a steel casing. The remaining of the trench shall be backfilled per the requirements of Section 13.

(ii) When rock is encountered at six inches (6") or less below grade, the rock shall be excavated minimum of eight inches (8") deep from the top of the rock, maintaining a minimum cover of eighteen inches (18") below grade. The Conduit System shall be installed by one of the following three (3) methods:

- The Conduit System shall be installed on a two-inch (2") bed of select backfill and covered in a one and one half (1-1/2) sack concrete mix eight inches (8") thick. The remainder of the trench shall be backfilled per the requirements of Section 13.

- The Conduit System shall by installed on a two-inch (2") bed of select backfill and then covered by select backfill to two inches (2") above the Conduit System. A one-quarter-inch (1/4") steel plate will cap the backfill. The remainder of the trench shall be backfilled per the requirements of Section 13.

- The Conduit System shall be installed in a steel casing. The remaining of the trench shall be backfilled per the requirements of Section 13.

(iii) When rock is encountered more than six inches (6") but less than thirty inches (30") below grade, the rock shall be excavated minimum of eight inches (8") deep from the top of the rock, maintaining a minimum cover of eighteen inches (18") below grade. The Conduit System shall be installed by one of the following four (4) methods:

- The Conduit System shall be installed on a two-inch (2") bed of select backfill and covered in a one and one half (1-1/2) sack concrete mix eight inches (8") thick. The remainder of the trench shall be backfilled per the requirements of Section 13.

- The Conduit System shall by installed on a two-inch (2") bed of select backfill and then covered by select backfill to two inches (2") above the Conduit System. A one-quarter-inch (1/4") steel plate will cap the backfill. The remainder of the trench shall be backfilled per the requirements of Section 13.

- The Conduit System shall be installed in a steel casing. The remaining of the trench shall be backfilled per the requirements of Section 13.

- The rock shall be excavated eighteen inches (18") deep from the surface of the rock or to forty-two inches (42") of cover whichever requires less excavation. No further protection will be required other than a two-inch (2") bed of select backfill and then covered by select backfill to four inches (4) above the Conduit System.

(iv) When rock is encountered thirty inches (30") or more below grade, the rock shall be excavated eight inches (8") deep from the top of the rock, or forty-two inches (42") of cover whichever requires less excavation. The Conduit System shall be installed by the following method:

- The Conduit System shall be installed on a two-inch (2") bed of select backfill and then covered by select backfill to two inches (2") above the Conduit System. The remainder of the trench shall be backfilled per the requirements of Section 13.

2. Materials

(a) **General.**

(i) Subcontractor shall furnish all materials not otherwise furnished by the Contractor necessary to complete the Work. Materials shall be new and complete in all respects. Subcontractor shall assume full responsibility for ordering materials of the quality specified, and in the quantity necessary, and shall be responsible for the timely delivery of all materials. Major materials to be furnished by Subcontractor shall conform to the respective Specifications.

(ii) For substitutes and "or equal" materials refer to the requirements of Article E.

(iii) Prior to beginning construction, Subcontractor shall submit drawings and data to the Contractor for approval of the material specified or incorporated into the Work. The drawings shall indicate the general arrangement, sizes, general appearance, sequence, procedure, and materials of construction.

(iv) All materials not specifically described shall meet ASTM or other construction industry standards appropriate to the type of work being performed.

(v) All steel hardware shall be hot-dip galvanized after fabrication in accordance with ASTM A153, unless otherwise specified.

(vi) Multiple ducts to be installed shall be color coded as follows;

- Each duct shall have a different color.
- Colors shall be; orange, yellow, black, white, red, green , blue ,gray, lilac, buff, brown and pipe green.
- Subcontractor shall assure that the duct reels contain the following color arrangement:
  - One reel red and green
  - One reel blue and gray
  - One reel lilac and buff

- One reel brown and pipe green
- One reel orange and yellow
- One reel black and white

Subcontractor shall install the orange and yellow and black and white ducts on the bottom. Placement of other colors shall be provided by the Contractor based on the number of ducts to install and arrangement of them. See Section 18 for arrangement of ducts in handholes and manholes.

(vii) The duct shall be supplied on ninety-six-inch (96") reels containing two colors of thirty six hundred feet (3600') each.

(b) **Codes and Standards.** Materials and devices furnished shall be in accordance with applicable standards of ANSI, ASTM, NEMA, UL, all local codes, and requirements of the permits. In case of conflict between the requirements of the above referenced codes and standards and the requirements of these Specifications, the most stringent requirements shall govern. All materials, devices, and practices shall be in accordance with the applicable requirements of the Federal "Occupational Safety and Health Standards."

(c) **Duct and Pipe.** Piping materials will be as outlined below, unless otherwise specified in the Drawings.

(i) **Steel**

- Black iron steel pipe shall be resistance welded or seamless, structural grade, with an average minimum wall thickness of 0.250", single random length pipe, plain end.
- Galvanized steel pipe shall be thoroughly hot-dip galvanized both inside and outside before threading, according to the requirements of ASTM A53 "Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless". Threads shall be thoroughly greased in the field prior to final connections.
- Cathodic protection shall be provided for steel casings at locations where grounding is required in the vicinity of high voltage power transmission towers, electric transit systems, catenary wires, or underground power cables.

(ii) **PVC**

- PVC pipe and fittings shall be polyvinyl chloride (PVC) manufactured from a PVC compound meeting the requirements of Type 1, Grade 1 PVC in accordance with ASTM D1784, D1785, and D2241. The PVC pipe colors shall be matched to the duct color and shall be equal to Schedule 40 in wall thickness.
- PVC pipe shall have a long bell on 1 end and be plain on the other end. Pipe shall be in accordance with ASTM D1785.
- PVC pipefittings shall be in accordance with ASTM D2466.
- PVC solvent cement shall be in accordance with ASTM D2564.
- PVC pipe supplied is 20' sections of Quad Duct (4) and 20' section of Hex Duct (6) in matching colors to the HDPE Duct.

(iii) **HDPE**

- Pipe shall be smooth wall SDR 9 or 11, high-density polyethylene (HDPE), color as specified, and manufactured in accordance with standards established by the Plastic Pipe Institute and shall be furnished without pull rope unless otherwise specified.
- Subcontractor shall use SDR 11, except Subcontractor shall install SDR 9 where indicated in other Specification Sections and on the drawings.

(iv) **Pipe Plugs**

- Vacant pipes shall be sealed with solid duct plugs. Contractor Predetermined materials, duct plugs and simplex split cable plugs will be furnished by Subcontractor.
- Plugs for Multicell duct shall be provided by the duct manufacturer.
- Voids between the pipe and core bores shall be sealed with "Model CSL Linx" mechanical seal as manufactured by Calpico. Building vault seals shall use stainless steel bolts, nuts, washers, and pressure plates, and shall be capable of developing a hydrostatic seal of up to forty (40) feet of head.

(v) **Sealing Foam**

Sealing foam shall be expanding, non-degradable urethane foam, with a density of 1.75.

(vi) **Buried Warning Tape**

Cable warning tape for burial shall be three-inch (3") wide 6 mil. Super Stretch marker tape in 6,000 foot rolls. It shall be imprinted custom black on orange virgin polyethylene tape with three-inch (3") diameter PVC cores. The imprinted image shall be repeated approximately every twenty-three inches (23") as shown in the Drawings.

3. General Requirements for Pipe

(a) **Description.**

(i) In addition to other applicable specifications, Subcontractor shall provide all labor, equipment, supplies, materials (unless otherwise provided), and supervision to furnish and install the Work herein specified, as applicable.

(ii) This specification is to be utilized in conjunction with other applicable specifications and Subcontract Documents.

(b) **Requirements for Pipe.**

(i) Protective coating on pipe that has been scratched, scraped, gouged, or damaged in any manner shall be repaired in accordance with the pipe coating manufacturer's specifications prior to placement.

(ii) Subcontractor shall transport all pipe to the site of the Work. All pipe materials shall be properly handled and stored. Reels shall be placed on a level area and securely blocked to prevent accidental movement.

(iii) Defective pipe shall not be installed and shall be removed immediately from the site of the Work.

(c) **Pipe Jointing.**

(i) Pipe jointing shall be completed as the material is installed. Pipes indicated to be occupied by FOC, including spares for future FOC use, shall have joints capable of withstanding two hundred (200) p.s.i. air pressure for installing pull line or blowing FOC. Pipe joints shall be as specified below:

- Rigid Galvanized Steel: The pipe ends shall be threaded with fittings that are hot-dip galvanized both inside and outside including threads;

- Black Steel: The pipe ends shall be plain ended. Steel casing pipe shall be full circle welded and the inside of the pipe shall be free of burrs and weld slag.

- PVC: The pipe ends shall be joined with PVC solvent cement as recommended by the pipe manufacturer. The joint shall be allowed to cure before handling or lowering the pipe into the trench. Care shall be taken to prevent twisting or pulling the joint.

- HDPE: The duct pipe shall be spliced together with Contractor predetermined Materials, using equipment recommended by the manufacturer. Where pipe is or may be occupied by FOC, joining by the butt fusion method shall not be allowed. HDPE casing pipe shall be joined by the butt fusion method using the duct manufacturer's recommended equipment.

- PVC Materials: PVC bends shall be manufactured prefabricated bends.

(e) **Pipe Testing and Cleaning.**

(i) When pipe is installed, it shall be proofed by testing and cleaning before acceptance. As a test, the duct shall pass a solid aluminum or steel mandrel or a pig with a minimum length of four inches (4") and a one-inch (1") diameter. The mandrel or pig shall be accepted by Contractor prior to proofing any duct. All foreign material, earth, sand, and gravel shall be removed from the pipes. Pipes that will not be immediately used shall be tested and plugged at each end.

(ii) The Contractor must be informed at least forty-eight (48) hours prior to the start of any proofing operation. At the discretion of the Contractor, Contractor shall have an opportunity to witness part or all of the proofing operations. Pipe that is proofed without the advance knowledge of Contractor shall be considered incomplete. Failure to obtain written approval and/or observation may result in Subcontractor being required to reproof.

4. Right-of-Way Preparation

(a) **Description.** This section describes the Work associated with ROW preparation and consists of the clearing and grubbing of brush, tree limbs, trees, stumps, and incidental debris from the Conduit System alignment.

(b) **Clearing.**

(i) Subcontractor shall remove and dispose of trees and/or brush within the path of the Network as required by the route drawings. All Clearing shall conform to the laws, rules and regulations of all authorities having jurisdiction of the ROW. Subcontractor shall clear cut all brush and trees to create a clean path for construction and at a width of no less than five feet (5') on each side of the Network running line. When cleared, trees, brush and stumps shall not protrude from the ground greater than two inches (2").

(ii) Where required by governing authorities or ROW owners, landscaped, decorated, ornamental trees, or any tree over six (6) inches in diameter shall be preserved and protected.

(c) **Waste Disposal.** Tree tops, tree trimmings, slashing, branches, brush, stumps and other debris may be chipped and spread over the ROW when accepted by Contractor, governing authorities, and ROW owners or shall be removed from the ROW and disposed of in a manner satisfactory to the Contractor. Chipped material shall not be left in proximity to railways or roadways. Debris shall not be burned, buried or pushed off the cleared ROW and left on adjoining areas, or shoved into piles either separately or with earth from grading. Debris shall be completely disposed of ahead of the Conduit System installation.

(d) **Temporary Construction.**

(i) Where it is necessary to remove existing fences at Conduit System crossings and along the ingress and egress routes, temporary fences or gates shall be installed immediately. All fences shall be "H" braced before being cut. Temporary fences or gates shall be provided with suitable materials and fasteners of a type and character equivalent to the existing fence, and shall be kept closed at all times except when necessary to be opened for construction purposes. Existing fencing so removed shall be replaced in kind as the Conduit System installation is completed.

(ii) Temporary construction, including, but not limited to, bridges, roadways, and ramps, may be constructed as required to provide for the passage of equipment necessary for construction operations. Subcontractor shall furnish any materials required for this purpose. Forging streams shall be prohibited unless specifically provided for in the Subcontract Documents. Any such temporary construction shall be removed as the Conduit System installation is completed.

(e) **Grading.**

(i) Grading shall be held to the absolute minimum required to perform the Work.

(ii) Irregularities in the ROW shall be graded preceding the Conduit System installation to permit the Conduit System to be correctly installed.

(iii) Subcontractor shall grade the ROW such that no sharp over-bends or sag bends will be required when the Conduit System is constructed. Grading shall be

performed to ensure that the Conduit System vertical and horizontal alignment is smooth and uniform and required depths are maintained while minimizing environmental damage.

(iv) Where large rocks, fill, or other such materials have been placed over the Conduit System alignment, Subcontractor shall remove the materials to expose natural ground surface.

5. Duct Placement

(a) **Description.** This section covers the installation of duct. Subcontractor shall provide all equipment and tools for pulling the duct.

(b) **Duct Placement.**

(i) Prior to beginning operations, Subcontractor shall review each casing section between existing manhole or handhole locations. Subcontractor shall determine the length of each pull by determining the feed location and the pulling location. Subcontractor shall not leave an excess of more than one (1) foot of duct protruding from the ground at handhole or manhole locations.

(ii) All ducts being placed in a casing shall be pulled in simultaneously. Innerducts shall be of one (1) continuous length between pull points unless intermediate splice points are otherwise accepted by the Contractor, and if Contractor approved when pulling multiple innerducts that have been spliced, the splices shall be staggered. After FOC has been installed, the Orange innerduct on each side of a handhole or manhole shall be plugged with Jackmoon simplex plugs.

(iii) The pulling force on the innerduct shall not exceed 3000 psi.

(iv) On completion of duct placing, the innerduct shall rest freely in casing without tension. Sealing and racking of the duct in manholes shall be completed after the cable is placed and as a part of cable placing.

(v) The ducts shall enter and leave manholes and handholes exactly opposite each other within the manhole or handhole to facilitate the cable coils and/or splice closures. Each duct length inside manholes and handholes shall be a minimum length of eighteen inches (18").

(vi) Duct shall have a gradual sweep into the manholes and handholes if the depth of duct bury exceeds forty-eight inches (48").

(vii) Prior to duct placement in the trench, the multiple duct shall be bundled, tied and/or bound by an accepted method to eliminate the possibility of the duct twisting and/or waving in the trench.

(c) **Duct Splicing.** Duct ends shall be cut square to provide flush-butting surfaces when spliced. The inside edge shall be free of burrs that could impede the cable installation operations. Duct splicing shall be accomplished only by the utilization of Contractor predetermined materials furnished by Luzon or owner/approved substitutions.

6. Duct Placement – Plow Method

(a) **General.** To avoid possible damage to the Conduit System from exposure, including, but not limited to, traffic, livestock, and other hazards, Subcontractor shall complete the trenching of laterals, around culverts, and similar operations as soon as feasible following plow operations. Subcontractor shall complete such operations within twenty-four (24) hours following plowing operations unless additional protective measures, as accepted by Contractor, are employed.

(b) **Plow Equipment.**

(i) The equipment and construction methods used by Subcontractor shall be such as to cause minimum displacement of the soil.

(ii) The plow tractor shall be equipped with hydrostatic type steering. The plow tractor and pull tractor, if required, shall be capable of maintaining the specified cover and prevent damage to the duct system. Any additional equipment that is necessary to accomplish the plowing operation shall be at the discretion and expense of the Subcontractor. The plowing equipment shall be subject to the approval of governing authorities and ROW owner.

(iii) The equipment shall be capable of extending the plow in order to maintain the required minimum depths under all terrain conditions.

(iv) The reel carrier(s) shall be of adequate size and be configured so that the reel sizes being used can be properly and safely handled.

(v) The plowshare shall be designed so that the duct passing from the reels through the feed chute will not bind nor bend in a radius of more than twenty (20) times the outside diameter of the duct. The feed chute must have a removable gate for the purpose of inspection and to allow the duct to be removed from or inserted into the feed chute. The duct path inside the feed chute must have low friction surfaces and be free of burrs and sharp edges to prevent damage to the duct as it passes through. Any welds must be smoothed. Internal guide rollers shall not be used.

(c) **Pre-ripping.**

(i) Where required to ensure duct installation at proper depth, pre-ripping shall be performed at a depth of four inches (4") greater than the minimum innerduct depth required.

(ii) The final ripping pass shall be in the same direction as plowing.

(iii) Subcontractor shall examine the work and determine the character and nature of the materials to be encountered. This examination shall include

evaluating subsurface soil conditions and Existing Facilities as otherwise called for in the Subcontract Documents.

(d) **Duct Placement – Plow Requirements & Precautions.**

(i) Start and finish pits and pits at points of intersections, as needed, must be excavated in advance of plowing. Ends of casings and crossings of Existing Facilities and utilities shall be exposed prior to start of plowing operations.

(ii) During the plowing operation, the duct shall pass through the plow chute without tension. Equipment and construction means and methods shall assure compliance with this requirement. Subcontractor shall furnish competent supervision and craftsmen at all times at the site of plowing operations to assure compliance with this requirement.

(iii) The plowing operation shall be observed continuously by Subcontractor for improper conditions, including, but not limited to, obstructions, proper feeding of duct, and maintaining proper depth. At no time shall any reels be unmanned during duct installation.

(iv) At no time will the plow be wobbled either vertically or horizontally to break through an obstruction.

(i) Duct shall be placed directly in the ground with plowing equipment and delivery chutes designed to accommodate the duct material being installed without damaging or overstressing the duct. Duct shall be installed at the depth specified and where indicated on the Drawings. Warning marker tape shall be installed simultaneously with the duct twelve inches (12") below the ground surface directly above the duct or as indicated on the Drawings and with a minimum separation of twelve inches (12") above the duct.

(ii) The plow shank position shall not be changed unless the prime mover is moving forward and any changes shall be gradual, not to exceed one foot (1') in ten feet (10') in length. Should it be necessary to raise the plow shank to the surface when the plow is not moving, the duct to the rear of the feed chute shall be excavated and slack pulled so that the duct is not kinked over the feed chute exit. The plow shall not be set at extreme forward rake angles. The prime mover shall never be backed up with the plow in the ground.

(iii) Abrupt changes in the terrain along the duct path shall be graded off ahead of the plow, if possible. Such grading changes shall be in accordance with the requirements of governing authorities and ROW owner.

(iv) At no time shall the plow deviate from the normal route to seek an "on grade" crossing level for roads. Unless the road is bored, Subcontractor shall level the plow train path in order to make a level crossing of the road. Subcontractor shall repair the road after passage, including re-paving or reapplying gravel, as required.

(v) No Practice will be allowed that will cause an abrupt change in direction of the plowed in duct.

(x) The Subcontractor shall exercise particular care in the use of trenching equipment and shovels in joining trenches to the slot made by the plow to be certain that the duct is not damaged.

(xi) When rigging for offset plowing, the duct shall be re-routed over the duct feed systems to conform to the new configuration.

(xii) The slot made in the soil by the plow shank shall be closed immediately after duct installation by means, methods, and procedures that satisfactorily close and compact the slot without damaging the Conduit System.

(e) **Duct Placement Depth Verification.** On the first day of plowing and at other times directed by the Contractor, Subcontractor shall demonstrate that the duct is being placed to the specified depth by excavating and observing the duct.

7. Pipe Placement – Trench

(a) **Description.** This section covers the installation of the Conduit System by trenching.

(b) **Pipe/Duct Placement.**

(i) The Conduit System shall be placed in the center of the bottom of the trench with the entire length of pipe or duct bearing on the trench bottom. The trench bottom shall be re-graded if the pipe or duct does not have full bearing. Depressions for joints shall be dug after the trench bottom has been graded, and shall be only of the length, depth, and width required for making the particular type joint.

(ii) After final placement, duct shall rest on the bottom of the trench in a straight line under slight tension. A check shall be made that proper depth is obtained and the duct is in a straight line and under tension during backfilling.

(iii) Warning marker tape shall be installed twelve inches (12") below the ground surface.

(b) Quad and Hex PVC Pipe should be used when ROW conditions are such that the ability to handle the multiple Duct Reels is impracticable.

(c) When Quad and Hex PVC Pipe is being installed, handholes shall be placed at 1,500’ intervals rather than the normal 3,600’ intervals.

(d) When Duct is used in trenching operations, the duct shall be bound at a minimum of five-foot (5’) intervals. Tie raps or other contractor-approved methods shall be used to bind the duct to eliminate the possibility of twisting or waving in the ditch.

8. Bore Operations

(a) **Description.**

(i) This section covers pushing, boring, or simultaneously boring and pushing casing pipes and Duct under roads, exit ramps railroad tracks, driveways, sidewalks, trees, environmental sensitive areas and other features as indicated on the Drawings or as directed by the Contractor.

(ii) This section specifies conventional horizontal boring, directional/guided bores, rock bores, and long directional bores with use of drilling mud.

(iii) All boring Work performed shall be in accordance with laws, permits and the requirements of governing authorities and ROW owner.

(b) **Material Requirements.**

The material for boring shall be one of the following:

- Ten (10) innerduct encased in one (1) eight-inch (8") SDR 11 HDPE pipe for soil or rock bores at the discretion of Subcontractor.
- Ten (10) innerduct encased in one (1) ten-inch (10") SDR 9 HDPE pipe for rock bores and soil bores at the discretion of Subcontractor.
- Ten (10) innerduct encased in one (1) eight-inch (8") 0.250 wall steel pipe for rock bores and bores soil bores as required by ROW owners or shown on the drawings.
- Ten (10) innerduct encased in one (1) nine-inch (9") 0.250 wall steel pipe for rock bores or soil bores as required by ROW owners or shown on the drawings.
- Ten (10) one-and-one-quarter-inch (1-1/4") SDR 9 ducts pulled back without a casing in soil.

(c) **Pipe Placement – Bore Method.**

(i) Acceptable boring installation methods include:

- Jack Boring (jacking the casing through the sub-grade).
- Dry auger boring
- Dry directional boring
- Mini-directional boring.

(ii) Casing pipes shall be pushed or bored in place at locations as indicated on the Drawings as directed by Contractor.

(iii) All rock bores shall be cased in one of three alternatives: steel pipe; eight-inch (8") SDR 11 HDPE; or ten-inch (10") SDR 9 HDPE. SDR 11 duct shall be placed in the casing.

(iv) Adequate barricades shall be erected to limit access to the boring machine to operating personnel only.

(v) Subcontractor shall calibrate the boring head locator at the start of the day and at each new boring operation. A daily calibration log shall be established and maintained for Contractor review and submitted for final record.

(vi) Before boring, all clearances shall be checked by Subcontractor. All Existing Facilities shall be located and marked or exposed as necessary for safety and for protection of the Existing Facility.

(vii) Boring machines shall be grounded at all times during operation. The grounding method and operator's safety practices shall comply with the manufacture's guidelines and requirements.

(viii) Casing pipe shall be placed through an augured hole or shall be advanced by jacking as the soil is removed by the auger or by jacking directly through soil. The installation shall be performed in a manner that will not disrupt traffic nor damage the subgrade, and will provide accurate alignment and grade

of the casing pipe. Removal of material from an augured hole by washing will not be permitted. Small amounts of water may be used as a lubricant in the boring or jacking operation.

(ix) Water slurry for mini-directional boring may only be used for head lubrication and spoils return. The use of wet bores or jetting by using high-pressure liquids or large liquid volume boring is not an acceptable method of boring.

(x) The boring operator shall have full control of the direction of the boring tool at all times. Shallow, misdirected or other unsuccessful bores shall be abandoned and filled at the direction of Contractor at Subcontractor's expense. If a bore cannot be completed but has to be abandoned, any void shall be completely filled. Governing authorities and ROW owners may require abandoning the casing.

(xi) Under no circumstances will Subcontractor be allowed to cut or disturb pavement, asphalt, railroad ballast, or other Existing Facilities, or excavate within the relative limits of any roadway or railway surface to retrieve any lost boring apparatus.

(xii) Bore pull back reamers shall be a minimum of two inches (2) greater than the diameter of the casing.

(xiii) The maximum entry bore angle shall be fifteen (15) degrees as measured from grade at the bore entry to the deepest bore elevation.

(xiv) Bore pits shall be no less than: fifteen feet (15') from the edge of a public road; no less than five feet (5') from the edge of a driveway; no less than thirty feet (30') from railroad tracks, and will conform to the requirements of governing authorities and ROW owners or as required by the Drawings.

(xv) If the bore exits below the prescribed depth, the Subcontractor shall take measures to gradually return the bore depth to the prescribed depth.

(xvi) All bore pits shall be backfilled and compacted in eight-inch (8") lifts, or in accordance with Governing Authority or ROW owner. Surfaces shall be restored to original or better condition and to the satisfaction of Contractor, governing authorities, and ROW owners.

(xvii) When trenching is required from a bore pit to the end of plowing or trenching operations, prior to innerduct placement in the trench, the innerduct shall be bundled, tied and or bound by an accepted method to eliminate the possibility of the innerduct twisting and or waving in the trench.

(xviii) The boring subcontractor shall be responsible for proofing the bored duct installed. Tie-ins are the responsibility of the subcontractor making the tie-in.

(d) **Rock Identification - Bores.**

(i) If after two (2) unsuccessful attempts by Subcontractor to bore with soil boring machines due to the possibility of rocks, then the Contractor shall determine if rock conditions exist by:

(ii) Prior to additional boring, excavations indicate the existence of ledge rock.

(iii) Determining that "Hard Rock" exists if the rock is ten thousand (10,000) psi and higher and where a minimum of fifty thousand (50,000) pound rock-boring machines are used in combination with mud motors or special rock bits. If Contractor and Subcontractor cannot agree on the hardness of the rock, Subcontractor shall provide a core sample and shall have the sample tested. If the test shows that the sample rock has a compressive strength of less than 10,000 psi, Subcontractor shall pay for the coring and testing costs. If the test shows that the sample rock has a compressive strength of 10,000 psi or more, Contractor shall pay for the coring and testing costs. See Article E, Section 31 (g) and (h).

(iv) Determining that "Rock" exists if it is greater than three thousand (3,000) psi but less than ten thousand (10,000) psi rock including shot rock and concrete roadway fill, where a minimum of fifty thousand (50,000) pound rock-boring machines are used in combination with mud motors or special rock bits.

(v) All other bores shall be considered soil bores.

(e) **Railroad Boring Restrictions.**

(i) When directional bore methods are used, the bore depth with steel casing shall be a minimum of five feet (5') below base of rail and five feet (5') below natural ground. For depths greater than ten feet (10') below base of rail and five feet (5') below natural ground, a single HDPE SDR 11 casing may be used In lieu of a steel casing. Approved mini-directional wet bores shall be installed a minimum depth of ten feet (10') below the toe of ballast section and a minimum of five feet (5') feet below natural ground line.

(ii) Subcontractor shall not excavate into the side slopes of raised track beds. Backfill for excavations shall be mechanically tamped in six-inch (6") lifts to same density as adjoining earth, and as otherwise specified.

(iii) Steel casing shall be installed to a minimum of thirty feet (30') from the track centerline on each side of the track.

(iv) On Railroads, Bore locations shall be greater than one hundred feet (100') from bridges or culverts and fifty feet (50') from the nearest switch.

(v) Bore pits shall be a minimum of thirty feet (30') from the centerline of the track and never located in the slope, cut or fill section of the roadbed.

(vi) Blasting shall not be allowed.

(f) **Long Directional Bores.**

(i) When long boring requires the use of drilling mud, such as bentonite, no discharge or runoff will be allowed into waterways. Mud tank capacities shall be sized to hold excess material without spillage. The casing pipe entry point shall be appropriately enclosed and equipped with a sump pump to reclaim or discharge excess mud to a reuse or disposal tank. Earth spoiled by drilling mud shall be removed and disposed of by Subcontractor and the site refilled with clean material. The site shall be restored to a condition equal to or better than its original condition.

(ii) Sufficient personnel, equipment, and materials to contain drilling fluid that upwells to the surface or is discharged into a body of water shall be onsite during all drilling operations.

(iii) Subcontractor shall maintain a record of the drilling pressures maintained and the quantities of drilling fluid used during the entire boring operation. This record shall be tied to both time of day and station of the bore head. These records shall be made available to the Contractor at all times during the drilling operations and submitted as record at the conclusion of the operation.

(iv) Subcontractor shall maintain continuous visual inspection of the bore alignment at all times when the bore operation is proceeding without return of drilling fluid to the drill site. When the bore alignment is beneath a body of water, a visual inspection shall be made at the most accessible point immediately downstream of the bore alignment for changes in turbidity or color, which may indicate a fluid discharge into the waterway. Unusual conditions, including excessive loss of drilling fluid, shall be reported promptly to the Contractor.

(v) Drilling fluids shall be disposed of in an acceptable manner.

(g) **Exceptions.**

(i) If Subcontractor reasonably and prudently attempts a crossing bore several times, and is unsuccessful due to impassable obstructions, excluding rock, Subcontractor may request Contractor to apply for an open-cut permit.

(ii) In any such request, Subcontractor shall carefully set forth the facts and circumstances in writing and shall define what section of the crossing needs to be open-cut, and provide any additional information so requested by the Contractor or government authorities. The Contractor will prepare and submit the application, relying on information provided.

(iii) If an open-cut permit is granted, all Work shall be performed in accordance with the permit and "Changes in the Work" clause of these Subcontract Documents, Division I, Article E.

(h) **Open-Cut Installation**.

(i) Subcontractor shall comply with all Federal, State, County and Local laws, rules, regulations, and Contractor obtained permits when crossing lakes, canals, streams, or river crossings.

(ii) The bank or stream crossings shall be graded according to permit conditions to provide the required burial depth under the stream and to provide a proper pathway slope for the plow train or trencher to traverse the bank and make a smooth transition to the stream bottom. Transitions from normal depth to stream crossing depth shall be made smoothly without sharp bends in the innerduct. When grading the approach of stream banks, Subcontractor shall pull the spoil back from the bank and not push spoil into the stream. Permit related erosion measures must be implemented for the spoil piles.

(iii) Subcontractor shall comply with all permit conditions when diverting the stream in any way to construct a stream crossing. The use of cofferdams, flumed crossings etc. will be constructed only in accordance with the site specific permit conditions.

(iv) All cuts in banks and cofferdams shall be restored according to permit conditions.

(v) Restoration and erosion control shall be performed as required by the agency having jurisdiction and as accepted by Contractor.

(vi) It is the intent of these Specifications to require Subcontractor to install the innerduct below the bed of the canal, stream, river, or watercourse at such a depth that shall prevent flood water from affecting the Network by reason of the scouring action of the water.

9. Directional Bore Payment Guide.

(a) This Directional Bore Payment Guide shall be used as the basis for compensating Subcontractor for bore operations. Longer pay distances will be paid for the actual work performed when caused by unknown circumstances when approved by Contractor. Subcontractor shall notify Contractor of any unknown circumstances prior to the Work being performed to obtain Contractor approval for any additional pay length determination.

(b) The directional drilling design guide, A.G.A. Catalog No. L51730, as published by the American Gas Association is the basis for the calculations of the bore distances based on the use of 2-5/8" drill steel. If Subcontractor plans to use larger diameter drill steel, which may increase the bore length, Subcontractor shall obtain Contractor approval for additional pay length prior to performing the work, but Contractor is not obligated to make such approvals.

(c) Owner's cover requirement of the duct system is forty-two inches (42"). The pay length of the bore is defined as the horizontal distance measured between the point where the bored duct will have forty-two inches (42") inches of cover on bore start side and where the bored duct will have forty-two inches (42") of cover on the bore termination side. Subcontractor may excavate the bore and receive pits to allow for the forty-two-inch (42") cover requirement that would be the pay length demarcation points.

(d) Subcontractor is required to provide Contractor a bore profile for each completed bore that measures the depth in relation to distance for the total bore length. These actual measurements shall be recorded as the work is being performed in increments of a minimum of ten feet (10') or at the direction of Contractor.

(e) There are five parameters that need to be reviewed for each bore:

(i) Entry and exit angles. The design entry angle shall be a maximum of fifteen (15) degrees. All HDPE bores should be designed to this angle. On shallow steel bores, a minimum of an eight-(8) degree entry angle should be used.

(ii) The minimum bending radius of the bore components. The following formula will be used as the design guide for designing the radius of curvature for a HDD bores: R=70*D" where R equals the radius of curvature of circular bends in feet and D" equals the nominal diameter of the pipe in inches. The standard drill steel size for the 24,000-pound up to 50,000- pound machines is 2-5/8 inches. For the Duct bores and the HDPE cased bores, this would equate to a fixed design radius of 185 LF. The steel cased HDD bores would vary based on the size of the casing. An 8-inch steel casing will accommodate 12 each, 1¼-inch innerducts. The radius of curvature for this casing would be 560 LF. The

overage in bore lengths longer than that derived using this criteria would not be paid for unless the added length was dictated by parameters # 3 and # 4 as detailed below or Contractor approval for unknown circumstances or larger diameter drill steel.

(iii) The vertical component including owner/agency required clearances. As shown in Diagram #1 below, an on grade obstacle would require a duct bore with a total length of ninety-six feet (96') and a theoretical pay length of sixty-four feet (64'), but to be paid at a pay-length minimum of seventy feet (70'). The vertical clearance of the bore at that point is 6.3 feet. These values would be the same for a HDPE cased bore. Therefore, any duct or HDPE cased bore with a total vertical component (depth to obstruction plus required clearance) of 6.3 feet or less would have a pay-length minimum of seventy feet (70').

If the total vertical component is greater than 6.3 feet, the vertical component will determine the bore design. Every foot of depth beyond the 6.3 feet will add 7.46 LF of bore design/pay length.

The same calculations for the minimum parameters for a steel cased bore with a minimum eight (8) degree entry angle would yield a total length of 156 LF with a design/pay length of 93 LF and a total vertical component of 5.5 LF. The chart below details the footage changes as the entry angle approaches the fifteen-(15) degree maximum angle. Every foot of depth beyond the 19.1 feet will add 7.46 LF of bore design/pay length. For depths shallower than the 19.1 feet, the entry angle must be reduced.

The following chart is to be used as guideline for duct and HDPE cased bore and steel bore pay lengths:

	Duct and HDPE			Steel Cased		
	Cased Bore			Bore		
Vertical		Minimum	Actual		Minimum	Actual
Component	Entry	Design Length	Entry to Exit	Entry	Design Length	Entry to Exit
Ft	Angle	= Pay Footage	Bore Length	Angle	= Pay Footage	Bore Length
3.5	15	64	96	8	93	156
4	15	64	96	8	93	156
5	15	64	96	8	93	156
6	15	64	96	8.4	105	164
7	15	71	102	9.1	125	176
8	15	81	109	9.7	142	189
9	15	89	117	10.3	157	200
10	15	97	124	10.8	170	211
11	15	105	132	11.4	183	221
12	15	112	139	11.9	194	231
13	15	120	147	12.4	205	240
14	15	127	154	12.8	216	249
15	15	135	161	13.3	226	258
16	15	142	169	13.7	235	266
17	15	150	176	14.2	244	274
18	15	157	184	14.6	253	282
19	15	165	191	15	262	289
20	15	172	199	15	269	297
21	15	180	206	15	277	304
22	15	187	214	15	285	312
23	15	194	221	15	293	319
24	15	202	229	15	300	326
25	15	209	236	15	308	334
26	15	217	244	15	316	341
27	15	224	251	15	322	349
28	15	232	259	15	330	356
29	15	239	266	15	338	364
30	15	247	273	15	345	371

(iv) The horizontal distance of the obstacle that the bore needs to traverse including clear zones. If the distance across the obstacle is greater than that listed for the total vertical component above, then that distance will become the bore design/pay length. In addition, the chart above assumes a low point crossing. Should the bore require a horizontal distance be traversed once it has obtained grade, that horizontal distance must be added to the distance of the vertical component described above. Refer to Diagram #2 below.

(v) Owner requirements. Owner has set the following casing parameters:

- All bores are to be either Duct or HDPE-casing bores with the exception of those where the ROW owner specifies steel.

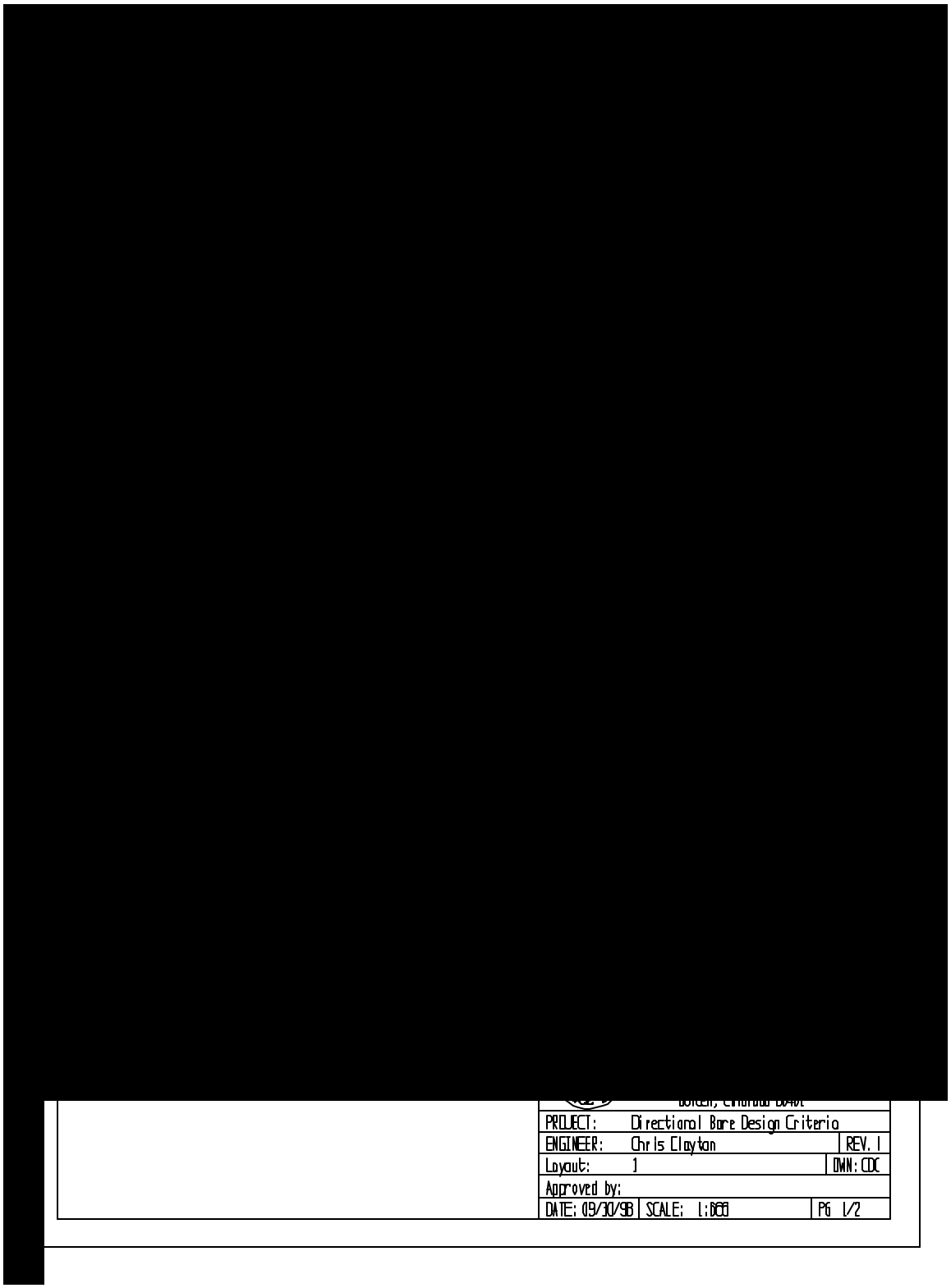
- All Duct bores (bores without casing) with the exception of common driveway crossings shall use SDR 9 Duct. Driveway bores and cased bores may use SDR 11 innerduct.

- Casing is required in all rock bores. In soil through cobble conditions, the use of casing is at the contractor's option.

- The standard casing provided will be an eight-inch (8") SDR 11 HDPE.

- For rock bores, Subcontractor may elect to use a ten-inch (10") SDR 9 HDPE.

- The use of steel casing is also Subcontractor's option. Where Subcontractor elects to use steel for Subcontractor's convenience, steel casing was not required by an agency, or the requirement to use of steel casing was not noted on the plans, there will be no increase in payment or adjustment in the pay length unless previously agreed to by Contractor.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ENGINEER: Chris Clayton
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Layout: 1
DWN: CDC
Approved by:
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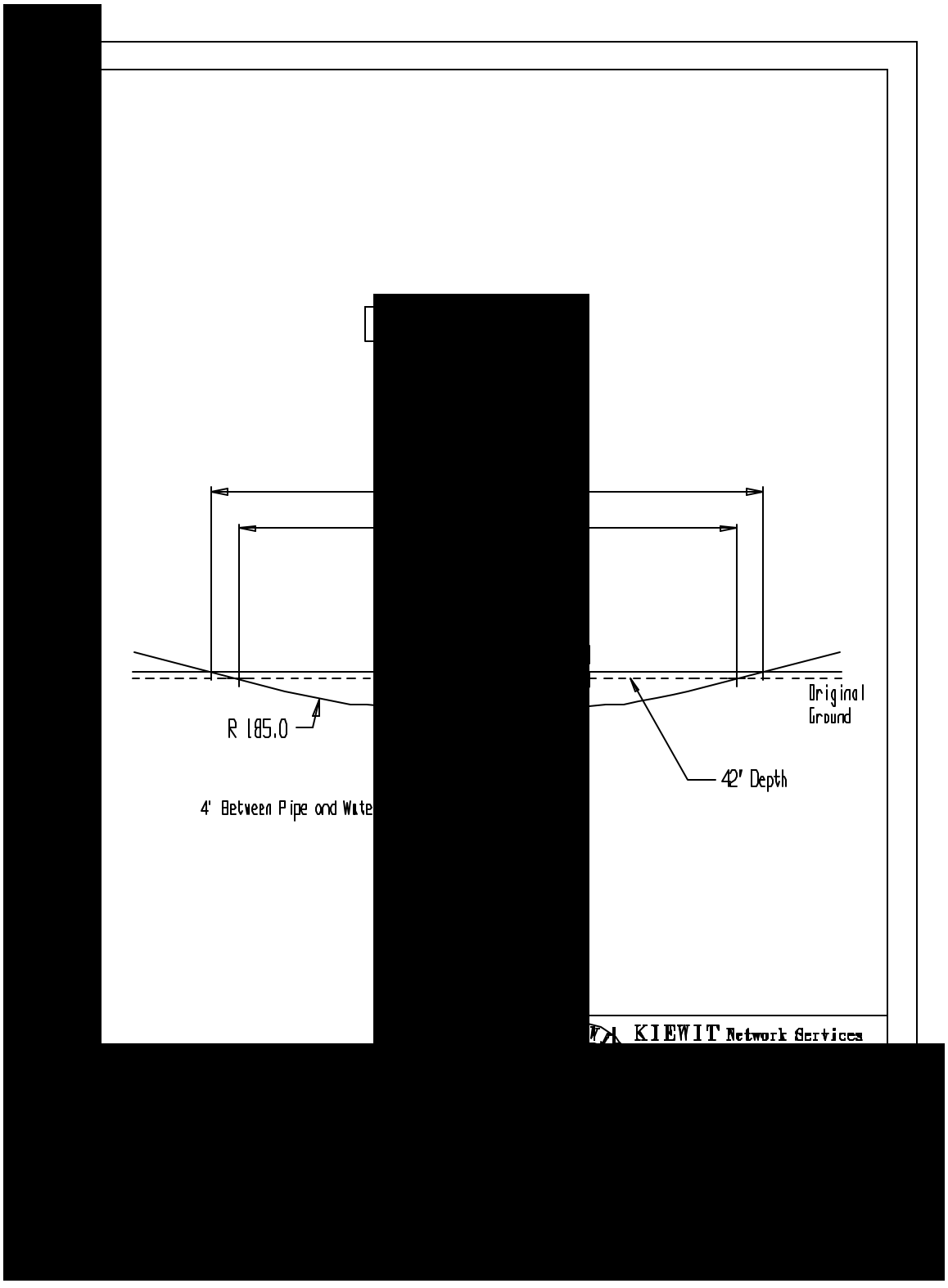
R 185.0
Original
Ground
42" Depth
KIEWIT Network Services

10. Common Excavation

(a) **General.** This specification describes common excavation Work necessary to install the Conduit System, including those excavations necessary to set manholes, handholes, bore pits, and other miscellaneous excavations required throughout performance of the Work.

(b) **Trench Excavation.**

(i) During trench excavations, materials suitable for backfilling shall be stockpiled in an orderly manner a sufficient distance from the banks of the trench to avoid overloading and to prevent slides or cave-ins. All material not suitable for backfill shall be removed and disposed of properly.

(ii) Wherever possible, the trench shall be excavated to permit the Conduit System to rest on undisturbed earth. Care shall be taken not to excavate below the depths indicated. Unauthorized over-excavation shall be backfilled with suitable bedding material and thoroughly compacted. Care shall be taken not to exceed the limits imposed by governing authorities, ROW owners, or permit requirements.

(iii) No unprotected open trench shall be allowed to remain at the end of the workday in public or private ROW. Trenches left open overnight or unattended shall be fenced or barricaded in accordance with the requirements of governing authorities and ROW owner and accepted by the Contractor. A trench shall not remain open overnight on railroad ROW unless approved in writing by the railroad representative on a site and date specific basis. Any open trench not back filled may be covered as accepted by Contractor in accordance with these specifications, Article A and the governing authorities' or ROW owners' rules and regulations.

(iv) Driveways, lanes, or roadways, which are open cut, shall be opened just prior to the duct placement. In no case shall the driveway, lane, or roadway be left impassable at the end of the day.

(v) The Conduit System trench line shall be as straight as practicable, following the staked alignment. The bottom of the trench shall be smooth and free from any sharp edges. The trench shall be kept clear of debris and loose rock. All changes in trench grade shall be gradual and accepted by the Contractor. In general the vertical change in grade shall not exceed one foot (1') foot in three feet (3') in length (1:3).

(c) **Sheeting and Shoring.**

(i) Subcontractor shall comply with all current and applicable Occupational Safety and Health Administration (OSHA), federal, state, and local rules and regulations governing the safety of men and material during excavation, installation, and backfilling operations.

(ii) Banks of trenches shall be properly shored and braced as may be necessary to facilitate excavation and to prevent caving, and to protect the workmen, adjacent property, and Existing Facilities. In areas where unstable material is encountered, shoring or sheeting may be required to prevent lateral

movement of material into the excavation. Sheeting, bracing, and shoring shall be designed and built to withstand all loads that might be caused by earth movement or pressure, and shall maintain the shape of the excavation under all circumstances.

(d) **Hand Trenching.**

(i) Hand trenching shall be performed to place the Conduit System under, over, or adjacent to Existing Facilities.

(ii) Handwork to grade the trench bottom, hand digging of test pits to expose Existing Facilities and to verify utility locations, and sections of handwork combined with careful backhoe excavation shall not be considered as hand trenching.

(iii) Unless otherwise designated, the Conduit System shall be placed below all Existing Facilities, which are encountered except when the Existing Facilities are at a depth greater than seventy-two inches (72") per Section 1. Clearances, both vertical and horizontal, shall be as indicated on the Drawings or as required by governing authorities and ROW owners.

(e) **Double Trenching.**

(i) Double trenching shall be performed to preserve special surface materials as indicated on the Drawings or as required by governing authority and ROW owners. Two (2) excavation passes shall accomplish trenching in the designated areas. The first pass shall remove the specified depth of special material and stockpile it on one (1) side of the trench. The second pass shall trench to the specified depth and stockpile the material on the other side of the trench.

(ii) In areas where double trenching has been performed, the backfill shall be placed in reverse order of the trenching. The top material shall not be mixed with the other materials.

(iii) The removal of vegetation and residue prior to trenching shall not be considered double trenching.

(f) **Trench Width.**

(i) All trenches shall be wide enough to provide ample room for proper installation of the Conduit System.

(ii) Where it is necessary to reduce the earth load on trench banks to prevent sliding or caving, trench banks may be cut back on slopes which shall not extend lower than twelve inches (12) above the top of the Conduit System.

(g) **Subgrade Preparation and Stabilization.**

Subgrade for manholes and handholes shall be firm and free from all loose materials, shall be free from mud and muck, and shall be sufficiently stable to remain firm and intact.

(h) **Subsurface Groundwater, Dewatering.**

When groundwater is encountered in excavations, Subcontractor shall dewater as required to provide for stability and firmness. Dewatering shall be performed as

needed for placement, inspections, measurement, and backfilling operations before and during installation of the Work.

11. Rock Excavation

(a) **General.**

(i) This specification prescribes rock excavation Work necessary to install the underground Conduit System, including those excavations necessary to set manholes, handholes, bore pits, and other miscellaneous excavations required throughout the performance of the Work.

(ii) Subcontractor shall determine the character and nature, quantity, and distribution of all subsurface material to be excavated, including an investigation of rock.

(iii) Those provisions in the previous Section 10 that are general in nature are applicable here, including paragraphs (b), (f), (g), and (h).

(b) **Classification of Earth – Common Versus Rock Excavation.**

(i) The term "Rock Excavation" shall be understood to indicate a method of removal and not a geological formation. Boulders or pieces of concrete below grade larger than one-half (½ cubic yard will be classified as rock if drilling, breaking, splitting, blasting, sawing, or other accepted methods are actually used for removal. If material which would otherwise be classified as rock as herein defined is mechanically removed without drilling, breaking, splitting, blasting, or sawing it will be considered "Common Excavation" for which no separate measurement and payment will be made. If larger equipment is brought in for the sole purpose of rock removal, as herein defined, then such removal will be considered "Rock Excavation" and will be paid for accordingly at the contract unit price for "Rock Excavation."

(ii) The following classifications of materials shall be used when using plowing or trenching methods to install the Conduit System. The Contractor will employ reasonable judgment making material classifications. "Rock Excavation" shall be defined as materials that cannot be ripped or excavated with equipment, operating in good mechanical condition, as specified hereinafter.

- Plowing: In locations where plowing methods are permitted, materials shall be classified as "Common Excavation" if the material can be properly ripped to the required plow depth in two (2) ripping passes with a D8N tractor with the tow of a D8N or equal. When the capability of the equipment is in question, Subcontractor shall provide a performance test at his own cost to verify capabilities. The performance test shall use a load cell recommended by the equipment manufacturer and acceptable to the Contractor. The location of the test shall be acceptable to the Contractor.

- Trenching: When trenching and rock is encountered, the following definitions apply:

  Ten thousand (10,000) psi rock and higher is considered "Hard Rock"

Greater than 3,000 psi, but less than 10,000-psi rock, including shot rock and concrete roadway fill is considered "Rock". Shot rock is defined as fifty percent (50%) or greater, boulders, concrete road fill or other rock.

(iii) Rock shall be removed by drilling, breaking, splitting, sawing, or otherwise to the required trench limits using specialized equipment or procedures. The use of three (3) or more additional ripping passes instead of sawing or excavating will not be considered “Rock Excavation” or a basis for extra payment.

(iv) The equipment used during “Rock Excavation” shall be designed for and suitable to “Rock Excavation.” Excavation by means of 225 Caterpillar-sized backhoe, pre-ripper plow, or cable plow does not qualify as “Rock Excavation.”

(c) **Rock Characteristics.** When rock is encountered along the FOC System alignment, Subcontractor shall excavate test pits, allowing Contractor to reasonably characterize depth to rock, depth and type of rock, and length of rock excavation. Sections of “Rock Excavation” evaluated to exceed one hundred feet (100') may require test pits at intervals a minimum of ten feet (10') and a maximum of one hundred feet (100') between pits. Test pit information may be part of the basis for the Contractor's determination on length and depths of “Rock Excavation” and removal.

(d) **Rock in Structure Excavations.**

(i) Excavations for handholes, bore pits, or other nonstructural items are not considered structural excavations and will be classified in accordance with the associated Conduit System trench.

(ii) For the purpose of material classification, structure excavation will be excavation required for the preparation of building sites incorporated into the Work. Structure excavations will be classified as rock when the material consists of boulders one-half (1/2) cubic yard in volume or greater, or all igneous, metamorphic, and sedimentary rock that may be in ledges, bedded deposits, or conglomerate deposits. The material will present all of the physical characteristics of rock and will require the continuous use of pneumatic or hydraulic tools or other specialized power equipment for its removal.

12. Concrete Encasement

(a) **Description.** This specification is for Work, including, but not limited to, preparation, forming, placing, curing, and all other Work incidental to the placement of concrete encasement of casing pipe, duct, or innerduct as indicated on the Drawings or as otherwise directed.

(b) **Material Requirements.**

(i) Concrete encasement will be furnished and installed in accordance with details shown on the drawings or as otherwise required by governing authorities and ROW owners.

(ii) The concrete shall be a minimum of one-and-one-half (1-½ sack mix unless otherwise indicated. Other products such as "Flow Fill" or flowable fill may be acceptable by Contractor on a case-by-case basis.

(iii) Subcontractor shall furnish the quantity and quality of concrete required. Subcontractor shall submit to Contractor the source and mix design one (1) week in advance for review and approval before the concrete is ordered from the supplier or furnished in the Work.

(c) **Placing.**

(i) Care shall be taken while placing concrete to prevent the casing pipe or duct from being damaged or displaced either in grade or alignment.

(ii) Fresh concrete shall be leveled and consolidated by rodding or spading only. Mechanical vibrators shall not be used unless accepted by the Contractor. Particular care shall be taken to keep concrete or other substances from entering the casing pipe or ducts.

(iii) After the initial set of the concrete, backfill material shall be placed and compacted in a manner that will not crack or damage the concrete.

(iv) In locations where railroad ballast rock is the only permitted backfill and where shown on the drawings, concrete encasement shall be covered with a plastic sheathing accepted by the Contractor.

(v) In cases where the casing pipe or duct pass above or below an underground obstruction or Existing Facility, including, but not limited to, a utility line, a minimum clearance of six inches (6") shall be maintained between the concrete and such Existing Facilities. A minimum of twelve inches (12") of clearance shall be maintained between the concrete encasement and a paralleling Existing Facility or utility. No Existing Facility or utility shall be contained within the concrete encasement.

13. Backfilling and Compaction

(a) **Description.** This section specifies the Work of backfilling and compacting excavations necessary to install the FOC System. Backfill, compaction, compaction testing, and surface treatments will not be measured for payment. They will be considered incidental to other elements of the Work.

(b) **General.**

(i) All excavations shall be backfilled at the end of each working day, except as otherwise authorized by the Contractor, governing authorities, and ROW owner. Where applicable, backfill shall be compacted and shaped to the original contour and drainage. Backfill and compaction shall be performed with extreme care so as not to damage the FOC System.

(ii) On finished areas including road surfaces, road shoulders, parking areas, lawns, and public ROW, backfill and compaction shall be in accordance with the governing authority and ROW owner having jurisdiction thereof, and in accordance with these Specifications or as indicated on the Drawings. In the event of a conflict between these Specifications or the Drawings, and the requirements of governing authorities or ROW owners, the more stringent requirements shall apply.

(c) **Earth Backfill.**

(i) Excavations shall be backfilled and compacted as much as possible with material removed from excavations and shall be crowned with surplus earth as necessary for proper settlement.

(ii) Material for backfill shall be as accepted by Contractor and composed of earth only and shall not contain unsuitable material, including, but not limited to, logs, stumps, frozen material, wood, grass, roots, broken concrete, boulders, trash, organic material, other debris or rocks greater than 4" in diameter.

(iii) All backfill material shall consist of loose earth having moisture content such that the required density of the compacted soil will be obtained with the compaction method used. Moisture content shall be distributed uniformly. Water for correction of moisture content shall be added sufficiently in advance so that proper moisture distribution and compaction will be obtained.

(iv) If rocks are removed from any backfill material, Subcontractor shall remove such rock and unused spoil from the Rights-of-Way. Subcontractor may dispose of the rock on the ROW with written approval of governing authorities or ROW owners.

(v) Rock will not be permitted in the backfill where it may interfere with plowing and cultivation, or the passage of farm vehicles and livestock. In this event, rock free soil shall be used to fill the excavation.

(vi) The Conduit System, whether installed in Common Excavation or Rock Excavation, shall be covered by an initial layer of select backfill. In Common Excavations, the Conduit System shall be covered with a four-inch (4") select backfill. In Rock Excavation, in addition to a four-inch (4") layer covering the Conduit System, two inches (2") of select backfill shall be placed beneath the Conduit System.

(vii) Well graded backfill with rock less than four inches (4") maximum dimension may be placed in excavations on top of the select backfill provided that enough smaller graded material is also used to allow complete compaction of the trench without damaging the Conduit System. If rock areas are within public Rights-of-Way, Subcontractor shall provide select backfill material to satisfy the backfill compaction requirements of the governing authority having jurisdiction thereof.

(viii) On a case by case basis with Contractor approval, after placement of the handhole at a splice location, Subcontractor may backfill to a level even with the top of the handhole with the excavation being left in the above condition until after fiber placement and splice completion. After the splice is completed, the Subcontractor shall complete the backfill of handhole pit in accordance with the Drawings.

(d) **Compaction.**

(i) Backfill material shall be placed and compacted in accordance with the requirements of governing authorities and ROW owners.

(ii) Backfill shall be compacted to meet the following conditions or the stringent requirements of governing authorities or ROW owners:

- Backfill under or within ten feet (10') from the edge of paved roads, or under unpaved roads, or under drives and parking areas shall

be compacted to a minimum of ninety-five percent (95%) of maximum density in accordance with ASTM D698.

- Backfill beyond ten feet (10') from the edge of paved or unpaved roads shall be compacted to a minimum of ninety percent (90%) of maximum density in accordance with ASTM D698.
- Backfill in unfinished areas and all other areas shall be compacted to a minimum of eighty-five percent (85%) of maximum density in accordance with ASTM D698.

(iii) Each lift shall be mechanically compacted. Subcontractor's method of placing and compacting the backfill shall be subject to the Contractor's review and approval, and be performed with equipment suitable for the intended purpose. Contractor's review and approval shall not relieve Subcontractor of full responsibility for meeting compaction requirements. Contractor may request adjustments to the procedure depending on changes in soil types and other conditions such as moisture content. Particular care shall be taken to compact backfill that will be beneath or adjacent to pipes, drives, roads, or other Existing Facilities.

(iv) All excavations that have not been acceptably backfilled and compacted, or which settle after backfilling, shall be removed and replaced or otherwise corrected in accordance with these specifications.

(v) Subcontractor shall install specified warning tape a minimum of one foot (1') below grade.

(vi) When an excavation is located under paved surfaces, cold-mix patch shall be placed as a temporary surface restoration as soon as possible after the completion of backfill compaction if permanent paving will not occur within one week, or as otherwise required by governing authorities and ROW owners.

(e) **Compaction Testing.**

Compaction testing shall be performed in accordance with the requirements of governing authorities or ROW owners.

14. Pipe Placement – Bridge Attachment

(a) **Description.** This section covers the minimum requirements for the attachment of the pipe to structures, including, but not limited to, concrete box culverts, and to road, railroad, and other types of bridges that may be constructed of steel, concrete, arch stone, or timber. The Work includes coring of abutments, diaphragms, or retaining walls as required**.**

(b) **Material Requirements.**

(i) Hangers and hardware required to attach the pipe to structures shall be as indicated on the Drawings. Unless otherwise specified on the Drawings, pipe used for structure attachments shall be bullet proof FRE except where GRS pipe is required by the structure owner's specifications. Attachments to steel structures will be accomplished by the use of accepted galvanized beam clamps and hangers.

(ii) All support hardware shall be hot dipped galvanized after manufacture according to ASTM A153, or ASTM A304 stainless steel, unless otherwise specified.

(iii) Insulator sleeves shall be “Garlock” or approved equal.

(iv) Bolts for connecting hanger brackets to structures shall be galvanized minimum grade eight (8) high strength bolts conforming to AASHTO M164. Galvanized bolts shall meet the galvanizing requirements of AASHTO M232.

(v) All nuts shall be placed with a locking compound, such as “Loctite” or approved equal. All nuts shall be locked with an additional locking nut, or double nutted. Nuts shall be torqued according to the equation: Torque = 0.25PD where Torque is the calculated torque, P = measured bolt tension in foot-pounds and D= normal bolt diameter in feet. The minimum bolt tension shall be according to AASHTO M164 and AASHTO M253. Galvanized nuts shall meet the requirements of AASHTO M164 type one (1). Galvanized nuts shall be oversized tapped the minimum required for proper assembly before galvanizing. Galvanized nuts shall be lubricated in accordance with AASHTO M291. Washers shall meet the requirements of AASHTO M293.

(vi) Primer shall meet the Federal Specification TT-P641. Primer paint shall be Zinc Dust-Zinc Oxide Type III, Formula A-6-86 Zinc Dust Zinc Oxide Primer. Galvanizing repair paint shall meet the requirements of Federal Specification MIL-P-21035 (Ships) Paint, High Zinc Dust Content, Galvanizing Repair. Formula A-9-73 – Galvanizing Repair Paint, High Zinc Dust Content.

(c) **Pipe Placement.**

(i) Subcontractor shall not attach the pipe to the structure fascia or to the lowest point on the underside of the structure. On any overhead crossing of a railroad track, the pipe shall be installed a minimum of twenty-seven feet (27') above the top of the rail.

(ii) Pipe shall be attached to structures and sloped to drain as indicated on the Drawings.

(iii) Work on any structure shall not disrupt road or railroad traffic on or below the structure unless approved by governing authorities and ROW owners. The facility owner will be allowed to inspect the Work at any time during construction.

(iv) When indicated on the Drawings, bridge abutments and other structures shall be cored to allow passage of the Conduit System. Coring shall be of the diameter and at the location indicated on the Drawings. After placement, the remaining space between the outside of the pipe and the cored hole shall be filled with non-shrink grout or other accepted material unless otherwise indicated on the Drawings. The coring of structures, including, but not limited to, bridge abutments, diaphragms, and retaining walls will not be paid for separately but will be considered incidental to attachment work.

(v) The pipe shall extend outside the bridge abutments into the ground with bends as indicated on the Drawings. The bending and placing of the Conduit System outside of structures, including, but not limited to, bridge abutments will not be paid for separately but will be considered incidental to the attachment Work.

(vi) Drilling steel bridge structures or field welding will not be allowed on any steel structure or bridge unless approved by the facility owner. The attachment to concrete structures and concrete bridges will be accomplished by the use of epoxy anchor bolts in drilled holes or as specified by the governing authority and facility owner, and as shown on the Drawings. The use of driven or explosive set anchors will not be permitted.

(vii) All field cuts or holes drilled into parts shall be painted before final assembly with accepted zinc coating. Areas of steel structures that are to be covered by hanger brackets shall be protected by spot painting the area to be covered plus two inches (2") beyond the contact area. The surface shall first be cleaned according to SSPC-SPW, SP2 or SP3. The surface shall then be primed with an accepted universal primer, such as Wasser MC Miomastic. The primer coat shall be followed by a minimum of one coat of epoxy mastic, such as Amerlock 400 AL, Carbomastic 15LO, Chemical-Mastic CM-15-SF, Dupont 25P or Rustoleum 9115 Aluminum, 9171 Tan or 9179 Black, or approved equal.

(viii) Exposed pipe shall be supported at intervals as shown on the Drawings but not exceeding ten feet (10'). Approved expansion joints will be installed at all structure joints and in no case will the spacing between expansion joints of the casing pipe exceed one hundred lineal feet (100 LF) intervals or manufacturer's recommendations. All supports, support spacing, expansion joint, and expansion joints spacing shall meet or exceed the specifications of the governing authority or facility owner.

(ix) Insulator sleeves shall be provided and installed by Subcontractor if required per the Drawings or by governing authorities or the facility owner. Insulator sleeves are necessary to insulate the duct from bridge structure and prevent electrolysis damage to the bridge or duct.

15. Cable Installation, Splicing and Testing

(a) **Description.**

(i) This specification is for Work to cover the FOC reel testing, installation of cable, cable splicing and fiber optic link/span proofing between ILA/3R/Gateway.

(ii) All cable reels will be approximately fifty-four inches (54") wide by ninety-six inches (96") high and weigh approximately 8500 lbs. The fiber counts will be a minimum of 96 typically with higher or lower counts as designated by Owner. Reel lengths will be approximately 28,978 feet.

(iii) Subcontractor shall be responsible for the FOC upon receipt until Contractor acceptance, although Fiber Cable testing is not required on delivery, but is at the option and expense of Subcontractor.

(iv) The preferred method to install cable is blowing. The FOC System has been designed to install the cable by blowing. Handholes have been placed at approximately thirty-six hundred feet (3,600') to accommodate cable cascading to attain greater installation cable length.

(v) Pull methods may be used only when accepted by Contractor.

(vi) All splice points are to be fusion spliced.

(vii) All spans are to be proofed bi-directionally with an OTDR at 1550nm / 1625nm and end-to-end power loss is to be tested and recorded. All these tests shall be saved electronically for Contractor to review.

(viii) All data to be collected will be delivered on contractor approved hardcopy logs and electronic media.

(ix) Contractor will approve all fiber optic splicing and proofing technicians through an approved pre-qualification program.

(x) Contractor will inspect all hand tools and test equipment at anytime prior to or during the project. A list of standard tools is listed in the Fiber Optic Engineering Handbook.

(xi) Contractor will be supplying a fiber optic engineering handbook that will be used to assist Subcontractor and Quality Control Field Engineers/Inspectors who will be verifying conformance to these technical requirements.

(b) **Material Requirements.**

(i) Contractor will furnish the FOC and cable labels. All FOC will become the financial and physical responsibility of Subcontractor upon delivery.

(ii) Breakaway swivel connectors pull line for FOC pulling, tie wraps, lubricant, and all other required materials shall be furnished by Subcontractor.

(iii) Subcontractor shall provide pulling grip, bending shoes, and all other supplies and equipment.

(iv) All splice enclosures, cable locating and grounding equipment and splice sleeves will be furnished by Contractor. These splice enclosure kits will be provided in one box of materials per splice location.

(c) **Cable Placement Plan.**

(i) At least two (2) weeks prior to beginning cable-placing operations, Subcontractor shall submit to Contractor a cable-placing plan. This proposed plan should outline the types of equipment and overnight cable protection, the amount of manpower, and plan of action for each reel to be placed. Cable may be placed by blowing or pulling (when accepted by Contractor) techniques. When pulling fiber, break away swivel along with a Slip Clutch Capstan Winch that shows the dynamometer reading shall be used at all times.

(ii) The proposed plan will be reviewed for compliance with the Specifications within one (1) week from submittal. Subcontractor shall correct conflicts before cable placing will be allowed.

(iii) Subcontractor shall follow the accepted cable-placing plan. Deviations from the cable-placing plan will not be allowed without the prior approval of Contractor.

(iv) The Owner-supplied FOC shall be installed in the orange duct, which will be located on the bottom of the duct bank. Contractor shall maintain the orange color code system of Owner FOC throughout the Network.

(v) All FOC placement sheets and diagrams will be filled out in their entirety. These will be filed with the Fiber Optic Field Engineers.

(vi) Contractor has the option of using a preferred spooling method of cable placement such as the cable extractor as long as it is operated within cable manufacturer's guidelines that are located in the fiber optic engineering handbook. "Figure-eighting" of cable on the ground is a procedure that should be used only when the cable extractor/re-spooler is not recommended. When "figure-eighting" is performed, the cable should be placed on plywood or other ground cover.

(d) **Cable Handling.**

(i) Subcontractor shall transport cable reels and other Contractor-furnished material from designated storage yards to the site. Cable reels shall be placed upright on a level area and securely blocked to prevent accidental movement. Partially placed cable reels to be left on the ROW overnight or for an extended period of time shall be covered with a heavy steel box or other methods acceptable to Contractor. Full unplaced reels shall not be left overnight on the ROW.

(ii) Subcontractor shall inspect the cable prior to placement and notify Contractor of damage. Cable shall not be subjected to rough treatment or sharp bending that could cause crushing or kinking. Cable will be tested in one direction at 1550nm/1625nm at Subcontractor's option. All armor will be tested for continuity at Subcontractor's option. All manufacturer's recommendations for cable handling shall be followed. All Manufacturer supplied cable data sheets/birth certificates will be turned into Contractor upon Fiber Cable receipt and inspection.

(e) **Placing Length.**

(i) Prior to beginning operations, Subcontractor shall examine each manhole and handhole and each duct or innerduct section. Subcontractor shall determine if cable will be placed from splice location to splice location or if assistance will be required at intermediate locations.

(ii) Contractor will assist the subcontractor with a preliminary design as to the exact starting point for placement and location of splice handholes. In the event additional handholes will need to be placed for splicing locations, Contractor will provide services to set these handholes for the placement subcontractor.

(f) **Manhole and Handhole Preparation for Cable Pulling.**

Subcontractor shall prepare manholes and handholes to provide a smooth path through the manholes and handholes for the cable and pull line and to ensure that cable lubricant, once applied to the cable or duct, will be retained inside the duct system for the duration of the cable placing operation. Subcontractor shall prepare rigging in the manholes to ensure that the cable will not bend to less than the minimum cable-bending radius.

- Manholes or Handholes with Duct: In intermediate manholes or handholes without continuous duct, previously placed duct shall be overlapped at the midpoint of the manhole. The two ends of duct shall be joined together securely to provide a continuous duct

arrangement. If the opposing ducts do not line up, accepted bending shoes or pulley wheels and bracing shall be used.

- Manholes or Handholes without Duct: All intermediate manholes or handholes shall be bridged to provide a smooth cable path and transfer of lubricant. For manholes with a large offset or a change in direction, sheaves or quadrant blocks shall be used as required and shall be securely tied in position to guide the cable into the duct to prevent cable sheath abrasion at the duct entrance. Lubrication points shall be provided as required.
- Feed Manholes or Handholes: The feed manhole or handhole shall have a smooth cable feeder extended out of the manhole or handhole. The cable feed apparatus shall be securely fastened to ensure that specified minimum bends are not exceeded. The feed manhole or handhole shall be rigged to ensure that the cable passes directly and freely over a sheave or quadrant block, and directly into the duct entrance without rubbing against parts of the rigging.
- Pull Manhole or Handhole: A pull manhole or handhole for both the placement of the pull line and cable shall be rigged to ensure that the pull line passes directly and freely from the duct entrance into the manhole or handhole, around a snatch block, up the manhole or handhole chimney, over a manhole or handhole sheave or quadrant block, and directly to the capstan winch without rubbing against parts of the manhole or handhole rigging.

(g) **Manholes and Handholes for Splicing and Assisting in FOC Installation.**

Splice and assist manholes and handholes shall be placed prior to cable placement, and shall be prepared and rigged for cable placement similar to the requirements previously specified for manholes and handholes.

(h) **Cable Placement.**

(i) Subcontractor shall install the single armored FOC in existing duct. Contractor supplied FOC shall be installed in the orange duct. Subcontractor shall maintain the Orange color code system for FOC installation throughout the Conduit System.

(ii) Handholes are located approximately every three thousand six hundred feet (3,600') with additional handholes located at bores and bridges. Subcontractor shall coil one loop of the FOC around the handhole and place the cable in the furnished cable holders. In splice point manholes or handholes, fifty feet (50') of each FOC shall be coiled in the splice handhole. The splice point manholes or handholes are located at approximately every twenty-eight thousand eight hundred feet (28,800'). Each fiber cable reel will be marked to indicate the cable footage length. Subcontractor shall install the FOC in accordance with the Subcontract Documents with special attention given to the fiber cable manufacture's recommendations and standards for cable handling and installation.

(iii) Contractor reserves the right to have Subcontractor test all equipment prior to any cable placement.

(iv) At each splice location the cable ends will be sealed watertight at all times to keep water from entering the cable ends.

(v) When possible, the entire length of cable shall be placed in one uninterrupted operation. At no time shall any reels be unmanned during cable installation.

(vi) Subcontractor shall have working radio communications between all personnel involved in the cable placement. Cable placement shall not begin unless radio communications are onsite and operating.

(vii) Subcontractor shall calibrate all cable placing equipment each day before cable pulling begins.

(viii) Lubrication shall be provided as recommended by the lubricant manufacturer to minimize tension on the cable.

(ix) Cable shall be placed with sufficient control of speed to prevent cable damage.

(x) When cable placing through the duct is too difficult or otherwise not possible, the duct shall be dug up and cut and the cable shall be pulled through or a blowing assist shall be installed. Whenever the duct must be dug up due to the duct being damaged or improperly placed, the addition dig up expense shall be the responsibility of the duct installer. If the duct is not damaged or no fault can be found with the duct, the dig up expense shall be the responsibility of the Subcontractor. After the cable is placed, the duct shall be repaired by the use of split couplers and joined. Backfilling shall be per the requirements of Section 13.

(xi) For placement by blowing, Subcontractor shall install airtight couplings at handholes at bores and bridges that are less than thirty-six hundred feet (3,600'). Subcontractor shall utilize the blowing machine manufacturer's approved procedures.

(i) **Cable Pulling.**

(i) Subcontractor shall furnish a pull line winch that will meet the following requirements:

- Pulling force maximum of one thousand (1,000) pounds.
- Remote start and stop controls.
- Minimum capstan diameter of twelve inches (12"). Mid-assist winch shall have a minimum capstan diameter of thirty inches (30").
- A running line tension meter recorder.

(ii) The pull line shall be placed between pulling sections with no line splices.

(iii) The innerduct or conduit does not have a pull line installed. If Subcontractor plans to pull the fiber cable, Subcontractor shall install the pull line with a minimum of twenty-five feet (25') of pull line shall be left in each pull location beyond the duct face.

(iv) The maximum pulling tension is six hundred (600) lbs. and the minimum

bending radius is: (A) dynamic (cable in movement) equals twenty (20) times outside diameter of the cable; and (B) static (cable in place) equals ten (10) times outside diameter of the cable. These minimums shall be strictly adhered to at all times when placing excess cable in handholes for splicing and slack coils.

(v) Cable shall be installed using a winch equipped with a recording running line dynamometer graph to measure and record the pulling tension. The graph shall run continuously through the pulling operation. If tensions at the recording running line dynamometer approach or exceed the allowable tensile limit, the pull shall be stopped and the winch moved closer to the pulling end of the cable. When a mid-point assist cable puller is used in a pull length, this cable puller shall also have a recording running line dynamometer.

(vi) At the end of each pull, Subcontractor and Contractor shall sign and date the recording running-line dynamometer graph and record the reel number. Abnormalities in a graph of a cable reel pull shall be explained on the graph. All graphs shall be submitted to Contractor.

(vii) An accepted cable grip with pulling eye shall be attached to the cable end. The pulling eye on the cable grip shall be connected to the pulling line using a breakaway away swivel along with a Slip Clutch Capstan Winch. The cable shall be pulled off the top of the cable reel by hand during the cable pull to maintain cable slack and to prevent reverse bends. The cable reel shall be tended for the entire pull. The recording running line dynamometer shall monitor the pull line tension just ahead of the capstan.

(j) **Cable Cutting.**

Subcontractor shall not cut the cable without written approval from Contractor. The fiber cable shall not be cut or spliced at bridges, road, pipe or other crossings without written approval from Contractor.

(k) **Cable Racking – Manholes, or Vaults.**

(i) After cable placement, all placing hardware and lubricant shall be removed.

(ii) Racking shall be started at the center manhole and proceed in each direction towards the cable ends. The necessary cable slack shall be pulled by hand. Subcontractor shall use caution when pulling cable to prevent damage. The cable shall then be covered with split duct, if bare, and laid on the racking shelves along the sidewalls at the same height as it enters and exits or as instructed by Contractor. Secure the duct with cable to the manhole hardware using plastic tie wraps. All cable coils in intermediate manholes shall be gently formed and secured to the manhole hardware in a safe location using plastic tie wraps. Cable coils shall not be covered with split innerduct.

(iii) Excess cable in the splice manholes shall be coiled by hand. Certain pull manholes shall have a specified amount of cable coiled in them as indicated on the Drawings. The cable shall be coiled from the cable end toward the duct face of the manhole. Bundle the turns of the coil together with loosely applied plastic tie wraps at several locations on the circumference of the coil. The coil shall then be racked to a sidewall in a safe location using plastic tie wraps. Subcontractor shall perform splicing.

(iv) Manholes shall be cleaned after the cable is installed. All manhole hardware shall be installed and secured. The manhole lid shall be cleaned and properly placed.

(l) **Cable Splicing, Termination, and Testing.**

(i) Subcontractor shall utilize and maintain the FOC reel testing, splicing and proofing documentation system that will be supplied by Contractor to archive all tests on floppy diskettes and be available for review by Contractor at any time. Subcontractor will make available its OTDR, Power Meter and Fusion Splicers emulation software package to Contractor. The splice test documentation system shall archive test data records in a written and / or electronic format acceptable to Contractor.

(ii) All splice environments will be kept as clean as possible and no smoking, eating or drinking will be permitted inside.

(iii) The preferred method of cleaving will be with an electronic cleaver but a mechanical cleaver will be accepted.

(iv) The preferred method of stripping will be with a thermal stripping tool but microstrips will be accepted. The mechanical Miller strippers will not be allowed.

(v) The fusion splicers electrodes will be changed every one thousand (1000) splices and the used electrodes turned into the QC Field Engineers

(vi) All FOC preparation will be conducted inside a temperature-controlled vehicle. At no time will FOC be opened up in the elements. All fiber trays, buffer tubes and cables will be labeled as to their inbound and outbound directions.

(vii) Subcontractor shall fusion splice the FOC as splice points become available during FOC installation and as shown on the Splice Assignment Sheet. All fusion splices shall be a maximum of .04dB per splice as indicated on the splice machine's video screen. All spliced fibers will be protected by a fiber optic heat-shrink sleeve. A heat oven shall be used to shrink all sleeves. Care must be exercised to prevent damage to exposed fibers by overheating. At each splice point, Subcontractor shall ground the FOC from the splice case to an existing ground rod and install a locate system device as per the Drawings. During the splicing process, a technician will be located in the closest ILA/3R/Gateway with an OTDR. If such facilities are available, this technician will scan the FOC as splices are made, verifying the integrity of all the fibers in the next cable segment.

(viii) If after three (3) attempts, Subcontractor is not able to produce a fiber splice loss value of .04dB or less then a splice loss of .06dB will be acceptable. If after two (2) additional attempts, a value of less than .06 dB is not achievable, then the splice will be noted as an out-of-specification splice.

(ix) Subcontractor shall continue splicing to complete all the required splice points, located approximately every twenty eight thousand eight hundred feet (28,800'), between ILA/3R/Gateway facilities. Subcontractor shall also terminate the fiber cable at the ILA/3R/Gateway facilities by fusion splicing to factory fabricated pigtails.

(x) Subcontractor shall be very careful when wrapping the fiber in the appropriate trays so as not to introduce any type of macrobends that could cause severe signal losses at 1550nm and 1625nm.

(xi) Subcontractor shall clean off all gel from the fibers and keep the fiber splice trays free of all dirt, gel and coating particles.

(xii) Upon completion of all splicing requirements, the following tests shall be performed from end points designated on the Splice Loss Worksheet and all results archived:

- Subcontractor shall collect and record on the Link Loss and Power Levels Worksheet overall span loss data for all fibers by performing bi-directional OTDR end-to end span tests at both 1550 nm and 1625 nm wavelengths. Loss measurements will be recorded with a Power Meter with a stable laser light source in one direction at 1550 nm and 1625 nm.

- Subcontractor shall collect and record on the Splice Loss Worksheet and electronically if preferred splice losses for each field fiber splice by observing estimated loss on fusion splicer.

- During the proofing process, each pigtail shall be visually inspected to verify fiber color and buffer tube color. This format should be logged in the OTDR's file and also a link/span naming criteria between ILA/3R/Gateways will used that will be supplied by Contractor. As each fiber is scanned, the technicians should be in contact with each other using a fiber phone. Visual inspection should be used to verify the fiber color and buffer tube color of the fiber on the receiving end matches the fiber color and buffer tube color of the fiber on the transmitting end. All fiber terminal block frames will be labeled with fiber colors, buffer tube colors and inbound/outbound cable direction.

- All unidirectional splice losses shall be .13dB or less. After testing is completed in one direction the same tests will be conducted in the opposite direction utilizing the same loss parameters. Upon completing the secondary unidirectional OTDR tests the traces will be averaged. The bi-directional OTDR average of each individual splice loss will be .08dB per fusion splice.

- All end-to-end losses will be conducted in one direction using a Power meter and a stable laser light source. The levels shall be stored electronically and on hard copy. The maximum connector loss shall be .50dB and the approximately loss of signal per km of fiber @1550nm shall be no more than .20dB and @1625nm shall be no more than .25dB.

(xiii) All testing shall be facilitated by attaching a 1km-launch reel between the OTDR/Stable laser light source and a jumper between the Power Meter and the termination panel bulkhead. Loss measurements shall be measured and recorded in one direction and the OTDR trace values and events shall be measured in both directions and then be averaged.

(xiv) The loss value of the pigtail connector and its associated splice will not exceed 0.50 dB.

(xv) The cable sheath for all armored cable of each installed reel of cable shall be tested for continuity and the results recorded on the Splice Loss Worksheet.

(xvi) All manufacturer's installation manuals will be followed. All these manuals will be located in the materials section of the Fiber optic Engineering Handbook.

(xvii) The Fiber Optic Engineering Handbook guidelines procedures for "FIBER OPTIC CABLE RECEIVING", "FIBER OPTIC CABLE INSTALLATION AND PLACEMENT", "ILA / 3R SITES- CONSTRUCTION AND ENGINEERING", FIBER OPTIC CABLE PREPPING AND SPLICING", "FIBER OPTIC CABLE SPAN PROOFING / ACCEPTANCE and DOCUMENTATION AND REPOORTING" will be followed including the technical requirements of this section. The splicing and testing crews performance will be judged by the Fiber Optic Field Engineers who will follow the criteria outlined in this section including the guidelines outlined in the Fiber Optic Engineering Handbook.

(xviii) The Contractor reserves the right to inspect and approve all fusion splicers and OTDRs as acceptable for use. All OTDRs and Power Meters shall be calibrated every ninety (90) days and a sticker with the date of calibration form the factory or certified test lab shall be fixed to the equipment (calibration certificates shall be kept with the equipment for presentation to the Contractor upon request). To insure acceptable splices prior to closing the splice case and splice handhole, Subcontractor shall use fusion splicers that utilize the "LID" system or a profile alignment type system.:

16. Cable Damage During Installation

(a) If the FOC becomes damaged due to Subcontractor's operations, Subcontractor shall stop its operations and notify Contractor immediately. Contractor, at its sole discretion, will decide whether to replace the entire reel of cable, to install a splice at the damaged section, or another accepted repair method at Subcontractor's expense.

(b) If Contractor decides to replace the entire reel of cable, Subcontractor shall begin the installation at the last designated splice point and replace the new cable in the same location. The damaged cable between these points shall be removed from the ground, coiled, tagged, and delivered to Contractor. Installation of new cable to replace damaged cable shall not be a basis of extra payment. In addition to installation of the new cable, Subcontractor shall reimburse Contractor the entire costs of the replacement reel of cable.

(c) If Contractor decides to install a splice at the damaged point, Subcontractor shall carefully excavate from the damaged point a distance along the cable as directed by Contractor and expose the cable. A splice box shall be installed at this point. Repairs shall proceed as directed by the Contractor. Subcontractor shall be responsible for all costs including but not limited to splicing, handhole, splice case and handhole installation.

(d) If damaged cable appears during installation, such as a manufacturing defect, Subcontractor shall stop the installation of the cable immediately and notify the Contractor requesting instruction.

17. Cable Placing and Splicing – Bonding and Grounding

(a) **Description.**

(i) This section covers the installation of bonding and grounding items to protect against stray voltages (lightning and induced 60-hertz voltage) to minimize personal injury, equipment damage, and service interruptions.

(ii) Bonding and grounding work shall be performed as indicated on the Drawings and as specified in these Specifications.

(iii) All materials shall be furnished as specified herein, and as indicated on the Drawings and Subcontract Documents.

(b) **General Construction.**

(i) Subcontractor shall bond all metal racking hardware, if any, in all manholes and handholes as specified and as indicated on the Drawings

(ii) Steel pipe conduit entering a manhole or handhole shall be bonded to metal racking hardware. A No. 6 AWG insulated solid copper conductor shall be attached to the steel pipe with a grounding pipe clamp. The other end of the conductor shall be bolted to the hardware with a two-(2) hole connector exothermically welded to the conductor.

(iii) In splice manholes Subcontractor shall furnish and install a thirty-foot (30') coil of No. 6 AWG insulated solid copper conductor with two (2) hole connectors exothermically welded to each end. One end of the conductor shall be attached to the manhole ground lug with a stainless steel bolt. The coil of conductor shall be attached to a cable rack with a plastic tie wrap.

(iv) In splice manholes, Subcontractor shall furnish and install a No. 6 AWG insulated solid copper conductor. The conductor shall be exothermically welded to the ground rod in the locator box and shall be bonded to the splice manhole.

(v) As shown on the drawings, Subcontractor shall install a filter-protector by attaching it to the cable sheath and a ground rod. At these locations, Subcontractor shall furnish and install a ground rod if there is no locator box.

(vi) In splice handholes, Subcontractor shall furnish and install a No. 6 AWG insulated solid copper conductor. The conductor shall be exothermically welded to the ground rod in the locator box and shall be bonded to the splice closure.

(vii) Subcontractor shall ground the fiber cable from the splice box to an existing ground rod.

(viii) Exothermic welding shall be performed in accordance with the specifications of the manufacturer of exothermic weld materials.

(ix) In locator boxes, subcontractor shall furnish and install a ground rod as indicated on the Drawings and as specified in these Specifications. The ground rod shall be driven into the earth through a 1-1/2” opening in the bottom of the locator box. The top 2” (+/- ¼”) of the ground rod shall remain exposed in the locator box for weld connection of the ground wire. The 1-1/2” conduit shall extend not more than 4” below the locator box.

(x) All penetrations into splice manholes shall be sealed with a Type CSB conduit sealing bushing, as manufactured by OZ/GEDNEY.

(xi) All ground rods shall be minimum 5/8" x 8' copper clad steel. In rock areas, two 20-foot #4 AWG bare copper wire (grounding electrode), laid in bottom of trench, shall be extended in each direction from locator box, to form grounding electrode, instead of a ground rod.

(xii) All concrete manholes and handholes shall be provided with a bonding lug. The bonding lug shall be accessible from the cover, and shall be bonded to the reinforcing steel. The bonding lug shall be metallic, and at least 1" x 2" x ¼" thick, and offset from the surface of the concrete to facilitate connection of a clamp. If the manhole/handhole is in close proximity to a driven ground rod or is used for the filter protector or locator box, the bonding lug shall be connected to this ground rod, with a #6 AWG conductor.

(xiii) All metallic manholes and handholes shall be provided with a bonding lug. The bonding lug shall be accessible from the cover, and shall be bonded to the manhole/handhole steel. The bonding lug shall be metallic, and at least 1" x 2" x ¼" thick, and offset from the surface of the manhole/handhole to facilitate connection of a clamp. If the manhole/handhole is in close proximity to a driven ground rod, used for the filter protector or locator box, the bonding lug shall be connected to this ground rod, with a #6 AWG conductor.

(xiv) At designated steel pipe casing locations, Subcontractor shall bond all metallic parts with a No. 6 AWG insulated solid copper conductor. The conductor shall be exothermically welded to the steel pipe and all other metallic parts. If the pipe is in close proximity to a driven ground rod used for the filter protector, or a locator box the No. 6 AWG conductor shall be attached to this ground rod.

18. Manhole and Handhole Placement

(a) **Description.** This section covers the installation of manholes and handholes for housing FOC System.

(b) **Material Requirements.**

(i) Handholes shall be forty-eight-inch (48") diameter handholes as shown in the Drawings. Handholes shall be provided with a polymer concrete frame and cover when specified to be buried and provided with a cast iron frame and cover when specified to be exposed. Polymer concrete covers shall have an EMS marker embedded within the cover. Polymer concrete covers shall be load rated to 20,000 pounds with a non-skid surface and be secured by hex head bolts. Cast iron frame and covers shall have an AASHTO HS-20 load rated surcharge in addition to normal soil pressure.

(ii) Where handholes and manholes are placed in roadways, they shall have a AASHTO HS-20 load rated surcharge in addition to normal soil pressure. Handhole placement between fifteen feet (15') and twenty-five feet (25') from the centerline of railroad tracks shall be AASHTO HS-20 loaded.

(iii) When handholes and manholes are placed within fifteen feet (15') of a railroad track centerline, they shall be load rated for a Cooper E-80 surcharge in addition to normal soil pressure.

(c) **Handhole and Manhole Placement.**

(i) Handholes shall be placed at the end of duct reels, approximately every three thousand six hundred feet (3,600') for HDPE ducts and one thousand five hundred feet (1,500') for PVC duct. Handholes shall be located on one (1) side of every bore location except if the pay length of the bore is less than one hundred feet (100') and the bore is closer than two thousand feet (2,000') from another handhole. Handholes shall be placed on one (1) side of each bridge attachment.

(ii) Subcontractor shall install handholes at locations as shown on the Drawings and as directed by Contractor. Handholes shall not be placed within fifteen feet (15') feet from the edge of roadway pavements or within thirty feet (30') from the centerline of railroad tracks without prior written authorization.

(iii) Handholes shall be set level on a base of a minimum thickness of twelve inches (12") consisting of clean gravel or crushed stone with a minimum diameter of three-quarter inch (3/4") and a maximum diameter one-and-one-half inches (1-1/2"). Each handhole shall be installed prior to placing cable.

(iv) Minimum cover for handholes shall be six inches (6") and a maximum of twelve inches (12") below finished grade. A marker shall be placed to mark the location. At all splice manhole locations, a locate-system box shall be installed in close proximity to the splice handhole. The size of the locate-system box shall be twelve inches (12") by twelve inches (12") by twelve inches (12"), and the top side of the box shall be between finished grade and six inches (6") below grade.

(v) Handholes shall not be installed on steep banks or slopes where the cover can not be leveled within a tolerance of one inch (1") of drop to twelve inches (12") of grade.

(vi) Handholes shall be placed at all splice locations. Handholes may be ordered at other locations directed by Contractor or shown on the Drawings.

(vii) Manholes shall be installed in the same manner as handholes with the following exceptions:

- Subcontractor shall not use material less than five thousand (5,000) pounds per square inch (PSI) in density to shim frames and covers.

- Frames and covers shall be installed to match existing grade and shall be shimmed with either steel or concrete spacers.

- Manholes shall be installed to provide the proper manhole lid elevation and shall be set level and plumb. A six-inch (6") pad of coarse aggregate shall be placed to obtain a level subgrade prior to manhole placement.

- All joints between precast concrete elements shall be sealed with sealant material in accordance with the manufacturer's specifications.

- Grade adjustment of the manhole frame and lid of three inches (3") and over shall be accomplished with precast concrete grade rings. Adjustments less than three inches (3") shall be made with nonshrink grout.

(viii) Manholes with frame, locking lid, riser casting, and grade rings shall be placed to provide a final finish grade elevation as follows:

- Roadway Concrete or Asphalt Pavement: The frame and lid shall be placed flush with the existing or proposed finish pavement grade to prevent a rough or uneven driving surface. Final pavement placement shall be flush with the top of the manhole frame.

- Off-Roadway Concrete or Asphalt Pavement: The frame and lid shall be placed two inches (2") higher than the existing or proposed finish grade to prevent surface run-off water from entering. Final pavement placement shall be flush with the top of the manhole frame by tapering the pavement to the finish grading in all directions from the manhole frame, as required by governing authorities or ROW owners. Manhole frame shall be set level.

- Residential Lawns: The frame and lid shall be placed two inches (2") higher than the existing finish grade to prevent surface run-off water from entering the manhole. Final sodding or topsoil for seeding shall be placed to the top of the manhole frame and graded to taper the lawn areas to the existing contour and provide drainage in all directions from the manhole frame. Manhole frames shall normally be set level, but may be set unleveled to match the existing grade as required by governing authorities or ROW owners.

- Undeveloped or Rural Areas: The frame and lid shall be placed two inches (2") higher than the existing finish grade to prevent surface run-off water from entering the manhole. Final soil grading shall be to the top of the manhole frame and tapered to existing contour to provide drainage in all directions from the manhole frame. Manhole frames shall be set level or as required by governing authorities or ROW owners.

(ix) Subcontractor shall install manhole and handhole hardware in accordance with the manhole and handhole fabricator's Specifications and Drawings. All hardware shall be installed prior to cable placing.

d) **Installing Pipe Into Manholes.**

(i) All manhole penetrations shall be sealed with a non-shrink grout.

(ii) Manhole openings shall be enlarged, if necessary, by drilling to accept the diameter of pipe being installed. A core type bit shall be used to make the opening. The finished diameter of the enlarged opening shall not exceed the outside diameter of the pipe by more than one-half inch (1/2"). Care shall be taken not to damage pipe at manhole connections during the placement of backfill material.

(e) **Installation of ducts in handholes.**

The arrangement of colored ducts exiting a handhole shall be the same as their entrance.

19. Marker Placement

(a) **Description.** This section covers the installation of FOC System markers with warning and information signs identifying the cable route.

(b) **Material Requirements.**

(i) Marker poles, cable route signs, special markers, and mounting hardware shall be furnished as specified in the Drawings.

(ii) Requirements of each individual marker for appropriate signs shall be as indicated on the Drawings. Signs shall be nine inches (9") by twelve inches (12") by 0.05 inches aluminum baked enamel (alloy # 5052H38) warning sign. Signs shall be custom printed, black on orange, dual sided with ultra violet clear coat with radius corners. Signs shall be furnished with two prepunched holes to match holes provided on the steel posts having a spacing of one inch (1") on center.

(iii) All mounting hardware shall be hot-dip galvanized. Nails shall be hot-dip galvanized barbed deck nails. Rivets shall be aluminum with a 7/8" to 1-1/8" grip range part number BALM-8BP-18.

(iv) Cable warning signs shall be installed on eight-foot (8') long steel posts as shown on the Drawings. Steel posts shall have a white polyester powder coating and weigh approximately 1.12 lbs. per foot.

(v) Warning signs shall be stamped with individual numbers and shown on the Redline Drawings.

(c) **Installation.**

(i) All markers shall be installed as indicated on the Drawings and as follows:

- A maximum distance of five hundred feet (500').
- Whenever the last marker cannot be seen (line of sight).
- Whenever a change in the running line occurs.
- At every splice location.
- One side of each bore and bridge attachment handhole location.

(ii) The cable marker posts shall be placed whenever possible with a one foot offset from the Network running line.

(iii) Posts shall be plumb, with signs level and correctly positioned. Markers shall be set concurrently with other FOC System Work. Markers shall be set prior to installation of the cable.

(iv) Driven posts shall be held in alignment while being driven. The post top shall be protected during driving by means of a cap or other accepted device to prevent damage. All damaged posts shall be removed and replaced at no additional cost to the Contractor. Posts shall be driven to a depth of thirty-six inches (36"), unless Rock or other subsurface obstacles occur, in which case the post may be installed a minimum of eighteen inches (18") with a concrete slurry backfill of six inches (6") around the post.

(v) Warning signs shall be installed at the time the post is set.

20. Regenerator Buildings and ILA's

(a) **Description.**

(i) This section covers the placement of innerduct and cable in entrance pipes, racking the cable, and associated work for placing cable in each regenerator building and ILA's.

(ii) Unless otherwise provided in the Subcontract Documents, the regenerator or ILA building sitework including building construction, entrance pipes, and equipment installation will be performed by others.

(b) **Material Handling.** Duct bends shall have a minimum radius of twenty-four inches (24").

(c) **Regenerator or ILA Building Delivery and Installation.** Others will perform the regenerator or ILA building delivery and placement.

(d) **Innerduct and Cable Placement.**

(i) The pulling force on the duct shall not exceed the tensile yield strength or the rated pull strength established by the manufacturer.

(ii) Placement of the duct and FOC shall be as indicated on the Drawings. Duct shall be installed in the building or vault entrance pipe to a point four inches (4") past the end of the entrance pipe. FOC shall be placed in duct from outside of the building or vault to a location on the wall above the entrance pipes and next to the termination location. Spare ducts shall be sealed with standard fitting duct plugs. FOC shall be terminated in the fiber distribution panels as per the drawings.

(iii) The interior end of the building or vault entrance pipe containing the ducts shall be sealed. If the exterior end of the entrance pipe does not require connections to additional pipe, the end shall be sealed.

(iv) If the regenerator or ILA buildings are not in place at the time that FOC System construction arrives at the location, Subcontractor shall mobilize the remaining building tie-in work within three (3) days after notification by Contractor that the building has been set.

21. Right-of-Way Restoration and Protection – Erosion Control

(a) **Description.** Subcontractor shall provide all Work, including labor, equipment, supplies, materials (unless otherwise specified), and furnish and install ROW erosion control protection as herein specified. Subcontractor shall furnish and place materials for erosion

protection and watercourse channel-grade stabilization along and including, but not limited to, trench lines, streams, steep ground areas, and road ditches.

(b) **Material Requirements.** All materials for erosion control shall be furnished by Subcontractor as specified or as required by governing authorities and ROW owners.

(c) **General.**

(i) Trench plugs shall be constructed with fabric bags, filled two-thirds (2/3) full with backfill per Section 13.

(ii) Terraces shall be constructed with native soil. If available, terrace material shall be cohesive soil.

(iii) Baffles shall be constructed with new boards and posts.

(iv) Soil-cement bags shall consist of fabric bags filled two-thirds (2/3) full with soil-cement.

(v) Hay bale checks shall consist of straw or hay bales, filter fabric, and anchoring stakes.

(vi) Silt fencing shall be constructed in accordance with the drawings and requirement of governing authorities or ROW owners.

(d) **Construction Methods.**

(i) Trench plugs shall be installed at locations indicated on the Drawings and as designated by Contractor or as required by governing authorities and ROW owners. The soil-filled bags shall be placed in a manner that will produce a compact mass with a minimum percentage of voids. A minimum of two (2) rows of bags shall be arranged so that the long dimension of bags is parallel to the Conduit System in one (1) layer and perpendicular to it in the next layer.

(ii) Terraces (interceptor dikes) shall be constructed at locations indicated on the Drawings and as designated by the Contractor, or as required by governing authorities and ROW owners. Terraces shall be placed so that the terrace flow line is unobstructed and has a grade of between two percent (2%) and five percent (5%). Terraces shall extend the full width of the area disturbed by construction and shall discharge to the down slope side of the ROW into an undisturbed area. Terraces shall be compacted in accordance with the compaction requirements of the underlying trench as specified in these Subcontract Documents. Terrace construction shall begin immediately following backfill operations.

(iii) Baffles shall be installed at locations indicated on the Drawings and as designated by Contractor, or as required by governing authorities and ROW owners. Baffles shall be placed so that the flow line is unobstructed and has a grade of between two percent (2%) and five percent (5%)t. Baffles shall extend the full width of the area disturbed by construction and shall discharge to the down slope side of the ROW into an undisturbed area. The posts shall be set or driven into the soil to the depth indicated on the Drawings. Care shall be taken not to damage the posts or boards during installation. Subcontractor shall replace all damaged posts and boards. The boards shall be securely attached to the posts with galvanized nails or bolts. A trench plug shall be constructed directly beneath each baffle.

Backfill around the baffle and trench plug shall be compacted to a minimum of eighty-five percent (85%) of maximum density.

(iv) Soil-cement filled fabric bags shall be installed as indicated on the Drawings, or as required by governing authorities and ROW owners. The bags shall be placed in a manner that will produce a compact mass with a minimum percentage of voids.

(v) The soil-cement shall be made by mixing ten percent (10%) by weight of cement with soil. Water shall be added to create a moist mixture. All mixing shall be done in a concrete mixer acceptable to the Contractor. The mixing time shall be that which is required to produce a uniform mixture of the soil, cement, and water. Mixing will not be permitted when the soil is frozen, or when the air temperature is below forty (40) degrees Fahrenheit, unless the temperature is at least thirty-five (35) degrees Fahrenheit and rising.

(vi) The soil-cement mixture shall be transported from the mixer to the placement location in clean equipment. The total elapsed time between the addition of water to the mixture and placement of the soil-cement filled bags shall not exceed two (2) hours. The mixture shall not be left undisturbed for longer than thirty (30) minutes during this period. Mist shall be sprayed on the soil-cement as required after mixing to keep it moist.

(vii) The fabric bags shall be filled two-thirds (2/3) full of soil-cement, loosely packed to leave room for folding or tying at the top. Immediately after filling, the bags shall be placed as indicated on the Drawings, as required by governing authorities and ROW owners, and compacted to conform with the earth subgrade and with adjacent bags in place. All dirt and debris shall be removed from the top of the bags before the next course is laid thereon. The subgrade and each course of bags shall be premoistened by spraying with water prior to placement of later courses. To ensure a proper bond between successive courses, the bags shall be placed as specified in a continuous manner. Voluntary delays will not be permitted during placement operations.

(viii) Riprap shall be placed as indicated on the Drawings, as required by governing authorities and ROW owners, or as directed by the Contractor.

(ix) Hay bale checks and filter fabric shall be installed as indicated on the Drawings, as required by governing authorities and ROW owners, and as directed by the Contractor. The installation shall be perpendicular to the flow of the water. Filter fabric shall be placed on the bottom and along the downstream vertical side of the excavation made for placing the bales and extend downstream a minimum of two feet (2'). Fabric shall be pinned to the bottom of the trench and at the downstream edge of the fabric. Bales shall be placed with the tied surfaces parallel to the sides of the trench. The top surface of the bale shall project above the adjacent ground not less than two inches (2") nor more than four inches (4"). Backfill around the bale shall be firmly compacted and the bale staked in position with two-inch (2") by two-inch (2") by thirty-six-inch (36") wood stakes driven vertically through the bale. Subcontractor shall reshape the surrounding disturbed areas and re-seed by hand methods

22. Right-of-Way Restoration and Protection – Restoration and Revegetation

(a) **Description.** Subcontractor shall furnish all Work, including labor, equipment, supplies, materials (unless otherwise specified), and supervision to furnish and install ROW restoration and vegetation as herein specified. Subcontractor shall furnish and

install ROW restoration and revegetation, including, but not limited to, clean-up, repair, protection, and revegetation of the ROW after installation of the Conduit System. Restoration shall begin within forty-eight (48) hours following duct installation and be completed as soon as practicable as determined by the Contractor or the requirements of governing authorities or ROW owners.

(b) **Material Requirements.** All materials for restoration and revegetation shall be furnished as specified or as required by governing authorities and ROW owners, and as indicated on the Drawings or as directed by the Contractor.

(c) **Restoration.**

(i) Subcontractor shall repair or restore ROW disturbed by construction operations to a condition equal to or better than its pre-existing condition and to the satisfaction of governing authorities and ROW owners. This Work shall include, but not be limited to, retrieving and compacting displaced material on steep slopes or high embankments, grading and compacting backfill in the plow furrow to prevent settlement, and grading and shaping of the railroad ballast disturbed during the Work.

(ii) Damage to banks, ditches, driveways, and roads shall be immediately repaired to the satisfaction of Contractor, governing authorities, and ROW owners.

(iii) Other areas disturbed by construction shall be restored within two (2) weeks of construction completion. Restoration shall include, but is not limited to:

- Removal of excess excavation spoils from the construction area.
- Removal of trash and construction debris.
- Filling, repairing, and stabilizing ground surfaces disturbed by construction.
- Regrading, handraking, or manipulating the finished ground surface to the level of smoothness necessary for seeding or sodding.
- Treating, repairing, or replacing, trees and shrubs specified for preservation but damaged by construction activity.

(iv) Natural grades shall be reestablished to the extent practical. Care shall be taken so as not to disturb natural surface drainage patterns.

(d) **Preparation of Soil.**

(i) When required by the permits, Governing Authorities and ROW owners, areas to be planted shall be thoroughly tilled to a depth of at least three inches (3") by discing, harrowing, or other acceptable methods until the soil is well pulverized. After completion of the tilling operation, the surface shall be cleared of all stones, stumps, or other objects larger than one and one-half inches (1-1/2") in thickness or diameter, and of roots, wire, grade stakes, and other objects that might be a hindrance to maintenance operations. Undisturbed areas with a satisfactory cover of native grasses shall be left untilled and unplanted.

(ii) Soil preparation shall be performed only during periods when satisfactory results are likely to be obtained. When results are not satisfactory because of

drought, excessive moisture, or other causes, the Work shall be stopped until such conditions have been corrected.

(e) **Fertilizing.**

(i) Fertilizer shall be applied at rates specified by governing authorities and ROW owners, or as specified in the Subcontract Documents. Fertilizer shall be applied uniformly with a fertilizer spreader before the beginning of the seeding operation. The first application of fertilizer shall become a part of the bed preparation.

(ii) When seed is applied by hydraulic application, the fertilizer may be mixed with the seed and mulch and applied as a slurry as specified.

(f) **Seeding.**

(i) Subcontractor shall seed all disturbed areas, except croplands and areas to receive sod.

(ii) Seed shall be applied uniformly over the disturbed area by one of the following methods. Seed mix and application rates shall be as specified by the governing authorities or ROW owners, or as specified in the Subcontract Documents.

- Broadcast Spreading: Broadcast spreading shall be the method of seed application over required areas unless otherwise specified.

- Seed Drills: Seed drills shall be operated only on slopes less than two feet (2') horizontal to one foot (1') vertical unless otherwise accepted by Contractor. Provisions shall be made to prevent the equipment from sliding down the seedbed.

  The seed drill shall be regulated to uniformly distribute the seed. Drilling shall be parallel to the contour of the land where possible and not uphill and downhill. The drill shall be regulated so that seed is properly placed in the soil and covered to a depth of one-quarter inch (1/4") to one-half inch (1/2").

  Successive planted strips shall overlap or shall not be separated by a space greater than the distance of the rows generated by the seed drill. If an inspection indicates that there is excessive space between rows or there are areas that did not receive seed, Subcontractor shall apply additional seed to these areas.

- Hydro Seeding: Seeding with an accepted hydroseeder will be acceptable provided wind velocities permit uniform distribution of the seed, water, and wood fiber slurry on the areas to be seeded. The slurry mixture shall be prepared immediately prior to application. Slurry mixtures prepared more than one (1) hour prior to application are not acceptable. The hydroseeder shall uniformly apply the seed and mulch at the rates specified herein. The hydroseeder shall be equipped with a paddle type agitator and recirculating pump that will continually stir and mix the slurry to prevent settling of solids in corners and at the bottom of the tank and maintain a uniform mixture of seed, mulch, and water at all times during the entire seeding operation.

(g) **Mulching.**

(i) Where required by the permit, Governing Authorities or ROW owners, mulch shall be applied to all areas that have been seeded. Seeded areas shall be mulched within twenty-four (24) hours of seeding.

(ii) Straw mulch shall be applied with a mulch-blowing machine or other accepted method and shall be evenly applied to obtain a uniform cover. Straw mulch shall be applied at a rate of two and one quarter (2.25) tons per acre.

(iii) Hydromulching shall be performed with hydroseeding operations. Cellulose fiber mulch shall be applied uniformly by spraying to the seedbed at a rate of fifteen hundred (1,500) pounds per acre.

(h) **Sodding.**

(i) Turfed areas within commercial and residential areas shall be sodded as indicated on the Drawings, as required by governing authorities or ROW owners, and as designated by Contractor or required by the Subcontract Documents.

(ii) The soil to be sodded shall be loosened to a depth of not less than two inches (2") by discing, harrowing, raking, or other accepted means. The resulting sodbed shall be free of debris, waste materials, and vegetation. The sodbed shall be graded to allow for the thickness of sod and to match abutting vegetation. Sod shall be placed only during seasons when satisfactory results can be expected. All soil surfaces shall be moist when the sod is placed. Sod shall be placed when the ground is in a workable condition and temperatures are less than ninety (90) degrees Fahrenheit. Sod shall not be placed when the sod or ground surface is frozen.

(iii) Sod shall be placed on the prepared surface with the edges in close contact and alternate courses staggered. In ditches, sod shall be placed with the longer dimension perpendicular to the flow of water in the ditch. On slopes, starting at the bottom of the slope, the sod shall be placed with the longer dimension parallel to the contours of the ground. The exposed edges of sod shall be buried flush with the adjacent soil. Sod edges shall be filled to present a smooth surface. The sod shall be rolled, tamped, and thoroughly watered to ensure good root contact and tie to the prepared subgrade.

(iv) Sod shall be staked on all slopes of two-to-one (2:1) or steeper. Sod shall be staked with not less than four (4) stakes per square yard with at least one (1) stake for each piece of sod. Stakes shall be a minimum of six inches (6") long. Stakes shall be installed so that they hold the sod firmly in place yet present no danger to pedestrians or mowing crews. The type of stake and the method of installation shall meet Contractor's approval and be in accordance with the requirements of governing authorities and ROW owners.

(v) Subcontractor shall keep all sodded areas, including the subgrade, thoroughly moist until the newly laid sod is firmly established as indicated by at least one inch (1") of new growth developed after the sod is laid.

(i) **Vegetation Limits.**

All earth surface disturbed by construction activities except croplands and where no vegetation existed prior to construction activities, shall be revegetated by seeding or sodding. Additional areas to receive seed or sod will be indicated on the Drawings

or designated by the Contractor, and in accordance with the requirements of governing authorities and ROW owners. Seeding or sodding required due to unreasonable and excessive disturbance by Subcontractor shall be performed by Subcontractor at its own expense. Seeding and sodding operations shall take place only during seasons when satisfactory results can be expected. Subcontractor may be required to return after completion of construction to meet above specified seeding limits.

(j) **Matting and Netting Placement.**

(i) Erosion control matting shall consist of excelsior blankets, mulch blankets, jute blankets, synthetic blankets, as indicated on the Drawings, or as required by governing authorities and ROW owners, or as otherwise provided in the Subcontract Documents.

(ii) Matting and netting shall be placed on steep or highly erodible soil areas for erosion control. Matting shall be placed on the graded and prepared surface after the seeding operation. Ground surface shall be free of rocks, soil clumps, sticks, or other imperfections which would prevent the matting from laying flat with the ground. The material shall be pinned or anchored to the ground as recommended by the manufacturer. In areas of watercourses, pin spacing shall not exceed two feet (2') between rows and two feet (2') on centers in a row.

(k) **Contact with Landowners.**

All restoration and revegetation shall be performed to the satisfaction of governing authorities and ROW owners, and as accepted by Contractor. Restoration and revegetation work that is not satisfactory shall be corrected within ten (10) days from the notice of deficiency.

23. Right-of-Way Restoration and Protection – Pavement, Gravel Surfaces, Etc.

(a) **Description.** Subcontractor shall provide all Work, including labor, equipment, supplies, materials (unless otherwise specified), and supervision to furnish and install ROW pavement, restoration, including, but not limited to, gravel surfaces, sidewalks, driveways and curbs. Restoration shall begin within forty-eight (48) hours following duct installation and be completed as soon as practicable as determined by Contractor or the requirements of governing authorities or ROW owners.

(b) **Material Requirements.**

(i) All material for pavement, gravel surfaces, sidewalks, and curbs shall be furnished as specified in the Subcontract Documents, as required by governing authorities and ROW owners, and as indicated on the Drawings or as directed by Contractor.

(ii) Temporary patching material shall be in accordance with the appropriate governing authority, including, but not limited to, city, county, or state specifications for asphaltic mixed materials for roadway patching.

(c) **Removal.**

(i) Pavement removal, including location of cuts and the extent of pavement removal, shall be in accordance with the requirements of governing authorities or ROW owners and as specified in these Specifications.

(ii) Cuts in concrete or asphalt pavement shall be no larger than necessary to provide adequate working space. Cutting shall be started with a concrete saw in a manner that will provide a clean vertical groove at least four inches (4") deep along each side of the trench.

(iii) Where Conduit System trench excavation is in a location such that the outside edge of the trench is within eighteen inches (18") of the outside edge of the asphalt pavement, the entire width of asphalt between the outside edge of the trench and the edge of pavement shall be removed. Undercutting will not be permitted. If undercutting occurs, the overhanging pavement shall be cut and removed.

(iv) Trenches excavated in graveled roadways or driveways may contain surfacing material of a quality that, in the opinion of the governing authorities and ROW owners, can be reused. Surfacing material accepted for reuse shall be piled or wind rowed separately from other excavated material and replaced on the surface over the backfilled trench.

(v) Subcontractor shall dispose of material removed that cannot be reused.

(vi) When the Conduit System trench is located parallel to a length of concrete sidewalk or curb and gutter and the limits of the trench are under or near enough to undermine the sidewalk or curb, the entire sidewalk or curb shall be removed.

(vii) When construction requires the removal and replacement of sidewalk or curb and gutter, removal shall extend to the nearest joint. Cutting of sidewalk or curb and gutter between joints will not be allowed.

(d) **Replacement.**

(i) Asphalt and concrete paving shall be in accordance with the governing authorities or ROW owners, including, but not limited to, state highway departments or local permit standards, and shall be as specified in these Specifications, or as directed by Contractor.

(ii) Pavement replacement shall match existing pavement in type, appearance, wearing surface, and durability to the maximum extent practical. Pavement thickness shall be; as required by applicable governing authorities or ROW owners; or shall match existing thickness, whichever is greater.

(iii) Base and subbase material shall be compacted, graded, and prepared, as required by applicable governing authorities or ROW owners, or shall match existing thickness, whichever is greater.

(iv) Cut edges of asphalt pavement shall be thoroughly cleaned and a tack coat shall be uniformly applied to cut edges before pavement repair.

(v) Pavement striping and markings shall be replaced in accordance with the requirements of governing authorities or ROW owners, or as directed by Contractor.

(vi) Gravel surface replacement shall be in accordance with the requirements of the governing authorities or ROW owners, as specified in these Specifications, and as indicated on the Drawings, or directed by Contractor. The replacement surface material shall match existing surface material in type, thickness, and appearances to the maximum extent practical.

(vii) Sidewalk and curb and gutter replacement shall be in accordance with the requirements of governing authorities or ROW owners, and as specified in these Specifications, or as directed by Contractor. Sidewalks and curb and gutter shall be placed to the lines and grades indicated on the Drawings or shall match adjacent existing sections. Reinforcement for sidewalks and curb and gutter shall be in accordance with the requirements of governing authorities or ROW owners, or as directed by Contractor.

Appendix D.2

ILA Construction Specifications

Appendix D.2

ILA Construction Specifications

Preliminary Site Work Guide

1.1.1 Clearing and Grubbing. Clearing and grubbing shall consist of complete removal and disposal of all trees, brush, stumps, roots, grass, weeds, rubbish, and all other obstructions resting on or protruding through the surface of the existing ground and surface of the excavated areas.

1.1.1.1 Unless otherwise shown on the plans, clearing and grubbing shall be accomplished within all areas of the right-of-way, except where designated on the plans or directed by the engineer. Areas designated for site grading shall also be cleared and grubbed. Selective clearing will be performed in some areas by retaining selected trees. The trees selected by the engineer for saving shall be protected from construction equipment by the Subcontractor in a manner approved by the engineer.

1.1.1.2 Where excavation is done within the roadway area, all stumps, roots, etc. protruding through or appearing on the surface of the completed excavation shall be removed. All stumps within building site areas shall be grubbed to a depth of 2' below existing grade and replaced with compacted backfill before the area is filled.

1.1.1.3 Within all other areas where clearing and grubbing is to be performed, all stumps, roots, and other debris projecting through or appearing on the surface of the ground shall be removed to a depth of 6" to 12" below the completed surface in order to fully remove organic matter.

1.1.1.4 All debris shall be removed to a qualified dump facility as soon as practicable. This shall be completed prior to any punch list walk-throughs.

1.1.1.5 No debris shall be moved to private property or burned without prior approval of the contractor. All applicable permits for burning or other disposal of debris must be acquired by Subcontractor.

1.1.1.6 All off right-of-way damage caused by Subcontractor will be the responsibility of Subcontractor.

1.1.1.7 Trees scarred or nicked will be trimmed and painted with a sealant approved by the landscape contractor/consultant.

1.1.1.8 As an exception to the above provisions, where so directed by the contractor, desirable trees shall be trimmed, protected, and left standing.

1.1.2 Excavation. Subcontractor shall perform all excavation of every description and of whatever substances encountered, to the depths indicated on the drawings or as otherwise specified.

1.1.2.1 During excavation, material suitable for backfilling shall be piled in an orderly manner a sufficient distance from the banks of the trench to avoid overloading and to prevent slides or cave-ins. Suitable backfill to be determined/approved by geotechnical engineer of record. All excavated materials not required or unsuitable for backfill shall be

removed and disposed of at Subcontractor's expense. Backfill requirements may vary by jurisdiction.

1.1.2.2 Grading shall be done as may be necessary to prevent surface water from flowing into trenches or other excavations, and any water accumulating therein shall be removed by pumping or by other approved method. Sheeting and shoring shall be done as necessary for the protection of the Work and for the safety of personnel. Subcontractor may encounter all types of soil materials during earth excavation.

1.1.2.3 Excavation shall conform to the limits indicated on the plans or specified herein. This Work shall include the shaping, sloping, and other Work necessary to bring the excavation to the required grade, alignment, and cross-section. Site elevation shall be set to allow for balanced cuts and fills to avoid the need to provide off-site fill materials.

1.1.2.4 All suitable materials removed from the excavation shall be used as far as practicable in the formation of the embankments, subgrades, shoulders, building sites, and other places as directed. No excavated material shall be wasted without permission, and where it is necessary to waste such material it shall be disposed of as directed by the contractor.

1.1.2.5 For sites with cut areas at the perimeter, sufficient cut shall be done to allow for drainage swales to be cut outside the rock surfacing and below the backslope cuts. All such swales shall be stabilized by seeding or by stone.

1.1.2.6 Topsoil shall be excavated a minimum of 8"and stockpiled on site. Direct surface water away from stockpile site to prevent erosion or deterioration of materials.

1.1.3 Trenching and Backfill. All construction, inspections, protection, and monitoring shall comply with all OSHA, state, and local laws, ordinances, and procedures. The foregoing shall include all construction methods, materials, and safety procedures, and comply with recommendations set forth in the soils report prepared by the Geotechnical Engineer of record. Additional trench safety design, monitoring, and inspections shall be designed and furnished by Subcontractor and comply with OSHA, state, and local laws, ordinances, and regulations.

1.1.3.1 Subcontractor shall plan all Work so that backfilling can be completed on all open trenches each day. Any trench left open overnight shall be protected adequately by barricades or steel plates to prevent any hazards to the general public.

1.1.3.2 Subsurface obstructions shall be exposed by hand and suitable barricade stakes installed prior to trenching. It shall be the responsibility of Subcontractor to coordinate the Work with foreign utility companies.

1.1.3.3 Suitable materials for fills and backfills shall be non-cohesive, non-plastic granular mixture of local dirt and rock and shall be free from vegetation, organic material, marl, silt, or muck. Backfill requirements may vary by jurisdiction.

1.1.3.4 Where the bottom of the trench is irregular or rocky, a 9" layer of fine materials (free of stone and frozen lumps) such as sand, soil, or other similar fine materials that will pass through a 1" mesh screen shall be hauled in or obtained from the spoil. At locations where the trench is on steep sloping ground and it is difficult to maintain the cushion, the fine

materials shall be sacked and the sacks placed in the trench for the specific cushion. If the trench contains water, dewatering shall be necessary prior to placing any cushion.

1.1.3.5 Compaction requirements for site grading are as follows: Special compaction shall consist of placing backfill and tamping in 12" lifts, or as specified on the plans. It will be used on steep grades or at other specified locations, excluding special compaction covered elsewhere such as a road crossing, which requires compaction in 6" lifts.

1.1.3.6 All excavations shall be kept in as small an area as practical. Trenches shall be neatly cut, with sides kept vertical.

1.1.4 Rock Removal. In the event rock is encountered, Subcontractor shall first attempt to remove the rock with a backhoe and hammer.

1.1.4.1 If removal is impossible with mechanical equipment, blasting may then be permitted under the direction of the contractor.

1.1.4.2 All blasting shall be performed by qualified personnel experienced in demolition work. All blasting shall be done in accordance with OSHA regulations or other applicable regulations. Permits or other authorizations shall be obtained by Subcontractor prior to detonation. Exercise all measures necessary, including mats, notifications etc., to protect life, property, landscape, and other on-site and off-site elements. Subcontractor shall use mats to cover the area to be blasted. To eliminate the possibility of injury, all personnel in the area of blasting shall be made aware of the detonation.

1.1.5 Select Fill. Material description, placement, and subgrade preparation for the design of the building pad for the Regeneration Hut as specified or as indicated on plans.

1.1.6 Compaction. The following represent minimum requirements for compaction.

1.1.6.1 Fills and backfills beneath building pads and in all utility trenches shall be compacted to a density of not less than 95% of its maximum density as determined by ASTM D698, Standard Proctor, and fill within other areas shall be compacted to a density of not less than 90% of its maximum density as determined by ASTM D698, Standard Proctor. Building and/or equipment pads shall be soil density tested by Subcontractor. Soils testing is to be coordinated with the contractor, who shall be given 48 hours notice of testing. Any costs incurred from failed tests will be the subcontractor's responsibility.

1.1.6.2 Compaction requirements for pads are as follows: Fills and backfills shall be formed of suitable material placed in layers of not more than 8" in depth measured loose and rolled and/or vibrated with suitable equipment until compacted. Thickness of layers may be increased provided the equipment and methods used are proved by field density testing to be capable of compacting thicker layers to specified densities. Layer thickness shall be decreased if equipment and methods used are proven to be incapable of compacting layers to specified densities.

1.1.6.3 Rock that will not pass through a 6" diameter ring shall not be placed within the top 12" of the surface of the completed fill and not within the top 24" under building and/or equipment pads. Rock that will not pass through a 3" diameter ring shall not be placed within the top 4" of the completed fill.

1.1.7 Access Roads. Unless otherwise stated in the Scope of Work, the construction of roadways shall conform to the requirements set forth hereinafter and shall consist of bringing the top of the roadway sub-grade between the outer limits of the base course, to a surface conforming to the grades, lines and cross-section shown on the plans. Unless otherwise specified herein, all materials, their application, sampling, and testing shall comply with applicable sections of the governing **State Highway Department Specifications**.

1.1.7.1 A 20' wide strip shall be cleared and grubbed for the access road to the compound. The access road shall be graded to provide a level surface. Attention should be paid towards maintaining the existing drainage patterns, incorporating culverts and berms where shown on the construction drawings.

1.1.7.2 The access road subgrade should be prepared in pursuant to Section 1.1.6 Compaction (above) and shall be done in concurrence with the grade and cross-section indicated on the drawings and as shown on plans. Preparations shall be made immediately prior to final surfacing.

1.1.7.3 After the roadway sub-grade has been prepared, Subcontractor shall maintain it free of ruts, depressions, and damage resulting from the hauling and handling of any material, equipment, tools, etc. during the site construction process. Ditches or drains shall be constructed and maintained along the completed sub-grade section. Just before the base course is laid, the sub-grade shall be tested as to crown and elevation.

1.1.7.4 The sub-grade shall then receive a base course consisting of a 12' wide by 4" thick layer of clean crushed stone or approved gravel. Material greater than 2" in diameter shall be cleaned of loose and foreign matter during placement or as shown on plans. A 10lb. sample of all aggregates must be submitted to the contractor for approval prior to placement. The stone shall be placed, compacted to not less than 95% of the maximum standard density. The base course shall be finished by blading or by automated equipment designed for the purpose. Addition of layers of smaller diameter materials on top of the aforementioned layer to meet grade is unacceptable. This surface shall be used for access during the entire construction process.

1.1.8 Soil Erosion. The placement of specific control measures as shown on the construction drawings will be necessary. These measures include terraces, diversion berms, dams, sand bagging, hay bales, and riprap.

1.1.8.1 Contractor shall comply with applicable requirements of all governing authorities, including all requirements of the National Pollutant Discharge Elimination System (NPDES) program.

1.1.8.2 The placement of reinforced concrete pipes or corrugated metal pipes with headwalls to solve specific drainage problems may be required.

1.1.8.3 The disturbed areas in all pastures shall be leveled, scarified, and fertilized. Reseeding and fertilizer shall be with like seed as specified in **the California Department of Transportation** specifications.

1.1.8.4 Where specified, the seeding of disturbed areas, other than cultivated fields with suitable grass mixtures, shall be done as soon as practical.

1.1.8.5 Vehicular or equipment traffic in disturbed areas shall be kept to a minimum, consistent with proper operation of the job.

1.1.8.6 Bulldozing of road shoulders, ditches, gullies, and stream banks shall be kept to a minimum. (Restoration by control devices will be required where banks are destroyed.)

1.1.8.7 Existing vegetation cover shall not be disturbed any more than necessary. Restore existing vegetation cover to original condition where damaged.

1.2 BONDING, GROUNDING, AND TRANSIENT PROTECTION

1.2.1 General. Contractor shall provide all materials, and the subcontractor shall supply all equipment, tools, labor, and incidentals as necessary for site electrical protection as indicated below. Contractor shall perform tests and submit test reports to Level 3 Communications as specified herein. The subcontractor shall notify the contractor a minimum of ten (10) working days prior to the testing of the grounding system

1.2.2 Type:

- A buried #2 solid ground loop with grounding electrode rods 5/8" by 10' surrounding the site with all CADWELD® connections, good for soil resistivities of up to 10,000 ohm-cm. Additional grounding requirements may be necessary as defined within the contract drawings.

1.2.3 "Single Point" Master Ground Bar Design. The "single point" master ground bar design shall conform to the following requirements:

1.2.3.1 The Regeneration Hut site shall be bonded to the grounding electrode system at one (1) and only one (1) unique point. This point is referred to as the Main Isolated Ground Bar (MGB). The grounding electrode system is CADWELD® to the MGB by the bid package No. 2 subcontractor.. The MGB will be provided with the Regeneration Hut.

1.2.4 Connection Standards. All connections exterior to a shelter shall be exothermically welded joints or CADWELD®. Mechanical connections are not permitted.

1.2.5 Hardware. All hardware, bolts, nuts, washers, and belleville washers shall be 18-8 stainless steel.

1.2.6 Anti-Oxidation Compound. All connections, interior and exterior, made in accordance with this document shall be made with Thomas and Betts KOPR-SHIELD (TM of Jet Lube Inc.). There is no equivalent for this specification; no other compound will be accepted. Coat all wires before lugging. Coat all surfaces before connecting. This product is available in small containers with a brush attached to the lid for easy application.

1.2.7 Minimum Bend Radius. The minimum bend radius throughout the installation of this practice shall be 8" for #6 wire and smaller, 12" for wire larger than #6.

1.2.8 Grounding Electrode System. All wire in the grounding electrode system shall be solid #2 pure copper tinned.

1.2.8.1 Ground rods shall be 5/8" steel, clad with a pure copper jacket not less than 0.0012" thick and 10' long and supplied by the contractor.

1.2.8.2 The gate jumper shall be an 4/0 welding cable with sleeves on each end designed for exothermic welding. Remove the insulation at the bottom of the jumper down to the bare wire for water drainage.

- Accepted products: Erico Model FJ2Q24, or equivalent.

1.2.9 External Ground Ring (EGR) Installation. Ground rings shall be installed as shown on Construction Drawings.

1.2.9.1 After completion of the exterior ground system, the site shall be tested to ascertain the resistance to earth of the site per Section 1.4.7 Site Resistance to Earth Testing. It is the contractor's responsibility to test the resistance of the site to earth. It is the subcontractor's responsibility to advise the contractor ten days in advance of said testing to coordinate and schedule the test. In this situation the engineer shall advise Subcontractor as to the next course of action, whether placing additional ground rods, expanding the ground ring, installing an XIT ground rod, or issuing a specification variance.

1.2.9.2 The ground ring shall be bare tinned #2 copper as specified.

1.2.9.3 All connections to the ground ring shall be CADWELD®.

1.2.9.4 The ground ring shall be buried at least 18" below final grade, or at least 6" below the frost line whichever is greater.

1.2.9.5 The grounding electrode rod shall be driven at a minimum of every twenty (20) linear wire foot interval of the ground ring and shall be positioned as shown in the drawings. The ring shall be CADWELD® to the rod.

1.2.9.6 An concrete inspection well that is 12" diameter by 12" deep, circular well or equivalent, shall be installed at the CADWELD® point of the #2 from the MGB to the EGR. The inspection well will be supplied by the contractor.

1.2.9.7 Bond the fence to the ground ring at each corner and at each gate post with #2 solid tinned copper wire. CADWELD® both ends. If the fence is more than 25' away from any point of the EGR or shelter, then it may be left unbonded to the system. If the site is near to just one (1) face of a very large fence, then bonding to just the near face shall be sufficient. Bond each gate to the gate post at the hinged end with a gate jumper as specified. CADWELD® both ends. Use the 45° CAD mold specified to reduce strain. Bond each horizontal pole/brace to each other and to each vertical pole that is bonded to the exterior ground ring using one (1) of the following two (2) methods:

1. Spot weld and paint with cold galvanizing.

2. CADWELD® a #2 tinned solid copper wire to each steel member and paint with cold galvanizing.

1.2.10 AC Power Bonding and Protection. Service to the Regeneration Hut shall be bonded to the grounding electrode system.

1.2.10.1 The neutral ground bond point at the 400 Amp Service station shall be bonded to the grounding electrode system using a #2 solid tinned wire. This grounding electrode wire shall be CADWELD® to the ground ring. Approximately 13ft. of #2 solid tinned wire shall be coiled and left at the location shown on the drawings. The shelter installation bid package No. 2 Subcontractor is to terminate the ground at the 400 Amp service entrance, at a later date.

1.2.10.2 The equipment shall be protected by its own internal circuitry.

1.2.11 Telco Bonding and Protection. All Telco cable sheaths and protector housings shall be bonded back to the grounding electrode system by a minimum of a #6 conductor. Approximately 13 ft. of #6 conductor shall be coiled and left at a location shown on the drawings. The shelter installation Phase II Subcontractor is to terminate the Telco Ground at a later date.

1.2.12 All other future grounding connections to the EGR as shown on the drawings will be CADWELD by the subcontractor. Approximately 13' of copper ground cable will be coiled above the ground surface at the locations shown on the drawings.

1.3 FINAL SITE WORK

1.3.1 General. The Work included under this section consists of furnishing all materials, equipment, and labor necessary to complete final site grading, foundation pads/piers, installing fence posts, gates, mesh and barbed wire, treatment of soil, Mirafi 500X or equivalent underlayment, gravel, landscaping as required, and final site cleanup for all areas and access roads.

1.3.2 Final Grading. Upon completion of Regeneration Hut construction, Subcontractor shall perform final fills, compaction, and finish grading of the site and access road as shown on civil drawings and as specified in the Geotechnical Report.

1.3.3 Finished Surface. The finished surface of the site shall extend 1' beyond the fence lines as shown on the site plan. Provide gravel-finished surface for crane areas as shown on the Typical Site Off Loading Detail. Provide gravel-finished surfaces throughout site as required in contract documents. Sub-Contractor to insure that there is stable and firm substrait in which to set up crane rigging for support. Provide AASHTO #57 gravel or equal.

1.3.4 Foundation Pads. Pads shall be accurately located, sized and plumbed in accordance with the contract documents.

1.3.5 Foundation Piers. Foundation piers shall be drilled with an auger in earth and with a roller bit in rock using equipment designed to drill straight and clean holes. Casings shall be used when

drilling in unstable soil. The hole may be excavated using the drilling and slurry method. Drilling mud shall be used according to auger manufacturer's instructions. Piers shall be accurately located, sized, plumbed, and drilled to a depth in accordance with the contract documents.

1.3.6 Fencing. Subcontractor shall furnish all materials, labor, and equipment to perform all operations in connection with a 8' high chain link fence with a 14' wide vehicle entrance consisting of a double swing gate. Fencing shall be installed within one (1) week of Regeneration Hut placement or upon completion of final sitework, whichever comes first.. Any materials not in compliance with these specifications will be removed and replaced at Subcontractor's expense. Subcontractor shall furnish temporary construction fencing when required.

1.3.6.1 Gate frames, posts, braces, truss rods, and stretcher bars shall be hot dipped galvanized steel. Gate hinges, post caps, and barbed wire support arms shall be hot dipped galvanized steel. All clips and ties must be aluminum.

1.3.6.2 Vehicle gate posts shall be 2-7/8" diameter, Sch. 40, galvanized steel tubing (ASTM F1083) equipped with top caps.

1.3.6.3 Chain link fabric shall be 12 gauge, galvanized steel wire (ASTM A392, Class 2). The size of mesh shall be 2", with twisted selvage on top and knuckled selvage on bottom.

1.3.6.4 Corner posts shall be 2-7/8" diameter, Sch. 40, galvanized steel tubing (ASTM F1083) equipped with top caps.

1.3.6.5 Line posts shall be 2-3/8" diameter, Sch. 40, galvanized steel tubing (ASTM F1083) equipped with top caps.

1.3.6.6 Top rail supports shall be 1-5/8" diameter, Sch. 40, galvanized steel tubing (ASTM F1083).

1.3.6.7 Top rail couplings shall be of the sleeve type with a 6" expansion spring in every fifth (5th) coupling.

1.3.6.8 Post Bracing shall be 1-5/8" diameter, Sch. 40, galvanized steel tubing (ASTM F1083) equipped with 3/8" diameter steel rod truss and tightener. Braces must be placed at gate corners, pull and end posts. Post braces must extend to each adjacent post and must be placed in the center of the fabric. Corner posts where the deflection angle is greater than 10° shall be braced in both directions.

1.3.6.9 Barbed wire support arms shall be of hot dipped galvanized steel measuring 3/16" x 3/4" or equivalent cross-section area. Support arms shall be 45° angle, capable of accommodating three (3) strands of 14 gauge barbed wire. The design of the support arms should be such as to allow the top strand of barbed wire to be 12" above the fence line and 12" in front of the fence line.

1.3.6.10 Barbed wire shall be three (3) twisted strands of 14 gauge galvanized steel wire (ASTM A121, Class 3) with 14 gauge galvanized four (4) point barbs on approximately 4" centers.

1.3.6.11 Tension wire shall be 7 gauge galvanized steel wire or aluminum coated coil spring wire.

1.3.6.12 Padlocks shall be Schlage 45-102, 26D with two (2) keys. One (1) padlock shall be supplied for each gate latch and shall be keyed according to Kiewit Network Services requirements to allow for one (1) key access to all sites. Padlocks shall be provided by the shelter manufacturer and shipped with the shelters.

1.3.6.13 Gates shall be of 1-7/8" diameter, Sch. 40, galvanized steel tubing (ASTM F1083) equipped with galvanized hardware. Gate shall be swing type and completely accessorized with frames, latches, stops, keepers, fabric (complying with 1.3.6.3 "Fabric"), braces, and three (3) strands of barb wire (complying with 1.3.6.10 "Barbed Wire") hung on support arms (complying with 1.3.6.9 "Barbed Wire Support Arms"). Gates shall be fitted with intermediate members and 3/8" diagonal truss rods to insure a rigid gate free of sag and twist. Frame members shall be connected by welding or heavy fittings. Latches shall be full gate height plunger bars providing engagement of stops and capable of padlocking from inside or outside the compound. Stops shall be roadway plates set in concrete and provide engagement of latches. Keepers shall be mounted on 2-7/8" diameter posts (complying with 1.3.6.2 "Gate Posts") filled with concrete and set in concrete foundations and be fully capable of securing and supporting the free end of an open gate.

1.3.7 Installation. Fence gates, posts and wires shall be installed as described below.

1.3.7.1 Gate and corner posts will be set plum in concrete at a depth of 3' (or 18" in bedrock - whichever is further) in post OD plus 9" diameter (or post OD plus 6" diameter in bedrock) round holes. Concrete must be crowned approximately 3/4" above ground level to shed water.

1.3.7.2 Line posts shall be set at approximately 10' centers (or evenly spaced for odd dimensions - not to exceed 10') at a depth of 3' (or 18" in bedrock - whichever is further) in 10" diameter round holes. Concrete must be crowned approximately 3/4" above ground level to shed water.

1.3.7.3 Top rails and tension wires shall be installed before the fabric. Rails shall be furnished in at least 18' lengths and secured to posts. Tension wires shall be installed approximately 6" above grade and secured to line posts and anchored to gate and corner posts.

1.3.7.4 All Gates must be installed plum level and secure. All gate posts will be set in concrete at a depth of 6 inches deeper than the prevailing frost depth, or 3 feet 3 inches, whichever is greater in12" round holes. Concrete must be crowned at ground level to shed water. Gates shall be installed such that they cannot be removed without disassembly. Hardware bolts shall be peened to create difficult removal.

1.3.7.5 Leave approximately 1" between finished grade and the bottom of the fabric. Fabric should be pulled tight and secured on the outside of the compound posts to within 2" of the ground such that a pull of 150 lbs. in the middle of the panel will not lift the bottom of the fabric more than 6". Fabric shall be secured to top rails and tension wires at approximately 24" centers on the outside of the posts. Stretcher bars shall be threaded through the fabric

at each corner, gate, and pull post and anchored to each post at 15" centers by positive mechanical means.

1.3.7.6 Barbed wire shall be fastened to each support arm by internal clips or external fabric ties.

1.3.8 Site Work. Site work shall be done in all areas to be enclosed within the security fence. Upon completion of fills, compaction, final grading, and the placement of the fence support posts, the following items shall be performed by Subcontractor:

1.3.8.1 Subcontractor shall furnish and install Mirafi 500x ground stabilization fabric over the entire finished subgrade, including the 1' apron outside the fence line. Other approved fabric manufacturers are Amoco, 3M, Phillips 66, and Exxon. Joints in the fabric shall be overlapped 6".

1.3.8.2 Subcontractor shall furnish and place a 3" layer of crushed stone, (3/4" to 1" diameter) over the entire finished site, including the 1' apron outside the fence line. Stone shall be spread evenly and firmly compacted.

1.3.9 Landscaping. Under normal circumstances minimal landscaping will be required. Special landscaping requirements shall be as shown on the site plans.

1.3.9.1 For remote sites, landscaping will be limited to restoring grades surrounding the finished site and minimal reseeding to control erosion.

1.3.9.2 For populated sites, landscaping will require restoration of surrounding grades, reseeding with grass, sod, and planting of some shrubbery.

1.3.9.3 All landscaping shall be installed in accordance with general landscaping practices to ensure proper growth and in accordance with local ordinances. Landscaping shall be included in the guarantee for the project.

1.3.10 Clean-Up and Restoration. Initial clean-up shall consist of removing any unwanted soil, rocks, tree branches, and construction material. The entire Work area shall be smoothed and graded. Initial clean-up shall also involve temporary soil erosion control measures.

1.3.10.1 Final clean-up shall be completed within five (5) working days following construction.

1.3.10.2 Final clean-up shall consist of preparation of ground, seeding, and fertilizing of all disturbed areas and will include hand raking as necessary, fence restoration, terraces, and berms.

1.3.10.3 The entire Work area, including ingress/egress to the construction site, shall be restored as nearly to its original condition as practical.

1.3.10.4 All complaints concerning clean-up and restoration of property disturbed by construction are to be handled immediately. If the situation warrants, the Subcontractor will be expected to form an additional and separate clean-up crew to handle property owner complaints.

1.3.10. 5 All areas disturbed by construction shall be leveled, fertilized, lime applied, and seeded with local grass of a type and in proportions as recommended by the engineer. Mulching shall be at a rate per acre approved by the engineer. The right-of-way in pastures and fields shall be seeded with like seed.

1.3.10.6 Where any Work disturbs the area outside the right-of-way, Subcontractor shall ensure that the area is completely restored in a manner acceptable to the contractor and property owner. Sod that is removed shall be replaced with the same type. Unsodded areas shall be graded and then seeded and mulched. Subcontractor is responsible for establishing a dense stand of permanent grass within a reasonable time. Shrubbery that is removed or destroyed shall be replaced with equal types and sizes. Grassing and mulching operations are to begin immediately after construction/installation has been completed.

1.3.10.7 When crossing manicured grass areas of Centipede, St. Augustine, Zoysia, or like sod, sod is to be replaced with the same sod type as found in similar undisturbed areas.

1.3.10.8 Subcontractor shall paint over with an approved sealant any damaged areas of any trees on or off the property that have been scarred, nicked, or damaged by construction. Removal of damaged trees may be necessary if determined by the contractor.

1.4 QUALITY ASSURANCE/ QUALITY CONTROL

1.4.1 Conditions for Subcontractor. Subcontractor shall provide necessary materials, equipment, and labor to complete work functions satisfactorily as described in this specification. In cases where there are multiple Subcontractors, it is each Subcontractor's responsibility to clarify which sections are applicable. Major work functions are listed in this specification along with major equipment and materials. Minor items such as connectors, lugs, and other miscellaneous hardware and materials shall be furnished by Subcontractor under this specification even though they may not be specifically itemized. Material furnished shall meet applicable standards and be installed to applicable codes. This specification shall be the minimum accepted standard. Where local code and/or local authority having jurisdiction supersedes or exceeds this specification, local code shall prevail.

1.4.2 Subcontractor Responsibility/Duty to Inspect and Advise. It is Subcontractor's responsibility/duty to inspect and advise. Subcontractor shall be fully acquainted with site conditions relating to performance of work under this practice. Subcontractor shall take such steps as necessary to be familiar with requirements of this practice. Requirements of this practice must be performed in good faith. Costs claimed by Subcontractor in excess of the quote submitted to the contractor will only be allowed through written change order, approved and authorized by the contractor.

1.4.3 Questions, Clarifications and Intent to Participate. Subcontractor shall submit questions or necessary clarifications to the contractor in writing before submitting a formal quote for work under the Subcontract. Submission of a quote to perform work shall imply that all questions have been answered and clarifications made to the extent necessary to bid the job without additional costs. Submission of a quote under these Specifications shall imply that Subcontractor fully understands these Specifications and fully intends to participate after award of the Subcontract.

1.4.4 Inspection. The contractor will appoint a representative to inspect all parts of the Work performed pursuant to this Specification, including preparation of materials and equipment to be used. The representative shall advise the contractor of work progress and of Subcontractor's performance, and shall notify Subcontractor of any infringements or variations from this practice. Subcontractor shall not vary in any way from these Specifications without written authorization from the contractor.

1.4.5 Testing/Final Acceptance. Testing of soils, concrete, associated materials, and work shall be performed by Subcontractor at its expense and in accordance with Subcontractor's established tests and/or standard procedures, to include the tests specified herein, as well as any mutually agreeable tests and/or procedures required by the contractor. Subcontractor must notify the contractor in writing two (2) working days prior to the start of said testing for the contractor to schedule attendance of contractor appointed representative. Failure to notify the contractor may cause Subcontractor to retest at Subcontractor's expense.

1.4.6 Concrete Testing and Reports. Standard laboratory compressive test cylinders will be obtained by Subcontractor when concrete is discharged from the mixer at the site of the Work.

1.4.6.1 A set of four (4) cylinders will be obtained for each placement (i.e. Regeneration Hut foundation, equipment pad, power module pad), placed each day, for each type of concrete. The cylinders shall be cured under laboratory conditions and shall be tested at seven (7), twenty-one (21), and twenty-eight (28) days of age (one (1) each). One (1) cylinder shall be set aside for insurance purposes.

1.4.6.2 At twenty-eight (28) days, all cylinders must test at 4,000 PSI and be free of honeycombs, air pockets, and voids. Concrete not passing appropriate tests, or where contaminants or trash is evident, must be removed and replaced at the expense of Subcontractor.

1.4.6.3 Concrete test cylinders must be obtained by Subcontractor and clearly marked with the location, date, and batch number for transporting to the testing lab. Testing will be in strict accordance with ASTM 31 (latest edition).

1.4.6.4 Subcontractor should make slump tests of concrete as it is discharged from the mixer at the site of the work. Slump tests shall not exceed 5" as a max, and not be less than 3". Slump tests, in accordance with ASTM C143, may be made on any batch, and failure to meet specified slump requirements will be sufficient cause for rejection of that batch.

1.4.6.5 Proper reports of all tests performed by the laboratory will be prepared by the laboratory and submitted promptly to Subcontractor. Such reports shall be properly labeled so as to identify the portions of the project into which the materials have been placed. Reports shall be submitted to the contractor before shelter installation begins.

1.4.6.6 The quality of the concrete as to conformance to the Specifications is the entire responsibility of Subcontractor until the concrete is accepted in place in the structure and verified by the final cylinder tests made by the laboratory. Arrangements for field testing shall be made by Subcontractor with a laboratory approved by Level 3 Communications.

1.4.7 Site Resistance to Earth Testing. This specification is intended to provide a standard procedure for testing facility ground resistance to earth for verification of ground systems. Compliance with this document will insure that all installations exceed all equipment manufacturer specifications

1.4.7.1 Local Engineering/Operations forces for the contractor will ensure nationwide consistency in the engineering and construction of facilities for the long-term integrity and reliability of the network. Modifications dictated by geographic, regulatory, or protection requirements will be executed as appropriate by local Engineering/Operation forces.

1.4.7.2 The procedure of measuring resistance of the ground system to true earth shall be done by using an AEMC Model 4500 (or approved equivalent). The measurement technique shall be the fall of potential method. In order to test only the driven electrode system, all other bonds to other systems shall be removed. This means the test should be made before the neutral is bonded to the EGR and before the Telco facility shield is bonded to the EGR. If these bonds are present, remove them if possible. DO NOT REMOVE the neutral-to-ground bond for the AC service while power is connected to the facility from the utility—this will result in a hazardous situation for both equipment and human beings. The measurement shall be made along four (4) radials out from the center of each building face. This will allow for the greatest possible separation from the ground system radials. Do not measure along a buried ground ring conductor as this will nullify the test results.

1. Fill out the Form 1. Ground Resistance Test Report form provided in at the end of this Specification.

2. Perform the test as described in the manual for the instrument used.

3. Connect terminals C1 and P1 (X and Xv) directly to the ground ring at one of the inspection hand holes.

4. Connect terminal C2 (Z) to a test rod driven 300’ to 500’ away from the face of the building. It is understood that this is not always possible. Move the test rod or be as creative as possible to find a way to get four (4) test radials. As a rule, C2 should be at least five (5) times the maximum distance from any two (2) driven rods. All measurements for P2 and C2 are from the center of the ground system.

5. Connect terminal P2 (Y) to a test rod and insert at the following intervals from the center of the ground system to the test rod C2: 10%, 20%, 30%, 40%, 50%, 60%, 70%, 80% and 90%. Record the resistance at each interval in a table for each point for all four (4) directions on the Form 2. Resistance Data form provided at the end of this specification.

6. Calculate the average or mean of the four (4) 60% values. Throw out any one direction if it is more than three (3) times the mean or less than one third (1/3) of the mean and recalculate the mean using the three (3) closest resistances.

7. Record the mean calculated in #6 as the resistance of the site.

1.4.8 Compaction Testing

1. Fills and Backfills: Subcontractor shall perform one compaction test as specified herein for each lift per 1,000 square feet with a minimum of two tests per lift under the equipment shelter pad and two tests per lift under the generator pad. The in-place field density shall be determined in accordance with ASTM D 1556 or D 2167.

3.0 BUILDING PAD

3.0.1 General. The Work included in this section consists of furnishing all materials and labor required to construct the concrete slab foundation for the regeneration hut and generator pads.

3.0.1.1 All concrete Work shall comply with applicable sections of the building code for reinforced concrete (ACI 318-95) of the American Concrete Institute or as stated on the attached detailed drawings.

3.0.1.2 All concrete will require special care as to assure no voids, bleeding, honeycombs, segregation, or shrinkage occurs.

3.0.2 Materials. Materials shall conform to the following requirements:

3.0.2.1 All cement shall be of Portland type conforming to ASTM C150, Type I or II. All cement shall be sand mill, uniform in color, and free of all contaminants. Any material deteriorated or damaged will not be acceptable.

3.0.2.2 All concrete aggregates shall conform to ASTM C33 and shall be free of debris and contaminant matter. Fine aggregate shall consist of natural sand evenly graded from fine to coarse. Coarse aggregate shall consist of crushed stone or gravel evenly graded of the 3/4" to 3/8" size.

3.0.2.3 All water used for mixing shall be clean and free of contaminants.

3.0.2.4 Admixtures, General: Provide concrete admixtures that contain no chloride ions.

3.0.2.5 Forms must be designed and constructed in accordance with ACI 347 and in such a way as to ensure smooth concrete surfaces. Forms may be reused only if proper cleaning takes place after removal and only after inspection by the contractor.

3.0.3 Steel Reinforcement. All reinforcement steel will be new manufacture and shall conform to ASTM A615, Grade 60, or as specified on attached subcontracted drawings. All steel accessories shall conform to ACI and CRSI Bar Support Specifications. Concrete mesh reinforcement shall conform to ASTM A185. All reinforcement shall be securely tied, supported, and connected at intersections with 14 lb. BWG annealed iron wire. Form ties are to be cone type. All reinforcing steel must be inspected by the contractor prior to pouring concrete.intermediate grade of American

3.0.4 Concrete Placement. Concrete shall be placed as described below:

3.0.4.1 All concrete must have a minimum compression strength of 4,000 PSI at 28 days, unless specified at a higher strength or as specified in the Geotechnical Report. If it is determined from the 7 day concrete test cylinder that the concrete has attained a minimum of 80% of its 28 day design strength (3200 psi for 4000 psi design strength), then the concrete foundation may be loaded with the weight of the shelter.

3.0.4.2 When placed in the forms, reinforcement shall be clean and free from rust, scale, dust, dirt, paint, oil, or other foreign material and shall be accurately and securely positioned in the forms as shown on the drawings before the placement of concrete. Reinforcing steel shall be wired or otherwise fastened together at intersections and shall be supported by concrete or metal supports, spacers or hangers. Bar supports, where adjacent to the ground, shall be set on precast concrete pads compressed into the subgrade. Minimum bar clearance to soil shall be 3".

3.0.4.3 Concrete shall not be placed under water without approval of the contractor.

3.0.4.4 Concrete shall be placed in piers the same day holes are drilled, and a tremie or funnel shall be used to prevent concrete from dropping more than 6 feet. Should the concreting be suspended for more than thirty (30) minutes before completion, laitance and water shall be removed from the joint surface and the joint surface shall be coated with epoxy bonding compound before resuming.

3.0.4.5 Cold-weather concreting methods per ACI 306. Protect concrete from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.

3.0.4.6 Hot-weather placement: When hot weather conditions exist that would effect the quality and strength of concrete, place concrete complying with ACI 305.

3.0.5 Curing. All concrete shall be water cured by covering with a double thickness of burlap, cotton mats, or other approved material kept thoroughly saturated with water. The forms shall be kept wet until removed. Upon removal, the curing specified herein shall be started immediately. Concrete shall be cured for a period of seven (7) days for normal Portland cement or four (4) days for high early strength cement. Concrete poured in the dry shall not be submerged until it has attained sufficient strength to adequately sustain the stress involved, nor shall it be subjected to flowing water across its surface until it has cured four (4) days.

3.0.5.1 In lieu of wet burlap or cotton mats as specified above, concrete slabs may be covered with wet sand and kept moist for the specified curing period. The initial curing period of not less than twenty-four (24) hours shall consist of the wet burlap or cotton mat method, then the wet sand method may be utilized until the end of the curing period.

3.0.5.2 Concrete surfaces that will not be coated, painted, plastered, stuccoed, or covered with tile or floor covering, or that will not require a bonding surface, may be cured by means of a membrane curing compound in lieu of the wet cure method. The curing compound shall be applied immediately after a satisfactory surface finish has been completed or forms have been removed. The rate of application of the membrane curing compound shall be at least one (1) gallon to every two hundred (200) square feet of exposed surface to be cured. The membrane curing compound and impervious covering shall be continuous and without defects and shall retain the required moisture in the concrete. Membrane curing compound

that becomes damaged by rain, foot traffic, or other conditions within five (5) days of application shall be reapplied.

3.0.6 Finishes. Finishes shall be applied as follows:

3.0.6.1 As soon as forms can safely be removed, all irregular projections shall be chipped off flush with the concrete surfaces. All voids produced by spacers or any honeycombing shall be pointed up with grout and trowelled flush with the concrete surface immediately after removal of forms and water cured to prevent shrinkage. Form ties are to be removed and holes patched with concrete adhesive. Honeycombing shall be cut out to expose a sound concrete surface prior to pointing. The use of mortar pointing or patching shall be confined to the repair of small defects in relatively green concrete. Where, in the opinion of Subcontractor, substantial repairs are required, the defective concrete shall be cut out to sound concrete and repaired, or the concrete shall be removed and reconstructed as directed.

3.0.6.2 Exposed exterior slabs and pier tops shall have a light broom finish.

3.0.6.3 All exposed vertical corners will be chamfered, and all exposed horizontal corners are to be tooled .

3.0.6.4 Contraction joints for slab on grade placement may be immediately tooled or sawcut after slab finishing, provided it can be safely done without dislodging aggregate and within 8 hours of concrete placement. All contraction joints are to be 1/8" wide and ¾ deep.

3.0.6.5 Roadway swales or pavement will have a transverse rake finish.

3.0.6.6 Exposed vertical concrete surfaces will be grouted to a uniform appearance immediately upon removal of the forms.

3.0.7 Grout. Grout for pointing and patching shall consist of cement and fine aggregate mixed in the proportions used in the concrete and a minimum of water and concrete adhesive to produce a workable grout.