PROJECT MANUAL

For

AIRPORT BOULEVARD – PARKING IMPROVEMENTS PROGRAM
PHASE 2 – VOLUME 3

RS&H No. 2003-0070-006

WILMINGTON INTERNATIONAL AIRPORT
WILMINGTON, NORTH CAROLINA

RS&H ARCHITECTS – ENGINEERS – PLANNERS, INC.
Charlotte, North Carolina

March 14, 2025

100% CONSTRUCTION DOCUMENTS SUBMITTAL
NOT RELEASED FOR CONSTRUCTION

TABLE OF CONTENTS

Cape Fear Public Utility Authority

Appendices:

SPECIAL PROVISIONS

DESCRIPTION

SP-1 North Carolina Department of Transportation (NCDOT)
Reference to NCDOT specifications and standard drawings is to the January 2024 Standard Specifications for Roads and Structures.

SP-2 Definitions of Terms
Reference to "Department or Department of Transportation" within the NCDOT specifications shall mean "Wilmington International Airport".

SP-3 Construction Safety and Phasing Plan (CSPP)
Contractor is responsible for compliance with Federal Aviation Administration (FAA) Advisory Circular (AC) 150-5370-2, most current edition, "Operational Safety on Airports During Construction" and the project Construction Safety and Phasing Plan (CSPP) for the Project. This includes temporary construction equipment which includes:

- Standard construction equipment of 50-feet above ground level.
- Large crane equipment of 150-feet above ground level.

The plans include areas of work for the temporary construction equipment. Should the Contractor need additional temporary construction equipment that are higher than noted and/or beyond the work areas identified, the Contractor is responsible for submitting the FAA Form 7460-1 supplements which may take **at least 45 working days** for FAA review and determination. Should the Contractor need to submit a supplement, no additional compensation to the Contractor shall be allowed due to delays to the Project.

The large crane is anticipated to be a boom type crane which can be lowered when not in use within the crane area shown in the plans (below 100' nightly). This large crane is to be used for construction of the parking garage, terminal atrium, tunnel and roadway (Airport Boulevard and Commercial Road) canopies. At the direction of the Owner, Airport Operations and/or FAA, due to inclement weather, low visibility, or other safety related concerns, the large crane shall be lowered until further direction is provided for use

CSPP compliance is incidental to the Project.

SP-4 Safety Plan Compliance Document (SPCD)
Contractor is responsible for compliance with Federal Aviation Administration (FAA) Advisory Circular (AC) 150-5370-2, most current edition, "Operational Safety on Airports During Construction" and the project Construction Safety and Phasing Plan (CSPP). The Contractor is responsible for preparing a project specific Safety Plan Compliance Document (SPCD) describing their plan for said compliance for the Project. Efforts to complete the SPCD for review, revisions, and approval is incidental to the Project.

SP-5 FAA Airspace 7460-1 Forms
Contractor is responsible for compliance with Federal Aviation Administration Determinations associated with airspace. The Owner has submitted temporary construction equipment and permanent objects to be used and/or installed as part of the project through the FAA Obstruction Evaluation/Airport Airspace Analysis portal.

Temporary construction equipment includes:

- Standard construction equipment of 50-feet above ground level.
- Large crane equipment of 150-feet above ground level.

Should the Contractor need additional temporary construction equipment that are higher than noted and/or beyond the work areas identified, the Contractor is responsible for submitting the FAA Form 7460-1 supplements which may take **at least 45 working days** for FAA review and determination. Should the Contractor need to submit a supplement, no additional compensation to the Contractor shall be allowed due to delays to the Project.

Permanent construction includes all project related objects that protrude above ground level and/or building level (i.e. vents, HVAC units, etc…that protrude above the building roof line and/or parapet).

SP-6 TRAFFIC CONTROL

Contractor shall provide traffic control, including maintenance during construction and removal upon completion and acceptance by the Owner of the work, to meet project plans in accordance with Division 11 of the 2024 Standard Specifications for Roads and Structures. This includes all temporary signage that may require specialty information.

Method of measurement and Basis of payment will be as an allowance. The Contractor shall provide to the Owner all receipts of actual costs (materials, delivery, installation, taxes, insurance, equipment rental, preparation, and other costs to complete the work to the Owners satisfaction) associated with traffic control to be included on a Contractor pay application. No Contractor markup or other costs shall be added to the actual costs incurred by the Contractor.

Payment will be made under:

SP-6 Traffic Control per Allowance

SP-7 EROSION CONTROL

Contractor shall provide erosion control, including maintenance during construction and removal upon completion and acceptance by the Owner of the work, to meet project plans in accordance with Division 16 of the 2024 Standard Specifications for Roads and Structures and North Carolina Department of Environmental Quality. Additionally, the Contractor is required to meet NCDEQ permit requirements that will be provided prior to the start of construction.

Method of measurement and Basis of payment will be as a lump sum. This includes cost to the Contractor of specific products and materials per the contract documents inclusive of taxes, freight, and delivery to the Project site. Additionally, costs for receiving and handling at Project site, labor, installation, overhead and profit, and other costs to complete the work.

The 100% documents will provide a list of erosion control items based on the Erosion Control plan sheets. Regardless of the list provided, the Contractor is responsible for meeting the NCDEQ permit and other Federal, State, and local requirements.

Payment will be made under:

SP-7 Erosion Control per Lump Sum

SP-8 PERMITTING

The Contractor shall procure permits and licenses per 107-3 of the 2024 Standard Specifications for Roads and Structures unless noted as Owner secured.

Permits to be secured by the Owner include:

- North Carolina Department of Environmental Quality
  - Erosion and Sediment Control / NPDES
  - Stormwater Permit
- New Hanover County Technical Review Committee (TRC)
- New Hanover County Stormwater Permit
- New Hanover County Building Permits (refer to Volumes 1 and 2)

Permits will be provided by the Owner to the Contractor upon receipt from the appropriate entity/agency. The Contractor shall adhere to the provisions as part of the Owner secured permits.

Method of measurement and Basis of payment will be as an allowance. The Contractor shall provide to the Owner all receipts of actual costs (materials, delivery, installation, taxes, insurance, equipment rental, preparation, and other costs to complete the work to the Owners satisfaction) associated with permitting to be included on a Contractor pay application. No Contractor markup or other costs shall be added to the actual costs incurred by the Contractor.

Payment will be made under:

SP-8 Permitting per Allowance

SP-9 UNDERCUT EXCAVATION

It is assumed that 10% of the Unclassified Excavation volume will require Undercut Excavation due to soft, yielding or unsuitable materials encountered during construction. Work associated with Undercut Excavation shall be in accordance with Division 2, Section 225 of the 2024 Standard Specifications for Roads and Structures.

This pay item shall only be used upon approval from the Engineer and Owner. Additionally, per Division 1, Section 104-5 Overruns and Underruns of Contract Quantities is waived for Undercut Excavation.

SP-9 relates to only the areas shown within the Volume 3 plan set. Areas of undercut within a building footprint or under work areas covered under Volumes 1 or 2 shall reference the respective specifications.

SP-10 EARTHWORK

It is assumed that 10% loss will occur for existing materials reused on site in fill areas due to compaction. Borrow quantities in the Bid Form show an additional 10% needed due to the compaction loss.

Any excess cut material, if acceptable for future fill use when tested, shall be stockpiled on airport property at a location approved by the Owner and Engineer. Measures associated with erosion and sediment control, seeding and other items shall be met and are incidental to the Project. All costs for hauling, trucking, and other incidentals for the excess cut material to be placed in an on-site stockpile shall be incidental to Division 2, Section 225 of the 2024 Standard Specifications for Roads and Structures.

SP-10 relates to only the areas shown within the Volume 3 plan set. Areas of earthwork within a building footprint or under work areas covered under Volumes 1 or 2 shall reference the respective specifications.

SP-11 UNCLASSIFIED EXCAVATION

Contractor shall review Unclassified Excavation per Division 2, Section 225 of the 2024 Standard Specifications for Roads and Structures related to removal, demolition and other items identified under 225-7 Measurement and Payment.

Additionally, there are existing stockpiles located within the airport property. Removal and/or reuse of these stockpiles to facilitate project construction shall be completed by the Contractor. Any reuse of these stockpiles within the Project shall require testing. Test reports shall be provided to Engineer for approval.

SP-12 EXISTING TREE DEMOLITION

Salvage of existing trees, identified as tree demolition on the Demolition Sheets in the plan set, is to be assessed for replanting. Assessment shall include cost and health of the tree. Contractor shall coordinate with Owner and Engineer regarding salvaging of existing trees. Should trees be determined to not be salvaged for replanting, the Contractor shall remove the tree(s) and dispose off-site. Costs for removal, disposal, hauling, trucking or other means for disposal off-site shall be per Division 2, Section 200 of the 2024 Standard Specifications for Roads and Structures.

SP-13 WAYFINDING SIGNAGE

Signage associated with Specialties, refer to Specification 10 14 00 and plan sheet series GR.

Method of measurement and Basis of payment will be lump sum. This includes cost to the Contractor of specific products and materials per the contract documents inclusive of taxes, freight, and delivery to the Project site. Additionally, costs for receiving and handling at Project site, labor, installation, overhead and profit, and other costs to complete the work.

Payment will be made under:

SP-13 Wayfinding Signage per Lump Sum

SP-14 Watermain, Sanitary Sewer, and Natural Gas

Watermain and sanitary sewer utilities shall meet Cape Fear Public Utility Authority (CFPUA) requirements. This shall include all plan reviews, approvals, permits, inspections and other items as required by CFPUA.

Coordination with CFPUA shall occur for all project related work related to watermain and sanitary sewer utilities such that review for time, revisions, inspections, permits, or other requirements by CFPUA shall be met.

Current project related design will require CFPUA review and approval prior to construction and may take up to three (3) months or more.

The contractor is to review and coordinate all work in proximity and with relocating existing gas lines or services with Piedmont Natural Gas or the respective gas utility company. All work associated with relocating gas lines shall be coordinated in advance and relocated prior to completing major work item installation such that review for time, revisions, inspections, permits or other requirements by Piedmont Natural Gas shall be met.

Method of measurement and Basis of payment will be as an allowance. The Contractor shall provide to the Owner all receipts of actual costs (materials, delivery, installation, taxes, insurance, equipment rental, preparation, and other costs to complete the work to the Owners satisfaction) associated with watermain, sanitary sewer, and gas services to be included on a Contractor pay application. No Contractor markup or other costs shall be added to the actual costs incurred by the Contractor.

Payment will be made under:

SP-14-1 Watermain per Allowance.
SP-14-2 Sanitary Sewer per Allowance.
SP-14-3 Gas per Allowance.

SP-15 AIRFIELD SAFETY AND SECURITY

Contractor shall provide low profile barricades, including maintenance during construction and removal upon completion and acceptance by the Owner of the work, and any other maintenance of traffic in accordance with the Federal Aviation Administration (FAA) Advisory Circular 150/5370-2 most current edition.

It is not anticipated that this contract will require construction activities within the Airport's Air Operations Area (AOA) fence, however if there is AOA work needed due to Airport direction, Contractor shall submit a Safety and Security site access and barricade layout plan to the Owner for review prior to completing work on the airfield or due to a relocation of an existing AOA fence.

Method of measurement and Basis of payment will be as a lump sum. **This item shall only be used when directed by the Airport and approved by the Engineer for safety and security measures when working within the AOA.**

Payment will be made under:

SP-15 Airfield Safety and Security per Lump Sum

SP-16 LANDSCAPING & IRRIGATION

An allowance is to be used for landscaping and irrigation related work on the project. This is to allow replanting of existing trees, new trees, irrigation systems and other landscaping items per the project plans. This allows the Owner to revise and/or add plantings and irrigation as needed.

Method of measurement and Basis of payment will be as an allowance. The Contractor shall provide to the Owner all receipts of actual costs associated with landscaping to be included on a Contractor pay application. No Contractor markup or other costs shall be added to the actual costs incurred by the Contractor.

Payment will be made under:

SP-16 Landscaping and Irrigation per Allowance

SP-17 HARDSCAPING

An allowance is to be used for hardscaping related work on the project. This is to allow for specialty concrete finishes, walkway designs (including concrete stamping), flagpole seating area (including flags, poles and monuments), bollards, and furnishings (seating, trash

receptacles, etc) per the project plans. This allows the Owner to revise and/or add hardscaping as needed.

Method of measurement and Basis of payment will be as an allowance. The Contractor shall provide to the Owner all receipts of actual costs associated with hardscaping to be included on a Contractor pay application. No Contractor markup or other costs shall be added to the actual costs incurred by the Contractor.

Payment will be made under:

SP-17 Hardscaping per Allowance

SP-18 WATER FEATURE

An allowance is to be used for water feature / fountain work on the project. This is to allow for fountain design, including but not limited to, permitting, plans for Owner review and approval, pumps, water connection (including meter), electrical connections, light fixtures, water basins, drainage, specialty finishes and other appurtenances necessary for a complete functioning feature based the project plans and specifications as well as Owner revisions during the review/approval process. This allows the Owner to revise and/or add water feature as needed.

Method of measurement and Basis of payment will be as an allowance. The Contractor shall provide to the Owner all receipts of actual costs associated with the water feature to be included on a Contractor pay application. No Contractor markup or other costs shall be added to the actual costs incurred by the Contractor.

Payment will be made under:

SP-18 Water Feature per Allowance

SP-19 STRUCTURES

There are large building and miscellaneous structures to be provided such as a parking garage, tunnel connector, vestibule, curbfront canopies, entry plaza canopy extensions, garage entry plaza, and bus shelter (1), refer to project plans. These structures include the foundation, other structural items, architectural items, mechanical, electrical, plumbing, technology and other appurtenances necessary to construct these structures.

See specifications in Volumes 1 and 2 when referring to work items associated with all structures on site.

Method of measurement and Basis of payment will be per Volume 1 and 2 specifications. No additional payment will be made in Volume 3 for work items associated within the scope of the plans and specifications in Volumes 1 and 2.

END OF SPECIAL PROVISIONS

SECTION 26 05 19 – LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Building wires and cables rated 600 V and less.
2. Connectors, splices, and terminations rated 600 V and less.

B. Related Sections:

1. Section 27 13 00 – “Communications Backbone Cabling”

1.3 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by UL and marked for intended use.

B. Comply with ASTM.

C. Comply with UL 44, 83, and 486.

D. Comply with NFPA 70.

E. All current carrying components shall be copper. Substitutions are not allowed.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Include data sheets for the following additional items:

1. Splices and terminations.
2. Pulling compounds.
3. Cable accessories.

C. Field quality-control test reports.

1.5 PROJECT CONDITIONS

A. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by the airport unless approved by the airport.
   1. Notify Airport no fewer than two calendar weeks in advance of proposed interruption of electric service.
   2. Indicate method of providing temporary utilities.
   3. Do not proceed with interruption of electrical service without the Airports written permission.
   4. The Lock-out/Tag-out procedures shall be used with Contractor controlled locks and tags.
   5. Comply with NFPA 70E.

PART 2 - PRODUCTS

2.1 CONDUCTORS AND CABLES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   1. General Cable Technologies Corporation.
   2. Okonite Company.
   3. Southwire Company.

B. Copper Conductors: Comply with NEMA WC 70.

   1. Aluminum conductors shall not be used under any circumstances.

C. Conductor Insulation: Comply with NEMA WC 70 for Types THHN, THWN, *THWN-2*, XHHW-2, and SO.

   1. Voltage rating: 600 Volts for 480/277V and 208/120V.

D. VFD Cable:

   1. Comply with UL 1277, UL 1685, and NFPA 70 for Type TC-ER cable.
   2. Type TC-ER with oversized cross-linked polyethylene insulation, and sunlight- and oil-resistant outer PVC jacket.

E. Multi-conductor Cable type MC and AC: Use of MC or AC cable is not permitted.

F. Use of Nonmetallic sheathed (NM) cable is not permitted under any circumstances.

G. Flat or Under-carpet type cable is not permitted under any circumstances.

2.2 CONNECTORS AND SPLICES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   1. Burndy, Thomas & Betts.

2. O-Z/Gedney; EGS Electrical Group LLC.
3. 3M; Electrical Products Division.
4. Ilsco.
5. Hubbell Power Systems, Inc.
6. Ideal Industries, Inc.

B. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

1. Aboveground Circuits (No. 10 AWG and smaller):

a. Connectors: Solderless, screw-on, reusable pressure cable type, rated 600 V, 90˚ C, with integral insulation, approved for copper conductors.
b. The integral insulator shall have a skirt to completely cover the stripped wires.
c. The number, size, and combination of conductors, as listed on the manufacturer's packaging, shall be strictly followed.
d. Use of “push-in” type splice connectors is not permitted.

2. Aboveground Circuits (No. 8 AWG and larger):

a. Cable termination lugs shall be made of high conductivity and corrosion-resistant material, electro-tin plated, listed for use with copper conductors only, rated for 600 V. Lugs shall be color-coded by size.
b. Cable termination lugs shall be indent type, long barrel with chamfered entry, 2 – hole, compression type for 250 kcmil and above, 1 – hole for less than 250 kcmil.

PART 3 - EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

A. Feeders: Soft annealed Copper stranded, class B compressed.

B. Branch Circuits: Copper. Stranded for No. 12 AWG and larger.

C. Minimum Wire Size: #12 AWG for power and lighting circuits, #14 AWG for control circuits. In the case of “homeruns” over 125 feet in length, no conductor smaller than a No. 10 wire shall be used. The tap conductor from the J-box in the ceiling to the receptacle may be No. 12. Each 120-volt phase conductor shall have a neutral conductor of the same size. The sizing of all wire shall be accomplished in the case of both feeder and branch circuits by conforming to the following provisions.

3.2 CONDUCTOR INSULATION AND MULTI-CONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

A. Service Entrance: Type XHHW, or type THHN/THWN up to and including 600 kcmil, single conductors in conduit as shown on the plans.

B. Exposed Feeders: Type XHHW for all sizes up to and including 600 kcmil, single conductors in conduit.

C. Feeders Concealed in Concrete, and underground: Type XHHW for #2 AWG and larger, single conductors in conduit.

D. Exposed Branch Circuits, Including in Crawlspaces: Type XHHW, single conductors in conduit.

E. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type XHHW, single conductors in conduit.

F. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and underground: Type XHHW single conductors in conduit.

G. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless-steel, wire-mesh, and strain relief device at terminations to suit application. Service voltage shall not exceed 240 VAC.

H. Recessed or Semi-recessed Lighting Fixture Whips: Type THHN-THWN (90 deg C), single conductors in FMC in lengths not to exceed six (6) feet.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

A. Splices in feeder circuits shall be avoided unless necessitated by the length. of the run more than 500 feet.

B. Conductors may be run parallel from sizes 250 kcmil up to and including 600 kcmil provided all paralleled conductors are of the same size, manufacturer, length and type of insulation.

C. Homeruns may not contain more than three circuits

D. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.

E. Use pulling means; including fish tape, cable, rope, and basket-weave wire/cable grips that will not damage cables or conduit.

3.4 CONNECTIONS

A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A.

B. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.

C. Splices and terminations for cables # 6 and larger shall utilize compression-type connectors.

3.5 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

B. Tests and Inspections:

1. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors, and conductors feeding the following critical equipment and services for compliance with requirements.

2. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

C. Test Reports: Prepare a written report to record the following:

1. Test procedures used.
2. Test results that comply with requirements.
3. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

D. Remove and replace non-compliant cables or wires and retest as specified above.

3.6 REMOVAL OF CONDUCTORS AND CABLES.

A. Remove abandoned conductors and cables. Abandoned conductors and cables are those installed that are not terminated at equipment and are not identified for future use with a tag.

3.7 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies.

3.8 FIRESTOPPING

A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly.

PART 4 - CONTRACTOR'S QUALITY CONTROL REQUIREMENTS

4.1 FIELD QUALITY CONTROL

A. General: Comply with applicable standards of The International Electrical Testing Association (NETA) including Standard ATS, "Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems."

B. Test Objectives: To assure conductor and cable installation is operational within industry and manufacturer's tolerances, is installed in accordance with Contract Documents, and is suitable for energizing.

C. Testing agency: Arrange and pay for the services of an independent electrical testing organization to perform tests on low-voltage electrical power conductors and cables.

D. Schedule tests and notify RPR at least two weeks in advance of schedule for test commencement.

E. Test Instruments, Meters, and Auxiliary Equipment: Tested and calibrated within 6 months of use on this contract and provided by the Contractor, independent testing companies and by manufacturers' field service personnel where required.

F. Test procedures:

1. After installing conductors and cables and before electrical circuitry has been energized, test for compliance with requirements.

2. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

3. Perform insulation resistance tests on 600V wiring using instrument which applies a voltage of 1000V.

G. Correct deficiencies and retest to demonstrate compliance.

H. Reports: The testing organization shall maintain a written record of observations and tests, report defective materials and workmanship, and retest corrected defective items. Testing organization shall submit certified written reports to the RPR and Contractor, to include the following:

1. Test procedures used.
2. Test results that comply with requirements.
3. Test results that do not comply with requirements and corrective actions taken to achieve compliance with requirements.
4. Calibration records for the test instruments, meters and auxiliary equipment.

PART 5 - METHOD OF MEASUREMENT

Low voltage power conductors and cables shall be measured per linear feet completed in place and accepted.

PART 6 - BASIS OF PAYMENT

The accepted quantity of cable will be paid for at the Contract unit price per each, complete and in place. This price shall be full compensation for furnishing all materials and for all preparation, equipment, excavation, backfilling and placing of the materials, furnishing, and installation of appurtenances and connections to duct banks and other structures as may be required to complete the item as shown on the plans and for all labor, equipment, tools, and incidentals necessary to complete the structure.

Payment will be made under:

Pay Item	**Pay Unit**
No. 6 AWG, Solid, Bare Counterpoise Wire, Installed in Trench, Above the Duct Bank or Conduit, Including Ground Rods and Ground Connectors	per linear foot
3/4" x 10' Copper Clad Ground Rod - Supplemental	per each
1-6 Strand Fiber Optic Cable - Single Mode with 1-4 MAXCELL Inner Duct	per linear foot
1-12 Strand Fiber Optic Cable - Single Mode with 1-4 MAXCELL Inner Duct	per linear foot
1-48 Strand Fiber Optic Cable – Single Mode with 1-4 MAXCELL Inner Duct	per linear foot
No. 10 AWG, XHHW Cable, 600V	per linear foot

No. 8 AWG, XHHW Cable, 600V	per linear foot
No. 6 AWG, XHHW Cable, 600V	per linear foot
No. 4 AWG, XHHW Cable, 600V	per linear foot
No. 2 AWG, XHHW Cable, 600V	per linear foot
No. 1 AWG, XHHW Cable, 600V	per linear foot

END OF SECTION 26 05 19

THIS PAGE IS INTENTIONALLY BLANK

SECTION 26 05 43 - UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Conduit, ducts, and duct accessories for direct-buried and concrete-encased duct banks, and in single duct runs.
2. Handholes and boxes.
3. Manholes.

1.3 DEFINITION

A. RNC: Rigid nonmetallic conduit.

B. RGC: Rigid galvanized conduit.

1.4 ACTION SUBMITTALS

A. Product Data: For the following:

1. Duct-bank materials, including separators and miscellaneous components.
2. Ducts and conduits and their accessories, including elbows, end bells, bends, fittings, and solvent cement.
3. Accessories for manholes, handholes, boxes**,** and other utility structures.
4. Warning tape.

B. Shop Drawings for Precast or Factory-Fabricated Underground Utility Structures: Shop drawings shall be sealed by a Professional Engineer. Include plans, elevations, sections, details, attachments to other work, and accessories, including the following:

1. Duct entry provisions, including locations and duct sizes.
2. Reinforcement details.
3. Frame and cover design and manhole frame support rings.
4. Grounding details.
5. Dimensioned locations of cable rack inserts, pulling-in and lifting irons, and sumps.
6. Joint detail / keyways

C. Shop Drawings for Factory-Fabricated Handholes and Boxes Other Than Precast Concrete: Include dimensioned plans, sections, and elevations, and fabrication and installation details, including the following:

1. Duct entry provisions, including locations and duct sizes.
2. Cover design.
3. Grounding details.

4. Dimensioned locations of cable rack inserts, and pulling-in and lifting irons.

1.5 INFORMATIONAL SUBMITTALS

A. Duct-Bank Coordination Drawings: Show duct profiles and coordination with other utilities and underground structures.

1. Include plans and sections, drawn to scale, and show bends and locations of expansion fittings.

B. Product Certificates: For concrete and steel used in precast concrete manholes and handholes, as required by ASTM C 858.

C. Source quality-control test reports.

D. Field quality-control test reports.

1.6 QUALITY ASSURANCE

A. All products shall be UL labeled for their intended use.

B. Comply with ANSI C2.

C. Comply with NFPA 70.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver ducts to Project site with ends capped. Store nonmetallic ducts with supports to prevent bending, warping, and deforming.

B. Lift and support precast concrete units only at designated lifting or supporting points.

1.8 COORDINATION

A. Coordinate layout and installation of ducts, manholes, handholes, and boxes with final arrangement of other utilities, site grading, and surface features as determined in the field.

B. Coordinate elevations of ducts and duct-bank entrances into manholes, handholes, and boxes with final locations and profiles of ducts and duct banks as determined by coordination with other utilities, underground obstructions, and surface features. Revise locations and elevations from those indicated as required to suit field conditions and to ensure that duct runs drain to manholes and handholes.

PART 2 - PRODUCTS

2.1 CONDUIT

A. Rigid Steel Conduit: Galvanized. Comply with ANSI C80.1.

B. RNC: NEMA TC 2, Type EPC-40-PVC, UL 651, with matching fittings by same manufacturer as the conduit, complying with NEMA TC 3 and UL 514B.

2.2 NONMETALLIC DUCTS AND DUCT ACCESSORIES

A. Manufacturers: Subject to compliance with requirements, products of all manufacturers are acceptable provided they are sunlight resistant and UL listed for the intended installation. Conduit and fittings shall be provided from the same manufacturer whenever possible.

B. Duct Accessories:

1. Duct Separators: Factory-fabricated rigid PVC interlocking spacers, sized for type and sizes of ducts with which used, and selected to provide minimum duct spacings indicated while supporting ducts during concreting or backfilling.
2. Warning Tape: Underground-line warning tape specified in Division 26 Section 26 05 53 "Identification for Electrical Systems."

2.3 HANDHOLES AND BOXES

A. Description: Comply with SCTE 77.

1. Tier 22 rated.
2. Color: Gray.
3. Configuration: Units shall be designed for flush burial and have open bottom, unless otherwise indicated.
4. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.
5. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
6. Direct-Buried Wiring Entrance Provisions: Knockouts equipped with insulated bushings or end-bell fittings, selected to suit box material, sized for wiring indicated, and arranged for secure, fixed installation in enclosure wall.
7. Duct Entrance Provisions: Duct-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.
8. Handholes 12 inches wide by 24 inches long (300 mm wide by 600 mm long) and larger shall have factory-installed inserts for cable racks and pulling-in irons.

B. Polymer Concrete Handholes and Boxes with Polymer Concrete Cover: Molded of sand and aggregate, bound together with a polymer resin, and reinforced with steel or fiberglass or a combination of the two.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Quazite, Hubbell Power Systems
   b. Highline Products

2. Cover Legend: Cast in, selected to suit the system.

   a. Legend: "ELECTRIC" for duct systems with power wires and cables for systems operating at 600 V and less.
   b. Legend: "COMM" for communications, data, and telephone duct systems.

2.4 PRECAST MANHOLES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Cretex.
2. Utility Concrete Products.

B. Comply with ASTM C 858**,** with structural design loading as specified in Part 3 "Underground Enclosure Application" Article and with interlocking mating sections, complete with accessories, hardware, and features.

1. Windows: Precast openings in walls, arranged to match dimensions and elevations of approaching ducts and duct banks plus an additional 12 inches (300 mm) vertically and horizontally to accommodate alignment variations.

a. Windows shall be located no less than 6 inches (150 mm) from interior surfaces of walls, floors, or roofs of manholes, but close enough to corners to facilitate racking of cables on walls.
b. Window opening shall have cast-in-place, welded wire fabric reinforcement for field cutting and bending to tie in to concrete envelopes of duct banks.
c. Window openings shall be framed with at least two additional No. 4 steel reinforcing bars in concrete around each opening.

C. Concrete Knockout Panels: 1-1/2 to 2 inches (38 to 50 mm) thick, for future conduit entrance and sleeve for ground rod.

D. Joint Sealant: Asphaltic-butyl material with adhesion, cohesion, flexibility, and durability properties necessary to withstand maximum hydrostatic pressures at the installation location with the ground-water level at grade.

2.5 UTILITY STRUCTURE ACCESSORIES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Neenah Foundry Company.
2. East Jordan Iron Works, Inc.
3. McKinley Iron Works, Inc.

B. Manhole Frames, Covers, and Chimney Components: Comply with structural design loading specified for manhole.

1. Frame and Cover: Weatherproof, gray cast iron complying with ASTM A 48/A 48M, Class 30B with milled cover-to-frame bearing surfaces; diameter, 29 inches (737 mm).

a. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
b. Special Covers: Recess in face of cover designed to accept finish material in paved areas.
c. Covers shall have locking provisions.

2. Cover Legend: Cast in. Selected to suit system.

a. Legend: ELECTRIC" for duct systems with power wires and cables for systems operating at 600 V and less.
b. Legend: “ELECTRIC-MV" for duct systems with medium-voltage cables.
c. Legend: "COMM" for communications, data, and telephone duct systems.

3. Manhole Chimney Components: Precast concrete rings with dimensions matched to those of roof opening.

a. Mortar for Chimney Ring and Frame and Cover Joints: Comply with ASTM C 270,

Type M, except for quantities less than 2.0 cu. ft. (60 L) where packaged mix complying with ASTM C 387, Type M, may be used.

C. Manhole Sump Frame and Grate: ASTM A 48/A 48M, Class 30B, gray cast iron.

D. Pulling Eyes in Concrete Walls: Eyebolt with reinforcing-bar fastening insert, 2-inch- (50-mm-) diameter eye, and 1-by-4-inch (25-by-100-mm) bolt.

1. Working Load Embedded in 6-Inch (150-mm), 4000-psi (27.6-MPa) Concrete: 13,000-lbf (58-kN) minimum tension.
2. Four required.

E. Pulling-In and Lifting Irons in Concrete Floors: 7/8-inch- (22-mm-) diameter, hot-dip galvanized, bent steel rod; stress relieved after forming; and fastened to reinforcing rod. Exposed triangular opening.

1. Ultimate Yield Strength: 40,000-lbf (180-kN) shear and 60,000-lbf (270-kN) tension.
2. Four required.

F. Bolting Inserts for Concrete Utility Structure Cable Racks and Other Attachments: Flared, threaded inserts of noncorrosive, chemical-resistant, nonconductive thermoplastic material; 1/2-inch (13-mm) ID by 2-3/4 inches (69 mm) deep, flared to 1-1/4 inches (32 mm) minimum at base.

1. Tested Ultimate Pullout Strength: 12,000 lbf (53 kN) minimum.

G. Cable Rack Assembly: Nonmetallic. Components fabricated from nonconductive, Heavy duty Plastic.

1. Stanchions: Nominal 36 inches (900 mm) high by 4 inches (100 mm) wide, with minimum of 9 holes for arm attachment.
2. Arms: Arranged for secure, drop-in attachment in horizontal position at any location on cable stanchions, and capable of being locked in position. Arms shall be available in lengths ranging from 3 inches (75 mm) with 450-lb (204-kg) minimum capacity to 20 inches (508 mm) with 250-lb (114-kg) minimum capacity. Top of arm shall be nominally 4 inches (100 mm) wide, and arm shall have slots along full length for cable ties.

H. Duct-Sealing Compound: Non-hardening, safe for contact with human skin, not deleterious to cable insulation, and workable at temperatures as low as 35 deg F (2 deg C). Capable of withstanding temperature of 300 deg F (150 deg C) without slump and adhering to clean surfaces of plastic ducts, metallic conduits, conduit coatings, concrete, masonry, lead, cable sheaths, cable jackets, insulation materials, and common metals.

2.6 SEAL – SLEEVE ASSEMBLIES

A. Products: “Link-Seal”® by GPT Industries.

B. Exterior Wall or Stub-Ups through Floor: Modular seal assembly to provide a hydrostatic seal, using mechanical interlocking synthetic rubber links shaped to fill the annular opening between the conduit and the wall. Pressure plate shall be reinforced nylon-polymer. Hardware shall be stainless steel.

C. Sleeves shall be Schedule 40 galvanized steel pipe.

2.7 SOURCE QUALITY CONTROL

A. Test and inspect precast concrete utility structures according to ASTM C 1037.

B. Non-concrete Handhole and Pull-Box Prototype Test: Test prototypes of manholes and boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied.

1. Strength tests of complete boxes and covers shall be by either an independent testing agency or the manufacturer.
2. Testing machine pressure gages shall have current calibration certification complying with ISO 9000 and ISO 10012, and traceable to NIST standards.

PART 3 - EXECUTION

3.1 UNDERGROUND DUCT APPLICATION

A. Minimum conduit/duct size for underground installations shall be one inch for branch circuits, four inch for primary and main feeder conductors, and four inch for telecom services, unless otherwise indicated.

B. Ducts for Electrical Cables over 600 V: NEMA Type EPC-40 PVC in a concrete-encased duct bank, unless otherwise indicated.

C. Ducts for Electrical Feeders 600 V and Less: RNC**,** NEMA Type EPC-40 PVC, in concrete-encased duct bank, unless otherwise indicated.

D. Ducts for Electrical Branch Circuits: RNC, NEMA Type EPC**-**40 PVC, in direct-buried duct bank, unless otherwise indicated.

E. Underground Ducts for Telephone, Communications, or Data Utility Service Cables: RNC, NEMA Type EPC-40 PVC, in concrete-encased duct bank, unless otherwise indicated.

F. Underground Ducts Crossing Paved Paths, Walks, Driveways and Roadways: NEMA Type EPC**-**40 PVC, in direct-buried duct bank, unless otherwise indicated.

G. A nylon pull cord shall be installed and tied off in each duct, including spares. The nylon pull cord shall have a minimum tensile strength of 200 pounds.

3.2 UNDERGROUND ENCLOSURE APPLICATION

A. Handholes and Boxes for 600 V and Less, Including Telephone, Communications, and Data Wiring:

1. Units in Roadways and Other Deliberate Traffic Paths: Precast concrete. AASHTO HB 17, Minimum H-20 structural load rating.
2. Units in Driveway, Parking Lot, and Off-Roadway Locations, Subject to Occasional, Non-deliberate Loading by Heavy Vehicles: Precast concrete, AASHTO HB 17, H-20 (minimum); Polymer concrete, SCTE 77, Minimum Tier 15 structural load rating, unless otherwise indicated.
3. Units in Sidewalk and Similar Applications with a Safety Factor for Non-deliberate Loading by Vehicles: Precast concrete, AASHTO HB 17, H-10 (minimum), Polymer concrete units, SCTE 77, Minimum Tier 8 structural load rating, unless otherwise indicated.

B. Manholes: Precast concrete.

1. Units Located in Roadways and Other Deliberate Traffic Paths by Heavy or Medium Vehicles: Minimum H-20 structural load rating according to AASHTO HB 17, unless

otherwise indicated.

2. Units Not Located in Deliberate Traffic Paths by Heavy or Medium Vehicles: Minimum H-10 load rating according to AASHTO HB 17, unless otherwise indicated.

3.3 EARTHWORK

A. Excavation and Backfill: Comply with earth moving Specifications, but do not use heavy-duty, hydraulic-operated, compaction equipment.

B. Restore surface features at areas disturbed by excavation and reestablish original grades, unless otherwise indicated. Replace removed sod immediately after backfilling is completed.

C. Restore areas disturbed by trenching, storing of dirt, cable laying, and other work. Restore vegetation and include necessary top-soiling, fertilizing, liming, seeding, sodding, sprigging, and mulching.

D. Cut and patch existing pavement in the path of underground ducts and utility structures if shown on plans.

3.4 DUCT INSTALLATION

A. Slope: Pitch ducts a minimum slope of 1:300 down toward manholes and handholes and away from buildings and equipment. Slope ducts from a high point in runs between two manholes to drain in both directions.

1. This Contractor shall be fully responsible for corrective action necessary to ensure water infiltration is eliminated.

B. Curves and Bends: Use 5-degree angle couplings for small changes in direction. Use manufactured long sweep GRC bends with a minimum radius of 48 inches both horizontally and vertically, at other locations, unless otherwise indicated.

C. Joints: Use solvent-cemented joints in ducts and fittings and make watertight according to manufacturer's written instructions. Stagger couplings so those of adjacent ducts do not lie in same plane.

D. Duct Entrances to Manholes and Polymer Concrete Handholes: Use end bells, spaced approximately 10 inches (250 mm) O.C. for 5-inch (125-mm) ducts, and vary proportionately for other duct sizes.

1. Begin change from regular spacing to end-bell spacing 10 feet (3 m) from the end bell without reducing duct line slope and without forming a trap in the line.
2. Direct-Buried Duct Banks: Install an expansion and deflection fitting in each conduit in the area of disturbed earth adjacent to manhole or handhole.
3. Grout end bells into structure walls from both sides to provide watertight entrances.

E. Sealing: Provide temporary closure at terminations of ducts that have cables pulled. Seal spare ducts at terminations. Use sealing compound and plugs to withstand at least 15-psig (1.03-MPa) hydrostatic pressure.

F. Connections to Existing Ducts: Where connections to existing ducts are indicated, excavate around the ducts as necessary. Cut off the ducts and remove loose concrete from inside before installing new ducts. Provide a reinforced-concrete collar, poured monolithically with the new ducts, to take the shear at the joint of the duct banks.

G. Concrete-Encased Ducts: Support ducts on duct separators.

1. Separator Installation: Space duct spacers close enough to prevent sagging and deforming of ducts, with not less than 5 spacers per 20 feet (6 m) of duct. Secure duct spacers to earth and to ducts to prevent floating during concreting. Stagger duct spacers approximately 6 inches (150 mm) between tiers. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around ducts or duct groups.
2. Concrete: 3000 psi (20 kPa) minimum, 28-day strength and complying with the Concrete Specifications.
3. Concreting Sequence: Place each run of concrete envelope between manholes or other terminations in one continuous operation.

    a. Start at one end and finish at the other, allowing for expansion and contraction of ducts as their temperature changes during and after the concrete placement. Use expansion fittings installed according to manufacturer's written recommendations, or use other specific measures to prevent expansion-contraction damage.
    b. If more than one concrete placement is necessary, terminate each in a vertical plane and install 3/4-inch (19-mm) reinforcing rod dowels extending 18 inches (450 mm) into concrete on both sides of joint near corners of envelope.

4. Placing Concrete: Spade concrete carefully during placement to prevent voids under and between conduits and at exterior surface of envelope. Do not allow a heavy mass of concrete to fall directly onto ducts. Use a plank to direct concrete down sides of bank assembly to trench bottom. Allow concrete to flow to center of bank and rise up in middle, uniformly filling all open spaces. Do not use power-driven agitating equipment unless specifically designed for duct-bank application.
5. Forms: Use walls of trench to form side walls of duct bank where soil is self-supporting and concrete envelope can be placed without soil inclusions; otherwise, use forms.
6. Minimum Space between Ducts: 3 inches (75 mm) between ducts and exterior envelope wall, 2 inches (50 mm) between ducts for like services, and 12 inches (300 mm) between power and signal ducts, unless otherwise indicated.
7. Depth: Depth: Install top of duct bank at 36 inches (900 mm) below finished grade, unless otherwise indicated.

8. Install insulated grounding bushings on conduit terminations.
9. Warning Tape: Comply with Section 26 05 53. Bury metallic detectable warning tape approximately 18 inches (450 mm) above all concrete-encased ducts and duct banks. Align tape parallel to and within 3 inches (75 mm) of the centerline of duct bank. Provide an additional warning tape for each 12-inch (300-mm) increment of duct-bank width over a nominal 18 inches (450 mm). Space additional tapes 12 inches (300 mm) apart, horizontally as needed.

H. Direct-Buried Duct Banks:

1. Support ducts on duct separators coordinated with duct size, duct spacing, and outdoor temperature.
2. Space duct spacers close enough to prevent sagging and deforming of ducts, with not less than 5 spacers per 20 feet (6 m) of duct. Secure separators to earth and to ducts to prevent displacement during backfill and yet permit linear duct movement due to expansion and contraction as temperature changes. Stagger spacers approximately 6 inches (150 mm) between tiers.
3. Excavate trench bottom to provide firm and uniform support for duct bank.
4. Install backfill as specified in earth moving as shown on plans.
5. After installing first tier of ducts, backfill and compact. Start at tie-in point and work toward end of duct run, leaving ducts at end of run free to move with expansion and

contraction as temperature changes during this process. Repeat procedure after placing each tier. After placing last tier, hand-place backfill to 4 inches (100 mm) over ducts and hand tamp. Firmly tamp backfill around ducts to provide maximum supporting strength. Use hand tamper only. After placing controlled backfill over final tier, make final duct connections at end of run and complete backfilling with normal compaction.

6. Install ducts with a minimum of 3 inches (75 mm) between ducts for like services and 12 inches (300 mm) between power and signal ducts, unless otherwise indicated.
7. Depth: Install top of duct bank at 24 inches below finished grade, unless otherwise indicated.
8. Set elevation of bottom of duct bank below the frost line.
9. Install manufactured duct elbows for stub-ups at poles and equipment and at building entrances through the floor, unless otherwise indicated. Encase elbows for stub-up ducts throughout the length of the elbow.
10. Warning Tapes: Comply with Section 26 05 53. Bury warning tape approximately 18 inches (450 mm) above all duct banks. Align tape parallel to and within 3 inches (75 mm) of the centerline of duct bank. Provide an additional warning tape for each 12-inch (300-mm) increment of duct-bank width over a nominal 18 inches (450 mm). Space additional tapes 12 inches (300 mm) apart, horizontally.

3.5 INSTALLATION OF CONCRETE MANHOLES, HANDHOLES, AND BOXES

A. Precast Concrete Handhole and Manhole Installation:

1. Comply with ASTM C 891, unless otherwise indicated.
2. Install unit level and plumb and with orientation and depth coordinated with connecting ducts to minimize bends and deflections required for proper entrances.
3. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1-inch (25-mm) sieve to No. 4 (4.75-mm) sieve and compacted to same density as adjacent undisturbed earth.

B. Elevations:

1. Manhole Roof: Install with rooftop at least 18 inches (450 mm) below finished grade.
2. Manhole Frame: In paved areas and traffic-ways, set frames flush with finished grade. Set other manhole frames 1 inch (25 mm) above finished grade.
3. Where indicated, cast handhole cover frame integrally with handhole structure.

C. Drainage: Install drains in bottom of manholes where indicated. Coordinate with drainage provisions indicated.

D. Waterproofing: Apply waterproofing to exterior surfaces of manholes and handholes after concrete has cured at least three days. After ducts have been connected and grouted, and before backfilling, waterproof joints and connections and touch up abrasions and scars. Waterproof exterior of manhole chimneys after mortar has cured at least three days. Joint between manhole and chimney shall be sealed with a flexible epoxy or EPDM rubber seal.

E. Hardware: Install removable hardware, including pulling eyes, cable stanchions, and cable arms as required for installation and support of cables and conductors and as indicated.

F. Field-Installed Bolting Anchors in Manholes and Concrete Handholes: Do not drill deeper than 3-7/8 inches (98 mm) for manholes and 2 inches (50 mm) for handholes, for anchor bolts installed in the field. Use a minimum of two anchors for each cable stanchion.

3.6 INSTALLATION OF HANDHOLES AND BOXES

A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting ducts to minimize bends and deflections required for proper entrances. Use box extension if required to match depths of ducts, and seal joint between box and extension as recommended by the manufacturer.

B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch (12.7-mm) sieve to No. 4 (4.75-mm) sieve and compacted to same density as adjacent undisturbed earth.

C. Elevation: In paved areas and traffic-ways, set so cover surface will be flush with finished grade. Set covers of other handholes 1 inch (25 mm) above finished grade.

D. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables, but short enough to preserve adequate working clearances in the enclosure.

E. Field-cut openings for ducts and conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

F. For enclosures installed in asphalt paving and concrete and subject to occasional, non-deliberate, heavy-vehicle loading, form and pour a concrete ring encircling, and in contact with, enclosure and with top surface screeded to top of box cover frame. Bottom of ring shall rest on compacted earth.

1. Concrete: 3000 psi (20 kPa), 28-day strength, complying with Division 03 Concrete Sections with a troweled finish.
2. Dimensions: 10 inches wide by 12 inches deep (250 mm wide by 300 mm deep).

3.7 GROUNDING

A. Ground underground ducts and utility structures according to Division 26 Section "Grounding and Bonding for Electrical Systems."

3.8 IDENTIFICATION

A. Comply with Division 26 Section "Identification for Electrical Systems."

3.9 FIELD QUALITY CONTROL

A. Perform the following tests and inspections and prepare test reports:

1. Demonstrate capability and compliance with requirements on completion of installation of underground ducts and utility structures.
2. Pull aluminum or wood test mandrel through duct to prove joint integrity and test for out-of-round duct. Provide mandrel equal to 80 percent fill of duct. If obstructions are indicated, remove obstructions and retest.
3. Test manhole and handhole grounding to ensure electrical continuity of grounding and bonding connections. Measure and report ground resistance as specified in Division 26 Section "Grounding and Bonding for Electrical Systems."

B. Correct deficiencies and retest as specified above to demonstrate compliance.

3.10 CLEANING

A. Pull mandrel duct cleaner sized at least 75% of the conduit diameter, through the full length of ducts. Follow with rubber duct swab for final cleaning and to assist in spreading lubricant throughout ducts.

B. Clean internal surfaces of manholes, including sump. Remove foreign material.

PART 4 – METHOD OF MEASUREMENT

Underground conduits and duct banks shall be measured by the linear feet of conduits and duct banks installed, including encasement, locator tape, trenching and backfill with designated, resolution, all measured in place, completed, and accepted. Separate measurement shall be made for the various types and sizes.

PART 5 – BASIS OF PAYMENT

Payment will be made at the contract unit price per linear foot for each type and size of conduit and duct bank completed and accepted, including trench and backfill with the designated material. This price shall be full compensation for furnishing all materials and for all preparation, assembly, and installation of these materials, and for all labor, equipment, tools, and incidentals necessary to complete this item in accordance with the provisions and intent of the plans and specifications.

Payment will be made under:

Pay Items	**Pay Unit**
1 Way 1-inch Schedule 40 PVC Conduit - Direct Earth Buried	per linear foot
1 Way 2-inch Schedule 40 PVC Conduit - Direct Earth Buried	per linear foot
1 Way 3-inch Schedule 40 PVC Conduit - Direct Earth Buried	per linear foot
4 Way 4-inch Schedule 40 PVC Conduit - Direct Earth Buried	per linear foot
10 Way 6-inch Schedule 40 PVC Conduit – Direct Earth Buried	per linear foot
2 Way 6-Inch Schedule 40 PVC Conduit - Concrete Encased	per linear foot
4 Way 6-inch Schedule 40 PVC Conduit - Concrete Encased	per linear foot
2 Way 6-inch HDPE Conduit - Directional Drill	per linear foot

END OF SECTION 26 0543

SECTION 26 05 50 - ROADWAY LIGHTING FOUNDATIONS

PART 1 - DESCRIPTION

1.1 SUMMARY

A. Roadway lighting foundations include foundations for light standards. Standard foundations for light standards consist of drilled piers or footings with pedestals, conduit and anchor rod assemblies. Construct roadway lighting foundations in accordance with the contract, and accepted submittals. “Standard foundation” are defined as a drilled pier or footing with pedestal including the conduit and anchor rod assembly.

PART 2 – PRODUCTS

2.1 MATERIALS

A. Use roadway lighting foundation materials that meet the Foundations and Anchor Rod Assemblies for Metal Poles provision. Provide metal shrouds for median mounted light standards in accordance with Subarticle 1400-4(I) of the Standard Specifications.

2.2 ROADWAY LIGHTING FOUNDATIONS

A. Standard Foundations

1. Construct standard foundation types for the light standard types shown in the plans and the site conditions at each light standard location. When weathered or hard rock, boulders or obstructions conflict with standard foundations, submit an alternate standard foundation design for acceptance in accordance with Article 105-2 of the Standard Specifications. No extension of completion date or time will be allowed for alternate standard foundations.

PART 3 – EXECUTION

3.1 SUBSURFACE INVESTIGATIONS

A. Use a prequalified geotechnical consultant to perform one standard penetration test (SPT) boring in accordance with ASTM D1586 at each high mount location requiring a subsurface investigation. Rough grade high mount locations to within 2 ft of finished grade before beginning drilling. Drill borings to 2 drilled pier diameters below anticipated pier tip elevations or refusal, whichever is higher.

B. Use the computer software gINT version V8i or later manufactured by Bentley Systems, Inc. with the current NCDOT gINT library and data template to produce SPT boring logs. Provide boring logs sealed by a geologist or engineer licensed in the state of North Carolina.

3.2 CONSTRUCTION METHODS

A. Grade around roadway lighting locations with cut and fill slopes as shown on Roadway Standard Drawing No. 1402.01 or 1405.01. Construct drilled piers, footings and pedestals and install anchor rod assemblies for roadway lighting foundations in accordance with the Foundations and Anchor Rod Assemblies for Metal Poles provision.

B. For median mounted light standards, place concrete for median barriers and underlying pedestals in the same pour. Construct concrete barriers in accordance with the contract

and make concrete median barriers continuous through standard foundations. Coordinate construction of median mounted light standards with sign structures, concrete barriers, drainage structures, etc. to avoid conflicts.

PART 4 – METHOD OF MEASUREMENT

The items described in this section are incidental to other sections and must not be measured for payment.

PART 5 – BASIS OF PAYMENT

No direct payment will be made for the work described in this specification. The work described in this specification is incidental to other items and must be paid for in the respective bid item for which it is a component part.

END OF SECTION 26 05 50

SECTION 26 56 00 - EXTERIOR LIGHTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section provides general requirements for a complete and fully operational Exterior Lighting System including:

1. Exterior Luminaires
2. Accessories
3. Luminaire supports
4. Poles
5. LED Arrays
6. Controls
7. Standard Fixture Schedule

B. Related Sections:

1. Section 26 05 19 “Low Voltage Electrical Power Conductors and Cables” for wire and cabling.

1.3 SYSTEM DESCRIPTION

A. Catalog numbers indicated in the Luminaire Schedule are a design series reference and do not necessarily represent the exact catalog number, size, voltage, wattage, type of LED, driver, finish trim, mounting hardware, or special requirements as specified or as required by the particular installations. Provide complete luminaire to correspond with the features, accessories, number of LEDs, wattage, and/or size specified in the text description of each luminaire type. Additional features, accessories, and options specified shall be included.

B. Luminaire voltage shall match the voltage of the circuit serving the luminaire.

1.4 DEFINITIONS

A. CCT: Correlated color temperature.

B. CRI: Color-rendering index.

C. LER: Luminaire efficacy rating.

D. Luminaire: Complete lighting fixture, LED arrays, including driver housing.

E. Pole: Luminaire support structure, including tower used for large area illumination.

F. Standard: Same definition as "Pole" above.

1.5 STRUCTURAL ANALYSIS CRITERIA FOR POLE SELECTION

A. Dead Load: Weight of luminaire and its horizontal and vertical supports, lowering devices, and supporting structure, applied as stated in AASHTO LTS-4-M.

B. Live Load: Single load of 500 lbf, distributed as stated in AASHTO LTS-4-M.

C. Ice Load: Load of 3 lbf/sq. ft., applied as stated in AASHTO LTS-4-M Ice Load Map.

D. Wind Load: Pressure of wind on pole and luminaire and banners and banner arms, calculated and applied as stated in AASHTO LTS-4-M.

1. Basic wind speed of calculating wind load for poles 50 feet (15 M) high or less is 90 mph.

a. Wind Importance Factor: 1.3.
b. Minimum Design Life: 25 years.
c. Wind induced vibration.

1.6 SUBMITTALS

A. The authorized manufacturer's representative for the Project area shall prepare Submittals for each luminaire type. In addition to the luminaire Submittals, a list shall be provided identifying the manufacturer representative for each luminaire type. Provide manufacturers' names, addresses, and telephone numbers. Requests for prior approval shall also include this information. Submittals or requests for prior approval without this information will be rejected.

B. Product Data shall indicate that luminaire, LED arrays, and drivers fully comply with Contract Documents. Data shall be submitted for each type of luminaire indicated, arranged in order of luminaire designation. For standard catalog luminaires provide original product catalog sheets indicating data on features, accessories, finishes, and the following:

1. Materials and dimensions of luminaires.
2. Photometric data, in IESNA format, based on certified results of laboratory tests of each luminaire type, outfitted with LED arrays, drivers and accessories identical to those indicated for the luminaire as applied in the Project.

a. Photometric data shall be certified by a qualified independent testing agency.
b. Foot-candle map including existing fixtures' contributions

3. Low voltage transformers.
4. LED power supplies.
5. Types of LED's, including manufacturer, wattage, and Color Rendering Index (CRI) and color temperature in degrees Kelvin (K).
6. Wireless controls: nodes, gateways, modems, and server.

C. Shop Drawings shall:

1. Show details of nonstandard or custom luminaires.
2. Indicate dimensions, weights, method of field assembly, components, features, and accessories.
3. This Contractor shall provide the manufacturer with accurate field dimensions where required.
4. Include wiring diagrams, power and control wiring.

D. Wiring Diagrams shall detail wiring for luminaires and differentiate between manufacturer-installed and field-installed wiring.

E. Product Certificates shall be signed by manufacturers of luminaires certifying that products comply with requirements.

F. Maintenance Data shall be provided for luminaires and equipment to include in emergency, operation, and maintenance manuals Specified in Specifications Section describing Operations and Maintenance Data.

G. Field quality control test reports.

H. Special Warranties Specified in this Section.

I. Review of luminaire submittals which indicate voltage, mounting condition, or quantities shall not be considered to be approval of said voltage, mounting condition, or quantities. This Contractor shall field verify voltage and actual mounting condition and method.

J. Product samples complete with housing, trim, specified lumen package, and 8’ cord with plug for 120 V shall be submitted if requested.

K. Pole and Support Component Certificates: Signed by Manufacturers of poles, certifying that products are designed for indicated load requirements in AASHTO LTS-4-M and that load imposed by luminaire and attachments has been included in design.

1.7 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For lighting equipment and luminaires to include in emergency, operation, and maintenance manuals.

1. Provide a list of all driver types used on Project; use ANSI and manufacturers' codes.
2. Submit site map showing dimensioned locations all exterior lighting fixtures and poles with tags as shown on plans. Also show stubbed-out spare conduits, in-ground junction boxes, and underground sleeves. Indicate dimensioned locations of sleeve ends, conduits, and junction boxes from a permanent building or landscape feature. Circuit numbers for all loads shall be shown. Electronic files of site lighting maps be provided at Substantial Completion and submitted to the Electric Shop.

1.8 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Glass, Plastic Diffusers and Lenses: 10% or one dozen (whichever is less) of each type and rating installed. Furnish at least one of each type.

2. Globes and Guards: 5% of each type and rating installed. Furnish at least one of each type.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Package poles for shipping according to ASTM B 660.

B. Store poles on decay-resistant-treated skids at least 12 inches above grade and vegetation. Support poles to prevent distortion and arrange to provide free air circulation.

C. Retain factory-applied pole wrappings on metal poles until right before pole installation. Handle with web fabric straps.

1.10 QUALITY ASSURANCE

A. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by an independent agency, with the experience and capability to conduct the testing indicated.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to Authorities Having Jurisdiction, and marked for intended use.

C. Comply with IESNA TM-15-11 and Addendum A for Backlight, Uplight, and Glare (BUG) ratings.

D. Comply with ANSI C7.3777.208 Standards for chromaticity of SSL products.

E. Comply with NFPA 70.

F. All luminaires shall bear a UL or ETL label.

G. Comply with IEEE C2, “National Electrical Safety Code.”

H. Designated manufacturers are listed in the Luminaire Schedule to define the requirements for quality and function of the specified product.

1.11 COORDINATION

A. Coordinate layout and installation of luminaires with plantings, paving, site walls, other site work elements, and existing luminaires.

B. Coordination Meetings: The electrical Contractor shall attended all construction meetings.

1.12 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace products that fail in materials or workmanship; that corrode; or that fade, stain, perforate, erode, or chalk due to effects of weather or solar radiation within specified warranty period. Manufacturer may exclude lightning damage, hail damage, vandalism, abuse, or unauthorized repairs or alterations from special warranty coverage.

1. Warranty Period for Fixture, including the LEDs, drivers and electrical components: Ten years from date of beneficial use.
2. Warranty Period for housing paint and finish: Ten years from date of Beneficial Occupancy.
3. Warranty Period for Color Retention: Ten years from date of Beneficial Use.
4. Warranty Period for Poles: Repair or replace lighting poles and standards that fail in finish, materials, and workmanship within manufacturer's standard warranty period, but not less ten years from date of Beneficial Use.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Products: Subject to compliance with requirements, provide one of the products indicated on Drawings and/or the Schedule at the end of this document.

2.2 GENERAL REQUIREMENTS FOR LUMINAIRES

A. Luminaires shall comply with UL 1598 and be listed and labeled for installation in wet locations by an NRTL acceptable to Authorities Having Jurisdiction.

B. Comply with IESNA RP-8 for parameters of lateral light distribution patterns indicated for luminaires.

C. Comply with IESNA TM-15-07 Luminaire Classification System for Outdoor Luminaires.

D. Metal Parts: Free of burrs and sharp corners and edges.

E. Housings: Rigidly formed, weather- and light-tight enclosures that will not warp, sag, or deform in use.

F. Exposed Hardware Material: Stainless steel.

G. Plastic Parts: High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.

H. Light Shields: Baffles made of metal or similar sturdy material, field installable and adjustable, arranged to block light distribution to indicated portion of normally illuminated area or field.

I. Optical assemblies: where specified, full cutoff with zero uplight, “dark sky” compliant. LED assemblies shall comply with IESNA BUG rating system.

J. Lenses and Refractors Gaskets: Use heat- and aging-resistant resilient gaskets to seal and cushion lenses in luminaire doors.

K. Luminaires utilizing internal refractors are not allowed.

L. Factory-Applied Finish for Luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

1. Finish: premium polyester powder coat paint minimum 2.5 mils thick, applied to factory-

assembled and -tested luminaires before shipping. Where indicated, match the finish process and color of pole or support materials.

a. Color: See Luminaire Schedule.

2.3 LED DRIVERS AND ARRAYS

A. UL 1598 listing.

B. LED arrays shall have LED's that produce minimum 80 lumens/watt @ 525mA.
1. Lumen Depreciation Data: maintain greater than 95% lumen maintenance at 60,000 hours per IES TM-21.
2. LED color: neutral white, 4000 deg K, minimum CRI of 70, or as scheduled on the drawings.

C. LED arrays shall have an IP66 enclosure rating.

D. Driver + LED Life Rating not less than 100,000 hours.

E. Power supply / driver shall be field replaceable by means quick-disconnect connectors and easy access mounting hardware.

F. Drives shall accept 120 – 277 volts or 480 volts, 60 Hz.

G. Power Factor > 0.9@ full load.

H. THD < 20% @ full load.

I. Surge protection: 10kA/10kV per ANSI/IEEE C136.2-2014

J. The housing shall have an integral thermal management system with extruded radiation fins and lateral airways for passive cooling, no devices using moving parts are permitted.

K. Minimum starting temperature: minus 30 deg C, 40 deg C ambient.

L. Comply with IES LM-79-08 and LM-90-08 Approved Methods.

M. Comply with In-Situ testing for more reliable results.

N. LED's shall be Restriction of Hazardous Substances Directive (RoHS) compliant.

O. Provide a photocell with each light for on/off control

P. Provide 7-pin socket with each light for future implementation of a mesh control system.

2.4 LUMINAIRE-MOUNTED PHOTOELECTRIC RELAYS

A. Comply with UL 773 or UL 773A.

B. Compatible with 7 – pin socket.

C. Contact Relays: Factory mounted, single throw, designed to fail in the on position, and factory set to turn light unit on at 1.5 to 3 fc and off at 4.5 to 10 fc with 15-second minimum time delay. Relay shall have directional lens in front of photocell to prevent artificial light sources from causing false turnoff.

2.5 GENERAL REQUIREMENTS FOR POLES AND SUPPORT COMPONENTS

A. Structural Characteristics: Comply with AASHTO LTS-4-M.

1. Wind-Load Strength of Poles: Adequate at indicated heights above grade without failure, permanent deflection, or whipping in steady winds speeds of 130MPH with a gust factor of 1.3.

2. Strength Analysis: For each pole, multiply the actual equivalent projected area of luminaires and brackets by a factor of 1.1 to obtain the equivalent projected area to be used in pole selection strength analysis.

B. Luminaire Attachment Provisions: Comply with luminaire manufacturers' mounting requirements. Use stainless-steel fasteners and mounting bolts, unless otherwise indicated.

C. Mountings, Fasteners, and Appurtenances: Corrosion-resistant items compatible with support components.

1. Materials: Shall not cause galvanic action at contact points.
2. Anchor Bolts, Leveling Nuts, Bolt Caps, and Washers: Hot-dip galvanized after fabrication unless otherwise indicated.
3. Anchor-Bolt Template: Plywood or steel.

D. Handhole: Minimum clear opening of 2-1/2 by 5 inches with cover secured by stainless-steel captive screws.

E. Concrete Pole Foundations: Cast in place, with anchor bolts to match pole-base flange. Concrete, reinforcement, and formwork are specified in Concrete Sections.

2.6 ROUND TAPERED STEEL POLES

A. Poles: Seamless, extruded structural tube complying with A, unless noted otherwise, and access handhole in pole wall.

1. Shape: Refer to Luminaire Schedule.
2. Mounting Provisions: Butt flange for bolted mounting on foundation.

B. Pole-Top Tenons: Fabricated to support luminaire or luminaires and brackets indicated, and securely fastened to pole top.

C. Grounding and Bonding Lugs: Welded 1/2-inch threaded lug, complying with requirements in Section 26 05 26 "Grounding and Bonding for Electrical Systems," listed for attaching grounding and bonding conductors of type and size listed in that Section, and accessible through handhole.

D. Brackets for Luminaires: Detachable, with pole and adapter fittings of cast steel. Adapter fitting welded to pole and bracket, and then bolted together with stainless-steel bolts.

1. Tapered oval cross section, with straight tubular end section to accommodate luminaire.
2. Finish: Match pole and luminaire material and finish.

E. Finish: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

1. Finish: Premium powder coat paint.

a. Color: As shown on the plans.

2.7 POLE ACCESSORIES

A. Base Covers: Manufacturers' standard metal units, arranged to cover pole's mounting bolts and nuts. Finish same as pole.

B. Fusing: One in each ungrounded power supply conductor. Voltage and current ratings as recommended by driver manufacturer. Fuseholders shall be completely waterproof and shall grip the fuse in the load side section when opened. The circuit shall be fused in the base of the pole and accessible through the handhole.

C. Wind Mitigation Devices: Provide manufacturer’s stiffeners to mitigate high wind loads and uneven wind loads.

PART 3 - EXECUTION

3.1 LUMINAIRE INSTALLATION

A. Fasten luminaire to indicated structural supports.

1. Use fastening methods and materials selected to resist seismic forces defined for the application and approved by the manufacturer.

B. Adjust luminaires that require field adjustment or aiming. Include adjustment of photoelectric device to prevent false operation of relay by artificial light sources, favoring a north orientation.

1. Provide house-side shields where necessary to control spill light.

3.2 POLE INSTALLATION

A. Alignment: Align pole foundations and poles for optimum directional alignment of luminaires and their mounting provisions on the pole.

B. Clearances: Maintain the following minimum horizontal distances of poles from surface and underground features unless otherwise indicated on Drawings:

1. Fire Hydrants and Storm Drainage Piping: 60 inches.
2. Water, Gas, Electric, Communication, and Sewer Lines: 10 feet.
3. Trees: 15 feet from tree trunk.

C. Concrete Pole Foundations: Set anchor bolts according to anchor-bolt templates furnished by pole manufacturer. Concrete materials, installation, and finishing requirements are specified in

Concrete Specification.

D. Foundation-Mounted Poles: Mount pole with leveling nuts, and tighten top nuts to torque level recommended by pole manufacturer.

1. Grout void between pole base and foundation. Use non-shrink or expanding concrete grout firmly packed to fill space.
2. Install base covers unless otherwise indicated.
3. Use a short piece of 1/2-inch diameter pipe to make a drain hole through grout. Arrange to drain condensation from interior of pole.

E. Raise and set poles using web fabric slings (not chain or cable).

3.3 CORROSION PREVENTION

A. Steel: Do not use in contact with earth or concrete. When in direct contact with a dissimilar metal, protect steel by insulating fittings or treatment.

B. Steel Conduits: Comply with Section 26 05 43 "Underground Ducts and Raceways for Electrical Systems."

3.4 GROUNDING

A. Ground metal poles and support structures according to Section 26 05 26 "Grounding and Bonding for Electrical Systems."

1. Install grounding electrode for each pole unless otherwise indicated.
2. Install grounding conductor pigtail in the base for connecting luminaire to grounding system.
3. Provide a continuous grounding conductor in all exterior lighting circuits.

3.5 FIELD QUALITY CONTROL

A. Inspect each installed luminaire for damage. Replace damaged luminaires and components.

B. Replace all burned out or inoperative LED arrays at the end of Construction.

C. Advance Notice: Give dates and times for field tests.

D. Provide instruments to make and record test results.

E. Test as follows:

1. Verify proper operation, switching and phasing of each luminaire after installation.
2. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to the lighting system, retest to demonstrate compliance with standards.

F. Malfunctioning Luminaires and Components: Replace or repair, then retest. Repeat procedure until units operate properly.

G. Observations: Verify normal operation of lighting units after installing luminaires and energizing circuits with normal power source.

H. Illumination Tests: The Engineer will field measure light intensities at night using a light meter with calibration referenced to NIST standards. The engineers field test will comply with the following IESNA testing guide(s): IESNA LM-64, "Photometric Measurements of Parking Areas."

I. The Engineer will prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards. Light levels that do not meet the design requirements will need to be corrected by the contractor at the contractor's expense.

PART 4 - METHOD OF MEASUREMENT

4.1 Light fixtures, handholes, gates, equipment rack, and parking ticket equipment will be measured as complete units per each, inclusive of foundations, gate operators and motors, grounding, connections, and all materials and tools as noted in the plans and specifications and as needed to provide complete and operational unit. There must be no separate measurement for this item.

4.2 Electrical Demolition pay item include all materials, labor, transportation incidentals, and services required for the electrical demolition as shown on the plans. It is the intent of the demolition pay items that all equipment, devices, fixtures, wiring, materials, systems, appurtenances, etc., which are no longer required as a result of the project to be removed and will be measured by the contract lump sum.

PART 5 - BASIS OF PAYMENT

5.1 Payment will be made under the contract unit price for the completed light fixture and gate install, including the gate, light fixture, pole, foundations, gate operator, conduits, wires, grounding, etc. This price must be full compensation for furnishing all materials, and for all preparation, assembly, and installation of these materials, and for all labor equipment tools and other incidentals necessary to complete this item.

5.2 Payment for Removal of electrical items shall include all electrical demolition as shown on plans and will be made at the contract price per lump sum. This item includes all materials, labor, transportation, incidentals, and services required for the gate and operator removal, light pole removal, and foundation demolition, as shown on the plans.

Pay Items	**Pay Unit**
Miscellaneous Electrical Demolition	per lump sum
Remove Existing Parking Lot Light	per each
Remove Existing Illuminated Bollard	per each
Remove Handhole	per each
Remove Ticket Spitter	per each
Remove License Plate Recognition Camera	per each
Remove Arm Gate	per each
Remove Existing Power Panel	per each
Remove Existing Camera	per each
Heavy Duty Traffic Rated Handhole - H-20	per each
10'x10' Duke Energy Utility Manhole	per each

Roadway LED Light - One Fixture - Acorn	per each
Parking Lot LED Light, One Fixtures	per each
Parking Lot LED Light, Two Fixtures	per each
Power Utility Coordination and Utility Fees	per lump sum
Main Lot Entry Plaza Expansion	per lump sum
Shuttle Bus Entry/Exit Gates	per lump sum

END OF SECTION 26 56 00

SECTION 27 10 00 – SITE COMMUNICATION CABLING

PART 1 - GENERAL

1.1 RELATED DOCUMENT

A. Drawings and general provisions of the Contract.

1.2 SUMMARY

A. The Section defines the requirements for the installation of the structured cabling system. As described elsewhere in these Documents the system consists of fiber optic cable, twisted pair cabling and hardware, and related hardware. In addition to the basic cable plant requirements, the testing and identification requirements are also defined. Racks, enclosures, and pathway hardware is also defined herein

B. This Section includes the following:
1. Fiber optic Cable
2. Patch Panels
3. Racks
4. Wire Management

1.3 QUALITY ASSURANCE

A. NFPA 70 – The National Electrical Code

B. ANSI/TIA 568-C.0 – Generic Telecommunications Cabling for Customer Premise
C. ANSI/TIA/EIA 568-C.1 – Commercial Buildings Telecommunications Cabling Standard
D. ANSI/TIA/EIA 569 – Commercial Building Standard for Telecommunications Pathways and Spaces
E. ANSI/TIA/EIA 606-A – Administration Standard for the Telecommunications Infrastructure of Commercial Building; TR-42.6 - Labeling

F. ANSI/TIA/EIA 607A – Commercial Building Grounding and Bonding Requirements for Telecommunications
G. ANSI/TIA – TSB 95 – Testing Standards
H. ANSI/TIA-568-B.2-ad10 – Augmented Category 6
I. ANSI/TIA 942 – Data Center Cabling Standard
J. BICSI TDMM – Telecommunications Distribution Methods Manual

1.4 SUBMITTALS

A. Product Data: For each type of product indicated.
B. Include data sheets for the following additional items:

1. Fiber Optic Cable
2. Patch Panels (Fiber optic)
3. Racks
4. Wire Management

C. **Shop Drawings**
1. A detailed riser diagram demonstrating the Contractor's understanding of the backbone cabling.
2. Drawings of any through floor fittings with details of their contents.

1.5 **CLOSEOUT SUBMITTALS**
A. Field quality-control test reports
B. The Contractor shall include the riser diagram for all backbone cabling and testing data from this system within a unique section of the Operation and Maintenance Manual.

1.6 The Operations and Maintenance Manual section for this Section shall include a copy of all test results in native format. QUALITY ASSURANCE
A. Qualifications

1. The Contractor shall be fully qualified to perform installations as described on the Contract Drawings and within these Specifications.
2. The Contractor shall have completed a minimum of three projects of like scope and complexity within the last three (3) years.
3. The Contractor shall have been active in bidding, being awarded, and performing work consistent with that which is indicated on the Contract Documents for a period not less than five (5) years.
4. The Contractor shall maintain an installation staff whose sole function is the installation of Structured Cabling and associated equipment and shall not utilize additional personnel obtained by means of a temporary placement or staffing agency.
5. The Contractor shall have a dedicated Project Manager, who shall be the sole point of contact for the Engineer or Owner. The Project Manager shall be assigned to the project for the duration of the project.

B. **Certifications**

1. The Contractor shall possess current certifications by BICSI for the installation and maintenance of all Structured Cabling and associated equipment being provided under the Structured Cabling Contract.
2. The Contractor shall possess current certification for the installation of all required fire stopping to be installed under the scope of the Structured Cable Plant.

C. Meetings - The Contractor shall be attend all Pre-Construction, Pre-Installation or Progress Meetings.

1.7 **DELIVERY STORAGE AND HANDLING**

A. The Contractor shall responsible for the storage and handling of all Materials required by the Structured Cabling portion of this Contract.

B. Storage and Protection
1. Any Materials that show signs of mishandling or have been stored in a fashion so as to reduce the value of the Materials shall be replaced with new Materials at no additional cost to the Owner.

C. Waste Management and Disposal
1. All excess Materials shall be discarded in an appropriate manner.
2. Any/all hazardous materials shall be handled appropriately and shall be disposed of in a manner consistent with same, and compliant with all applicable codes and regulations.

1.8 **PROJECT/SITE CONDITION**S

A. The Contractor shall become and remain familiar with all project/site conditions that may have impact on the timing, quality and/or quantity of Materials for the project. The Contractor shall coordinate their efforts with changes in the Project/Site conditions so as to optimize the installation for the Owner.

B. Any additional efforts by the Contractor due to a lack of awareness of project/site conditions shall not require additional compensation from the Owner. .

PART 2 - PRODUCTS

2.1 **FIBER BACKBONE COMPONENTS**

A. Connectors
1. The connector shall be a duplex type LC connector on a single mode fiber optic pigtail.
2. The average insertion loss shall be 0.2dB with a maximum of 0.75dB for a mated pair.
3. Acceptable Manufacturer and Model
a. Corning # CH-LC900-12KIT-1M , or FL2-LCU-900-SM-6

B. Fiber Connector Panels
1. The cabinets shall be capable of being mounted in a standard 19” rack utilizing four units of standard height (1.75 inch EIA hole spacing).
2. The cabinets shall utilize a modular connector plate (Connector Panel) with LC connectors.
3. Connectors shall be duplex ‘LC’ unless otherwise noted on Drawings.
4. Acceptable Manufacturer and Model:
a. Corning # CCH-04U
b. Corning # CCH-CP24-A9 or CCH-CS24-A9-P00RE

NOTE: The Contractor shall provide all adapter panels required to terminate 100% of the fibers indicated on the Drawings. The Contractor shall provide blank fillers for all unutilized openings in the housing. All components must be by Corning.

C. Fiber Cabinets
1. The cabinets shall be capable of being mounted in a standard 19” rack utilizing one, two three or four units of standard height (1.75 inch EIA hole spacing).
2. The cabinets shall utilize a modular connector plate to allow for versatile connector configuration, with panels for LC connectors.

3. The unit shall be capable of flush or partially flush mounting with a front protector that shall be capable of readily mounting any required labeling.

4. The unit shall be compliant with both ANSI/TIA/EIA-568C and ANSI/TIA/EIA-606.
5. The unit shall utilize a slide out drawer assembly.
6. The unit shall be capable of accepting a field installable lock mechanism.
7. Connectors shall be duplex 'LC' unless otherwise noted on Drawings.
8. Acceptable Manufacturer and Model
   a. Hubbel - Superquad Can Assembly. 48h X 36d, Window Door,

   NOTE: The Contractor shall provide all connector panels required to terminate 100% of the fibers indicated on the Drawings unless noted otherwise. The Contractor shall provide blank fillers for all unutilized openings in the housing. The blank fillers shall be as manufactured by the same manufacture as the housing, and shall be designed specifically for the housing utilized.

D. Fiber Cabling
   1. Fiber
      a. Outdoor Single Mode Fiber
         1) Singlemode (OS2) fiber type shall be 8.3/125 micron fiber.
         2) Interbuiding Singlemode fiber strands will be as shown on plans with a "green" stranded 12AWG routed alongside the fiber for the entire length of the cable.
         3) Acceptable Manufacturer and Model
            a) Corning "ALTOS,""FREEDM," (dryblock) or RocketRibbon.

E. Cabling
   1. Copper
      a. Category 6a Unshielded Twisted Pair (UTP), rated for outdoor use and power of ethernet (POE) rated.
         1) Category 6a UTP, 4 Pair Horizontal Distribution Cables shall routed as shown on plans and shall consist of 4 pair, 24 gauge, UTP, and shall terminate all conductors onto an 8 pin modular jack provided at each outlet.
         2) The Category 6a UTP cable shall be a round cable design with fluting to maintain the appropriate pair spacing relationship. The cable shall support all current future applications designed to run on Category 6 cabling.
         3) The Category 6a UTP cable shall be designed to have improved balance of 10dB as compared to current Category 5e cable, which shall result in higher immunity to EMI.
         4) The Category 6a cable shall be specified to a minimum of 500 MHz.

PART 3 -EXECUTION

3.1 EXAMINATION

A. Materials shall be examined for damage on receiving the materials. Reject any materials that are damaged.

B. Examine all materials before installation. Reject and materials that are damaged.

C. Examine elements and surfaces to which materials will be installed.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Cable Routing

1. Cables shall be bundled by means of either Velcro or Milli-Ties. Zip-ties are unacceptable.
2. The combined length of jumpers, or patch cords and equipment cables in the telecommunications room/closet and the Work Area shall not exceed 10m (33 ft).
3. A minimum of three horizontal cables shall be routed to each Work Area, unless otherwise noted on the Drawings.
4. Horizontal pathways shall be installed such that the minimum bending radius of horizontal cables is kept within manufacturer specifications both during and after installation.
5. The Contractor shall provide all devices for routing the cabling as indicated on the Drawings, and as required by the manufacturer of the Structured Cabling System, so as to maintain the long term health and operability of the Structured Cabling System.
6. Maximum conduit pathway capacity shall not exceed a 40%.
7. Horizontal distribution cables shall not be exposed in the Work Area or other locations with public access.
8. Cables routed in a suspended ceiling shall not be draped across the ceiling tiles. Cable supports shall be mounted a minimum of 75 mm (3 inches) above the ceiling grid supporting the tiles.
9. Cables shall be bundled by means of either Velcro strap or Milli-Ties. Zip-ties are unacceptable.

3.3 LABELING

A. General Labeling Requirements

1. All cables, cabling enclosures, patch panels, termination blocks, racks, equipment enclosures and related hardware shall be labeled in compliance with ANSI/ TIA/EI 606.
2. All labels shall be permanently attached, and shall be constructed of materials so as to assure the lifespan of the identification marker to be equal or greater than that of the device being identified.
3. The identification tag or placard shall be self-adhering or attached by means of a permanent adhesive listed for the application, or other permanent mechanical means.
4. All means of identification shall be visible and clearly identifiable by personnel in charge of maintaining the cabling infrastructure.
5. All tape based products shall be manufactured for the purpose of identifying flexible communications cabling, and shall be used only on flexible materials.
6. All labels shall be machine generated onto adhesive labels or tags, or engraved on plastic laminated placards or brass tags.
7. All laminated placards shall have a black field with white letters, unless otherwise noted.

B. Patch Panel Labeling

1. Each port of a patch panel shall be labeled with a three-eighths of an inch tall label consisting of one line of text of black ink on a white background.
2. Patch panel port label shall be as shown on the plans.

3. Length of label shall not exceed 0.65”, equivalent to width of a Modular Jack.
4. Font size shall allow one line of text while preserving 0.65” length.
5. Refer to project detail drawings patch panel port labeling. The label shall be installed in the space provided by the manufacturer for this purpose. If no space is provisioned, the Contractor shall provide a laminated placard that shall be engraved with the identification of the patch panel, and shall be mounted in the upper right corner of the patch panel, but shall not block the proper installation of the patch panel.

C. LIU/ Patch Panels Labeling

1. All schedules shall be filled out, including source and/or destination of the fibers terminated within.

D. Rack Labeling

1. All racks shall be labeled as to the identity of the device indicated on the Drawings. The label shall be made of plastic laminate and attached at the center of the front top rail of the rack and shall be visible from eye level.

3.4 FIELD QUALITY CONTROL

A. Site Test, Inspection

1. ILM retains the right to be present at any or all cable certifications. The Contractor shall provide written notice 48 hours prior to the beginning of the certification process.
2. The Contractor shall provide a copy of the unaltered certification test reports to the Engineer in both hardcopy and electronic format. The Contractor shall also provide a copy of the associated Cable Tester’s Database Management Software with unedited soft copy.
3. Independent System Certified testing may be required, at the discretion of the Engineer, provided at the expense of the Contractor, in the event of non-performance of the specified testing procedures, submittals and/or installation procedures.
4. Fiber Optic Cabling

    a. In addition to any specific tests mentioned here, the Contractor shall perform all required testing and documentation to obtain a fully certified installation from the manufacturer.
    b. Fiber optic cabling shall be tested with a Power Meter and OTDR. The results of the tests shall be delivered to ILM.

3.5 CLEANING

All equipment and Materials furnish, installed or provided shall be cleaned of all debris construction or otherwise prior to Owner final Acceptance.

3.6 DEMONSTRATION

Upon completion of all installation, termination and testing, the Contractor shall review the

entire installation with ILM. At the time of this review, the Contractor shall present the hard copies of all unadulterated test results.

3.7 **PROTECTION**

The Contractor shall protect all aspects of the cabling system from damage during the time period from the notice to proceed through the point of Owner Acceptance.

PART 4 – PAYMENT

No separate measurement is being made for furnishing and installing all the requirements of the contract documents.

END OF SECTION

SECTION 31 23 34.01

EXCAVATING, TRENCHING, DEWATERING AND BACKFILLING FOR UTILITY WORK

PART 1 GENERAL

1.1 SUMMARY

A. Furnish all labor, equipment, supplies and materials, and perform all operations in connection with the following:
   1. Clearing, grubbing, and preparation of the site; removal and disposal of all debris.
   2. Pipeline and utility structure excavations including trenching, subgrade preparation, embedment, backfilling, pumping, and dewatering
   3. Tunneled (trenchless construction) crossings.
   4. Sheeting, shoring, and protection of work.
   5. Borrow, transportation, handling, storage, and disposal of suitable and unsuitable materials for pipelines, utility structures, site fills, curb and gutters, sidewalks, driveways, and pavements
   6. Subgrade preparation, grading, wetting, rolling, surfacing and other operations pertaining to the site work
   7. Protection of adjacent property.

B. No classification of excavated materials will be made. Excavation includes all materials regardless of type, character, composition, moisture, or condition thereof.

C. Related Requirements:
   1. Section 03 05 00 - Concrete
   2. Section 32 92 01 - Seeding and Sodding
   3. Section 33 14 13 - Water Distribution Piping, Valves, Hydrants, and Appurtenances
   4. Section 31 31 11 - Sanitary Sewer Gravity Mains
   5. Section 33 31 23 - Sanitary Sewer Force Mains, Valves, and Appurtenances
   6. Section 33 32 11 - Wastewater Pumping Stations

1.2 REFERENCES

A. Definitions:
   1. "Subgrade" is the uppermost surface of native soil material unmoved from cuts, the bottom of excavation.

B. Reference Standards:
   1. OSHA - Safety and Health Regulations for Construction, Chapter XVII of Title 29, CFR, Part 126
   2. NCDOT Positive Shoring Plan - issued with Right-of-Way Encroachment Agreement
   3. AASHTO T99/T180 - Standard Method of Test for Moisture-Density Relations of Soils.
   4. ASTM C136 - Sieve analysis of fine and coarse aggregates.
   5. ASTM D448 - Standard Classification for Sizes of Aggregate for Road and Bridge Construction.

6. ASTM D698 - Tests for moisture-density relations of soils and soil-aggregate mixture using 5.5 lb (2.49 kg) rammer and 12 inch (305 mm) drop.
7. ASTM D2321 – Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications.
8. ASTM D2487 - Classification of Soils for Engineering Purposes.
9. ASTM D4253 - Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table.
10. ASTM D4254 - Test Methods for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density.
11. ASTM D4318 - Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
12. ASTM D4832 - Test Method for Preparation and Testing of Controlled Low Strength Material (CLSM) Test Cylinders.
13. ASTM D6023 - Test Method for Density (Unit Weight), Yield, Cement Content, and Air Content (Gravimetric) of Controlled Low-Strength Material (CLSM).
14. ASTM D6938 - Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

1.3 SUBMITTALS

A. Contractor Excavation Protection Plans or NCDOT Positive Shoring Plans:
   1. Provide sheeting, shoring, and bracing materials and installation required to protect excavations and adjacent structures and property.
   2. At least 30 days before starting construction on sheeting and shoring, and in accordance with the OSHA and NCDOT requirements, the Contractor shall ensure the sheeting and shoring design engineer complete and submit the Protective System Design Certificate(s) for the sheeting and shoring systems that the Contractor will install.
   3. If required by the OSHA regulations to protect existing facilities, the Contractor shall submit separate certificates for each unique design. The certificate(s) shall be signed and sealed by the registered professional engineer that designed the protection system.

B. Geotextile Fabrics: Samples, manufacturer’s product data, installation instructions

C. Embedment and Backfills Materials:
   1. Name and location of proposed material suppliers.
   2. Standard test results for materials proposed by independent materials testing firm.

D. Trench Shields: Fabricator/manufacturer certifications

1.4 QUALITY ASSURANCE

A. Contractor to provide experienced on-site Safety Officer and Superintendent to comply with OSHA regulations for site excavations and engineered shoring plans.

B. Safety Officer and Superintendent shall hold OSHA 30-Hour Construction Certifications and classified as the competent person.

1.5 EXISTING SITE CONDITIONS

A. Every reasonable effort has been made to provide accurate information on existing site conditions. The Contractor should become familiar with the site and satisfy himself as to the scope of the work involved and the materials to be encountered. Any significant change in conditions should be immediately brought to the attention of the Engineer.

PART 2 PRODUCTS

2.1 MATERIALS

A. Geotextile Fabric. The fabric shall be provided in rolls wrapped with covering for protection from mud, dirt, dust, and debris.

1. Geotextile Fabric Type A. Geotextile fabric Type A shall be provided for installation at locations indicated on the Drawings and as specified herein. Geotextile Fabric Type A shall be a nonwoven fabric consisting of only continuous chains of polymeric filaments or yarns of polyester formed into a stable network by needle punching. The fabric shall be inert to commonly encountered chemicals; shall be resistant to mildew, rot, ultraviolet light, insects, and rodents; and shall have the indicated properties:

Property	Test Method	Unit	Minimum Average Roll Value *
Fabric Weight	ASTM D3776	oz/yd2	5.7
Grab Strength	ASTM D4632	lb	155
Grab Elongation	ASTM D4632	percent	50
Mullen Burst Strength	ASTM D3786	psi	190
Apparent Opening Size	CW-02215	U.S. Std. Sieve Size	70

* Minimum average roll value in weakest principal direction.

B. Polyethylene Film: Polyethylene film beneath concrete slabs or slab base course material shall be Product Standard PS17, 6 mil minimum thickness.

C. Granular Materials and Soils: Five classes defined according to properties and characteristics as follows.

a. **Class I** - Angular, 25 mm (1-in.) to No.4 (3/16 in.) in size, #57 or #67 graded stone or equivalent regional material from crushed rock, slag, and/or coral.

b. **Class II** - Coarse sands and gravels with maximum size of 25 mm (1-in.), including variously graded sands and gravels containing small percentages of fines, generally granular and non-cohesive, either wet or dry. Soil Types GW, GP, SW, and SP are included in this class.

c. **Class III** - Fine sand and clayey gravels, including fine sands, sand-clay mixtures, and gravel-clay mixtures. Soil Types GM, GC, SM, and SC are included in this class.

d. **Class IV** - Silt, silty clays, and clays, including inorganic clays and silts of medium to high plasticity and liquid limits. Soil Types MH, ML, CH, and CL are included in this class. These materials are not acceptable for bedding, haunching, or initial backfill.
e. **Class V** - This class includes the organic soil, OL, OH, PT as well as soils containing frozen earth, debris, rocks, larger than 37.5 mm (1-1/2 in.) in diameter, and other foreign materials. These materials are not acceptable for bedding, haunching, initial backfill, or final backfill.

D. General Fill:
1. Use soils free of organic matter, refuse, rocks and lumps greater than 4 inches in diameter and other deleterious matter.
2. Fill shall have a liquid limit not greater than 45, and plasticity index not greater than 25.
3. Previously excavated materials complying with the Contract Documents requirements for general fill may be used for general fill.
4. When on-site materials are found unsuitable for use as general fill, provide approved off-site general fill materials. Prior to using off-site material as general fill, furnish submittal for and obtain Engineer's approval of the material proposed for use.
5. General fill material not otherwise specified shall be Class II or III.

E. Granular Fill: Granular fill under floor slabs shall be Class I material.

F. Structural Fill: Fill material placed inside the line of the building foundation or slab shall be Class I or II.

G. Fill Under Pavement: Fill material used beneath pavement and for road shoulders shall be Class II or III.

H. Topsoil: Natural, friable soil free of subsoil, stumps, rocks larger than 2 inches in diameter, weeds, and other material detrimental to plant growth.

I. Concrete: Concrete placed for cradles, thrust blocks, or encasement shall be Class B concrete as specified in Section 03 05 00 - Concrete.

J. Subbase Material:
1. Material shall be naturally- or artificially graded mixture of natural or crushed gravel, crushed stone, or natural or crushed sand. Crushed slag is unacceptable.

K. Drainage Fill:
1. Material shall be washed, uniformly graded mixture of crushed stone, or crushed or uncrushed gravel, with 100 percent passing 1-1/2-inch sieve and not more than 10 percent passing a No. 4 sieve (#57 or #67 stone).

L. Controlled Low Strength Material (CLSM):
1. CLSM shall be self-leveling and self-compacting cementitious material.
a. Cement: Type I or Type II Portland cement complying with ASTM C150/C150M.
b. Fly Ash Mineral Admixture: Comply with ASTM C618, Class F.

c. Water: Clean, potable.
d. Admixtures: Provide admixtures in accordance with product manufacturer's published instructions. Admixtures shall be compatible with each other. Do not use calcium chloride or admixtures containing chloride ions. Use only admixtures that have been tested and approved in the mix designs.
e. Fine Aggregates: ASTM C33/C33M.

2. CLSM Mix:
   a. Cement Content: 50 pounds per cubic yard.
   b. Fly Ash Mineral Admixture: 250 pounds per cubic yard.
   c. Fine Aggregate Content: 2910 pounds per cubic yard.
   d. Water Content: 500 pounds per cubic yard.
   e. Admixtures shall comply with manufacturer's recommendations for use with CLSM.
   f. Unconfined compressive strength shall be not more than 100 psi.
   g. Adjustment of Mixes.
      1) Mix design adjustments may be requested by Contractor when warranted by characteristics of materials, Site conditions, weather, test results, or other, similar circumstances.
      2) Submit for Engineer's approval laboratory test data for adjusted mix designs, including compressive strength test results.
      3) Implement adjusted mix designs only after Engineer's approval.
      4) Adjustments to mix designs shall not result in additional costs to Owner.

2.2 SOURCE QUALITY CONTROL

A. Perform quality assurance testing, and submit results to Engineer, in accordance with the 'Submittals" Article in Part 1 of this Section.

PART 3 EXECUTION

3.1 INSPECTION

A. Familiarization: Prior to commencement of the Work, become thoroughly familiar with the site, the site conditions, and all portions of the work specified in this Section.

B. Provide Engineer with sufficient notice and with means to examine areas and conditions under which excavating, filling, and grading will be performed. Do not proceed with the Work until unsatisfactory conditions are corrected.

C. Approvals: Backfilling and grading operations near foundations, walls, pipes and other portions of the work to be covered shall not commence until the Engineer has completed all required inspections, tests and approvals. Work covered prior to inspection shall be uncovered for inspection purposes and backfilled.

3.2 SUBSURFACE UTILITY LOCATION AND EXPLORATION

A. Existing Utilities Location:

1. Prior to excavation, Contractor shall contact local underground alert hotlines, “North Carolina 811” and/or individual utility owners for marking underground utilities. A survey shall be made of the utility size, material, location, and elevation prior to trench excavation and information shall be recorded on the record Drawings maintained by the Contractor.
2. Once utilities are marked and recorded, Contractor shall excavate to expose the existing utilities in advance of the construction.
3. Perform all work required in connection with excavating, stockpiling, maintaining, sheeting, shoring, filling, and replacing pavement for utility location pits.
4. Contractor shall be responsible for the definite location of each existing underground utility involved within the area of excavation for the Work and exercise care during such location work to avoid damaging and disrupting the affected underground facilities or structures. Contractor shall be responsible for repairing, at his expense, damage to underground facility or structures caused during exploratory Work.

3.3 PREPARATION

A. Surface Preparation
1. Clearing: Areas designated for clearing and required for construction operations shall be cleared of trees, brush, structures and other materials within the defined rights-of-way, easements, and limits of disturbance indicated. Trees which are to remain shall be protected during clearing operations and subsequent work.
2. Grubbing: Roots, stumps and other materials shall be grubbed from the cleared areas to a depth of at least 18 inches. Tree stumps shall be grubbed in their entirety, including tap roots where applicable.
3. Topsoil: Strip existing topsoil to a depth of 4 inches from areas to be excavated or graded. Stockpile the topsoil in a suitable area for use during final grading operations. Protect the topsoil from excessive erosion.
4. Unsuitable Material: Remove sod, muck, or other unsuitable material to firm subsoil in areas designated for filling or grading operations.
5. Disposal: Trees, stumps, roots, rubbish, unsuitable soil, or other material resulting from surface preparation shall be remove from the site by the Contractor and disposed of.

B. Prohibited Work:
1. Burning or blasting and use of explosives is not allowed.

C. Dust Control:
1. Control objectionable dust caused by Contractor’s operation of vehicles and equipment, clearing and other actions. To minimize airborne dust, apply water or use methods subject to approval of authorities having jurisdiction.

3.4 EXCESS WATER CONTROL

A. General Dewatering:
1. Grade and maintain all areas of the site to preclude surface runoff into excavations and prevent ponding of water.
2. Remove all soil softened or eroded by the presence of water and replace with suitable backfill material.

3. Provide and maintain drainage and dewatering equipment to remove and dispose of all surface water and ground water entering excavations, or other parts of the Work areas. Keep excavations dry during execution of Work, subgrade preparation, and continually thereafter until the pipeline or structure to be built therein is acceptable to Engineer and backfilling operations are completed and acceptable to Engineer.
4. Provide temporary drainage ditches and temporary dikes and provide required temporary pumping and other work necessary for diverting or removing rainfall and all other accumulations of surface water from excavations and fill areas. Perform diversion and removal of surface water in manner that prevents accumulation of water behind permanent or temporary structures and at any other locations in the construction area where such accumulations may be detrimental.
5. Water used for working or processing, resulting from dewatering operations, or containing oils or sediments that will reduce the quality of the surface water or groundwater downstream of the point of discharge, shall not be directly discharged. Divert such waters through temporary settling basin or filter before discharging to surface water, groundwater, or drainage routes.
6. Contractor shall be responsible for condition of piping, conduits, and channels used for drainage and such piping, conduits, and channels shall be clean and free of sediment.

B. Temporary Dewatering Systems:
1. Contractor shall design, provide, and operate dewatering system to include sufficient trenches, sumps, pumps, hose, piping, well points, deep wells, and similar facilities, necessary to depress and maintain groundwater level below the base of each excavation during all stages of construction operations.
2. Design and operate dewatering system to avoid settlement and damage to existing structures and underground facilities.
3. Groundwater table shall be lowered in advance of excavation for a sufficient period of time to allow dewatering of fine grain soils.
4. Maintain groundwater level at excavations 2-feet below lowest subgrade excavation until the structure has sufficient strength and weight to withstand horizontal and vertical soil and water pressures from natural groundwater.
5. Operate dewatering system continuously, 24-hours per day, 7-days per week. Provide standby pumping facilities and personnel to maintain the continued effectiveness of the system. Do not discontinue dewatering operations without first obtaining Engineer's acceptance for such discontinuation.
6. Locate elements of temporary dewatering system to allow continuous dewatering operation without interfering with the Work to the extent practicable.
7. Where portions of dewatering system are located in the area of permanent construction, submit to and obtain Engineer's acceptance of details of proposed methods of constructing the Work at such location. Control of ground water shall continue until the permanent construction provides sufficient dead load to withstand hydrostatic uplift of the normal groundwater, until concrete has attained sufficient strength to withstand earth and hydrostatic loads, and until waterproofing Work is completed.
8. Perform pumping of water from excavations in a manner that prevents carrying away of unsolidified concrete materials, and that avoids damaging the subgrade.

C. Disposal of Water Removed by Dewatering System:

1. Contractor's dewatering system shall discharge to in accordance with the NC Sedimentation Pollution Control Act, NCDEQ Erosion Control Permit, and NC Stormwater Permit for Construction Activities.
2. Convey water from excavations in closed conduits. Do not use trench excavations as temporary drainage ditches.
3. Dispose of water removed from excavations in a manner that does not endanger health and safety, property, the Work, and other portions of the Project.
4. Dispose of water in manner that causes no inconvenience to Owner, others involved in the Project, and adjacent and downstream properties.

3.5 SHEETING, SHORING AND BRACING

A. General:
   1. Design and provide sheeting, shoring, bracing, cofferdams, and similar excavation supports as shown, specified, and required for the Work. Where sheeting, shoring, bracing, or trench boxes are used, they must be designed and sealed by a professional engineer licensed to practice in the State of North Carolina.
   2. Clearances and types of temporary sheeting, shoring, bracing, and similar excavation supports, insofar as they may affect the finished character of the Work and the design of sheeting to be left in place, will be subject to the Engineer's approval; but Contractor is responsible for adequacy of all sheeting, shoring, bracing, cofferdams, and similar excavation supports.
   3. Materials:
      a. Previously used materials shall be in good condition and shall not be damaged or excessively pitted. All steel or wood sheeting designated to remain in place shall be new. New or used sheeting may be used for temporary sheeting, shoring, and bracing.
      b. All steel work for sheeting, shoring, bracing, cofferdams, and other excavation supports, shall be in accordance with ANSI/AISC 360, except that field welding will be allowed.
      c. When required, provide permanent steel sheet piling or treated timber sheet piling where subsequent removal of sheet piling might allow lateral movement of soil under adjacent structures
   4. As excavation progresses, carry down shoring, bracing, cofferdams, and similar excavation supports to required elevation at bottom of excavation.
   5. Maintain sheeting, shoring, bracing, bracing, and other excavation supports in excavations regardless of time-period excavations will be open.
   6. Unless otherwise shown, specified, or directed, remove materials used for temporary construction when the Work is completed. Perform such removal in manner not injurious to the structures and underground facilities, their appearance, and adjacent construction.

B. Removal of Shoring, Sheeting and Bracing:
   1. Remove sheeting and bracing from excavations, unless otherwise directed by Engineer in writing. Perform removal to avoid damaging the Work and adjacent construction. Removal shall be equal on both sides of excavation to ensure no unequal loads on structures and underground facilities.
   2. Defer removal of sheeting and bracing, where removal may cause soil to come into contact with concrete, until the following conditions are satisfied:
      a. Concrete has cured for not less than 7 days.

b. Wall and floor framing, up to and including grade level floors, is in place.

3. When shoring is installed that does not extend below the invert of the underground structure, the shoring shall be removed. Backfill and compaction shall be executed in conformance with the specifications.

C. Shoring Left in Place:
   1. Only shoring authorized by the Engineer and approved by the Engineer shall be left in place.
   2. When shoring is installed to extend below the underground structure, the shoring shall remain with the top edge 4-feet below the finished grade.

D. Sheeting Left in Place:
   1. Materials: Steel sheeting shown or indicated to be left in place shall consist of rolled sections of continuous interlocking type. Steel sheeting material designated to be left in place shall be new. Type and design of the sheeting and bracing shall comply with the above requirements for steel work for all sheeting and bracing.
   2. Installation:
      a. Steel sheeting to be left in place shall be driven straight to lines and grades as shown, indicated, or directed. Piles shall penetrate into firm materials with secure interlocking throughout pile's entire length. Damaged piling having faulty alignment shall be pulled and replaced by new piling.
      b. Type of guide structure used and method of driving steel sheeting to be left in place shall be determined by Contractor's professional engineer.
   3. Cut off at elevations shown, indicated, or directed by Engineer sheeting left in place and remove cut off pilings from the Site.
   4. Clean wales, braces, and all other items to be embedded in the permanent structure and ensure that concrete surrounding the embedded element is sound and free of air pockets and harmful inclusions. Provisions shall include the cutting of holes in the webs and flanges of wale and bracing members, and welding of steel diaphragm water stops perpendicular to the centerline of brace ends that are to be embedded.

3.6 TRENCH EXCAVATION

A. Cutting Existing Surface Pavements.
   1. Cuts in concrete pavement and concrete base pavements shall be no larger than necessary to provide adequate working space for proper installation of pipe and appurtenances.
   2. Cutting shall be started with a concrete saw in a manner which will provide a clean groove at least 1-½ inches deep along each side of the trench and along the perimeter of cuts for structures.
   3. Concrete pavement and concrete base pavement over trenches excavated for pipelines shall be removed so that a shoulder not less than 12-inches in width at any point is left between the cut edge of the pavement and the top edge of the trench.
   4. Pavement cuts shall be made to and between straight or accurately marked curved lines which, unless otherwise required, shall be parallel to the center line of the trench.
   5. Pavement removal for connections to existing lines or structures shall not exceed the extent necessary for the installation.

6. Where the trench parallels the length of concrete walks, and the trench location is all or partially under the walk, the entire walk shall be removed and replaced.
7. Where the trench crosses drives, walks, curbs, or other surface construction, the surface construction shall be removed and subsequently replaced between existing joints or between saw cuts as specified for pavement.

B. Trench Width: Trenches shall be excavated to a width which will provide adequate working space and sidewall clearance for proper installation, jointing, and embedment haunching. Trench banks from the top of the pipe to trench bottom shall be as vertical as practicable.

C. Over-Excavation: Over-depth excavation carried below required grade, unless authorized by the Engineer, shall be backfilled with Class I material, and compacted as embedment at no additional cost to Owner.

D. Alignment and Depth: Trench to the lines and grades shown on the drawings. Where elevations are not shown, trench to a depth sufficient to provide at least 36-inches of cover above the top of pipe, unless otherwise specified. Grade trenches to provide a constant slope free of sags and high spots.

E. Dewatering: Keep trenches free of water.

F. Trench Bracing: Properly brace, sheet and support trench walls as soil conditions indicate and in conformance OSHA regulations. Provide adequate bracing and shoring to protect adjacent improvements according to contractor submitted excavation plan or NCDOT positive shoring plan. Contractor shall provide certification for all premanufactured trench bracing devices prior to any excavation activities.

G. Bedding, Haunching and Backfill: Tamp to provide firm, even bedding. Excavate bedding material to match the shape of the bottom of the pipe and bell, as detailed in the drawings. Shovel slice haunching material to provide full bearing around the bottom of the pipe.

H. Method of Compaction Density Testing: ASTM D698 Standard Proctor

I. Pipe Trench Construction: (Depth measured from top of pipe to final grade)
1. Bedding requirements for sewer force mains and water mains listed in Section 3.6.I below shall be followed, if it has been determined that unsuitable soils exist within the excavated trench. Otherwise bedding for sewer force mains and water mains may be Class I or Class II. All other backfill for sewer force mains and water mains shall be as shown below.
2. <u>Type A – Sewer mains 12-feet and deeper</u>
   a. Bedding, Haunching, and Initial Backfill – Class I bedding material, 4-inch minimum depth or 1/8 pipe diameter from stable subgrade to pipe invert; Class I haunching and initial backfill from invert to 6-inces above top of pipe; compact all zones to 95% standard density.
   b. Final Backfill – Class II material from top of initial backfill to ground surface; compact to 95% standard density.
3. Type B – <u>Sewer mains between 6-feet and 12-feet deep (occasional water and sewer force mains)</u>

a. Bedding and Haunching – Class I bedding material, 4-inch minimum depth or 1/8 pipe diameter from stable subgrade to pipe invert; Class I haunching to spring-line of pipe; compact both zones to 95% standard density.
b. Initial Backfill – Class II material from spring-line of pipe to 6-inches above top of pipe; compact to 95% standard density.
c. Final Backfill – Class II or III material from top of initial backfill to ground surface; compact to 95% standard density.

4. Type C – Sewer, water, and sewer force mains 3-feet to 6-feet deep
   a. Bedding and Haunching – Class I material 4-inch minimum depth or 1/8 pipe diameter from stable subgrade to 1/6 pipe outside diameter above invert; compact to 95% standard density.
   b. Initial Backfill – Class II or III material from top of pipe to a minimum of 6-inches above top of pipe; compact to 95 standard density.
   c. Final Backfill – Class II or III material from top of initial backfill to ground surface; compact to 95% standard density.
5. Type S – Water and sewer service lines 3-feet to 6-feet deep
   a. Bedding, Haunching, and Initial Backfill – Class I or II material 3-inch minimum depth from stable subgrade to 3-inch minimum above top of pipe; compact to 95% standard density.
   b. Final Backfill – Class II or III material from top of initial backfill to ground surface; compact to 95 percent standard density.

J. Trench Compaction Lifts:
   1. Embedment and initial backfill zones – 6-inch lifts
   2. Final backfill zone – 8-inch lifts

K. Subgrade Stabilization: Wet, yielding, and mucky trench bottoms shall be stabilized by removal of the material and replacement with sufficient Class I embedment material to correct the instability.

L. Backfilling Under NCDOT or City Pavements
   1. As indicated on standard detail drawings
      a. Top 12-inches of final backfill for road or street subbase shall be compacted to 98% standard density.
      b. CLSM trench embedment and backfill.

M. Trench Shields:
   1. When using a shield for installing pipe, bottom of the shield shall not extend below pipe spring-line and haunching embedment.
   2. When using a shield for installing structures, bottom of the shield shall not extend below the top of the bedding for the structures.
   3. When removing the shield or moving the shield ahead, exercise extreme care to prevent moving piping, structures, and other underground facilities, and prevent disturbance of bedding material for piping, structures, and other underground facilities. When piping, structures, or underground facilities are disturbed, remove, and reinstall the disturbed items.

3.7 SITE AND STRUCTURE EXCAVATION

A. Perform all excavation required to complete the Work as shown, specified, and required. Excavation shall include the removal and replacement of all asphalt, concrete, curb, rock, earth, fences, trees, shrubs, and other materials as applicable within the defined rights-of-way, easements, and limits of disturbance indicated.

B. Excavation Protection:
   1. Under all other conditions, excavations shall be sloped and benched, shielded, or shored and braced.
   2. Provide and maintain excavation protection system(s) in accordance with submittals accepted by Engineer.

C. All areas of the site shall be graded and maintained at all times to prevent surface runoff from draining into the excavations, and to prevent ponding of water therein.

D. Excavation shall be accomplished in accordance with the grades and lines as established by the Engineer and as required by the work to be performed. Exercise care to prevent undercutting lower than the required subgrades. When excavations are made below required grades without written order of Engineer, fill such excavations with compacted select fill material, as directed by Engineer, at Contractor's expense.

E. Extend excavations sufficiently on each side of foundation slabs, wet wells, manholes, valve vaults, and similar construction to allow setting of forms, installation of shoring and bracing, and the safe sloping of banks, as necessary.

F. General Site Subgrades:
   1. Subgrades shall be firm, dense, and thoroughly compacted and consolidated; shall be free from mud, muck, and other soft or unsuitable materials; and shall remain firm and intact under all construction operations. Subgrades that are otherwise solid but become soft or mucky on top due to construction operations shall be reinforced with select fill. Finished elevation of stabilized subgrades shall not be above subgrade elevations shown.
   2. If, in Engineer's opinion, subgrade becomes softened or mucky because of construction delays, failure to dewater properly, or other cause within Contractor's control, subgrade shall be excavated to firm material, trimmed, and backfilled with select fill material at Contractor's expense.
   3. Upon completion of site preparation and excavation, scarify to a depth of 12-inches and compact as specified. For areas to receive fill, the compacted subgrade shall be scarified to a depth of 4-inches prior to placing the fill.

G. Proof-rolling Subgrades:
   1. Prior to placing fill or constructing pavements or slabs-on-grade, proof-roll the subgrade surface with sufficient proof-rolling apparatus. Before starting proof-rolling, submit to and obtain acceptance from Engineer of proof-rolling apparatus and procedure to be used.
   2. Proof-rolling operations shall be made in the presence of Engineer. Notify Engineer in advance of start of proof-rolling operations.
   3. Subgrades displaying pronounced elasticity or deformation, deflection, cracking, or rutting shall be stabilized as directed by Engineer. Unsuitable materials shall be undercut to the depth directed by Engineer and replaced with select fill material. Other suitable stabilization methods may be directed by Engineer.

H. Excavated Materials to be Used as Fill:
   1. All materials from excavation, considered as suitable by the Engineer, shall be used as fill wherever required, and the Contractor shall arrange his work so that this usage of excavated materials will be possible.
   2. Stockpile excavated materials that are acceptable for use as fill.
   3. As excavation proceeds, keep stockpiles of excavated materials suitable for use as fill separate from unsuitable materials and waste materials.
   4. Place, grade, and shape stockpiles for proper drainage.
   5. Locate and retain soil materials away from edge of excavations.
   6. Dispose of excess soil material and waste materials.
   7. Stockpiled excavated soils for use as select fill or general fill shall be tested and classified by laboratory as on-Site select fill or on-Site general fill. Perform required quality assurance testing for material verification on stockpiled materials as soon as possible to demonstrate compliance of excavated materials.

3.8 SITE AND STRUCTURE FILL AND COMPACTION

A. Provide and compact all fill required for the finished grades as shown on the drawings.

B. Place fill in excavations as promptly as progress of the Work allows, but not until completing the following:
   1. Engineer's authorization after observation of construction below finish grade, including damp-proofing, waterproofing, perimeter insulation, and similar Work.
   2. Inspection, testing, approval and recording of locations of underground facilities.
   3. Removal of concrete formwork.
   4. Removal of shoring and bracing, and filling of voids with satisfactory materials.
   5. Removal of trash and debris.
   6. Permanent or temporary horizontal bracing is in place on horizontally supported walls.
   7. Field testing of tanks, underground facilities including piping and conduits, and water-retaining structures.

C. Fill that includes organic materials, debris, roots, trash, stones, or other unacceptable material shall be removed and replaced with approved fill material.

D. Borrow: The Contractor will supply all borrow necessary and will provide all labor and equipment necessary to dig and haul such borrow.

E. Placement:
   1. Place fill to the grades shown or indicated. Bring up evenly on all sides fill around structures and underground facilities.
   2. Fill shall be spread in successive layers of loose material not more than 8 inches in depth. Each layer shall be spread uniformly by motor grader or other approved device and rolled with an approved tamping or 3-wheeled power roller until thoroughly compacted to 90 percent of maximum density obtained at optimum moisture content, as determined by the AASHTO Standard Method T-180.
   3. Fill areas shall be undercut, and proof rolled as directed by Engineer.
   4. Place fill materials at moisture content and density as specified in Table 31 23 34-A of this Section and this Article's requirements on compaction density. Furnish and use equipment capable of adding measured amounts of water to the fill

materials to bring fill materials to a condition within required moisture content range. Furnish and use equipment capable of disking, aerating, and mixing the fill materials to ensure reasonable uniformity of moisture content throughout the fill materials, and to reduce moisture content of borrow materials by air drying, when necessary. When subgrade or lift of fill materials requires moisture-conditioning before compaction, fill material shall be sufficiently mixed or worked on the subgrade to ensure uniform moisture content throughout the lift of material to be compacted. Materials at moisture content in excess of specified limit shall be dried by aeration or stockpiled for drying.

5. Perform compaction with equipment suitable for the type of fill material placed. Select and use equipment capable of providing the minimum density required. Use lightweight or hand operated compaction equipment within horizontal distance of 10 feet from the wall of completed, below-grade structures. Furnish and use equipment capable of compacting in restricted areas next to structures and around piping and underground facilities. Effectiveness of the equipment selected by Contractor shall be tested at start of compacted fill Work by constructing a small section of fill within the area where fill will be placed. If tests on the test section of fill indicate that required compaction is not obtained, do one or more of the following: increase the amount of coverage, decrease the lift thicknesses, or use different compactor equipment.
6. Place fill materials in horizontal, loose lifts, not exceeding specified uncompacted thickness. Place fill in a manner ensuring uniform lift thickness after placing. Mechanically compact each lift, by not less than two complete coverages of the compactor. One coverage is defined as the conditions reached when all portions of the fill lift have been subjected to the direct contact of compactor's compacting surface. Compaction of fill materials by inundation with water is unacceptable.
7. Do not place fill materials when standing water is present on surface of the area where fill will be placed. Do not compact fill when standing water is present on the fill to be compacted. Do not place or compact fill in a frozen condition or on top of frozen material. Fill containing organic materials or other unacceptable material previously described shall be removed and replaced prior to compaction.
8. If required densities are not obtained because of improper control of placement or compaction procedures, or because of inadequate or improperly-functioning compaction equipment, Contractor shall perform all work required to provide the required densities. Such work shall include, at no additional cost to Owner, complete removal of unacceptable fill areas and replacement and re-compaction until acceptable fill is provided.
9. Repair, at Contractor's expense, observed or measured settlement. Make repairs and replacements as required within 30 days after being so advised by Engineer.
10. When any portion of the fill is constructed on an old roadbed, the existing surfaces shall be scarified and manipulated as directed by the Engineer in order that, when compacted, it shall have a uniform density. Fills shall be shaped and maintained at all times during their construction to prevent an accumulation of standing water in the event of rain.

F. Fill Against Concrete:
   1. Placing fill against concrete below finished grade is not allowed until the concrete has attained its specified strength, as determined by duration of concrete curing and testing of field-cured concrete cylinders. Requirements for strength and curing time are in Section 03 05 00 – Concrete.

2. Backfill structural foundation units as soon as practicable, after concrete has gained sufficient strength to avoid damage, to avoid ponding of surface water and accumulation of debris.
3. Where fill is placed against waterproofed surface, exercise care that waterproofing material is not damaged.

G. Fill in Electrical Ductbank Trenches:
1. Provide general fill for full depth of electrical ductbank trench, below and above electrical ductbank.
2. Where one ductbank passes beneath another pipe or ductbank, provide select fill to the elevation of the bottom of upper ductbank or pipe, as applicable.
3. Placing and compacting fill in electrical ductbank trenches shall comply with Type S trench construction requirements.

H. Pavement:
1. Compact the subgrade and fill material beneath paved areas and shoulders to a minimum 98 percent ASTM D698 maximum density at optimum moisture content.
2. Place 1-½ inches of temporary asphalt concrete pavement immediately after filling excavations in paved roadways and other paved areas that will remain for permanent use.
3. Maintain surface of paved area over the fill in good and safe condition during progress of the Work, and promptly fill depressions over and adjacent to the fill area caused by settlement of fill.
4. Permanent replacement pavement shall be equal to that of the existing roadways, unless otherwise shown or specified.

I. Subbase Placement:
1. Provide subbase material where shown to the limits shown or indicated.
2. Place subbase material in compacted lifts not exceeding depth of 6-inches each.

J. Drainage Fill Placement:
1. Provide drainage fill material where shown to the limits shown or indicated.
2. Place drainage fill material in compacted layers of uniform thickness not exceeding depth of 6-inches each. Compact lifts of drainage fill using suitable compaction equipment.

K. Granular Fill Placement
1. Place granular fill on compacted subgrade.

L. Compaction Density Requirements:
1. Compaction required for all types of fills shall be in accordance with Table 31 23 34-A of this Section. Moisten material or aerate the material as necessary to provide the moisture content that will facilitate obtaining the required compaction.
2. Fill shall be wetted and thoroughly mixed to achieve optimum moisture content plus-or-minus 3-percent, with the following exceptions:
   a. On-site clayey soils: Optimum to plus 3-percent.
3. Replace natural, undisturbed soils or compacted soil subsequently disturbed or removed by construction operations with materials compacted as indicated in Table 31 23 34-A.

TABLE 31 23 34-A

REQUIRED MINIMUM DENSITY

Material	Percent Compaction (ASTM D698)	Uncompacted Lift (inches)
General Fill		
More than 5-feet below final grade	100	8
Less than 5-feet below final grade	95	8
Select Fill		
Below concrete slabs or mats	100	8
Below pavement and sidewalks	100	12
Behind concrete walls	95	8
Subbase Material		
Below pavement and sidewalks	100	12
All other locations	100	8
Drainage Fill	N/A	6
Structural Fill	98	-
Granular Fill	100	-
Landscaped Areas		
Subgrade	98	-
Topsoil	85	

4. Field quality control testing for density; to verify that specified density was obtained, will be performed during each day of compaction Work. Responsibility for field quality control testing is specified in the "Field Quality Control" Article in Part 3.
5. When field quality control testing indicates unsatisfactory compaction, provide additional compaction necessary to obtain the specified compaction. Perform additional compaction Work at no additional cost to Owner until specified compaction is obtained. Such work includes complete removal of unacceptable (as determined by Engineer) fill areas and replacement and re-compaction until acceptable fill is provided in accordance with the Contract Documents.

M. Replacement of Unacceptable Excavated Materials: In cases where over-excavation to replace unacceptable soil materials is required, backfill the excavation to required subgrade with select fill material and thoroughly compact in accordance with Table 31 23 34-A and the associated "Compaction Density Requirements" in this Article. Slope the sides of excavation in accordance with the maximum inclinations specified for each structure location

3.9 SITE GRADING

A. General:
1. Uniformly grade areas within limits of grading under this Section, including adjacent transition areas. Finished grades should be smooth and provide positive drainage.
   a. Rough Grade Plus or minus 0.1 foot
   b. Finish Grade Plus or minus 0.1 foot

2. Smooth subgrade surfaces within specified tolerances, compact with uniform levels or slopes between points where elevations are shown, or between such points and existing grades.

B. Topsoil: The top 4-inches of soil in landscaped areas shall be topsoil.

C. Protection: Protect areas which have been graded from equipment traffic.

D. Grading Outside Building Lines: Grade areas adjacent to building lines to drain away from structures and to prevent ponding. Finish surfaces free of irregular surface changes, and shall comply with the following:

E. Grassed Areas or Areas Covered with Gravel, Stone, Wood Chips, or Other Special Cover: Finish areas to receive topsoil or special cover to within not more than one inch above or below the required subgrade elevations.

F. Sidewalks: Shape surface of areas under sidewalks to line, grade, and cross section, with finish surface not more than 1-inch above or below the required subgrade elevation.

G. Pavements: Shape surface of areas under pavement to line, grade, and cross section, with finish surface not more than ½-inch above or below the required subgrade elevation.

H. Grading Surface of Fill Under Concrete Slabs: Grade smooth and even, free of voids, compacted as specified, and to required elevation. Provide final grades within a tolerance of ½-inch when tested with a 10-foot straight edge.

I. Compaction: After grading, compact subgrade surfaces to the depth and percentage of maximum density for each area classification.

3.10 CONTROLLED LOW STRENGTH MATERIAL (CLSM)

A. Controlled Low Strength Materials Placement:
1. Discharge CLSM from the mixer by reasonable means into the space to be filled.
2. Bring the fill material uniformly up to the fill line indicated on drawings.
3. Placement of fill over the CLSM may proceed after a curing period of not less than 3-days.

3.11 SITE PAVEMENT SUBBASE COURSE

A. General:
1. Place subbase material, in layers of specified thickness, over ground surface to support pavement base course.
2. After completing filling and grading, shape, and compact pavement subgrade to an even, firm foundation in accordance with this Section. Remove unsuitable subgrade materials, including soft materials, boulders, vegetation, and loose stones, and replace with compacted fill material as directed by Engineer.

B. Undercutting: Undercutting, unless authorized by the Engineer, shall be replaced, and compacted at the Contractor's expense. If the material, after excavation to subgrade, is found to be soft, spongy, or unfit for use as subgrade, such unsuitable material shall be removed to a depth as directed by the Engineer and the subgrade shall be brought to proper elevation by filling with suitable material from excavation or from an approved borrow site.

C. Grade Control:
   1. During construction, maintain lines and grades including crown and cross-slope of subbase course.

D. Placing of Pavement Subbase Course:
   1. Place subbase course material on prepared subgrade in layers of uniform thickness, in accordance with indicated cross-section and thickness. Maintain optimum moisture content for compacting subbase material during placing operations.
   2. When indicated on the drawings, provide geotextile separation fabric over the prepared subgrade

E. Compaction and Grade Control: Comply with compaction requirements for excavation and fill in this Section, and the following requirements:
   a. Compaction with roller shall begin at the sides of the area to be paved and continue toward the center. Continue compaction until there is no movement of the course ahead of the roller.
   b. After compaction of top lift of pavement subbase, provide and uniformly spread pipe bedding material and screenings compacted, on the surface, and sweep using gang-dragged broom, followed by compaction.
   c. After rolling, check for grade with a line not less than 40-feet in length; depression over ½-inch deep shall be filled to satisfaction of Engineer.
   d. After completing compaction, other than that necessary for bringing material for the next course, do not haul or drive over the compacted subbase.
   e. Do not install pavement subbase in excess of 500-feet in length without compacting to prevent softening of the subgrade.
   f. If subgrade material becomes churned up into or mixed with the subbase material, remove the mixed material, and replace with clean, compacted subbase material.

3.12 DISPOSAL OF EXCAVATED MATERIALS

A. Unsuitable materials encountered in an excavation shall be removed by the Contractor and backfilled with suitable material and compacted. Unsuitable materials include organic soils, muck, soft and compressible silts, and clays and running sands.

B. Excavated materials not required for topsoil, fill, or backfill shall be removed from the site of the work by the Contractor, but none shall be deposited on private property without written consent of the property owner.

3.13 TEMPORARY BARRIERS

A. Provide temporary barrier surrounding excavations and excavation work areas to provide temporary protection to persons and property. Barrier shall have openings only at vehicular, equipment, and worker access points.

B. Minimum Material Requirements for Temporary Barriers:
   1. Temporary barrier shall not be less snow fence-type fencing, 4-feet high.
   2. Fence shall be constructed of vertical hardwood slats measuring not less than 1-1/2 inches by 1/4 inch interwoven with strands of horizontal wire or shall be of equivalent plastic construction.
   3. Posts:
      a. Posts shall be steel, either “U”-, “Y”-, “T”-shaped, or channel section.
      b. Posts shall have a nominal weight of not less than 0.33-pound per linear foot, exclusive of the anchor.
      c. Posts shall have tapered anchors weighing not less than 0.67 pounds, each firmly attached by means of welding, riveting, or clamping.
      d. Posts shall have corrugations, knobs, notches, or studs placed and constructed to engage a substantial number of fence line wire in the proper position.
      e. Provide each post with sufficient quantity of galvanized wire fasteners or clamps, of not less than 0.120-inch diameter, for attaching fence wire to post.

3.14 FIELD QUALITY CONTROL

A. Field inspection, sampling and testing shall be performed.

B. Site Tests: Owner will employ an independent testing laboratory to perform field quality control testing.
   1. Testing Laboratory Scope:
      a. Perform field moisture content and density tests to ensure that the specified compaction of embedment and fill materials has been obtained.
      b. Perform tests of actual unconfined compressive strength or bearing tests on structure subgrades.
      c. Report results of each test to CFPUA, Engineer, and Contractor.
   2. Authority and Duties of Testing Laboratory:
      a. Technicians representing the testing laboratory shall inspect the materials in the field, perform testing, and report findings. When materials furnished or the Work performed does not comply, technician will direct attention of CFPUA, Engineer, and Contractor to such failure.
      b. Technician will not act as foreman or perform other duties for Contractor. Work will be checked as it progresses, but failure to detect defective Work or non-complying materials shall not in any way prevent later rejection when defect is discovered. Technicians are not authorized to revoke, alter, relax, enlarge, or release requirements, or to approve any portion of the Work.
   3. Responsibilities and Duties of Contractor:
      a. To facilitate testing laboratory, Contractor shall advise testing laboratory at least 2-days in advance of excavating filling operations to allow for assignment of personnel for field quality control testing.

b. It shall be Contractor's responsibility to control construction operations to accomplish the specified compaction for fill and trench construction and confirm tests verify that Contractor has complied and is complying relative to compaction control.
c. Contractor shall demonstrate adequacy of compaction equipment and procedures before exceeding one or more of the following quantities of earthwork:
    1) 200 linear feet of trench embedment and backfill.
    2) 10 cubic yards of select fill.
    3) 100 cubic yards of general fill.
    4) 50 cubic yards of subbase material.
d. Each test location shall include tests for each layer, type, or class of fill to finish grade.

4. Testing laboratory will inspect and indicate acceptable subgrades and fill layers using the interval/units listed below as a guide. Actual inspection and testing interval/units will vary based on specific project conditions.
    a. Trenches for pipelines and underground facilities (including buried ductbanks):
        1) In Open Fields: Two locations every 1,000 linear feet.
        2) Along Dirt or Gravel Roads or Off Traveled Right-of-Way: Two locations every 500 linear feet.
        3) Crossing Paved Roads: Two locations along each crossing.
        4) Under Pavement Cuts or Within Two Feet of Pavement Edges: One location every 400 linear feet.
    b. Footing Subgrade: For each stratum of soil on which footings will be placed, perform not less than one test to verify required design bearing capacities. Subsequent verification and approval of each footing subgrade may be based on a visual comparison of each subgrade with related tested strata, when acceptable to Engineer.
    c. For Select Fill: On 30-foot intervals on all sides of the structure for every compacted lift, but not less than one per lift on each side of the structure for structures less than 60 feet long on a side.
    d. For General Fill: One per 1,000 square feet on every compacted lift.
    e. Subbase Material: One per 1,000 square feet on every compacted lift.
5. Test reports shall be provided to Owner, Engineer and Contractor.
6. If testing laboratory reports or inspections indicate subgrade, fills, or bedding compaction below specified density, Contractor shall remove unacceptable materials as necessary and replace with specified materials and provide additional compaction at Contractor's expense until subgrades, bedding, and fill are acceptable.

END OF SECTION

TABLE 1 Classes of Embedment and Backfill Materials

Class	Type	Soil Group Symbol D 2487	Description	Percentage Passing Sieve Sizes			Atterberg Limits		Coefficients	
				1½ in. (40 mm)	No. 4 (4.75 mm)	No. 200 (0.075 mm)	LL	PI	Uniformity C_U	Curvature C_C
IA	Manufactured Aggregates: open-graded, clean.	None	Angular, crushed stone or rock, crushed gravel, broken coral, crushed slag, cinders or shells; large void content, contain little or no fines.	100 %	≤10 %	<5 %	Non Plastic			
IB	Manufactured, Processed Aggregates; dense-graded, clean.	None	Angular, crushed stone (or other Class 1A materials) and stone/sand mixtures with gradations selected to minimize migration of adjacent soils; contain little or no fines (see X1.8).	100 %	≤50 %	<5 %	Non Plastic			
II	Coarse-Grained Soils, clean	GW	Well-graded gravels and gravel-sand mixtures; little or no fines.	100 %	<50 % of "Coarse Fraction"	<5 %	Non Plastic		>4	1 to 3
		GP	Poorly-graded gravels and gravel-sand mixtures; little or no fines.						<4	<1 or >3
		SW	Well-graded sands and gravelly sands; little or no fines.		>50 % of "Coarse Fraction"				>6	1 to 3
		SP	Poorly-graded sands and gravelly sands; little or no fines.						<6	<1 or >3
	Coarse-Grained Soils, borderline clean to w/fines	e.g. GW-GC, SP-SM.	Sands and gravels which are borderline between clean and with fines.	100 %	Varies	5 % to 12 %	Non Plastic		Same as for GW, GP, SW and SP	
III	Coarse-Grained Soils With Fines	GM	Silty gravels, gravel-sand-silt mixtures.	100 %	<50 % of "Coarse Fraction"	12 % to 50 %		<4 or <"A" Line		
		GC	Clayey gravels, gravel-sand-clay mixtures.					<7 and >"A" Line		
		SM	Silty sands, sand-silt mixtures.		>50 % of "Coarse Fraction"			>4 or <"A" Line		
		SC	Clayey sands, sand-clay mixtures.					>7 and >"A" Line		
IVA[A]	Fine-Grained Soils (inorganic)	ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands, silts with slight plasticity.	100 %	100 %	>50 %	<50	<4 or <"A" Line		
		CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays.					>7 and >"A" Line		
IVB	Fine-Grained Soils (inorganic)	MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts.	100 %	100 %	>50 %	>50	<"A" Line		
		CH	Inorganic clays of high plasticity, fat clays.					>"A" Line		
V	Organic Soils	OL	Organic silts and organic silty clays of low plasticity.	100 %	100 %	>50 %	<50	<4 or <"A" Line		
		OH	Organic clays of medium to high plasticity, organic silts.				>50	<"A" Line		
	Highly Organic	PT	Peat and other high organic soils.							

[A] Includes Test Method D 2487 borderline classifications and dual symbols depending on plasticity index and liquid limits.

Note—"Coarse Fraction" as used in this table is defined as material retained on a No. 200 sieve.

SECTION 33 01 12

IDENTIFICATION FOR UTILITIES PIPING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Underground Pipeline Detection and Warning.
      a. Tracer wire system
         1) Vinyl/PVC adhesive tape.
         2) Polyethylene adhesive tape.
         3) Direct bury wire splice kits.
      b. Tracer wire system testing
      c. Metal detectable underground warning tape.
      d. Marker posts.
   2. Above Ground Piping and Valve Identification at CFPUA Facility Sites.
      a. Tags
      b. Applied pipe markers.

B. Related Requirements:
   1. Section 09 91 00 - Painting and Protective Coating: Execution requirements for painting specified by this Section.
   2. Section 33 05 07.13 - Horizontal Directional Drilling: Materials and methods for piping and appurtenances.
   3. Section 33 05 07.23 - Jacking and Boring: Materials and methods for carrier pipes and appurtenances.
   4. Section 33 14 13 - Water Distribution Piping and Appurtenances: Materials and methods for piping and appurtenances.
   5. Section 33 14 14 - Public Water Service Connections: Materials and methods for piping, valves, and appurtenances.
   6. Section 33 31 23 - Sanitary Sewer Force Mains, Valves and Appurtenances: Materials and methods for piping, valves, and appurtenances.
   7. Section 40 71 00 - Magnetic Flow Meter
   8. Section 43 21 39.13 - Submersible End Suction Pumps: Materials and methods for piping, valves, pumps, and other station equipment.

1.2 REFERENCE STANDARDS

A. NCGS 87-8A Underground Utility and Damage Prevention Act

B. American Public Works Association: Uniform Color Code

C. American Society of Mechanical Engineers: ASME A13.1 - Scheme for the Identification of Piping Systems.

1.3 SUBMITTALS

A. Product Data: Submit manufacturer's catalog literature for each product required.

PART 2 PRODUCTS

2.1 UNDERGROUND PIPELINE DETECTION AND WARNING

1. Tracer Wire
   a. Vinyl/PVC adhesive tape.
   b. Polyethylene adhesive tape.
2. Direct bury wire splice kits.
3. Metal detectable underground warning tape.
4. Refer to CFPUA Material Specification Manual (MSM) for the following products:

MSM Section	Material
K-Miscellaneous	Warning Tape
L-Electrical	Wire and splice kits

2.2 ABOVE GROUND PIPING AND VALVE IDENTIFICATION

A. Above Grade Pipe Identification
   1. Color-Coding and Lettering Size: Conform to ASME A13.1.
   2. Applied Pipe Markers
      a. Factory-fabricated, flexible, semi-rigid plastic.
      b. Preformed to fit around pipe or pipe covering.
      c. Larger sizes may have maximum sheet size with spring fastener.
   3. Applied Tape Pipe Markers
      a. Flexible, vinyl film tape with pressure-sensitive adhesive backing and printed markings.
   4. Stencils
      a. Clean-cut symbols.
      b. Letters:
         1) Up to 2-inch Outside Diameter of Insulation or Pipe === ½-inch high letters.
         2) 2-½- to 6-inch Outside Diameter of Insulation or Pipe == 1-inch high letters.
         3) Over 6-inch Outside Diameter of Insulation or Pipe == 1-¾-inch high letters.
         4) Stencil Paint: As specified in Section 099000 - Painting and Coating; semi-gloss enamel.

B. Valves
   1. Plastic Tags
      a. Laminated three-layer plastic with engraved letters on light, contrasting background color.
      b. Minimum Tag Size and Configuration: 1-½ inch.
   2. Metal Tags
      a. Stainless-steel construction; stamped letters.
      b. Minimum Tag Size and Configuration: 1-½ inch with finished edges.

PART 3 EXECUTION

3.1 PREPARATION

A. Identify prescribed materials and color code for each pipeline type to be installed.

B. Degrease and clean surfaces to receive adhesive for identification materials.

C. Prepare surfaces as specified in Section 09 90 00 - Painting and Protective Coating for stencil painting.

3.2 INSTALLATION

A. Buried Pipeline Detection and Warning
   1. Tracer wire system termination and access.
      a. Tracer wire systems must be installed as a single continuous wire. No looping or coiling of wire is allowed.
      b. All tracer wire termination points must be grade level/in-ground access boxes identified with “sewer” or “water” cast into the cap.
      c. A minimum of 2 ft. of excess/slack wire is required in all tracer wire access boxes after meeting final elevation.
      d. Runs without service laterals or hydrants shall provide intermediate tracer wire access at minimum 1,000-foot intervals and must be provided utilizing a grade level/in-ground access box located at the edge of the road right-of-way and outside the roadway surface.
      e. Termination and access shall be installed as indicated on the Drawings for all pressure piping at the following locations:
         1) Cast iron boxes located at minimum 1,000-foot intervals
         2) All in-line valve boxes on water mains and services and on sewer force mains and services.
         3) At hydrant valve boxes and hydrants
         4) Water meter service boxes
   2. Tracer wire repairs
      a. Any damage occurring during installation of the tracer wire must be immediately repaired by removing the damaged wire and installing a new section of wire with approved connectors. Taping and/or spray coating shall not be allowed.
   3. Tracer wire attachment and connections
      a. Tracer wire shall be installed at the top half (11-1 o’clock position) of the pipe and secured (taped/tied) at 12-foot intervals.
      b. Mainline tracer wire shall not be connected to existing conductive pipes. Treat as a mainline dead end and ground using an anode buried at the same depth as the tracer wire.
      c. All service lateral tracer wires shall be a single wire, connected to the mainline tracer wire using a mainline to lateral lug connector, installed without cutting/splicing the mainline tracer wire.
      d. In occurrences where an existing tracer wire is encountered on an existing utility that is being extended or tied into, the new tracer wire and existing

tracer wire shall be connected using approved splice connectors and shall be properly grounded at the splice location as specified.

e. A mainline tracer wire must be installed, with all service lateral tracer wires properly connected to the mainline tracer wire, to ensure full tracing/locating capabilities from a single connection point.
f. Lay Mainline tracer wire continuously on the North or East side of valves and fittings.
g. Tracer wire on all service laterals must terminate at an approved tracer wire access located directly above the service lateral at the edge of road right of way.
h. Connect tracer wire using direct bury splice kits in accordance with manufacturer's recommendations

4. Tracer wire testing and verification
   a. Provide locating equipment to verify tracer wire locating system in presence of CFPUA or ENGINEER construction observer.
   b. The test will take the following form:
      1) A standard 5-watt generator will be used to provide an AC current on the wire.
      2) The frequency of the signal from the generator will be initially restricted to 33 kHz or less.
      3) A standard hand-held detector will be used to trace the signal.
   c. The installed tracer wire will be deemed to pass the test if using the above set up:
      1) The tracer wire is accessible at all access points.
      2) The tracer wire can be traced from access point to access point.
      3) Widely spaced access points can be traced out in the worst-case from each end to a common meeting point between them.
      4) Depth readings are consistent and accurate to within a 15:1 depth to diameter ratio.
5. Horizontal Directional Drill and Bore/Jack Crossings
   a. Follow special tracer wire procedures identified in those specification sections.

B. Buried Pipeline Metal Detectable Warning Tape
   a. For all diameter potable water mains (excluding 1-inch service lines) and all diameter sewerage force mains
      1) Install 1'-6" deep and directly above pipeline during backfilling operation.

C. Above Ground Piping and Valve Identification at CFPUA Facility Sites:
   1. Piping:
      a. Identify with plastic tape pipe markers or stenciled painting.
      b. Apply stencil painting as specified in Section 09 90 00 - Painting and Protective Coating.
      c. Identify service, flow direction, and pressure.
      d. Install in clear view and align with axis of piping.
      e. Locate identification not to exceed 20 feet on straight runs, including risers and drops, adjacent to each valve and tee, at each side of penetration of structure or enclosure, and at each obstruction.
   2. Valves:
      a. Install tags using corrosion-resistant chain.

b. Number tags consecutively by type and location.

END OF SECTION

SECTION 33 01 30.86

MANHOLE RIM ADJUSTMENT

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Raising manhole frames and covers.
   2. Replacing manhole frames and covers.

B. Related Requirements:
   1. Section 33 05 13 – Precast Concrete Manholes and Utility Structures

1.2 REFERENCES

A. CFPUA Material Specification Manual (MSM)

1.3 SUBMITTALS

A. Product Data: Manufacturer information for manhole covers and riser rings construction, features, configuration, and dimensions.

B. Manufacturer's Certificate: Products meet or exceed specified requirements.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Store materials according to manufacturer instructions.

B. Protection:
   1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
   2. Provide additional protection according to manufacturer instructions.

1.5 FIELD CONDITIONS

A. Field Measurements:
   1. Verify field measurements prior to fabrication.

PART 2 PRODUCTS

2.1 MATERIAL SPECIFICATION MANUAL

A. Refer to CFPUA Material Specification Manual (MSM) for the following products:

MSM No.	Product

I	Manhole Casting/ Standard Ring and Cover
K	Manhole Casting Adjustment Rings/ HDPE
N	Concrete/ Non-Shrink Grout, Type S Mortar

2.2 RISER RINGS

A. Clay Brick Units:
   1. Description:
      a. Solid units.
      b. Comply with ASTM C32 or AASHTO M91.

B. Precast circular rings.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify and locate manholes requiring grade adjustment.

3.2 INSTALLATION

A. Raising Manhole Frames and Covers:
   1. Locate and raise manholes to grade as indicated.
      a. Cone Sections:
         1) Do not adjust elevation greater than 8 inches without addition of a new manhole section.
         2) Use no more than three courses (8 inches) of brick or precast concrete riser rings to achieve indicated elevation for frame and cover.
      b. Flat Top Manholes:
         1) Shall not be adjusted more than a single course of brick (4 inches).

B. Replacing Manhole Frames and Covers:
   1. Locate manholes for replacement of frames and covers as indicated.
   2. Deliver removed manhole frames and covers to Owner as maintenance materials.
   3. Install new frames and covers for manholes as indicated.
   4. Adjust new frames and covers to match finished grade as indicated.
   5. Seal joints between manholes and manhole frames.

C. Paving Restoration:
   1. Restore bituminous paving areas as specified.

D. Landscaping Restoration:
   1. Restore grassed areas as specified.

END OF SECTION

SECTION 33 05 05.31

HYDROSTATIC TESTING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes: Hydrostatic testing of pressure piping.

B. Related Requirements:
   1. Section 33 31 23 - Sanitary Sewer Force Mains, Valves and Appurtenances: Pipe materials and accessories normally encountered with municipal sanitary sewage force mains.
   2. Section 33 14 13 - Water Distribution Piping: Pipe materials and accessories normally encountered with pressurized water distribution systems.

1.2 REFERENCE STANDARDS

A. American Water Works Association:
   1. AWWA C600 - Installation of Ductile-Iron Water Mains and Their Appurtenances.
   2. AWWA C605 - Underground Installation of PVC

1.3 ADMINISTRATIVE REQUIREMENTS

A. The foreman of the contracting crew must speak fluent English.

B. Any event requiring a CFPUA representative to be present will require a minimum of two (2) business day notice to schedule the event.

C. No valves are to be operated unless a CFPUA representative is present. Any valves operated without a CFPUA representative present, or a directive may be subject to penalties in accordance with CFPUA's Ordinance.

1.4 SUBMITTALS

A. Section 01 33 00 - Submittals.

B. Submit following items prior to start of testing upon request:
   1. Testing procedures.
   2. List of test equipment.
   3. Testing sequence schedule.
   4. Provisions for disposal of flushing and test water.
   5. Certification of test gage calibration.

C. Test and Evaluation Reports: Indicate results of piping tests.

D. Qualifications Statement:
   1. Submit qualifications for applicator upon request.

PART 2 PRODUCTS

2.1 HYDROSTATIC TESTING

A. Equipment:
   1. Pressure pump.
   2. Pressure hose.
   3. Water meter.
   4. Test connections.
   5. Pressure relief valve.
   6. Pressure Gage: Calibrated to 0.1 psi.

PART 3 EXECUTION

3.1 EXAMINATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for installation examination.

B. Verify that piping and appurtenances are installed and ready for testing.

C. Verify that trenches are backfilled.

D. Verify that pressure piping thrust restraints have been installed. Where any section of piping is provided with concrete thrust blocking, the hydrostatic test shall not be made until at least 5 days after installation of the concrete thrust blocking unless otherwise approved.

3.2 FIELD QUALITY CONTROL

A. Section 01 70 00 - Execution and Closeout Requirements.

B. Testing of Pressure Piping to be performed according to AWWA C600 (DIP), AWWA C605 (PVC) and the following as applicable:
   1. Hydrostatic testing procedure:
      a. Testing shall be performed in the presence of the CFPUA representative. Testing shall be scheduled with CFPUA a minimum of two business days in advance and shall not proceed until granted approval by CFPUA. The contractor will pre-test the lines prior to the CFPUA representative arrival. The contractor is to cancel the test if the lines will not pass the required test, correct all visible leakage, and locate and repair leakage in lines which exceeds the specified amounts. When completed, the contractor will re-schedule the test.
      b. Slowly fill with clean potable water portion of piping to be tested, expelling air from piping. Fill and test mains and services.
      c. Close air vents after air is expelled.

d. Raise pressure to specified test pressure. For purposes of testing, working pressure shall be 100 psi and test pressure shall be 150 psi. The pressure gauge must be liquid filled with 2 psi increments maximum. The gauge must be a minimum of three feet above grade. No more than 3 psi can be lost during the two-hour test. The gauge must return to 0 psi when the test is completed. There will be no allowable leakage. Air testing will not be accepted on mains and services, but will be accepted for tapping sleeves, 40 psi for 15 minutes or hydrostatic testing @150 psi for 15 min with zero pressure loss for both.
e. Observe joints, fittings, and valves undergoing testing.

2. Hydrostatic Testing Requirements for Pipe Burst Installations
   a. Subject pipe burst installations to a pressure test before connecting to direct bury mains. Testing shall be performed in the presence of the CFPUA representative. Testing shall be scheduled with CFPUA a minimum of two business days in advance and shall not proceed until granted approval by CFPUA.
   b. The pipe shall be filled with clean potable water and pressurized to 1.5 times the working pressure at the point of testing with a minimum of 150 psi, for a period of no less than 24 hours and then subjected to the specified test pressure.
   c. Pretest pipe burst installations for a period of 2 hours before notifying CFPUA that the main is ready for a final pressure test. No final pressure test shall begin after 2:00 pm.
   d. Perform testing as follows:
      1) Test pressure shall be at least 1.5 times the working pressure at the point of testing with a minimum of 150 psi. Test pressure shall not be less than 1.25 times the working pressure at the highest point along the test section. Test pressure shall not exceed the pipe or thrust restraint design pressure. Test pressure shall not vary by more than +/- 5 psi for the duration of the test.
      2) The pressure test duration shall be 2 hours.
      3) Ensure that the pipe is full of water and that the air has been removed before testing.
   e. Pressure testing is the responsibility of the Contractor, who shall provide materials, labor, and equipment.
3. If testing of piping and appurtenances indicates leakage greater than that allowed, locate source of leakage, make corrections, and retest until leakage is within acceptable limits.
4. Correct visible leaks regardless of quantity of leakage.

END OF SECTION

SECTION 33 05 13

PRECAST CONCRETE MANHOLES AND UTILITY STRUCTURES

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Modular precast concrete manholes and structures with tongue-and-groove joints and masonry transition to cover frame, covers, anchorage, and accessories.

B. Related Sections:
   1. CFPUA Material Specification Manual (MSM)
   2. Section 01 51 00 – Bypass Pumping.
   3. Section 03 05 00 – Concrete.
   4. Section 31 23 34.01 – Excavating, Trenching, Dewatering and Backfilling.
   5. Section 33 01 30.86 – Manhole Rim Adjustment.
   6. Section 33 14 22 – Testing of Sanitary Sewer Mains and Manholes.
   7. Section 33 31 11 – Sanitary Sewer Gravity Mains.
   8. Section 33 31 23 – Sanitary Sewer Force Mains, Valves and Appurtenances.

1.2 REFERENCE STANDARDS

A. American Association of State Highway Transportation Officials:
   1. AASHTO M91 – Standard Specification for Sewer and Manhole Brick (Made from Clay or Shale).
   2. AASHTO M306 – Standard Specification for Drainage, Sewer, Utility, and Related Castings.

B. American Concrete Institute:
   1. ACI 530 – Building Code Requirements and Specification for Masonry Structures.

C. ASTM International:
   1. ASTM A48 – Standard Specification for Gray Iron Castings.
   2. ASTM A123M – Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
   3. ASTM C32 – Standard Specification for Sewer and Manhole Brick (Made from Clay or Shale).
   4. ASTM C478 – Standard Specification for Circular Precast Reinforced Concrete Manhole Sections.
   5. ASTM C497 – Standard Test Methods for Concrete Pipe, Manhole Sections, or Tile.
   6. ASTM C877 – Standard Specification for External Sealing Bands for Concrete Pipe, Manholes, and Precast Box Sections.
   7. ASTM C913 – Standard Specification for Precast Concrete Water and Wastewater Structures.
   8. ASTM C990 – Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants.

1.3 QUALITY ASSURANCE

A. Perform Work according to ASTM and AASHTO standards and manufacturer's instructions.

1.4 WARRANTY

A. Section 01 70 00 – Execution and Closeout Requirements.

B. Furnish a one-year manufacturer's warranty for concrete manholes and structures.

1.5 SUBMITTALS

A. Section 01 33 00 – Submittal Procedures.

B. Submittals:
   1. Section 01 70 00 – Execution and Closeout Requirements.
   2. Product Data: Submit manufacturer information for manhole covers, component construction, features, configuration, and dimensions.
   3. Manufacturer Instructions: Submit detailed instructions on installation requirements, including storage and handling procedures.
   4. Shop Drawings:
      a. Indicate structure locations and elevations.
      b. Indicate sizes and elevations of piping, conduit, and penetrations.
   5. Source Quality-Control Submittals: Indicate results of factory tests and inspections.
   6. Qualifications Statement: Submit qualifications for manufacturer.
   7. Project Record Documents: Record actual locations of manholes and connections, and record invert elevations.

1.6 SITE CONDITIONS

A. DELIVERY, STORAGE, AND HANDLING
   1. Section 01 60 00 – Product Requirements.
   2. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.
   3. Handling: Comply with precast concrete manufacturer instructions and ASTM C913 for unloading and moving precast manholes and drainage structures.
   4. Bent Reinforcing steel bars are not permitted for use as lifting devices.
   5. Lifting devices shall be evaluated and approved by the Engineer.
   6. Storage:
      a. Store materials according to manufacturer instructions.
      b. Store precast concrete manholes and drainage structures to prevent damage to Owner's property or other public or private property.
      c. Repair property damaged from materials storage.
   7. Protection:
      a. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
      b. Provide additional protection according to manufacturer instructions.

B. EXISTING CONDITIONS
   1. Field Measurements:
      a. Verify field measurements prior to fabrication.
      b. Indicate field measurements on Shop Drawings.

PART 2 PRODUCTS

2.1 MATERIAL SPECIFICATION MANUAL

A. Refer to CFPUA Material Specification Manual (MSM) for the following products:

MSM Section	Product
I	Castings and Access Covers
M	Coatings and Sealants
O	Structures

2.2 SOURCE QUALITY CONTROL

A. Section 01 40 00 – Quality Requirements: Requirements for testing, inspection, and analysis.

B. Provide shop inspection and testing of completed assembly.

C. Verify that items provided have met factory testing requirements and are inspected upon delivery.

D. Certificate of Compliance:
   1. If manufacturer is approved by authorities having jurisdiction, submit certificate of compliance indicating Work performed at manufacturer's facility conforms to Contract Documents.

2.3 MATERIALS AND ACCESSORIES

A. Lining Systems
   1. MSM Section M – Coatings and Sealants

B. Grouts
   1. MSM Section N - Concrete
   2. Section 03 05 00 - Concrete

C. Sewer Guards
   1. Stainless steel straps, anchors and sewer guards required at all Manholes.

PART 3 EXECUTION

3.1 EXAMINATION

A. Section 01 70 00 – Execution and Closeout Requirements: Requirements for installation examination.

B. Verify that items provided by other Sections of Work are properly sized and located.

C. Verify that built-in items are in proper location and are ready for roughing into Work.

D. Verify that excavation base is ready to receive Work and excavation dimensions and elevations are as indicated on Drawings.

3.2 PREPARATION

A. Mark each precast structure by indentation or waterproof paint showing date of manufacture, manufacturer, and identifying symbols and numbers as indicated on Drawings to indicate its intended use.

B. Coordinate placement of inlet and outlet pipe or duct sleeves as required by other Sections.

C. Do not install manholes and structures where Site conditions induce loads exceeding structural capacity of manholes or structures.

D. Inspect precast concrete manholes and structures immediately prior to placement in excavation to verify that they are internally clean and free from damage; remove and replace damaged units.

3.3 INSTALLATION

A. Conduct operations not to interfere with, interrupt, damage, destroy, or endanger integrity of surface structures or utilities in immediate or adjacent areas.

B. Correct over-excavation with Class 1 aggregate.

C. Remove large stones or other hard matter impeding consistent backfilling or compaction.

D. Protect manhole and structures from damage or displacement while backfilling operation is in progress.

E. Excavating:
1. As specified in Section 31 23 34.01 – Excavating, Trenching, Dewatering and Backfilling and in indicated locations and depths.
2. Provide clearance around sidewalls of manhole or structure for construction operations.
3. If ground water is encountered, prevent accumulation of water in excavations, place manhole or structure in dry trench.
4. Where possibility exists of watertight manhole or structure becoming buoyant in flooded excavation, anchor manhole or structure to avoid flotation as approved by Engineer.

F. Base and Alignment:
   1. Install manholes and structures supported at proper grade and alignment on compacted crushed-stone bedding or piles as indicated on Drawings.
   2. Grout base of shaft sections to achieve slope to exit piping, trowel smooth, and contour to form continuous drainage channel.
   3. Form and place manhole or structure cylinders plumb and level, to correct dimensions and elevations.

G. Coating:
   1. All structures shall be coated prior to testing.
      a. The exterior of all structures shall be coated with two coats of a bituminous coating system at a rate of 120 square feet per gallon.
      b. The interior of all structures shall be lined with a preapproved lining system per Material Section M – Coating and Sealants.

H. Precast Concrete Manholes:
   1. Lift precast components at lifting points designated by manufacturer.
   2. When lowering manholes and structures into excavations and joining pipe to units, take precautions to ensure that interior of pipeline and structure remains clean.
   3. Assembly:
      a. Assemble multi-section manholes and structures by lowering each section into excavation.
      b. Install rubber gasket joints between precast sections according to manufacturer recommendations.
      c. Lower, set level, and firmly position base section before placing additional sections.
   4. Remove foreign materials from joint surfaces and verify that sealing materials are placed properly.
   5. Maintain alignment between sections by using guide devices affixed to lower section.
   6. Joint sealing materials may be installed on Site or at manufacturer's plant.
   7. Verify that installed manholes and structures meet required alignment and grade.
   8. Remove knockouts or cut structure to receive piping without creating openings larger than required to receive pipe; fill annular spaces with mortar.
   9. Cut pipe flush with interior of structure.
   10. Shape inverts through manhole and structures as indicated on Drawings.

I. Grouting:
   1. Section 03 05 00 – Concrete
   2. Verify all surfaces have been inspected and prepared for application. All surfaces shall be free of dirt, oil, grease, and other contaminants.
   3. Surface shall be clean, sound and roughened to ensure a sufficient bond.
   4. Surface shall be saturated up to 24 hours prior to application but free of standing water at the time of application.
   5. Provide sufficient support for items to be embedded into the work. Diagrams, templates, and other forms can be used to properly locate such items.
   6. Refer to Manufacturer’s instructions for proper grouting application and installation.
   7. Application shall be inspected immediately after and any defects repaired or removed for re-installation if directed by the Engineer.

J. Castings:
   1. Set frame and cover at finished grade for manholes and other structures with covers located within unpaved areas and graded away from cover.
   2. Set frames using mortar and masonry as indicated on Drawings.
   3. Lay concrete brick in full bed of mortar and completely fill joints.
   4. If more than one course of concrete brick is required, stagger vertical joints.

K. Backfilling: As specified in Section 31 23 34.01 – Excavating, Trenching, Dewatering and Backfilling.
   1. All structures shall be leak tested prior to backfilling.

3.4 FIELD QUALITY CONTROL

A. Section 01 40 00 – Quality Requirements.

B. Testing:
   1. Perform testing in accordance with ASTM C497.
   2. Concrete Manhole Sections: As specified in Section 33 14 22 – Testing of Sanitary Sewer Mains and Manholes.
   3. Conduct a visual inspection of concrete structures.
   4. Repair all visible and detectable leaks.
   5. Leakage testing for structures shall be performed prior to backfilling by the following procedure:
      a. Temporarily plug all wall sleeves, piping entrances and other openings during test period.
      b. Fill structure to overflow level.
      c. Allow to stand for a minimum of four (4) hours.
      d. Refill to overflow level.
      e. Allow to stand for 24 hours.
      f. Examine exterior surfaces and joints for leakage. Measure drop in surface water. Allowable leakage is a drop of ½ inch or less during the test period and no visible signs of leakage.
      g. Repair all visible and detectable leaks. If leakage exceeds allowable limit, the structure shall be repaired by approved method per Engineer.

C. Equipment Acceptance: Contractor shall adjust, repair, modify, or replace components failing to perform as specified and rerun tests at no cost to the Owner.

3.5 ADJUSTING

A. Section 01 70 00 – Execution and Closeout Requirements.

B. Vertical Adjustment of Existing Manholes and Structures:
   1. As specified in Section 33 01 30.86 – Manhole Rim Adjustment.

END OF SECTION

SECTION 33 14 13

WATER DISTRIBUTION PIPING, VALVES, HYDRANTS, AND APPURTENANCES

PART 1 GENERAL

1.1 DESCRIPTION

A. Section Includes Installation of:
   1. Pipe and fittings for public water mains and service connections.
   2. Valves, fire hydrants, blow offs, sampling stations, air release assemblies, and other water distributions appurtenances.

B. Related Requirements:
   1. CFPUA Material Specification Manual (MSM).
   2. Section 03 05 00 - Concrete.
   3. Section 09 91 00 - Painting and Protective Coatings.
   4. Section 31 23 34.01 - Excavating, Trenching, Dewatering and Backfilling.
   5. Section 33 01 12 - Identification for Utilities Piping.
   6. Section 33 05 05.31 - Hydrostatic Testing.
   7. Section 33 05 09.33 - Thrust Restraint for Utility Piping.
   8. Section 33 05 13 - Precast Concrete Manholes and Utility Structures.
   9. Section 33 14 14 - Public Water Service Connections.
   10. Section 33 14 20 - Disinfection of Water Pipelines, Facilities and Appurtenances.

1.2 REFERENCES

A. American Association of State Highway and Transportation Officials:
   1. AASHTO T 180 – Standard Method of Test for Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18-in.) Drop.

B. American Society of Mechanical Engineers:
   1. ASME B16.1 – Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.

C. ASTM International:
   1. ASTM A307 – Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength.
   2. ASTM D698 – Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12 400 ft-lbf/ft3 (600 kN-m/m3).
   3. ASTM D1557 – Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3 (2,700 kN-m/m3).
   4. ASTM D1785 – Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.
   5. ASTM D2241 – Standard Specification for Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series).
   6. ASTM D3035 – Standard Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Controlled Outside Diameter.
   7. ASTM D3139 – Standard Specification for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals.

8. ASTM D6938 – Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).
9. ASTM F477 – Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.

D. American Water Works Association:
1. AWWA C104 – Cement-Mortar Lining for Ductile-Iron Pipe and Fittings.
2. AWWA C105 – Polyethylene Encasement for Ductile-Iron Pipe Systems.
3. AWWA C110 – Ductile-Iron and Gray-Iron Fittings.
4. AWWA C111 – Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
5. AWWA C115 – Flanged Ductile-Iron Pipe with Ductile-Iron or Gray-Iron Threaded Flanges.
6. AWWA C116 – Protective Fusion-Bonded Coatings for the Interior and Exterior Surfaces of Ductile-Iron and Gray Iron Fittings.
7. AWWA C151 – Ductile-Iron Pipe, Centrifugally Cast.
8. AWWA C153 – Ductile-Iron Compact Fittings.
9. AWWA C500 – Metal-Seated Gate Valves for Water Supply Service.
10. AWWA C502 – Dry-Barrel Fire Hydrants.
11. AWWA C509 – Resilient-Seated Gate Valves for Water Supply Service.
12. AWWA C512 – Air-Release, Air/Vacuum, and Combination Air Valves for Water and Wastewater Service.
13. AWWA C550 – Protective Interior Coatings for Valves and Hydrants.
14. AWWA C600 – Installation of Ductile-Iron Mains and Their Appurtenances.
15. AWWA C605 – Underground Installation of Polyvinyl Chloride (PVC) and Molecularly Oriented Polyvinyl Chloride (PVCO) Pressure Pipe and Fittings.
16. AWWA C900 – Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 In. Through 60 In. (100 mm Through 1,500 mm), for Water Transmission and Distribution.
17. AWWA C901 – Polyethylene (PE) Pressure Pipe and Tubing, 1/2 In. (13 mm) Through 3 In. (76 mm), for Water Service.
18. AWWA C906 – Polyethylene Pressure Pipe and Fittings, 4-In. Through 65-In. for Waterworks.

E. Manufacturers Standardization Society of the Valve and Fittings Industry:
1. MSS SP-60 – Connecting Flange Joints between Tapping Sleeves and Tapping Valves.

F. National Fire Protection Association:
1. NFPA 24 – Standard for the Installation of Private Fire Service Mains and Their Appurtenances.
2. NFPA 291 – Recommended Practice for Fire Flow Testing and Marking of Hydrants.

G. NSF International:
1. NSF 61 – Drinking Water System Components - Health Effects.
2. NSF 372 – Drinking Water System Components - Lead Content.

1.3 ADMINISTRATIVE REQUIREMENTS

A. Section 01 30 00 - Administrative Requirements

B. Coordination:
   1. Coordinate Work of this Section with termination of water main connection at Site boundary, connection to CFPUA, and trenching.
   2. The existing system must be kept in operation at all times. Where connections are made to existing mains or other shutdowns are necessary, permission must be obtained and arrangements must be made with the CFPUA Distribution ORC, Utility Services Division for removing from service those mains that will be affected.
   3. No valves are to be operated unless a CFPUA representative is present. Any valves operated without a CFPUA representative present, or a directive may be subject of penalties in accordance with CFPUA's ordinance.
   4. Notify CFPUA no less than two business days prior to an event requiring a CFPUA representative to be present.
   5. The Contractor shall, at least two business days in advance, notify citizens subject to interruption of service by means of door hangers or any other approved method of the starting time and duration of such interruption.

1.4 SUBMITTALS

A. Section 01 33 00 - Submittals: Requirements for submittals.

B. Product Data/Source Quality:
   1. Manufacturer information regarding pipe, pipe fittings, valves, hydrants, and appurtenances including component material, assembly, and parts diagrams.
   2. Shop test results and inspection data, certified by manufacturer.

C. Testing Procedures:
   1. Submit proposed testing procedures, methods, apparatus, and sequencing. Obtain ENGINEER and CFPUA approval prior to commencing testing.

D. Manufacturer Instructions:
   1. Detailed instructions on installation requirements, including storage and handling procedures.

E. Manufacturer's Certificate:
   1. Certify that products meet or exceed specified requirements.

F. Field Quality-Control Submittals:
   1. Results of Contractor-furnished laboratory testing and field test results.

1.5 CLOSEOUT SUBMITTALS:

A. Section 01 70 00 - Execution and Closeout Requirements.

B. Project Record Documents:
   1. Maintain accurate and up-to-date record documents showing modifications made in the field, in accordance with approved submittals, and other Contract modifications relative to buried piping Work.
   2. Record actual locations of piping mains, valves, hydrants, connections, thrust restraints, elevations, and other utilities found and not indicated on design plans.

C. Operations and Maintenance Data:
   1. Furnish in operations and maintenance manuals complete data for materials in accordance with Section 01 60 00 - Product Requirements.

1.6 QUALITY ASSURANCE

A. Qualifications: Company specializing in manufacturing products specified in the CFPUA Materials Specification Manual.
   1. Cast manufacturer's name, pressure rating, and year of fabrication into valve body.

B. Materials in Contact with Potable Water: Certified according to NSF 61 and NSF 372.

C. Perform Work according to AWWA and PVC Pipe Association standards.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements.

B. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.

C. Storage:
   1. Store materials according to manufacturer instructions.
   2. Block individual and stockpiled pipe lengths to prevent moving.
   3. Do not place pipe or pipe materials on private property or in areas obstructing pedestrian or vehicle traffic.
   4. Store PE and PVC materials out of sunlight.

D. Protection:
   1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
   2. Provide additional protection according to manufacturer instructions.

1.8 SITE CONDITIONS

A. Field Measurements:
   1. Verify field measurements prior to fabrication.
   2. Indicate field measurements on Shop Drawings.

1.9 WARRANTY

A. Section 01 70 00 - Execution and Closeout Requirements.

B. Furnish 10-year manufacturer's warranty for valves.

PART 2 PRODUCTS

2.1 CFPUA MATERIAL SPECIFICATION MANUAL

A. Refer to CFPUA Material Specification Manual (MSM) for the following products:

MSM Section	Material
A	Pipe
B	Fittings and Accessories
C	Joint Restraints
D	Valves and Accessories
E	Fire Hydrants
F	Service Saddles and Tapping Devices
I	Castings & Aluminum Access Covers
K	Miscellaneous
L	Electrical
M	Coatings and Sealants

2.2 MATERIALS & ACCESSORIES

A. Bedding, Cover, and Backfill:
   1. As specified in Section 31 23 34.01 - Excavating, Trenching, Dewatering and Backfilling.

B. Pipe Location Wire: As specified in Section 33 01 12 - Identification for Utilities Piping.

C. Thrust Restraints: As specified in Section 33 05 09.33 - Thrust Restraint for Utility Piping.

D. Service Connections: As specified in Section 33 14 14 - Public Water Service Connections.

E. Vaults and Utility Boxes: As specified in Section 33 05 13 - Precast Concrete Manholes and Utility Structures.

F. Fire Hydrant Drainage Gravel: Provide #57 Stone.

PART 3 EXECUTION

3.1 EXAMINATION

A. Section 01 70 00 - Execution and Closeout Requirements.

B. Identify project horizontal and vertical control points, establish easement and right-of-way lines, stakeout construction points for work and pipeline alignments, establish limits of disturbance.

C. Determine exact location and size of water mains, valves, hydrants, and appurtenances from Drawings

D. Verify location and elevation of existing facilities prior to excavation and installation of proposed interconnecting water mains, valves, and hydrants.

3.2 PREPARATION

A. Section 01 35 00 - Special Procedures.
   1. Pre-construction Site Audio/Video Inspections and Photography:
   2. Show mailboxes, curbing, lawns, driveways, signs, culverts, and other existing Site features.

B. Section 01 70 00 - Execution and Closeout Requirements.

C. All materials, unless otherwise directed, shall be unloaded as nearby as possible to the location of installation by the Contractor. Materials shall be handled with care to avoid damage.

D. All materials found during the progress of work to have flaws, cracks, or other defects will be rejected by the Engineer regardless of whether or not it has been installed and shall be replaced by and at the expense of the Contractor.

E. All PVC pressure pipe, upon delivery to the site and until such time as it is placed in the trench, shall be shielded from the weather and direct sunlight to prevent pipe deterioration.

F. Slings, hooks, or tongs used for lifting shall be padded in such a manner as to prevent damage to exterior surfaces, interior linings, and components. If any part of the coating, lining or components is damaged, the repairs or replacement shall be made by the Contractor at his expense and in a manner satisfactory to the Engineer prior to attempting installation.

G. Pipe Cutting:
   1. Cut pipe ends square, ream pipe and tube ends to full pipe diameter, and remove burrs.
   2. Use only equipment specifically designed for pipe cutting; use of chisels or hand saws is not permitted.
   3. Grind edges smooth with beveled end for push-on connections.

H. Remove scale and dirt on inside and outside before assembly.

I. Prepare pipe connections to equipment with flanges or unions.

3.3 INSTALLATION

A. Placement: As specified in Section 31 23 34.01 - Trenching, Excavation, Dewatering and Backfilling.
   1. All mains shall be laid and maintained at the required lines and grades with fittings, valves, and appurtenances at the described locations. All pipe shall be laid to the depth as shown on the drawings, or when a depth is not indicated, with a minimum cover of thirty (30) inches and a maximum of (60) inches below finished grade. Grade lines shall be set by the Contractor. Realignments must be approved by the Engineer. The Contractor shall have suitable survey equipment on the site at all times.

2. After placement in the trench the spigot end of the pipe shall be centered in the bell and the pipe shall be driven home and then brought to the proper line and grade by tamping approved backfill material under it, except for the bell. Joint deflection shall not exceed manufacturer's limit.
3. The Work shall at all times progress with caution so as to prevent damage to underground obstructions both known and unknown. Should an obstruction not shown on the drawings be encountered, the Engineer shall be immediately notified, and he shall be responsible for alteration to the design should realignment be necessary. Notify the Engineer far enough in advance to allow the realignment to be accomplished by deflection in the pipe joints.

B. Pipe and Fittings:
1. Handle and assemble pipe according to manufacturer instructions.
2. Install pipe and fittings in strict conformance with AWWA C600 and AWWA C605.
3. Install plastic pipe in conformance with ASTM D2774 and recommended practices of the UNI-BELL Plastic Pipe Association.
4. Joint Deflection: Maximum joint deflection shall meet requirements of AWWA C600, AWWA C605, or AWWA Manual of Practice M23.
5. Prevent foreign material from entering pipe during placement. Seal pipe openings with watertight plugs during Work stoppages using plugs designed for that purpose. If trench contains standing water in joining zone, plug shall remain in place until the trench has been pumped dry before proceeding pipe laying.
6. Allow for expansion and contraction without stressing pipe or joints.
7. Install access fittings to permit disinfection of water system performed under Section 33 14 20 – Disinfection of Water Distribution Mains.
    a. Blowoffs shall be installed for pipe flushing, disinfection, and test sampling.
    b. Blowoffs shall be located as follows:
        1) Dead ends.
        2) Stub-outs greater than one pipe section in length for future interconnecting mains.
        3) Valves closed against disinfection, flushing, and sampling.
    c. Blowoff should be installed as follows:
        1) Opening pointing downward.
        2) Minimum 24-inches clearance between opening and ground for proper sampling.
8. Cover: Measure depth of cover from final surface grade to top of pipe barrel and record.
9. Jointing:
    a. Fused HDPE:
        1) HDPE Pipe shall be joined by the butt-fusion process in accordance with pipe manufacturer’s directions.
        2) Contractor shall provide butt-fusion technicians who are trained and certified by the HDPE pipe manufacturer to complete the project. The date of technician certification shall not exceed 12 months before commencing construction.
        3) Butt-fusion means the butt-joining of the pipe by softening the aligned faces of the pipe ends in a suitable apparatus and pressing them together under controlled pressure.

4) The internal and external beads resulting from the butt-fusion process shall be visible and examined for penetration 360 degrees around the pipe diameter.
5) DI/HDPE Mechanical Joint Adaptors shall be ductile iron mechanical joint fittings per CFPUA Material Specification Manual and shall be joined to the HDPE pipe by a heat-fused joint on one end, and connected to a ductile iron pipe valve, or fitting with a mechanical joint on the other end.
6) Solvent epoxy cementing, electro-fusion couplings, and mechanical joining with bolt on wrap around clamps or mechanical joints without an adapter shall not be used for connections.

b. Push-On Joints:
1) The inside of the bell and the outside of the spigot end shall be thoroughly cleaned to remove dirt, grit, oil or excess coatings and other foreign matter. For ductile iron pipe, the gasket shall be flexed inward and inserted in the gasket recess of the bell socket.
2) A thin film of gasket lubricant shall be applied to either the inside surface of the gasket or the spigot ends, care will be taken to avoid contact with the ground.
3) The joint shall be completed by forcing the plain end to the bottom of the socket with a forked tool or jacking device or other approved method. All pipe shall have depth mark prior to insertion. Pipe cut in the field shall be filed to resemble the spigot end of manufactured pipe.
4) When deflection is required, the joint shall be completed prior to setting the deflection. The deflection shall conform to applicable AWWA Standards or manufacturer's recommendation.

c. Mechanical Joints:
1) The inside of the socket, the outside of the spigot end and the gland shall be thoroughly cleaned and or washed with an approved solution to remove dirt, grit, oil or excess coatings and foreign matter to improve gasket seating.
2) The gland shall then be placed on the plain end of the pipe with the lip extension toward the plain end, followed by the gasket with the narrow edge of the gasket toward the plain end of the pipe.
3) The pipe shall be inserted into the socket and the gasket pressed firmly and evenly into the gasket recess. The joint shall be kept straight during the assembly and any deflection required shall be done after the joint has been assembled but prior to tightening the bolts.

C. Valves:
1. Valves shall be set and joined to the pipe and each type of joint as specified for pipe.
2. Cast iron valve boxes shall be firmly supported, maintained centered and plumb over the operating nut of the valve. Outside of paved areas, valve boxes shall be set in a 2' diameter x 6" thick concrete collar. The box cover shall be flush with the surface of the finished pavement. All water main valve box lids shall have the word “WATER” cast in the lid.
3. All reasonable effort must be made to locate valves/valve boxes, back of curb, in grass areas and at street corners, whenever possible.
4. Valve boxes in areas that will require sod at a later date must be left one to two inches above existing grade (to allow for sod thickness).

5. All valves must be centered over the operating nut and all valves, after being fully opened, will be backed off one-quarter turn to prevent them from being jammed open. This procedure should take place only after the main has passed pressure testing and has been certified by the Engineer.
6. Should the operating nut be more than three feet below the final grade, an extension shall be supplied and installed by the Contractor. The extension shall bring the nut to within twelve (12) inches of final grade.

D. Installing Valves on Existing Mains
1. When installing valves in existing mains (cutting-in), the Contractor shall insure that the pipe is kept clean at all times and no debris, ground water, mud, oil, etc., will make their way into the pipe.

E. Installation of Tapping Sleeves and Valves
1. Install the tapping sleeve and valve and pressure test prior to making the tap.
2. If leaks are present, the Contractor shall repair them to the satisfaction of the Engineer or Resident Project Representative.
3. Complete the tapping operation and close tapping valve.
4. Tapping valve shall not be opened until new main has been tested and certified for operation.

F. Hydrants
1. Each hydrant shall be connected to the main with a 6-inch branch line.
2. Hydrants shall be set with the pumper nozzle facing the roadway and with the center of the lowest outlet not less than 18 inches above the finished surrounding grade and the operating nut not more than 48 inches above the finished surrounding grade.
3. Set fire hydrants with safety flange not more than 6 inches and not less than 2 inches above grade.
4. The hydrant shall be set in a bed of # 57 stone which shall surround the barrel at least twelve (12) inches in all directions.
5. Hydrants and tees (runs and branches) shall be restrained using field-applied restraint system per CFPUA MSM.
6. Provide support blocking and drainage gravel while installing fire hydrants; do not block drain hole.
7. After main-line pressure testing, flush fire hydrants and check for proper drainage.

G. Thrust Restraints: As specified in Section 33 05 09.33 - Thrust Restraint for Utility Piping.
1. New main construction shall be restrained by means of field or factory applied systems as shown on the Engineer drawings.
2. Thrust blocks in new mains is prohibited except when directed by the Engineer.
3. Where a fitting or device is to be inserted into an existing main, thrust blocking shall be installed as directed by the Engineer or CFPUA.

H. Polyethylene (PE) encasement when indicated for ductile iron pipe and fittings:
1. Encase piping in PE as indicated on Drawings to prevent contact with surrounding soil material or insulation from adjacent cathodic protection system.
2. Comply with AWWA C105.
3. Where pipe exits ground, terminate encasement 3 to 6 inches above surface.

I. Pipe Locator Wire: Install per Section 33 01 12 - Identification for Utilities Piping.

J. Service Connections: As specified in Section 33 14 14 - Public Water Service Connections.

K. Disinfection of Potable Water Piping Systems: As specified in Section 33 14 20 - Disinfection of Water Distribution Mains.

L. Pipe Markers: According to CFPUA Details and Material Specification Manual.

3.4 FIELD QUALITY CONTROL

A. Section 01 70 00 - Execution and Closeout Requirements.

B. Section 33 05 05.31 - Hydrostatic Testing.
   1. Pressure test piping system according to AWWA C600 and AWWA C605.

C. Section 33 14 20 - Disinfection of Water Pipelines, Facilities, and Appurtenances.

D. Pigging – Flushing and Cleaning Alternative for Large Mains
   1. For mains where flowrates cannot be achieved to create minimum cleaning velocities of 2 feet per second or greater, cleaning of the new piping system by pigging methods shall be established for the project by the Engineer. Pigging includes the following measures:
      a. Pig launching and retrieval equipment to minimize additional valves, fittings, and auxiliary water supplies.
      b. Valves and blowoff assemblies, which are installed as part of the project, shall be used as much as possible to minimize the number of temporary ports required for pigging.
      c. Pig materials used shall be specifically manufactured for flushing and cleaning pressure pipes, bends, and valves. The pigs shall be able to go through bends, open valves, and fittings, and provide adequate cleaning of the pipe.
      d. Pigging shall be accomplished by the controlled and pressurized passage of a series of hydraulic or pneumatic polyurethane plugs of varying dimensions, coatings, and densities.
      e. Pigs shall be selected by the Contractor and approved by the Engineer.
      f. The Contractor shall provide means to enter the pig into the system, control and regulate flow, monitor flows and pressures, and to remove the pig from the system.
      g. The Contractor shall maintain constant surveillance of the pig while active in the pipe system and immediately report problems encountered or any malfunctions discovered in the piping system.

END OF SECTION

SECTION 33 14 14

PUBLIC WATER SERVICE CONNECTIONS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Pipe and fittings for water service connections to small commercial, light industrial, and residential homes 2" service and smaller.
   2. Corporation stop assemblies.
   3. Curb stop assemblies.
   4. Backflow preventers.
   5. Meter setting equipment.
   6. Meter boxes.
   7. Trenching, bedding, and cover.

B. Related Requirements:
   1. CFPUA Material Specification Manual (MSM).
   2. Section 31 23 34.01 – Excavating, Trenching, Dewatering and Backfilling.
   3. Section 33 14 13 – Water Distribution Piping and Appurtenances.
   4. Section 33 14 13 – Water Distribution Valves and Fire Hydrants.
   5. Section 33 14 20 – Disinfection of Water Distribution Mains.
   6. Section 33 05 13 – Precast Concrete Manholes and Utility Structures.

C. CFPUA provides potable water service which may be interrupted for repairs, system expansion, or other general requirements. CFPUA does not guarantee adequate fire flow for protection of life or property. There shall be no domestic use taps allowed on a dedicated fire line. Some facility owners choose to utilize this interruptible potable water supply from the CFPUA system for fire protection. If facility owners choose to utilize the potable water system for fire protection flow, the service for fire protection shall be configured according to Part 3 of this Section.

1.2 REFERENCES

A. American Association of State Highway and Transportation Officials:
   1. AASHTO T 180 - Standard Method of Test for Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18-in.) Drop.

B. American Society of Mechanical Engineers:
   1. ASME B16.18 – Cast Copper Alloy Solder Joint Pressure Fittings.
   2. ASME B16.22 – Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.

C. American Society of Sanitary Engineering:
   1. ASSE 1012 – Performance Requirements for Backflow Preventers with an Intermediate Atmospheric Vent.

2. ASSE 1013 – Performance Requirements for Reduced Pressure Principle Backflow Preventers and Reduced Pressure Principle Fire Protection Backflow Preventers.

D. ASTM International:
   1. ASTM B62 – Standard Specification for Composition Bronze or Ounce Metal Castings.
   2. ASTM D698 – Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3).
   3. ASTM D1557 – Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3 (2,700 kN-m/m3).
   4. ASTM D2737 - Standard Specification for Polyethylene (PE) Plastic Tubing.
   5. ASTM D3350 - Standard Specification for Polyethylene Plastics Pipe and Fittings Materials.
   6. ASTM D6938 – Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

E. American Welding Society:
   1. AWS A5.8/A5.8M - Specification for Filler Metals for Brazing and Braze Welding.

F. American Water Works Association:
   1. AWWA C509 – Resilient-Seated Gate Valves for Water Supply Service.
   2. AWWA C600 – Installation of Ductile-Iron Mains and Their Appurtenances.
   3. AWWA C800 – Underground Service Line Valves and Fittings.
   4. AWWA C901 – Polyethylene (PE) Pressure Pipe and Tubing, 1/2 In. (13 mm) Through 3 In. (76 mm), for Water Service.
   5. AWWA M6 – Water Meters – Selection, Installation, Testing, and Maintenance.

1.3 ADMINISTRATIVE REQUIREMENTS

A. Any event requiring a CFPUA representative to be present shall require a minimum of 2 business day notice to schedule the event.

B. No valves are to be operated unless a CFPUA representative is present. Any valves operated without a CFPUA representative present, or a directive may be subject to penalties in accordance with CFPUA’s ordinance.

1.4 SUBMITTALS

A. Section 01 33 00 – Submittal Procedures.

B. Informational Submittals:
   1. Product Data: Submit manufacturer information regarding pipe materials, pipe fittings, corporation stop assemblies, curb stop assemblies, meters, meter setting equipment, service saddles, backflow preventers, and accessories.
   2. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
   3. Manufacturer Instructions: Submit detailed instructions on installation requirements, including storage and handling procedures.

C. Action Submittals:
   1. Test Reports: Submit all the results of the bacteriological tests to the CFPUA Engineering Inspector.
   2. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.
   3. Qualifications Statement:
      a. Submit qualifications for manufacturer.

1.5 CLOSEOUT SUBMITTALS

A. Section 01 70 00 – Execution and Closeout Requirements.

B. Project Record Documents: Record actual locations of piping mains, curb stops, connections, thrust restraints, pressure-pipe centerline elevations, and gravity-pipe invert elevations.

C. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

1.6 QUALITY ASSURANCE

A. Qualifications:
   1. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum three years' documented experience.

B. Perform Work according to CFPUA standards and details.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 – Product Requirements.

B. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.

C. Store materials according to manufacturer instructions.

D. Protection:
   1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
   2. Provide additional protection according to manufacturer instructions.

PART 2 PRODUCTS

2.1 MATERIAL SPECIFICATION MANUAL

A. Refer to CFPUA Material Specification Manual (MSM) for the following products:

MSM No.	Product
A	Polyethylene Service Tubing
F	Service Saddles/ Hinged Type for 2” PVC
F	Service Saddles/ Brass Alloy/ Stainless Steel Straps for Cast, Ductile & PVC Pipe
F	Service Saddles/ Ductile Iron/ Stainless Steel Straps for Cast, Ductile & PVC Pipe
F	Service Saddles/ Ductile Iron/ Stainless Steel Straps for HDPE Pipe
F	Service Saddles/ Hinged Type for 2” HDPE
G	Inline Valves
G	Straight Couplings (3/4" X 1”)
G	Straight Couplings (1”)
G	Meter Setters (5/8" X 3/4" Meter)
G	Meter Setters (1" Meter)
G	Meter Setters (1 1/2"& 2” Meter)
G	Dual Service U-Branch (5/8" X 3/4" Meter)
G	Dual Service U-Branch (1" METER)
G	Curb Stop Assemblies
J	Meter Box (5/8”, 3/4", & 1”) Single Service Non-Traffic Areas
J	Meter Box (5/8”, 3/4", & 1”) Dual Service Non-Traffic Areas
J	Meter Box (5/8”, 3/4", & 1”) Single Service Traffic Rated
J	Meter Box (5/8”, 3/4", & 1”) Dual Service Traffic Rated
J	Meter Box (1 1/2", & 2”) Single Service Non-Traffic Areas
J	Meter Box (1 1/2", & 2”) Single Service Traffic Rated
J	Lid Details (5/8”, 3/4", & 1”) Single Service Non-Traffic Areas
J	Lid Details (5/8”, 3/4", & 1”) Dual Service Non-Traffic Areas
J	Lid Details (5/8”, 3/4", & 1”) Single Service Traffic Rated
J	Lid Details (5/8”, 3/4", & 1”) Dual Service Traffic Rated
J	Lid Details (1 1/2" & 2”) Single Service Non-Traffic Areas
J	Lid Details (1 1/2" & 2”) Single Service Traffic Rated
L	Tracer Wire (Solid Copper)
L	Direct Bury Wire Splice Kit

2.2 CURB STOP ASSEMBLIES

A. For ⅝-inch through 2-inch services provide a CTS inlet X Female iron pipe thread curb stop on CTS line 3” from inlet of meter setter.

2.3 WATER METERS SINGLE SERVICE

A. Meter box shall be installed flush with grade. Box shall be sized and centered around the meter assembly to allow for access and future maintenance.

2.4 DUAL SERVICE

A. Meter box shall be installed flush with grade. Box shall be sized and centered around the meter assembly to allow for access and future maintenance.

B. U-branch shall be installed prior to meter setter.

C. Meter setter shall be installed to allow three (3) to six (6) inches from top of meter from bottom of lid.

D. Meter setter shall be installed in the upright position.

2.5 MATERIALS

A. Bedding: As specified in Section 31 23 34.01 – Excavating, Trenching, Dewatering and Backfilling.

B. Cover: As specified in Section 31 23 34.01 – Excavating, Trenching, Dewatering and Backfilling.

C. Soil Backfill from Above Pipe to Finish Grade: As specified in Section 31 23 34.01 – Excavating, Trenching, Dewatering and Backfilling.

PART 3 EXECUTION

3.1 EXAMINATION

A. Section 01 70 00 – Execution and Closeout Requirements.

B. Verify that building service connections and municipal utility water main sizes, locations, and inverts are as indicated on Shop Drawings.

3.2 PREPARATION

A. Section 01 70 00 – Execution and Closeout Requirements.

B. Cut pipe ends square, ream pipe and tube ends to full pipe diameter, and remove burrs.

C. Remove scale and dirt from inside and outside of piping before assembly.

3.3 INSTALLATION

A. 1-inch Service Corporation Stop Assemblies:
   1. Make connection for each different kind of water main, using suitable materials, equipment, and methods as approved by Engineer.
   2. Provide service clamps for mains constructed of materials other than cast iron or ductile iron.
   3. Location:
      a. Locate and stagger corporation stops at least 36 inches apart longitudinally.
   4. Plastic Pipe Mains:
      a. Provide full support for service clamp for full circumference of pipe, with minimum 2-inch width of bearing area.
      b. Exercise care against crushing or causing other damage to mains at time of tapping or installation of service clamp or corporation stop.

5. Use seals or other devices such that no leaks are present in mains at points of tapping.
6. Do not backfill and cover service connections until installation has been approved by Engineer and CFPUA inspector.

B. Bedding:
   1. Excavate pipe trench as specified in Section 31 23 34.01 – Excavating, Trenching, Dewatering, and Backfilling.
   2. Placement:
      a. Place bedding material as indicated on Drawings.
      b. Level fill materials in one continuous layer not exceeding 8 inches of compacted depth.
      c. Compact to 95 percent maximum density.
   3. Place fill materials as specified in Section 31 23 34.01 – Excavating, Trenching, Dewatering and Backfilling.

C. Pipe and Fittings:
   1. Maintain separation of water main from **sewer piping** according to code.
   2. Group piping with other Site piping Work whenever practical.
   3. Install pipe to allow for expansion and contraction without stressing pipe or joints.
   4. Install access fittings to permit disinfection of water system.
   5. Jointing of Pipe:
      a. Connections between different types of pipe and accessories shall be made with transition fittings approved by CFPUA's representative.
      b. Service laterals shall consist of a tapping saddle, corporation stop and a length of PE pipe with no joint installed between the main service tap and the service stop. Service laterals shall be installed perpendicular to the water main. Contractor shall install all material per the CFPUA Material Specification Manual allowing for meter installation at a later date by CFPUA personnel. Locator wire shall be installed as per specifications.
   6. Thrust Restraints: Form and place concrete for thrust restraints at each elbow or change of direction of pipe.
   7. Establish elevations of buried piping with not less than three (3) feet of cover.
   8. Pipe Markers: According to CFPUA MSM.
   9. Backfill trench as specified in Section 31 23 34.01 – Excavation, Trenching, Dewatering and Backfill for Pipes.

D. Curb Stop Assemblies:
   1. Set curb stops on 95% compacted soil.

E. Water Meters: 2-inch and smaller shall be set by CFPUA.

F. Backflow Preventers:
   1. Install backflow preventers where indicated on Drawings and according to manufacturer instructions.
   2. Testing and Installation Requirements: Comply with CFPUA requirements and plumbing codes, see CFPUA's website under Departments, Environmental Management – Backflow and Cross Connections.

G. Service Connections:

1. Install water service according to as indicated on Drawings.
2. Install water service to 18” of right-of-way and connect to building water service as specified in CFPUA details and referenced in CFPUA Material Specification Manual.
3. All meters installed on lines greater than 2-inch diameter must have a strainer and be installed in an appropriately sized, approved meter vault that provides sufficient access for reading, maintenance, and protection in accordance with Water Meter Vaults specification.

H. Service Intended for Fire Protection:
1. Two taps shall be installed, one for potable water and one for fire flow. The potable water tap shall be installed and metered in accordance with this Section. The fire flow tap shall not be metered, and the fire flow system shall be fully segregated from the potable system throughout the facility. A valve will be installed at the tap and the right-of-way or easement line denoting the CFPUA owned/privately owned boundary. A privately owned, privately maintained backflow prevention device shall be installed in the line immediately after entering a structure in accordance with the North Carolina State Building Code and the CFPUA Cross Connection Control Ordinance.

I. Pipe Locator Wire: As specified in Section 33 01 12 – Identification for Utilities Piping.

J. Disinfection of Water Piping System: Flush and disinfect system as specified in Section 33 14 20 – Disinfection of Water Distribution Mains.

3.4 TOLERANCES

A. Install pipe to indicated elevation to within tolerance of 1-inch.

3.5 FIELD QUALITY CONTROL

A. Section 01 40 00 – Quality Requirements.

B. Pressure test water distribution system according to Section 33 05 05.31– Hydrostatic Testing of Water Distribution and Sanitary Sewer Force Mains.

C. If tests indicate Work does not meet specified requirements, remove Work, replace, and retest.

END OF SECTION

SECTION 33 14 20

DISINFECTION OF WATER PIPELINES, FACILITIES AND APPURTENANCES

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Essential procedures for disinfecting new and repaired water mains. All new water mains, services, and appurtenances shall be disinfected before they are placed in service. All water mains taken out of service for inspection, repair, or other activities shall be disinfected before they are returned to service.
   2. Testing and reporting of results.

B. Each unit of constructed water main, services, and appurtenances shall be disinfected with chlorine upon successful completion of the hydrostatic test. The disinfection procedure shall be performed in strict conformance with Cape Fear Public Utility Authority (CFPUA) procedures for disinfecting water mains, as outlined in paragraphs 3.2 and 3.3 of this Section.

C. Related Requirements:
   1. CFPUA Material Specification Manual (MSM).
   2. Section 33 14 13 – Water Distribution Piping and Appurtenances.
   3. Section 33 14 14 – Public Water Service Connections.
   4. Section 33 14 13 – Water Distribution Valves and Fire Hydrants.

1.2 REFERENCE STANDARDS

A. American Water Works Association:
   1. AWWA B300 – Hypochlorites.
   2. AWWA C651 – Disinfecting Water Mains.
   3. AWWA M12 – Simplified Procedures for Water Examination.
   4. APHA, AWWA, WEF – Standard Methods for the Examination of Water and Wastewater.

B. North Carolina Public Water Supply:
   1. NCPWS Rules Governing Public Water Systems Section .1000 – Disinfection of Water Supply Systems.

1.3 ADMINISTRATIVE REQUIREMENTS

A. Any event requiring a CFPUA representative to be present will require a two-business day notice to schedule the event.

B. No valves are to be operated unless a CFPUA representative is present. Any valves operated without a CFPUA representative present, or a directive may be subject to penalties in accordance with CFPUA's Ordinance.

C. The Contractor shall pay particular attention to the scheduling requirements outlined in the procedures. The Contractor shall be responsible for furnishing and installing all required chlorine injection and monitoring ports at no additional cost to CFPUA.

D. The mains will in no case be accepted by CFPUA for public use until the CFPUA Engineer approves the mains as having been properly disinfected.

1.4 SUBMITTALS

A. Section 01 33 00 – Submittal Procedures.

B. Submittals:
   1. Product Data: Submit manufacturer information for proposed chemicals and treatment doses.
   2. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
   3. Disinfection Procedure: Submit description of procedure, including type of disinfectant and calculations indicating quantities of disinfectants required to produce specified chlorine concentration.
   4. Certify that final water complies with disinfectant quality standards of CFPUA.
   5. Test and Evaluation Reports: Indicate testing results comparative to specified requirements. All lab reports shall be from certified lab and submitted to CFPUA representative.
   6. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

1.5 CLOSEOUT SUBMITTALS

A. Section 01 70 00 – Execution and Closeout Requirements.

B. Disinfection Report:
   1. Type and form of disinfectant used.
   2. Date and time of disinfectant injection start and completion.
   3. Test locations.
   4. Name of person collecting samples.
   5. Initial and 24-hour disinfectant residuals in treated water in ppm for each outlet tested.
   6. Date and time of flushing start and completion.
   7. Disinfectant residual after flushing in ppm for each outlet tested.

1.6 QUALITY ASSURANCE

A. Perform Work according to AWWA C651.

B. QUALIFICATIONS
   1. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum three years' documented experience.
   2. Applicator: Company specializing in performing Work of this Section with minimum three years' documented experience.

PART 2 PRODUCTS

2.1 DISINFECTION CHEMICALS

A. Chemicals:
   1. Calcium hypochlorite: Comply with AWWA B300.
   2. Sodium hypochlorite: Comply with AWWA B300.

2.2 CHLORINE RESIDUAL TEST KITS

1. Test kits shall use methodology conforming with *Standard Methods for the Examination of Water and Wastewater* or AWWA Manual M12.
2. Manufacturers:
   a. Hach Company.
   b. LaMotte.
   c. Fisher Scientific.
   d. Hellige.
   e. Or equal.

PART 3 EXECUTION

3.1 PREVENTIVE AND CORRECTIVE MEASURES DURING CONSTRUCTION

Heavy particulates generally contain bacteria and prevent even very high chlorine concentrations from contacting and killing such organisms. It is, therefore, essential that the procedures of this section be observed to assure that a water main and its appurtenances are thoroughly clean for the final disinfection by chlorination. Also, any connection of a new water main to the active distribution system prior to receipt of satisfactory samples may constitute a cross-connection. Therefore, the new main must be isolated until all bacteriological and other tests are satisfactorily completed.

A. KEEPING PIPE CLEAN AND DRY: Precautions shall be taken to protect the interiors of pipes, fittings, and valves against contamination. Pipe delivered for construction shall be strung so as to minimize the entrance of foreign material. All openings in the pipeline shall be closed with watertight plugs when work is stopped at the end of the day or for other reasons.

B. JOINTS: Joints of all pipes in the trench shall be completed before work is stopped. If water accumulates in the trench, the plugs shall remain in place until the trench is dry.

C. PACKING MATERIAL: All packing material shall consist of molded or tubular rubber rings, or other approved material. Lead or asbestos material in any form shall not be permitted.

D. SEALING MATERIALS: No contaminated material or any material capable of supporting prolific growth of microorganisms shall be used for sealing or lubricating joints. Sealing and lubricating material or gaskets shall be handled in a manner that avoids

contamination. The lubricant used in the installation of sealing gaskets shall be suitable for use in potable water. It shall be delivered to the job in closed containers and shall be kept clean. Soil conditions could warrant the upgrade of gasket material to a volatile resistant material.

E. CLEANING OF PIPE AND APPURTENANCES: If dirt enters the pipe, it shall be removed, and the interior pipe surface cleaned. If, in the opinion of the CFPUA representative, the dirt remaining in the pipe will not be removed by the flushing operation, then the interior shall be cleaned by mechanical means such as a hydraulically propelled foam pig or another suitable device. The cleaning method used shall not force mud or debris into the interior pipe joint spaces and shall be acceptable to CFPUA.

F. FLOODING BY STORM OR ACCIDENT DURING CONSTRUCTION: If the main is flooded during construction, it shall be cleared of the floodwater by draining and flushing with potable water until the main is clean. The section of pipeline shall be flushed until water from the pipe runs clear.

3.2 EXAMINATION

A. Section 01 70 00 – Execution and Closeout Requirements.

B. Chlorination Planning:
   1. Before calling the CFPUA office for a time to be set up for disinfection, all of the following shall be installed or supplied by the Contractor at no cost to CFPUA. This list shall be checked and/or assembled before the CFPUA Engineering personnel arrive.
      a. A valve may be required to be installed in the line to be disinfected near the CFPUA water main connection.
      b. A blowoff of a brass or approved material faucet may be required to be installed at the dead end of the line, at all closed valves, and every 1,200 feet to be disinfected for flushing purposes and bacteria sampling. The opening to this blowoff should point downward, and there should be at least twenty-four inches clearance between the opening and the ground for proper sampling.
      c. Mains connecting other mains with open valves within the system to be disinfected may cause “short circuits” resulting in improper disinfection. Valves on these connecting mains shall be checked to see if they should be closed to eliminate this problem. Blowoffs should be at both sides of valves closed to prevent “short circuits”.
      d. Successful hydrostatic testing and CFPUA acceptance of said testing of the line is required before disinfection procedures.
      e. A clean container shall be used to mix and/or dissolve the hypochlorite.
      f. A clean, new wooden mixer shall be present for mixing and dissolving the hypochlorite.
      g. A pump for pumping the chlorine solution into the line shall be present. This pump shall be gasoline or electrically powered chemical feed pump designed for feeding chlorine solutions. For small applications, the solutions may be fed with a hand pump, for example, a hydraulic test pump. Feed lines shall be of such material and strength as to withstand safely the maximum pres-

sures that may be created by the pumps. All connections shall be checked for tightness before the hypochlorite solution is applied to the main.

h. All temporary blowoffs and injection points shall be properly abandoned and physically disconnected when directed by CFPUA prior to the line being placed into service.

C. Verify that access fittings have been installed under Section 33 14 13 – Water Distribution Piping and Appurtenances.

D. Perform scheduling and disinfecting activity with startup, water pressure testing, adjusting, and balancing, and demonstration procedures, including coordination with related systems.

3.3 DISINFECTION PROCEDURE FOR NEW WATER MAINS AND FIRELINES

A. Provide required equipment to perform Work of this Section.

B. Method of Chlorination:

1. Use the continuous feed method for disinfection of all new water mains. This method must give a minimum of 10 mg/L of chlorine residual at the end of the 24-hr period.
    a. Continuous-Feed Method**:** The continuous-feed method is the process in which a concentrated solution of chlorine is injected into the water main. Caution shall be observed during the handling and injection of the chlorine solution as chlorine in any form is very toxic and any error could be harmful to the employees and to the public.
    b. Preliminary Flushing: Before chlorine solutions are injected, the main shall be filled with potable water to eliminate air pockets and shall be flushed to remove particulates. The flushing velocity in the main shall not be less than 3.0 ft/sec (preferably 3.5 ft/sec) unless the CFPUA representative determines that conditions do not permit the required flow or that the flow will cause undue problems when discharged to waste. An acceptable flushing velocity shall then be determined and used.
    c. Procedure for Chlorinating the Main:
        1) Water supplied from the existing distribution system or other Approved public water supply shall be made to flow at a constant, measured rate into the newly installed water main. In the absence of a meter, the rate may be approximated by Approved method.
        2) At a point, not more than 10 ft downstream from the beginning of the new main, water entering the new main shall receive a dose of chlorine fed at a constant rate such that the water will have not less than 50 mg/L and not greater than 100 mg/L free chlorine residual. To ensure that this concentration is provided, measure the chlorine concentration at regular intervals of distance and time in accordance with the procedures described in the current edition of *Standard Methods for the Examination of Water and Wastewater* or AWWA Manual M12, or by using Approved chlorine test kits.
        3) During the application of the chlorine, valves shall be adjusted by or under the supervision of the CFPUA representative to prevent the chlorine solution from entering the existing water system. The chlorine injection

shall not cease until the entire water main is filled with a chlorine concentration of not less than 50 mg/L. All appurtenances and valves shall be operated to ensure that the chlorine solution has contact with them. The chlorinated water shall be allowed to remain for a period of not less than 24-hours.

4) At the end of the 24-hour period, the chlorine residual shall be measured and shall not be less than 10 mg/L in any samples collected along the water main and at the end of said water main.

C. Final Flushing:
   1. Clearing the Main of Highly Chlorinated Water: Highly chlorinated water shall not remain in prolonged contact with pipe. At the end of the 24-hour contact period, the water shall be removed in order to prevent damage to the pipe lining or corrosion damage to the pipe itself. The highly chlorinated water shall be flushed from the main until chlorine measurements show that the concentration in the water leaving the main is no higher than that generally prevailing in the distribution system.
   2. Disposing of Highly Chlorinated Water: A neutralizing chemical shall be applied to the chlorinated water to be discharged to neutralize thoroughly the chlorine residual. Chlorine residual of water being disposed shall be neutralized by treating with one of the chemicals listed below:
      a. Ascorbic Acid
      b. Sodium Ascorbate
      c. Sulfur Dioxide
      d. Sodium Bisulfate
      e. Sodium Sulfite
      f. Sodium Thiosulfate

D. Bacteriological and Other Tests:
   1. Standard Conditions: After final flushing and before the new main is opened to the distribution system, two consecutive sets of acceptable samples, taken at least 24-hours apart, shall be collected from the new main. Samples shall be collected from every 1,200-ft of new water main, from the end of the water line, and from each branch. All samples shall be tested in accordance with *Standard Methods for the Examination of Water and Wastewater*. All samples shall show the absence of coliform organisms, and a free chlorine residual equal to the level present in the existing system and shall have no visible color or particulate matter. **Must be submitted in the form of an official report by a certified lab.**
   2. Special Conditions: If in the opinion of CFPUA, excess contamination has been allowed to enter the water main during construction or other events, bacteriological samples shall be taken at intervals of approximately 400 to 500 ft and shall be identified by location. Samples shall be taken of water that has stood in the new main for at least 16 hours after final flushing has been completed.
   3. Sampling Procedures: Sample collection shall be in accordance with *Standard Methods for the Examination of Water and Wastewater*. A copper or PVC assembly or a combination blowoff and sampling tap may be used for mains up to 8-inches diameter. Fire hydrants may not be used for sampling purposes. After samples have been collected, analyzed, and accepted, the sampling assemblies may be removed and retained for future use. All bacteriological analysis must be completed by a N.C. certified Drinking Water laboratory. The utility contractor

shall be responsible for all costs associated with the sampling and analysis of all samples required for acceptance. **All Lab Reports shall be delivered to the CFPUA Representative before any activation can proceed.**

E. Replace permanent system devices that were removed for disinfection.

3.4 DISINFECTION PROCEDURE FOR REPAIRED WATER MAINS

A. The following procedures apply primarily when mains are wholly or partially dewatered. After the appropriate repair procedures have been completed, the existing main may be returned to service prior to completion of the bacteriological testing to minimize the time customers are out of water. Leaks or breaks that are repaired with clamping devices while the mains remain full of water under pressure present little danger of contamination and require no disinfection.

B. The following procedure is considered as a minimum that may be used.
   1. Swabbing with Hypochlorite Solution: The interior of all pipe and fittings used in making repair (particularly couplings and tapping sleeves) shall be swabbed with a five (5) percent hypochlorite solution (300 mg/l concentration) before they are installed.
   2. Flushing: Thorough flushing is the most practical means of removing contamination introduced during repairs. If valve and hydrant locations permit, flushing toward the work location from both directions independently is recommended. Flushing shall be started as soon as the repairs are completed and shall be continued until discolored water and particulate matter are eliminated.
   3. Slug Chlorination: When practical, in addition to the procedures above, the section of main in which the break is located shall be isolated, all service connections shut off, and the section flushed and chlorinated with a high concentration of chlorine (as much as 300 mg/L), and the concentration allowed to stay in contact with the main for a minimum of 15 minutes. After chlorination, flushing shall be resumed and continued until discolored water is eliminated and the water is free of noticeable high chlorine odor. A chlorine residual of no greater than 3.0 mg/L shall be acceptable.
   4. Sampling: Bacteriological samples shall be taken after repairs are completed to provide a record for determining the procedure's effectiveness. If the direction of flow is known, sample locations shall be determined. If the direction of flow is unknown, then samples shall be taken on each side of the main break. If bacteriological samples are unacceptable, the CFPUA representative shall determine corrective action. Daily sampling shall be continued until two successive daily samples are acceptable.

3.5 REPEAT DISINFECTION OF WATER MAIN

A. If the initial disinfection fails to produce satisfactory results as per specifications, the new main shall be reflushed, rechlorinated and resampled; CFPUA may also require further cleaning methods (i.e., pigging the line) if the disinfection fails twice. If check samples also fail to produce acceptable results, the new main shall be reflushed and rechlorinated by the continuous-feed method of chlorination until satisfactory results are obtained.

B. High velocities in the existing system, resulting from flushing the new main may disturb sediment that has accumulated in the existing mains. When check samples are taken, it is advisable to also sample water entering the new main.

3.6 CONNECTION TO EXISTING SYSTEM

A. The NCPWS certifications, final acceptance, opening of valves and activation of the existing water system will only be allowed after satisfactory samples and chlorine levels have been produced. All sampling devices and blowoffs must be removed from the water main by the contractor prior to acceptance by CFPUA. The CFPUA Operations Department will activate the system when their procedures are completed.

3.7 FIELD QUALITY CONTROL

A. Section 01 70 00 – Execution and Closeout Requirements.

END OF SECTION

SECTION 33 31 11

SANITARY SEWER GRAVITY MAINS

PART 1 GENERAL

1.1 DESCRIPTION

A. Section Includes Installation of:
   1. Pipe and fittings for sewer gravity mains.
   2. Gasket materials, couplings and other gravity main appurtenances.

B. Related Requirements:
   1. CFPUA Material Specification Manual (MSM).
   2. Section 01 50 00 – Bypass Pumping.
   3. Section 03 05 00 – Concrete.
   4. Section 31 23 34 – Excavation, Trenching, Dewatering and Backfilling.
   5. Section 33 01 12 – Identification for Utilities Piping
   6. Section 33 14 22 – Testing of Gravity Sewer Mains and Manholes.
   7. Section 33 05 13 – Precast Concrete Manholes and Utility Structures.
   8. Section 33 05 07.13 – Utility Horizontal Directional Drilling.
   9. Section 33 05 07.23 – Jacking and Boring Pipe Construction.

1.2 REFERENCE STANDARDS

A. American Water Works Association:
   1. AWWA C105 - Polyethylene Encasement for Ductile-Iron Pipe Systems.
   2. AWWA C111 – Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
   3. AWWA C115 - Flanged Ductile-Iron Pipe with Ductile-Iron or Gray-Iron Threaded Flanges.
   4. AWWA C116 – Protective Fusion-Bonded Coatings for the Interior and Exterior Surfaces of Ductile-Iron and Gray Iron Fittings.
   5. AWWA C151 – Ductile-Iron Pipe, Centrifugally Cast.
   6. AWWA C153 – Ductile-Iron Compact Fittings.
   7. AWWA C600 – Installation of Ductile Iron Mains and Their Appurtenances.
   8. AWWA C605 – Underground Installation of Polyvinyl Chloride (PVC) and Molecularly Oriented Polyvinyl Chloride (PVCO) Pressure Pipe and Fittings.
   9. AWWA C900 – Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 In. Through 60 In. for Water Transmission and Distribution.
   10. AWWA C906 – Polyethylene Pressure Pipe and Fittings, 4-In. Through 65-In. for Waterworks.

B. ASTM International:
   1. ASTM D698 – 12e2 Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3)).
   2. ASTM D1557 – 12e1 Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3 (2,700 kN-m/m3)).
   3. ASTM D1785 – Standard Specification for Poly (Vinyl Cloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.

4. ASTM D2241 – Standard Specification for Poly Vinyl Chloride (PVC) Pressure-Rated Pipe (SDR Series).
5. ASTM D6938 – Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).
6. ASTM F477 - Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.

1.3 ADMINISTRATIVE REQUIREMENTS

A. Section 01 30 00 – Administrative Requirements

B. Coordination:
   1. Coordinate Work of this Section with connection to CFPUA and trenching.
   2. The existing system must be kept in operation at all times. Where connections are made to existing mains or other shutdowns are necessary, permission must be obtained and arrangements must be made with the CFPUA Wastewater Collections ORC, Utility Services Division for removing from service those mains that will be affected.
   3. Notify CFPUA no less than two business days prior to an event requiring a CFPUA representative to be present.
   4. The Contractor shall, at least two (2) business days in advance, notify citizens subject to interruption of service by means of door hangers or any other approved method of the starting time and duration of such interruption.
   5. Bypass pumping and hauling operations may be required to interrupt service. A bypass pumping plan shall be submitted in accordance with Section 01 50 00 – Bypass Pumping. Shutdowns must be held to a minimum in both number and duration.

1.4 SUBMITTALS

A. Section 01 33 00 – Submittals: Requirements for submittals.

B. Product Data/Source Quality:
   1. Manufacturer’s literature and specifications, as applicable, for products specified in this Section.
   2. Shop test results and inspection data, certified by manufacturer.

C. Testing Procedures:
   1. Submit proposed testing procedures, methods, apparatus, and sequencing. Obtain ENGINEER’s approval prior to commencing testing.

D. Manufacturer Instructions:
   1. Submit manufacturer's instructions for handling, storing, and installing pipes and appurtenances.

E. Manufacturer Certificates:
   1. Certificates of compliance with referenced standards, where applicable, including those of AWWA and others required by Engineer.

F. Field Quality Control Submittals:
   1. Results of Contractor furnished testing and inspections.

1.5 CLOSEOUT SUBMITTALS

A. 01 70 00 – Execution and Closeout Requirements

B. Project Record Documents:
   1. Maintain accurate and up-to-date record documents showing modifications made in the field, in accordance with approved submittals, and other Contract modifications relative to buried piping Work.

   2. Record actual locations and elevations of piping mains, valves, hydrants, manholes, service laterals, cleanouts, connections, thrust restraints, and other utilities found and not indicated on design plans.

C. Operations and Maintenance Data:
   1. Furnish in operations and maintenance manuals complete data for materials in accordance with 01 60 00 - Product Requirements.

1.6 QUALITY ASSURANCE

A. Qualifications: Company specializing in manufacturing products specified in the CFPUA Materials Specification Manual.

B. Perform Work according to AWWA and PVC Pipe Association standards.

C. The bell ends of pipe shall face the direction of laying unless otherwise directed by the Engineer, for lines on appreciable slope, the Engineer may require that bell ends face upgrade.

D. All stainless-steel fasteners shall be 316.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 – Product Requirements.

B. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.

C. Storage:
   1. Store materials according to manufacturer instructions.
   2. Block individual and stockpiled pipe lengths to prevent moving.
   3. Do not place pipe or pipe materials on private property or in areas obstructing pedestrian or vehicle traffic.
   4. Store PE and PVC materials out of sunlight.

D. Protection:
   1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
   2. Provide additional protection according to manufacturer instructions.

1.8 SITE CONDITIONS

A. Field Measurements:
   1. Verify field measurements prior to fabrication.
   2. Indicate field measurements on Shop Drawings.
   3. A minimum of ten-foot utility easement must be provided along the frontage of all lots and as shown for new developments.

1.9 WARRANTY

1. Section 01 70 00 – Execution and Closeout Requirements.

PART 2 PRODUCTS

2.1 CFPUA MATERIALS SPECIFICATION MANUAL

A. Refer to CFPUA Material Specification Manual (MSM) for the following products:

MSM Section	Material
A	Pipe
B	Fittings and Accessories
C	Joint Restraints
I	Castings & Aluminum Access Covers
K	Miscellaneous
L	Electrical
M	Coatings and Sealants
N.	Concrete

2.2 MATERIALS & ACCESSORIES

A. Bedding, Cover, and Backfill:
   1. As specified in Section 31 23 34.01 – Excavating, Trenching, Dewatering and Backfilling.

B. Manholes:

   1. As specified in Section 33 05 13 – Precast Concrete Manholes and Utility Structures.

PART 3 EXECUTION

3.1 EXAMINATION

A. Section 01 70 00 – Execution and Closeout Requirements.

B. Identify required lines, levels, contours, and datum locations.

C. Determine exact location and size of water mains, valves, hydrants, and appurtenances from Drawings.

D. Verify location and elevation of existing facilities prior to excavation and installation of proposed gravity sewer mains and services.

3.2 PREPARATION

A. Section 01 35 00 – Special Procedures
   1. Pre-construction Site Audio/Video Inspections and Photography:
   2. Show mailboxes, curbing, lawns, driveways, signs, culverts, and other existing Site features.

B. Section 01 70 00 – Execution and Closeout Requirements.

C. All materials, unless otherwise directed, shall be unloaded as nearby as possible to the location of installation by the Contractor. Materials shall be handled with care to avoid damage.

D. All materials found during the progress of work to have flaws, cracks, or other defects will be rejected by the Engineer regardless of whether or not it has been installed and shall be replaced by and at the expense of the Contractor.

E. All PVC pipe, upon delivery to the site and until such time as it is placed in the trench, shall be shielded from the weather and direct sunlight to prevent pipe deterioration.

F. Slings, hooks, or tongs used for lifting shall be padded in such a manner as to prevent damage to exterior surfaces, interior linings and components. If any part of the coating, lining or components is damaged, the repairs or replacement shall be made by the Contractor at his expense and in a manner satisfactory to the Engineer prior to attempting installation.

G. Pipe Cutting:
   1. Cut pipe ends square, ream pipe and tube ends to full pipe diameter, and remove burrs.
   2. Use only equipment specifically designed for pipe cutting; use of chisels or hand saws is not permitted.
   3. Grind edges smooth with beveled end for push-on connections.

H. Remove scale and dirt on inside and outside before assembly.

3.3 INSTALLATION

A. Placement: As specified in Section 31 23 34.01 – Trenching, Excavation, Dewatering and Backfilling.
   1. All mains shall be laid and maintained at the required lines and grades with fittings and appurtenances at the described locations. All pipe shall be laid to the depth as shown on the drawings, or when a depth is not indicated, with a minimum cover of thirty-six (36) inches unless otherwise shown or approved by engineer. Grade lines shall be set by the Contractor. Realignments must be approved by the

Engineer. The Contractor shall have suitable survey equipment on the site at all times.

2. After placement in the trench the spigot end of the pipe shall be centered in the bell and the pipe shall be driven home and then brought to the proper line and grade by tamping approved backfill material under it, except for the bell. Joint deflection shall not exceed manufacturer's limit.
3. The Work shall at all times progress with caution so as to prevent damage to underground obstructions both known and unknown. Should an obstruction not shown on the drawings be encountered, the Engineer shall be immediately notified, and he shall be responsible for alteration to the design should realignment be necessary. Notify the Engineer far enough in advance to allow the realignment to be accomplished by deflection in the pipe joints.

B. Pipe and Fittings
   1. Handle and assemble pipe according to manufacturer instructions.
   2. Install pipe and fittings in strict conformance with AWWA C600 and C605.
   3. Joint Deflection: Maximum joint deflection shall meet requirements of AWWA C600, C605 or AWWA Manual of Practice M23.
   4. Prevent foreign material from entering pipe during placement and Work stoppages using plugs designed for that purpose. If trench contains standing water in joining zone, plug shall remain in place until the trench has been pumped dry before proceeding pipe laying.
   5. Allow for expansion and contraction without stressing pipe or joints.
   6. Solvent epoxy cementing, electro-fusion couplings and mechanical joining with bolt on wrap around clamps or mechanical joints without an adapter shall not be used for connections.

C. Push-On Joints
   1. The inside of the bell and the outside of the spigot end shall be thoroughly cleaned to remove dirt, grit, oil or excess coatings and other foreign matter. For ductile iron pipe, the gasket shall be flexed inward and inserted in the gasket recess of the bell socket.
   2. A thin film of gasket lubricant shall be applied to either the inside surface of the gasket or the spigot ends, care will be taken to avoid contact with the ground.
   3. The joint shall be completed by forcing the plain end to the bottom of the socket with a forked tool or jacking device or other approved method. All pipe shall have depth mark prior to insertion. Pipe cut in the field shall be filed to resemble the spigot end of manufactured pipe.
   4. When deflection is required the joint shall be completed prior to setting the deflection. The deflection shall conform to applicable AWWA Standards or manufacturer's recommendation.

D. Mechanical Joints
   1. The inside of the socket, the outside of the spigot end and the gland shall be thoroughly cleaned and or washed with an approved solution to remove dirt, grit, oil or excess coatings and foreign matter to improve gasket seating.
   2. The gland shall then be placed on the plain end of the pipe with the lip extension toward the plain end, followed by the gasket with the narrow edge of the gasket toward the plain end of the pipe.

3. The pipe shall be inserted into the socket and the gasket pressed firmly and evenly into the gasket recess. The joint shall be kept straight during the assembly and any deflection required shall be done after the joint has been assembled but prior to tightening the bolts.

E. Polyethylene Encasement
   1. Polyethylene (PE) encasement when indicated for ductile iron pipe and fittings:
   2. Encase piping in PE as indicated on Drawings to prevent contact with surrounding soil material or insulation from adjacent cathodic protection system.
   3. Comply with AWWA C105.

F. Transition from One Type of Pipe to Another
   1. Provide necessary adapters, special, and connection pieces required when connecting different types and sizes of pipe or connecting pipe made by different manufacturers.
   2. Sewer service laterals shall be connected in accordance with Cape Fear Public Utility Authority Standard Drawing Details.
   3. No flexible couplings shall be used.

G. Pipe Restraint
   1. Provide restraint on ductile iron piping systems where shown or indicated in the Contract Documents below but not limited to:
      a. All ductile iron pipe aerial crossings and carrier pipes with any joints supported on pier or inside an encasement pipe shall require the use of a rigid joint restraint.
      b. All ductile iron pipe carrier pipes installed with joints inside an encasement pipe must utilize rigid restrained joints.

H. Service Connections
   1. In new sewer construction, PVC service connections shall be made by means of a wye, DIP service connections shall be made by means of a wye or a tee. All joints connected to the wye unit shall remain flexible.
   2. Service pipe for all properties shall be laid to the property line and plugged, as shown on the Standard Details. All sewer services shall be installed perpendicular to the main and terminate at the Right-Of-Way line. Sewer services in Cul-De-Sacs are required to be perpendicular or must originate in end of line manhole and terminate at Right-of-Way, no acute angles to downstream main.
   3. All services tying into ductile iron mains shall be constructed of class 50, DIP with Protecto 401 ceramic epoxy lining.
   4. Cleanouts shall be located a minimum of 6 feet from all property corners. Water meter boxes are to be a minimum of 5 feet from the property corner.
   5. In cases of extra depth where service pipe cannot be laid on a continuous grade to the property line, the Contractor shall construct risers as shown on the Plans. When pipe cannot be adequately supported on undisturbed earth, it shall be supported on a concrete cradle.
   6. Trench and backfill or bore to install lateral. Bore shall accommodate pipe without void around pipe. Bore shall be at least 5’ from the edge of pavement or back of curb on either side of the roadway unless approval to the contrary is given by the engineer.
   7. Connect lateral with wye.

8. Install sewer lateral with plug and one-way clean-out. Clean-out shall consist of a ¼ bend long sweep, with the necessary vertical 4" Schedule 40 PVC/DWV pipe stack. The clean-out plug shall be installed into a cast iron box and cover.

I. Service Reconnections
   1. Service reconnections require adapters for all joints that will not connect properly with ordinary factory joints. Approved pipe cutting methods shall be used to cut any pipe required for the connection. No mortar or collars shall be used on reconnections unless specifically approved by the Engineer.
   2. No flexible couplings shall be used.

J. Joining New Pipe to Old Pipe
   1. Joining PVC pipe to existing vitrified clay pipe requires an adapter approved in the Cape Fear Public Utility Authority's Materials Specification Manual for all joints that will not connect properly with ordinary factory joints. Approved pipe cutting methods must be used to cut any pipe required for the connection. No mortar or collars shall be used for such connections unless approved by the Engineer.
   2. No flexible couplings shall be used.

K. Joining Pipe to Manholes or Other Structures
   1. All manhole connection holes shall be core drilled with a maximum hole diameter not to exceed one and a half times the pipe diameter.
   2. Approved standard groutable PVC-to-manhole fitting approved in the Cape Fear Public Utility Authority's Materials Specification Manual, or a flexible rubber boot may also be used at the manhole connection. The connection at the manhole wall shall be flexible and watertight. Any annular space inside the manhole at the connection shall be filled with approved caulking material or joint filler.
   3. Pipe connections to existing manholes shall be made so that finished work will conform, as nearly as possible to the essential requirements for new manhole construction, as specified above. Drop connections on existing manholes *shall be strengthened by use of eight #6 pins*, placed around the drop elbow and tee, or inside PVC drops may be used.
   4. Provide a minimum of six (6) inches of separation between edge of manhole core holes and manhole barrel joints. Provide a minimum six (6) inches separation between edges of core holes. Coring the manhole cone section is not allowed.

L. Sewer Manhole Inserts
   1. Sewer manhole inserts are required at all manholes. Stainless steel sewer manhole inserts are required at manholes located in traffic areas.

M. Pipe Markers: According to CFPUA Details and Material Specification Manual.

3.4 FIELD QUALITY CONTROL

A. Section 01 70 00 – Execution and Closeout Requirements.

B. Section 33 14 22 – Testing of Sanitary Sewer Mains and Manholes.

END OF SECTION

APPENDIX D

NCDOT Specification List

ILM Airport Boulevard-Parking Improvements
Bid Package 3 - Phase 2
List of Specifications

100% SUBMITTAL - BID PACKAGE 3 - PHASE 2

NCDOT Division	Section Number	Section Name	Associated work aspects, Pay Item or other notation
2	200	Clearing and Grubbing	CLEARING AND GRUBBING
2	200	Clearing and Grubbing	SELECT TREE REMOVAL
2	200	Clearing and Grubbing	WAYFINDING AND PARKING LOT SIGN REMOVAL
2	225	Roadway Excavation	UNCLASSIFIED EXCAVATION
2	225	Roadway Excavation	UNDERCUT EXCAVATION
2	226	Comprehensive Grade	GRADING
2	230	Borrow Excavation	BORROW MATERIAL
2	250	Removal of Existing Pavement	REMOVAL OF EXISTING ASPHALT PAVEMENT
2	250	Removal of Existing Pavement	REMOVAL OF EXISTING CURB AND GUTTER
2	250	Removal of Existing Pavement	REMOVAL OF EXISTING CONCRETE SIDEWALK PAVEMENT
2	260	Proof Rolling	PROOF ROLLING
2	265	Select Granular Material	SELECT GRANULAR MATERIAL
3	300	Pipe Installation	UNDERCUT EXCAVATION
3	300	Pipe Installation	UNCLASSIFIED EXCAVATION
3	300	Pipe Installation	FOUNDATION CONDITIONING GEOTEXTILE
3	305	Drainage Pipe	15" DRAINAGE PIPE
3	305	Drainage Pipe	18" DRAINAGE PIPE
3	305	Drainage Pipe	24" DRAINAGE PIPE
3	305	Drainage Pipe	30" DRAINAGE PIPE
3	305	Drainage Pipe	36" DRAINAGE PIPE
3	305	Drainage Pipe	42" DRAINAGE PIPE
3	305	Drainage Pipe	48" DRAINAGE PIPE
3	340	Pipe Removal	PIPE REMOVAL
4	402	Removal of Existing Structures	REMOVE EXISTING DRAINAGE STRUCTURE
5	500	Fine Grading Subgrade, Shoulders, and Ditches	FINE GRADING
5	520	Aggregate Base Course	AGGREGATE BASE COURSE
6	600	Prime Coat	PRIME COAT
6	605	Asphalt Tack Coat	
6	607	Milling Asphalt Pavement	MILLING ASPHALT PAVEMENT, 2" Depth
6	610	Asphalt Concrete Plant Mix Pavements	ASPHALT CONCRETE SURFACE COURSE, TYPE S9.5C and S9.5D per plans
6	610	Asphalt Concrete Plant Mix Pavements	ASPHALT CONCRETE BASE COURSE, TYPE I19.0C per plans
7	700	General Requirements for Portland Cement Concrete Pavement	PORTLAND CEMENT CONCRETE PAVEMENT
7	710	Concrete Pavement	PORTLAND CEMENT CONCRETE PAVEMENT
8	800	Mobilization	MOBILIZATION
8	801	Construction Stakes, Lines and Grade	CONSTRUCTION SURVEYING
8	838	Endwalls	PIPE END SECTION
8	840	Minor Drainage Structures	MANHOLE (6' DIAMETER) FRAME WITH COVER, STD 840.54
8	840	Minor Drainage Structures	MANHOLE (7' DIAMETER) FRAME WITH COVER, STD 840.55
8	840	Minor Drainage Structures	MANHOLE (8' DIAMETER) FRAME WITH COVER, STD 840.56
8	840	Minor Drainage Structures	CATCH BASIN WITH GRATE (STD 840.03)
8	840	Minor Drainage Structures	DROP INLET WITH GRATE (STD 840.16)
8	840	Minor Drainage Structures	TEMPORARY INLET
8	846	Curb and Gutter	CONCRETE CURB AND GUTTER
8	848	Concrete Sidewalks, Driveways and Curb Ramps	CONCRETE SIDEWALK
8	852	Traffic Islands and Medians	MONOLITHIC CONCRETE ISLANDS
8	858	Adjustment of Catch Basins, Manholes, Drop Inlets, Meter Boxes and Valve Boxes	ADJUSTMENT OF CATCH BASINS ADJUSTMENT OF MANHOLES ADJUSTMENT OF VALVE BOXES
8	859	Converting Existing Catch Basins, Drop Inlets and Junction Boxes	CONVERT EXISTING CATCH BASIN TO DROP INLET
8	866	Fence	REMOVAL OF EXISTING POST AND CABLE FENCE
8	866	Fence	4' HIGH POST AND CABLE
8	876	RipRap	RIPRAP FOR FES/PIPE OUTLETS
9	901	Sign Fabrication	CONTRACTOR FURNISHED, TYPE SIGN
9	902	Foundations for Ground Mounted Signs	REINFORCED CONCRETE SIGN FOUNDATIONS
9	903	Ground Mounted Sign Supports	
9	904	Sign Erection	
9	906	General Requirements for Signing	
9	907	Disposal and Stockpiling of Signing Components	SIGN DISPOSAL
11	1101	Work Zone Traffic Control General Requirements	TRAFFIC CONTROL
11	1105	Temporary Traffic Control Devices	TRAFFIC CONTROL
11	1110	Work Zone Signs	TRAFFIC CONTROL

ILM Airport Boulevard-Parking Improvements
Bid Package 3 - Phase 2
List of Specifications

100% SUBMITTAL - BID PACKAGE 3 - PHASE 2

NCDOT Division	Section Number	Section Name	Associated work aspects, Pay Item or other notation
11	1115	Flashing Arrow Boards	TRAFFIC CONTROL
11	1130	Drums	TRAFFIC CONTROL
11	1145	Barricades	TRAFFIC CONTROL
11	1150	Flaggers	TRAFFIC CONTROL
11	1160	Temporary Crash Cushions	TRAFFIC CONTROL
11	1165	Truck Mounted Attenuators	TRAFFIC CONTROL
11	1170	Positive Protection	TRAFFIC CONTROL
11	1180	Skinny Drums	TRAFFIC CONTROL
12	1205	Pavement Marking General Requirements	PAVEMENT MARKING REMOVAL
12	1250	Pavement Markers General Requirements	
12	1251	Raised Pavement Markers	
12	1267	Flexible Delineators	NCDOT PAVEMENT MOUNTED FLEXIBLE TRAFFIC DELINEATOR
15	1505	EXCAVATION, TRENCHING, PIPE LAYING AND BACKFILLING FOR UTILITIES	
15	1515	UTILITY CONTROLS	RELOCATE FIRE HYDRANT
15	1540	ENCASEMENT	ENCASEMENT PIPE
16	1605	Temporary Silt Fence	Temporary Silt Fence
16	1607	Gravel Construction Entrance	Gravel Construction Entrance
16	1610	Stone for Erosion Control	Stone for erosion control; sediment control stone
16	1615	Temporary Mulching	Temporary Mulching
16	1620	Temporary Seeding	Seed for temporary seeding; fertilizer for temporary seeding
16	1630	Construction and Maintenance of Silt Detention Basin	Silt Excavation
16	1631	Rolled Erosion Control Product	Matting for Erosion Control
16	1632	Rock Inlet Sediment Trap	1/4" hardward cloth
16	1633	Temporary Rock Silt Checks	Flocculant
16	1660	Seeding and Mulching	Seeding and mulching, mowing
16	1661	Repair Seeding	Seed for repair seeding, fertilizer for repair seeding
16	1662	Supplemental Seeding	Seed for supplemental seeding
16	1665	Fertilizer Topdressing	Fertilizer
16	1667	Specialized Hand Mowing	N/A
16	1675	Response for Erosion Control	All E&SC Items (silt fence, mulching, seeding, matting)
SP	SP	Special Provisions	
FAA	CQCP	Contractor Quality Control Program (CQCP)	
Div 26 CSI	26 05 19	LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES	cable / wiring
Div 26 CSI	26 05 5	ROADWAY LIGHTING FOUNDATIONS	roadway foundations
Div 26 CSI	26 5600	EXTERIOR LIGHTING	Lights
Div 26 CSI	26 0526	GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS	Grounding
Div 26 CSI	26 0543	UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS	Underground conduit

APPENDIX E

Bid Form

STATEMENT OF QUANTITIES

Wilmington International Airport

Airport Boulevard and Parking Improvements
Bid Package 3 - Phase 2

Quantities provided are based on 100% design documents, dated 3-14-2025. The quantities below are provided as information only, may not be all inclusive, and are preliminary as of 100% design efforts.
Contractor is responsible for completing quantity take-offs from bid documents provided.

100% DOCUMENTS

ITEM NO.	PAY ITEM NO.	DESCRIPTION	QTY	U of M
SITE CIVIL				
1	800	MOBILIZATION (7% OF ALL UNITS)	1	LS
2	SP-6	TRAFFIC CONTROL, INCLUDING TEMPORARY ROADWAYS, BARRICADES, MAINTENANCE OF EXISTING TICKETTING EQUIPMENT AND PARKING LOT LIGHTING	1	ALLOW
3	SP-15	AIRFIELD SAFETY AND SECUIRTY	1	LS
4	801	CONSTRUCTION SURVEYING	1	LS
5	SP-7	EROSION CONTROL, INCLUDING PERMANENT TURF ESTABLISHMENT	1	LS
6	SP-8	PERMITTING	1	ALLOW
7	200	CLEARING & GRUBBING INCLUDING TREE REMOVAL	1	LS
8	SP-12	SELECT TREE REMOVAL AND RELOCATION ON-SITE	1	ALLOW
9	200	WAYFINDING AND PARKING LOT SIGN REMOVAL	1	LS
10	225	UNCLASSIFIED EXCAVATION	74,500	CY
11	SP-9	UNDERCUT EXCAVATION	7,450	CY
12	230	BORROW MATERIAL	61,400	CY
13	250	REMOVAL OF EXISTING ASPHALT PAVEMENT, FULL DEPTH	48,200	SY
14	250	REMOVAL OF EXISTING CURB AND GUTTER	910	LF
15	250	REMOVAL OF EXISTING CONCRETE SIDEWALK PAVEMENT, FULL DEPTH	5,500	SY
16	520	AGGREGATE BASE COURSE	8,700	TON
17	610	ASPHALT CONCRETE INTERMEDIATE COURSE, TYPE I19.0C (NOT INCLUDING TEMPORARY ROADS OR CONNECTIONS)	2,900	TON
18	610	ASPHALT CONCRETE SURFACE COURSE, TYPE S9.5C (NOT INCLUDING TEMPORARY ROADS OR CONNECTIONS)	1,800	TON
19	610	RAISED CROSSWALK	304	LF
20	846	2'-6" CONCRETE CURB AND GUTTER	11,600	LF
21	846	MOUNTABLE FLUSH CURB, INCLUDING WALKING RAMP GROOVING	600	LF
22	846	PARKING CURB STOPS	93	EA
23	848	4" CONCRETE SIDEWALK	4,400	SY
24	SP	BOLLARDS (WESTFIELD IMPACT BOLLARD - UNLIT. MODEL NUMBER WFB-IMP-U)	102	EA
25	848	NCDOT CURB RAMP	1	EA
26	848	5" CONCRETE SIDEWALK (ENTRY PLAZAS ONLY)	375	SY
27	850	NCDOT SIDE DITCH, 4' WIDTH	215	SY
28	852	CONCRETE ISLANDS (AT ENTRY PLAZA AND GARAGE ENTRACNE)	3	EA
29	1205	PAVEMENT MARKING REMOVAL	1	LS
30	1205	PAVEMENT MARKING	1	LS
DRAINAGE				
31	305	3" PVC PIPE	64	LF
32	305	4" PVC PIPE	116	LF
33	305	6" PVC PIPE	277	LF
34	305	12" PVC PIPE	404	LF
35	305	15" PVC PIPE	177	LF
36	305	15" RCP CLASS III	1,965	LF
37	305	18" RCP CLASS III	639	LF
38	305	24" RCP CLASS III	1,666	LF
39	305	30" RCP CLASS III	451	LF
40	305	36" RCP CLASS III	399	LF
41	305	42" RCP CLASS III	526	LF
42	305	4" PVE PIPE 45 DEGREE ELBOW	2	EA
43	305	6" PVE PIPE WYE ELBOW	1	EA
44	305	12" PVC 22.5 DEGREE ELBOW	1	EA
45	305	12" PVE PIPE 45 DEGREE ELBOW	1	EA
46	305	12" PVE PIPE 60 DEGREE ELBOW	1	EA
47	305	12" PVE PIPE 90 DEGREE ELBOW	2	EA
48	305	15" PVE PIPE 90 DEGREE ELBOW	1	EA
49	340	REMOVE TEMPORARY 15" HDPE PIPE	314	LF
50	340	REMOVE 12" RCP	166	LF
51	340	REMOVE 15" RCP	1,942	LF
52	340	REMOVE 18" RCP	676	LF
53	340	REMOVE 24" RCP	853	LF
54	340	REMOVE 36" RCP	231	LF
55	402	REMOVE EXISTING DRAINAGE STRUCTURE	37	EA
56	815	6" PERFORATED SUBDRAIN PIPE	2147	LF
57	815	SUBDRAIN CLEANOUT STRUCTURE	16	EA
58	838	24" RCP END SECTION	2	EA
59	838	42" RCP END SECTION	1	EA
60	840	MANHOLE (6' DIAMETER) - FRAME WITH COVER, STD 840.54	3	EA
61	840	MANHOLE (7' DIAMETER) - FRAME WITH COVER, STD 840.55	4	EA
62	840	CATCH BASIN WITH GRATE (STD 840.03)	46	EA

STATEMENT OF QUANTITIES

Wilmington International Airport

Airport Boulevard and Parking Improvements
Bid Package 3 - Phase 2

Quantities provided are based on 100% design documents, dated 3-14-2025. The quantities below are provided as information only, may not be all inclusive, and are preliminary as of 100% design efforts.
Contractor is responsible for completing quantity take-offs from bid documents provided.

100% DOCUMENTS

ITEM NO.	PAY ITEM NO.	DESCRIPTION	QTY	U of M
63	840	DROP INLET WITH GRATE (STD 840.16)	19	EA
64	859	CONVERT EXISTING CATCH BASIN TO DROP INLET	9	EA
FENCING				
65	866	REMOVAL OF EXISTING POST AND CABLE FENCE	350	LF
66	866	4' HIGH POST AND CABLE FENCE	1,240	LF
67	866	WALKWAY SAFETY RAILING	260	LF
68	866	DECORATIVE FENCE (AT LOADING DOCK RETAINING WALL)	600	LF
UTILITIES				
69	DIV 15	1" WATER SERVICE LINE, INCLUDING TAP, CHECK VALVES, GATE VALVES, METER, AND TRACER WIRE PER CFPUA	75	LF
70	DIV 15	2" WATER SERVICE LINE, INCLUDING TAP, CHECK VALVES, GATE VALVES, METER, AND TRACER WIRE PER CFPUA	50	LF
71	DIV 15	12" WATER MAIN LINE, INCLUDING TAP, BENDS, TEES, CONNECTIONS, AND TRACER WIRE PER CFPUA	2,600	LF
72	DIV 15	6" DIP HYDRANT LATERAL, INCLUDING TAPPING SLEEVE, VALVES, AND TRACER WIRE PER CFPUA	300	LF
73	DIV 15	HYDRANT ASSEMBLY, COMPLETE, PER CFPUA	6	EA
74	DIV 15	6" DOUBLE CHECK VALVE ASSEMBLY AND ENCLOSURE PER CFPUA	1	EA
75	DIV 15	4" C-900 PVC SANITARY LATERAL, INCLUDING CLEANOUTS, WYE CONNECTION, AND TRACER WIRE, PER CFPUA	110	LF
76	DIV 15	6" C-900 PVC SANITARY LATERAL, INCLUDING CLEANOUTS, WYE CONNECTION, AND TRACER WIRE, PER CFPUA	170	LF
77	DIV 15	8" C-900 PVC SANITARY MAIN, INCLUDING CLEANOUTS, WYE CONNECTION, AND TRACER WIRE, PER CFPUA	1,100	LF
78	DIV 15	16" SPLIT STEEL CASING	55	LF
79	DIV 16	16" SPLIT STEEL CASING	50	LF
80	DIV 16	SANITARY MANHOLE, PER CFPUA	6	LF
81	DIV 15	PROTECTION, ADJUSTMENT, AND RELOCATION OF EXISTING UTILITY INFRASTRUCTURE	1	ALLOW
82	SP-14-1	WATERMAIN ALLOWANCE	1	ALLOW
83	SP-14-2	SANITARY SEWER ALLOWANCE	1	ALLOW
84	SP-14-3	GAS ALLOWANCE	1	ALLOW
SITE ELECTRICAL				
85	Div 26	MISCELLANEOUS ELECTRICAL DEMOLITION	1	LS
86	Div 26	REMOVE EXISTING PARKING LOT LIGHT	49	EA
87	Div 26	REMOVE EXISTING ILLUMINATED BOLLARD	25	EA
88	Div 26	REMOVE HANDHOLE	11	EA
89	Div 26	REMOVE TICKET SPLITTER	15	EA
90	Div 26	REMOVE LICENSE PLATE RECOGNITION CAMERA	3	EA
91	Div 26	REMOVE ARM GATE	15	EA
92	Div 26	REMOVE EXISTING POWER PANEL	2	EA
93	Div 26	REMOVE EXISTING CAMERA	1	EA
94	Div 26	NO. 6 AWG, SOLID, BARE COUNTERPOISE WIRE, INSTALLED IN TRENCH, ABOVE THE DUCT BANK	13,000	LF
95	Div 26	3/4" X 10' COPPER CLAD GROUND ROD - SUPPLEMENTAL	40	EA
96	Div 26	1-6 STRAND FIBER OPTIC CABLE - SINGLE MODE WITH 1-4 MAXCELL INNER DUCT	2,900	LF
97	Div 26	1-12 STRAND FIBER OPTIC CABLE - SINGLE MODE WITH 1-4 MAXCELL INNER DUCT	1,000	LF
98	Div 26	1-48 STRAND FIBER OPTIC CABLE - SINGLE MODE WITH 1-4 MAXCELL INNER DUCT	2,000	LF
99	Div 26	NO. 10 AWG, XHHW CABLE, 600V	250	LF
100	Div 26	NO. 8 AWG, XHHW CABLE, 600V	4,600	LF
101	Div 26	NO. 6 AWG, XHHW CABLE, 600V	3,700	LF
102	Div 26	NO. 4 AWG, XHHW CABLE, 600V	9,100	LF
103	Div 26	NO. 2 AWG, XHHW CABLE, 600V	4,100	LF
104	Div 26	NO. 1 AWG, XHHW CABLE, 600V	10,600	LF
105	Div 26	1 WAY 1-INCH SCHEDULE 40 PVC CONDUIT - DIRECT EARTH BURIED	4,600	LF
106	Div 26	1 WAY 2-INCH SCHEDULE 40 PVC CONDUIT - DIRECT EARTH BURIED	4,400	LF
107	Div 26	1 WAY 3-INCH SCHEDULE 40 PVC CONDUIT - DIRECT EARTH BURIED	75	LF
108	Div 26	4 WAY 4-INCH SCHEDULE 40 PVC CONDUIT - DIRECT EARTH BURIED	500	LF
109	Div 26	4 WAY 3 1/2-INCH SCHEDULE 40 PVC CONDUIT - DIRECT EARTH BURIED	200	LF
110	Div 26	2 WAY 6-INCH SCHEDULE 40 PVC CONDUIT - CONCRETE ENCASED	600	LF
111	Div 26	4 WAY 6-INCH SCHEDULE 40 PVC CONDUIT - CONCRETE ENCASED	1,500	LF
112	Div 26	2 WAY 6-INCH HDPE DIRECTIONAL DRILL	75	LF
113	Div 26	HEAVY DUTY TRAFFIC RATED HANDHOLE - H-20	7	EA
114	Div 26	10' X 10' DUKE ENERGY UTILITY MANHOLE	2	EA
115	Div 26	ROADWAY LED LIGHT - ONE FIXTURE - ACORN	4	EA
116	Div 26	PARKING LOT LED LIGHT, ONE FIXTURES	10	EA
117	Div 26	PARKING LOT LED LIGHT, TWO FIXTURES	23	EA
118	Div 26	POWER UTILITY COORDINATION AND UTILITY FEES	1	LS
119	Div 26	MAIN LOT ENTRY PLAZA EXPANSION	1	LS
120	Div 26	SHUTTLE BUS ENTRY/EXIT GATES	1	LS