PROJECT MANUAL
(VOLUME 2 OF 3)

PUMP STATION #1
TECHNICAL SPECIFICATIONS

FOR THE CONSTRUCTION OF
PUMP STATION #1 & FORCE MAIN IMPROVEMENTS
SRP-W-ARP-0063

SMITHFIELD, NORTH CAROLINA

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NORTH CAROLINA

TOWN COUNCIL:
M. Andy Moore, Mayor
Roger A. Wood, Mayor Pro-Tem
Marlon Lee, Sloan Stevens, Travis Scott, Dr. David Barbour
John A. Dunn, Stephen Rabil

Michael L. Scott, Town Manager
Elaine Andrews, Town Clerk

October 2025

NORTH CAROLINA
SEAL
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Final Specifications – For Review Purposes Only
Not Released for Construction

SECTION 022100
PROJECT CONTROLS (SURVEYING)

PART 1 GENERAL

1.01 SCOPE OF WORK

A. Contractor shall provide and pay for field engineering services required for project; including but not limited to:

1. Survey work required for project controls and layout.

2. Certified as-built surveys specified herein.

3. Certified as-built survey data to support record drawings as specified in Section 017839.

B. Contractor shall retain the services of a registered land surveyor licensed in the state of North Carolina:

1. Identify existing control points and property line corners indicated on the Drawings.

2. Verify and record all existing structure locations in the vicinity of, or adjacent to, the proposed Work.

3. Maintain an accurate record of locations of all new buried piping and existing buried piping and other buried existing facilities (conduits, and structures) encountered and/or relocated during construction of the Work.

C. There shall be no direct payment for this item, the cost of which shall be included in pay items identified in Section 012000.

1.02 RELATED WORK

A. Record Drawings are included in Section 017839.

B. Contract Closeout is included in Section 017700.

1.03 SUBMITTALS

A. Submit, to the Engineer, the name, address and state of registration and license number of proposed registered land surveyor. Show minimum of 5 years of experience on similar sized project.

B. On request of the Owner/Engineer, submit documentation to verify accuracy of field engineering work.

1.04 QUALIFICATIONS OF SURVEYOR

A. Registered land surveyor, licensed in North Carolina. Show minimum of 5 years of experience on similar sized project.

1.05 SURVEY REFERENCE POINTS

A. Existing basic horizontal and vertical control points for the project are those designated on Drawings.

B. Locate and protect control points prior to starting site work and preserve all permanent reference points during construction.

1. Make no changes or relocations without prior written notice to and approval by the Owner/Engineer.

2. Report to the Owner/Engineer when any reference point is lost or destroyed, or requires relocation because of necessary changes in grades or locations.

3. Require the registered surveyor to correctly replace project control points which may be lost or destroyed. Establish replacements based on original survey control.

4. Coordinates on the plans are based on North Carolina State Plane Coordinate System: NAVD 88 Vertical Control and NAD 83 Horizontal Control unless otherwise noted. The data collection methods used for this project may be survey grade, mapping grade GPS equipment and/or a combination of both.

1.06 PROJECT SURVEY REQUIREMENTS

A. For work contained to an individual site or property, establish a minimum of two permanent bench marks on site, referenced to data established by survey control points.

B. For pipeline projects, establish one permanent bench mark for every one half mile of new pipe.

1. Record locations, with horizontal and vertical data, on the as-built Drawings.

2. Permanent benchmarks shall be installed and spaced for convenient reference and used at locations along the pipeline route.

3. Benchmarks shall be installed to National Geodetic Survey standards and shall include horizontal and vertical data, as well as the installation date.

C. Establish lines and levels; locate and lay out:

1. Site improvements

   a. Stakes for grading, fill and topsoil placement.
   b. Utility slopes and invert elevations.
   c. Sidewalks, pavement, fencing, storm drainage facilities, and other finish surface work.

2. Batter boards for structures.

3. Building foundation, column locations and floor levels.

4. Controlling lines and levels required for mechanical and electrical trades.

D. If lines, levels or layouts are lost or destroyed, or if required by the Owner/Engineer, verify layouts by same methods.

E. Establish all lines and grades prior to construction of line work for all force mains, transmission mains, storm drainage piping, gravity sewers and other new utility lines at 100-ft increments, at defined breaks in grade, and at manholes.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 RECORDS

A. Maintain a complete, accurate log of all control and survey work as it progresses.

B. Update the project as-built survey on a monthly basis.

C. Maintain an accurate record of new and existing piping, conduit and structure changes, revisions, relocations, and modifications.

D. At the end of the project, submit the following:

1. Two signed and sealed prints of all required as-built survey information.

2. Digital file of all surveyed control points, including elevations, for downloading into the City's GIS.

END OF SECTION

SECTION 031513
WATERSTOPS

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. Provision of waterstops embedded in concrete and spanning control, expansion, and/or construction joints to create a continuous diaphragm to prevent liquid migration.

B. Non-metallic waterstops for use in concrete joints subjected to chlorinated water, seawater, and many waterborne chemicals.

C. Related Sections:
1. Section 033000 “Cast-in-Place Concrete”.
2. Section 034100 "Precast Structural Concrete”.

1.3 DEFINITIONS

A. Cementitious Materials: Portland cement alone or in combination with one or more of the following: blended hydraulic cement, fly ash and other pozzolans, ground granulated blast-furnace slag, and silica fume; subject to compliance with requirements.

1.4 ACTION SUBMITTALS

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

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For manufacturer.

B. Material Certificates: Retain first paragraph below if Contractor is responsible for field quality-control testing and inspecting.

C. Field quality-control reports.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Waterstop installer/concrete subcontractor shall demonstrate five (5) years minimum continuous, successful experience in installing PVC waterstops.

B. Manufacturer Qualifications: Waterstop manufacturers shall demonstrate five (5) years minimum continuous, successful experience in production of PVC waterstops.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store waterstops under tarps to protect from oil, dirt, and sunlight.

PART 2 - PRODUCTS

2.1 Material

A. Provide flexible PVC (polyvinyl chloride) waterstop as manufactured by Sika or approved equal, profile style number (fill in profile style number).

B. The PVC waterstop shall be extruded from an elastomeric plastic material of which the basic resin is prime virgin polyvinyl chloride. The PVC compound shall not contain any scrapped or reclaimed material or pigment.

C. Performance requirements as follows:

PROPERTY	TEST METHOD	REQUIRED LIMITS
Water absorption	ASTM D570	0.15% max
Tear Resistance	ASTM D624	300 lb/in (52.5 kN/m) min.
Ultimate Elongation	ASTM D638	350% min.
Tensile Strength	ASTM D638	2000 psi (13.78 Mpa) min.
Low Temperature Brittleness	ASTM D746	No Failure @ -35°F (-37°C)
Stiffness in Flexure	ASTM D747	700 psi (4.82 Mpa) min.
Specific Gravity	ASTM D792	1.38 max.
Hardness, Shore A	ASTM D2240	79 ± 3
Tensile Strength after accelerated extraction	CRD-C 572	1600 psi (9.54 Mpa) min.
Elongation after accelerated extraction	CRD-C 572	300% min.
Effect of Alkalies after 7 days: Weight Change Hardness Change	CRD-C 572	Between -0.10% / +0.25% ± 5 points

2.2 Accessories

A. Provide factory made waterstop fabrications for all changes of direction, intersections, and transitions leaving only straight butt joint splices for the field.

B. Provide grommets, pre-punched holes, or hog rings (installed by others) spaced at 12 inches on center along length of waterstop.

C. Provide Teflon coated thermostatically controlled waterstop welding irons for field butt splices.

PART 3 - EXECUTION

3.1 Installation

A. Field butt splices shall be heat fused welded using a Teflon coated thermostatically controlled waterstop welding iron at approximately 380 degrees F. Follow approved waterstop manufacturer recommendations. Lapping of waterstop, use of adhesives, or solvents shall not be allowed.

B. Center waterstop in joint and secure waterstop in correct position using grommets, pre-punched holes, or hog rings (installed by others) spaced at 12 inches on center along the length of the waterstop and wire tie to adjacent reinforcing steel.

3.2 FIELD QUALITY CONTROL

A. Waterstop splicing defects which are unacceptable include, but are not limited to the following:
   1. Tensile strength less than 80 percent of parent section.
   2. Misalignment of centerbulb greater than 1/16 inch.
   3. Bond failure at joint deeper than 1/16 inch or 15 percent of material thickness.
   4. Misalignment that reduces waterstop cross section more than 15 percent.
   5. Visible porosity in the weld.
   6. Bubbles or inadequate bonding.
   7. Visible signs of splice separation when cooled splice is bent by hand at a sharp angle.
   8. Charred or burnt material.

END OF SECTION 031513

SECTION 033000
CAST-IN-PLACE CONCRETE

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. Section includes cast-in-place concrete, including formwork, reinforcement, concrete materials, mixture design, placement procedures, and finishes, for the following:

1. Shallow Foundations.
2. Foundation walls.
3. Slabs-on-grade.
4. Concrete reinforcing.
5. Miscellaneous concrete elements including equipment pads, thrust blocks, and other elements shown on drawings.

B. Related Sections:
1. Section 031515 “Waterstops”.
2. Section 034100 "Precast Structural Concrete”.
3. Section 051200 "Structural Steel Framing ".

1.3 DEFINITIONS

A. Cementitious Materials: Portland cement alone or in combination with one or more of the following: blended hydraulic cement, fly ash and other pozzolans, ground granulated blast-furnace slag, and silica fume; subject to compliance with requirements.

1.4 ACTION SUBMITTALS

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

B. Design Mixtures: For each concrete mixture. Submit alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

C. Steel Reinforcement Shop Drawings: Placing drawings that detail fabrication, bending, and placement. Include bar sizes, lengths, material, grade, bar schedules, stirrup spacing, bent bar diagrams, bar arrangement, splices and laps, mechanical connections, tie spacing, hoop spacing, and supports for concrete reinforcement.

D. Formwork Shop Drawings: Prepared by or under the supervision of a qualified professional engineer detailing fabrication, assembly, and support of formwork.

1. The location of construction joints is subject to the approval of the Engineer.

E. Samples: For waterstops.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For manufacturer.

B. Welding certificates.

C. Material Certificates: For each of the following, signed by manufacturers:

1. Cementitious materials.
2. Admixtures.
3. Form materials and form-release agents.
4. Steel reinforcement and accessories.
5. Waterstops.
6. Curing compounds.
7. Bonding agents.
8. Adhesives.

D. Floor surface flatness and levelness measurements indicating compliance with specified tolerances.

E. Field quality-control reports.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: A qualified installer who employs on Project personnel qualified as ACI-certified Flatwork Technician and Finisher and a supervisor who is an ACI-certified Concrete Flatwork Technician.

B. Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.

C. Testing Agency Qualifications: An independent agency, qualified according to ASTM C 1077 and ASTM E 329 for testing indicated.

D. ACI Publications: Comply with the following unless modified by requirements in the Contract Documents:

1. ACI 117, Standard Specifications for Tolerances for Concrete Construction and Materials; American Concrete Institute International latest revision.
2. ACI 211.1, Standard Practice for Selecting Proportions for Norma, Heavyweight, and Mass Concrete; American Concrete Institute International; latest revision.

3. ACI 301, Specifications for Structural Concrete for Buildings; American Concrete Institute International; latest revision.
4. ACI 302 1R , Guide for Concrete Floor and Slab Construction; American Concrete Institute International; latest revision.
5. ACI 304R, Guide for Measuring, Mixing, Transporting, and Placing Concrete; American Concrete Institute International; latest revision.
6. ACI 305R, Hot Weather Concreting: American Concrete Institute International; latest revision.
7. ACI 306R, Cold Weather Concreting; American Concrete Institute International; latest revision.
8. ACI 308R, Guide to Curing Concrete; American Concrete Institute International; latest revision.
9. ACI 318, Building Code Requirements for Structural Concrete and Commentary; American Concrete Institute International; latest revision.
10. ACI 350, Code Requirements for Environmental Engineering Concrete Structures
11. ASTM C33/C33M, Standard Specification for Concrete Aggregates; latest revision.
12. ASTM C39/C39M, Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens; latest revision.
13. ASTM C94/C94M, Standard Specification for Ready-Mixed Concrete; latest revision.
14. ASTM C150/C150M, Standard Specification for Portland Cement; latest revision.
15. ASTM C173/C173M, Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method; latest revision.
16. ASTM C260, Standard Specification for Air-Entraining Admixtures for Concrete; latest revision.
17. ASTM C618, Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete; latest revision.
18. ASTM E1745, Standard Specification for Plastic Water Vapor Retarders Used in Contract with Soil or Granular Fill under Concrete Slabs; latest revision.

E. Concrete Testing Service: Engage a qualified independent testing agency to perform material evaluation tests and to design concrete mixtures.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Steel Reinforcement: Deliver, store, and handle steel reinforcement to prevent bending and damage.

PART 2 - PRODUCTS

2.1 FORM-FACING MATERIALS

A. Smooth-Formed Finished Concrete: Form-facing panels that will provide continuous, true, and smooth concrete surfaces. Furnish in largest practicable sizes to minimize number of joints.

1. Plywood, metal, or other approved panel materials.

B. Rough-Formed Finished Concrete: Plywood, lumber, metal, or another approved material. Provide lumber dressed on at least two edges and one side for tight fit.

C. Pan-Type Forms: Glass-fiber-reinforced plastic or formed steel, stiffened to resist plastic concrete loads without detrimental deformation.

D. Chamfer Strips: Wood, metal, PVC, or rubber strips, 3/4 by 3/4 inch, minimum.

E. Rustication Strips: Wood, metal, PVC, or rubber strips, kerfed for ease of form removal.

F. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces.

G. Form Ties: Factory-fabricated, removable or snap-off metal or glass-fiber-reinforced plastic form ties designed to resist lateral pressure of fresh concrete on forms and to prevent spalling of concrete on removal.

2.2 STEEL REINFORCEMENT

A. Reinforcing Bars: ASTM A 615/A 615M, Grade 60, deformed.

2.3 REINFORCEMENT ACCESSORIES

A. Joint Dowel Bars: ASTM A 615/A 615M, Grade 60, plain-steel bars, cut true to length with ends square and free of burrs.

B. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire reinforcement in place. Manufacturing bar supports from steel wire, plastic, or precast concrete according to CRSI's "Manual of Standard Practice," of greater compressive strength than concrete.

2.4 CONCRETE MATERIALS

A. Cementitious Material: Use the following cementitious materials, of the same type, brand, and source, throughout Project:

1. Portland Cement: ASTM C 150, Type I

a. Fly Ash: ASTM C 618, Class F or C.

B. Silica Fume: ASTM C 1240, amorphous silica.

C. Normal-Weight Aggregates: ASTM C 33, coarse aggregate or better, graded.

1. Maximum Coarse-Aggregate Size: 3/4 inch nominal.
2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.

D. Water: ASTM C 94/C 94M.

2.5 ADMIXTURES

A. Air-Entraining Admixture: ASTM C 260.

B. Chemical Admixtures: Provide admixtures certified by manufacturer to be compatible with other admixtures and that will not contribute water-soluble chloride ions exceeding those permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride.

1. Water-Reducing Admixture: ASTM C 494/C 494M, Type A.
2. Retarding Admixture: ASTM C 494/C 494M, Type B.
3. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.
4. High-Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F.
5. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type G.
6. Plasticizing and Retarding Admixture: ASTM C 1017/C 1017M, Type II.

2.6 CURING MATERIALS

A. Evaporation Retarder: Waterborne, monomolecular film forming, manufactured for application to fresh concrete.

B. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. when dry.

C. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.

D. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, dissipating.

2.7 RELATED MATERIALS

A. Bonding Agent: ASTM C 1059/C 1059M, Type II, non-redispersible, acrylic emulsion or styrene butadiene.

B. Epoxy Bonding Adhesive: ASTM C 881, two-component epoxy resin, capable of humid curing and bonding to damp surfaces, of class suitable for application temperature and of grade to suit requirements, and as follows:

2.8 CONCRETE MIXTURES, GENERAL

A. Prepare design mixtures for each type and strength of concrete, proportioned on the basis of laboratory trial mixture or field test data, or both, according to ACI 301.

1. Use a qualified independent testing agency for preparing and reporting proposed mixture designs based on laboratory trial mixtures.

2.9 FABRICATING REINFORCEMENT

A. Fabricate steel reinforcement according to CRSI's "Manual of Standard Practice."

2.10 CONCRETE MIXING

A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94/C 94M, and furnish batch ticket information.

1. When air temperature is between 85 and 90 deg F, reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F, reduce mixing and delivery time to 60 minutes.

PART 3 - EXECUTION

3.1 FORMWORK

A. Design, erect, shore, brace, and maintain formwork, according to ACI 301, to support vertical, lateral, static, and dynamic loads, and construction loads that might be applied, until structure can support such loads.

B. Construct formwork so concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of ACI 117.

C. Construct forms tight enough to prevent loss of concrete mortar.

D. Fabricate forms for easy removal without hammering or prying against concrete surfaces. Provide crush or wrecking plates where stripping may damage cast concrete surfaces. Provide top forms for inclined surfaces steeper than 1.5 horizontal to 1 vertical.

1. Install keyways, reglets, recesses, and the like, for easy removal.
2. Do not use rust-stained steel form-facing material.

E. Set edge forms, bulkheads, and intermediate screed strips for slabs to achieve required elevations and slopes in finished concrete surfaces. Provide and secure units to support screed strips; use strike-off templates or compacting-type screeds.

F. Provide temporary openings for cleanouts and inspection ports where interior area of formwork is inaccessible. Close openings with panels tightly fitted to forms and securely braced to prevent loss of concrete mortar. Locate temporary openings in forms at inconspicuous locations.

G. Chamfer exterior corners and edges of permanently exposed concrete.

H. Form openings, chases, offsets, sinkages, keyways, reglets, blocking, screeds, and bulkheads required in the Work. Determine sizes and locations from trades providing such items.

I. Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other debris just before placing concrete.

J. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.

K. Coat contact surfaces of forms with form-release agent, according to manufacturer's written instructions, before placing reinforcement.

3.2 REMOVING AND REUSING FORMS

A. General: Formwork for sides of beams, walls, columns, and similar parts of the Work that does not support weight of concrete may be removed after cumulatively curing at not less than 50 deg F for 24 hours after placing concrete. Concrete has to be hard enough to not be damaged by form-removal operations and curing and protection operations need to be maintained.

1. Leave formwork for beam soffits, joists, slabs, and other structural elements that supports weight of concrete in place until concrete has achieved its 28-day design compressive strength.
2. Remove forms only if shores have been arranged to permit removal of forms without loosening or disturbing shores.

B. Clean and repair surfaces of forms to be reused in the Work. Split, frayed, delaminated, or otherwise damaged form-facing material will not be acceptable for exposed surfaces. Apply new form-release agent.

C. When forms are reused, clean surfaces, remove fins and laitance, and tighten to close joints. Align and secure joints to avoid offsets.

3.3 SHORES AND RESHORES

A. Comply with ACI 318 and ACI 301 for design, installation, and removal of shoring and reshoring.

B. Plan sequence of removal of shores and reshore to avoid damage to concrete. Locate and provide adequate reshoring to support construction without excessive stress or deflection.

3.4 STEEL REINFORCEMENT

A. General: Comply with CRSI's "Manual of Standard Practice" for placing reinforcement.

B. Clean reinforcement of loose rust and mill scale, earth, ice, and other foreign materials that would reduce bond to concrete.

C. Accurately position, support, and secure reinforcement against displacement. Locate and support reinforcement with bar supports to maintain minimum concrete cover. Do not tack weld crossing reinforcing bars.

D. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.

3.5 JOINTS

A. General: Construct joints true to line with faces perpendicular to surface plane of concrete.

B. Construction Joints: Install so strength and appearance of concrete are not impaired.

1. Place joints perpendicular to main reinforcement. Continue reinforcement across construction joints unless otherwise indicated. Do not continue reinforcement through sides of strip placements of floors and slabs.
2. Use a bonding agent at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.

3.6 CONCRETE PLACEMENT

A. Before placing concrete, verify that installation of formwork, reinforcement, and embedded items is complete and that required inspections have been performed.

B. Do not add water to concrete during delivery, at Project site, or during placement unless approved by Engineer.

C. Before test sampling and placing concrete, water may be added at Project site, subject to limitations of ACI 301.

1. Do not add water to concrete after adding high-range water-reducing admixtures to mixture.

D. Deposit concrete continuously in one layer or in horizontal layers of such thickness that no new concrete will be placed on concrete that has hardened enough to cause seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as indicated. Deposit concrete to avoid segregation.

1. Deposit concrete in horizontal layers of depth to not exceed formwork design pressures and in a manner to avoid inclined construction joints.
2. Consolidate placed concrete with mechanical vibrating equipment according to ACI 301.
3. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations to rapidly penetrate placed layer and at least 6 inches into preceding layer. Do not insert vibrators into lower layers of concrete that have begun to lose plasticity. At each insertion, limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing mixture constituents to segregate.

E. Deposit and consolidate concrete for floors and slabs in a continuous operation, within limits of construction joints, until placement of a panel or section is complete.

1. Consolidate concrete during placement operations so concrete is thoroughly worked around reinforcement and other embedded items and into corners.
2. Maintain reinforcement in position on chairs during concrete placement.
3. Screed slab surfaces with a straightedge and strike off to correct elevations.
4. Slope surfaces uniformly to drains where required.

5. Begin initial floating using bull floats or darbies to form a uniform and open-textured surface plane, before excess bleedwater appears on the surface. Do not further disturb slab surfaces before starting finishing operations.

F. Cold-Weather Placement: Comply with ACI 306.1 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.

1. When average high and low temperature is expected to fall below 40 deg F for three successive days, maintain delivered concrete mixture temperature within the temperature range required by ACI 301.
2. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in mixture designs.

G. Hot-Weather Placement: Comply with ACI 301 and as follows:

1. Maintain concrete temperature below 90 deg F at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
2. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade uniformly moist without standing water, soft spots, or dry areas.

3.7 MISCELLANEOUS CONCRETE ITEMS

A. Filling In: Fill in holes and openings left in concrete structures after work of other trades is in place unless otherwise indicated. Mix, place, and cure concrete, as specified, to blend with in-place construction. Provide other miscellaneous concrete filling indicated or required to complete the Work.

B. Equipment Bases and Foundations:

1. Coordinate sizes and locations of concrete bases with actual equipment provided.
2. Construct concrete bases 6 inches high unless otherwise indicated; and extend base not less than 6 inches in each direction beyond the maximum dimensions of supported equipment unless otherwise indicated or unless required for seismic anchor support.

3.8 CONCRETE PROTECTING AND CURING

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection and ACI 301 for hot-weather protection during curing.

B. Evaporation Retarder: Apply evaporation retarder to unformed concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.

C. Formed Surfaces: Cure formed concrete surfaces, including underside of beams, supported slabs, and other similar surfaces. If forms remain during curing period, moist cure after loosening forms. If removing forms before end of curing period, continue curing for the remainder of the curing period.

D. Unformed Surfaces: Begin curing immediately after finishing concrete. Cure unformed surfaces, including floors and slabs, concrete floor toppings, and other surfaces.

E. Cure concrete according to ACI 308.1, by one or a combination of the following methods:

1. Moisture Curing: Keep surfaces continuously moist for not less than seven days with the following materials:

    a. Water.
    b. Continuous water-fog spray.
    c. Absorptive cover, water saturated, and kept continuously wet. Cover concrete surfaces and edges with 12-inch lap over adjacent absorptive covers.

2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive. Cure for not less than seven days. Immediately repair any holes or tears during curing period using cover material and waterproof tape.

    a. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive floor coverings.
    b. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive penetrating liquid floor treatments.
    c. Cure concrete surfaces to receive floor coverings with either a moisture-retaining cover or a curing compound that the manufacturer certifies will not interfere with bonding of floor covering used on Project.

3. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.

    a. Removal: After curing period has elapsed, remove curing compound without damaging concrete surfaces by method recommended by curing compound manufacturer.

4. Curing and Sealing Compound: Apply uniformly to floors and slabs indicated in a continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Repeat process 24 hours later and apply a second coat. Maintain continuity of coating and repair damage during curing period.

3.9 CONCRETE SURFACE REPAIRS

A. Defective Concrete: Repair and patch defective areas when approved by Engineer. Remove and replace concrete that cannot be repaired and patched to Engineer's approval.

B. Repairing Formed Surfaces: Surface defects include color and texture irregularities, cracks, spalls, air bubbles, honeycombs, rock pockets, fins and other projections on the surface, and stains and other discolorations that cannot be removed by cleaning.

1. Immediately after form removal, cut out honeycombs, rock pockets, and voids more than 1/2 inch in any dimension to solid concrete. Limit cut depth to 3/4 inch. Make edges of cuts perpendicular to concrete surface. Clean, dampen with water, and brush-coat holes and voids with bonding agent. Fill and compact with patching mortar before bonding agent has dried. Fill form-tie voids with patching mortar or cone plugs secured in place with bonding agent.

3.10 FIELD QUALITY CONTROL

A. Testing and Inspecting: Engage a qualified testing and inspecting agency to perform tests and inspections and to submit reports.

B. Concrete Tests: Testing of composite samples of fresh concrete obtained according to ASTM C 172 shall be performed according to the following requirements:

1. Testing Frequency: Obtain one composite sample for each day's pour of each concrete mixture exceeding 5 cu. yd., but less than 25 cu. yd., plus one set for each additional 50 cu. yd. or fraction thereof.
2. Testing Frequency: Obtain at least one composite sample for each 100 cu. yd. or fraction thereof of each concrete mixture placed each day.

    a. When frequency of testing will provide fewer than five compressive-strength tests for each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.

3. Slump: ASTM C 143/C 143M; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture. Perform additional tests when concrete consistency appears to change.
4. Air Content: ASTM C 231, pressure method, for normal-weight concrete; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.

5. Compressive-Strength Tests: ASTM C 39/C 39M; test one set of two laboratory-cured specimens at 7 days and one set of two specimens at 28 days.

    a. Test one set of two field-cured specimens at 7 days and one set of two specimens at 28 days.
    b. A compressive-strength test shall be the average compressive strength from a set of two specimens obtained from same composite sample and tested at age indicated.

6. When strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, Contractor shall evaluate operations and provide corrective procedures for protecting and curing in-place concrete.
7. Strength of each concrete mixture will be satisfactory if every average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi.
8. Test results shall be reported in writing to Engineer, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.
9. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met. Testing and inspecting agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C 42/C 42M.
10. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
11. Correct deficiencies in the Work that test reports and inspections indicate do not comply with the Contract Documents.

END OF SECTION 033000

SECTION 034100
PRECAST STRUCTURAL CONCRETE

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. Section Includes:

1. Precast structural concrete vaults.

B. Related Sections:
1. Section 033000 “Cast-in-Place Concrete”.
2. Section 031513 "Waterstops”.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Design Mixtures:For each precast concrete mixture. Include compressive strength and, if required, water-absorption tests.

C. Shop Drawings:

1. Include member locations, plans, elevations, dimensions, shapes and sections, openings, support conditions, and types of reinforcement, including special reinforcement.
2. Detail fabrication and installation of precast structural concrete units, including connections at member ends and to adjoining construction.
3. Indicate joints, reveals, drips, chamfers, and extent and location of each surface finish.
4. Indicate type, size, and length of welded connections by AWS standard symbols.
5. Detail loose and cast-in hardware, lifting and erection inserts, connections, and joints.
6. Indicate locations, tolerances, and details of anchorage devices to be embedded in or attached to structure or other construction.
7. Include and locate openings larger than 10 inches. Where additional structural support is required, include header design.
8. If design modifications are proposed to meet performance requirements and field conditions, submit design calculations and Shop Drawings. Do not adversely affect the appearance, durability, or strength of units when modifying details or materials and maintain the general design concept.

D. Delegated-Design Submittal: For precast structural concrete indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer, fabricator, testing agency.

B. Welding certificates.

C. Material Certificates: For the following:

1. Cementitious materials.
2. Reinforcing materials and prestressing tendons.
3. Admixtures.
4. Structural-steel shapes and hollow structural sections.

D. Material Test Reports: For aggregates, by a qualified testing agency.

E. Preconstruction test reports.

F. Source quality-control reports.

G. Field quality-control reports.

1.5 QUALITY ASSURANCE

A. Fabricator Qualifications: A firm that assumes responsibility for engineering precast structural concrete units to comply with performance requirements. Responsibility includes preparation of Shop Drawings and comprehensive engineering analysis by a qualified professional engineer.

B. Installer Qualifications: A precast concrete erector qualified and designated by PCI's Certificate of Compliance, to erect Category S1 - Simple Structural Systems.

C. Testing Agency Qualifications: Qualified according to ASTM C 1077 and ASTM E 329 for testing indicated.

D. Quality-Control Standard: For manufacturing procedures, testing requirements, and quality-control recommendations for types of units required, comply with PCI MNL 116, "Manual for Quality Control for Plants and Production of Structural Precast Concrete Products."

1.6 COORDINATION

A. Furnish loose connection hardware and anchorage items to be embedded in or attached to other construction before starting that Work. Provide locations, setting diagrams, templates, instructions, and directions, as required, for installation.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Support units during shipment on nonstaining shock-absorbing material in same position as during storage.

B. Store units with adequate bracing and protect units to prevent contact with soil, to prevent staining, and to prevent cracking, distortion, warping or other physical damage.

C. Handle and transport units in a manner that avoids excessive stresses that cause cracking or damage.

D. Lift and support units only at designated points indicated on Shop Drawings.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Design Standards: Comply with ACI 318, ACI 350 and with design recommendations in PCI MNL 120, "PCI Design Handbook - Precast and Prestressed Concrete," applicable to types of precast structural concrete units indicated.

2.2 MOLD MATERIALS

A. Molds: Rigid, dimensionally stable, non-absorptive material, warp and buckle free, that provides continuous precast concrete surfaces within fabrication tolerances indicated; nonreactive with concrete and suitable for producing required finishes.

1. Mold-Release Agent: Commercially produced form-release agent that does not bond with, stain, or adversely affect precast concrete surfaces and does not impair subsequent surface or joint treatments of precast concrete.

B. Form Liners: Units of face design, texture, arrangement, and configuration. Furnish with manufacturer's recommended form-release agent that does not bond with, stain, or adversely affect precast concrete surfaces and does not impair subsequent surface or joint treatments of precast concrete.

C. Surface Retarder: Chemical set retarder, capable of temporarily delaying setting of newly placed concrete mixture to depth of reveal specified.

2.3 REINFORCING MATERIALS

A. Reinforcing Bars: ASTM A 615/A 615M, Grade 60, deformed.

B. Supports: Suspend reinforcement from back of mold or use bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire reinforcement in place according to PCI MNL 116.

2.4 CONCRETE MATERIALS

A. Portland Cement: ASTM C 150/C 150M, Type I or Type III, gray, unless otherwise indicated.

B. Supplementary Cementitious Materials:

1. Fly Ash: ASTM C 618, Class C or F, with maximum loss on ignition of 3 percent.
2. Metakaolin: ASTM C 618, Class N.
3. Silica Fume: ASTM C 1240, with optional chemical and physical requirement.

C. Normal-Weight Aggregates: Except as modified by PCI MNL 116, ASTM C 33/C 33M.

D. Water: Potable; free from deleterious material that may affect color stability, setting, or strength of concrete and complying with chemical limits of PCI MNL 116.

E. Air-Entraining Admixture: ASTM C 260, certified by manufacturer to be compatible with other required admixtures.

F. Chemical Admixtures: Certified by manufacturer to be compatible with other admixtures and to not contain calcium chloride, or more than 0.15 percent chloride ions or other salts by weight of admixture.

1. Water-Reducing Admixtures: ASTM C 494/C 494M, Type A.
2. Retarding Admixture: ASTM C 494/C 494M, Type B.
3. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.
4. Water-Reducing and Accelerating Admixture: ASTM C 494/C 494M, Type E.
5. High-Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F.
6. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type G.
7. Plasticizing Admixture: ASTM C 1017/C 1017M, Type I.
8. Plasticizing and Retarding Admixture: ASTM C 1017/C 1017M, Type II.
9. Corrosion-Inhibiting Admixture: ASTM C 1582/C 1582M.

2.5 STEEL CONNECTION MATERIALS

A. Carbon-Steel Shapes and Plates: ASTM A 36/A 36M.

B. High-Strength Bolts and Nuts: ASTM A 325 or ASTM A 490 Type 1, heavy hex steel structural bolts; heavy hex carbon-steel nuts, ASTM A 563; and hardened carbon-steel washers, ASTM F 436.

C. Welding Electrodes: Comply with AWS standards.

D. Precast Accessories: Provide clips, hangers, plastic or steel shims, and other accessories required to install precast structural concrete units.

2.6 GROUT MATERIALS

A. Sand-Cement Grout: Portland cement, ASTM C 150/C 150M, Type I, and clean, natural sand, ASTM C 144 or ASTM C 404. Mix at ratio of 1 part cement to 2-1/2 to 3 parts sand, by volume, with minimum water required for placement and hydration. Water-soluble chloride ion content less than 0.06 percent by weight of cement when tested according to ASTM C 1218/C 1218M.

2.7 MOLD FABRICATION

A. Molds: Accurately construct molds, mortar tight, of sufficient strength to withstand pressures due to concrete-placement operations and temperature changes and for prestressing and detensioning operations. Coat contact surfaces of molds with release agent before reinforcement is placed. Avoid contamination of reinforcement and prestressing tendons by release agent.

   1. Place form liners accurately to provide finished surface texture indicated. Provide solid backing and supports to maintain stability of liners during concrete placement. Coat form liner with form-release agent.

B. Maintain molds to provide completed precast structural concrete units of shapes, lines, and dimensions indicated, within fabrication tolerances specified.

2.8 FABRICATION

A. Cast-in Anchors, Inserts, Plates, Angles, and Other Anchorage Hardware: Fabricate anchorage hardware with sufficient anchorage and embedment to comply with design requirements. Accurately position for attachment of loose hardware, and secure in place during precasting operations. Locate anchorage hardware where it does not affect position of main reinforcement or concrete placement.

B. Furnish loose hardware items including steel plates, clip angles, seat angles, anchors, dowels, cramps, hangers, and other hardware shapes for securing precast structural concrete units to supporting and adjacent construction.

C. Cast-in reglets, slots, holes, and other accessories in precast structural concrete units as indicated on the Contract Drawings.

D. Cast-in openings larger than 10 inches in any dimension.

E. Reinforcement: Comply with recommendations in PCI MNL 116 for fabricating, placing, and supporting reinforcement.

F. Reinforce precast structural concrete units to resist handling, transportation, and erection stresses and specified in-place loads.

G. Comply with requirements in PCI MNL 116 and in this Section for measuring, mixing, transporting, and placing concrete. After concrete batching, no additional water may be added.

H. Place face mixture to a minimum thickness after consolidation of the greater of 1 inch or 1.5 times the maximum aggregate size, but not less than the minimum reinforcing cover specified.

I. Place concrete in a continuous operation to prevent cold joints or planes of weakness from forming in precast concrete units.

   1. Place backup concrete mixture to ensure bond with face-mixture concrete.

J. Thoroughly consolidate placed concrete by vibration without dislocating or damaging reinforcement and built-in items, and minimize pour lines, honeycombing, or entrapped air voids on surfaces. Use equipment and procedures complying with PCI MNL 116.

1. Place self-consolidating concrete without vibration according to PCI TR-6, "Interim Guidelines for the Use of Self-Consolidating Concrete in Precast/Prestressed Concrete Institute Member Plants." Ensure adequate bond between face and backup concrete, if used.

K. Comply with PCI MNL 116 procedures for hot- and cold-weather concrete placement.

L. Identify pickup points of precast structural concrete units and orientation in structure with permanent markings, complying with markings indicated on Shop Drawings. Imprint or permanently mark casting date on each precast structural concrete unit on a surface that does not show in finished structure.

M. Cure concrete, according to requirements in PCI MNL 116, by moisture retention without heat or by accelerated heat curing using live steam or radiant heat and moisture. Cure units until compressive strength is high enough to ensure that stripping does not have an effect on performance or appearance of final product.

N. Discard and replace precast structural concrete units that do not comply with requirements, including structural, manufacturing tolerance, and appearance, unless repairs meet requirements in PCI MNL 116 and meet Engineer's approval.

2.9 FABRICATION TOLERANCES

A. Fabricate precast structural concrete units to shapes, lines, and dimensions indicated so each finished unit complies with PCI MNL 116 product dimension tolerances as well as position tolerances for cast-in items.

2.10 COMMERCIAL FINISHES

A. Standard Grade: Normal plant-run finish produced in molds that impart a smooth finish to concrete. Surface holes smaller than 1/2 inch caused by air bubbles, normal color variations, form joint marks, and minor chips and spalls are permitted. Fill air holes greater than 1/4 inch in width that occur more than once per 2 sq. in.. Major or unsightly imperfections, honeycombs, or structural defects are not permitted. Limit joint offsets to 1/8 inch.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine supporting structural frame or foundation and conditions for compliance with requirements for installation tolerances, bearing surface tolerances, and other conditions affecting performance of the Work.

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

C. Do not install precast concrete units until supporting, cast-in-place concrete has attained minimum allowable design compressive strength and until supporting steel or other structure is structurally ready to receive loads from precast concrete units.

3.2 INSTALLATION

A. Install clips, hangers, bearing pads, and other accessories required for connecting precast structural concrete units to supporting members and backup materials.

B. Erect precast structural concrete level, plumb, and square within specified allowable tolerances. Provide temporary structural framing, shoring, and bracing as required to maintain position, stability, and alignment of units until permanent connections are complete.

1. Install temporary steel or plastic spacing shims or bearing pads as precast structural concrete units are being erected. Tack weld steel shims to each other to prevent shims from separating.
2. Maintain horizontal and vertical joint alignment and uniform joint width as erection progresses.
3. Remove projecting lifting devices and use plastic patch caps or sand-cement grout to fill voids within recessed lifting devices flush with surface of adjacent precast surfaces when recess is exposed.
4. For hollow-core slab voids used as electrical raceways or mechanical ducts, align voids between units and tape butt joint at end of slabs.

C. Connect precast structural concrete units in position by bolting, welding, grouting, or as otherwise indicated on Shop Drawings. Remove temporary shims, wedges, and spacers as soon as practical after connecting and grouting are completed.

D. Field cutting of precast units is not permitted without approval of Engineer.

E. Fasteners: Do not use drilled or powder-actuated fasteners for attaching accessory items to precast, prestressed concrete units.

F. Welding: Comply with applicable requirements in AWS D1.1/D1.1M and AWS D1.4/D1.4M for welding, welding electrodes, appearance, quality of welds, and methods used in correcting welding work.

G. At bolted connections, use lock washers, tack welding, or other approved means to prevent loosening of nuts after final adjustment.

1. Where slotted connections are used, verify bolt position and tightness. For sliding connections, properly secure bolt but allow bolt to move within connection slot.

2. For slip-critical connections, use method and inspection procedure approved by Engineer and coordinated with inspection agency.

H. Grouting or Dry-Packing Connections and Joints: Grout connections and joints and open spaces at keyways, connections, and joints where required or indicated on Shop Drawings. Retain flowable grout in place until hard enough to support itself. Alternatively, pack spaces with stiff dry-pack grout material, tamping until voids are completely filled.

3.3 ERECTION TOLERANCES

A. Erect precast structural concrete units level, plumb, square, and in alignment without exceeding the noncumulative erection tolerances of PCI MNL 135.

B. Minimize variations between adjacent slab members by jacking, loading, or other method recommended by fabricator and approved by Engineer.

3.4 FIELD QUALITY CONTROL

A. Special Inspections: Engage a qualified special inspector to perform special inspections.

B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

C. Visually inspect field welds and test according to ASTM E 165 or to ASTM E 709 and ASTM E 1444. High-strength bolted connections are subject to inspections.

D. Testing agency will report test results promptly and in writing to Contractor and Engineer.

E. Repair or remove and replace work where tests and inspections indicate that it does not comply with specified requirements.

F. Additional testing and inspecting, at Contractor's expense, shall be performed to determine compliance of replaced or additional work with specified requirements.

G. Prepare test and inspection reports.

3.5 REPAIRS

A. Repair precast structural concrete units if permitted by Engineer.

1. Repairs may be permitted if structural adequacy, serviceability, durability, and appearance of units have not been impaired.

B. Mix patching materials and repair units so cured patches blend with color, texture, and uniformity of adjacent exposed surfaces and show no apparent line of demarcation between original and repaired work, when viewed in typical daylight illumination from a distance of 20 feet.

C. Prepare and repair damaged galvanized coatings with galvanizing repair paint according to ASTM A 780/A 780M.

D. Wire brush, clean, and paint damaged prime-painted components with same type of shop primer.

E. Remove and replace damaged precast structural concrete units that cannot be repaired or when repairs do not comply with requirements as determined by Engineer.

3.6 CLEANING

A. Clean mortar, plaster, fireproofing, weld slag, and other deleterious material from concrete surfaces and adjacent materials immediately.

B. Clean exposed surfaces of precast concrete units after erection and completion of joint treatment to remove weld marks, other markings, dirt, and stains.

1. Perform cleaning procedures, if necessary, according to precast concrete fabricator's written recommendations. Protect other work from staining or damage due to cleaning operations.
2. Do not use cleaning materials or processes that could change the appearance of exposed concrete finishes or damage adjacent materials.

END OF SECTION 034100

SECTION 036000
GROUTING

PART 1 GENERAL

1.01 SUMMARY

A. The Contractor shall provide grout, complete and in place, in accordance with the Contract Documents. For concrete repair material and procedures, reference Section 030100 Maintenance of Concrete.

B. Grout provided as a base support for mechanical and electrical equipment shall conform to manufacturer's requirements and the requirements of this section.

C. The following types of grout are covered in this Section:

1. Neat Cement Grout
2. Non-Shrink Grout
3. High Strength Non-Shrink Grout
4. Non-Shrink Epoxy Grout
5. Topping Grout and Grout Fill

1.02 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. The edition of the standards applicable to the Work shall be those editions referenced by the 2021 International Building Code (IBC). If the standard is not referenced by the IBC, nor an IBC-referenced standard listed below, the edition of the standard applicable to the Work shall be the edition in effect on the date of signing and sealing of the contract specifications.

B. Reference Specifications

1. Section 033000 “Cast-in-Place Concrete”.
2. Section 034100 "Precast Structural Concrete”.

C. Reference Standards

ASTM International (ASTM)	
ASTM C109	Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or [50-mm] Cube Specimens)
ASTM C307	Standard Test Method for Tensile Strength of Chemical-Resistant Mortar, Grouts, and Monolithic Surfacings
ASTM C531	Standard Test Method for Linear Shrinkage and Coefficient of Thermal Expansion of Chemical-Resistant Mortars, Grouts, Monolithic Surfacings, and Polymer Concretes

ASTM C579	Standard Test Methods for Compressive Strength of Chemical-Resistant Mortars, Grouts, Monolithic Surfacings, and Polymer Concretes
ASTM C580	Standard Test Method for Flexural Strength and Modulus of Elasticity of Chemical-Resistant Mortars, Grouts, Monolithic Surfacings, and Polymer Concretes
ASTM C827	Standard Test Method for Change in Height at Early Ages of Cylindrical Specimens of Cementitious Mixtures
ASTM C882	Standard Test Method for Bond Strength of Epoxy-Resin Systems Used with Concrete by Slant Shear
ASTM C1090	Standard Test Method for Measuring Changes in Height of Cylindrical Specimens from Hydraulic-Cement Grout
ASTM C1107	Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink)
ASTM C1116	Standard Specification for Fiber-Reinforced Concrete
ASTM C1339	Standard Test Method for Flowability and Bearing Area of Chemical-Resistant Polymer Machinery Grouts
International Concrete Repair Institute (ICRI)	
ICRI 310.2R-2013	Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, Polymer Overlays, and Concrete Repair

1.03 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 013300 Submittal Procedures.

1. Certified testing lab reports for tests indicated herein.

2. Test results and service report from the field tests and the demonstration and training session verifying the requirements indicated herein.

3. Manufacturer’s literature containing instructions and recommendations on the mixing, handling, placement, curing, and appropriate uses for each type of grout used in the Work, and location of use.

4. Documentation indicating that the grouts contain no chlorides or other chemicals that cause corrosion.

5. Manufacturer’s Safety Data Sheet documenting composition of grouts.

6. Submit manufacturer's written warranty as indicated herein.

1.04 QUALITY ASSURANCE

A. Field Tests

1. Compression test specimens will be taken from the first placement of each type of grout, and at intervals thereafter selected by the Engineer. The specimens will be made by the Engineer or its representative.

2. Compression tests and fabrication of specimens for cement based non-shrink grout will be performed in accordance with ASTM C1107 at intervals during construction selected by the Engineer.

3. Compression tests and fabrication of specimens for topping grout and grout fill will be performed in accordance with Section 033000 Cast-in-Place Concrete at intervals during construction selected by the Engineer.

4. Compression tests and fabrication of specimens for epoxy grouts will be performed in accordance with ASTM C579, Method B, at intervals during construction selected by the Engineer. A set of 3 specimens will be made for testing at 7 Days and each earlier time period as appropriate.

5. The cost of laboratory tests on grout will be paid by the OWNER except where test results show the grout to be defective. In such case, the Contractor shall pay for the tests, removal and replacement of Defective Work, and re-testing, all as part of the Work.

6. The Contractor shall assist the Engineer in obtaining specimens for testing and shall furnish materials necessary for fabricating the test specimens.

B. Construction Tolerances: Construction tolerances shall be as indicated in Section 033000 Cast-in-Place Concrete unless indicated otherwise.

C. Pre-Installation Demonstration and Training

1. Non-Shrink Grouts

a. The grout manufacturer shall give a demonstration and training session for the cement based and epoxy non-shrink grouts to be used on the project before any installation of grout is allowed.

b. The Contractor shall transport the test cubes to an independent test laboratory, obtain the test reports, and report these demonstration and training test cube strengths to the Engineer.

1.05 SPECIAL CORRECTION OF DEFECTS PROVISIONS

A. Manufacturer's Warranty

1. Furnish one year warranty for Work provided under this section.

2. Manufacturer's warranty shall not contain a disclaimer limiting responsibility to the purchase price of products or materials.

PART 2 PRODUCTS

2.01 APPLICATION

A. Unless indicated otherwise, grouts shall be provided as listed below whether indicated on the Drawings or not.

Application	Type of Grout
Beam and column (1 or 2 story) base plates less than 16-inches in the least dimension.	Non-Shrink
Column base plates (greater than 2 story or larger than 16-inches in the least dimension)	High Strength Non-Shrink
Under precast concrete elements	High Strength Non-Shrink
Storage tanks and other non-motorized equipment or machinery under 30 horsepower	Non-Shrink
Motorized equipment over 30 horsepower and equipment under 30 horsepower but subject to severe shock loads and high vibrations	Non-Shrink Epoxy
Filling blockout spaces for embedded items such as railing posts, gate guide frames, etc.	Non-Shrink
Toppings and grout fill less than 3-inches thick	Topping Grout
Toppings and grout fill greater than 3-inches thick	Section 2.4 and Structural Concrete per Section 033000 Cast-in-Place Concrete
Anchor bolts, anchor rods and reinforcing steel required to be set in epoxy or adhesive.	Post Installed Anchors in Concrete per Section 050519 Post-Installed Concrete Anchors
Repair of holes and defects in concrete members.	Concrete Repair and Rehabilitation per Section 030100 Maintenance of Concrete

2.02 NEAT CEMENT GROUT

A. Neat cement grout shall be composed of one 94 pound bag of cement and 5 gallons minimum to 6 gallons maximum of clean water to obtain the desired consistency.

B. Cement material and water shall be as indicated in 033000 Cast-in-Place Concrete.

2.03 NON-SHRINK GROUTS

A. General

1. All non-shrink grout shall be cement based unless otherwise noted.

2. Cement-based non-shrink grout shall be a prepackaged, inorganic, fluid, non-gas liberating, non-metallic, cement type grout requiring only the addition of water. Cement from kilns burning metal-rich hazardous waste fuel shall not be used.

3. Manufacturer's instructions shall be printed on each bag or other container in which the materials are packaged. The specific formulation for each non-shrink grout shall be as recommended by the manufacturer for the particular application.

4. The manufacturer’s product information shall state the acceptability of the non-shrink grout for the intended purpose and location.

5. Grout shall not contain chlorides or additives that may contribute to corrosion.

6. Grout placed in continuously wet environments or in exterior conditions shall not contain gypsum or calcium salt.

7. All cement-based non-shrink grout shall have the following general properties:

   a. Meet the requirements of ASTM C1107.

   b. Have a maximum early age height change of 4.0 percent expansion, and shall have no shrinkage (0.0 percent) in accordance with ASTM C827. The grout when tested shall not bleed or segregate at maximum allowed water.

   c. No shrinkage (0.0 percent) and a maximum of 0.3 percent expansion in the hardened state when tested in accordance with ASTM C1090.

   d. A minimum bond strength (concrete to grout) of 1900 psi per modified ASTM C882.

8. Environmental and ambient conditions shall be a factor in the selection of non-shrink grout. If a non-shrink grout is to be used in a high temperature environment or freeze/thaw environment, the manufacturer’s product information shall state the acceptability for each environmental condition.

9. Grout shall be suitable for use in freeze/thaw environments.

B. Non-Shrink Grout

1. Non-Shrink Grout shall have a minimum 28 Day compressive strength of 5000 psi when mixed at a fluid consistency and tested per ASTM C109.

2. Non-Shrink Grout shall be Five Star Grout by Five Star Products, Inc., Fluid Grout 100 by Five Star Products, Inc., Sikagrout 212 by Sika Corporation, or approved equal.

C. High Strength Non-Shrink Grout

1. High Strength Non-Shrink Grout shall have a minimum 28-Day compressive strength of 10,000 psi when mixed at a fluid consistency and tested per ASTM C109.

2. High Strength Non-Shrink Grout shall be High Strength Grout by Five Star Products, Inc., Sikagrout 428 FS by Sika Corporation, or approved equal.

2.04 NON-SHRINK EPOXY GROUT

A. Non-shrink epoxy grout shall develop a minimum compressive strength of 9000 psi in 24 hours and 13,000 psi in seven days when tested in accordance with ASTM C579, method B.

B. Non-shrink epoxy grout shall be a flowable, non-shrink, 100 percent solids system. The epoxy grout system shall have 3 components: resin, hardener, and specially blended aggregate, each premeasured and prepackaged. The resin component shall not contain any non-reactive diluents.

C. The manufacturer’s product information shall state the acceptability of the epoxy grout for the intended purpose and location.

D. Variation of component ratios is not permitted unless specifically recommended by the manufacturer. Manufacturer's instructions shall be printed on each container in which the materials are packaged.

E. Resins containing butyl glycidyl ether (BGE) or other highly volatile and hazardous reactive diluents are not acceptable.

F. Non-shrink epoxy grout shall have a negligible (less than 0.0006 in/in) length change after hardening, and a coefficient of thermal expansion less than 0.00003 in/in F when tested in accordance with ASTM C531.

G. The effective bearing area shall be a minimum of 85 percent effective bearing area (EBA) in accordance with ASTM C1339, for bearing area and flow.

H. The chemical formulation of the non-shrink epoxy grout shall be that recommended by the manufacturer for the particular application. Do not reduce aggregate loading or add solvents to increase flowability.

I. Non-shrink epoxy grout shall have the following minimum properties when tested at 7 Days:

1. Minimum bond strength to concrete of 3000 psi per ASTM C882 modified.

2. Minimum bond strength to steel of 1700 psi per ASTM C882 modified.

3. Minimum flexural strength of 2500 psi per ASTM C580.

4. Minimum tensile strength of 2000 psi per ASTM C307.

J. Non-shrink epoxy grout shall be DP Epoxy Grout by Five Star Products, Inc., MasterFlow 648 by BASF/Master Builders, Sikadur 42 Grout-Pak by Sika Corporation, or approved equal.

2.05 TOPPING GROUT AND GROUT FILL

A. Topping grout and grout fill for built-up surfaces of tanks, channels, and basin bottoms shall be composed of cement, fine aggregate, coarse aggregate, water, and admixtures proportioned and mixed as indicated. Materials and procedures indicated for structural concrete in Section 033000 Cast-in-Place Concrete, shall apply unless indicated otherwise

B. Topping grout used in clarifiers, or where the fill thickness is 3 inches or greater shall contain fiber reinforcing, unless otherwise shown on the Contract Documents. Fiber reinforcing shall be 100 percent virgin polypropylene fibrillated fibers specifically manufactured in a blended gradation for use as concrete secondary reinforcement. Fibers shall be added at a rate of 1.5 pounds per cubic yard of concrete. Fibers shall conform to ASTM C1116.

C. For topping grout and grout fill thickness greater than 3-inches, ready-mix concrete may be used with the following requirements:

1. Strength: Minimum compressive strength of topping grout and grout fill at 28 days shall be 4000 psi.

2. Minimum of 564 pounds of cement per cubic yard with a maximum water/cement ratio of 0.45

3. Coarse aggregate shall be as follows:

U.S. Standard Sieve Size	**Percent By Weight Passing**
1/2 in	100
3/8 in	90-100
No. 4	20-55
No. 8	5-30
No. 16	0-10
No. 30	0

D. Final mix design shall be as determined by trial mix design as indicated in Section 033000 Cast-in-Place Concrete, except that drying shrinkage tests are not required.

E. Topping grout and grout fill shall contain air-entraining agent per Section 033000 Cast-in-Place Concrete.

2.06 CURING MATERIALS

A. Curing materials shall be in accordance with Section 033000 Cast-in-Place Concrete and as recommended by the manufacturer of prepackaged grouts.

2.07 CONSISTENCY

A. The consistency of grout shall be as necessary to completely fill the space to be grouted for the particular application. Dry pack consistency is defined such that the grout is plastic and moldable but will not flow. Where "dry pack" is called for in the Contract Documents, it shall mean a grout of that consistency; the type of grout to be used shall be as indicated herein for the particular application.

B. The slump for topping grout and grout fill shall be adjusted to match placement and finishing conditions but shall not exceed 4-inches.

2.08 MEASUREMENT OF INGREDIENTS

A. Measurements shall be made accurately by volume using containers. Shovel measurements are not allowed.

B. Prepackaged grouts shall have ingredients measured by means recommended by the manufacturer.

PART 3 EXECUTION

3.01 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Grout shall be stored in accordance with manufacturer's recommendations.

3.02 GENERAL

A. Contractor shall arrange for the manufacturer of prepackaged grouts to provide on-site technical assistance within 72 hours of request, as part of the Work.

B. Grout shall not be placed until base concrete or masonry has attained its design strength, unless authorized otherwise by the Engineer.

C. When cementitious grouts are used on concrete surfaces, the concrete surface shall be saturated with water for 24 hours prior to placement. Upon completion of the saturation period, excess water shall be removed with clean, oil free compressed air prior to grouting. Concrete substrate shall not be wet prior to placement of epoxy grouts.

D. Surface preparation, curing, and protection of cement based grout shall be in accordance with Section 033000 Cast-in-Place Concrete. The finish of the grout surface shall match that of the adjacent concrete unless otherwise indicated.

E. Surfaces that will be in contact with grout shall be free of dirt, loose rust, oil, wax, grease, curing compounds, laitance, loose concrete, and other deleterious materials.

F. Shade the Work from sunlight for at least 24 hours before and 48 hours after grouting.

G. Contact the grout manufacturer's representative for assistance on hot and cold weather grouting techniques and precautions if applicable.

3.03 GROUTING PROCEDURES

A. General: Mixing, surface preparation, handling, placing, consolidation, curing, and other means of execution for prepackaged grouts shall be done according to the instructions and recommendations of the manufacturer.

B. Structural, equipment, tank, and piping support bases shall be grouted, unless indicated otherwise.

1. The original concrete shall be blocked out or finished off a sufficient distance below the plate to provide for a minimum one-inch thickness of grout or other thickness if indicated.

2. After the base plate has been set in position at the proper elevation by steel wedges or double nuts on the anchor bolts, the space between the bottom of the plate and the original pour of concrete shall be filled with non-shrink-type grout through a headbox of appropriate size. The mixture shall be of a fluid consistency and poured continuously into the space between the plate and the base concrete. Forms for grout shall be tight against retaining surfaces, and joints shall be sealed as recommended by the grout manufacturer to be liquid-tight. Forms shall be coated as recommended by the grout manufacturer for easy form release. Where this method of placement is not practical or where required by the Engineer, alternate grouting methods shall be submitted by the Contractor for acceptance by the Engineer.

3. Concrete equipment pads for equipment bases that will be epoxy-grouted shall be sized so that, when the equipment base is fully grouted, the epoxy grout is stopped not less than 4-inches from the edge of the pad.

C. Topping Grout and Grout Fill

1. Mechanical, electrical, and finish Work shall be completed prior to placement of topping grout or grout fill.

2. To ensure bonding to the base slab, the base slab shall have a roughened surface to a ¼-inch amplitude. The base slab shall be thoroughly cleaned and wetted to saturated surface dry (SSD) condition per ICRI 310.2R-2013 prior to placing topping grout and grout fill. No topping grout shall be placed until the slab is completely free from standing pools or ponds of water. A thin coat of neat cement grout shall be broomed into the surface of the slab just before topping or fill placement. The neat cement grout shall not be allowed to dry before topping placement. If it does dry, it must be immediately removed using wet stiff brooms and reapplied.

3. The topping and fill shall be compacted by rolling or thorough tamping, brought to established grade, and floated. Grouted fill for tank and basin bottoms where scraping mechanisms are to be installed shall be screeded by blades attached to the revolving mechanism of the equipment in accordance with the procedures outlined by the equipment manufacturer after the grout is brought to the established grade. Coat surface with evaporation retardant as needed to prevent plastic shrinkage cracks.

4. The minimum thickness of grout topping and grout fill shall be one-inch. Where the finished surface of grout fill is to form an intersecting angle of less than 45 degrees with the concrete surface it is to be placed against, a key shall be formed in the concrete surface at the intersection point. The key shall be a minimum of 3-1/2 inches wide by 1-1/2 inches deep.

5. Topping grout placed on sloping slabs shall proceed uniformly from the bottom of the slab to the top, for the full width of the placement.

6. The surface shall be tested with a straight edge to detect high and low spots which shall be immediately eliminated. When the topping or fill has hardened sufficiently, it shall be steel troweled to a smooth surface free from pinholes and other imperfections. An approved type of mechanical trowel may be used as an assist in this operation, but the last pass over the surface shall be by hand-troweling. During finishing, no water, dry cement, or mixture of dry cement and sand shall be applied to the surface.

7. As soon as topping or fill finishing is completed, coat surface with curing compound. After the topping is set and sufficiently hard in clarifiers and where required by the Engineer, the tank shall be filled with sufficient water to cover the entire floor for 14 days.

3.04 CONSOLIDATION

A. Grout shall be placed in such a manner, for the consistency necessary for each application, to assure that the space to be grouted is completely filled.

END OF SECTION

SECTION 051200
STRUCTURAL STEEL FRAMING

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section Includes:

1. Structural steel.

2. Miscellaneous Steel.

1.03 DEFINITIONS

A. Structural Steel: Elements of structural-steel frame, as classified by AISC 303, "Code of Standard Practice for Steel Buildings and Bridges."

1.04 PERFORMANCE REQUIREMENTS

A. Connections: Provide details of connections required by the Contract Documents to be selected or completed by structural-steel fabricator, including comprehensive engineering analysis by a qualified professional engineer.

1. Select and complete connections using schematic details indicated.

1.05 ACTION SUBMITTALS

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

B. Shop Drawings: Show fabrication of structural-steel components.

1. Include details of cuts, connections, splices, camber, holes, and other pertinent data.

2. Include embedment drawings.

3. Indicate welds by standard AWS symbols, distinguishing between shop and field welds, and show size, length, and type of each weld. Show backing bars that are to be removed and supplemental fillet welds where backing bars are to remain.

4. Indicate type, size, and length of bolts, distinguishing between shop and field bolts. Identify pretensioned and slip-critical high-strength bolted connections.

1.06 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified fabricator.

B. Welding certificates.

1.07 QUALITY ASSURANCE

A. Fabricator Qualifications: A qualified fabricator that participates in the AISC Quality Certification Program and is designated an AISC-Certified Plant, Category STD.

B. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

1.08 DELIVERY, STORAGE, AND HANDLING

A. Store materials to permit easy access for inspection and identification. Keep steel members off ground and spaced by using pallets, dunnage, or other supports and spacers. Protect steel members and packaged materials from corrosion and deterioration.

1. Do not store materials on structure in a manner that might cause distortion, damage, or overload to members or supporting structures. Repair or replace damaged materials or structures as directed.

B. Store fasteners in a protected place in sealed containers with manufacturer's labels intact.

1. Fasteners may be repackaged provided Owner's testing and inspecting agency observes repackaging and seals containers.

2. Clean and relubricate bolts and nuts that become dry or rusty before use.

3. Comply with manufacturers' written recommendations for cleaning and lubricating ASTM F 1852 fasteners and for retesting fasteners after lubrication.

1.09 COORDINATION

A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' recommendations to ensure that shop primers and topcoats are compatible with one another.

B. Coordinate installation of anchorage items to be embedded in or attached to other construction without delaying the Work. Provide setting diagrams, sheet metal templates, instructions, and directions for installation.

PART 2 PRODUCTS

2.01 STRUCTURAL-STEEL MATERIALS

A. Channels, Angles: ASTM A 36/A 36M.

B. Plate and Bar: ASTM A 36/A 36M.

2.02 BOLTS, CONNECTORS, AND ANCHORS

A. High-Strength Bolts, Nuts, and Washers: ASTM A 325, Type 1, heavy-hex steel structural bolts; ASTM A 563, Grade C, heavy-hex carbon-steel nuts; and ASTM F 436, Type 1, hardened carbon-steel washers; all with plain finish.

2.03 PRIMER

A. Primer: Fabricator's standard lead- and chromate-free, nonasphaltic, rust-inhibiting primer complying with MPI#79 and compatible with topcoat.

B. Galvanizing Repair Paint: ASTM A 780.

2.04 FABRICATION

A. Structural Steel: Fabricate and assemble in shop to greatest extent possible. Fabricate according to AISC's "Code of Standard Practice for Steel Buildings and Bridges" and AISC 360.

B. Bolt Holes: Cut, drill, or punch standard bolt holes perpendicular to metal surfaces.

2.05 GALVANIZING

A. Hot-Dip Galvanized Finish: Apply zinc coating by the hot-dip process to structural steel according to ASTM A 123/A 123M.

2.06 SOURCE QUALITY CONTROL

A. Testing Agency: Owner will engage an independent testing and inspecting agency to perform shop tests and inspections and prepare test reports.

B. Correct deficiencies in Work that test reports and inspections indicate does not comply with the Contract Documents.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify, with steel Erector present, elevations of concrete- and masonry-bearing surfaces and locations of anchor rods, bearing plates, and other embedments for compliance with requirements.

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

3.02 PREPARATION

A. Provide temporary shores, guys, braces, and other supports during erection to keep structural steel secure, plumb, and in alignment against temporary construction loads and loads equal in intensity to design loads. Remove temporary supports when permanent structural steel, connections, and bracing are in place unless otherwise indicated.

3.03 ERECTION

A. Set structural steel accurately in locations and to elevations indicated and according to AISC 303 and AISC 360.

B. Maintain erection tolerances of structural steel within AISC's "Code of Standard Practice for Steel Buildings and Bridges."

C. Align and adjust various members that form part of complete frame or structure before permanently fastening. Before assembly, clean bearing surfaces and other surfaces that will be in permanent contact with members. Perform necessary adjustments to compensate for discrepancies in elevations and alignment.

D. Do not use thermal cutting during erection.

E. Do not enlarge unfair holes in members by burning or using drift pins. Ream holes that must be enlarged to admit bolts.

3.04 FIELD CONNECTIONS

A. High-Strength Bolts: Install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for type of bolt and type of joint specified.

1. **Joint Type: Snug tightened.**

B. Weld Connections: Comply with AWS D1.1/D1.1M for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.

3.05 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified independent testing and inspecting agency to inspect field welds.

B. Bolted Connections: Bolted connections will be inspected according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."

C. Welded Connections: Field welds will be visually inspected according to AWS D1.1/D1.1M.

D. Correct deficiencies in Work that test reports and inspections indicate does not comply with the Contract Documents.

3.06 REPAIRS AND PROTECTION

A. Galvanized Surfaces: Clean areas where galvanizing is damaged or missing and repair galvanizing to comply with ASTM A 780.

B. Touchup Painting: Immediately after erection, clean exposed areas where primer is damaged or missing and paint with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.

1. Clean and prepare surfaces by SSPC-SP 2 hand-tool cleaning or SSPC-SP 3 power-tool cleaning.

END OF SECTION

SECTION 221329
SUBMERSIBLE SEWER PUMPS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section includes:

1. Submersible sewage pumps

1.03 DEFINITIONS

A.	(AISI)	American Iron & Steel Institute
B.	(ASTM)	American Society for Testing and Materials
C.	(FM)	Factory Mutual
D.	(HI)	Hydraulic Institute Standards for Centrifugal, Rotary, and Reciprocating Pumps
E.	(NFPA)	National Fire Protection Agency
F.	(NEC)	National Electric Code
G.	(NEMA)	National Electrical Manufacturers Association
H.	(AFBMA)	Anti-Friction Bearing Manufacturers Association
I.	(ISO)-ISO9001	International Standards Organization

1.04 ACTION SUBMITTALS

A. Product Data: For each type of product indicated include construction details, material descriptions, dimensions of individual components and profiles. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Wiring Diagrams: For power, signal, and control wiring.

C. Closeout Submittals: For pumps and controls, to include in operation and maintenance manuals.

D. Warranty: The pump manufacturer shall warrant the pump, motor and guide system to the Owner against defects in workmanship and materials for a period of at least five (5) years. If a guide cable system is used the pump manufacturer shall warrant the guide cable system (including guide cables and brackets) to the Owner against defects in workmanship and materials for a period of five (5) years. Both pump manufacturer warranties shall be in published form, and shall apply to all similar units. A copy of each warranty shall be provided to the Owner at startup.

1.05 QUALITY ASSURANCE

A. Factory Testing: All pumps shall be tested by the manufacturer in accordance with the appropriate Hydraulics Institute standard prior to shipment for installation. The results of all factory testing shall be reviewed for compliance with specified requirements and maintained as part of the construction record documentation.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. UL Compliance: Comply with UL 778 for motor-operated water pumps.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Retain shipping flange protective covers and protective coatings during storage.

B. Protect bearings and couplings against damage.

C. Comply with pump manufacturer's written rigging instructions for handling.

D. Protect all cables, pumps, motors, equipment from moisture, dirt, foreign objects, and damage.

PART 2 PRODUCTS

2.01 REQUIREMENTS

A. Furnish and install quantity two(2) explosion proof, non-clog, submersible centrifugal type sewage pumps designed and manufactured to convey raw unscreened wastewater. Each pump shall be equipped with a minimum 40 HP submersible electric motor, connected for operation on 460 volts, 3 phase, 60 hertz, electrical supply service, with 50 feet of submersible cable (SUBCAB) suitable for submersible pump applications. The power cable shall be sized according to NEC and ICEA standards and also meet with P-MSHA Approval. Pump shall be capable of delivering specified GPM at the specified TDH as listed:

B. Operating Conditions

1. Design:	2,200 GPM @ 50 FT TDH @ 70% MIN.
2. Secondary:	2,700 GPM @ 41 FT TDH @ 70% MIN.
3. Min. Shutoff head:	80 FT
4. Min. Motor HP:	40 HP
5. Min. Hydraulic Efficiency (at design):	70%
6. Maximum Motor RPM:	1800 RPM

C. Pump data plate shall be mounted on inside of control panel door and identify the pump manufacturer, voltage, full load amperes, impeller size, pump model, pump serial number, and pump rating (GPM @ TDH). Fasteners shall be of, at minimum, ASTM A276 Type 316 stainless steel.

2.02 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, pumps manufactured by the following are acceptable: Flygt, ABS, and KSB.

B. All products, whether named as "acceptable" or proposed as "equal" must fully comply with these specifications. Standard product must be modified, if required, for compliance. The contractor shall base his bid price on the listed acceptable manufacturers for purposes of determining the successful bidder on this project.

2.03 PUMPS

A. PUMP DESIGN CONFIGURATION (Wet pit installation)

1. Provide pumps capable of handling raw unscreened wastewater. Design pumps to allow for removal and reinstallation without the need to enter the wet well and without removal of bolts, nuts or other fasteners.

2. The discharge base & elbow assembly shall be permanently installed in the wet well and connected to the discharge piping. The pump(s) shall be automatically and firmly connected to the discharge connection, guided by no less than two guide bars (304 stainless steel schedule 40) extending from the top of the station to the discharge connection. The rails shall be plumb and the distance between rail supports shall not exceed 15 feet. The sliding guide bracket shall be a separate part of the pumping unit, capable of being attached to standard 6 inch ANSI class pump flanges.

3. Sealing of the pumping unit to the discharge connection shall be accomplished by a machined metal to metal watertight contact or a field replaceable Nitrile (Buna-N) rubber profile gasket or o-ring. Final connection shall insure zero leakage between pump and discharge connection flange.

4. No portion of the pump shall bear directly on the sump floor. Each pump shall be fitted with 50 feet of stainless steel cable. The working load of the lifting system shall be 50% greater than the pump unit weight.

B. PUMP CONSTRUCTION

1. Major pump components shall be of gray cast iron, EN-GJL-250 (ASTM A-48, Class 35B) with smooth surfaces devoid of porosity or other irregularities. All exposed fasteners shall be stainless steel 1.4401 (AISI type 316) construction. All metal surfaces coming into contact with the pumped media (other than the stainless steel components) shall be protected by a factory applied spray coating of high solids two part epoxy paint finish on the exterior of the pump. The pump shall be equipped with an open lifting hoop suitable for attachment of standard chain fittings, or for hooking

from the wet well surface. The hoop shall be ductile cast iron EN-GJS-400-18 (ASTM A536; 60-40-18) with an option of stainless steel 1.4462, and shall be rated to lift a minimum of four times the pump weight.

2. Sealing design for the pump/motor assembly shall incorporate machined surfaces fitted with Nitrile (Buna-N) rubber O-rings. Sealing will be the result of controlled compression of rubber O- rings in two planes of the sealing interface. Housing interfaces shall meet with metal to metal contact between machined surfaces, and sealing shall be accomplished without requiring a specific torque on the securing fasteners. Rectangular cross sectioned gaskets requiring specific torque limits to achieve compression shall not be considered equal. No secondary sealing compounds shall be required or used.

C. MOTOR

1. The electric motor shall be a NEMA B design, induction type with a squirrel cage rotor, housed in a watertight cast iron, EN-GJL-250 (ASTM A-48, Class 35B) chamber for operation on 460 volts, 3 phase, 60 hertz, electrical power supply. Stator windings shall be copper and insulated with moisture resistant Class H insulation, rated for 356°F (180°C). The motor and cable shall be capable of continuous submergence underwater without loss of watertight integrity to a depth of 65 feet or greater. The motor shall be designed for continuous duty while handling pumped media with a maximum temperature of 104°F (40°C). The motor shall be capable of no less than 15 evenly spaced starts per hour.

2. The service factor (combined effect of voltage, frequency, and specific gravity) shall be a minimum of 1.15. The motor shall have a voltage tolerance of +/- 10% from nominal. The motor shall be FM and CSA approved for use in NEC Class I, Division I, Groups C & D hazardous locations.

3. The motor horsepower shall be adequate so that the pump is non-overloading throughout the entire pump performance curve from shut-off through run-out.

4. The motor shall meet the requirements of NEMA MG1 Part 30 and 31 for operation with Variable Frequency Drives. The motor shall meet efficiency standards in accordance with IEC 60034-30, level IE3. Motor rating tests shall be conducted in accordance with IEC 60034-2-1 requirements and shall be certified accurate and correct by a third party certifying agency. A certificate shall be provided upon request.

D. MOTOR PROTECTION

1. Each pump motor stator shall incorporate three thermal switches, one per stator phase winding and be connected in series, to monitor the temperature of the motor. The switches shall be connected to the pump control panel to provide a high stator temperature shutdown signal and alarm, and are used in conjunction with external motor overload protection. The switches shall automatically reset once motor temperature returns to normal. Set temperature monitors at levels recommended by the pump manufacturer.

E. COOLING SYSTEM

1. Each pump unit shall be provided with an integral motor cooling system which allows for continuous duty operation in a completely dry mode; as well as; in a fully submerged condition, without damage to the motor. The motor cooling system shall consist of a cooling jacket surrounding the stator housing. Non-toxic, environmentally safe antifreeze or propylene glycol solution shall be circulated through the jacket by a circulating impeller attached to the main motor shaft. The cooling system shall provide for continuous pump operation in liquid or ambient temperatures of up to 104°F (40°C).

F. POWER CABLE

1. The power cable shall be sized according to NEC and ICEA standards and shall be of sufficient length to reach the junction box without requiring splices. The outer jacket of the cable shall be oil, water, and UV resistant. The cable shall be capable of continuous submergence underwater without loss of watertight integrity to a depth of 65 feet or greater.

G. CABLE ENTRY SEAL

1. The cable entry seal design shall preclude specific torque requirements to insure a watertight and submersible seal. The cable entry shall consist of compressible cylindrical elastomer grommets, flanked by washers, all having a close tolerance fit against the cable outside diameter and the entry inside diameter. A strain relief device, in direct contact with both the cable and the cast iron entry housing, shall be provided. The cable entry shall be rated by Factory Mutual (or UL) for submerged operating depths to a minimum of 65 feet. The assembly shall provide ease of changing the cable when necessary using the same entry seal. The cable entry junction chamber and motor shall be sealed from each other, which shall isolate the stator housing from foreign material gaining access through the pump top.

H. MECHANICAL SEALS

1. Provide a minimum of two totally independent mechanical shaft seals, installed in tandem, each with its own independent single spring system acting in a common direction. The upper set of tandem seals shall operate in an oil chamber located below the stator housing. The set shall contain one stationary tungsten or silicon carbide ring and one positively driven rotating carbon ring, functioning as an independent secondary barrier between the pumped liquid and the stator housing. The lower tandem set shall function as the primary barrier between the pumped liquid and the stator housing. This set shall consist of a stationary ring and a positively driven rotating ring both being tungsten carbide or silicone carbide. Each seal interface shall be held in contact by its own spring system. The seals shall not require maintenance or adjustment, but shall be easily replaceable.

2. Each pump shall be provided with a lubricant chamber for the shaft sealing system. The lubricant chamber shall be designed to prevent overfilling and shall provide capacity for lubricant expansion. The seal lubricant chamber shall have one drain and one inspection plug that are accessible from the exterior of the motor unit. The seal system shall not rely upon the pumped media for lubrication. Lubricant in the chamber shall be environmentally safe non-toxic material.

3. Provide seals requiring neither routine maintenance nor adjustment, but capable of being easily inspected and replaced. Provide seals which are non-proprietary in design and manufactured by a major independent manufacturer specializing in the design and manufacture of mechanical seals, with replacements available from a source other than the pump manufacturer or its distributors.

4. Do not provide seals with the following characteristics: conventional double mechanical seals with single or multiple springs acting in opposed direction; cartridge-type mechanical seals; seals incorporating coolant circulating impellers, seals with face materials other than those specified.

I. MECHANICAL SEAL PROTECTION AND WARNING SYSTEM

1. The pump shall be equipped with a seal leak detection device and warning system. This shall be designed to alert maintenance personnel of lower seal failure without having to take the unit out of service for inspection or requiring access for checking seal chamber oil level and consistency.

2. There shall be a seal failure sensor installed in the seal chamber between the two tandem mechanical seals or in the stator housing. If the lower seal fails, contaminants which enter the seal chamber or the stator housing shall be detected by the sensor and send a signal to operate the specified warning device.

J. PUMP SHAFT

1. The pump shaft and motor shaft shall be an integral, one piece unit adequately designed to meet the maximum torque required at any normal start-up condition or operating point in the system. The maximum shaft deflection shall not exceed 0.002 inch (0.05 mm) at the lower seal during normal pump operation. Shafts using mechanical couplings or multi piece welded shafts shall not be acceptable. The shaft shall be AISI 420 or 431 stainless steel.

K. BEARINGS

1. The integral pump/motor shaft shall rotate on a minimum of two bearings. The motor bearings shall be permanently lubricated with high temperature grease. The upper motor bearing shall be a two row angular contact ball bearing. The lower bearing shall be a two row angular contact ball bearing to handle the thrust and radial forces. Bearings shall be of sufficient size and properly spaced to transfer all radial and axial loads to the pump housing and minimize shaft deflection. The minimum L_{10} bearing life shall be a minimum of 50,000 hours at any usable portion of the pump curve. The bearings shall be manufactured by a major internationally known manufacturer of high quality bearings, and shall be stamped with the manufacturer’s name and size designation on the race. Generic or unbranded bearings from other than major bearing manufacturers shall not be considered acceptable.

L. IMPELLER

1. The impeller shall be enclosed, non-clogging, and have pump out vanes to prevent grit and other materials from collecting in the seal area. The impeller shall be

capable of passing a minimum 3-inch solid sphere. Impellers shall have replaceable wear rings. The impeller shall be dynamically balanced to the ISO 10816 standard to provide smooth vibration free operation. Impellers shall be slip fit to a tapered shaft and key driven. The impeller shall be fastened to the shaft with a 400 series stainless steel washer and bolt. A volute case wear ring or wear plate shall be provided to minimize impeller wear. The wear ring/plate shall be field replaceable.

M. VOLUTE

1. The pump volute shall be a single piece grey cast iron, ASTM A-48, Class 35B, non-concentric design with smooth passages of sufficient size to pass any solids that may enter the impeller. Minimum inlet and discharge size shall be as specified. The pump discharge shall be fitted with standard ANSI 125 lb. flanges. All external-mating parts shall be machined and Buna N Rubber O-ring sealed on a beveled edge. Gaskets shall not be acceptable.

PART 3 EXECUTION

3.01 EARTHWORK

A. Excavation and filling are specified in Section 312300 Excavation and Fill.

3.02 EXAMINATION

A. Examine roughing-in for plumbing piping to verify actual locations of discharge and suction piping connections before sewage pump installation.

3.03 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

B. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

C. Tests and Inspections:

1. Perform each visual and mechanical inspection.

2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.

3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.

4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

5. Drawdown Testing: Following installation, each pump in the pump station shall be subjected to drawdown and “shut-off” head tests to verify that pump performance meets the design criteria with a full, operational force main. Surge pressure will also be measured. These tests shall be performed in the presence of an authorized TOWN OF SMITHFIELD representative and in conjunction with other instrumentation and control testing. The results shall be maintained as part of the construction record documentation.

6. Witness Testing: Witness testing will be required by TOWN OF SMITHFIELD for this installation. All costs associated with Witness testing shall be borne by the bidding contractor. The results of all witness testing shall be maintained as part of the construction record documentation.

D. Pumps and controls will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports.

3.04 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.

3.05 ADJUSTING

A. Adjust pumps to function smoothly, and lubricate as recommended by manufacturer.

B. Adjust control set points.

3.06 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain controls and pumps.

END OF SECTION

SECTION 260500
BASIC ELECTRICAL MATERIALS AND METHODS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes: General requirements for providing basic electrical materials and methods and specific work included as follows:

B. The work required includes all materials, labor and auxiliaries required to install a complete and properly operating electrical system. The electrical system required under this Division consists basically of, but is not limited to the following:

1. Electrical Service and complete distribution system for power including feeders, and connections to motors and other power loads.
2. A complete grounding and bonding system and special grounds as required or noted.
3. Standby Power and Automatic Transfer systems.
4. Power, instrumentation and control Surge Suppression systems.
5. Site lighting.
6. Instrumentation and control conduit and wiring systems.
7. Concrete work for pad mounted equipment, encased raceways, etc.
8. Electrical testing of equipment.
9. Motor starting and control systems.
10. Control PLC systems

C. Related Work Specified in Other Sections Includes:

1. Submittals Section 013300
2. Quality Control Section 014500
3. Delivery Storage and Handling Section 016600
4. Operation and Maintenance Manuals Section 017823.
5. Project Record Documents Section 017839.
6. Certain items of equipment, and various control devices including conduit and wiring which are indicated on electrical drawings to be connected, but are specified in other sections pertaining to process equipment, process control systems, and instrumentation. Install and connect these items to the electrical system as indicated or required in accordance with the Contract Documents

D. Overall Application of Specifications: This Section applies to all sections of Division 26 and to other sections that include electrical equipment requirements except when in these individual sections requirements are otherwise specified to provide and install all materials necessary for a complete operational system.

E. Drawings are diagrammatic. Correlate final equipment locations with governing Civil, Structural, Process Mechanical and Instrumentation and Control drawings. Lay out before installation so that all trades may install equipment in spaces available. Provide coordination as required for installation in a neat and workmanlike manner. Provide layout shop drawings for engineers review for the elevated platform equipment rack.

1.2 DEFINITIONS

A. Hazardous Areas: Equipment, materials and installation in areas designated as hazardous on the Drawings shall comply with NEC Articles 500, 501, 502 and 503. Hazardous areas as defined by the NEC as Class I, Division 1, Group D, or Class I, Division 2, Group D; hazardous areas as follows:

1. Refer to the hazardous boundary classification detail in the design drawings.

1.3 SYSTEM DESCRIPTION

A. Design Requirements: Design requirements are specified in the applicable sections.

B. Performance Requirements: Performance requirements are specified in the applicable sections.

1.4 SUBMITTALS

A. General: Reference Submittals Section 013300: Provide submittals for all electrical material and devices.

B. Substitutions:

1. Each bidder represents that his bid is based upon the materials and equipment described in this division of the specifications.
2. Submit substitutions to the Engineer for review and approval at least ten days prior to the bid date. Submittal shall include the name of the material or equipment for which it is to be substituted, drawings, cuts, performance and test data and any other data or information necessary for the Engineer to determine that the equipment meets all specification and requirements. If the Engineer approves any proposed substitutions, such approval will be set forth in an addendum.
3. Substituted equipment or optional equipment where permitted and approved, must conform to space requirements. Any substituted equipment that cannot meet space requirements, whether approved or not, shall be replaced at the Contractor's expense. Any modifications of related systems as a result of substitutions shall be made at the Contractor's expense.

C. Product Data and Information: Provide complete list of electrical equipment and materials to be furnished showing manufacturer, catalog number, size, type, voltage rating and other pertinent information.

1. Provide catalog data on manufacturer's standard equipment and materials. Clearly indicate on catalog cuts the equipment and devices being proposed.
2. Identification: Provide complete schedule and listing of system and equipment identification labels with legends.
3. Material shall not be ordered or shipped until the shop drawings have been approved.
4. The Engineer's shop drawing review shall be for conformance with the design concept of the project and compliance with the Specifications and the Drawings. Errors and omissions on approved shop drawings shall not relieve the Contractor from the responsibility of providing materials and workmanship required by the Specifications and the Drawings.
5. Shop drawings shall be stamped with the date checked by the contractor and a statement indicating that the shop drawings conform the Specifications and the Drawings. This statement shall also list all exceptions to the Specifications and the Drawings. Shop drawings not so checked and noted shall be returned.

D. CONTRACTOR's Shop Drawings: Provide shop drawings on items manufactured for the Contract.

1. Provide connection diagram and schematic for each piece of electrical equipment. A manufacturer's standard connection diagram or schematic showing more than one method of connection is not acceptable unless it is clearly marked to show the intended method of connection.
2. Provide diagrams showing connections to field equipment. Clearly differentiate between manufacturer's wiring and field wiring.
3. Provide raceway layout drawings showing conduits, boxes, and panels which contain the conductors to be provided. Include schedules listing conduit sizes and conductor content and identification.
4. Where additions and modifications are made to existing equipment, provide drawings which include both retained existing equipment and new Work.

E. Coordination Drawings: Prepare dimensioned sketches detailing major elements, components, and systems of electrical equipment and materials in relationship with other systems, installations indicating how actual size of equipment to be provided is to fit into space available; show NEC required working space clearances on plan.

F. Record Documents: Prepare record documents in accordance with Section 017839 – Project Record Documents. As the work progresses, legibly record all field changes on a set of Project Contract Drawings, (the "Record Drawings"). indicate installed conditions for:

1. Major raceway systems, size and location, for both exterior and interior; locations of control devices; distribution and branch electrical circuitry; and fuse and circuit breaker size and arrangements.
2. Equipment locations (exposed and concealed), dimensioned from prominent building/structure lines.
3. Approved substitutions, and actual equipment and materials installed.
4. Record Drawings shall accurately show the installed condition of the following items: Power Riser Diagram(s). Equipment elevations (front views). Raceways and pullboxes. Conductor sizes. Control Wiring Diagram(s). Underground raceway and duct bank routing. Plan view, sizes and locations of distribution transformers and outdoor electrical equipment enclosure.

G. Operation and Maintenance Manuals: Prepare operation and maintenance manuals, and in addition to the requirements specified in other Divisions, include the following information for equipment items:

1. Description of function, normal operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and catalog numbers of replacement parts. Complete parts list with stock numbers, including spare parts. A complete bill of material supplied, including serial numbers, ranges and pertinent data.
2. Manufacturer's printed operating procedures to include start-up, break-in, and routine and normal operating instructions; regulation, control, stopping, shutdown, and emergency instructions; and summer and winter operating instructions. The operating instructions shall also incorporate a functional description of the entire system, with references to the systems schematic drawings and instructions.
3. Maintenance procedures for routine preventative maintenance and troubleshooting; disassembly, repair, and reassembly; aligning and adjusting instructions.
4. A comprehensive index.
5. A complete "As Built" set of approved shop drawings.
6. A table listing of the "as left" settings for all timing relays and alarm and trip setpoints. A complete listing of As left programmable parameters for all drives, soft-starters and

other microprocessor controlled equipment.

7. System schematic drawings "As Built", illustrating all components, piping and electric connections of the systems supplied under this Section.

1.5 QUALITY ASSURANCE

A. Codes: Provide all electrical Work in accordance with applicable local codes, regulations and ordinances. If there is a conflict between the requirements specified in the Contract Documents and the codes, follow the more stringent requirements as determined and approved.

B. Testing: As a minimum, provide standard factory and field tests for each type of equipment. Other tests may be specified in the applicable equipment section.

C. Labeling: Provide all electrical equipment and materials listed and approved by Underwriters Laboratories with the UL label or other OSHA recognized testing laboratories attached to it.

D. Standard Products: Unless otherwise indicated, provide electrical materials and equipment which are the standard products of manufacturers regularly engaged in the production of such materials and equipment. Provide the manufacturer's latest standard design that conforms to these Specifications. When two or more units of the same class of material and equipment are required, provide the products of the same manufacturer.

1.6 DELIVERY, STORAGE AND HANDLING

A. General: Deliver, store and handle all products and materials as specified in Division 1 and as follows:

B. Shipping and Packing: Provide materials and equipment suitably boxed, crated or otherwise completely enclosed and protected during shipment, handling, and storage. Clearly label such boxes, crates or enclosures with manufacturer's name, and name of material or equipment enclosed.

C. Acceptance at Site: Conform to acceptance requirements as required in Division 1. Repair or replace all materials and equipment damaged by handling and storage as directed at no additional Contract cost.

D. Storage and Protection: Protect materials and equipment from exposure to the elements and keep them dry at all times. Handle and store to prevent damage and deterioration in accordance with manufacturer's recommendations.

1.7 PROJECT CONDITIONS

A. General: The Drawings indicate the extent and general arrangement of the principal electrical elements, outlets and circuit layouts. Connect and install all electrical elements and devices to form a workable system as required by the Contract Documents whether the connections and installations are specifically stated in the Specifications or shown. Provide necessary materials and installation wherever required to conform to the specific requirements of the furnished equipment and for proper installation of the Work.

B. Schematics: In general the runs of feeders are shown schematically and are not intended to show exact routing and locations of raceways. Verify actual and final arrangement, equipment locations, and prepare circuit and raceway layouts before ordering materials and equipment. Equipment locations are approximate and are subject to modifications as determined by equipment dimensions.

C. Coordination of Work: Coordinate the Work so that the electrical equipment may be installed without altering building components, other equipment or installations.

D. Departure from Design: If departures are deemed necessary due to structural conditions, obstructions, or other problems, provide details of such departures and the reasons for requesting approval as soon as practicable but not later than the submittal of the raceway layout drawings. Do not make any departures without written approval.

PRODUCTS

Not Used

EXECUTION

3.1 ROUGH-IN

A. Final Location: Verify final locations for rough-ins with field measurements, vendor shop drawings and with the requirements of the actual equipment to be connected.
B. The Drawings are not intended to show exact locations of conduit runs. Coordinate the conduit installation with other trades and the actual supplied equipment.
C. Install each 3-phase circuit in a separate conduit unless otherwise shown.
D. Except where dimensions are shown, the locations of equipment, fixtures, outlets, and similar devices shown on the Drawings are approximate only. Exact locations shall be determined by the Contractor and approved by the Engineer during construction. Obtain information relevant to the placing of electrical work and in case
E. Surface mounted panel boxes, junction boxes, conduit, etc., shall be supported by spacers to provide a clearance between wall and equipment.
F. All floor mounted electrical equipment shall be placed on 4-inch thick (3/4-inch, 45-degree chamfer at all exposed edges) concrete pads, provide reinforcement, anchors, etc.

3.2 ELECTRICAL INSTALLATIONS

A. Sequence, coordinate, and integrate the various elements of electrical systems, materials, and equipment. Comply with the following requirements:

1. Coordinate electrical systems, equipment, and materials installation with other disciplines' components.
2. Verify all dimensions by field measurements. Investigate each space in the structure through which equipment must pass to reach its final location.

3. The equipment shall be kept upright at all times during storage and handling. When equipment must be tilted, brace the equipment to ensure that the tilting does not impair the functional integrity of the equipment.
4. Arrange for chases, slots, and openings in other building components during progress of construction, to allow for electrical installations.
5. Coordinate the installation of required supporting devices and sleeves to be set in cast-in-place concrete and other structural components, as they are constructed.
6. Sequence, coordinate, and integrate installations of electrical materials and equipment for efficient flow of the Work. Give particular attention to large equipment requiring positioning prior to closing in the building.
7. Where mounting heights are not detailed or dimensioned, install systems, materials, and equipment to provide the maximum headroom possible.
8. Coordinate connection of electrical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies. Provide required connection for each service.
9. Install systems, materials, and equipment to conform with approved submittal data, including coordination drawings, to greatest extent possible. Conform to arrangements indicated by the Contract Documents, recognizing that portions of the Work are shown only in diagrammatic form. Where coordination requirements conflict with individual system requirements, refer conflict to the ENGINEER for resolution.
10. Install systems, materials, and equipment level and plumb, parallel and perpendicular to other structural systems and components, where installed exposed in finished spaces.
11. Install electrical equipment to facilitate servicing, maintenance, and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations.
12. Install access panel or doors where units are concealed behind finished surfaces.
13. Install systems, materials, and equipment giving right-of-way priority to systems required to be installed at a specified slope.

3.3 CUTTING AND PATCHING

A. Perform cutting and patching as specified in Division 1. In addition to the requirements specified in Division 1, the following requirements apply:

1. Perform cutting, fitting, and patching of electrical equipment and materials required to:
    a. Uncover Work to provide for installation of ill-timed Work.
    b. Remove and replace defective Work.
    c. Remove and replace Work not conforming to requirements of the Contract Documents.
    d. Remove samples of installed Work as specified for testing.
    e. Install equipment and materials in existing structures.
    f. Locate existing structural reinforcing where core drilled penetrations are required so as not to cut the steel reinforcing.

2. Cut, remove, and properly dispose of selected electrical equipment, components, and materials as indicated, including but not limited to removal of electrical items indicated to be removed and items made obsolete by the new Work. Deliver all the existing removed to the OWNER as directed.
3. Protect the structure, furnishings, finishes, and adjacent materials not indicated or scheduled to be removed.

4. Provide and maintain temporary partitions or dust barriers adequate to prevent the spread of dust and dirt to adjacent areas.
5. Protection of Installed Work: During cutting and patching operations, protect adjacent installations.
6. Patch finished surfaces and building components using new materials as specified for the original installation and experienced Installers. Installers' qualifications refer to the materials and methods required for the surface and building components being patched.

3.4 EXISTING CONDITIONS

A. Investigate site thoroughly and reroute all conduit and wiring in area of new construction in order to maintain continuity of existing circuitry. Existing conduits depicted on plans show approximate locations only. Contractor must verify and coordinate existing site conduits and pipes to any excavation on site.

3.5 ELECTRICAL SERVICE.

A. Description of System:

1. The Electrical Utility Company will provide the electrical service of the characteristics as shown on the Drawings. This Contractor's work will begin where the Utility Company's work ends.
2. The Contractor shall furnish all labor, materials, etc., necessary for a complete approved electrical service as required for this project, including inspection and approval by the Utility and local Inspection Departments (if any) and inform the Engineer prior to energizing power lines.
3. This Contractor shall notify the Utility Company in writing, with two copies to the Engineer, no later than ten (10) days after signing contracts as to when this Contractor anticipates the building power service will be required.

B. Construction Facilities:

1. The facilities and equipment required providing all electrical power for construction, lighting and balancing and testing consumed prior to final acceptance of the project shall be provided under this section of the specifications. All wiring, outlets and other work required to provide this power at the site and within the building for all trades shall be arranged for, furnished and installed under this section of the specifications including any fee, charge or cost due the utility company for temporary power installation or hook-ups.
2. Facilities shall be furnished in a neat and safe manner in compliance with governing codes, good working practices and OSHA regulations.

C. Underground Electrical Service:

1. Furnish and install underground 277/480 volt 3ph, 4 wire service from power company transformer to main service equipment.
2. The underground service shall comply with all the requirements of the NEC, local Utility Company and local enforcing authority.
3. Coordinate with the Duke Energy and provide site routing layout drawing in submittals.

D. Metering: The necessary utility meter base and/or C.T cabinets (where required) shall be furnished and installed by this Contractor. Approval of the metering equipment must be obtained by the Contractor from the Electric Utility Company prior to submitting the Shop Drawings. Provide aluminum or stainless steel meter bases. Metering bases and conduits must be installed by the Contractor in accordance with the Utility Company requirements.

E. Utility requirements. Work to be completed under this section shall be in accordance with the local electric utility documentation and standards.

END OF SECTION

SECTION 260511
SPECIAL ELECTRICAL REQUIREMENTS

PART 1 GENERAL

1.01 SCOPE OF WORK

A. Furnish all labor, materials, equipment and incidentals required and install complete and make operational, electrical and process instrumentation systems for the Town of Smithfield Pump Station #1 as shown on the Drawings and as specified herein.

B. The work shall include furnishing, installing and testing the equipment and materials specified in other Sections of the Specifications and shown on the Drawings. Provide all required coordination and supervision where work connects to or is affected by work of others, and comply with all requirements affecting this Division. Work required under other divisions, specifications or drawings, indicated to be performed by this Division shall be coordinated with the Contractor and such work performed at no additional cost to Owner including but not limited to electrical work required for roll- up doors, control panel installation, instrumentation and control installation, etc.

C. It is the intent of these Specifications that the electrical system shall be suitable in every way for the service required. All material and all work which may be reasonably implied as being incidental to the work of this Section shall be furnished at no extra cost. The work shall include but not be limited to furnishing and installing the following:

1. Conduit, wire and field connections for all motors, motor controllers, control devices, control panels and electrical equipment furnished under other Divisions of these specifications.

2. Conduit, wiring and terminations for all field-mounted instruments furnished under other Divisions of these specifications, including process instrumentation primary elements, transmitters, local indicators and control panels. Surge protection equipment wiring at process instrumentation transmitters. Install vendor furnished cables specified under other Divisions of these specifications.

3. The drawings and specifications describe specific sizes of switches, breakers, fuses, conduits, conductors, motor starters and other items of wiring equipment. These sizes are based on specific items of power consuming equipment (heaters, lights, motors for fans, compressors, pumps, etc.). Wherever the contractor provides power consuming equipment which differs from, the basis of design, drawings and specifications, the wiring and associated circuit components for such equipment shall be changed to proper sizes to match at no additional expense to the Owner.

4. Provide final Short Circuit & Coordination Study and Arc Flash Analysis.

5. Provide a complete grounding system and special grounds as required or noted.

6. Provide Power and signal Surge Suppression systems.

7. Provide Concrete work for pad mounted equipment.

8. Provide Instrumentation and control conduit and wiring systems and installation of field instrumentation.

9. Provide Electrical testing of equipment

10. Provide bonding and grounding systems.

D. Each bidder or their authorized representatives shall, before preparing their proposal, visit all areas of the existing site and structures in which work under this Division is to be performed and inspect carefully the present installation. The submission of the proposal by this bidder shall be considered evidence that their representative has visited the site and structures and noted the locations and conditions under which the work will be performed and that the bidder takes full responsibility for a complete knowledge of all factors governing the work.

E. Field verify all existing underground electrical and mechanical piping. Locate all openings required for work performed under this section.

F. Provide sleeves, guards or other approved methods to allow passage of items installed under this section.

G. The Contractor shall prepare and furnish electrical and instrumentation conduit layout shop drawings for yard electrical, within and under all roads, buildings and structures to the Engineer for approval prior to commencing work. Layouts shall include but not be limited to equipment, pull boxes, conduit routing, dimensioning, methods and locations of supports, reinforcing, encasement, materials, conduit sizing, equipment access, potential conflicts, building and yard lighting, and all other pertinent technical specifications for all electrical and instrumentation conduits and equipment to be furnished.

H. The work shall include complete testing of all equipment and wiring at the completion of work and making any minor correction changes or adjustments necessary for the proper functioning of the system and equipment. All workmanship shall be of the highest quality; substandard work will be rejected.

I. A single manufacturer shall provide panelboards, main breakers, transformers, disconnect switches, etc.

J. Contractor shall provide their own temporary power for miscellaneous power (drills, pumps, etc.). No facility circuits shall be used unless approved by the engineer. Any temporary added shall be removed at job completion.

K. Complete coordination with other contractors. Contractor shall coordinate with all other contractors equipment submittals and obtain all relevant submittals.

L. Mount transmitters, process instruments, operator’s stations, etc. furnished under other Divisions of these specifications.

M. Concrete electrical duct encasement, including but not limited to excavation, concrete, conduit, reinforcement, backfilling, grading and seeding is included. Excavation, bedding material, forms, concrete and backfill for underground raceways; forms and concrete for electrical equipment furnished herein is included in this Division.

1.02 QUALIFICATIONS

A. The electrical contractor shall have regularly engaged in the installation of industrial electrical power systems for a minimum period of ten (10) years. When requested by the engineer, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.

B. provide a field superintendent who has had a minimum of ten (10) years previous successful experience on projects of comparable size and complexity. Superintendent shall be present at all times that work under this Division is being installed or affected. A resume of the Superintendent's experience shall be submitted to Engineer before starting work.

1.03 RELATED WORK

A. Submittals Section 013300

B. Quality Control Section 014500

C. Delivery Storage and Handling Section 016600

D. Operation and Maintenance Manuals Section 017823.

E. Cast in place concrete work, including concrete encasements for electrical duct banks, equipment pads, and reinforcing steel, is specified in other Divisions.

F. Excavation and backfilling, including gravel or sand bedding for underground electrical work is specified in other Divisions.

1.04 REFERENCE STANDARDS

A. Electric equipment, materials and installation shall comply with the latest edition of National Electrical Code (NEC) and with the latest adopted edition of the following codes and standards:

1. Electrical Safety in the Workplace (NFPA70E)
2. National Electrical Safety Code (NESC)
3. Occupational Safety and Health Administration (OSHA)
4. National Fire Protection Association (NFPA)
5. National Electrical Manufacturers Association (NEMA)
6. American National Standards Institute (ANSI)
7. Insulated Cable Engineers Association (ICEA)
8. Instrument Society of America (ISA)
9. Underwriters Laboratories (UL)
10. Factory Mutual (FM)

11. International Electrical Testing Association (NETA)

12. Institute of Electrical and Electronic Engineers (IEEE)

13. American Society for Testing and Materials (ASTM)

14. National Building Code

15. Local Codes and Ordinances

B. All electrical equipment and materials shall be listed by Underwriter's Laboratories, Inc., or a nationally recognized Electrical Testing Agency and shall bear the appropriate UL listing mark or classification marking. Equipment, materials, etc. utilized not bearing a UL certification shall be field or factory UL certified prior to equipment acceptance and use. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

C. All materials shall be new and free of defects, and shall be U.L. listed, bear the U.L. label or be labeled or listed with an approved agency. Where no labeling or listing service is available for certain types of equipment, test data shall be submitted to prove to the Engineer that equipment meets or exceeds available standards.

1.05 ENCLOSURE TYPES

A. Unless otherwise specified herein or shown on the Drawings, electrical enclosures shall have the following ratings:

1. NEMA 1 for dry, non-process indoor locations.

2. NEMA 12 for "DUST" locations.

3. NEMA 4X for all outdoor locations, rooms below grade (buried vaults), "DAMP" and "WET" locations.

4. NEMA 4X for "CORROSIVE" locations.

5. NEMA 7 (and listed for use in the area classifications shown) for "Class I Division 1 Group D", "Class I Division 2 Group D" and "Class II Division 1" hazardous locations shown on the Drawings.

1.06 CODES, INSPECTION AND FEES

A. Equipment, materials and installation shall comply with the requirements of the local authority having jurisdiction. The installation shall comply with the governing state and local codes or ordinances. Completed electrical installation shall be inspected and certified by all applicable agencies that it is in compliance with all codes. Comply with latest utility company regulations.

B. Obtain all necessary permits and pay all fees required for permits and inspections. It is the contractor's responsibility to contact the required Utility Company to determine if any fees, charges, or costs will be due the Utility Company, as required by the Utility Company for temporary power, installations, hook-ups, etc. This fee, charge or cost shall be included in this contractor's bid price.

1.07 TESTS AND SETTINGS

A. Test systems and equipment furnished under Division 16 and other divisions supplying electrical equipment. Repair or replace all defective work and equipment. Refer to Acceptance Testing section and the individual equipment sections for additional specific testing requirements.

B. Make adjustments to the systems and instruct the Owner's personnel in the proper operation of the systems.

C. In addition to the specific testing requirements listed and the individual Sections, the following minimum tests and settings shall be performed. Submit test reports upon completion of testing.

1. Mechanical inspection, testing and settings of circuit breakers, disconnect switches, motor starters, overload relays, control circuits and equipment for proper operation.

2. Check the full load current draw of each motor. Where power factor correction capacitors are provided the capacitor shall be in the circuit at the time of the measurement. Check ampere rating of thermal overloads for motors and submit a typed record to the Engineer of the same, including driven load designation, motor service factor, horsepower, and Code letter. If incorrect thermal overloads are installed replace same with the correct size overload.

3. Check power and control power fuse ratings. Replace fuses if they are found to be of the incorrect size.

4. Check settings of the motor circuit protectors. Adjust settings to lowest setting that will allow the motor to be started when under load conditions.

5. Check motor nameplates for correct phase and voltage. Check bearings for proper lubrication.

6. Check rotation of motors prior to testing the driven load. Disconnect the driven equipment if damage could occur due to wrong rotation. If the rotation is incorrect for the driven equipment correct motor connections at the motor terminal box.

7. Check interlocking, control and instrument wiring for each system and/or part of a system to prove that the system will function properly as indicated by control schematic and wiring diagrams.

8. Inspect each piece of equipment in areas designated as HAZARDOUS to ensure that equipment of proper rating is installed.

9. Verify all terminations at transformers, equipment, panels and enclosures by producing a 1, 2, 3 rotation on a phase sequenced motor when connected to "A", "B" and "C" phases.

10. Check all wire and cable terminations. Verify to the Engineer connections meet the equipment’s torque requirements.

11. Field set all transformer taps as required to obtain the proper secondary voltage.

12. Infra-red hot spot inspection shall be made of all electrical equipment including but not limited to switchgear, motor control centers, transformers, switches, power and control panels, etc. This shall be done under representative load conditions before the equipment is used by the Owner.

1.08 PHASE BALANCING

A. The Drawings do not attempt to balance the electrical loads across the phases. Circuits on panelboards shall be field connected to result in evenly balanced loads across all phases.

B. Field balancing of circuits shall not alter the conductor color coding requirements as specified herein.

1.09 EQUIPMENT IDENTIFICATION

A. Shall be as described in section 26 05 53 Identification.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 SLEEVES AND FORMS FOR OPENINGS

A. Provide and place all sleeves for conduits penetrating floors, walls, partitions, etc. Locate all necessary slots for electrical work and form before concrete is poured.

B. Exact locations are required for stubbing-up and terminating concealed conduit. Obtain shop drawings and templates from equipment vendors or other subcontractors and locate the concealed conduit before the floor slab is poured.

C. Where setting drawings are not available in time to avoid delay in scheduled floor slab pours, the Engineer may allow the installations of such conduit to be exposed. Requests for this deviation must be submitted in writing. No additional compensation for such change will be allowed.

D. Seal all openings, sleeves, penetration and slots.

3.02 INSTALLATION

A. Any work not installed according to the Drawings and this Division or without approval by the Engineer shall be subject to change as directed by the Engineer. No extra compensation will be allowed for making these changes.

B. Electrical equipment shall at all times during construction be adequately protected against mechanical injury or damage by water. Electrical equipment shall not be stored out-of-doors. Electrical equipment shall be stored in dry permanent shelters. If an apparatus has been damaged, such damage shall be repaired at no additional cost. If any apparatus has been subject to possible injury by water, it shall be replaced at no additional cost to the Owner, the damaged unit(s) or systems shall remain on site and returned to the manufacturer after the replacement unit(s) or systems have been delivered to the site. Under no circumstances will electrical equipment damaged by water be rehabilitated or repaired, new equipment shall be supplied and all cost associated with replacement shall be borne by the Contractor.

C. Equipment that has been damaged shall be replaced or repaired by the equipment manufacturer, at the Engineer's discretion.

D. Repaint any damage to factory applied paint finish using touch-up paint furnished by the equipment manufacturer. The entire damaged panel or section shall be repainted at no additional cost to the Owner.

3.03 MANUFACTURER’S SERVICE

A. Provide manufacturer's services for testing and start-up of all major electrical equipment: Control Panels, ATS, Genset, etc.

B. Testing and startup shall not be combined with training. Testing and start-up time shall not be used for manufacturer’s warranty repairs.

C. The manufacturers of the above listed equipment shall provide experienced Field Service Engineer to accomplish the following tasks:

1. The equipment shall be visually inspected upon completion of installation and prior to energization to assure that wiring is correct, interconnection complete and the installation is in compliance with the manufacturer's criteria. Documentation shall be reviewed to assure that all Drawings, operation and maintenance manuals, parts list and other data required to check out and sustain equipment operation is available on-site. Documentation shall be red-lined to reflect any changes or modifications made during the installation so that the "as-built" equipment configuration will be correctly defined. Spare parts shall be inventoried to assure correct type and quantity.

2. The Field Service Engineers shall provide engineering support during the energization and check-out of each major equipment assembly. They shall perform any calibration or adjustment required for the equipment to meet the manufacturer's performance specifications.

3. Upon satisfactory completion of equipment test, they shall provide engineering support of system tests to be performed in accordance with manufacturer's test specifications.

4. A final report shall be written and submitted to the Contractor within fourteen days from completion of final system testing. The report shall document the inspection and test activity, define any open problems and recommend remedial action. The reports after review by the Contractor shall be submitted to the Engineer.

3.04 TRAINING

A. The cost of training programs to be conducted with Owner's personnel shall be included in the Contract Price. The training and instruction, insofar as practicable, shall be directly related to the system being supplied.

B. Provide detailed O&M manuals to supplement the training courses. The manuals shall include specific details of equipment supplied and operations specific to the project.

C. The training program shall represent a comprehensive program covering all aspects of the operation and maintenance including trouble-shooting of each system.

D. All training schedules shall be coordinated with and at the convenience of the Owner. Shift training may be required to correspond to the Owner's working schedule. The training shall be conducted with record "as-built" drawings sufficient for each class member.

E. The Contractor shall submit an overview of the proposed training plan. This overview shall include, for each course proposed:

1. An overview of the training plan.
2. Course title and objectives.
3. Recommended types of attendees.
4. Course Content - A topical outline.
5. Course Format - Lecture, laboratory demonstration, etc.
6. Schedule of training courses including dates, duration and locations of each class.

3.05 WARRANTY

A. Unless specified otherwise elsewhere, the work under this Division shall include a one-year warranty. This warranty shall be by the Contractor to the Owner for any defective workmanship or material that has been furnished under this Contract at no cost to the Owner for a period of one years from the date of substantial completion of the System.

NOT USED

SECTION 260519
LOW VOLTAGE WIRES AND CABLES

1.1 GENERAL

A. Referenced Standards:
   1. Institute of Electrical and Electronics Engineers, Inc./American National Standards Institute (IEEE/ANSI):
   2. Standard for Flame Testing of Cables for Use in Cable Tray in Industrial and Commercial Occupancies.
   3. National Electrical Manufacturers Association (NEMA): ICS 4, Industrial Control and Systems: Terminal Blocks.
   4. National Electrical Manufacturers Association/Insulated Cable Engineers Association (NEMA/ICEA): WC 57/S-73-532, Standard for Control Cables: WC 70/S- 95-658, Non-Shielded Power Cables Rated 2000 Volts or Less for the Distribution of Electrical Energy.
   5. National Fire Protection Association NFPA-70, National Electrical Code (NEC).
   6. Underwriters Laboratories, Inc. (UL44): Standard for Safety Thermoset-Insulated Wires and Cables; (UL83): Standard for Safety Thermoplastic-Insulated Wires and Cables; UL467 Standard for Safety Grounding and Bonding Equipment. UL486A Standard for Safety Wire Connectors and Soldering Lugs for use with Copper Conductors; UL 486C, Standard for Safety Splicing Wire Connections. UL510, Standard for Safety Polyvinyl Chloride, Polyethylene and Rubber Insulating Tape.

B. Definitions:
   1. Building Wire: Copper single conductor, cross link polyethylene insulated; type XHHW-2;
   2. Cable: Multi-conductor, insulated, with outer sheath containing either building wire or instrumentation wire.
   3. Instrumentation Cable (Analog signal cable): Multiple conductor, polyethylene insulated, twisted Pair/Triad, with individual Pair/Triad shield and outer overall shield and outer sheath. Used for the transmission of low current (e.g., 4-20mA DC) using No. 16 AWG conductors. Common Types, TSP: Twisted shielded pair, TST: Twisted shielded triad.
   4. Control Cable: Multi-conductor, insulated, with outer sheath containing building wires, No. 14, AWG. With overall shield where specified. Type SIS and MTW approved for use in the wiring of control equipment; otherwise type XHHW-2.
   5. Power Cable: Multi-conductor, insulated, with outer sheath containing building wire, No. 12 AWG and larger. Rated XHHW-2
   6. Digital signal cable: Used for the transmission of digital signals between computers, PLC's, RTU's, etc. Common Types: Ethernet UTP-unshielded twisted pair.

1.2 POWER CONDUCTORS:

A. Branch circuits and feeder conductors for electric power shall be stranded copper type XHHW-2 cross-link polyethylene (XLP) insulation and derated to 75 degrees Centigrade. No aluminum wiring shall be permitted. Wire shall be in accordance to NEC and minimum No. 12, except that branch "homeruns" over 50 ft. in length shall be minimum No. 10 for 120/208V circuits. All wire shall be manufactured in the USA.

B. Taps and Splices:
   1. All power wiring taps and splices in No. 8 or smaller wire shall be fastened together by

means of terminal strips except within lighting fixtures and wiring devices where conformance to NEC practices will be acceptable (Twist/screw on type connectors). All taps and splices in wire larger than No. 8 shall be made with compression type connectors and taped to provide insulation equal to wire. Tape shall be heavy duty, flame retardant and weather resistant vinyl electrical tape, minimum 7 mil premium grade with an operating temperature of 0 degree F. to 220 degree F. Provide tape meeting UL 510 and CSA standard C22.2.

2. All taps and splices in manholes or in ground pull boxes, etc. shall be approved by the engineer on a case by case basis; be made with high press long barrel double crimp compression type connectors and covered with Raychem heavy wall cable sleeves (type CTE or WCS) with type "S" sealant coating. Install sleeve kits as per manufacturer's installation instructions.

1.3 INTRUMENTATION AND CONTROL CABLE:

A. Multiconductor and Multi pair Process instrumentation cable shall be #16 AWG stranded, twisted pair, 600 V, (XLP) cross link polyethylene insulated, aluminum tape pair shielding, cross link polyethylene or chlorinated polyethylene (CPE) overall sheathed and shielded, type TC instrument cable as manufactured by the American Insulated Wire Co., Belden Wire Co. or equal.

B. Multiconductor control cable shall be #14 AWG stranded, 600V, (XLP) cross link polyethylene insulated or polyolefin, with cross link polyethylene or chlorinated polyethylene (CPE or Hypalon) overall sheathed type TC control cable.

1.4 DATA NETWORK SIGNAL CABLE:

A. Ethernet Data Cable: Provide field cable that is Multi paired Data Signal cable, TIA 5638B Cat 5e, #22 AWG, twisted pair, 600V, PVC insulated, aluminum tape pair shielding, thermoplastic (PVC) overall sheathed and shielded, Data Tuff industrial ethernet cable as manufactured by Beldon or equal.

B. Ethernet Cable Connections:
1. All conductor connections shall be to RJ45 and M12 compatible jacks.
2. All conductors shall be marked with Mylar wrap type "Brady" labels. Identification labels shall be permanent type and be machine printed. All terminal block terminations shall be labeled. The inside portion of the terminal cabinet doors shall display a protected terminal cabinet drawing with all connections shown and described as to color code, number assigned to connection function of conductor and destination.
3. Wire shall be guided within terminal cabinets by cable supports. All conductors shall be neatly led to terminations.
4. Instrumentation and control field cables on the unprotected side of SPD devices within the cabinet shall not run in parallel to the cables on the protected side of the SPD device. Separate cable supports (duct) will be provided.
5. No splices shall be made within a conduit run or in manholes.

1.5 CABLE IDENTIFICATION

A. Cable: Brady Permasleeve PSPT type labels shall be used for conductors (used on a Brady TLS 2200 label machine).

   1. For instrumentation and control circuits, labels shall include three lines of text, and shall be the same on both ends of the conductor:
      - Line one: shall indicate the origination of circuit.
      - Line two: shall indicate the destination of the circuit.
      - Line three: brief description of circuit function

      Examples:

PLC-1-TB2-5	PLC-1-TB2-7
MCC-1-Pump 1-TB-6	MCC-1-Pump 1-TB-7
Run Status	Stop Status

B. Labels shall be readily visible, legible, and shall not be heat shrunk.

C. Power conductors shall be phased as follows:
   1. Conductors #6 and smaller shall have insulation that is continuously color coded.

   2. Conductors #4 and larger shall be phase taped:
      - 120/208 V, 3Ph/4W – Black, Red, Blue. Neutral – White.
      - 120/240V – 1Ph/3W – Black, Red, Neutral – White.
      - 480V – Brown, Orange, Yellow

1.6 CABLE SEPERATION:

A. The labeling system shall be consistent throughout the loop and follow the standard detailed above.

B. Provide for separation of Data, Instrumentation, Control Cables from power conductors. Provide a minimum of 24" inch separation for parallel run of power conduit and Data, Instrumentation or control conduit. This separation can be reduced to 8" if metallic grounded separation is provided.

C. Connections:
   1. All conductor connections shall be on terminal strips including all spare conductors. Provide terminal strips in all cabinets; etc.
   2. All connections of stranded wire to screw terminals shall be by insulated spade lugs, crimp fastened to wire. Provide stranded wire crimp ferrules for all stranded wire connections not requiring spade lugs for screw type terminal blocks. The stranded wire ferrule is to be crimped to all stranded wire using a crimping tool specifically approved for crimping the size and type of ferrule.
   3. All terminal block terminations shall be labeled. The inside portion of the terminal cabinet doors shall display a protected terminal cabinet drawing with all connections shown and described as to color code, number assigned to connection function of conductor and destination.
   4. Wire shall be guided within terminal cabinets by cable supports. All conductors shall be neatly led to terminations.
   5. Instrumentation and control field cables on the unprotected side of SPD devices within the cabinet shall not run in parallel to the cables on the protected side of the SPD device. Separate cable supports (duct) will be provided.

6. Cabinets: All cabinets shall be labeled with an engraved plastic laminate label riveted to the door.
7. No splices shall be made within a conduit run or in manholes.

1.7 SUBMITTALS:

A. Submit cut sheets on all major types of wires and cables including splicing tape, and terminating/splicing lugs, conductor identification systems and connectors and cable sleeves. Submit sample of all instrumentation and control cable. Sample shall be a minimum of 24" with exterior sheath clearly marked.
B. Submit sample of all cable identification systems products.

END OF SECTION

SECTION 260526
GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 – GENERAL

1.1 DESCRIPTION; the terms "connect", "ground" and "bond" are used interchangeably in this specification and have the same meaning

A. This section specifies general grounding and bonding requirements of electrical equipment operations and to provide a low impedance path for possible ground fault currents.

B. "Grounding electrode system" refers to all electrodes required by NEC, as well as including made, supplementary, perimeter counterpoise ground, lightning protection system grounding electrodes.

1.2 RELATED WORK

A. Section 26 05 00, Basic Materials and methods.
B. Section 26 05 19, Low Voltage Wires and Cables

1.3 SUBMITTALS

A. Submit in accordance with Division 26.

B. Shop Drawings:
   1. Sufficient information, clearly presented, shall be included to determine compliance with drawings and specifications.
   2. Include the location of system grounding electrode connections and the routing of aboveground and underground grounding electrode conductors.

C. Test Reports: Provide certified test reports of ground resistance.

D. Certifications: Two weeks prior to final inspection, submit four copies of the following to the Project Engineer:
   1. Certification, by the Contractor, that the complete installation has been properly installed and tested.

1.4 APPLICABLE PUBLICATIONS

A. American Society for Testing and Materials (ASTM).

B. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System.

C. National Fire Protection Association (NFPA):
National Electrical Code (NEC) 2008

D. Underwriters Laboratories, Inc. (UL):
Thermoset-Insulated Wires and Cables
Thermoplastic-Insulated Wires and Cables
Grounding and Bonding Equipment
Wire Connectors

PART 2 – PRODUCTS

2.1 GROUNDING AND BONDING CONDUCTORS

A. Equipment grounding conductors shall be UL 83 insulated stranded copper, except that sizes 2 AWG and smaller may be solid copper unless noted otherwise noted on the drawings. Insulation color shall be continuous green for all equipment grounding conductors, except that wire sizes 4 AWG and larger shall be permitted to be identified per NEC.

B. Bonding conductors shall be ASTM B8 bare stranded copper, except that sizes 2 AWG and smaller may be ASTM B1 solid bare copper wire.

C. Electrical System Grounding: Conductor sizes shall not be less than what is shown on the drawings and not less than required by the NEC, whichever is greater.

2.2 SPLICES AND TERMINATION COMPONENTS

A. Components shall meet or exceed UL 467 and be clearly marked with the manufacturer, catalog number, and permitted conductor size(s).

2.3 GROUND CONNECTIONS

A. Above Grade:
1. Bonding Jumpers: compression type connectors, using zinc-plated fasteners and external tooth lock washers.
2. Ground Busbars: Two-hole compression type lugs using tin-plated copper or copper alloy bolts and nuts.

PART 3 – EXECUTION

3.1 GENERAL

A. Ground in accordance with the NEC, as shown on drawings, and as hereinafter specified.

B. System Grounding:
1. Secondary service neutrals: Ground at the supply side of the secondary disconnecting means and at the related transformers.
2. Separately derived systems (transformers downstream from the service entrance): Ground the secondary neutral.

C. Equipment Grounding: Metallic structures (including ductwork and building steel), enclosures, raceways, junction boxes, outlet boxes, cabinets, machine frames, and other conductive items in close proximity with electrical circuits shall be bonded and grounded.

3.2 GROUNDING CONNECTIONS

A. Make grounding connections that are below grade by exothermic weld. Make grounding connections that are above grade but are otherwise normally inaccessible (poured columns, within walls) with exothermic weld.

3.3 SECONDARY EQUIPMENT AND CIRCUITS

A. Transformers:
1. Exterior: Exterior transformers supplying interior service equipment shall have the neutral

grounded at the transformer secondary. Provide a grounding electrode at the transformer.

2. Separately derived systems (transformers downstream from service equipment): Ground the secondary neutral at the transformer. Provide a grounding electrode conductor from the transformer to the ground bar at the service equipment.

B. Conduit Systems:

1. Ground all metallic conduit systems. All conduit systems shall contain an equipment grounding conductor (except service entrance with grounded neutral). Ground conductor shall be bonded to metallic conduit systems at the entrance and exit from the conduit.

D. Boxes, Cabinets, Enclosures, and Panelboards:

1. Bond the equipment grounding conductor to each pullbox, junction box, outlet box, device box, cabinets, and other enclosures through which the conductor passes.
2. Provide lugs in each box and enclosure for equipment grounding conductor termination.
3. Provide ground bars in panelboards, bolted to the housing, with sufficient lugs to terminate the equipment grounding conductors.

E. Motors and Starters: Provide lugs in motor terminal box and starter housing or motor control center compartment to terminate equipment grounding conductors.

F. Receptacles shall not be grounded through their mounting screws. Ground with a jumper from the receptacle green ground terminal to the device box ground screw and the branch circuit equipment grounding conductor.

3.4 CORROSION INHIBITORS

A. When making ground and ground bonding connections, apply a corrosion inhibitor to all contact surfaces. Use corrosion inhibitor appropriate for protecting a connection between the metals used.

3.5 CONDUCTIVE PIPING

A. Bond all conductive piping systems, interior and exterior, to the building to the grounding electrode system.

3.6 GROUND RESISTANCE

A. Grounding system resistance to ground shall not exceed 5 ohms. Make necessary modifications or additions to the grounding electrode system for compliance without additional cost to the owner. Final tests shall assure that this requirement is met.

B. Resistance of the grounding electrode system shall be measured using a four-terminal fall-of-potential method as defined in IEEE 81. Ground resistance measurements shall be made before the electrical distribution system is energized and shall be made in normally dry conditions not less than 48 hours after the last rainfall. Resistance measurements of separate grounding electrode systems shall be made before the systems are bonded together below grade. The combined resistance of separate systems may be used to meet the required resistance, but the specified number of electrodes must still be provided.

C. Below-grade connections shall be visually inspected by the Project Engineer prior to backfilling. Provide ground inspection wells at all ground rod locations.

3.7 GROUND ROD INSTALLATION

A. Drive each rod vertically in the earth.

B. Where permanently concealed ground connections are required, make the connections by the exothermic process to form solid metal joints.

C. Make above grade accessible ground connections with mechanical pressure type ground connectors, unless indicated otherwise.

D. Where rock prevents the driving of vertical ground rods, drill rock then install rod. Backfill with flowable fill or concrete mix. Obtain the necessary permits if required for drilling.

END OF SECTION

SECTION 260529
HANGERS AND SUPPORTS

PART 1 - GENERAL

1.1 SCOPE;

A. The work under this sections includes conduit and equipment supports, straps, clamps, steel channel, etc, and fastening hardware for supporting electrical work. Furnish and install all supports, hangers and inserts required to mount fixtures, conduit, cables, pull boxes and other equipment furnished under this Division. All supporting devices and hardware exterior of buildings or interior of structures except in air conditioned spaces shall be stainless steel. Aluminum and non metallic supports (fiberglass) and hardware will be reviewed by the Engineer on a case-by-case basis.

B. All items shall be supported from the structural portion of the building. Supports and hangers shall be of a type approved by Underwriters' Laboratories. Wire or plastic tie straps shall not be used as a support. Boxes and conduit shall not be supported or fastened to ceiling suspension wires or to ceiling channels.

C. The Contractor shall furnish and install all sleeves that may be required for openings through floors, wall etc. Where plans call for conduit to be run exposed, the Contractor shall furnish and install all inserts and clamps for the supporting of conduit. If the Contractor does not properly install all sleeves and inserts required, contractor to provide cutting and patching to the satisfaction of the Engineer.

1.2 SUBMITTALS: Product Data: Provide data for support channel.

1.3 QUALITY ASSURANCE: Support systems shall be adequate for weight of equipment and conduit, including wiring, which they carry.

PART 2 - PRODUCTS

2.1 MATERIAL

A. Support Channel: Stainless steel throughout except galvanized steel in conditioned interior areas.

B. Hardware: Stainless steel throughout

C. Minimum sized threaded rod for supports shall be 3/8”.

D. Conduit clamps, straps, supports, etc., shall be stainless steel or malleable iron. One-hole straps shall be heavy duty type.

PART 3 - EXECUTION

3.1 INSTALLATION

A. All RMC shall be securely fastened in place on maximum of 6 foot intervals; all PVC conduits shall be securely fastened in place on maximum of 3 foot intervals vertically and 2 foot intervals horizontally. Hangers, supports or fastenings shall be provided at each elbow and at the end of each straight run terminating at a box or cabinet. The required strength of the supporting equipment and size and type of anchors shall be based on the combined weight of conduit, hanger and cables. Horizontal and vertical conduit runs may be supported by two-hole malleable straps, clamp-backs, or other approved devices with suitable bolts, expansion shields (where needed) or beam-clamps for mounting to building structure or special brackets.

B. On concrete or masonry construction, use "Tapcon" type fasteners. For brick construction, insert anchors shall be installed with round head machine screws. In wood construction, round head screws shall be used. An electric or hand drill shall be used for drilling holes for all inserts in brick, concrete or similar construction. Steel members shall be drilled and tapped, and round head machine screws shall be used. All screws, bolts, washers, etc., used for supporting conduit or outlets shall be fabricated from stainless steel, or approved substitution.

C. Fasten hanger rods, conduit clamps, outlet, junction and pull boxes to building structure using preset inserts, beam clamps, expansion anchors, or spring steel clips (interior metal stud walls only). Use toggle bolts or hollow wall fasteners in hollow masonry, plaster, or gypsum board partitions and walls; expansion anchors or preset inserts in solid masonry walls; self-drilling anchors or expansion anchors on concrete surfaces; sheet metal screws in sheet metal studs and wood screws in wood construction.

D. File and de-bur cut ends of support channel and spray paint with cold galvanized paint to prevent rusting. Do not fasten supports to piping, ductwork, mechanical equipment, cable tray or conduit. Do not drill structural steel members unless approved by the engineer.

E. Fabricate supports from min 1-5/8”x1-5/8” 12GA stainless steel channel, rigidly welded or bolted to present a neat appearance. Use hexagon head bolts with spring lock washers under all nuts. Install surface-mounted cabinets and panelboards with minimum of four anchors. Provide steel channel supports to stand cabinets, min. one inch off wall.

F. Furnish and install all supports as required to fasten all electrical components required for the project, including free standing supports required for those items remotely mounted from the building structure, catwalks, walkways etc.

END OF SECTION

SECTION 260551
CONDUIT SYSTEMS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Description of System: This Section includes requirements for raceways, fittings, boxes, enclosures, and cabinets for electrical, instrumentation and control system wiring.

B. Minimum conduit size for all systems shall be 3/4". All conduits shall be U.L. listed and labeled. Conduit sizes shown on the drawings are to aid the contractor in bidding only; the contractor is responsible for conduit sizes as required by NEC fill tables but do not provide smaller conduits than indicated. The contractor is responsible to coordinate the required conduit sizes and conductor quantities for all control and instrumentation system conduit and wiring with the controls subcontractor prior to installation.

C. Provide stainless steel or non-metallic conduit supports and 316 stainless steel hardware in all areas except air conditioned spaces which may be painted steel.

1.2 SUBMITTALS

A. Product Data:
   1. Product data shall be submitted on:
      a. Conduit, raceways, wireways.
      b. Conduit fittings, boxes, enclosures and cabinets.
      c. Surface metal raceway

PART 2 - PRODUCTS

2.1 LIQUID-TIGHT FLEXIBLE CONDUIT

A. Provide liquid-tight flexible conduit constructed of a flexible galvanized metal core with a sunlight-resistant thermoplastic outer jacket.

B. Provide liquid-tight flexible conduit manufactured in accordance with the requirements of UL-360 - Steel Conduits, Liquid-Tight Flexible.

C. Zinc Plated steel fittings.

D. Manufacturer, or Equal
   1. Anaconda, Sealtite
   2. Electriflex, Liquatite

2.2 PVC CONDUIT

A. Provide rigid non-metallic conduit manufactured from Schedule 40 or 80 PVC, as indicated, and sunlight-resistant.

B. Provide rigid non-metallic conduit manufactured in accordance with NEMA TC-2 - Electrical Plastic Tubing and Conduit, and UL-651 - Standard for Rigid Non-metallic Conduit.

C. Manufacturer, or Equal
   1. Carlon
   2. Cantex
   3. J.M. Plastics
   4. Queen City Plastics

2.3 Rigid Aluminum Conduit (RAL)

A. Provide Rigid Aluminum Conduit of 6063 alloy in temper designation T-1. The fittings are of the same alloy. Provide threaded Rigid Aluminum Conduit to Underwriters Laboratories U.L. 6A, “Standard for Electrical Rigid Metal Conduit and manufactured to ANSI C80.5.

B. Provide threaded aluminum conduit fittings, of 6063 alloy, cast aluminum with integral insulated throat as manufactured by Allied, OZ Gedney, T&B, Crouse-Hinds, Killark or Appleton.

2.4 RIGID PVC-COATED ALUMINUM CONDUIT

A. The conduit shall meet the requirements for RAL conduit as indicated above.

B. Bond a PVC coating to the outer surface of the conduit.

C. Ensure that the bond between the coating and the conduit surface is greater than the tensile strength of the coating.

D. Provide the inside surfaces and threads of the conduit with a 2-mil urethane coating.

E. Provide a PVC coating thickness not less than 40 mils.

F. The PVC-coated RGS shall be manufactured in accordance with the following standards:

1. UL-6A
2. ANSI C80.5

G. Manufacturer, or Equal

1. Robroy Industries
2. O’Kote
3. Thomas & Betts

2.5 CONDUIT FITTINGS

A. Fittings for Conduit (Including all Types and Flexible and Liquidtight), and Cable: NEMA FB 1; listed for type and size raceway with which used, and for application and environment in which installed.

B. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 886.

C. Fittings, surface boxes and conduit bodies for Rigid Aluminum Conduit shall be heavy cast aluminum with external raised hubs and mounting lugs;- Appleton, Crouse Hinds or approved substitution. Cover plates cast aluminum. Zinc die cast not acceptable.

D. Conduit locknuts shall be aluminum throughout except steel is acceptable within air conditioned spaces.

E. Conduit expansion fittings shall be malleable iron, and shall be hot dipped galvanized inside and outside. These fittings shall have a four-inch expansion chamber to allow approximately two-inch movement parallel to conduit run in either direction from normal. They shall have factory-installed packing and internal tinned copper braid packing to serve as an emergency bonding jumper. Unless the fitting used is listed by Underwriters' Laboratories for use "without external bonding jumpers", an external copper bonding jumper shall be installed with each expansion fitting with one end clamped on each conduit entering fitting.

PART 3 - EXECUTION

3.1 INSTALLATION

A. In general, conduits shall be installed as follows:

1. Use rigid aluminum conduit in above grade exposed locations.
2. Use PVC coated rigid aluminum conduit for all areas where aluminum conduit is in contact with concrete or earth, extending above 4” beyond transition point.
3. Where conduit transitions underground, Transition to PVC conduit shall be made after the sweep, along horizontal underground run.
4. Only heavy wall PVC (Schedule 80) shall be used for all raceways trapped

underground without concrete encasement protection. Conduits in concrete encasement use Schedule 40-PVC.

B. All raceways shall be run in neat and workmanlike manner and shall be properly supported in accordance with latest edition of NEC with approved conduit clamps, hanger rods and structural fasteners except for PVC conduit installed in exterior locations. PVC conduit installed in exterior locations shall be supported at two foot intervals. Supporting conduit and boxes with wire is not approved.
C. Conduits shall be run parallel to building walls wherever possible, exposed or concealed, and shall be grouped in workmanlike fashion. Crisscrossing of conduits shall be minimized.
D. All raceways runs, whether terminated in boxes or not, shall be capped during the course of construction and until wires are pulled in, and covers are in place. No conductors shall be pulled into raceways until construction work which might damage the raceways has been completed.
E. All raceways shall be kept clear of plumbing fixtures to facilitate future repair or replacement of said fixtures without disturbing wiring. Except where it is necessary for control purposes, all raceways shall be kept away from items producing heat.
F. All underground raceways (with exception of raceways installed under floor slab) shall be installed in accordance with Section 300-5 of the NEC except that the minimum cover for any conduit shall be two feet. Included under this Section shall be the responsibility for verifying finished lines in areas where raceways will be installed underground before the grading is complete.
G. All raceways shall have an insulated copper system ground conductor throughout the entire length of circuit installed within conduit in strict accordance with NEC. Grounding conductor shall be included in total conduit fill determining conduit sizes, even though not included or shown on drawings. Grounding conductors run with feeders shall be bonded to portions of conduit that are metal by approved ground bushings.
H. Insulated bushings shall be used on all rigid steel conduits terminating in panels, wire gutters, or cabinets, and shall be impact resistant plastic molded in an irregular shape at the top to provide smooth insulating surface at top and inner edge. Material in these bushings must not melt or support flame.
I. Spare conduit stubs shall be capped and location and use marked with concrete marker set flush with finish grade or terminated in a manhole. Marker shall be 6" round X 6" deep with appropriate symbol embedded into top to indicate use. Also, tag conduits in panels where originating.
J. All conduit stubbed above floor shall be separated with plastic interlocking spacers manufactured specifically for this purpose, or shall be strapped to Kindorf channel supported by conduit driven into ground or tied to steel.
K. Raceways which do not have conductors furnished under this Division of the specifications shall be left with an approved nylon pullcord in raceway.
L. Conduit shall be manufactured within the United States.
M. All connections to motors or other vibrating equipment (except dry type transformers) or at other locations where required shall be made with not less than 12" nor more than 20” of flexible liquid-tight steel conduit, using special type of connectors with strain relief fittings at both terminations of conduit. Flex connectors shall have insulated throat and shall be T & B 3100 Series or approved substitution. Use angle connectors wherever necessary to relieve angle strain on flex conduit. Connections to dry type transformers shall be made with flexible conduit. Typical length of flex conduit shall be limited to 20” unless specifically approved by the engineer.
N. PVC joints shall be solvent welded. Threads will not be permitted on PVC conduit and fittings, except for rigid steel to PVC couplings. Installation of PVC conduit shall be in

accordance with manufacturer's recommendations. PVC conduit shall not be used to support fixture or equipment. Field bends shall be made with approved hotbox. Heating with flame and hand held heat guns are prohibited.

O. Expansion fittings shall be installed in the following cases: In each conduit run wherever it crosses an expansion joint in the concrete structure; on one side of joint with its sliding sleeve end flush with joint, and with a length of bonding jumper in expansion equal to at least three times the normal width of joints; in each conduit run which mechanically attached to separate structures to relieve strain caused by shift on one structure in relation to the other; in straight conduit run above ground which is more than fifty feet long and interval between expansion fittings in such a runs shall not be greater than 100 feet for steel conduit and 50 feet for PVC conduit.

P. Only heavy wall PVC (Schedule 80) shall be used for raceways trapped underground without concrete encasement protection with a minimum cover of 24-inches. Conduits in concrete encasement use Schedule 40-PVC.

Q. Ground Rods shall be installed at every manhole.

R. Conduit installations on roofs shall be kept to a bare minimum. Where required, conduit shall be rigid aluminum conduit, including couplings. Conduit shall be supported above roof at least 6 inches using approved conduit supporting devices. Supports to be fastened to roof using roofing adhesive as approved by roofing contractor.

S. Underground cable identification: bury a continuous, pre-printed, bright colored metalized plastic (electronically traceable) ribbon cable marker with each underground conduit (or group of conduits), regardless of whether conduits are in ductbanks. Locate directly over conduits, 6" to 8" below finished grade. Delete this requirement under building slabs.

T. Provide for separation of instrumentation, control and power conductors.

END OF SECTION

SECTION 260553
IDENTIFICATION OF ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 GENERAL

A. Provide materials and installation for the identification of electrical equipment, components, cables and wiring and safety signs.

B. Related Work Specified in Other Sections Includes:
Basic Electrical Materials and Methods; Acceptance Testing; Wires and Cables; Control Panels,

1.2 REFERENCES:

A. Codes and standards incorporated within this Section are:
1. ANSIC2/NFPA70E National Electrical Safety Code (NESC)
2. ANSI Z535.1 Safety Color Code
3. ANSI Z535.2 Environmental and Facility Safety Signs
4. ANSI Z535.3 Criteria for Safety Symbols
5. OSHA Occupational Safety and Health Act: specification 1910.145, Standards for Accident Prevention, Signs and Tags

1.3 SUBMITTALS: Furnish all product submittals used.

A. Product Data and Information: Furnish manufacturer's catalog data for safety signs, nameplates, labels and markers.
B. Furnish manufacturer's instructions indicating application conditions and limitations of use; and storage, handling, protection, examination and installation of product.

Part 2: PRODUCTS

2.1 MANUFACTURES:

A. Acceptable Manufacturers: Acceptable manufacturers are listed below. Other manufacturers of equivalent products may be submitted for review.
1. W. H. Brady Company
2. Seton
3. Thomas & Betts A.
4. Approved Equal

2.2 MATERIALS

A. General: Provide identification materials listed and classified by UL or tested by an acceptable Electrical Testing Company certifying the equivalence of the materials to UL listing requirements and OSHA approved.

B. Laminated Plastic Nameplates: Provide engraved three layer laminated plastic nameplates with white letters on black background with lettering etched through the outer covering and fastened with corrosion resistant brass or stainless steel screws. Do not use mounting cement for fastening nameplates.
1. Provide nameplates with 1-inch high lettering for main breakers, automatic transfer switches, panelboards, transformers, VFD's, control panels and disconnect switches.
2. Provide nameplates for each motor identifying service or function and lettering of an appropriate size to suit each motor. Submersible motor nameplates to be affixed to equipment disconnect.
3. Provide approved directories of circuits with typewritten designations of each branch

circuit in each panelboard.

4. Provide smaller lettering for a neat, legible nameplate where the amount of lettering causes excessively large nameplates.

2.3 WIRE MARKERS: Identify wire bundles and each individual wire.

A. Wire bundles: Provide a permanent waterproof brass or rigid fiber identifying tag attached with nylon self-locking "Ty-Raps".

B. Wire identification markers: Provide a printed white, heat-shrink, seamless tubing type with black bold lettering for wires size No. 10 AWG and smaller. Provide a printed self-laminating white, vinyl type with black bold lettering for wires No. 8 AWG and larger.

C. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.

D. Write-On Tags: Polyester tag, 0.015-inch thick, with corrosion-resistant grommet and polyester or nylon tie for attachment to conductor or cable: Marker for Tags: Permanent, waterproof, black-ink marker recommended by tag manufacturer.

2.4 SAFETY SIGNS: Provide safety signs in accordance with OSHA standards meeting the requirements of ANSI C2, ANSI Z535.1 , ANSI Z535.2 and ANSI Z535.3. Comply with NFPA 70 and 29 CFR 1910.145

A. Provide safety signs manufactured from vinyl having a minimum thickness of 60 mils with red and black letters and graphics on a white background.

B. Size: Provide 7-inch by 10-inch signs or smaller if larger size cannot be applied.

C. Mount safety signs using corrosion-resistant screws. Do not use mounting cement.

D. Self-Adhesive Warning Labels: Factory printed, multicolor, pressure-sensitive adhesive labels, configured for display on front cover, door, or other access to equipment, unless otherwise indicated.

E. All receptacles and switches shall be identified on the inside of the cover plate by circuit number and panelboard.

F. Baked-Enamel Warning Signs: Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for application and with 1/4-inch grommets in corners for mounting. Nominal size, 7 by 10 inches.

G. Metal-Backed, Butyrate Warning Signs: Weather-resistant, non-fading, preprinted, cellulose-acetate butyrate signs with 0.0396-inch galvanized-steel backing, and with colors, legend, and size required for application and with 1/4-inch grommets in corners for mounting. Nominal size, 10 by 14 inches.

2.5 EQUIPMENT IDENTIFICATION LABELS

A. Engraved, Laminated Acrylic or Melamine Label: Punched or drilled for screw mounting. White letters on a Black background. Minimum letter height shall be 3/8 inch. Identification plates shall be furnished for lighting and power panelboards, motor control centers, all line voltage heating and ventilating control panels, fire detector and sprinkler alarms, pilot lights, disconnect switches, manual starting switches, magnetic starters, and all miscellaneous controls, switches and enclosures.

B. Process control devices and pilot lights shall have identification plates. Identification plates shall be furnished for all line-voltage enclosed-circuit breakers; the plates shall identify the equipment served, voltage, phase(s), and power source. Circuits 480 volts and above shall have conspicuously located warning signs in accordance with OSHA requirements.

C. Identification plates shall be three-layer white-black-white, engraved to show black letters on a white background. Letters shall be uppercase. Identification plates 1-1/2 inches high and smaller shall be 1/16 inch thick with engraved lettering 1/8 inch high. Identification plates larger than 1-1/2 inches high shall be 1/8 inch thick with engraved lettering not less than 3/16 inch high. Identification plates having edges of 1-1/2 inches high and larger shall be beveled.

D. Provide nameplates of minimum letter height as follows: Panelboards, switchboards, safety switches and motor control centers: 1/4-inch, identify panel name; 1/8-inch, identify voltage, phase, number of wires, and source.

E. Safety color coding for identification of warning signs shall conform to NEMA Z 535. Red identification plates reading CAUTION: 480/277 VOLTS shall be provided in switch and outlet boxes containing 277-or 480-volt circuits. An identification plate marked DANGER: 480 VOLTS shall be provided on the outside of 480-volt enclosures. Identification plate shall use white lettering on a red laminated plastic.

F. Any equipment with externally powered wiring shall be marked with a laminated plastic name plate having 3/16-inch-high white letters on a red background as follows: DANGER – EXTERNAL VOLTAGE SOURCE.

2.6 CABLE IDENTIFICATION

A. Cable: Brady Permasleeve PSPT type labels shall be used for conductors (used on a Brady TLS 2200 label machine).

1. For instrumentation and control circuits, labels shall include three lines of text, and shall be the same on both ends of the conductor:
    - Line one: shall indicate the origination of circuit.
    - Line two: shall indicate the destination of the circuit.
    - Line three: brief description of circuit function

    Examples:

PLC-1-TB2-5	PLC-1-TB2-7
MCC-1-Pump 1-TB-6	MCC-1-Pump 1-TB-7
Run Status	Stop Status

B. Labels shall be readily visible, legible, and shall not be heat shrunk.

C. Power conductors shall be phased as follows:
1. Conductors #6 and smaller shall have insulation that is continuously color coded.
2. Conductors #4 and larger shall be phase taped:
    - 120/208 V, 3Ph/4W – Black, Red, Blue. Neutral – White.
    - 120/240V – 1Ph/3W – Black, Red, Neutral – White.
    - 480V – Brown, Orange, Yellow
    - 4160V conductors shall be identified as follows:
A phase: 1 yellow wrap of phase tape, 2” to 3” wide.
B phase: 2 yellow wraps of phase tape, each wrap 2” to 3” wide.
C phase: 3 yellow wraps of phase tape, each wrap 2” to 3” wide.

Part 3: EXECUTION

3.1 INSTALLATION

A. General: Install nameplates on the front of equipment, parallel to the equipment lines and secured with corrosion resistant screws. Labels to be consistent with wiring diagrams, schedules, and the Operation and Maintenance Manual designations. Warning Labels for Cabinets, Boxes, and Enclosures for Power and Lighting: Comply with 29 CFR 1910.145 and apply metal-backed, butyrate warning signs. Identify system voltage with black letters on an orange background. Apply to exterior of door, cover, or other access.

B. Install laminated nameplates identifying, each electrical equipment enclosure and Individual equipment and devices. The following items shall be equipped with nameplates: All motors; motor starters, motor-control centers, pushbutton stations, control panels, time switches, disconnect switches panelboards, circuit breakers, contactors, recorders, transmitters, instruments or relays in separate enclosures, thermostats, photocells, power receptacles, switches controlling equipment or receptacles, switches controlling lighting fixtures where the fixtures are not located within the same space as the controlling switch, termination cabinets, manholes and pull boxes, instrumentation and control terminal cabinets, pull boxes manholes and cabinets. Special electrical systems shall be identified at junction and pull boxes, terminal cabinets and equipment racks.

C. Electrical contractor is responsible for nameplates on electrical equipment supplied by other divisions and installed and wired by electrical including all instrumentation and controls equipment. A portion of existing equipment affected by this contract shall also receive nameplates as determined by the engineer.

D. Surface Preparation: Degrease and clean surfaces to receive nameplates, labels and marking paint.

E. Nameplates shall adequately describe the function of the particular equipment involved. Nameplates for panelboards and switchboards shall include the panel designation, voltage and phase of the supply. For example, "Panel A, 277/480V, 3- phase, 4-wire". The name of the machine on the nameplates for a particular machine shall be the same as the one used on all motor starters, disconnect and

P.B. station nameplates for that machine. Equipment Requiring Workspace Clearance shall be labeled According to NFPA 70 applied to door or cover of equipment.

F. Rework or reuse of existing equipment will require new identification tags for some existing equipment.

G. Wire Markers: Identify each individual wire with identification tags as follows:

1. Wire identification markers: Provide wire identification markers on each wire at all termination points.
    a. On power and lighting circuits: The branch circuit or feeder number as indicated on drawings
    b. On control circuits terminated in motor control centers, switchgears, control panels and alike: The field device and terminal number of the opposite end connection.
    c. On control circuits at each field device: The panel or compartment number and terminal number of the opposite end connection.
2. Provide oversize wire markers so that after heat shrinking the wire marker can be rotated on the wire. Rotate wire markers so that wire identification number is visible.

H. Raceway Tags: Provide raceway tags to identify origin and destination of conduit. Install tags at each terminus and at midpoint of run. Provide tags at minimum intervals of every 50 feet of above grade raceway except where concealed in walls. Provide brass tags and nylon straps for attachment.

I. Safety Signs: Provide safety signs as follows or as shown:
   1. Wording: "DANGER -ELECTRICAL EQUIPMENT, AUTHORIZED PERSONNEL ONLY"
      Location: On the outside door of all electrical equipment rooms or areas. On the outside door of all electrical equipment cabinets.
   2. Wording: "DANGER -POWERED FROM MORE THAN ONE SOURCE" Location: Outside all equipment that operates from more than one power source; ATS, PLCs, Main Tie Main switchgear/MCCs, etc.
   3. Wording: "NOTICE -KEEP DOOR CLOSED" Location: On all doors with another safety sign installed.
   4. Wording: "CAUTION -CONTROLS & INTERLOCKS POWERED FROM MULTIPLE SOURCES". Location: On all control panel doors, MCCs I&C terminal cabinets, etc.

END OF SECTION

SECTION 260570
WIRING DEVICES

PART 1 - GENERAL

1.1 SCOPE: The Work of this Section shall consist of furnishing all labor, materials, and equipment necessary for installation of wiring devices and plates. Provide extra heavy duty wiring devices as manufactured by General Electric, Bryant, Hubbell, Pass and Seymour, Sierra, Leviton or approved equal.

1.2 REFRENCES: The latest edition of the following codes or standards shall apply to the design and fabrication of the products and equipment to be supplied under this contract.

A. NEC (NFPA 70) National Electrical Code
B. NETA International Electrical Testing Association - Acceptance Testing specifications
C. NEMA 250 - Enclosure for Electrical Equipment (1,000 Volts Maximum)
D. Local Building Codes and Standards
E. UL 1449 3rd edition Standard for Surge Protection Devices
F. UL 498 Standard for Safety Attachment Plugs and Receptacles

1.4 Furnish submittals in accordance with Section 260500.

A. Shop Drawings: Complete catalog cuts of switches, receptacles, enclosures, covers, and appurtenances, marked to clearly identify proposed materials
B. Documentation showing that proposed materials comply with the requirements of NEC and U.L.

1.7 TESTING:

A. Provide checkout, field, and functional testing of wiring devices.
B. Test each receptacle for polarity and ground integrity with a standard receptacle tester.
C. Test GFCI receptacle for correct tripping operation with tester.

PART 2 – PRODUCTS

2.1 SNAP SWITCHES:

A. Unless otherwise specified, each snap switch (flush tumbler-toggle) shall be of the Specification grade, heavy-duty type for mounting in a single-gang spacing, fully rated 20 amperes, minimum, at 120-277 VAC, conforming to minimum requirements of the latest revision of the UL.
B. Switches shall operate in any position and shall be fully enclosed cup type with entire body molded phenolic or melamine. Fiber, paper of similar insulating material shall not be used for body or cover. White color handles unless otherwise indicated on the drawings. Silver or silver alloy contacts. Brass contact arm.
C. Switches installed outdoors shall have NEMA 4X rated covers.
D. Switches for hazardous locations shall be factory sealed, rated at 20 amperes, 120-277 VAC, capable of controlling 100 percent tungsten filament, fluorescent and HID lamp loads.

2.2 RECEPTACLES:

A. Industrial or Hospital Grade: receptacles shall be in accordance with NEMA Publications and UL Listings. Receptacles shall be rated for 125VAC, 20 amperes, shall be polarized 3 wire type for use with 3 wire cord with grounded lead and 1 designated stud shall be permanently grounded to the conduit system (NEMA 5-20R). Receptacles shall also be fire-resistant, with nylon top (face) and bodies and bases with metal plaster ears (integral with the supporting member).

B. Provide single or duplex receptacles as shown or noted on drawings, and white color unless otherwise noted. Approved manufacturers are Hubbell, Cooper, Pass & Seymour, or Leviton.
C. All receptacles shall be grounding type with a green-colored hexagonal equipment ground screw of adequate size to accommodate an insulated grounding jumper in accordance with NEC, Article 250. Grounding terminals of all receptacles shall be internally connected to the receptacle mounting yoke.
D. GFCI: Ground-fault circuit interrupting receptacles (GFCI's) shall be installed at the locations indicated and as required by the NEC. GFCI's shall be duplex, Industrial or Hospital grade, tripping at 5 mA. Ratings shall be 125 V, 20 amperes, NEMA WD-1, Configuration 5-20R, capable of interrupting 5,000 amperes without damage.
E. Provide GFCI receptacles where shown and as required. Feed-through type GFCI's serving standard receptacles will not be permitted.
F. Pedestal type boxes receptacles shall be cast iron 3/4 inch N.P.T. tapped flanged inlet; double gang, meeting UL Standard 514.
G. Special purpose receptacles shall have ratings and number of poles as indicated or required for anticipated purpose. Matching plug with cord-grip features shall be provided with each special-purpose receptacle.
H. Outdoor mounted Receptacles shall be Corrosion-Resistant and shall in addition to meeting the requirements of general-purpose receptacle have Nickel coated metal parts. Manufacturer; Hubbell Bryant; 20A rated HBL53CM62 Series or equal.

2.3 **DEVICE PLATES:** Provide device plates for each switch, receptacle, signal and telephone outlet, and special purpose outlet. Do not use sectional gang plates for multi- gang boxes. Plates shall be of stainless steel.

2.4 **Covers for cast boxes (flush and surface) installed in damp or wet locations shall be UL approved for weatherproof locations (UL standard 498 and 514; OSHA standard Subpart "S"; NEMA Standard WD-1) with plug inserted and shall comply with NEC-410-57b; shall be heavy cast copper free aluminum with 2 coat baked epoxy finish; while-in-use door. Provide Crouse Hinds, Appleton or equal. This requirement includes outlets mounted flush in exterior lighting poles.**

PART 3 – EXECUTION

3.1 **GENERAL:** Perform work in accordance with the National Electrical Code.

3.2 **CONNECTION:** Rigidly attach wiring devices in accordance with National Electrical Code. Coordinate installation avoiding interference with other equipment.

3.3 **GROUNDING:** Ground all devices, including switches and receptacles, in accordance with NEC, ART 250.
A. Ground switches and associated metal plates through switch mounting yoke, outlet box, and raceway system.
B. Ground flush receptacles and their metal plates through grounding jumper connections to outlet box and grounding system.

END OF SECTION

SECTION 260573
SHORT CIRCUIT, COORDINATION STUDY & ARC FLASH HAZARD ANALYSIS

PART 1 - GENERAL

1.1 GENERAL SCOPE

A. The Contractor shall Provide the services of a recognized corporately and financially independent firm for performing electrical studies and reports on all new electrical equipment supplied in this contract and on existing equipment as herein specified. The study firm shall provide all material, equipment, labor, and technical supervision required to perform the studies and reports.

B. Provide a short circuit, coordination and arc-flash study for entire electrical system. Provide a single final electrical study report incorporating the short circuit, coordination, and arc flash study.

C. Provide a short circuit, coordination, and arc-flash study from the Utility Service primary OCP to all points downstream. Provide system studies in latest release of SKM Power Systems, ETAP, or other software.

1.2 APPLICABLE CODES, STANDARDS, AND REFERENCES

A. Institute of Electrical and Electronics Engineers, Inc. (IEEE) :
1. IEEE 141 – Recommended Practice for Electric Power Distribution and Coordination of Industrial and Commercial Power Systems
2. IEEE 399 – Recommended Practice for Industrial and Commercial Power System Analysis
3. IEEE 1584 – Guide for Performing Arc-Flash Hazard Calculations

B. American National Standards Institute (ANSI):
1. ANSI C57.12.00 – Standard General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers
2. ANSI C37.13 – Standard for Low Voltage AC Power Circuit Breakers Used in Enclosures
3. ANSI C37.010 – Standard Application Guide for AC High Voltage Circuit Breakers Rated on a Symmetrical Current Basis
4. ANSI C 37.41 – Standard Design Tests for High Voltage Fuses, Distribution Enclosed Single-Pole Air Switches, Fuse Disconnecting Switches and Accessories
5. ANSI C37.5 – Methods for Determining the RMS Value of a Sinusoidal Current Wave and Normal-Frequency Recovery Voltage, and for Simplified Calculation of Fault Currents

C. The National Fire Protection Association (NFPA)
1. NFPA 70 - National Electrical Code, latest edition
2. NFPA 70E – Standard for Electrical Safety in the Workplace

1.3 QUALIFICATIONS

A. The study firm shall be regularly engaged in the study of electrical equipment devices, installations, and systems. The lead, technical person shall be a electrical professional engineer. The study firm shall provide in house electrical studies and reports as specified.

PART 2 - PRODUCTS

2.1 Provide a current and complete short-circuit study, equipment interrupting or withstand evaluation, and a protective device coordination study for the electrical distribution system.

A. The studies shall include all portions of the electrical distribution system from the normal and alternate sources of power. Normal system operating method, alternate operation, and operations which could result in maximum fault conditions shall be thoroughly covered in the study.

B. The studies shall be submitted to the project electrical engineer prior to granting final approval of the distribution equipment shop drawings and/or prior to release of equipment for manufacture.

C. The study shall be in accordance with applicable ANSI and IEEE Standards. The study input shall include the utility company's short circuit single and three phase contribution, with the X/R ratio, the resistance and reactance components of each branch impedance, motor and generator contributions, base quantities selected, and all other applicable circuit parameters.

D. Short circuit momentary duties and interrupting duties shall be calculated on the basis of maximum available fault current at each switchgear bus, switchboard, motor control center, distribution panelboard, pertinent branch circuit panelboards, and other significant locations through the system.

E. An equipment evaluation study shall be performed to determine the adequacy of new circuit breakers, controllers, surge arresters, busways, switches, and fuses by tabulating and comparing the short circuit ratings of these devices with the available fault currents. Any problem areas or inadequacies in the existing equipment shall be documented back to the project engineer with recommended remedial actions. The study firm shall coordinate with the supplier of the new equipment to assure all specifications of the new equipment meet or exceed the ratings required by the study at no additional cost to the owner.

F. A protective device coordination study shall be performed to select or to check the selections of power fuse ratings, protective relay characteristics and settings, ratios and characteristics of associated voltage and current transformers, and low-voltage breaker trip characteristics and settings. The coordination study shall include all voltage classes of equipment from the utility's incoming line protective device down to and including each motor control center and/or panelboard. The phase and ground overcurrent protection shall be included, as well as settings for all other adjustable protective devices.

G. The results of the power system study shall be summarized in a final report and made part of the operation and maintenance manuals. The report shall include the following sections;
   1. Description, purpose, basis written scope, and a single line diagram of the portion of the power system which is included within the scope of study.
   2. Tabulations of circuit breaker, fuse and other equipment ratings versus calculated short circuit duties, and commentary regarding same.
   3. Protective device time versus current coordination curves, tabulations of relay and circuit breaker trip settings, fuse selection and commentary regarding same.

4. Fault current tabulations including a definition of terms and a guide for interpretation.

2.2 ARC FLASH EVALUATION

A. Provide arc flash evaluations in conformance to IEEE Std. 1584-2004a *IEEE Guide for Performing Arc-Flash Hazard Calculations* and NFPA 70-2008 (NEC) and NFPA 70E-2009 *Standard for Electrical Safety in the Workplace.* The arc flash study shall be performed using computer software that uses methods based on IEEE Std. 1584-2004a. The software used must be capable of modeling all protective devices at the site and any mitigation devices used to limit the incident energy. The software used must have the capability of modeling user defined PPE descriptions and ATPV values as well as limiting the maximum clearing time where engineering judgment deems it prudent. Perform evaluation and furnish appropriate labels for both utility power source and generator source.

B. Provide permanent labels for each electrical enclosure or equipment where workers could be exposed to energized conductors. Provide die-cut 4" x 6" labels with preprinted headers. Organize safety information in approved order to communicate quickly, clearly and accurately. Provide Die-cut labels made from industrial grade indoor/outdoor vinyl, providing a long label life. Label layout shall be approved by the project engineer. Provide yellow Caution; orange Warning and red Danger labels for category zero, 1-3, 4 and above incident energy categories. Study firm shall supervise installation of labels and provide a statement in the project report that the labels are approved as installed. These labels shall comply with the requirements of NFPA 70E and include at least the following information:
   - Source (Utility or Genrator)
   - Voltage (phase to phase).
   - Flash Protection Boundary (inches).
   - Incident Energy at the working distance (cal/cm^2).
   - PPE Class and Description (Including glove rating).
   - Restricted Approach Boundary (inches).
   - Limited Shock Approach Boundary (inches).
   - Prohibited Shock Approach Boundary (inches).
   - Location Identification

C. Provide a report that includes the basis for and results of numerical assessments. The report shall include any significant conclusions and recommendations for corrective or mitigative action as appropriate. In addition, the report shall include the following:
   - Identification of the methods or software used.
   - Date work was performed.
   - Identification of the person that performed the assessment.
   - Tabular data indicating; the incident energy and required PPE for all locations evaluated.
   - A one-line diagram of the computer model.
   - Sample Arc Flash Labels:

D. Sample Arc Flash Labels:

DANGER

ARC FLASH & SHOCK HAZARD
No Energized Work Permitted

FLASH PROTECTION		SHOCK PROTECTION	
Flash Hazard at:	18 inches	Glove Class:	00
Flash Hazard Category:	D	Voltage Rating:	480 VAC
Min. Arc Rating:	52 cal/cm^2	Limited Approach Boundary:	42 inches
Flash Protection Boundary:	180 inches	Restricted Approach Boundary:	12 inches
EQUIPMENT:		Prohibited Approach Boundary:	1 inches

PPE Required: DANGEROUS!! NO SAFE PPE CATEGORY

WARNING

ARC FLASH & SHOCK HAZARD
APPROPRIATE PPE REQUIRED

FLASH PROTECTION		SHOCK PROTECTION	
Flash Hazard at:	18 inches	Glove Class:	00
Flash Hazard Category:	1	Voltage Rating:	240 VAC
Min. Arc Rating:	4.0 cal/cm^2	Limited Approach Boundary:	42 inches
Flash Protection Boundary:	38 inches	Restricted Approach Boundary:	Avoid Contact
EQUIPMENT:240V EQUIPMENT		Prohibited Approach Boundary:	Avoid Contact

PPE Required: Cotton or Non-Melting Undergarments, FR Shirt & Pants or FR Coveralls (Cat 1 or above), Hardhat, Arc-Rated Face-shield, Safety Glasses, Hearing Protection, Leather Work-boots

SOURCE: UTILITY

END OF SECTION

SECTION 260800
ACCEPTANCE TESTING & PERFORMANCE VERIFICATION

PART 1 GENERAL
1.1 GENERAL SCOPE

A. The Contractor shall engage the services of a recognized corporately and financially independent testing firm for the purpose of performing inspections and tests on all new electrical equipment supplied in this contract and on existing modified equipment as herein specified. All tests shall be documented. It is the intent of these specifications that the testing firm work in direct communication with the engineer of record with frequent testing data updates as the work progresses.

B. The testing firm shall provide all material, equipment, labor and technical supervision to perform such tests and inspections. Testing shall be supervised by qualified professional engineering staff.

C. It is the purpose of these tests to assure that all tested electrical equipment, is operational and within industry and manufacturer's tolerances and is installed in accordance with design specifications. Tests shall be performed with and in cooperation with certification tests performed by switchgear and generator manufacturer. The testing contractor shall be an integral part in assuring the coordinated testing and startup of the power system. The tests and inspections shall determine suitability for energization.

1.2 APPLICABLE CODES, STANDARDS, AND REFERENCES

A. All inspections and test shall be in accordance with the following codes and standards except as provided otherwise herein:
   1. National Electrical Manufacturer's Association - NEMA
   2. American Society for Testing and Materials - ASTM
   3. Institute of Electrical and Electronic Engineers - IEEE
   4. International Electrical Testing Association - NETA Acceptance Testing Specifications - ATS-1991
   5. American National Standards Institute - ANSI C2: National Electrical Safety Code.
   6. State and local codes and ordinances
   7. Insulated Cable Engineers Association - ICEA
   8. Association of Edison Illuminating Companies - AEIC
   9. Occupational Safety and Health Administration - OSHA
   10. National Fire Protection Association – NFPA
       a. ANSI/NFPA 70: National Electrical Code
       b. ANSI/NFPA 70B: Electrical Equipment Maintenance
       c. NFPA70E: Standard for Electrical Safety in the Workplace
       d. ANSI/NFPA 780: Lightning Protection Code
       e. ANSI/NFPA 101: Life Safety Code

B. All inspections and test shall utilize the following references:
   1. Project design specifications
   2. Project design drawings
   3. Manufacturer's instruction manuals applicable to each particular apparatus

1.3 QUALIFICATIONS OF TESTING FIRM

A. The testing firm shall be an independent testing organization which can function as an unbiased testing authority, professionally independent of the manufacturers, supplier, and installers of equipment or systems evaluated by the testing firm.

B. The testing firm shall be regularly engaged in the testing of electrical equipment devices, installations, and systems.

C. The testing firm shall meet OSHA criteria for accreditation of testing laboratories, Title 29, Part 1907, or be a Full Member company of the International Electrical Testing Association (NETA).

D. The lead, on-site, technical person shall be currently certified by the International Electrical Testing Association (NETA) or National Institute for Certification in Engineering Technologies (NICET) in electrical power distribution system testing or be a electrical professional engineer in the state of Florida.

E. The testing firm shall utilize engineers and technicians who are regularly employed by the firm for testing services. The testing firm shall provide in house electrical studies and reports as specified. The testing firm shall have a Florida registered professional electrical engineer on staff.

F. The testing firm shall submit proof of the above qualifications when requested. Pre- qualified testing firms for this project are:
   1. Emerson Electrical Reliability Services, Inc.
   2. Industrial Electrical Testing, Inc.
   3. Electric Power Systems

   Other firms will be considered by the engineer on submittal of qualifications on or before 20 days prior to bid.

1.4 DIVISION OF RESPONSIBILITY

A. The contractor shall perform routine insulation-resistance, continuity, and rotation test for all distribution and utilization equipment prior to and in addition to tests performed by the testing firm specified herein.

B. The contractor shall supply a suitable and stable source of electrical power to each test site.

C. The contractor shall notify the testing firm when equipment becomes available for acceptance tests. Work shall be coordinated to expedite project scheduling. However, the testing firm shall visit the job a minimum of once a week to perform coordination duties required and make reports to the engineer of the installation progress.

D. Any system, material, or workmanship which is found defective on the basis of acceptance tests shall be reported to the engineer.

E. The testing firm shall maintain a written record of all tests and, upon completion of project, shall assemble and certify a final test report.

F. Safety and Precautions

   1. Safety practices shall include, but are not limited to, the following

requirements:

a. Occupational Safety and Health Act.
b. Accident Prevention Manual for Industrial Operations, National Safety council
c. Applicable state and local safety operating procedures.
d. Owner's safety practices.
e. National Fire Protection Association - NFPA 70E
f. American National Standards for Personnel Protection

2. All test shall be performed with apparatus de-energized. Exceptions must be thoroughly reviewed to identify safety hazards and devise adequate safeguards.
3. The testing firm shall have a designated safety representative on the project to supervise the testing operations with respect to safety.

1.5 SUITABILITY OF TEST EQUIPMENT

A. All test equipment shall be in good mechanical and electrical condition.

B. Digital multimeters used shall be RMS sensing when the variable to be measured contains harmonics or dc offset or any deviation from a pure sine wave. Accuracy of metering in test equipment shall be appropriate for the test being performed but not in excess of 2 percent of the scale used.

PART 2 - INSPECTION AND TEST PROCEDURES

2.1 CABLES - LOW VOLTAGE - 600V Maximum (all cables except 20 and 30amp lighting and receptacle circuits).

A. Visual and Mechanical Inspection
1. Inspect cables for physical damage and proper connection in accordance with drawings.
2. Test cable mechanical connections to manufacturer's recommended values or NETA Standards using a calibrated torque wrench.
3. Check cable color coding with applicable engineer's specifications and National Electrical Code standards.

B. Electrical Tests
1. Perform insulation-resistance test on each conductor with respect to ground and adjacent conductors. Applied potential shall be 1000 volts dc for 3 minutes.
2. Perform continuity test to insure proper cable connection.
3. Test Values; Evaluate results by comparison with cables of same length and type. Minimum acceptable value shall be no less than 50 megohms for new feeders; 5megohms for existing reused, renovated, rerouted or extended feeders.

2.2 CIRCUIT BREAKERS (all breakers except 20amp 120V lighting and receptacle circuit breakers; test all GFCI breakers)

A. Circuit Breakers - Low Voltage insulated case/molded case
1. Visual and Mechanical Inspection

a. Check circuit breaker for proper mounting and compare nameplate data to drawings and specifications.
b. Operate circuit breaker to ensure smooth operation.

c. Inspect case for cracks or other defects.
d. Check tightness of connections using calibrated torque wrench. Refer to manufacturer's instructions or NETA standards for proper torque levels.

2. Electrical Tests
   a. Perform a contact-resistance test.
   b. Perform an insulation-resistance test at 1000 volts dc from pole to pole and from each pole to ground with breaker closed and across open contacts of each phase.
   c. Determine long-time minimum pickup current by primary current injection where practical.
   d. Perform long-time delay time-current characteristic tests by passing three hundred percent (300%) rated current through each pole separately. Record trip time.
   e. Determine short-time pickup and delay by primary current injection, if applicable.
   f. Determine ground-fault pickup and time delay by primary current injection, if applicable.
   g. Determine instantaneous pickup current by primary injection using run-up or pulse method.

3. Test Values
   a. Compare contact resistance or millivolt drop values to adjacent poles and similar breakers. Investigate deviations of more than fifty percent (50%). Investigate any value exceeding manufacturer's recommendations.
   b. Insulation resistance shall not be less than 100 megohms.
   c. Trip characteristic of breakers shall fall within manufacturer's published time-current characteristic tolerance band, including adjustment factors.
   d. All trip times shall fall within NETA Standards. Circuit breakers exceeding specified trip time at three hundred percent (300%) of pickup shall be tagged defective.
   e. Instantaneous pickup values shall be within NETA standards.

2.3 GROUNDING SYSTEMS: (provide for new and upgraded grounding systems)

A. Visual and Mechanical Inspection

B. Inspect ground systems for compliance with drawings and specifications.

C. Perform ground-impedance measurements utilizing the fall-of-potential method per ANSI/IEEE Standard 81 "IEEE Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System." Instrumentation utilized shall be as Approved by NETA Standards and shall be specifically designed for ground impedance testing. Provide sufficient spacing so that plotted curves flatten. In large ground grid systems where adequate pole distance is not practical provide Tagg Slope technique or the intersecting curves method. (Ref. Nos. 40 and 41 in IEEE Std. 81.) of calculating system resistance.

D. Equipment Grounds: Utilize two-point method of IEEE Std. 81. Measure between equipment ground being tested and known low-impedance grounding electrode of system:

E. Lightning protection ground system test values within the ground system should be 5 ohms or less tested with a clamp on ground test instrument. Down conductor tests at grade level should be 2 ohms or less. Investigate high resistance connections and correct readings above these limits.

F. The main ground electrode system impedance-to-ground should be no greater than one (1) ohms. Equipment grounds, depending on size and length of grounding conductor, should be only fractionally higher than system ground.

2.4 MOTORS (5hp and greater)

A. Visual and Mechanical Inspection
   1. Inspect for physical damage.
   2. Inspect for proper anchorage, mounting, grounding, connection and lubrication.
   3. When applicable, perform special tests as air gap spacing and pedestal alignment.

B. Electrical Tests - Induction Motors
   1. Perform insulation resistance tests in accordance with ANSI/IEEE Std. 43.
   2. Motors 200Hp and Less - Test duration shall be for one minute with resistances tabulated at 30 and 60 seconds and calculate the dielectric absorption ratio. Motors larger than 200 horsepower perform tests for ten minutes and calculate polarization index. Minimum acceptable polarization index for Class B or F insulated motors shall be 2.0.
   3. Perform insulation resistance test on pedestal per manufacturer instructions.
   4. Perform insulation resistance test on surge protection device in accordance with this specification.
   5. Check that the motor space heater circuit is in proper operating conduction.
   6. Check all protective devices in accordance with other sections of these specifications.
   7. Perform a rotation test to ensure proper shaft direction if the motor has been disconnected.
   8. Measure running current and evaluate relative to load conditions and nameplate full load amperes. Verify proper overload relays.

2.5 MOTOR CONTROL (all motors)

A. Visual and Mechanical Inspection
   1. Inspect for physical damage, proper anchorage, and grounding.
   2. Inspect equipment for compliance with drawings and specifications.
   3. Motor-running protection
      a. Compare overload heater rating with motor full-load current rating to verify proper sizing.
      b. If motor-running protection is provided by fuses, verify proper rating considering motor characteristics and power-factor correction capacitors if applicable. Check tightness of bolted connections using calibrated torque wrench.

B. Electrical Tests
   1. Insulation tests:
      a. Measure insulation resistance of each bus section phase-to-phase and phase-to-ground for three (3) minutes. Test voltage shall be in accordance with

NETA Standards.

b. Measure insulation resistance of each starter section phase-to-phase and phase-to-ground with the starter contacts closed and the protective device open. Test voltage shall be in accordance with NETA Standards.

c. Measure insulation resistance of each control circuit with respect to ground.

2. Test motor overload units by injecting current through overload unit and monitoring trip time at three hundred percent (300%) of motor full-load current.
3. Three phase power unbalance: Run motor at full load steady state conditions and take current readings on all three leads. Roll the motor leads maintaining the proper rotation and take motor current readings on all three possible hook-ups. Choose the least unbalance hookup for each motor. The maximum acceptable unbalance is 10 percent at full load. If the unbalance cannot be corrected by rolling leads, the source of the unbalance must be located and corrected. If on the three possible hook ups, the leg of "greatest unbalance" (furthest from the average) stays on the same power lead then most of the unbalance is being caused by the power source. However, if the leg of greatest unbalance moves on each of the hookups with a particular motor lead, the primary source of unbalance is on the motor side of the starter. Check for damaged cable, leaking splices, poor connections, or faulty motor winding.

2.6 TRANSFORMERS – DRY TYPE TRANSFORMERS – SMALL DRY TYPE, AIR-COOLED (600 Volt and Below)

A. Inspect for physical damage, broken insulation, tightness of connections, defective wiring, and general condition.

B. Thoroughly clean unit prior to making any tests.

C. Perform insulation-resistance test. Perform test verification for impedance.

D. Energize primary winding with system voltage. Measure secondary voltage with the secondary load disconnected. Record results.

2.7 LOW VOLTAGE SURGE SUPPRESSORS

A. Visual and mechanical inspection

1. Verify suppressors are installed with minimum length leads to the protected equipment. Verify connections to bus.
2. Verify ground connections to ground bus.

B. Electrical Tests

1. Test clamping voltage and verify meets specified ratings; test in accordance with ANSI C62.33 section 4.4 and 4.7

2.8 LOW VOLTAGE AIR SWITCHES (disconnect switches, manual & automatic transfer switches)

A. Visual and Mechanical Inspection

1. Compare equipment nameplate data with drawings and specs.
2. Inspection for mechanical and physical damage. Cleaning of interior, insulators, arc chutes.
3. Testing of mechanical operator. Cleaning and lubrication of contacts and

mechanism, as applicable.
4. Verification of contact alignment and wipe. Verify phase barrier insulation.
5. Inspect anchorage, alignment, grounding, and required clearances..
6. Documentation of fuse and types are in accordance with drawings, short circuit studies and coordination study.
7. Verification of tightness of accessible bolted electrical connections by calibrated torque-wrench method.
8. Verification of presence of expulsion-limiting devices on all holders having expulsion-type elements.
9. Verification of interlocking systems for proper operation and sequencing.
10. Verify proper lubrication on current carrying and moving sliding parts.

B. Electrical Tests
1. Contact resistance testing across each switch blade and fuse holder.
2. Measurement of fuse resistance.
3. Insulation resistance testing on each pole, phase-to-phase and phase-to- ground with switch closed and across each open pole for one minute.
4. AC or DC overpotential testing phase-to-phase and phase-to-ground.
5. Verification of proper space heater operation.

END OF SECTION

SECTION 262200
LOW-VOLTAGE TRANSFORMERS

PART 1 GENERAL

1.1 DESCRIPTION

This section specifies the furnishing, installation and connection of the dry type general- purpose transformers.

1.2 SUBMITTALS

A. In accordance with Division 26

B. Shop Drawings:
   1. Sufficient information, clearly presented, shall be included to determine compliance with drawings and specifications.
   2. Include electrical ratings, impedance, dimensions, weight, mounting details, decibel rating, terminations, temperature rise, no load and full load losses, and connection diagrams.
   3. Complete nameplate data including manufacturer’s name and catalog number.

C. Manuals:
   1. Submit, simultaneously with the shop drawings, companion copies of complete maintenance and operating manuals including technical data sheets and wiring diagrams.

1.3 REFRENCES

A. National Fire Protection Association (NFPA) 70-08 National Electrical Code (NEC)

B. National Electrical Manufacturers Association (NEMA): ST 20-97 Dry-Type Transformers for General Applications

PART 2 PRODUCTS

2.1 GENERAL PURPOSE DRY TYPE TRANSFORMERS

A. Unless otherwise specified, dry type transformers shall be in accordance with NEMA, NEC and as shown on the drawings. Transformers shall be UL listed or labeled.

B. Dry type transformers shall have the following features:
   1. Self-cooled by natural convection, isolating windings, indoor, dry type. Autotransformers will not be accepted.
   2. Rating shall be as shown on the drawings. Ratings shown on the drawings are for continuous-duty without the use of cooling fans.
   3. Transformers shall have copper windings.
   4. Insulation systems:
      a. Transformers 30 KVA and larger: UL rated 220 degrees C system having an average maximum rise by resistance of 150 degrees C in a maximum ambient of 40 degrees C.
      b. Transformers below 30 KVA: Same as for 30 KVA and larger or UL rated 185 degrees C system having an average maximum rise by resistance of 115 degrees C in a maximum ambient of 40 degrees C.
   5. Core and coil assemblies:
      a. Rigidly braced to withstand the stresses caused by short circuit currents and rough handling during shipment.
      b. Cores shall be grain oriented, non-aging, and silicon steel.
      c. Coils shall be continuous windings without splices except for taps.
      d. Coil loss and core loss shall be minimum for efficient operation.

e. Primary and secondary tap connections shall be brazed or pressure type.
f. Coil windings shall have end fillers or tie downs for maximum strength.

6. Certified sound levels determined in accordance with NEMA, shall not exceed the following:

Transformer Rating	Sound Level Rating
0 - 9 KVA	40 dB
10 - 50 KVA	45 dB

7. Nominal impedance shall be as per NEMA.
8. Single phase transformers rated 15 KVA through 25 KVA shall have two, 5 percent full capacity taps below normal rated primary voltage. All transformers rated 30 KVA and larger shall have two, 2-1/2 percent full capacity taps above, and four, 2-1/2 percent full capacity taps below normal rated primary voltage.
9. Core assemblies shall be grounded to their enclosures by adequate flexible ground straps.
10. Enclosures:
    a. Not less than code gage steel.
    b. Outdoor enclosures shall be NEMA 3R stainless steel or NEMA 4X stainless steel.
    c. Temperature rise at hottest spot shall conform to NEMA Standards, and shall not bake and peel off the enclosure paint after the transformer has been placed in service.
    d. Ventilation openings shall prevent accidental access to live components.
    e. Thoroughly clean and paint enclosure at the factory with manufacturer's prime coat and standard finish.
11. Standard NEMA features and accessories including ground pad, lifting provisions and nameplate with the wiring diagram and sound level indicated on it.
12. Dimensions and configurations shall conform to the spaces designated for their installations.
13. Transformers shall meet DOE 2016 minimum energy efficiency.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Installation of transformers shall be in accordance with the NEC, as recommended by the equipment manufacturer and as shown on the drawings.
B. Install the transformers with adequate clearance at a minimum of 4 inches from wall and adjacent equipment for air circulation to remove the heat produced by transformers.
C. Install transformers on vibration pads designed to suppress transformer noise and vibrations.
D. Use flexible metal conduit to enclose the conductors from the transformer to the raceway systems.

END OF SECTION

SECTION 26 29 13
CONTROL PANELS

PART 1 GENERAL

1. WORK INCLUDED

A. Furnish all labor, equipment, and materials for control panels as indicated on the drawings and specified herein.

B. The panel supplier shall be a UL listed panel shop and the control panel shall be UL-698A certified and labeled.

C. Refer to the elementary diagrams in the design drawing for additional requirements.

D. The Contractor shall be responsible for coordinating and interfacing with equipment and instrumentation supplied under other sections of the Contract Documents that are an integral part of the plant control systems. This interfacing shall be incorporated in the detailed systems drawings and data sections to be submitted by the contractor prior to rough-in work.

2. SUBMITTALS

A. The contractor shall submit to the Engineer for approval complete shop drawings, wiring diagrams, data, and operation and maintenance manuals of all equipment to be furnished under this section.

B. Coordination and Shop Drawings: Prepare and submit coordination drawings for installation of products and materials fabricated. Coordination and shop drawings shall be prepared using a computer aided drafting system. Shop drawings shall be submitted in electronic (PDF) format.

1. Submit component interconnect drawings showing the interconnecting wiring between each component including equipment supplied under other sections requiring interfacing with the control system. Diagrams shall show all component and panel terminal board identification numbers, and external wire and cable numbers. Note, this diagram shall include all intermediate terminations between field elements and panels (e.g., terminal junction boxes, pull boxes, etc.). Diagrams' devise designations, and symbols shall be in accordance with NEMA ICS 1-101.

2. Panel Wiring Diagrams: Elementary diagrams shall be similar to those diagrams shown in the drawings, but with the addition of all auxiliary devices such as additional relays, alarms, fuses, lights, fans, heaters, etc.

3. Panel wiring diagrams shall identify wire numbers and types, terminal numbers, tag numbers and PLC I/O identification (address) numbers. Wiring diagrams shall show all circuits individually; no common diagrams shall be allowed.

4. Submit arrangement and construction drawings for consoles, control panels, and for other special enclosed assemblies for field installation. Include dimensions, identification of all components, preparation and finish data, nameplates, enough other details to define the style and overall appearance of the assembly and a finish treatment. Drawings shall show the location of all front panel mounted

devices to scale, and shall include a panel legend and a bill of materials. The panel legend shall list and identify all front of panel devices by their assigned tag numbers, all nameplate inscriptions, service legends and annunciator inscriptions. The bill of materials shall list all devices mounted within the panel that are not listed in the panel legend, and shall include the tag number, description, manufacturer and complete model number for each service.

5. Submit installation, mounting, and anchoring details for all components.

6. Field testing checklists and procedures.

C. Operation, Maintenance and Repair Manuals

1. Submit operation and maintenance manuals.

3. CODES AND STANDARDS:

A. Equipment, materials, and workmanship shall comply with the latest revisions of the following codes and standards

1. Instrumentation: Instrument Society of America (ISA).
2. National Electrical Code (NEC) 2005,
3. Wiring: ISA S5.3 and S5.4, latest issue.
4. Control Panels and equipment: NEMA, UL and ANSI.
5. Control Logic: Joint Industrial Council (JIC).
6. UL508A, UL508A-SB and UL698A

PART 2 PRODUCTS

2.1 CONTROL PANELS

A. Control panels shall be UL698A compliant. Control panels shall be marked with a short circuit current rating (SCCR). The SCCR shall be equal to or more than the short circuit current available at the panel line terminals and in no case be less than 22,000A SCCR for 480V supplied panels or 10,000A SCCR for 208/120V panels. The panel designer shall verify the available short circuit required.

B. The electrical control equipment shall be mounted within a pad-lockable NEMA Type 4X dead-front enclosure constructed of not less than 304 stainless steel and shall be equipped with a 3-point latch with all hardware and exterior components construction of 300 series stainless steel (except control panels in air conditioned spaces and electrical room may be NEMA 1 painted steel). The enclosure shall be equipped with an inner dead front door and shall incorporate a removable, aluminum or stainless steel back panel on which control components shall be mounted. Back panel shall be secured to enclosure with collar studs. All hardware shall be stainless steel. Provide safety hardware to hold the door in an open position. Provide a folding shelf on the door for convenient temporary support of a laptop computer.

C. Components: All motor branch circuit breakers; motor starters and control relays shall be of highest industrial quality, securely fastened to the removable back panels with screws and lock washers. Back panels shall be tapped to accept all mounting screws. Self-tapping screws shall not be used to mount any component.

D. A circuit breaker shall be provided on each control panel as a means of disconnecting power to the control panel. The disconnect operating handle shall be installed on the right side of the cabinet not in the door.

E. Control transformers shall be installed where shown to provide 120VAC and 24VAC for control circuits. Transformers shall be fused on the primary and secondary circuits. The transformer secondary shall be grounded on one leg.

F. All control panel wiring shall be identified at both ends with type written heat shrinkable wire markers with the numbering system shown on the control submittal drawings.

1. Control wiring shall be stranded copper, minimum size #14 AWG (except for shielded instrumentation cable may be #16 AWG), with 600 volt, 90 degrees C, flame retardant, Type MTW thermoplastic insulation.
2. Wire shall be guided within control and terminal cabinets by cable supports (duct). Instrumentation and control field cables on the unprotected side of SPD devices within the cabinet shall not run in parallel to the cables on the protected side of the SPD device. Separate cable supports (duct) will be provided.
3. All conductors shall be neatly led to terminations. All connections of stranded wire to screw type terminal blocks shall be by insulated spade lugs, crimp fastened to wire. Provide stranded wire crimp ferrules for all stranded wire connections not requiring spade lugs for screw type terminal blocks.

G. The control panel shall be provided with nameplates identifying each component, selector switches, pilot lights, etc. Nameplates shall be permanently affixed using an epoxy process. Nameplates shall be laminated plastic, engraved white letters with a black background.

H. Corrosion Inhibitor Emitter: Provide an industrial corrosion inhibitor emitter on all exterior mounted control panels that will protect internal components of the control panel from corrosion one year. Provide one spare emitter for each control panel.

I. Terminal strips shall be provided for all signals as indicated on the drawings plus all spare conductors as specified. Terminal strips shall be switch type with integral fuses equal to Allen Bradley 1492-H6. Wiring from the control panel to the terminal strips shall be factory installed. All spare conductors shall be terminated and identified. All terminals over 200V phase to phase shall be covered with approved plastic shields.

J. Provide Intrinsic Safe Relays/Barriers for all field instrumentation located in hazardous areas. Coordinate with section 268500 – Instrumentation and Controls.

K. RELAYS

1. Control circuit switching shall be accomplished with relays. These relays, for interfacing and control applications, shall be the compact general purpose plug-in type having low coil inrush and holding current characteristics. A neon status-indicating light shall be provided with each relay. Contact arrangements shall be as noted or shown, and shall be rated for not less than 10 amperes at 120V ac or 28V dc. Coil voltage shall be as noted or shown. Non-latching relays shall have a single coil. Latching relays shall have two coils, unlatching being accomplished by energizing one coil, and latching being accomplished by energizing the other coil. Relays shall have plain plastic dust covers, test buttons, and mounting sockets

with screw terminals and hold down springs. Relays shall be UL recognized. Relays shall be Potter and Brumfield, Struthers- Dunn, or equal.

2. Time delay functions shall be accomplished with time delay relays. Units shall be adjustable time delay relays with the number of contacts and contact arrangements as shown. A neon status-indicating light shall be provided with each relay. Contacts shall be rated for 10 amperes at 120V ac. Integral knob with calibrated scale shall be provided for adjustment of time delay. Initial setting shall be as shown with time delay range approximately three times the initial setting. Time delay rangeability shall be at least 10:1. Operating voltage shall be 120V ac, plus 10 percent, -15 percent at 60-Hz. Operating temperature shall be -20 degrees F to 165 degrees F. Repeat timing accuracy shall be plus or minus 10 percent over the operating range. Units shall be Amerace Corp., Control Products Division, Agastat Series 7000, Cutler-Hammer Series D87, or equal.

3. All relays shall have a screw terminal interface with the wiring. Terminals shall have a permanent, legible identification. Relays shall be mounted such that the terminal identifications are clearly visible and the terminals are readily accessible.

L. Front Panel Operating Controls and Instruments

1. Operating controls and instruments shall be securely mounted on the control compartment inner swing door. All controls and instruments shall be clearly labeled to indicate function.

2. Breakers shall be accessible and operable with the inner swing door closed.

3. Breakers, indicating lamps, and switches shall be clearly labeled with engraved phenolic labels with white surface and black letters.

4. Indicator lamps shall be LED full voltage push to test type and mounted in NEMA 4X (800H) modules, as manufactured by Allen Bradley or SKPI as manufactured by Square D. Lamp modules shall be equipped to operate at 24 or 120-volt input. Lamps shall be easily replaceable from the front of the control compartment door without removing lamp module from its mounted position. Units shall be heavy-duty, oil-tight, push to test industrial type with screwed on prismatic glass lenses in colors as shown, and shall have factory engraved legend plates. LED's shall be high illumination type (5ma at 130V ac).

5. Selector switches shall be heavy-duty, oil-tight, industrial type selector switches with contacts rated for 120V ac service at 10 amperes continuous. Units shall have standard size, black field, legend plates with white markings, as indicated. Operators shall be black knob type. Units shall have the number of positions and contact arrangements and spring return function (if any) as shown. Units shall be single-hole mounting, accommodating panel thickness from 1/16-inch minimum to 1/4-inch maximum. Units with up to four selection positions shall be Allen Bradley 800H, Square D Type K, Cutler-Hammer Type T, or equal. Units with up to 12 selection positions shall be Rundel-Idec Standard Cam Switch, Electroswitch 31, or equal.

M. Pump Controller

1. Furnish and install pump control with interface controls on inner swing door. Design

basis is MPE SC1000 series or approved equal. The pump controller shall stage pumps on and off based on wet well level. The levels shall be user adjustable from the front interface panel without the use of specialized tools. The pump control panel shall call pumps to run based on pump start setpoints. Pumps that are called to run shall remain on until the wet well level drops below the pumps off setpoint.

2. The pump controller shall not operate more than one pump while the station is on backup generator power.

N. Backup Control

1. Provide relay based independent backup control. Refer to the design drawings for the control description.

2. The backup control shall not operate more than one pump while the station is on backup generator power.

2.2 ELECTRICAL SURGE PROTECTION

A. Refer to Section 268500 – Instrumentation and Control and Section 264300 – Surge Suppression.

2.3 REMOTE TELEMETRY UNIT (RTU)

A. The OWNER will furnish the RTU and antenna through their systems integrator Carolina Technical Services, Inc. (CTS) Refer to the design drawings for RTU installation requirements and related CONTRACTORS' scope. The CONTRACTOR shall coordinate with the OWNER and CTS for detail on the RTU and SCADA equipment and installation requirements.

PART 3 - EXECUTION

3.1 MOUNTING OF EQUIPMENT AND ACCESSORIES

A. Install and mount equipment in accordance with the Contract Documents, and installation detailed shop drawings. Mount equipment so that they are rigidly supported, level and plumb, and in such a manner as to provide accessibility; protection from damage; isolation from heat, shock and vibration; and freedom from interference with other equipment, piping, and electrical work.

B. Mount local equipment in cabinets or existing panels as specified. Mount associated terminals on a common panel or rack; all terminals over 200V phase to phase shall be covered with plastic shields.

3.2 TESTING

C. Provide services of panel manufacturer to test the completed system after installation to assure that all components are operating with the specified range and all interlocks are functioning properly. Panel manufacturer shall certify functional operation and calibration in written startup report. Perform field tests on all completed control assemblies to demonstrate conformance to specifications and functional compatibility.

D. See specification 268500 – Instrumentation and Controls for additional testing requirements.

END OF SECTION

SECTION 263213
DIESEL ENGINE DRIVEN GENERATOR SETS

PART 1 GENERAL

1.1 SCOPE OF WORK

A. Furnish all labor, materials, equipment and incidentals required and install, put into operation, and field test the diesel engine driven generator unit, and controls as shown on the Drawings and specified herein. The equipment installation shall be coordinated in detail by the Genset distributor. The distributor shall supervise the installation of the equipment from offloading to startup.

B. The installation, supervision, and the coordination of testing and startup of the system shall be provided by the installing contractor. The installing contractor shall be responsible for the complete coordination of the installation. The installing contractor shall be responsible to include all necessary equipment and services into the base bid for installation. Where shown on the drawings, accessory materials include but are not limited to sub-base tank, sound attenuated enclosure, exhaust muffler system, automatic transfer switch, battery charger, ETC.

C. These Specifications are intended to give a general description of what is required, but do not cover all details which will vary in accordance with the requirements of the equipment as offered. It is, however, intended to cover the furnishing, the shop testing, and delivery and complete installation and field testing, of all materials, equipment and appurtenances for the complete units as herein specified, whether specifically mentioned in these Specifications or not.

D. For all units there shall be furnished and installed all necessary and desirable accessory equipment and auxiliaries whether specifically mentioned in these Specifications or not. The genset supplier is responsible for field testing of the entire installation and instruction of the regular operating personnel in the care, operation and maintenance of all equipment.

E. Provide per the project scope all equipment as shown on the drawings but is not limited to supplying engine generator sets complete, sub-base fuel tank, sound attenuated enclosure, muffler, line circuit breakers, etc.

F. The generator Unit(s) shall be as manufactured by Cummins-Onan, Kohler Detroit Diesel, Caterpillar, or approved equal with a STANDBY rating per part 2.1. 1800RPM, 0.8 power factor, 277/480Volt, 3 phase.

1.2 DESCRIPTION OF SYSTEMS

A. A complete package shall be provided by the generator set distributor, maintaining single source responsibility. The Contractor shall utilize the authorized distributor, who shall be responsible to furnish, document, instruct and supervise installation, adjust, and test the complete system as shown on the plans and specified herein.

B. The Contractor shall furnish and install all interconnecting wiring as show on the authorized distributor’s shop drawings, accessories, and the like whether or not specifically detailed on the plans or in the specifications. It shall be the responsibility of the contractor to ascertain such items from the authorized distributor and include these costs in his bid. No additional payment will be made for items not specifically shown or detailed in the contract documents but needed for a complete installation.

C. The unit shall be shipped to the jobsite by an authorized engine distributor having a parts and service facility within a 150 mile radius of the jobsite. In addition, and in order not to penalize the Owner for unnecessary or prolonged periods of time for service or repairs to the standby power system, the bidding generator set supplier must have no less than eighty percent (80%) of all engine replacement parts locally available at all times. Certified proof of this requirement shall be furnished to the Engineer upon request.

D. Emergency warranty service response shall be guaranteed to be a maximum of four- hours between the time of emergency notification and arrival of service personnel on site. An emergency service condition shall be considered to exist when any failed standby power system hardware or software prevents or threatens to prevent the facility from fulfilling its intended purpose as determined by the owner or engineer. Non-emergency service requests shall be responded to within 2 business days. Telephone support for operating procedures and non-hardware problems shall be provided on an unlimited basis during the warranty period.

E. All materials and parts comprising the units shall be new and unused, of current manufacture, and of the highest grade, free from all defects or imperfections. Workmanship shall conform to the best modern practices. Only new and current models will be considered. The units offered under these Specifications shall be the product of a firm regularly engaged in the production of engine-generator equipment and shall meet the requirements of the Specifications set forth herein.

1.3 SUBMITTALS

A. Submit to the Engineer for review in accordance with division 1 Sections of the specifications, complete sets of installation drawings, schematics, and wiring diagrams which shall show details of installation and connections to the work of other Sections, including foundation drawing showing location and size of foundation bolts for the spring type vibration isolators and brochures covering each item of equipment.

B. In the event that it is impossible to conform with certain details of the Specifications due to different manufacturing techniques, describe completely all nonconforming aspects.

C. The submittal data for each unit shall include, but not necessarily be limited to, the following:
   1. Installation drawings showing plan and elevations of the complete generator unit; foundation plan; exhaust silencer; starting battery; battery charger; fuel tank; and all other items requiring space for installation. Layout and stub-up locations of electrical and fuel systems.
   2. Interconnect wiring diagram of complete standby power system, including generator, switchgear, fuel tank level monitor/transmitter, battery charger, remote alarm indications.
   3. Engine mechanical data at varying loads up to full load, including heat rejection, exhaust gas flows, combustion air and ventilation air flows, noise data, fuel consumption, etc.
   4. Generator electrical data including temperature and insulation data, cooling requirements, excitation ratings, voltage regulation, voltage regulator, efficiencies, waveform distortion and telephone influence factor.
   5. Engine Data:
      a. Manufacturer
      b. Model

c. Number of cylinders
d. RPM
e. Bore x stroke
f. Piston speed, RPM
g. Make and model and descriptive literature of electric governor
h. Fuel consumption rate curves at 25,50,75,100% loads
i. Engine continuous pump drive duty rating
j. Gross engine horsepower to produce generator standby rating (including fan and all parasitic loads).
k. Manufacturer's and dealer's written warranty.
l. Emissions data

6. Generator Data:
   a. Manufacturer
   b. Model
   c. Rated KVA
   d. Rated kw
   e. Voltage
   f. Temperature rise above 40 degree C ambient
   g. Generator efficiency including excitation losses and at 80 percent power factor
   h. Generator resistances, reactances and time constants.
   i. Generator current decrement curve.
   j. Generator motor starting capability.
   k. Generator thermal damage curve.
   l. Line circuit breaker.
7. Generator Unit Control Data:
   a. Actual electrical diagrams including schematic diagrams, and interconnection wiring diagrams for all equipment to be provided. Control panel schematics
   b. Legends for all devices on all diagrams
   c. Sequence of operation explanations for all portions of all schematic wiring diagrams
8. Generator Unit and Accessories:
   a. Weight of skid mounted unit
   b. Overall length
   c. Overall width
   d. Overall height
   e. Exhaust pipe size
   f. CFM of air required for combustion and ventilation
   g. Heat rejected to jacket water and lubricating oil...BTU/hr
   h. Heat rejected to room by engine and generator...BTU/hr
   i. Jacket water heater connection diagram.
   j. Automatic load transfer switch.

D. Submit to the Engineer operating and maintenance data as specified in 26 05 00 Basic Materials and Methods of this specification. Submit to the Engineer the equipment Manufacturer's Certificate of Installation, Testing and Startup Report.

1.4 SPARE PARTS

A. The Manufacturer shall furnish one (1) complete spare replacement sets of all filter elements required for the generator unit.

PART 2 PRODUCTS

2.1 RATINGS

A. The nominal kW rating on the drawings is preliminary, based on a design basis manufacturers available products. The Generator supplier shall perform a step-load calculation for final generator sizing. Refer to the Alternator subsection of this specification for voltage and frequency limitations. Refer to the generator load calculation on the drawings for quantity of pumps and house loads to operate on generator power.

B. The rating of the generator set shall not exceed the Manufacturer's published standby rating. The gross engine horsepower required to produce the standby rating shall not exceed the Manufacturer's published continuous duty rating by more than 150 percent. Continuous duty rating shall be as defined in BS5514 or DIN6271 but in no case shall it exceed the Manufacturer's published continuous duty rating for the engine as used in continuous rated pump drive applications. The gross engine horsepower required for the generator set standby rating described above shall include all parasitic demands such as generator inefficiencies, fuel pumps, water pumps, radiator fan (for fan cooled models) and all accessories necessary to the unit's proper operation while operating at rated load and at a rotative speed not to exceed 1800 rpm.

C. The diesel engine driven generator set shall be capable of producing the specified standby kw rating for continuous electrical service during interruption of the normal utility source and shall be certified to this effect by the Manufacturer for the actual unit supplied.

2.2 LOAD BANK

A. Furnish integrated cooling exhaust air mounted load bank. The load bank shall be sized to provide supplemental load as required maintain minimum 30% load on the generator to reduce wet stacking.

2.3 ENGINES

A. The engine shall be full compression ignition, four cycle, single acting, solid injection engines, either vertical or "V" type. Speed shall not exceed 1800 revolutions per minute at normal full load operation. The engine governor shall be +/- 0.25 percent accuracy electronic type governor.

B. The engine shall be capable of satisfactory performance on No. 2 fuel oil (ASTM Designation D396). Diesel engines requiring a premium fuel will not be considered.

C. The engine shall be capable of operating at light loads for extended periods of time and shall provide a means to reduce carbonization. Periodic cleaning of exhaust ports shall not be required.

D. The engine shall be equipped with fuel filters, lube oil filters, intake air filters, lube oil cooler, fuel transfer pump, engine driven water pump, and unit mounted instruments. The engine shall be provided with low oil pressure, high water temperature and overspeed safety shutdowns.

E. Injection pumps shall be pressure time common rail type. The system shall be self-bleeding and self-priming in design. The fuel system shall provide redundant overspeed protection with one governor having a dual flywheel fuel limiting mechanical control and the other fail safe electric control. The governors shall be located within the fuel pump body without external linkages or adjustments. Fuel injection pumps shall be positive action, constant-stroke pumps, activated by a cam driven by gears from the engine crankshaft. Fuel lines between injection pumps and valves shall be of heavy seamless tubing. Digital Electronic fuel injection systems shall be considered equal to common rail type pressure injection systems.

F. The fuel system shall be equipped with fuel filters having replaceable elements. Filter elements shall be easily removable from their housing for replacing without breaking any fuel line connections, or disturbing the fuel pump, or any other part of the engine. All fuel filters shall be conveniently located in one accessible housing, ahead of the injection pumps so that the fuel will have been thoroughly filtered before it reaches the pump. No screens or filters requiring cleaning or replacement shall be used in the injection pump or injection valve assemblies. The engines shall be equipped with a built-in gear-type, engine-driven fuel transfer pump, capable of supplying fuel through the filters to the injection pump at constant pressure.

G. The engine shall be provided with removable wet-type cylinder liners of close grained alloy iron, heat treated for proper hardness as required for maximum liner life. The cylinder block shall be a one piece stress relieved grey iron casting.

H. The engine shall have a gear-type lubricating oil pump for supplying oil under pressure to main bearings, crank pin bearings, pistons, piston pins, timing gears, camshaft bearings, valve rocker mechanism and governor. Effective lubricating oil filters shall be provided and so located and connected that all oil being circulated is continuously filtered and cleaned. Filters shall be accessible, easily removed and cleaned and shall be equipped with a spring-loaded by-pass valve as an insurance against stopping of lubricating oil circulation in the event the filters become clogged. The engine shall have a suitable water cooled lubricating oil cooler.

I. The engine shall be provided with one or more engine mounted dry type air cleaners of sufficient capacity to protect effectively the working parts of the engine from dust and grit.

J. Provide fuel ramping control to limit black smoke and frequency overshoot.

2.4 COOLING SYSTEMS

A. The engine shall be furnished with a unit mounted radiator type cooling system having sufficient capacity for cooling the engine when the diesel generator set is delivering full rated load in an ambient temperature of 122 degrees F. The engine shall be provided with a thermostatic valve placed in the jacket water outlet between the engine and the cooling source. This valve shall maintain the proper jacket water temperature under all load conditions.

B. Closed circuit jacket water systems shall be treated with a rust inhibiter as recommended by the engine Manufacturer.

C. A unit mounted thermal circulation type water heater incorporating a thermostatic switch shall be furnished to maintain engine jacket water to 70 degrees F. The heater shall be rated as shown on the drawings.

2.5 EXHAUST SYSTEMS

A. All exhaust equipment must be rated to withstand temperatures of approximately 1,000 degrees F. A flexible stainless steel pipe connection shall be provided between the engine exhaust stack and exhaust piping. One silencer raincap with counter weight shall be provided for each silencer. The exhaust system shall be mounted inside genset enclosure.

2.6 AUTOMATIC STARTING SYSTEM

A. A DC electric starting system with positive engagement shall be furnished. The starting motor voltage shall be as recommended by the engine Manufacturer.

B. An engine control shall be furnished as an integral part of the electric set to start and stop the engine as signaled by the automatic transfer controls on the generator control unit. The control shall start the engine by adjustable timed cranking cycles for a total period of not less than one minute. The crank and rest cycles shall be individually adjustable. The starting circuit shall open, and the control shall activate an alarm circuit if the engine does not start. The control shall be equipped with automatic safety shutdowns so that upon signal of a low oil pressure, high water temperature, or overspeed condition of the engine, the control shall immediately stop the engine. The control shall be equipped with digital display to indicate any of the engine failures and also with a 3-position control switch identified for "automatic-off- manual" externally mounted.

C. Engine Cranking Batteries: The batteries shall be of the lead acid type, and shall be of domestic manufacture. The battery shall be rated S.A.E. type "D", diesel engine starting type and of sufficient size and capacity in a fully charged condition to crank start the engine generator for the maximum allowed crank cycle, (minimum 20- second cranking periods) six consecutive times at 20 degrees F without recharging between cranks. The batteries shall be mounted in suitable covered racks. Battery rack location will be as shown on the Shop Drawings.

D. Battery Chargers:
1. Provide a 10amp battery charger. Chargers shall be UL 1236-BBHH listed for use in emergency applications. The charger shall be compliant with UL991 requirements for vibration resistance.
2. The charger shall be capable of charging a fully discharged battery without damage to the charger. It shall be capable of returning a fully discharged battery to fully charged condition within 24 hours. The charger shall be UL-labeled with the maximum battery amp-hour rating that can be recharged within 24 hours.
3. The charger shall incorporate a 4-state charging algorithm, to provide trickle charge rate to restore fully discharged batteries, a bulk charge rate to provide fastest possible recharge after normal discharge, an absorption state to return the battery to 100 percent of charge, and a float stage to maintain a fully charge battery and supply battery loads when the generator set is not operating. In addition, the charger shall include an equalization timer. Charge rates shall be temperature compensated based on the temperature directly sensed at the battery.
4. The DC output voltage regulation shall be within plus or minus 1%. The DC output ripple current shall not exceed 1 amp at rated output current level.
5. The charger shall include the following features:
   a. Two line alphanumeric display with programming keys to allow display of DC output ammeter and voltmeters (5% accuracy or better), display alarm messages, and perform programming;
   b. LED indicating lamp(s) to indicating normal charging condition (green), equalize charge state (amber), and fault condition (red);
   c. AC input overcurrent, over voltage, and undervoltage protection;
   d. DC output overcurrent protection;
   e. Alarm output relay;
6. Locate Charger in the automatic transfer switch.

2.7 ALTERNATOR, EXCITER AND ACCESSORIES

A. Rating: The alternator shall be rated as shown 1800 RPM 3 phase, 60 Hertz, 277/480 volts, at a maximum temperature rise of 80 degrees C (both armature and field) by resistance at full rated load in ambient air of 40 degrees C. The alternator shall be wound for 2/3rds pitch for harmonic mitigation. The alternator shall conform to NEMA Standard MG-1. As an alternate to the 80 degree C rise alternator

B. Performance: The instantaneous voltage dip shall not exceed 20 percent of rated voltage, at rated power factor, when load is suddenly applied. Recovery of stable operation shall occur within 1 second. Steady state modulation shall not exceed +/- l/2 percent. Provide documentation of submitted unit meeting performance criteria with shop drawing submittals.

C. The alternator shall be capable of starting across the line the maximum HP motors shown that are 85% efficient with a power factor of 0.8 in equal steps with no more than 20% instantaneous voltage dip and 5% frequency dip. Provide documentation of submitted unit meeting performance criteria with shop drawing submittals.

D. Construction:

1. The alternator and exciter shall be drip proof, with split sleeve, or ball race bearings. A shaft-mounted brushless exciter shall be a part of the assembly. The stator core shall be built up of high grade silicon steel laminations precision punched, and individually insulated. Armature lamination followers and frame ribs shall be welded integral with the frames for support of the stator core. A directional blower shall be mounted on the unit to draw cooling air from the exciter and over the rotor poles and through louvered openings on the opposite end.

2. The exciter shall be a fast response type, with a rotating 3-phase full-wave bridge. The exciter shall have a low time constant and large capacity to minimize voltage transients under severe load changes.

3. Alternator stator and exciter stator windings shall be a full Class H insulated system (generator rated for class B temperature rise of 80 degrees) vacuum impregnated with epoxy resin which after curing shall have additional treatment of epoxy for resistance to an environment of moisture and salt air.

4. Alternator rotor poles shall be built up of individually insulated silicon steel punchings. Poles shall be wound and bonded with high strength epoxy resin. Cage connections to the amortisseur rings shall be brazed for strong construction and permanent electrical characteristics. Each pole shall be securely bolted to the rotor shaft with bolts sized for the centrifugal forces on the rotor. Alternator windings shall be braced for full line to ground fault currents, on a solid grounded neutral system.

E. Accessories and Attachments

1. Terminal boxes: The unit shall contain a controls terminal box properly sized and provided with terminal strips and interposing relays and devices to properly interface genset controls with remote controls and instrumentation. The generator shall have separate AC and DC low voltage terminal boxes with suitably marked terminal strip for required connections.

2. All required P.T.'s, C.T.'s and protective relays shall be supplied by the engine-generator Manufacturer.

3. Vibration isolation: Provide spring type vibration isolation.

4. Provide a molded case line circuit breaker. Provide breaker with solid state adjustable functions for long time, and instantaneous trip. Instantaneous adjustment trip setting range 2-10 or greater. Provide line circuit breaker with a 100% continuous current rating.

F. Generator Associated Controls:

1. Voltage Regulator: The generator Manufacturer shall furnish a hermetically sealed, silicon controlled rectifier type voltage regulator employing a zener reference with a plus or minus one percent regulation for the generator. The regulator shall include 3 phase voltage sensing, automatic short circuit protection and shall include automatic under frequency protection to allow the generator to operate at no load at less than synchronous speed for engine start-up and shutdown procedures. Switches and/or fuses shall not be used to provide this protection. An over-voltage sensing module with manual reset shall be furnished with the regulator. A volts per Hz., sensing module shall be provided as part of the regulation system. A voltage adjustment rheostat for 5 percent voltage adjustment on the unit shall be provided.

2. A permanent magnet generator (PMG) shall be included to provide a reliable source of excitation power for optimum motor starting and short circuit performance. The PMG and controls shall be capable of sustaining and regulating current supplied to a single phase or three phase fault at 300% of rated current for not more than 10 seconds.

2.8 GENERATOR SET INSTRUMENTATION

A. The generator set shall be provided with a microprocessor-based control system which is designed to provide automatic starting, monitoring, and control functions, both local and remote, for the generator set. The control shall be mounted on the generator set. Controls shall be vibration isolated and prototype tested to verify the durability of all components in the system under the vibration conditions encountered. The control shall be UL508 listed, and meet IEC8528 part 4. All switches, lamps, and meters shall be oil-tight and dust-tight, and the enclosure door shall be gasketed. The entire control shall be tested and meet the requirements of IEEE-587 for voltage surge resistance.

B. The front display of the genset control panel unit shall include the following:

1. 1% accuracy generator set AC output instruments; Ammeter, Voltmeter, Frequency Meter, Wattmeter, KW-hour meter, Power Factor Meter. Selector switches to allow viewing of voltage and amperes for each phase shall be provided. For 3-phase/4-wire systems the voltmeter shall indicate line to line and line to neutral conditions. Running Time Meter and Start Counter.

2. Generator Set Mode Selector Switch: Switch shall provide run, off, and automatic functions for control of the generator set.

3. Control Reset push-button switch with indicating lamp. Lamp shall flash to indicate that

generator set is locked out due to a fault condition.

4. Lamp test push-button switch. Operation of this switch shall cause all lamps on the panel to be simultaneously tested.

5. Emergency Stop switch. The emergency stop switch shall be a red, mushroom head switch which maintains it's position until manually reset. Install switch external to genset enclosure at entrance door.

6. Precision voltage and frequency adjust raise/lower switches. Switches shall allow the generator set frequency and voltage to be adjusted plus or minus 5% when the generator set is operating independently of the system bus. Voltage and frequency adjustment switches shall be located adjacent to the generator set and bus metering, for ease of use by the operator.

7. Provide an alarm and status indicating panel to indicate the genset conditions to the operator via LED display; provide the following alarm condition indicators:
   Low DC Voltage
   High DC Voltage
   Weak Battery
   Low Oil Pressure Alarm
   Low Fuel - main tank Fuel
   tank leak
   High Engine Temp Alarm Amber Ground
   Fault
   Overcurrent Alarm
8. The alarm and status indicating panel shall indicate the following genset shutdown conditions to the operator:
   Breaker Failure
   Not in Auto
   High Engine Temp Low
   Oil Pressure
   Overcurrent
   Short Circuit
   Loss of Excitation
   Reverse Power
   Overcrank
   Overspeed Under
   Frequency Under
   Voltage Over
   Voltage
   Low Coolant Level

9. The alarm and status indicating panel shall indicate the following genset status conditions to the operator:
   Genset Ready (in auto and ready) Generator
   Running (ready to load)

10. In addition, provisions shall be made for indication of three (3) customer- specified alarm or shutdown conditions.

2.9 GENERATOR ENCLOSURE

A. Provide a sound attenuated weatherproof enclosure for use with a sub-base fuel tank base. The enclosure shall be designed to reduce source noise to an average 65 dBA at 21 feet including exhaust noise contribution. Enclosure shall be constructed of pre-coated aluminum panels. The enclosure shall be sized to adequately house the genset and all accessories. Enclosure shall be certified for the wind load. The tank/enclosure package shall be pre-wired by the supplier including instrumentation and alarm systems. The enclosure shall be manufactured by genset supplier or approved equal.

B. The Generator enclosure shall be designed in accordance with ASCE 7-10 Minimum Design Loads for Buildings and Other Structures and shall conform to the latest edition of the local Building Code with all applicable amendments by the County Building Department.

Generator enclosure/tank anchorages to concrete foundation shall be designed for the wind conditions specified above. All anchors shall be designed by a professional engineer registered in the State of NC. All concrete anchors shall be Type 316 stainless steel adhesive anchors minimum 0.75”inch diameter. Enclosure manufacturer shall provide shop drawings and design calculations signed and sealed by a professional engineer registered in the State of NC for the enclosure, components, cladding and enclosure/tank anchorages.

C. Walls shall be constructed of marine grade 0.090” minimum thickness type 5052- H32 formed aluminum panels. Roof shall be constructed of marine grade mill finish 0.04 minimum thickness type 5052-H32 formed aluminum panels using an interlocking standing seam design capable of supporting 20 pounds per square foot superimposed live load and 30 pounds per square foot superimposed dead load. All external attaching hardware shall be stainless steel screw type mechanical fasteners. Provide acoustic insulation and a perforated aluminum liner in the walls and roof as needed to achieve the sound reduction specified. Enclosure shall be equipped with 4 point lifting means to remove the enclosure from the tank.

D. Intake air shall enter the enclosure through an acoustic intake plenum utilizing internal sound baffles and bird screen. Intake shall be 900 feet per minute or less to minimize water intrusion. An intake gravity damper shall separate the intake plenum from the genset room. The radiator discharge air shall pass through a vertical discharge plenum section, which incorporates an aluminum bird screen. The air handling system shall be engineered and constructed so as not to exceed a total of 0.50 inches of water gauge static pressure drop with minimal water intrusion. The exhaust radiator shall be sealed to the exhaust plenum with a high temperature flexible connection.

E. Provide a complete pre-fabricated exhaust system for internal mounting of the silencer, including stainless steel flex connector, silencer, elbow, rain cap, rain shield, insulation and silencer mounting brackets. The exhaust system shall be completely assembled by the generator set supplier prior to start-up.

F. Provide additional requirements as indicated on drawings.

2.10 SUB-BASE FUEL TANK

A. Provide where shown on the drawings, a UL listed Double Wall diesel fuel storage tank. The fuel tank shall be an integral part of the enclosure/generator mounting frame. Fuel tank shall have a capacity of no less than 24 hours of run time under 100% generator full load conditions. Fuel tank provided shall comply with and be constructed in accordance with the requirements of Underwriters Laboratories UL- 142 “Special Purpose Protected Secondary Containment Generator Base Tank”; N.F.P.A. 30, 37 & 110; Fuel tank venting in compliance with NFPA and UL.

B. The top of the fuel tank and any components subject to damage from water intrusion shall be above the design flood elevation (DFE). The DFE is 24-inches above the concrete foundation for the generator. The basis of design is for the tank to be no shorter than 24-inches which results in the generator and ports located on top of the tank being above the DFE. If this is not the case, or the tank is shorter than 24-inches, the generator manufacturer shall supply framing to elevate the tank and generator to the required height. Alternatively, the generator manufacturer shall make modifications such that venerable components including but not limited to fuel tank ports, vents, instrumentation, battery, and the generator are elevated high enough to prevent damage due to flooding up to DFE.

C. Complete assembly shall be manufactured using minimum 3/16 sheet steel for the inner tank and type 304 Stainless Steel for outer tanks. All penetrations into the tank shall be schedule 40 stainless steel and be from the tank top. Fuel tank and containment basin are to be leak tested at 3-PSI air as outlined in UL-142 standards. The interstitial space shall be monitored using a float type level switch and shall indicate the presences of fuel in the annular space by use of normally open contacts that are to be wired back to the generator set control panel for visual/audible indication.

D. Fuel tank provided shall have the following devices but by no means be limited to those as specified. A 2” Manual fuel fill cap, with means to padlock fill cap, mechanical fuel level gauge, low level alarm set at 40% of tank capacity, rupture basin alarm with normally open contacts, fuel supply and return ports with full length pick-up tubes. A foot or check valve shall be installed on the generator supply to prevent loss of prime during idle conditions. A rectangular double-walled electrical stub-up area is to be provided and located directly under the generator circuit breaker to provide a pass-through for field installation of electrical load conductors. The tank exterior walls to be painted to match genset enclosure color.

E. The tank shall be elevated off the concrete pad with integral tank supports that provide a 2 inch air space to control moisture accumulation. The tank supports shall be arranged so that moisture is not trapped in the channel of the supports. Provide 3/8”TH x 6”W continuous neoprene pads between the tank supports and the concrete pad. The tank shall include the hurricane tie down restraint points and drillings for grounding attachments. The tank shall be constructed with no sharp edges to insure uniform coating coverage on all surfaces.

F. Provide a level gauge near the fill location. Provide a drop tube and leak alarm switch located in the interstitial space area of the tank indicating inner tank failure and wire to genset control panel and remote annunciator. Provide a high level alarm float switch in the tank and wire to the generator controller and remote annunciation alarm console. Provide Pneumercator or equal TMS2000A tank monitor with level sensor and a fuel level transmitter (4-20ma) output wired to the station control system. Provide a drop tube and leak alarm switch located in the interstitial space area of the tank indicating inner tank failure and wire to genset control panel.

G. Provide dry contacts for remote monitoring. Include at a minimum:

1. Running
2. Low Fuel
3. General Fault
4. Fuel Tank Leak

H. The contractor shall coordinate with the owner and provide all tank permit applications and review by the proper DEP and fire district regulating authority and properly permitted. The contractor shall provide tank testing after installation and before placing in service per NFPA30. 21.5.2.4 Horizontal shop-fabricated aboveground tanks shall be tested for tightness with air pressure at not less than a gauge pressure of 3 psi and not more than a gauge pressure of 5 psi. The pressure shall be held for not less than 1 hour or for the duration specified in the listing for the tank. All tanks shall be labeled by product, capacity and manufacturer. Provide a ten (10) year warranty for the tank.

PART 3 EXECUTION

3.1 SERVICES

A. Furnish the services of a competent and experienced Manufacturer's field service technician who has complete knowledge of proper operation and maintenance of the equipment to inspect the installed equipment, supervise the initial test run, coordinate checkout of the interlocks between ATS and the Genset and to provide instructions to the plant personnel. The first visit will be for checking and inspecting the equipment after it is installed.

B. Provide instruction of plant personnel in operation and maintenance of the equipment. This instruction period shall be scheduled at least ten days in advance with the Owner and shall take place prior to final acceptance and after substantial completion by the Owner.

C. The final copies of operation and maintenance manuals specified in division 1 Sections must be delivered to the Engineer prior to scheduling the instruction period with the Owner.

D. The distributor of the Genset shall provide installation coordination services to insure a properly installed and coordinated system including all coordination with the electrical and instrumentation contractor for proper interfacing. As a minimum the Genset Distributor shall coordinate the installation with factory trained technicians with weekly site visits from the time the genset arrives on site to the time it is fully operational. Also the technician shall provide onsite coordination of all conduit stub ups, fuel line stub-ups, pad dimensions, embedment etc. prior to slab pour. It is the intent of these specifications that the Distributor of the Genset provide complete system coordination including but not limited to; fuel system with venting and filling requirements; exhaust system requirements; cooling and ducting system; power; control, battery and grounding systems, switchgear system; testing and acceptance certification. The site technician shall submit written reports of the coordination efforts weekly to the engineer and meet with the engineer as requested. The technician shall certify the units installed per manufacturers recommendation prior to test runs or functional testing.

3.2 INSTALLATION

A. The genset installer shall install suitable jacket water additives as furnished by the engine Manufacturer and approved by the Engineer, for prevention of both scale formation and corrosion in the water jackets and cooling system components which are in contact with the engine jacket water. These additives shall be added to the cooling system prior to running the field acceptance test.

B. The Contractor shall install the complete exhaust system, together with the silencer, the piping and insulation, and the complete supporting system. Where the exhaust passes through the roof or side wall, furnish and install suitable thimble and "rain skirt".

C. The engine generator set and associated equipment shall be shop primed and finish coated in accordance with the Manufacturer's standard practice prior to shipment. An adequate supply of touch-up paint shall be supplied by the Manufacturer.

3.3 TESTING

A. The engine-generator set shall be given the Manufacturer's standard load bank test at full rated load and power factor at the factory.

B. Prior to final acceptance of the generator set, all equipment furnished under this Section shall be field tested to show it is free of any defects and that the generator set can operate satisfactorily under full load test using resistance type load banks. The genset testing shall be for four (4) continuous hours. Any defects which become evident at this time shall be corrected before acceptance.

C. During the field tests, readings will be taken at thirty (30) minute intervals of the following: oil temperature, exhaust temperature, water temperature, volts, amps, frequency, fuel pressure, manifold pressure, and oil pressure, KW, KWH.

D. The Contractor shall provide fuel for start-up and testing of the generator system.

3.4 WARRANTY

A. The complete electrical standby power system; generator set, controls, and associated switches, and accessories, as provided by the factory distributor including the ancillary equipment shall be warranted by the manufacturer against defects in materials and workmanship for a period of five years or 1500 genset run hours, whichever occurs first from the date of system startup. Coverage shall include parts, labor, travel expenses and labor to remove reinstall defective equipment under terms of the Manufacturer's comprehensive standard warranty. No deductibles shall be applied to the warranty except for starting batteries and water jacket heater being warranted for one year.

END OF SECTION

SECTION 263600
AUTOMATIC TRANSER SWITCH

PART 1 GENERAL

1.01 SUMMARY

A. Furnish and install automatic transfer switch complete and operational in accordance with the design drawings and specifications.

1.02 SHOP DRAWINGS

A. Submit shop drawings and product data clearly indicating:

Cut sheets showing cabinet dimensions, all applicable options and accessories, wiring diagrams, interrupting or withstanding current rating, and all electrical characteristics and data as required showing compliance with these specifications.

PART 2 PRODUCTS

2.01 AUTOMATIC TRANSFER SWITCH

A. Automatic transfer switches shall be furnished as shown on plans, with full load current and voltage rating as shown, normal and emergency. The transfer switch shall be capable of switching all classes of load, and shall be rated for continuous duty and installed in a NEMA 4X enclosure. The transfer switch shall be in accordance with Underwriters' Laboratories, Inc., Standard UL-1008.

B. Provide transfer switches by the genset manufacturer. The generator set manufacturer shall warrant transfer switches to provide a single source of responsibility. Transfer switches shall be rated to carry 100 percent of rated current continuously in the enclosure supplied, in ambient temperatures of -40 to +60 degrees C, relative humidity up to 95% (non-condensing).

C. Provide complete power transfer equipment with field programmable digital electronic controls designed for fully automatic operation and including: surge voltage isolation, voltage sensors on all phases of both sources, linear operator, permanently attached manual handles, positive mechanical and electrical interlocking, and mechanically held contacts for both sources. Equipment is to be integrated into the main switch board as illustrated in the drawings.

D. Transfer switch equipment shall have withstand and closing ratings (WCR) in RMS symmetrical amperes greater than the available fault currents. Contractor to verify available fault currents. The transfer switch and its upstream protection shall be coordinated. The transfer switch shall be third party listed and labeled for use with the specific protective device(s) installed in the application.

E. Transfer switches shall be double-throw, open-transition,, electrically operated, and mechanically held in the source 1 and source 2 positions. The transfer switch shall be specifically designed to transfer to the best available source if it inadvertently stops in a neutral position.

F. The transfer switch shall be configurable to control the operation time from source to source (program transition; delayed transition operation). Sync checked two position transfer switches without delayed transition are not acceptable.

G. The transfer switch shall be capable of transferring successfully in either direction with 90% of rated voltage applied to the switch terminals. Transfer switches that are designated on the drawings as 3-pole shall be provided with a neutral bus and lugs. The neutral bus shall be sized to carry 100% of the current designated on the switch rating. Transfer switch shall be provided with copper long barrel Hi-Press lugs sized to accept the full output rating of the switch. Lugs shall be suitable for the number and size of conductors shown on the drawings.

H. Operator Panel. Each transfer switch shall be provided with a control panel to allow the operator to view the status and control operation of the transfer switch. The operator panel controls shall be covered and locked to protect from sun/weather damage and unauthorized use. The operator panel shall be provided with the following features and capabilities:

1. High intensity LEDs to indicate the source that the load is connected to (source 1 or source 2); and which source(s) are available. Source available LED indicators shall operate from the control microprocessor to indicate the true condition of the sources as sensed by the control. High intensity LED lamps to indicate that the transfer switch is “not in auto” (due to control being disabled or due to bypass switch (when used) enabled or in operation) and “Test/Exercise Active” to indicate that the control system is testing or exercising the generator set.

2. “OVERRIDE” control to cause the transfer switch to bypass any active time delays for start, transfer, and retransfer and immediately proceed with its next logical operation. “TEST” control to initiate a preprogrammed test sequence for the generator set and transfer switch. The transfer switch shall be programmable for test with load or test without load.

I. Engine starting contacts shall be provided in transfer switch to start the generator if any phase of the normal source drops below 85% of rated voltage, after an adjustable time delay period of 1-120 seconds. Provide loss of normal source circuit with phase sequence sensing capability that verifies phase angle relationship of source voltage.

J. The transfer switch shall transfer to emergency as soon as the generator source voltage and frequency have reached 90% of rated. After restoration of normal power on all phases to 95% of rated voltage, adjustable time delay period of 2-25 minutes shall delay transfer to normal power until it has had time to stabilize. If the emergency power source should fail during the time delay period, the time delay shall be by-passed, and the switch shall return immediately to the normal source. Whenever the switch has re-transferred to normal, the engine-generator shall be allowed to operate at no load for an adjustable period of time (10 minutes initially) to allow it to cool before shut-down. Transfer switch voltage sensors shall be close differential type, providing source availability information to the control system based on the following functions:

1. Monitoring all phases of the normal service (source 1) for under voltage conditions (adjustable for pickup in a range of 85 to 98% of the normal voltage level and dropout in a range of 75 to 98% of normal voltage level).

2. Monitoring all phases of the emergency service (source 2) for under voltage conditions (adjustable for pickup in a range of 85 to 98% of the normal voltage level and dropout in a range of 75 to 98% of pickup voltage level).

3. Monitoring all phases of the normal service (source 1) and emergency service (source 2) for voltage imbalance, loss of single phase, phase rotation, over voltage conditions (adjustable for dropout over a range of 105 to 135% of normal voltage, and pickup at 95-99% of dropout voltage level), over or under frequency conditions.

4. Monitoring the neutral current flow in the load side of the transfer switch. The control shall initiate an alarm when the neutral current exceeds a preset adjustable value in the range of 100-150% of rated phase current for more than an adjustable time period of 10 to 60 seconds.

K. The transfer switch shall include a test switch to simulate normal power failure with actual load transfer. A remote contact from the plant control system shall be accepted by the ATS to provide generator start and load control testing. Pilot lights shall be included on the cabinet door to indicate the main switch closed on normal (green) or emergency (Red); a yellow pilot light shall indicate the emergency power source running.

L. Include an exerciser with transfer switch for exercising generator in loaded condition every 168 hours for a period adjustable to 15 minute increments from 20 minutes minimum. Include automatic return to normal should the genset fail to provide load during the exercise run, if normal power is available. Provide programmed transition controls with adjustable time delay option to limit inductive load inrush currents. Switches without adjustable programmed transition are not acceptable.

M. Provide for the Plant SCADA I/O as follows:

1. Digital outputs:

a. Loss of normal power

b. In normal position

c. In emergency position

d. general fault

e. not in auto

PART 3 EXECUTION

3.01 QUALITY ASSURANCE/TESTS

A. As a precondition for approval, transfer switch, complete with timers relays and accessories shall be listed by Underwriters' Laboratories, Inc. in their Electrical Construction Materials Catalog under Standard UL-1008 (automatic transfer switches) and approved for use on emergency systems.

B. When conducting temperature rise tests to paragraph 99 of UL-1008 the manufacturer shall include post-endurance temperature rise tests to verify the ability of the transfer switch to carry full rated current after completing the overload and endurance tests.

C. Electrical Field Tests: Field testing shall be performed prior to substantial completion.

1. Perform insulation resistance tests phase-to-phase and phase-to-ground with switch in both source positions.

2. Perform a contact resistance test across all main contacts.

3. Verify settings and operation of control devices in accordance with the specifications provided by the manufacturer.

4. Calibrate and test all relays and timers including voltage and frequency sensing relays, in phase monitor (synchronism check), engine start and cool- down timers, transfer and retransfer timers, etc.

5. Perform automatic transfer tests: Simulate loss of normal power. Test Return to normal power. Simulate loss of emergency power. Simulate all forms of single phase conditions. Monitor and verify correct operation and timing of the following simulations: Normal voltage-sensing relays: Engine start sequence: Time delay upon transfer: Alternate voltage-sensing relays: Automatic transfer operation: Interlocks and limit switch function: Time delay and retransfer upon normal power restoration: Engine cool-down and shutdown feature.

6. SYSTEM FUNCTION TESTS: Perform system function tests upon completion of equipment tests. It is the purpose of system function tests to prove the proper interaction of all sensing, processing, and action devices.

    a. Develop test parameters for the purpose of evaluating performance of all integral components and their functioning as a complete unit within design requirements.

    b. Test all interlock devices.

    c. Record the operation of alarms and indicating devices.

END OF SECTION

SECTION 263613
SAFETY SWITCHES AND DISCONNECTS

PART 1 GENERAL

1.01 SUMMARY

A. This section covers electrical disconnecting switches.

1.02 SUBMITTALS

A. Products shall be submitted in accordance with Section 26 05 01, and elsewhere in the Contract Documents, prior to installation.

B. Product Data: For each type of switch and circuit breaker indicated.

C. Shop Drawings: For each type of switch and circuit breaker indicated.

D. Field quality-control test reports.

E. Operation and maintenance data.

1.03 QUALITY ASSURANCE

A. 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.

B. Source Limitations: Obtain switches and circuit breakers through one source from a single manufacturer.

C. Comply with NFPA 70.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. All products under this Section shall be of the same manufacturer. Subject to compliance with these requirements, manufacturers offering products which may be incorporated in the work, are as follows:

1. Eaton Corp.; Cutler-Hammer Products.
2. General Electric Co.; Electrical Distribution & Control Division.
3. Siemens Energy & Automation, Inc.
4. Square D/Group Schneider NA.
5. Or equal.

2.02 ENCLOSED CIRCUIT BREAKERS

A. Molded-Case Circuit Breaker: NEMA AB 1, with interrupting capacity to meet available fault currents.

1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250A and larger.

2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.

3. GFCI Circuit Breakers: Single- and two-pole configurations with 30-mA trip sensitivity.

B. Molded-Case Circuit-Breaker Features and Accessories: Standard frame sizes, trip ratings, and number of poles.

1. Lugs: Suitable for number, size, trip ratings, and material of conductors.

2. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HACR for heating, air-conditioning, and refrigerating equipment.

3. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.

4. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 55 percent of rated voltage.

C. Switches used as service disconnect shall be service entrance rated.

2.03 ENCLOSURES

A. Listed for environmental conditions of installed locations, including:

1. Indoor Location: NEMA-1.

2. Outdoor Locations: NEMA 250, Type 4X, Stainless Steel.

3. Other, Process, Wet or Damp Indoor Locations: NEMA 250, Type 4X, Stainless Steel.

PART 3 EXECUTION

3.01 INSTALLATION

A. Disconnect switches shall be installed as indicated on the Drawings.

B. Provide grounding per NEC, and Section 26 05 26.

C. General: Provide circuit and motor safety disconnect switches as indicated and where required by the NEC. Comply with switch manufacturers' printed installation instructions.

D. Identify components; provide warning signs as specified in Section 26 05 00 - Basic Electrical Materials and Methods.

3.02 FIELD QUALITY CONTROL

A. Testing: After installing disconnect switches and circuit breakers and after electrical circuits have been energized, demonstrate product capability and compliance with requirements.

B. Inspections and Tests for Switches and Circuit Breakers: Make internal and external inspections and perform tests, including the following:

1. Inspect for freedom from physical damage, proper unit rating, mechanical condition, enclosure integrity, cover operation, unit anchorage, clearances, and tightness of electrical connections. If a loose electrical connection is observed on any unit, check each electrical connection for each switch and circuit breaker with a torque wrench for compliance with manufacturer's torquing instructions.

2. Test insulation resistance of each pole, phase-to-phase, and phase-to-ground, following manufacturer's written instructions. Test insulation resistance of shunt trip circuits. Use 500-V minimum test voltage for units and circuits rated up to 250 V, 1000-V minimum test voltage for units rated more than 250 V. Measured insulation resistance must be 25 megohms, minimum, for switches rated up to 250 V, and 100 megohms, minimum, for switches rated more than 250 V.

3. Test cover and other interlocks and interlock release devices for proper operation.

C. Additional Inspections and Tests for Circuit Breakers: Include the following:

1. Inspect for proper frame, trip, and fault current interrupting rating.

2. Test shunt trip devices, circuits, and actuating components for proper operation.

D. Correct defective and malfunctioning units on-site, where possible, and reinspect and retest to demonstrate compliance; otherwise, remove and replace with new units and retest.

END OF SECTION

SECTION 264300
SURGE PROTECTIVE DEVICES (SPDs)

PART 1 GENERAL

1.01 SCOPE

A. The Contractor shall furnish and install the Surge Protective Device (SPD) equipment having the electrical characteristics, ratings, and modifications as specified herein and as shown on the contract drawings. To maximize performance and reliability and to obtain the lowest possible let-through voltages, the ac surge protection shall be integrated into electrical distribution equipment such as switchgear, switchboards, panelboards, busway (integrated within bus plug), or motor control centers. Refer to related sections for surge requirements in:

1.02 REFERENCES

A. SPD units and all components shall be designed, manufactured, and tested in accordance with the latest applicable UL standard (ANSI/UL 1449 3rd Edition).

1.03 SUBMITTALS

A. The following information shall be submitted to the Engineer:

1. Provide verification that the SPD complies with the required ANSI/UL 1449 3rd Edition listing by Underwriters Laboratories (UL) or other Nationally Recognized Testing Laboratory (NRTL). Compliance may be in the form of a file number that can be verified on UL's website or on any other NRTL's website, as long as the website contains the following information at a minimum: model number, SPD Type, system voltage, phases, modes of protection, Voltage Protection Rating (VPR), and Nominal Discharge Current (I_n).
2. For sidemount mounting applications (SPD mounted external to electrical assembly), electrical/mechanical drawings showing unit dimensions, weights, installation instruction details, and wiring configuration.

B. Where applicable the following additional information shall be submitted to the engineer:

1. Descriptive bulletins
2. Product sheets

C. The following information shall be submitted for record purposes:

1. Final as-built drawings and information for items listed and shall incorporate all changes made during the manufacturing process

1.04 QUALIFICATIONS

A. The manufacturer of the assembly shall be the manufacturer of the major components within the assembly.

B. For the equipment specified herein, the manufacturer shall be ISO 9001 or 9002 certified.

C. The manufacturer of this equipment shall have produced similar electrical equipment for a minimum period of five (5) years. When requested by the Engineer, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.

1.05 OPERATION AND MAINTENANCE MANUALS

A. Operation and maintenance manuals shall be provided with each SPD shipped.

PART 2 PRODUCTS

2.01 MANUFACTURERS, OR EQUAL

A. Eaton / Cutler-Hammer products

B. Square-D products

C. General Electric products

D. EDCO

E. APT

2.02 VOLTAGE SURGE SUPPRESSION – GENERAL

A. Electrical Requirements

1. Unit Operating Voltage – Refer to drawings for operating voltage and unit configuration.
2. Maximum Continuous Operating Voltage (MCOV) – The MCOV shall not be less than 115% of the nominal system operating voltage.
3. The suppression system shall incorporate thermally protected metal-oxide varistors (MOVs) as the core surge suppression component for the service entrance and all other distribution levels. The system shall not utilize silicon avalanche diodes, selenium cells, air gaps, or other components that may crowbar the system voltage leading to system upset or create any environmental hazards.
4. Protection Modes – The SPD must protect all modes of the electrical system being utilized. The required protection modes are indicated by bullets in the following table:

	Protection Modes			
Configuration	L-N	L-G	L-L	N-G
Wye	●	●	●	●
Delta	N/A	●	●	N/A
Single Split Phase	●	●	●	●
High Leg Delta	●	●	●	●

5. Nominal Discharge Current (I_n) – All SPDs applied to the distribution system shall have a 20kA I_n rating regardless of their SPD Type (includes Types 1 and 2) or operating voltage. SPDs having an I_n less than 20kA shall be rejected.
6. ANSI/UL 1449 3rd Edition Voltage Protection Rating (VPR) – The maximum ANSI/UL 1449 3rd Edition VPR for the device shall not exceed the following:

Modes	208Y/120	480Y/277	600Y/347
L-N; L-G; N-G	700	1200	1500
L-L	1200	2000	3000

B. SPD Design

1. Maintenance Free Design – The SPD shall be maintenance free and shall not require any user intervention throughout its life. SPDs containing items such as replaceable modules, replaceable fuses, or replaceable batteries shall not be accepted. SPDs requiring any maintenance of any sort such as periodic tightening of connections shall not be accepted. SPDs requiring user intervention to test the unit via a diagnostic test kit or similar device shall not be accepted.
2. Balanced Suppression Platform – The surge current shall be equally distributed to all MOV components to ensure equal stressing and maximum performance. The surge suppression platform must provide equal impedance paths to each matched MOV.
3. Electrical Noise Filter – Each unit shall include a high-performance EMI/RFI noise rejection filter. Noise attenuation for electric line noise shall be up to 50 dB from 10 kHz to 100 MHz using the MIL-STD-220A insertion loss test method. Products unable able to meet this specification shall not be accepted.
4. Internal Connections – No plug-in component modules or printed circuit boards shall be used as surge current conductors. All internal components shall be soldered, hardwired with connections utilizing low impedance conductors.
5. Monitoring Diagnostics – Each SPD shall provide the following integral monitoring options:
   a. Protection Status Indicators - Each unit shall have a green / red solid-state indicator light that reports the status of the protection on each phase.
   b. For wye configured units, the indicator lights must report the status of all protection elements and circuitry in the L-N and L-G modes. Wye configured units shall also contain an additional green / red solid-state indicator light that reports the status of the protection elements and circuitry in the N-G mode. SPDs that indicate only the status of the L-N and L-G modes shall not be accepted.
   c. For delta configured units, the indicator lights must report the status of all protection elements and circuitry in the L-G and L-L modes.
   d. The absence of a green light and the presence of a red light shall indicate that damage has occurred on the respective phase or mode. All protection status indicators must indicate the actual status of the protection on each phase or mode. If power is removed from any one phase, the indicator lights must continue to indicate the status of the protection on all other phases and protection modes. Diagnostics packages that simply indicate whether power is present on a particular phase shall not be accepted.

6. Overcurrent Protection
    a. The unit shall contain thermally protected MOVs. These thermally protected MOVs shall have a thermal protection element packaged together with the MOV in order to achieve overcurrent protection of the MOV. The thermal protection element shall disconnect the MOV(s) from the system in a fail-safe manner should a condition occur that would cause them to enter a thermal runaway condition.
7. Safety Requirements
    a. The SPD shall minimize potential arc flash hazards by containing no user serviceable / replaceable parts and shall be maintenance free.
    b. SPDs designed to interface with the electrical assembly via conductors shall require no user contact with the inside of the unit.
    c. Sidemount SPDs shall be factory sealed to prevent access to the inside of the unit. Sidemount SPDs shall have factory installed phase, neutral, ground and remote status contact conductor's factory installed and shall have a pigtail of conductors protruding outside of the enclosure for field installation.

2.03 SYSTEM APPLICATION

A. The SPD applications covered under this section include distribution and branch panel locations, busway, motor control centers (MCC), switchgear, and switchboard assemblies. All SPDs shall be tested and demonstrate suitability for application within ANSI/IEEE C62.41 Category C, B, and A environments.

Surge Current Capacity – The minimum surge current capacity the device is capable of withstanding shall be as shown in the following table:	
Application	Min. Per Phase
Service Disconnect	200 kA
Pump Control Panel Main	100 kA
120/240V Distribution	50 kA

B. SPD Type – all SPDs installed on the line side of the service entrance disconnect shall be Type 1 SPDs. All SPDs installed on the load side of the service entrance disconnect shall be Type 1 or Type 2 SPDs.

2.04 ENCLOSURES

A. All enclosed equipment mounted for indoor application shall be NEMA 1 general purpose enclosures. Provide NEMA 4X enclosures for all outdoor applications.

1. NEMA 1 – Constructed of a polymer (units integrated within electrical assemblies) or steel (sidemount units only), intended for indoor use to provide a degree of protection to personal access to hazardous parts and provide a degree of protection against the ingress of solid foreign objects (falling dirt).
2. NEMA 4X – Constructed of stainless steel intended for either indoor or outdoor use to provide a degree of protection against access to hazardous parts; to provide a degree of protection of the equipment inside the enclosure against ingress of solid foreign objects (dirt and windblown dust); to provide a degree of protection with respect to the harmful effects on the equipment due to the ingress of water (rain, splashing water, and hose directed water).

2.05 POWER SUPPRESSORS FOR ELECTRONIC EQUIPMENT

A. Each item of electronic equipment provided under this contract and connected by line cord or direct wired to the building electrical system shall be provided with a three-stage single or multi-phase hybrid suppressor. Fusing shall be provided which removes the protective elements from the circuit upon failure. Visual indication or loss of output power shall be used to notify the user of device failure.

B. Suppressors shall be rated for a minimum of 125% of their continuous electrical load. Suppressors for cord connected equipment shall be equipped with standard NEMA cordsets one of which includes a molded grounding receptacle and the other, a molded grounding plug. Suppressor shall be installed in series with the power cord for the protected equipment. Where several items of equipment are grouped within the same cluster of equipment, one suppressor may be used in conjunction with properly sized grounding plugstrip to serve the equipment.

C. Suppressors for direct wired equipment shall be identical in internal design to the unit described for cord connected applications, however, protected screw terminals suitable for termination of solid copper wire shall be used for wiring terminations. One suppressor may be used to support several equipment cabinets provided all cabinets are located within the same equipment cluster and the maximum connected load shall not exceed eighty percent of the rated suppressor capacity.

D. Suppressors shall be constructed with a phenolic non-flammable exterior housing with provisions for mounting to the interior of equipment racks, cabinets, or to the exterior of free-standing equipment. Suppressors shall be constructed as three- stage devices. The first stage shall include a high-energy varistor clamp between line and neutral and from neutral to ground. The second stage shall consist of series air-core inductor installed in the line conductor(s) to properly coordinate the action of the first and third stages. The third, fast acting, hard clamping stage shall consist of a network of silicon avalanche bipolar surge suppression diodes between the neutral and line conductor(s).

E. Minimum suppressor performance characteristics shall be as follows:

1. Maximum single impulse line-to-neutral current withstand: 15,000 Amperes (8 x 20 us

waveform)
2. Maximum single impulse neutral-to-ground current withstand: 10,000 Amperes (8 x 20 us waveform)
3. Pulse lifetime rating Category B worst case current waveform (8 x 20 us @ 3000 Amperes): 1200 occurrences
4. Pulse lifetime rating for 200 Ampere (8 x 20 us waveform): 10,000 occurrences
5. Worst case response time: Five Nanoseconds
6. Worst case (Maximum Single Impulse Current Conditions) clamping voltage: 400% of nominal phase-to-ground RMS voltage.
7. Initial breakdown voltage: 200% of nominal phase-to-ground RMS voltage.

2.06 SUPPRESSORS FOR CONDUCTOR PAIR PROTECTION

A. Suppression devices for conductor pair protection shall be provided in multi-circuit pluggable packages suitable for the circuitry to be protected. Units for protection of data circuits which utilize standard connector configurations shall be equipped with connectors which install in series with the data cable to the protected equipment. Units intended for use with multiple wiring pairs shall be equipped with an accessory terminal blocks or strips suitable for the type of wiring being used. Single pair units shall be configured as encapsulated units with wire leads or screw-terminal wiring terminations. Suppressors installed outside of terminal or equipment cabinets (except at designated terminal boards) shall be provided with a housing to afford physical protection for the surge suppression modules.

B. Suppression for each pair shall consist of a three-element gas tube first stage, an isolating element in series with each conductor of the pair, and a silicon avalanche second stage. Second stage clamping shall be provided across the pair for differential mode protection and from each side of the pair to ground for common mode protection. Resistive limiting elements may be used on low current circuits where the effect of voltage drop across the series resistance has no effect on circuit operation. Inductive series elements shall be used on higher current circuits to effectively pass direct or low frequency alternating currents while limiting passage of fast risetime surge waveforms. Silicon avalanche devices shall be designed for surge suppressor applications and shall be polarized or bipolar as appropriate for each circuit.

C. Minimum performance criteria (each circuit) shall be as follows:
1. Maximum single impulse conductor-to-ground or conductor to conductor current withstand: 10,000 Amperes (8 x 20 us waveform)
2. Pulse lifetime rating Category B worst case current waveform (8 x 20 us @ 3000 Amperes): 10 occurrences
3. Pulse lifetime rating for 100 Ampere (10 x 1000 us waveform):1,000 occurrences
4. Worst case response time: Five Nanoseconds
5. Worst case (Maximum Single Impulse Current) clamping voltage: 200% of normal operating voltage amplitude and polarized or bipolar as appropriate for each circuit type.
6. Initial breakdown voltage: 150 percent of normal operating voltage peak amplitude plus or minus five percent.
7. Capacitance: Capacitance for DC or low frequency lines shall not exceed 2000 picofarads measured line to line or line to ground at the rated diode breakdown voltage. Suppressors intended for use on high frequency or high baud rate circuits shall be designed for use on such lines. Capacitance of such units shall be equated to equivalent cable feet based on the type of cabling used for the particular circuit. The sum of equivalent cable feet for suppressors and actual cable footage shall not exceed manufacturer's recommended maximum values for the system on which these devices are installed.
8. Circuit compensation: Any additional circuit compensation (gain or equalization)

required to compensate for the insertion of surge suppression devices shall be provided as part of this contract.

PART 2 EXECUTION

2.1 BONDING AND GROUNDING CONDUCTORS AND MATERIALS

A. Conductors utilized for surge suppressor bonding shall be a minimum of #6 AWG solid insulated copper unless otherwise specified.

B. Ground bus or strip material shall be copper, a minimum of 26 gauge in thickness and three inches wide unless otherwise specified. Bus materials may be secured to surfaces with an appropriate mastic material or mechanical fasteners. Bus connections shall be bolted or brazed and reinforced as necessary on thin bus material to provide a permanent and secure connection.

C. Unless otherwise specified, all surge suppression grounding electrodes shall be 5/8" diameter copperweld rods, twenty feet in length.

D. Connectors, splices, and other fittings used to interconnect grounding conductors, bond to equipment or ground bars, shall comply with requirements of the National Electric Code and be approved by Underwriters Laboratories for the purpose.

E. Connectors and fittings for grounding and bonding conductors shall be of the compression or set-screw type in above grade locations. Connections below grade shall be exothermically welded or brazed.

F. Bonding connections between electrically dissimilar metals shall be made using exothermic welds or using bi-metal connectors designed to prevent galvanic corrosion.

2.2 SEGREGATION OF WIRING

A. All system wiring shall be classified into protected and non-protected categories. Wiring on the exposed side of suppression devices shall be considered unprotected. Surge suppressor grounding and bonding conductors shall also fall into this category.

B. All wiring between surge suppressors and protected equipment shall be considered protected. Isolated circuitry exempted from surge suppression requirements in part one of this section shall also be considered protected.

C. A minimum of three inches of separation shall be provided between parallel runs of protected and unprotected wiring in control panels, terminal cabinets, terminal boards and other locations. In no case shall protected and unprotected wiring be bundled together or routed through the same conduit. Where bundles of protected and unprotected wiring cross, such crossings shall be made at right angles.

2.3 INSTALLATION OF SUPPRESSORS

A. Suppressors shall be installed as close as practical to the equipment to be protected consistent with available space. Where space permits and no code restrictions apply, suppressors may be installed within the same cabinet as the protected equipment. Suppressors installed in this manner shall utilize the equipment chassis as a medium for bonding of their ground terminals. Bonding jumpers not exceeding two inches in length shall be installed between the chassis and suppressor ground terminals. Bolted connections with star washers shall be used to insure electrical and mechanical integrity of connections to the equipment chassis.

B. Suppressors shall be installed in a neat, workmanlike manner. Lead dress shall be consistent with recommended industry practices for the system on which these devices are installed.

C. Bonding between ground terminals for power and signal line suppressors serving a particular item or cluster of equipment shall be kept as short as possible. Where practical, suppressors shall be installed in a common location for the cluster with their ground terminals bonded closely together. For installations requiring separation between the various suppressor grounds and equipment chassis within an equipment cluster, the following table shall be used to determine bonding conductor requirements (distances are measured between most distant suppressor or chassis grounds):

BONDING DISTANCE	MATERIAL
0 - 10 feet	#6 AWG Bare Copper (Solid) 10-
25 feet	1-1/2" Copper Strip 26ga. Min.
25- 50 feet	3" Copper Strip 26ga. Min.
Over 50 feet	6" Copper Strip 26ga. Min.

Care shall be exercised to avoid connection of incidental grounds to the bonding bus system.

D. Where terminal cabinets are used to house surge suppressors, painted steel backboards shall be used to serve as a low impedance ground plane for bonding surge suppressor leads together. Terminal boards used for the same purpose shall be laminated with a single sheet of 14 ga. galvanized steel to serve as a ground plane for suppressors. Suppressors with ground terminals not inherently bonded to the ground plane through their mounting shall be bonded to this plane using a two- inch maximum length of #12AWG copper wire and suitable lug. Ground planes and backboards shall be drilled to accept self-tapping screws, any paint in the area of the bond shall be removed and star washers shall be used.

E. Supplementary grounding and bonding connections required between the bonding bus or ground plane for each equipment cluster and other locations as indicated herein shall be accomplished using #6 AWG bare copper conductors and approved connections unless otherwise noted.

2.1 WARRANTY

A. The manufacturer shall provide a full five (5) year warranty from the date of shipment against any SPD part failure when installed in compliance with manufacturer's written instructions and any applicable national or local code.

END OF SECTION

SECTION 268500
INSTRUMENTATION AND CONTROL SYSTEM

PART 1 GENERAL

1.1 SCOPE

A. Furnish and install, complete with all accessories, a pump control panel with its associated instrumentation as described herein and shown on the contract drawings. The system shall serve as a self-contained monitoring and control system for all aspects of pumping station operation.

B. Refer to Section 262913 for additional Pump Control Panel requirements.

C. This specification is intended to be used in conjunction with all drawings supplied and is not intended to be complete without reference diagrams on system configurations, etc. All bidders must conform to all areas of the documentation. It is the intent of this specification that the monitoring and control system contractor have single source responsibility for the complete control and instrumentation package for the project; including but not limited to flow, pressure, level instrumentation and control, Variable Frequency Drives, and interconnecting conduit and control wiring for total system responsibility.

1.2 CONTRACTOR QUALIFICATIONS AND ADDITIONAL RESPONSIBILITY

A. The contractor providing this system shall be an instrumentation and control systems contractor who is experienced in and regularly engaged in engineering, installation and service of systems of similar size and complexity.

B. The contractor shall assume total systems responsibility for all aspects of this system including installation, commissioning and start-up of the system, training of operating personnel and coordinating interfaces between this system and equipment provided by others. This responsibility shall include mounting and wiring of relays, transformers, disconnecting means, and other control devices as required forming a complete system.

C. The installing contractor shall maintain an office with full time sales and service staff within a one hundred and fifty-mile radius of the site. Emergency warranty service response shall be guaranteed to be a maximum of four-hours between the time of emergency notification and arrival of service personnel on site. An emergency service condition shall be considered to exist when any failed system hardware or software prevents or threatens to prevent the pumping station from fulfilling it's intended purpose as determined by the owner or engineer.

D. Non-emergency service requests shall be responded to within 2 business days. Telephone support for operating procedures and non-hardware problems shall be provided on an unlimited basis during the warranty period.

E. An unconditional warranty shall be provided for all equipment supplied for Two years from date of final acceptance of system by the owner. THIS WARRANTY SHALL INCLUDE ANY DAMAGES CAUSED BY LIGHTNING INDUCED ELECTRICAL SURGES; ONLY DAMAGES CAUSED BY DIRECT LIGHTNING STRIKES TO THE BUILDING STRUCTURE (AS DETERMINED BY THE OWNER) SHALL BE EXCLUDED FROM THE WARRANTY. Theft, fire, vandalism and floods shall be excluded from the warranty except for fire damage which originates at equipment which is provided as part of this work.

1.3 SUBMITTALS

Shop Drawings shall be submitted in accordance with Section 26 05 00 BASIC ELECTRICAL MATERIALS AND METHODS. These drawings shall include:

1. a complete index which lists each device by tag number, type, and manufacturer.

2. A manufacturer technical brochure or catalog sheet shall be included with each specified instrument data sheet. If, within a single system or loop, a single instrument is employed more than once, one manufacturer brochure or catalog sheet may cover multiple identical uses of that instrument in that system. Each manufacturer brochure or catalog sheet shall include a list of tag numbers for which it applies. System groups shall be separated by labeled tags. Special options and features which are furnished shall be identified.

3. Cut sheets for all accessories and/or mounting hardware.

4. Testing checklists and procedures

PART 2 PRODUCTS

2.1 GENERAL

A. Unless otherwise specified, instruments shall be solid state, electronic, using enclosures to suit specified environmental conditions. All instruments shall be provided with mounting hardware and floor stands, wall brackets, or instrument racks as shown on the Drawings, or as required. Equipment installed in a hazardous area shall meet Class, Group, and Division as shown on the Drawings, to comply with the National Electrical Code. Provide heavy-duty type devices throughout that are designed for continuous industrial service. Equipment used shall be U.L. approved.

B. All field instrumentation for outdoor service shall be furnished and installed in Field Panels or Sun Shade. Unless otherwise specified, provide field instrument enclosures of stainless steel or copper free cast aluminum and powder coated white with NEMA 4X rated construction; provide sunshades for all exposed exterior panels.

C. Unless otherwise shown or specified, local indicators shall be provided for all instruments. Where instruments are located in inaccessible locations, local indicators shall be provided and shall be mounted remotely. All indicator readouts shall be linear in process units. Readouts of 0-100% shall not be acceptable (except for valve position). Floating isolated outputs shall be provided for all transmitters.

D. Electronic equipment shall utilize printed circuitry and shall be coated (tropicalized) to prevent contamination by dust, moisture and fungus. Solid-state components shall be conservatively rated for long-term performance and dependability over ambient atmosphere fluctuations. Ambient conditions shall be -15 to 50 degrees C and 20 to 100 percent relative humidity, unless otherwise specified. Field mounted equipment and system components shall be designed for installation in dusty, humid, and corrosive service conditions.

E. All analog transmitter and controller outputs shall be isolated, 4-20 milliamps into a load of 0-750 ohms, unless specifically noted otherwise. All switches shall have double-pole, double-throw contacts rated at a minimum of 600 VA, unless specified otherwise.

2.2 FLOAT SWITCHES

A. Level Float switches shall consist of a non-mercury type switch element encapsulated in a nominal 5-inch diameter PVC float housing. The switch contact shall be single-pole, double throw, rated 10 amperes at 120 volts AC. The float shall be supported from a flexible three-conductor 14 AWG cable which also acts as the float hinge. The cable shall be suitable for fixed mount or weighted suspension type installation as indicated on the Drawings. All necessary mounting hardware shall be provided. The hinge-cable length shall be field adjustable in a manner which allows the dead-band to be adjusted between 1 inch and 3 feet.

B. Mounting and installation hardware shall be 316L stainless steel. If necessary, the Contractor shall provide and install a pipe section for installation of the float switches.

C. Intrinsically safe relays shall be provided in the pump control panel to interface with switches in classified areas.

D. Securely mount the float switches to prevent damage or entanglement with other equipment or devices. Provide all cabling for a fully functional system.

E. As a minimum, the following spare parts shall be furnished:
    One spare float assembly.

F. Acceptable manufacturers: ITT-Flygt, Magnetrol, or approved equivalent.

2.3 HYDROSTATIC LEVEL TRANSMITTERS

A. The level element shall be attached and submersed with a flexible style waterproof cable assembly, complete with a stainless-steel strain cable. Each level element shall be provided with all required mounting hardware to accommodate the type of mounting. Each element shall be provided with a corrosion resistant mounting head or condulet. Mounting and installation hardware shall be 316L stainless steel.

B. Transmitters shall be loop-powered of the two-wire type. Process fluid shall be isolated from the sensing elements by AISI Type 316 stainless steel, Hastelloy-C, or cobalt-chromium-nickel alloy diaphragms, and a silicon oil fluid fill. Diaphragm material shall be selected based on the indicated measured process medium for proper operation in the process.

C. Vent shall be provided to atmosphere through a capillary tube integral to the cable. Transmitters shall have self-diagnostics and electronically adjustable span, zero, and damping. Transmitters shall have over-range protection greater than the maximum line pressure. Transmitters shall not be damaged by reverse polarity. Transmitters shall be capable of having an elevated or suppressed zero, as required by the application. Transmitters shall be provided with a 3-1/2 digit LCD display, calibrated in engineering units. The effect of static pressure changes on accuracy shall be negligible.

D. Vent shall be terminated in a sealed maintenance free diaphragm.

E. For systems which require a dedicated programming device for calibration, maintenance, or troubleshooting, one such programming device shall be provided. The programming device shall include appropriate operation manuals and shall be included in the training requirements. For systems which allow the programming device functions to be implemented in software, running on a laptop computer, the software shall be provided instead of the programming device.

F. Level meters shall be explosion proof Dwyer PBLTX Series, Xylem LTU 701 Series, with, or approved equal.

2.4 ELECTROMAGNETIC FLOWMETER

Refer to mechanical specifications

2.5 ELECTRICAL SURGE & TRANSIENT PROTECTION

A. General: All instrument and control equipment mounted outside of protective structures (field-mounted equipment) shall be equipped with suitable surge- arresting devices to protect the equipment from damage due to electrical transients induced in the interconnecting lines from lightning discharges and nearby electrical devices. Surge suppression equipment shall meet or exceed the requirements as specified herein. Surge suppressors shall be as manufactured by EDCO, Inc.

B. Suppressor Locations: Surge suppression equipment described herein and indicated on the contract drawings shall be installed in the following locations: At the point of connection between each equipment item and its power supply conductors (direct wired equipment).

C. Power Supply Suppressor Assemblies: Provide suppressors suitable for connection to 120-volt, single-phase power supply. Suppressors shall be EDCO "HSP-121 SERIES", or equal, and shall meet or exceed the following requirements:

1. Suppressors for direct wired equipment shall be provided with two 3- terminal barrier terminal strips capable of accepting no. 12 AWG solid or stranded copper wire. One terminal strip shall be located on each end of the suppressor unit.
2. Suppressors shall be epoxy encapsulated within a phenolic nonflammable enclosure with provision for mounting to interior of equipment racks, cabinets or to the exterior of free standing equipment. Epoxy encapsulation shall be flame retardant.
3. Suppressors shall be constructed as multistage devices. The first stage shall be a high-energy metal oxide varistor element. The second stage shall consist of fast acting high power bipolar silicon avalanche devices. First and second stages shall be interconnected through a series air core inductor of sufficient current carrying capacity to permit a continuous operating current of 15 amperes.
4. Suppressors shall meet or exceed the following performance criteria based on a test surge waveshape of 8 times 20 microseconds.
   Maximum Operating Voltage: 130V ac Minimum
   Breakdown Voltage: 150V ac Maximum Operating
   Current: 15 amps Response Time: 5 nanoseconds
   Peak First Stage Clamping Voltage: 20,000 amps Maximum
   First Stage Clamping Voltage: 350 Volts Maximum Second
   Stage clamping Voltage: 210 Volts Pulse Life Before Failure:
   2,000 occurrences

D. Analog Signal Cable Suppressor Assemblies: Suppressors shall be EDCO SRA or DRS Series, or equal. Provide EDCO type SS64 surge suppressors at all loop powered instrument locations. Suppressors shall be epoxy encapsulated within a phenolic enclosure and stainless steel for SS64 units. Suppressor Assembly shall be flame retardant. Suppressor assemblies shall be four lead devices and shall include a threaded mounting/grounding stud. Suppressors shall meet or exceed the following performance criteria based on a test surge waveshape of 8 times 20 microseconds:

1. Components: Hybird circuit consisting of a 3 electrode gas tube and silicone avalanche devices to clamp each line to ground. High energy gas tube and

silicone avalanche devices shall be separated by a series impedance.

2. Recovery: Automatic
3. Peak Surge Current: 10,000 amps
4. Pulse Life Before Failure: 100 occurrences
5. Response Time: 5 nanoseconds
6. Minimum Voltage Clamp Rating: 40 volts
7. Series Impedance: 24 ohms total
8. Temperature Range: -40 degrees C to +85 degrees C
9. Operating Voltage: Less than 30V dc
10. Operating Current: 4 to 20 Ma dc
11. Resistance Line to Ground: Greater than 1 megohm

E. Hybrid power and analog signal suppressor assemblies. Suppressors shall be EDCO SLAC units or approved equal.

F. Surge suppressor input (unprotected) and output (protected) wiring shall be kept segregated at the point of connection to the surge unit and external to the unit. Do not route unprotected cable adjacent to protected cable.

PART 3 - EXECUTION

3.1 INSTALLATION

A. The work included in this section consists of furnishing, installing and placing in operation the instruments and appurtenances, including all conduit, wiring and circuitry, necessary to provide the Owner with a fully operable system properly calibrated and installed.

B. Include the services of a factory trained, qualified service engineer of the equipment manufacturer to inspect the complete equipment installation to assure that it is installed in accordance with the manufacturer's recommendations, make all adjustments necessary to place the system in trouble-free operation and instruct the operating personnel in the proper care and operation of the equipment furnished.

C. All workmanship utilized in the manufacture and installation of this system shall be of the highest quality and performed in a manner which is consistent with all accepted practices for industrial controls.

D. Provide continuous protection of the installed instrumentation equipment from the elements, moisture, construction damage, dust, debris, paint spatter or other conditions which will adversely affect the unit operation until such time as the equipment is scheduled for start-up testing.

3.2 MOUNTING OF EQUIPMENT AND ACCESSORIES

A. Install and mount equipment in accordance with the Contract Documents, manufacturer's instructions and installation detailed shop drawings. Mount equipment so that they are rigidly supported, level and plumb, and in such a manner as to provide accessibility; protection from damage; isolation from heat, shock and vibration ; and freedom from interference with other equipment, piping, and electrical work. Do not install field enclosures, cabinets, and panels until heavy construction work adjacent to the equipment has been completed to the extent that there shall be no damage to the equipment.

B. Locate devices, including accessories, where they shall be accessible from grade, except as shown otherwise.

C. Coordinate the installation of the electrical service to components related to the system to assure a compatible and functionally correct system. All accessories shall be coordinated and installation supervised by the Contractor.

3.3 CALIBRATION

A. Calibrate each instrument in the factory before shipping and furnish with the calibration data and the certification of calibration.

B. The service technician shall calibrate all instruments and components of the instrumentation system with field adjustable ranges and/or settings after installation in conformance with the manufacturer's instructions, the Contract Documents and the reviewed shop drawings. Set each instrument and components for the specific conditions and intended application as specified for this installation. Replace defective instruments and components which cannot achieve correct calibration of stated accuracy, either individually or collectively within the system.

C. Certify in writing to the Owner that all calibrations have been completed and the instrumentation system is ready to be operated. Provide instrumentation calibration sheets in the O&M manuals for future reference for both factory and field calibration tests. Calibration certification documents shall be available on site at the time of substantial completion. Certification documents shall include the signature of the service technician performing the calibration.

3.4 GENERAL TESTING REQUIREMENTS

A. All system start-up and test activities shall follow detailed test procedures, check lists, etc., submitted and previously approved by the Engineer. The Engineer shall be notified at least 21 days in advance of factory system tests and reserves the right to have his and/or the Owner's representatives in attendance.

B. The Contractor shall provide the services of experienced factory trained technicians, tools and equipment to field calibrate, test, inspect, and adjust all equipment in accordance with manufacturer's specifications and instructions.

C. The Contractor shall maintain master log books for each phase of installation, startup and testing activities specified herein. Log book shall include signal, loop or control strategy tag number, equipment identification, description and space for sign-off dates, Contractor signature and Engineer signature. Example test documentation specific to each phase of testing shall be approved prior to initiation of that testing, as specified here.

D. All test data shall be recorded on test forms, previously approved by the Engineer. When each test has been successfully completed, a copy of all test results shall be furnished to the Engineer together with a statement that all specified test requirements have been met and that the system is operating in accordance with the Contract Documents.

3.5 START-UP SUPERVISION

A. The system supplier shall provide a qualified service technician to inspect all final connections and check the system prior to start-up of the system. The service technician shall coordinate with the owner's representative for functional check-out of the complete system.

B. The instrumentation subcontractor's personnel shall be available and on call (seven days/week) for support of equipment operating and maintenance activities for the duration of the facility start-up period. System verification marking end of supplier’s on-site start-up obligations will be issued after system functionality can be demonstrated for a period of 168 continuous hours without interruptions due to error on the part of the supplier.

C. The instrumentation subcontractor's startup personnel shall be present and coordinate with all other startup and testing activities especially the pump, odor control, standby power system and variable frequency drive startups.

3.6 INITIAL FIELD TESTING

A. All system start-up and test activities shall follow detailed test procedures, test report, check lists, etc., submitted and previously approved by the Engineer.

B. Control system start-up and testing shall be performed to ensure that all processes shall be systematically and safely placed under digital control in the following order:

1. Primary elements such as transmitters and switch devices shall be calibrated and tested as specified.

2. Each final control element shall be individually tested by Contractor.

3. Each instrument and control loop shall be tested by Contractor.

4. Each control strategy shall be tested under automatic control as specified.

5. The entire control system shall be tested for overall monitoring, control, communications, and information management functions, and demonstrated for system availability as specified.

C. System start-up and test activities shall include the use of water to establish service conditions that simulate, to the greatest extent possible, normal operating conditions in terms of applied process loads, operating ranges and environmental conditions.

D. Verify that each instrument, meters, and gage has been properly installed, connected, grounded and calibrated. Perform three-point calibration on continuous elements and systems. Provide calibration records.

E. Verify that the inputs/outputs functions of each instrument conform to the requirements of the application.

F. Exercise each system as defined by each loop description through operational tests to demonstrate that it performs as intended on a continuing basis and to demonstrate the integrity of the system.

3.7 LOOP CHECKS

A. Prior to control system startup and testing, each monitoring and control loop shall be tested by the Contractor on an individual basis from the primary element to the final element, including the PLC I/O module and PLC data table, for continuity and for proper operation and calibration.

B. Signals from transducers, sensors, and transmitters shall be utilized to verify control responses. Simulated input data signals may be used subject to prior written approval by the Engineer. All modes of control shall be exercised and checked for proper operation.

C. The accuracy of all analog inputs shall be verified using field inputs or by manually applying input signals at the final controller, and then reading and recording the resulting analog input data at the touch screen panel.

D. Final control elements and ancillary equipment shall be tested to verify that proper and stable control is achieved using local area control panels, motor control center circuits, and local field mounted control circuits. All hardwired control circuit interlocks and alarms shall be operational. The control to final control elements and ancillary equipment shall be tested using both manual and local automatic (where provided) control circuits.

E. Each loop tested shall be witnessed, dated and signed off by both the Contractor and the Engineer/owner upon satisfactory completion.

3.8 INTITAL START-UP TESTING

A. Perform satisfactory Contractor's initial start-up and functional test prior to demonstration for Owner and Engineer.

B. After the field testing has been successfully demonstrated, a date for system start up involving the Owner's operating personnel will be scheduled as agreed to by the Owner. Notify Engineer fourteen (14) days prior to initial start-up of each item of equipment.

C. Have Contract Documents, shop drawings, product data, and operation and maintenance data at hand during entire start-up process.

D. Provide control diagrams that show actual control components and wiring.

E. Coordinate sequence for initial start-up of various items of equipment

F. Verify control systems are fully operational in automatic and alternate modes of operation.

G. Start up and test the instrumentation equipment with the entire system operational. Conduct start-up and initial functional testing.

3.9 STARTUP AND FUNCTIONAL TESTING, DEMONSTRATION FOR OWNER AND ENIGNEER

A. Perform pre-startup inspection of installation. Perform startup under no-load conditions, if possible. Observe noise, vibration and operation. If all operating characteristics are normal, proceed with startup. Operate equipment and systems under all load conditions and confirm all operating characteristics are normal. If normal operation is observed, proceed with witnessed functional test and performance test as required.

B. Perform functional and performance tests under supervision of responsible manufacturer's representatives, instrumentation and control subcontractor, and Contractor personnel. Representatives of Owner and Engineer shall witness functional test.

C. Demonstrate that equipment operates and complies with specified performance requirements. Demonstrate that control panel functions, including failures and alarms operate and comply with specified performance requirements.

D. Functionally test failures and alarm conditions; or if approved by engineer simulate by jumping failure input terminals. Provide signal generators that simulate control conditions if it is not feasible to create actual conditions. Testing activities shall include the simulation of both normal and abnormal operating conditions.

E. Use Operation and Maintenance manuals, loop descriptions, submittals, graphic screens, etc. to demonstrate operation of equipment. Use actual as-built control diagrams in demonstration of functions.

F. Each control strategy shall be tested by the Engineer to verify the proper operation of all required functions. The control system start-up and test activities shall include procedures for tuning all control loops incorporating PID control modules, and for adjusting and testing all control loops as required to verify specified performance.

3.10 WARRANTY

A. Unless specified elsewhere, all products mentioned herein must be warranted by the supplier for a period of Two (2) years from the date of system turnover; final acceptance.

3.11 TRAINING

A. The system supplier shall provide a minimum of one full day of training instruction to the owner's personnel to include; operator training; and Controls system maintenance training including software maintenance training.

B. Training shall not occur until after completion of successful functional testing and performance testing. Provide training while equipment is fully operational

C. Training shall not occur until after review and approval of system O&M manuals. Use accepted Operation and Maintenance manuals as the basis of instruction.

D. Submit to Engineer not less than 14 days prior to each training session an outline of the training program and the qualifications of the trainer(s).

E. Training services are exclusive of travel time to and from the facility. The times specified shall not be construed as to relieve the manufacturer of any additional visits to provide sufficient service to insure equipment is in satisfactory and continuous operation.

END OF SECTION

SECTION 311000
SITE CLEARING

PART 1 GENERAL

1.01 SUMMARY

A. In its initial move onto the Site, the Contractor shall protect existing fences, houses and associated improvements, streets, and utilities downslope of construction areas from damage due to boulders, trees, or other objects dislodged during the construction process and clear, grub, strip; and regrade certain areas, in accordance with the Contract Documents. The Contractor shall also inspect the Site conditions and review maps of the Site, pipeline routes and facilities delineating the Owner's property and right-of-way lines.

B. Contractor shall provide all labor, materials, equipment, and incidentals required to perform all clearing and grubbing as shown and as specified herein. Contractor shall pay for all disposal fees. The Work covered by this Section consists of removing and disposing of all trees, stumps, bush, roots, shrubs, vegetation, logs, rubbish, and other objectionable material from the Site, as required to perform the Work.

PART 2 EXECUTION

2.01 SITE ACCESS

A. The Contractor shall develop any necessary access to the Site, including access barriers to prohibit entry of unauthorized persons.

B. **Utility Interference:** Where existing utilities interfere with the Work, notify the utility owner and the Engineer before proceeding in accordance with the General Conditions.

2.02 CLEARING, GRUBBING, AND STRIPPING

A. Limits of clearing and grubbing shall be all areas within the Contract limits, except as otherwise shown. Damage outside these limits caused by Contractor's operations shall be corrected at Contractor's expense.

B. Construction areas shall be cleared of grass and weeds to at least a depth of 6-inches and cleared of structures, pavement, sidewalks, concrete or masonry debris, trees, logs, upturned stumps, loose boulders, and any other objectionable material of any kind which would interfere with the performance or completion of the Work, create a hazard to safety, or impair the subsequent usefulness of the Work, or obstruct its operation. Loose boulders within 10-feet of the top of cut lines shall be incorporated in landscaping or removed from the Site. Trees and other natural vegetation outside the actual lines of construction shall be protected from damage during construction.

C. Within the limits of clearing, the areas below the natural ground surface shall be grubbed to a depth necessary to remove stumps, roots, buried logs, and other objectionable material. Septic tanks, drain fields, and connection lines and any other underground structures, debris or waste shall be removed at contractors expense if found on the Site. Objectionable material from the clearing and grubbing process shall be removed from the Site and wasted in approved safe locations.

D. The entire area to be affected by construction shall be stripped to a depth of one foot below the existing ground contours. The stripped materials shall be stockpiled and incorporated into landscaped areas or other non-structural embankments.

E. Stockpile topsoil in areas where it will not interfere with construction operations or existing facilities. Stockpiled topsoil shall be reasonably free of mineral subsoil, debris, and stones larger than two inches in diameter.

F. Unless otherwise indicated, native trees larger than 3-inches in diameter at the base shall not be removed without the Engineer's approval. The removal of any trees, shrubs, fences, or other improvements outside of rights-of-way, if necessary for the Contractor's choice of means and methods, shall be arranged with the owner of the property, and shall be removed and replaced, as part of the Work.

G. Burning on-site shall not be performed.

H. In order to avoid additional removal or damage, existing trees and shrubs shall be trimmed as required. Trimmed or damaged trees shall be treated and repaired by persons with experience in this specialty that are approved by Engineer. Trees and shrubs intended to remain, that are damaged beyond repair or removed, shall be replaced by Contractor, at no additional cost to the Owner.

I. Control air pollution caused by dust and dirt and comply with governing regulations.

2.03 OVEREXCAVATION, REGRADING, AND BACKFILL UNDER FILL AREAS

A. After the fill areas have been cleared, grubbed, and excavated, the areas to receive fill will require overexcavation, regrading, and backfill, consisting of the removal and/or stockpiling of undesirable soils. The ground surface shall be recontoured for keying the fill and removing severe or abrupt changes in the topography of the Site. Overexcavated volumes shall be backfilled to a level of one foot below the existing ground contours.

2.04 PROTECTION OF EXISTING TREES

A. GENERAL

1. Flagging of Existing Trees: Flag trees to remain and to be removed with a bright and different colored ribbon. Notify the Engineer at least 48 hours prior to commencing of Work to verify all trees that are flagged.

2. Do not park any vehicles or equipment, nor store any materials or stockpiled soil, nor dispose of building materials, chemicals, petroleum products or other detrimental substances within drip line of tree. Protect trees from flame, smoke and heat. Construction access to site shall not occur beneath drip line of trees.

B. EXISTING TREES TO REMAIN

1. Protect root systems from smothering. Restrict foot traffic to prevent excessive compaction of soil over root systems.

2. Individual trees and areas shown to remain shall be protected by six (6) foot high chain link fence. Install fencing before site preparation, grading and clearing and grubbing operations.

3. Under no circumstances shall the Contractor remove existing trees designated to remain for his/her convenience or ease of construction.

4. Prior to installation, stake the location of protection fencing for approval by the Engineer. Location stakes or marking shall be placed not greater than ten (10) feet on-center.

C. EXCAVATION AROUND TREES

1. Excavate within drip line of trees only where shown.

2. Where trenching for utilities is required within drip line, tunnel under or around roots by hand digging. Do not cut main lateral roots or tap roots. The Contractor shall notify the Engineer prior to cutting roots over 6-inch diameter. Roots up to and including ¾-inch shall be cut by hand saws. Do not leave roots exposed to sun or drying for more than 24 hours. Protect all exposed roots with moist organic mulch or burlap and backfill as soon as possible.

3. Where excavating for new construction is required within drip line of tree, excavate by hand to minimize damage to roots and perform as follows:

   a. Use narrow tine spading forks and comb soil to expose roots.

   b. If main lateral roots are immediately adjacent to location of new construction, cut roots three (3) inches from new construction.

   c. Do not allow exposed roots to dry out before permanent backfill is placed.

   d. Provide temporary earth cover, or pack with peat moss and wrap with burlap.

   e. Water and maintain in moist condition until covered with backfill.

D. TRIMMING OF EXISTING TREES

1. Engage a qualified tree surgeon to remove branches from tree. No pruning unless approved and directed by the Engineer.

2. Pruning: Cut branches with sharp pruning instruments and do not break or chop. Prune flush with trunk surface.

3. Trimming: Symmetry of the tree shall be preserved; no stubs or splits or torn branches left; clean cuts shall be made close to the trunk or large branch. Spikes shall not be used for climbing live trees. All cuts over 1-1/2-inches in diameter shall be coated with an asphaltic emulsion material.

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 312000
EARTH MOVING

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section Includes:

1. Excavating and filling for rough grading the Site.
2. Preparing subgrades for slabs-on-grade, walks, pavements, turf and grasses, and plants.
3. Excavating and backfilling for buildings and structures.
4. Drainage course for concrete slabs-on-grade.
5. Subbase course for concrete walks pavements.
6. Subbase course and base course for asphalt paving.
7. Excavating and backfilling trenches for utilities and pits for buried utility structures.

B. Related Requirements:

1. Section 033000 Cast-in-Place Concrete for granular course if placed over vapor retarder and beneath the slab-on-grade.
2. Section 311000 Site Clearing for site stripping, grubbing, stripping and stockpiling topsoil, and removal of above- and below-grade improvements and utilities.
3. Section 329200 Restoration for finish grading in turf and grass areas, including preparing and placing planting soil for turf areas.

1.03 UNIT PRICES

A. Work of this Section is affected by unit prices for earth moving specified in Section 012000 Measure and Payment.

1.04 DEFINITIONS

A. Backfill: Soil material or controlled low-strength material used to fill an excavation.

1. Initial Backfill: Backfill placed beside and over pipe in a trench, including haunches to support sides of pipe.
2. Final Backfill: Backfill placed over initial backfill to fill a trench.

B. Base Course: Aggregate layer placed between the subbase course and hot-mix asphalt paving.
C. Bedding Course: Aggregate layer placed over the excavated subgrade in a trench before laying pipe.
D. Borrow Soil: Satisfactory soil imported from off-site for use as fill or backfill.

E. Drainage Course: Aggregate layer supporting the slab-on-grade that also minimizes upward capillary flow of pore water.

F. Excavation: Removal of material encountered above subgrade elevations and to lines and dimensions indicated.

G. Fill: Soil materials used to raise existing grades.

H. Rock: Rock material in beds, ledges, unstratified masses, conglomerate deposits, and boulders of rock material that cannot be removed without drilling and blasting, wedging, sledging, cutting, or barring for its removal.

I. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface.

J. Subbase Course: Aggregate layer placed between the subgrade and base course for hot-mix asphalt pavement, or aggregate layer placed between the subgrade and a cement concrete pavement or a cement concrete or hot-mix asphalt walk.

K. Subgrade: Uppermost surface of an excavation or the top surface of a fill or backfill immediately below subbase, drainage fill, drainage course, or topsoil materials.

L. Utilities: On-site underground pipes, conduits, ducts, and cables as well as underground services within buildings.

1.05 ACTION SUBMITTALS

A. Product Data: For each type of the following manufactured products required:

1. Geotextiles.
2. Controlled low-strength material, including design mixture.
3. Geofoam.
4. Warning tapes.

B. Samples for Verification: For the following products, in sizes indicated below:

1. Geotextile: 12 by 12 inches (300 by 300 mm).
2. Warning Tape: 12 inches (300 mm) long; of each color.

1.06 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified testing agency.

B. Material Test Reports: For each on-site and borrow soil material proposed for fill and backfill as follows:

1. Classification according to ASTM D 2487.
2. Laboratory compaction curve according to ASTM D 698.

C. Blasting plan approved by authorities having jurisdiction.

D. Seismic survey report from seismic survey agency.

E. Pre-excavation Photographs or Videotape: Show existing conditions of adjoining construction and site improvements, including finish surfaces that might be misconstrued as damage caused by earth-moving operations. Submit before earth moving begins.

1.07 QUALITY ASSURANCE

A. Blasting: Comply with the Special Provisions of these Contract Specifications for Blasting.

B. Geotechnical Testing Agency Qualifications: Qualified according to ASTM E 329 and ASTM D 3740 for testing indicated.

1.08 FIELD CONDITIONS

A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during earth-moving operations.

1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
2. Provide alternate routes around closed or obstructed traffic ways if required by Owner or authorities having jurisdiction.

B. Improvements on Adjoining Property: Authority for performing earth moving indicated on property adjoining Owner's property will be obtained by Owner before award of Contract.

1. Do not proceed with work on adjoining property until directed by Engineer.

C. Utility Locator Service: Notify utility locator service for area where Project is located before beginning earth-moving operations.

D. Do not commence earth-moving operations until temporary site fencing and erosion- and sedimentation-control measures specified in Section 311000 Site Clearing are in place.

E. Do not commence earth-moving operations until plant-protection measures specified in Section 015639 Temporary Tree and Plant Protection are in place.

F. The following practices are prohibited within protection zones:

1. Storage of construction materials, debris, or excavated material.
2. Parking vehicles or equipment.
3. Foot traffic.
4. Erection of sheds or structures.
5. Impoundment of water.
6. Excavation or other digging unless otherwise indicated.
7. Attachment of signs to or wrapping materials around trees or plants unless otherwise indicated.

G. Do not direct vehicle or equipment exhaust towards protection zones.

H. Prohibit heat sources, flames, ignition sources, and smoking within or near protection zones.

PART 2 PRODUCTS

2.01 SOIL MATERIALS

A. General: All fill material shall be non-plastic in nature and free of roots, vegetative mater, waste, construction material, rocks, organics, or other objectionable matter. Materials deemed unsuitable by the inspector shall be removed and replaced with suitable fill. Provide borrow soil materials when sufficient satisfactory soil materials are not available from excavations.

B. Satisfactory Soils: Soil Classification [**Groups GW, GP, GM, SW, SP, and SM according to ASTM D 2487**] [**Groups A-1, A-2-4, A-2-5, and A-3 according to AASHTO M 145**], or a combination of these groups; free of rock or gravel larger than **3 inches (75 mm)** in any dimension, debris, waste, frozen materials, vegetation, and other deleterious matter.

C. Unsatisfactory Soils: Soil Classification [**Groups GC, SC, CL, ML, OL, CH, MH, OH, and PT according to ASTM D 2487**] [**Groups A-2-6, A-2-7, A-4, A-5, A-6, and A-7 according to AASHTO M 145**], or a combination of these groups.

   1. Unsatisfactory soils also include satisfactory soils not maintained within 2 percent of optimum moisture content at time of compaction.

D. Subbase Material: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940/D 2940M; with at least 90 percent passing a 1-1/2-inch (37.5-mm) sieve and not more than 12 percent passing a No. 200 (0.075-mm) sieve.

E. Base Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 294/D 2940M 0; with at least 95 percent passing a 1-1/2-inch (37.5-mm) sieve and not more than 8 percent passing a No. 200 (0.075-mm) sieve.

F. Engineered Fill: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940/D 2940M; with at least 90 percent passing a 1-1/2-inch (37.5-mm) sieve and not more than 12 percent passing a No. 200 (0.075-mm) sieve.

G. Bedding Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940/D 2940M; except with 100 percent passing a 1-inch (25-mm) sieve and not more than 8 percent passing a No. 200 (0.075-mm) sieve.

H. Drainage Course: Narrowly graded mixture of [**washed**]crushed stone, or crushed or uncrushed gravel; ASTM D 448; coarse-aggregate grading Size 57; with 100 percent passing a 1-1/2-inch (37.5-mm) sieve and zero to 5 percent passing a No. 8 (2.36-mm) sieve.

I. Filter Material: Narrowly graded mixture of natural or crushed gravel, or crushed stone and natural sand; ASTM D 448; coarse-aggregate grading Size 67; with 100 percent passing a 1-inch (25-mm) sieve and zero to 5 percent passing a No. 4 (4.75-mm) sieve.

J. Sand: ASTM C 33/C 33M; fine aggregate.

K. Impervious Fill: Clayey gravel and sand mixture capable of compacting to a dense state.

PART 3 EXECUTION

3.01 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earth-moving operations.

B. Protect and maintain erosion and sedimentation controls during earth-moving operations.

C. Protect subgrades and foundation soils from freezing temperatures and frost. Remove temporary protection before placing subsequent materials.

3.02 DEWATERING

A. The Contractor shall at all times provide and maintain ample means and equipment with which to remove and properly dispose of any and all water entering the excavation or other parts of the work and keep all excavations dry until such time as pipe laying and grading is completed and structures to be built therein are completed.

B. No water shall be allowed to rise around the pipe in unbackfilled trenches nor shall it be allowed to rise over masonry until the concrete or mortar has set (minimum 24 hours). All water pumped or drained from the work shall be disposed of in such a manner as to prevent siltation and erosion to adjacent property or other construction

C. Protect subgrades from softening, undermining, washout, and damage by rain or water accumulation.

1. Reroute surface water runoff away from excavated areas. Do not allow water to accumulate in excavations. Do not use excavated trenches as temporary drainage ditches.

3.03 SHORING AND SHIELDING

A. The Contractor shall comply with OSHA trenching and excavation regulations as revised in Subpart P of Part 1926 in the Federal Register. Shoring and/or shielding systems shall be used as specified in Subpart P to prevent caving of trench banks and to provide a safe excavation.

B. The Contractor will be responsible for excavation safety and shall designate his "competent person" (as defined in Subpart P) for the determination of proper shielding/shoring systems.

C. If, in the opinion of the Engineer, the trench/excavation is not in compliance with OSHA regulations, the Contractor may be directed to stop work. Continued unsafe conditions will be reported to the appropriate regulatory agency. The Contractor will be responsible for paying all fines resulting from safety violations.

3.04 BLASTING

A. Prior to commencing any blasting operations the Contractor shall notify either the City Fire Department - Fire Prevention Section or the County Fire Administrator as applicable, and obtain blasting permits as required. The Contractor must furnish certification of Insurance specifically covering any and all obligations assumed pursuant to the use of explosives.

B. All blasting operations shall be conducted in strict accordance with any and all decrees, rules, regulations, ordinances, and laws as may be imposed by any regulatory body and/or agency having jurisdiction over the work relative to handling, transporting, use and storage of explosives. Blasting shall be done only by competent, sober and experienced personnel whose activities shall be conducted in a workmanlike manner. Satisfactory information <u>must</u> be provided to the Engineer that the blaster meets or exceeds the qualifications enumerated in OSHA Regulations Part 1926, Subpart U, Section 1926.901 -Blaster Qualifications.

C. All rock, dirt and debris from blasting shall be contained within the excavation by use of weighted mats or undisturbed overburden. The Contractor's blaster shall be fully responsible for determining the method of containment and the weight, size and placement of material required to contain the charge he is using.

D. Charges shall be sized such that no damage to houses, structures, roadways etc., outside the limits of the excavation will occur. Where there is a possibility of such damage, the charge will initially be set at a very low level and increased in small increments until the proper charge is determined. The Contractor shall be held responsible for any and all injury to persons or damage to public or private property.

E. <u>Permission to Blast</u>: The Contractor shall not be allowed to blast within <u>any</u> rights-of- way maintained by any agency (D.O.T., R.R., Gas, etc.) other than the City without <u>specific approval</u> of the controlling agency and only in accordance with their respective requirements.

3.05 EXCAVATION, GENERAL

A. All excavations for pipe laying, manholes, piers, drainage ditches, grading and any other excavation required for the proper completion of this contract shall be included herein.

B. Excavation within street rights-of-way shall be backfilled when left unattended for more than 1 hour unless otherwise approved by the controlling agency. Excavations within sewer/water rights-of-way shall be backfilled, fenced or otherwise protected when left unattended for more than 1 hour. Fencing or other protection methods shall be designed to reasonably prevent people and large animals from entering the excavation.

C. Classified Excavation: Excavate to subgrade elevations. Material to be excavated will be classified as earth and rock. Do not excavate rock until it has been classified and cross sectioned by Engineer. The Contract Sum will be adjusted for rock excavation according to unit prices included in the Contract Documents. Changes in the Contract Time may be authorized for rock excavation.

1. Earth excavation includes excavating pavements and obstructions visible on surface; underground structures, utilities, and other items indicated to be removed; and soil, boulders, and other materials not classified as rock or unauthorized excavation.

    a. Intermittent drilling; blasting, if permitted; ram hammering; or ripping of material not classified as rock excavation is earth excavation.

2. Rock excavation shall be defined as solid ledge rock that requires drilling and blasting, sledging, or barring for its removal. Soft, disintegrated rock that can be removed with a pick shall not be classified as solidrock.

    a. Boulders greater than one cubic yard in volume will also be considered rock excavation. Smaller boulders and soft rock which in the opinion of the Engineer can be excavated by the use of a power shovel, without undue delay, shall not be classified as rock.
    b. Rock shall be removed to a depth of six (6) inches below the pipe bell and to the trench widths specified for each size and type of pipe installed. Rock around structures shall be removed to the same twelve (12) inch minimum as measured between vertical planes around the structure, but only to a depth necessary to allow proper installation. Over excavation of rock due to removal methods, or for safety considerations, shall be the Contractor's responsibility.
    c. When rock removal is necessary for pipeline installation either Type II or Type III bedding shall be installed as specified and directed by the Engineer.
    d. All blasting shall be conducted in a manner as specified elsewhere in these Specifications

3.06 EXCAVATION FOR STRUCTURES

A. The excavation shall be made to the lines, grades and elevations shown on the Plans and Standard Details. The area excavated shall be limited to no more than is necessary to allow the proper installation of the structure as determined by the Engineer. The excavation shall remain open no longer than is necessary to allow the proper and complete installation of the structure.

B. Excavate to indicated elevations and dimensions within a tolerance of plus or minus 1 inch (25 mm). If applicable, extend excavations a sufficient distance from structures for placing and removing concrete formwork, for installing services and other construction, and for inspections.

1. <u>Excavations for Footings and Foundations</u>: Do not disturb bottom of excavation. Excavate by hand to final grade just before placing concrete reinforcement. Trim bottoms to required lines and grades to leave solid base to receive other work.

2. <u>Excavation for Underground Tanks, Basins, and Mechanical or Electrical Utility Structures</u>: Excavate to elevations and dimensions indicated within a tolerance of plus or minus 1 inch (25 mm). Do not disturb bottom of excavations intended as bearing surfaces.
3. <u>Structure Pit Bottom Conformation</u>: The pit bottom shall be true and even, and capable of supporting the structure as determined by the Engineer. If the pit bottom is inadvertently cut below grade, the Contractor shall fill it to the proper elevation with approved material capable of continually maintaining adequate supportive strength

C. Excavations at Edges of Tree- and Plant-Protection Zones:

1. Excavate by hand or with an air spade to indicated lines, cross sections, elevations, and subgrades. If excavating by hand, use narrow-tine spading forks to comb soil and expose roots. Do not break, tear, or chop exposed roots. Do not use mechanical equipment that rips, tears, or pulls roots.
2. Cut and protect roots according to requirements in Section 015639 Temporary Tree and Plant Protection.

3.07 EXCAVATION FOR BORE PITS

A. The excavation shall be controlled by the limits of the existing rights-of-way and shall not exceed these without prior written approval of the current property owner. The excavation shall be made to the proper elevation, line and grade to install the casing pipe as shown on the constructionplans.
B. The pit bottom shall be true and even with adequate stabilization to maintain proper elevation and grade on the boring rig for the duration of the bore. The walls of the pit shall be shored or sloped to comply with OSHA requirements.
C. The bore pit shall not be left open overnight on NCDOT maintained roadways without specific approval from the NCDOT. If approval is obtained, concrete median barriers are required to be placed around the bore pit within the road right-of-way.

3.08 EXCAVATION FOR WALKS AND PAVEMENTS

A. Excavate surfaces under walks and pavements to indicated lines, cross sections, elevations, and subgrades.

3.09 EXCAVATION FOR UTILITY TRENCHES

A. <u>Trench Excavation</u>: Excavate trenches to indicated gradients, lines, depths, and elevations. No more than 100 LF of trench shall be opened in advance of the pipe laying than is necessary to expedite the work unless prior approval is given by the Engineer. Ground conditions and/or location requirements shall govern theamount of trench open at any one time as determined by the Engineer.

1. <u>Trench Width</u>: The maximum trench width shall be as indicated for each type of pipe specified. If the actual trench width exceeds the specified width, due to shoring methods, the contractor must obtain approval from the Engineer. Trench width shall be measured between faces of cut at the top of the pipe bell. If the Contractor varies from this

requirement without approval of the Inspector, he shall at his own expense install Type II or Type III bedding defined in this specification.

2. Trench Bottom Conformation: The excavation shall be made to the elevations, grades, and lines shown on the Construction Plans unless otherwise approved by the Engineer. The trench bottom shall be excavated slightly above grade and cut down to the pipe grade by hand in the fine grading operation. The trench bottom shall be true and even with bell holes at each joint to provide the barrel of the pipe with soil and/or granular bedding (as applicable) support for its full length. This should prevent point loading at the bells. If the trench bottom is inadvertently cut below grade, the Contractor shall (at his own expense) fill it to grade with approved material thoroughly tamped, or with #67 bedding stone. Pipe depth and/or soil conditions may require Type II or Type III granular embedment. This bedding shall also be shaped to allow adequate support of the pipe.
3. If the trench passes either under or over another pipeline or previous excavation, the trench bottom in this area shall be tamped, if necessary, so the disturbed soil has approximately the same supportive strength as the native soil.

B. Trenches in Tree- and Plant-Protection Zones:

1. Hand-excavate to indicated lines, cross sections, elevations, and subgrades. Use narrow-tine spading forks to comb soil and expose roots. Do not break, tear, or chop exposed roots. Do not use mechanical equipment that rips, tears, or pulls roots.
2. Do not cut main lateral roots or taproots; cut only smaller roots that interfere with installation of utilities.
3. Cut and protect roots according to requirements in Section 015639 Temporary Tree and Plant Protection.

3.10 SUBGRADE INSPECTION

A. Notify Engineer when excavations have reached required subgrade.

B. If Engineer determines that unsatisfactory soil is present, continue excavation and replace with compacted backfill or fill material as directed.

C. Proof-roll subgrade below the building slabs and pavements to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.

1. Completely proof-roll subgrade in one direction[, repeating proof-rolling in direction perpendicular to first direction]. Limit vehicle speed to 3 mph (5 km/h).
2. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by Engineer, and replace with compacted backfill or fill as directed.

D. Authorized additional excavation and replacement material will be paid for according to Contract provisions for unit prices

E. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by Engineer, without additional compensation.

3.11 UNAUTHORIZED EXCAVATION

A. Fill unauthorized excavations with lean concrete fill, with 28-day compressive strength of 2500 psi (17.2 MPa), or as directed by Engineer.

B. Fill unauthorized excavations under other construction, pipe, or conduit as directed by Engineer

3.12 STORAGE OF SOIL MATERIALS

A. Stockpile borrow soil materials and excavated satisfactory soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.

B. All excavated material shall be piled in a manner that will not endanger the work. Excavated material will be piled a safe distance away from the edge of the excavation allowing room for an adequate angle of repose and if shoring, sheeting, and bracing is used to protect the excavation, no material will be piled within three (3) feet of the nearest edge. Sidewalks, driveways, hydrants, valve pit covers, valve boxes, curb stop boxes, existing manholes, fire and police call boxes, or other utility controls shall be unobstructed and accessible until the work is completed. Gutters, catch basins, and natural watercourses shall not be obstructed or silted.

C. When working in close proximity with a creek channel or natural watercourse the Contractor shall pile all excavated material on the side of his excavation away from the watercourse.

3.13 BACKFILL, GENERAL

A. Place and compact backfill in excavations promptly, but not before completing the following:

1. Construction below finish grade including, where applicable, subdrainage, dampproofing, waterproofing, and perimeter insulation.
2. Surveying locations of underground utilities for Record Documents.
3. Testing and inspecting underground utilities.
4. Removing concrete formwork.
5. Removing trash and debris.
6. Removing temporary shoring, bracing, and sheeting.
7. Installing permanent or temporary horizontal bracing on horizontally supported walls.

B. Place backfill on subgrades free of mud, frost, snow, or ice.

3.14 UTILITY TRENCH BACKFILL

A. Place backfill on subgrades free of mud, frost, snow, or ice.

B. Place and compact bedding course on trench bottoms and where indicated. Shape bedding course to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits.

C. All backfill shall be of a non-plastic nature free from roots, vegetative matter, waste, construction material, rock larger than 3/4 cubic foot, or other objectionable material. Small rock (less than 3/4 cubic foot) shall not exceed 10% of the fill material. Rock shall not be placed within 3-feet of the pipeline or within three feet of the finished grade. Rock larger than 3/4 cubic foot will not be permitted within the trench. No objectionable or unsuitable material will be allowed in the backfill. Backfill material shall be capable of being tamped by mechanical tamps using relatively low velocity and heavy blows. The material shall have no tendency to flow or behave in a plastic manner under the tamping blows. Material deemed by the Engineer as unsuitable for backfill purposes shall be removed from the job site before backfilling operations begin.

D. When the Engineer determines that the material excavated from the trench is unsuitable for backfill because of the material type or because it contains excessive debris, rock or organics, it shall be removed from the project and replaced with a backfill material approved by the Engineer. When the moisture content of an otherwise suitable material is too high to achieve specified compaction, as determined by a moisture content and density test, the Contractor shall replace the material as necessary to meet backfill requirements. The wet material may be dried to optimum moisture content and used for backfill in subsequent phases of the project. Should an otherwise suitable material be found too dry to achieve compaction requirements, water may be added to the material to raise the moisture content to optimum.

E. Borrow material placed at the direction of the Engineer shall be clean earth at optimum moisture content, concord (pit) gravel or ABC stone.

F. Backfill shall be accomplished immediately after the pipe is laid. Backfill around pipe and to an elevation of one (1) foot above the pipe bell shall be done only by hand and in layers not exceeding six (6) inches with each and every layer thoroughly tamped. The first three (3) feet of fill shall be completely free of rocks. Successive layers of backfill shall be compacted in place as specified below.

G. Under no circumstances shall water be permitted to rise in unbackfilled trenches after the pipe has been placed. Should water rise in an unbackfilled ditch after the pipe has been placed, the Engineer may require the Contractor to remove the pipe, muck the trench and follow the procedure for either Type II or Type III Granular Embedment when relaying the pipe.

1. Backfill of trenches within utility rights-of-way: Trenches excavated outside existing roadway and railway right-of-way may be backfilled, above the initial one (1) foot, by mechanical means in layers up to twelve (12) inches thick unless otherwise directed by the Engineer.
2. Backfill of trenches within road and railway rights-of-way: Trenches excavated within existing road and railway rights-of-way shall be backfilled in layers not to exceed six (6) inches and each successive layer shall be thoroughly tamped, as specified.

H. Backfill voids with satisfactory soil while removing shoring and bracing.

I. Warning Tape: Install warning tape directly above utilities, 12 inches (300 mm) below finished grade, except 6 inches (150 mm) below subgrade under pavements and slabs.

3.15 SOIL FILL

A. Plow, scarify, bench, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so fill material will bond with existing material.

B. Place and compact fill material in layers to required elevations as follows:

1. Under grass and planted areas, use satisfactory soil material.
2. Under walks and pavements, use satisfactory soil material.
3. Under steps and ramps, use engineered fill.
4. Under building slabs, use engineered fill.
5. Under footings and foundations, use engineered fill.

C. Place soil fill on subgrades free of mud, frost, snow, or ice.

3.16 SOIL MOISTURE CONTROL

A. Uniformly moisten or aerate subgrade and each subsequent fill or backfill soil layer before compaction to within 2 percent of optimum moisture content.

1. Do not place backfill or fill soil material on surfaces that are muddy, frozen, or contain frost or ice.

2. Remove and replace, or scarify and air dry, otherwise satisfactory soil material that exceeds optimum moisture content by 2 percent and is too wet to compact to specified dry unit weight.

3.17 COMPACTION OF SOIL BACKFILLS AND FILLS

A. Compaction shall be attained by the use of mechanical tamps only. Each layer of backfill shall be placed loose and thoroughly compacted in place. Heavy rollers, vehicles or other equipment shall not be used for compacting pipeline and structure backfill nor allowed to cross over completed work except at points adjudged capable of adequately protecting the pipeline. Pneumatic tamps, gasoline ram type tamps or vibrating tamps with sheepsfoot rollers will be required to meet the specifications of "Mechanical Tamp". Variances shall only be with the explicit approval of the Engineer.

1. Compaction Within Sewer Rights-of-way: Trenches excavated outside existing road and railway rights-of-way shall be backfilled as hereinbefore specified and tamped thoroughly:

a. All material shall have an in-place density of at least 85% of maximum dry density or as approved by the Engineer.
b. Should any public or private roadways, service roads, drives, etc. be encountered during this construction, the Contractor shall at the Engineer's direction comply with those compaction requirements specified below for work within road and railway rights-of-way.

2. Compaction Within Road and Railway Rights-of-Way: Unless otherwise approved by the controlling agencies, trenches excavated within existing road and railway rights-of- way and all structure excavation regardless of location shall be backfilled as hereinbefore specified and thoroughly tamped:

a. Unless otherwise directed by the Engineer, all material from the bottom of trench to within six (6) inches of the subgrade shall have an in-place density of 95% of the maximum dry density as defined by a standard proctor curve for the material.
b. All material within six (6) inches of the subgrade level shall have an in place density of 100% of the maximum dry density.
c. On roadway shoulders, all material shall have an in place density of 95% of the maximum dry density. The Contractor shall remove and replace all material failing to meet these requirements with suitable material. The extent of this removal shall be determined by the Engineer.

3. Compaction for Pump Station Vault Structures: Suitable backfill around all pump station vault structures shall be compacted to 95% of max. dry density as determined by the standard Proctor curve (ASTM D-698). Foundation subgrade for these structures shall be compacted to 100% of Max. dry density.

B. Compaction Testing: Moisture content and density testing of backfill will be performed by a third party soils technician. Tests will be performed within all street, highway and railway rights-of-way to insure that the specified compaction requirements are met. The Contractor will cooperate fully with the soils technicians in providing access to backfill at any requested depth for the purpose of performing moisture content/density testing. When requested, the Contractor shall excavate a backfilled ditch to any specified depth for a compaction test and shall insure that the ditch meets all OSHA safety standards before the technician enters to perform the test. A "standard proctor curve" which establishes the relationship between moisture content and dry density for soil will be determined by the method described in ASTM D-698 or by AASHTO Method T-99. Field density tests will be performed using either the sand cone method or a nuclear moisture/density gauge. Any backfill which does not meet the specified compaction will be re-tamped, or removed and replaced as approved by the Engineer.

3.18 GRADING

A. General: Uniformly grade areas to a smooth surface, free of irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated.

1. Provide a smooth transition between adjacent existing grades and new grades.
2. Cut out soft spots, fill low spots, and trim high spots to comply with required surface tolerances.

B. Site Rough Grading: Slope grades to direct water away from buildings and to prevent ponding. Finish subgrades to elevations required to achieve indicated finish elevations, within the following subgrade tolerances:

1. Turf or Unpaved Areas: Plus or minus 1 inch (25 mm).
2. Walks: Plus or minus 1 inch (25 mm).
3. Pavements: Plus or minus 1/2 inch (13 mm).

C. Grading inside Building Lines: Finish subgrade to a tolerance of 1/2 inch (13 mm) when tested with a 10-foot (3-m) straightedge.

3.19 SUBBASE AND BASE COURSES UNDER PAVEMENTS AND WALKS

A. Place subbase course and base course on subgrades free of mud, frost, snow, or ice.
B. On prepared subgrade, place subbase course and base course under pavements and walks as follows:

1. Install separation geotextile on prepared subgrade according to manufacturer's written instructions, overlapping sides and ends.
2. Place base course material over subbase course under hot-mix asphalt pavement.
3. Shape subbase course and base course to required crown elevations and cross-slope grades.
4. Place subbase course and base course 6 inches (150 mm) or less in compacted thickness in a single layer.
5. Place subbase course and base course that exceeds 6 inches (150 mm) in compacted thickness in layers of equal thickness, with no compacted layer more than 6 inches (150 mm) thick or less than 3 inches (75 mm) thick.
6. Compact subbase course and base course at optimum moisture content to required grades, lines, cross sections, and thickness to not less than 95 percent of maximum dry unit weight according to ASTM D 698.

C. Pavement Shoulders: Place shoulders along edges of subbase course and base course to prevent lateral movement. Construct shoulders, at least 12 inches (300 mm) wide, of satisfactory soil materials and compact simultaneously with each subbase and base layer to not less than 95 percent of maximum dry unit weight according to ASTM D 698.

3.20 DRAINAGE COURSE UNDER CONCRETE SLABS-ON-GRADE

A. Place drainage course on subgrades free of mud, frost, snow, or ice.

B. On prepared subgrade, place and compact drainage course under cast-in-place concrete slabs-on-grade as follows:

1. Install subdrainage geotextile on prepared subgrade according to manufacturer's written instructions, overlapping sides and ends.
2. Place drainage course 6 inches (150 mm) or less in compacted thickness in a single layer.
3. Place drainage course that exceeds 6 inches (150 mm) in compacted thickness in layers of equal thickness, with no compacted layer more than 6 inches (150 mm) thick or less than 3 inches (75 mm) thick.
4. Compact each layer of drainage course to required cross sections and thicknesses to not less than **95** percent of maximum dry unit weight according to ASTM D 698.

3.21 FIELD QUALITY CONTROL

A. Special Inspections: Owner will engage a qualified special inspector to perform the following special inspections:

1. Determine prior to placement of fill that site has been prepared in compliance with requirements.
2. Determine that fill material classification and maximum lift thickness comply with requirements.
3. Determine, during placement and compaction, that in-place density of compacted fill complies with requirements.

B. Testing Agency: Owner will engage a qualified geotechnical engineering testing agency to perform tests and inspections.

C. Allow testing agency to inspect and test subgrades and each fill or backfill layer. Proceed with subsequent earth moving only after test results for previously completed work comply with requirements.

D. Footing Subgrade: At footing subgrades, at least one test of each soil stratum will be performed to verify design bearing capacities. Subsequent verification and approval of other footing subgrades may be based on a visual comparison of subgrade with tested subgrade when approved by Engineer.

E. Testing agency will test compaction of soils in place according to ASTM D 1556, ASTM D 2167, ASTM D 2937, and ASTM D 6938, as applicable. Tests will be performed at the following locations and frequencies:

1. Paved and Building Slab Areas: At subgrade and at each compacted fill and backfill layer, at least one test for every 200 sq. ft. (186 sq. m) or less of paved area or building slab but in no case fewer than three tests.

2. Trench Backfill: At each compacted initial and final backfill layer, at least one test for every 150 feet (46 m) or less of trench length but no fewer than two tests.

F. When testing agency reports that subgrades, fills, or backfills have not achieved degree of compaction specified, scarify and moisten or aerate, or remove and replace soil materials to depth required; recompact and retest until specified compaction is obtained.

3.22 PROTECTION

A. Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.

B. Repair and reestablish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction due to subsequent construction operations or weather conditions.

1. Scarify or remove and replace soil material to depth as directed by Engineer; reshape and recompact.

C. Where settling occurs before Project correction period elapses, remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing.

1. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

3.23 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Remove surplus satisfactory soil and waste materials, including unsatisfactory soil, trash, and debris, and legally dispose of them off Owner's property.

B. Transport surplus satisfactory soil to designated storage areas on Owner's property. Stockpile or spread soil as directed by Engineer.

1. Remove waste materials, including unsatisfactory soil, trash, and debris, and legally dispose of them off Owner's property.

END OF SECTION

SECTION 312319
DEWATERING

PART 1 GENERAL

1.01 SUMMARY

A. Design, installation, operation, and removal of dewatering system shall comply with current safety and environmental regulations.

B. The Contractor shall lower and control groundwater levels and hydrostatic pressures to permit construction work to be performed in the dry in accordance with the Contract Documents. Control of surface water shall be considered as part of the work under this specification.

C. The Contractor shall secure all necessary permits to complete the requirements of this Section of the Specifications.

D. The Contractor shall be responsible for providing all materials, equipment, labor, and services necessary for dewatering in a manner compatible with construction methods and site conditions.

E. The Contractor shall implement an erosion and sedimentation control plan before excavation work begins.

1.02 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. Reference Specifications

013300	Submittal Procedures
312000	Earthwork Moving

1.03 REQUIREMENT

A. Dewater system shall be of sufficient size and capacity necessary to lower and maintain groundwater level to an elevation at least one foot below the lowest excavation depth and to allow material to be excavated in a reasonably dry condition.

B. Maintain stability of excavation sides and base.

C. Prevent loss of fines, seepage, boils, quick conditions or softening of foundation strata.

D. Maintain dry and stable subgrade for subsequent construction operations.

E. Provide adequate control of surface and subsurface water such that:

1. Stability of sides and base of excavation is not adversely affected.

2. Erosion is controlled.

3. Flooding of excavations or damage to structures does not occur.

4. Surface water drains away from excavations and other work areas.

F. Preclude damage to adjacent properties, buildings, structures, utilities, installed facilities and other work.

G. Assume sole responsibility for the dewatering system and for any loss or damage resulting from inadequacy or failure of the system. Perform work necessary to repair the damages at no additional cost to the Owner.

1.04 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 013300 Submittal Procedures.

B. All required permits.

C. Prior to commencement of excavation, the Contractor shall submit a detailed plan and operation schedule for dewatering of excavations. The detailed plan shall include mitigation measures to prevent settlement of nearby structures and a contingency plan for restoring nearby structures if settlement is observed as a result of the Contractor’s dewatering operations. The Contractor may be required to demonstrate the system proposed and to verify that adequate equipment, personnel, and materials are provided to dewater the excavations at all locations and times. The Contractor's dewatering plan is subject to review by the Engineer. The plan shall be signed and sealed by a qualified Professional Engineer licensed in North Carolina and include the following:

1. Drawings and data showing the dewatering system, monitoring program, and erosion and sedimentation control plan to be employed.

2. Detailed description of the dewatering system, including arrangement, location, depth and capacities of the system components, installation details, and operation and maintenance procedures.

3. Description of the monitoring program, including instrument type, location, installation details, monitoring criteria, and operation and maintenance procedures.

4. A written report including control procedures to be adopted if dewatering problems arise.

5. Design calculations demonstrating adequacy of the dewatering system and selected equipment for intended applications.

6. Description of methods to be employed for disposal of removed water.

1.05 QUALITY CONTROL

A. It shall be the sole responsibility of the Contractor to control the rate and effect of the dewatering in such a manner as to avoid all objectionable settlement and subsidence.

B. All dewatering operations shall be adequate to assure the integrity of the finished project and shall be the responsibility of the Contractor.

C. All structures or facilities that are located within the radius of influence of the Contractor's dewatering operation shall have reference points established and observed at frequent intervals to detect any settlement which may develop. The responsibility for conducting the dewatering operation in a manner which will protect adjacent structures and facilities rests solely with the Contractor. The Contractor shall survey, record and report the reference points on a daily basis, and submit the written log to the Engineer at the completion of construction. The Engineer shall be immediately notified should any sign of settlement is observed. The cost of repairing any damage to adjacent structures and restoration of facilities shall be the responsibility of the Contractor.

D. The dewatering field supervisor shall have a minimum of five years of experience related to dewatering work and have completed at least three projects of similar scope and complexity.

PART 2 PRODUCTS

2.01 EQUIPMENT

A. Dewatering, where required, may include the use of well points, sump pumps, temporary pipelines for water disposal, rock or gravel placement, and other means. Sufficient standby pumping equipment and other materials shall be maintained on the Site to ensure continuous dewatering operation.

PART 3 EXECUTION

3.01 GENERAL REQUIREMENTS

A. The Contractor shall provide all equipment necessary for dewatering. It shall have on hand, at all times, sufficient pumping equipment and machinery in good working condition and shall have available, at all times, competent workmen for the operation of the pumping equipment. Adequate standby equipment shall be kept available at all times to insure efficient dewatering and maintenance of dewatering operation during power failure.

B. Install a dewatering system with sufficient capacities to lower and control groundwater level in order to permit excavation, structure construction, and backfilling to be performed in dry conditions. Ensure the dewatering system is adequate to pre-drain water-bearing strata and to maintain groundwater table below the bottom of structure foundations, utilities, and other excavations.

C. Dewatering for structures and pipelines shall commence when groundwater is first encountered, and shall be continuous until such times as water can be allowed to rise and dewatering is no longer required in accordance with the provisions of this Section or other requirements.

D. At all times, site grading shall promote drainage. Surface runoff shall be diverted from excavations. Water entering the excavation from surface runoff shall be collected in shallow ditches around the perimeter of the excavation, drained to sumps, and be pumped or drained by gravity from the excavation to maintain a bottom free from standing water.

E. Dewatering shall at all times be conducted in such a manner as to preserve the undisturbed bearing capacity of the subgrade soils at proposed bottom of excavation.

F. If foundation soils are disturbed or loosened by the upward seepage of water or an uncontrolled flow of water, the affected areas shall be excavated and replaced with drain rock.

G. The Contractor shall maintain the water level below the bottom of excavation in all work areas where groundwater occurs during excavation construction, backfilling, and up to acceptance.

H. Flotation shall be prevented by the Contractor by maintaining a positive and continuous removal of water. The Contractor shall be fully responsible and liable for all damages which may result from failure to adequately keep excavations dewatered.

I. If well points or wells are used, they shall be adequately spaced to provide the necessary dewatering and shall be sandpacked and/or other means used to prevent pumping of fine sands or silts from the subsurface. A continual check by the Contractor shall be maintained to ensure that the subsurface soil is not being removed by the dewatering operation.

J. The Contractor shall dispose of water from the Work in a suitable manner without damage to adjacent property and negatively impacting work areas. Contractor shall be responsible for obtaining any permits that may be necessary to dispose of water. No water shall be drained into work built or under construction without prior consent of the Engineer. Water shall be filtered using an approved method to remove sand and fine-sized soil particles before disposal into any drainage system.

K. The Contractor shall utilize all necessary erosion and sediment control measures to avoid construction related degradation of the natural water quality.

L. The Contractor shall implement correction measures if dewatering requirements are not satisfied due to inadequacy or failure of the dewatering system.

M. The Contractor shall immediately repair damages to adjacent facilities caused by dewatering operations.

N. The Contractor shall remove the dewatering system and monitoring instruments as directed by the Engineer when groundwater control is no longer required. The Contractor shall ensure compliance with all conditions of regulating permits and obtain written approval from the Engineer before discontinuing operation of dewatering system.

O. The release of groundwater to its static level shall be performed in such a manner as to maintain the undisturbed state of the natural foundation soils, prevent disturbance of compacted backfill and prevent flotation or movement of structures, pipelines, and sewers.

P. Dewatering of trenches and other excavations shall be considered as incidental to the construction of the Work and all costs thereof shall be included in the various contract prices in the Bid Forms unless a separate bid item has been established for dewatering.

END OF SECTION

SECTION 321216
ASPHALT PAVING

PART 1 GENERAL

1.01 SUMMARY

A. Asphalt paving base course, binder course, and wearing course.

1.02 REFERENCES

A. North Carolina Department of Transportation (NCDOT) "Standard Specifications for Roads and Structures," latest edition.

1.03 SUBMITTALS

A. Material Certificates: Provide copies of materials certificates signed by material producer and Contractor, certifying that each material item complies with, or exceeds, specified requirements.

1.04 QUALITY ASSURANCE

A. Perform Work in accordance with NCDOT or CLDSM standard specifications.

B. Obtain materials from same source throughout.

C. Saw cutting of edges of existing pavement is necessary for pavement addition and renovation. This work will be performed by the more stringent method as either specified by NCDOT standard specifications Section 250-2, Pavement Removal and Disposal, or as indicated in this specification under Part 3, Execution.

1.05 ENVIRONMENTAL REQUIREMENTS

A. Do not place asphalt mixture when ambient air or base surface temperature is less than 40 degrees F, or surface is wet or frozen.

PART 2 PRODUCTS

2.01 MATERIALS

A. Asphalt Cement: in accordance with NCDOT standard specifications.

B. Binder: In accordance with NCDOT standard specifications.

C. Tack Coat: In accordance with NCDOT standard specifications.

2.02 AGGREGATE MATERIALS

A. Base: General Aggregate Base Course in accordance with NCDOT standard specifications.

PART 3 EXECUTION

3.01 GENERAL

A. All removal and restoration of pavement and road surfaces will be in accordance with the specifications approved by the Town of Smithfield or the North Carolina Department of Transportation and Safety, Division of Highways, whichever applies.

B. All restored bituminous and concrete pavements shall be placed to existing cross-section and ride quality. Restored pavement will in all instances be flush and level with existing pavement at the sawed edges, and at existing gutter lines where applicable unless otherwise approved by the Engineer. When pavement repairs do not meet the above criteria or are not performed in a workmanship manner as determined by the Engineer, or North Carolina Department of Transportation, whichever applies, the contractor will remove and re-perform the restoration as specified.

C. When cuts are to be made in street rights-of-way under maintenance by the Town of Smithfield, the Contractor shall contact the Superintendent of Streets or his designated representative before each separate pavement cut is made and secure a permit.

D. Pavement will be replaced as follows. In all pavement cuts either the permanent pavement or a temporary pavement consisting of 1" of black asphaltic concrete (later to be replaced permanently) will be placed immediately upon completion of the subgrade unless otherwise approved by the Engineer.

1. <u>Specifications for Cutting Pavement</u>: Unless otherwise approved or required, concrete pavement shall be removed to the nearest expansion or contraction joint. The Contractor will contact the Superintendent of Streets and/or D.O.T.'s District Engineer for a determination of the limits of concrete replacement and location of joints. Where sawed joints are allowed, the depth of the sawed cut shall be at least one (1) inch and shall extend at least 1/5 of the depth of the concrete. More depth may be required if necessary to prevent damage to surrounding pavement. Bituminous pavement shall be cut in a smooth and straight line. Sawing is required on asphaltic concrete. The width of pavement left between the edge of the ditch and the existing edge of the pavement or the front line of the gutter, shall be at least 2 feet. Residual strips of pavement less than 2 feet in width must be removed and replaced. Existing pavement shall be removed on each side of the trench for at least 12 inches beyond top of trench. The Contractor shall remove and replace pavement which, in the opinion of the Engineer, has been cracked or displaced by the operation of the Contractor.

2. <u>Specification For Restoring Concrete Pavement</u>: The concrete used to restore pavement shall have a minimum 28 day compressive strength of 3600 P.S.I. The concrete as placed shall conform to the shape, grade, and finish of the existing pavement and will be one (1) inch deeper than the original pavement including base, but in no instance less than six (6) inches.

3. <u>Specification For Restoring Asphalt Pavement</u>: All material above the sub-base level shall be hot-mix bituminous concrete conforming to North Carolina Department of Transportation Standard Specifications for Roads and Structures for both mix design and placement. The asphalt pavement as placed shall be one (1) inch deeper than the

original pavement including base, but in no instance less than eight (8) inches within City maintained roadways or eight (8) inches within state maintained roadways. The asphalt shall be placed in lifts not greater than 4 inches and shall be hot mix bituminous concrete binder Type H. The last two (2) inches in either instance shall be bituminous plant mix (I-2) suitable to the appropriate controlling agency. I-2 asphalt pavement resurfacing will be placed with paving machines and/or rollers of a size and type currently approved by the North Carolina Department of Transportation for use on resurfacing contracts. If a bituminous surfacing overlays a concrete base, the Contractor, at the option of the Engineer, shall replace the concrete to its original thickness, or to a level 2 inches below the finished surface. The Engineer may direct the Contractor to omit all concrete and to replace the pavement with bituminous materials. Tack coats shall be employed with each lift. Tack coats shall be placed on both horizontal and vertical surfaces (pavement cuts or face of concrete gutters). Under normal conditions, asphalt binder will be placed in pavement cuts at the end of each work day. I-2 shall be replaced weekly or within five days following completion of pipeline construction along a continuous section of pavement. During inclement weather, the Engineer may permit the use of temporary asphalt (cold mix) to seal the trench until permanent asphalt can be placed.

3.02 EXAMINATION

A. Verify compacted subgrade is dry and ready to support paving and imposed loads.

B. Verify gradients and elevations of base are correct.

3.03 TACK COAT

A. Apply tack coat in accordance with NCDOT standard specifications.

B. Apply tack coat to contact surfaces of curbs, gutters and drainage structures.

C. Coat surfaces of manhole and catch basin frames with oil to prevent bond with asphalt paving. Do not tack coat these surfaces.

3.04 SINGLE COURSE ASPHALT PAVING

A. Install Work in accordance with NCDOT or CLDSM standard specifications.

B. Place asphalt within 24 hours of applying primer or tack coat.

C. Place to compacted thickness indicated on Drawings.

D. Install drainage structures and valve boxes in correct position and elevation.

3.05 ERECTION TOLERANCES

A. Flatness: Maximum variation of 1/4 inch measured with 10 foot straight edge.

B. Scheduled Compacted Thickness: Within 1/4 inch.

C. Variation from Indicated Elevation: Within 1/2 inch

3.06 FIELD QUALITY CONTROL

A. Take samples and perform tests in accordance with NCDOT standard specifications.

3.07 PROTECTION OF FINISHED WORK

A. Immediately after placement, protect paving from mechanical injury for 7 days or until surface temperature is less than 140 degrees

END OF SECTION

SECTION 321313
CONCRETE PAVING

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section Includes Concrete Paving including the following:

1. Curbs and gutters.

2. Walks

1.03 DEFINITIONS

A. Cementitious Materials: Portland cement alone or in combination with one or more of blended hydraulic cement, fly ash, slag cement, and other pozzolans.

B. W/C Ratio: The ratio by weight of water to cementitious materials.

C. NCDOT: North Carolina Department of Transportation

1.04 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Design Mixtures: For each concrete paving mixture. Include alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

1.05 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer of stamped detectable warnings, ready-mix concrete manufacturer, and testing agency.

B. Material Certificates: For the following, from manufacturer:

1. Cementitious materials.

2. Steel reinforcement and reinforcement accessories.

3. Fiber reinforcement.

4. Admixtures.

5. Curing compounds.

6. Applied finish materials.

7. Bonding agent or epoxy adhesive.

8. Joint fillers.

C. Material Test Reports: For each of the following:

1. Aggregates: Include service-record data indicating absence of deleterious expansion of concrete due to alkali-aggregate reactivity.

D. Field quality-control reports.

1.06 QUALITY ASSURANCE

A. Ready-Mix-Concrete Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.

1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities" (Quality Control Manual - Section 3, "Plant Certification Checklist").

B. Testing Agency Qualifications: Qualified according to ASTM C 1077 and ASTM E 329 for testing indicated.

1. Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-1 or an equivalent certification program.

1.07 PRECONSTRUCTION TESTING

A. Preconstruction Testing Service: Engage a qualified independent testing agency to perform preconstruction testing on concrete paving mixtures.

1.08 FIELD CONDITIONS

A. Traffic Control: Maintain access for vehicular and pedestrian traffic as required for other construction activities.

B. Cold-Weather Concrete Placement: Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing, or low temperatures. Comply with ACI 306.1 and the following:

1. When air temperature has fallen to or is expected to fall below 40 deg F, uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 deg F and not more than 80 deg F at point of placement.

2. Do not use frozen materials or materials containing ice or snow.

3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in design mixtures.

C. Hot-Weather Concrete Placement: Comply with ACI 301 and as follows when hot-weather conditions exist:

1. Cool ingredients before mixing to maintain concrete temperature below 90 deg F at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated in total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.

2. Cover steel reinforcement with water-soaked burlap, so steel temperature will not exceed ambient air temperature immediately before embedding in concrete.

3. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade moisture uniform without standing water, soft spots, or dry areas.

PART 2 PRODUCTS

2.01 CONCRETE, GENERAL

A. ACI Publications: Comply with ACI 301 unless otherwise indicated.

2.02 FORMS

A. Form Materials: Plywood, metal, metal-framed plywood, or other approved panel-type materials to provide full-depth, continuous, straight, and smooth exposed surfaces.

1. Use flexible or uniformly curved forms for curves with a radius of 100 feet or less. Do not use notched and bent forms.

B. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and that will not impair subsequent treatments of concrete surfaces.

2.03 STEEL REINFORCEMENT

A. Plain-Steel Welded-Wire Reinforcement: ASTM A 1064/A 1064M, fabricated from galvanized steel wire into flat sheets.

B. Deformed-Steel Welded-Wire Reinforcement: ASTM A 1064/A 1064M, flat sheet.

C. Epoxy-Coated Welded-Wire Reinforcement: ASTM A 884/A 884M, Class A, plain steel.

D. Reinforcing Bars: ASTM A 615/A 615M, Grade 60; deformed.

E. Galvanized Reinforcing Bars: ASTM A 767/A 767M, Class II zinc coated, hot-dip galvanized after fabrication and bending; with ASTM A 615/A 615M, Grade 60 deformed bars.

F. Epoxy-Coated Reinforcing Bars: ASTM A 775/A 775M or ASTM A 934/A 934M; with ASTM A 615/A 615M, Grade 60 deformed bars.

G. Steel Bar Mats: ASTM A 184/A 184M; with ASTM A 615/A 615M, Grade 60 deformed bars; assembled with clips.

H. Plain-Steel Wire: ASTM A 1064/A 1064M, galvanized.

I. Deformed-Steel Wire: ASTM A 1064/A 1064M.

J. Epoxy-Coated-Steel Wire: ASTM A 884/A 884M, Class A; coated, deformed.

K. Joint Dowel Bars: ASTM A 615/A 615M, Grade 60 plain-steel bars; zinc coated (galvanized) after fabrication according to ASTM A 767/A 767M, Class I coating. Cut bars true to length with ends square and free of burrs.

L. Epoxy-Coated, Joint Dowel Bars: ASTM A 775/A 775M; with ASTM A 615/A 615M, Grade 60 plain-steel bars.

M. Tie Bars: ASTM A 615/A 615M, Grade 60; deformed.

N. Hook Bolts: ASTM A 307, Grade A, internally and externally threaded. Design hook-bolt joint assembly to hold coupling against paving form and in position during concreting operations, and to permit removal without damage to concrete or hook bolt.

O. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars, welded-wire reinforcement, and dowels in place. Manufacture bar supports according to CRSI's "Manual of Standard Practice" from steel wire, plastic, or precast concrete of greater compressive strength than concrete specified, and as follows:

   1. Equip wire bar supports with sand plates or horizontal runners where base material will not support chair legs.

   2. For epoxy-coated reinforcement, use epoxy-coated or other dielectric-polymer-coated wire bar supports.

P. Epoxy Repair Coating: Liquid, two-part, epoxy repair coating, compatible with epoxy coating on reinforcement.

Q. Zinc Repair Material: ASTM A 780/A 780M.

2.04 CONCRETE MATERIALS

A. Cementitious Materials: Use the following cementitious materials, of same type, brand, and source throughout Project:

   1. Portland Cement: ASTM C 150/C 150M, gray portland cement Type I/II.

   2. Fly Ash: ASTM C 618, Class C or Class F.

   3. Slag Cement: ASTM C 989/C 989M, Grade 100 or 120.

B. Normal-Weight Aggregates: ASTM C 33/C 33M, Class 4M, uniformly graded. Provide aggregates from a single source with documented service-record data of at least 10 years' satisfactory service in similar paving applications and service conditions using similar aggregates and cementitious materials.

   1. Maximum Coarse-Aggregate Size: 1 inch nominal.

2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.

C. Exposed Aggregate: Selected, hard, and durable; washed; free of materials with deleterious reactivity to cement or that cause staining; from a single source, with gap-graded coarse aggregate as follows:

1. Aggregate Sizes: 3/4 to 1 inch nominal.

D. Air-Entraining Admixture: ASTM C 260/C 260M.

E. Chemical Admixtures: Admixtures certified by manufacturer to be compatible with other admixtures and to contain not more than 0.1 percent water-soluble chloride ions by mass of cementitious material.

1. Water-Reducing Admixture: ASTM C 494/C 494M, Type A.

2. Retarding Admixture: ASTM C 494/C 494M, Type B.

3. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.

4. High-Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F.

5. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type G.

6. Plasticizing and Retarding Admixture: ASTM C 1017/C 1017M, Type II.

F. Water: Potable and complying with ASTM C 94/C 94M.

2.05 CURING MATERIALS

A. Absorptive Cover: AASHTO M 182, Class 3, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. dry or cotton mats.

B. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.

C. Water: Potable.

D. Evaporation Retarder: Waterborne, monomolecular, film forming, manufactured for application to fresh concrete.

E. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, dissipating.

F. White, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 2, Class B, dissipating.

2.06 RELATED MATERIALS

A. Joint Fillers: ASTM D 1751, asphalt-saturated cellulosic fiber or ASTM D 1752, cork or self-expanding cork in preformed strips.

B. Slip-Resistive Aggregate Finish: Factory-graded, packaged, rustproof, nonglazing, abrasive aggregate of fused aluminum-oxide granules or crushed emery aggregate containing not less than 50 percent aluminum oxide and not less than 20 percent ferric oxide; unaffected by freezing, moisture, and cleaning materials.

C. Bonding Agent: ASTM C 1059/C 1059M, Type II, non-redispersible, acrylic emulsion or styrene butadiene.

D. Epoxy-Bonding Adhesive: ASTM C 881/C 881M, two-component epoxy resin capable of humid curing and bonding to damp surfaces; of class suitable for application temperature, of grade complying with requirements, and of the following types:

1. Types I and II, nonload bearing, for bonding hardened or freshly mixed concrete to hardened concrete.

E. Chemical Surface Retarder: Water-soluble, liquid, set retarder with color dye, for horizontal concrete surface application, capable of temporarily delaying final hardening of concrete to a depth of 1/8 to 1/4 inch.

F. Pigmented Mineral Dry-Shake Hardener: Factory-packaged, dry combination of portland cement, graded quartz aggregate, color pigments, and plasticizing admixture. Use color pigments that are finely ground, nonfading mineral oxides interground with cement.

1. Color: As indicated by manufacturer's designation.

G. Rock Salt: Sodium chloride crystals, kiln dried, coarse gradation with 100 percent passing 3/8-inch sieve and 85 percent retained on a No. 8 sieve.

2.07 CONCRETE MIXTURES

A. Prepare design mixtures, proportioned according to ACI 301, for each type and strength of normal-weight concrete, and as determined by either laboratory trial mixtures or field experience.

1. Use a qualified independent testing agency for preparing and reporting proposed concrete design mixtures for the trial batch method.

2. When automatic machine placement is used, determine design mixtures and obtain laboratory test results that comply with or exceed requirements.

B. Add air-entraining admixture at manufacturer's prescribed rate to result in normal-weight concrete at point of placement having an air content as follows:

1. Air Content: 2-1/2 percent plus or minus 1-1/2 percent for 1-1/2-inch nominal maximum aggregate size.

2. Air Content: 3 percent plus or minus 1-1/2 percent for 1-inch nominal maximum aggregate size.

3. Air Content: 3-1/2 percent plus or minus 1-1/2 percent for 3/4-inch nominal maximum aggregate size.

C. Limit water-soluble, chloride-ion content in hardened concrete to 0.30 percent by weight of cement.

D. Chemical Admixtures: Use admixtures according to manufacturer's written instructions.

1. Use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.

E. Synthetic Fiber: Uniformly disperse in concrete mixture at manufacturer's recommended rate, but not less than 1.0 lb/cu. yd..

F. Concrete Mixtures: Normal-weight concrete.

1. Compressive Strength (28 Days):

a. 4,000 p.s.i. for concrete endwalls.

b. 3,000 p.s.i. for curb and gutter, aprons, sidewalks, and concrete paved drainage channels.

2. Maximum W/C Ratio at Point of Placement: 0.45.

3. Slump Limit: 4 inches, plus or minus 1 inch.

2.08 CONCRETE MIXING

A. Ready-Mixed Concrete: Measure, batch, and mix concrete materials and concrete according to ASTM C 94/C 94M and ASTM C 1116/C 1116M. Furnish batch certificates for each batch discharged and used in the Work.

1. When air temperature is between 85 and 90 deg F, reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F, reduce mixing and delivery time to 60 minutes.

B. Project-Site Mixing: Measure, batch, and mix concrete materials and concrete according to ASTM C 94/C 94M. Mix concrete materials in appropriate drum-type batch machine mixer.

1. For concrete batches of 1 cu. yd. or smaller, continue mixing at least 1-1/2 minutes, but not more than 5 minutes after ingredients are in mixer, before any part of batch is released.

2. For concrete batches larger than 1 cu. yd., increase mixing time by 15 seconds for each additional 1 cu. yd..

3. Provide batch ticket for each batch discharged and used in the Work, indicating Project identification name and number, date, mixture type, mixing time, quantity, and amount of water added.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine exposed subgrades and subbase surfaces for compliance with requirements for dimensional, grading, and elevation tolerances.

B. Proof-roll prepared subbase surface below concrete paving to identify soft pockets and areas of excess yielding.

1. Completely proof-roll subbase in one direction. Limit vehicle speed to 3 mph.

2. Proof-roll with a pneumatic-tired and loaded, 10-wheel, tandem-axle dump truck weighing not less than 15 tons.

3. Correct subbase with soft spots and areas of pumping or rutting exceeding depth of 1/2 inch according to requirements in Section 312000 Earth Moving.

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

3.02 PREPARATION

A. Remove loose material from compacted subbase surface immediately before placing concrete.

3.03 EDGE FORMS AND SCREED CONSTRUCTION

A. Set, brace, and secure edge forms, bulkheads, and intermediate screed guides to required lines, grades, and elevations. Install forms to allow continuous progress of work and so forms can remain in place at least 24 hours after concrete placement.

B. Clean forms after each use and coat with form-release agent to ensure separation from concrete without damage.

3.04 STEEL REINFORCEMENT INSTALLATION

A. General: Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.

B. Clean reinforcement of loose rust and mill scale, earth, ice, or other bond-reducing materials.

C. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position during concrete placement. Maintain minimum cover to reinforcement.

D. Install welded-wire reinforcement in lengths as long as practicable. Lap adjoining pieces at least one full mesh, and lace splices with wire. Offset laps of adjoining widths to prevent continuous laps in either direction.

E. Zinc-Coated Reinforcement: Use galvanized-steel wire ties to fasten zinc-coated reinforcement. Repair cut and damaged zinc coatings with zinc repair material.

F. Epoxy-Coated Reinforcement: Use epoxy-coated steel wire ties to fasten epoxy-coated reinforcement. Repair cut and damaged epoxy coatings with epoxy repair coating according to ASTM D 3963/D 3963M.

G. Install fabricated bar mats in lengths as long as practicable. Handle units to keep them flat and free of distortions. Straighten bends, kinks, and other irregularities, or replace units as required before placement. Set mats for a minimum 2-inch overlap of adjacent mats.

3.05 JOINTS

A. General: Form construction, isolation, and contraction joints and tool edges true to line, with faces perpendicular to surface plane of concrete. Construct transverse joints at right angles to centerline unless otherwise indicated.

1. When joining existing paving, place transverse joints to align with previously placed joints unless otherwise indicated.

B. Construction Joints: Set construction joints at side and end terminations of paving and at locations where paving operations are stopped for more than one-half hour unless paving terminates at isolation joints.

1. Continue steel reinforcement across construction joints unless otherwise indicated. Do not continue reinforcement through sides of paving strips unless otherwise indicated.

2. Provide tie bars at sides of paving strips where indicated.

3. Butt Joints: Use epoxy-bonding adhesive at joint locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.

4. Keyed Joints: Provide preformed keyway-section forms or bulkhead forms with keys unless otherwise indicated. Embed keys at least 1-1/2 inches into concrete.

5. Doweled Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or coat with asphalt one-half of dowel length to prevent concrete bonding to one side of joint.

C. Isolation Joints: Form isolation joints of preformed joint-filler strips abutting concrete curbs, catch basins, manholes, inlets, structures, other fixed objects, and where indicated.

1. Locate expansion joints at intervals of 50 feet unless otherwise indicated.

2. Extend joint fillers full width and depth of joint.

3. Terminate joint filler not less than 1/2 inch or more than 1 inch below finished surface if joint sealant is indicated.

4. Place top of joint filler flush with finished concrete surface if joint sealant is not indicated.

5. Furnish joint fillers in one-piece lengths. Where more than one length is required, lace or clip joint-filler sections together.

6. During concrete placement, protect top edge of joint filler with metal, plastic, or other temporary preformed cap. Remove protective cap after concrete has been placed on both sides of joint.

D. Contraction Joints: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of the concrete thickness, as follows, to match jointing of existing adjacent concrete paving:

1. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint with grooving tool to a 1/4-inch radius. Repeat grooving of contraction joints after applying surface finishes. Eliminate grooving-tool marks on concrete surfaces.

a. Tolerance: Ensure that grooved joints are within [3 inches] either way from centers of dowels.

2. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch-wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before developing random contraction cracks.

a. Tolerance: Ensure that sawed joints are within 3 inches either way from centers of dowels.

3. Doweled Contraction Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or coat with asphalt one-half of dowel length to prevent concrete bonding to one side of joint.

E. Edging: After initial floating, tool edges of paving, gutters, curbs, and joints in concrete with an edging tool to a 1/4-inch radius. Repeat tooling of edges after applying surface finishes. Eliminate edging-tool marks on concrete surfaces.

3.06 CONCRETE PLACEMENT

A. Before placing concrete, inspect and complete formwork installation, steel reinforcement, and items to be embedded or cast-in.

B. Remove snow, ice, or frost from subbase surface and steel reinforcement before placing concrete. Do not place concrete on frozen surfaces.

C. Moisten subbase to provide a uniform dampened condition at time concrete is placed. Do not place concrete around manholes or other structures until they are at required finish elevation and alignment.

D. Comply with ACI 301 requirements for measuring, mixing, transporting, and placing concrete.

E. Do not add water to concrete during delivery or at Project site. Do not add water to fresh concrete after testing.

F. Deposit and spread concrete in a continuous operation between transverse joints. Do not push or drag concrete into place or use vibrators to move concrete into place.

G. Consolidate concrete according to ACI 301 by mechanical vibrating equipment supplemented by hand spading, rodding, or tamping.

1. Consolidate concrete along face of forms and adjacent to transverse joints with an internal vibrator. Keep vibrator away from joint assemblies, reinforcement, or side forms. Use only square-faced shovels for hand spreading and consolidation. Consolidate with care to prevent dislocating reinforcement, dowels and joint devices.

H. Screed paving surface with a straightedge and strike off.

I. Commence initial floating using bull floats or darbies to impart an open-textured and uniform surface plane before excess moisture or bleedwater appears on the surface. Do not further disturb concrete surfaces before beginning finishing operations or spreading surface treatments.

J. Curbs and Gutters: Use design mixture for automatic machine placement. Produce curbs and gutters to required cross section, lines, grades, finish, and jointing.

K. Slip-Form Paving: Use design mixture for automatic machine placement. Produce paving to required thickness, lines, grades, finish, and jointing.

1. Compact subbase and prepare subgrade of sufficient width to prevent displacement of slip-form paving machine during operations.

3.07 FLOAT FINISHING

A. General: Do not add water to concrete surfaces during finishing operations.

B. Float Finish: Begin the second floating operation when bleedwater sheen has disappeared and concrete surface has stiffened sufficiently to permit operations. Float surface with power-driven floats or by hand floating if area is small or inaccessible to power units. Finish surfaces to true planes. Cut down high spots and fill low spots. Refloat surface immediately to uniform granular texture.

1. Burlap Finish: Drag a seamless strip of damp burlap across float-finished concrete, perpendicular to line of traffic, to provide a uniform, gritty texture.

2. Medium-to-Fine-Textured Broom Finish: Draw a soft-bristle broom across float-finished concrete surface, perpendicular to line of traffic, to provide a uniform, fine-line texture.

3. Medium-to-Coarse-Textured Broom Finish: Provide a coarse finish by striating float-finished concrete surface 1/16 to 1/8 inch deep with a stiff-bristled broom, perpendicular to line of traffic.

3.08 DETECTABLE WARNING INSTALLATION

A. Stamped Detectable Warnings: Install stamped detectable warnings as part of a continuous concrete paving placement and according to stamp-mat manufacturer's written instructions.

1. Before using stamp mats, verify that the vent holes are unobstructed.

2. Apply liquid release agent to the concrete surface and the stamp mat.

3. Stamping: After application and final floating of pigmented mineral dry-shake hardener, accurately align and place stamp mats in sequence. Uniformly load, gently vibrate, and press mats into concrete to produce imprint pattern on concrete surface. Load and tamp mats directly perpendicular to the stamp-mat surface to prevent distortion in shape of domes. Press and tamp until mortar begins to come through all of the vent holes. Gently remove stamp mats.

4. Trimming: After 24 hours, cut off the tips of mortar formed by the vent holes.

5. Remove residual release agent according to manufacturer's written instructions, but no fewer than three days after stamping concrete. High-pressure-wash surface and joint patterns, taking care not to damage stamped concrete. Control, collect, and legally dispose of runoff.

3.09 CONCRETE PROTECTION AND CURING

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.

B. Comply with ACI 306.1 for cold-weather protection.

C. Evaporation Retarder: Apply evaporation retarder to concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete but before float finishing.

D. Begin curing after finishing concrete but not before free water has disappeared from concrete surface.

E. Curing Methods: Cure concrete by moisture curing, moisture-retaining-cover curing, curing compound, or a combination of these as follows:

1. Moisture Curing: Keep surfaces continuously moist for not less than seven days with the following materials:

a. Water.

b. Continuous water-fog spray.

c. Absorptive cover, water saturated and kept continuously wet. Cover concrete surfaces and edges with 12-inch lap over adjacent absorptive covers.

2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive. Immediately repair any holes or tears occurring during installation or curing period, using cover material and waterproof tape.

3. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating, and repair damage during curing period.

3.10 PAVING TOLERANCES

A. Comply with tolerances in ACI 117 and as follows:

1. Elevation: 3/4 inch.
2. Thickness: Plus 3/8 inch, minus 1/4 inch.
3. Surface: Gap below 10-feet-long; unleveled straightedge not to exceed 1/2 inch.
4. Alignment of Tie-Bar End Relative to Line Perpendicular to Paving Edge: 1/2 inch per 12 inches of tie bar.
5. Lateral Alignment and Spacing of Dowels: 1 inch.
6. Vertical Alignment of Dowels: 1/4 inch.
7. Alignment of Dowel-Bar End Relative to Line Perpendicular to Paving Edge: 1/4 inch per 12 inches of dowel.
8. Joint Spacing: 3 inches.
9. Contraction Joint Depth: Plus 1/4 inch, no minus.
10. Joint Width: Plus 1/8 inch, no minus.

3.11 FIELD QUALITY CONTROL

A. Testing Agency: Contractor is required to hire a qualified testing agency to perform tests and inspections.

B. Testing Services: Testing and inspecting of composite samples of fresh concrete obtained according to ASTM C 172/C 172M shall be performed according to the following requirements:

1. Testing Frequency: Obtain at least one composite sample for each 100 cu. yd. or fraction thereof of each concrete mixture placed each day.

    a. When frequency of testing will provide fewer than five compressive-strength tests for each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.

2. Slump: ASTM C 143/C 143M; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture. Perform additional tests when concrete consistency appears to change.
3. Air Content: ASTM C 231/C 231M, pressure method; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
4. Concrete Temperature: ASTM C 1064/C 1064M; one test hourly when air temperature is 40 deg F and below and when it is 80 deg F and above, and one test for each composite sample.

5. Compression Test Specimens: ASTM C 31/C 31M; cast and laboratory cure one set of three standard cylinder specimens for each composite sample.

6. Compressive-Strength Tests: ASTM C 39/C 39M; test one specimen at seven days and two specimens at 28 days.

    a. A compressive-strength test shall be the average compressive strength from two specimens obtained from same composite sample and tested at 28 days.

C. Strength of each concrete mixture will be satisfactory if average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi.

D. Test results shall be reported in writing to Engineer, Town of Smithfield, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.

E. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by The Engineer, or NCDOT but will not be used as sole basis for approval or rejection of concrete.

F. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by the Engineer, Town of Smithfield, or NCDOT.

G. Concrete paving will be considered defective if it does not pass tests and inspections.

H. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

I. Prepare test and inspection reports.

3.12 REPAIR AND PROTECTION

A. Remove and replace concrete paving that is broken, damaged, or defective or that does not comply with requirements in this Section. Remove work in complete sections from joint to joint unless otherwise approved by the Engineer, Town of Smithfield, or NCDOT.

B. Drill test cores, where directed by the Engineer, Town of Smithfield, or NCDOT, when necessary to determine magnitude of cracks or defective areas. Fill drilled core holes in satisfactory paving areas with portland cement concrete bonded to paving with epoxy adhesive.

C. Protect concrete paving from damage. Exclude traffic from paving for at least 14 days after placement. When construction traffic is permitted, maintain paving as clean as possible by removing surface stains and spillage of materials as they occur.

D. Maintain concrete paving free of stains, discoloration, dirt, and other foreign material. Sweep paving not more than two days before date scheduled for Substantial Completion inspections.

END OF SECTION

SECTION 323113
CHAIN LINK FENCES AND GATES

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section Includes:

1. Chain-link fences.

2. Swing gates.

3. Privacy slats.

B. Related Requirements:

1. Section 033000 Cast-in-Place Concrete.

1.03 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for the following:

a. Fence and gate posts, rails, and fittings.

b. Chain-link fabric, reinforcements, and attachments.

c. Accessories: Barbed wire, privacy slats.

d. Gates and hardware.

B. Shop Drawings: For each type of fence and gate assembly.

1. Include plans, elevations, sections, details, and attachments to other work.

2. Include accessories, hardware, gate operation, and operational clearances.

1.04 INFORMATIONAL SUBMITTALS

A. Qualification Data: For factory-authorized service representative.

B. Product Certificates: For each type of chain-link fence and gate.

C. Product Test Reports: For framework strength according to ASTM F 1043, for tests performed by manufacturer and witnessed by a qualified testing agency.

D. Field quality-control reports.

1.05 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For gate operators to include in emergency, operation, and maintenance manuals.

1.06 QUALITY ASSURANCE

A. Testing Agency Qualifications: For testing fence grounding; member company of NETA or an NRTL.

1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

B. Emergency Access Requirements: According to requirements of authorities having jurisdiction for gates with automatic gate operators serving as a required means of access.

1.07 FIELD CONDITIONS

A. Field Measurements: Verify layout information for chain-link fences and gates shown on Drawings in relation to property survey and existing structures. Verify dimensions by field measurements.

1.08 WARRANTY

A. Special Warranty: Installer agrees to repair or replace components of chain-link fences that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Failure to comply with performance requirements.

b. Deterioration of metals, metal finishes, and other materials beyond normal weathering.

2. Warranty Period: Five years from date of Substantial Completion.

PART 2 PRODUCTS

2.01 CHAIN-LINK FENCE FABRIC

A. General: Provide fabric in one-piece heights measured between top and bottom of outer edge of selvage knuckle or twist according to "CLFMI Product Manual" and requirements indicated below:

1. Fabric Height: 96 inches.

2. Steel Wire for Fabric: Wire diameter of 0.148 inch.

a. Mesh Size: 2 inches.

b. Zinc-Coated Fabric: ASTM A 392, Type II, Class 1, 1.2 oz./sq. ft. with zinc coating applied before weaving.

c. Coat selvage ends of metallic-coated fabric before the weaving process with manufacturer's standard clear protective coating.

3. Selvage: Twisted top and knuckled bottom.

2.02 FENCE FRAMEWORK

A. Posts and Rails: ASTM F 1083 for framework, including rails, braces, and line; terminal; and corner posts. Provide members with minimum dimensions and wall thickness according to ASTM F 1083 based on the following:

1. Fence Height: 96 inches.

2. Heavy-Industrial-Strength Material: Group IA, round steel pipe, Schedule 40.

a. Line Post: 2.375 inches in diameter.

b. End, Corner, Gate, and Pull Posts: 2.875 inches in diameter.

c. Top Rail and Braces: 1.660 inches in diameter.

d. Double Swing Gate Posts: 4.0 inches in diameter.

e. Personnel Gate Posts: 3.0 inches in diameter.

3. Horizontal Framework Members: Intermediate rails according to ASTM F 1083.

4. Brace Rails: ASTM F 1083.

5. Metallic Coating for Steel Framework:

a. Type A: Not less than minimum 2.0-oz./sq. ft. average zinc coating according to ASTM A 123/A 123M or 4.0-oz./sq. ft. zinc coating according to ASTM A 653/A 653M.

b. Type B: Zinc with organic overcoat, consisting of a minimum of 0.9 oz./sq. ft. of zinc after welding, a chromate conversion coating, and a clear, verifiable polymer film.

c. External, Type B: Zinc with organic overcoat, consisting of a minimum of 0.9 oz./sq. ft. of zinc after welding, a chromate conversion coating, and a clear, verifiable polymer film. Internal, Type D, consisting of 81 percent, not less than 0.3-mil-thick, zinc-pigmented coating.

d. Type C: Zn-5-Al-MM alloy, consisting of not less than 1.8-oz./sq. ft. coating.

e. Coatings: Any coating above.

2.03 TENSION WIRE

A. Metallic-Coated Steel Wire: 0.177-inch-diameter, marcelled tension wire according to ASTM A 817 or ASTM A 824, with the following metallic coating:

1. Type II: Zinc coated (galvanized) by hot-dip or electrolytic process, with the following minimum coating weight:

a. Class 4: Not less than 1.2 oz./sq. ft. (366 g/sq. m) of uncoated wire surface.

2.04 SWING GATES

A. General: ASTM F 900 for gate posts and single or double swing gate types.

1. Double Swing Gate: Two (2) panels at 10’-0” each, 20’ total width.

2. Personnel Gate: single panel, 10’ width.

3. Framework Member Sizes and Strength: Based on gate fabric height of 96 inches.

B. Pipe and Tubing:

1. Zinc-Coated Steel: ASTM F 1083; protective coating and finish to match fence framework.

2. Gate Posts for Double Swing Gate: 4.0” diameter round tubular steel.

3. Gate Posts for Personnel Gate: 3.0” diameter round tubular steel.

4. Gate Frames and Bracing: Round tubular steel, 1-5/8” diameter for Personnel Gate Frame; 2.0” diameter for Double Swing Gate Frame.

C. Frame Corner Construction: Welded.

D. Extended Gate Posts and Frame Members: Fabricate gate posts and frame end members to extend 12 inches above top of chain-link fabric at both ends of gate frame to attach barbed wire assemblies.

E. Hardware:

1. Hinges: 180-degree inward and 180-degree outward swing.

2. Latch: Permitting operation from both sides of gate.

2.05 FITTINGS

A. Provide fittings according to ASTM F 626.

B. Post Caps: Provide for each post.

1. Provide line post caps with loop to receive tension wire or top rail.

C. Rail and Brace Ends: For each gate, corner, pull, and end post.

D. Rail Fittings: Provide the following:

1. Top Rail Sleeves: round-steel tubing not less than 6 inches long.

2. Rail Clamps: Line and corner boulevard clamps for connecting intermediate rails to posts.

E. Tension and Brace Bands: Pressed steel.

F. Tension Bars: Steel length not less than 2 inches shorter than full height of chain-link fabric. Provide one bar for each gate and end post, and two for each corner and pull post, unless fabric is integrally woven into post.

G. Truss Rod Assemblies: Steel, hot-dip galvanized after threading rod and turnbuckle or other means of adjustment.

H. Barbed Wire Arms: Pressed steel or cast iron with clips, slots, or other means for attaching strands of barbed wire, and means for attaching to posts, integral with post cap, for each post unless otherwise indicated, and as follows:

1. Provide line posts with arms that accommodate top rail or tension wire.

2. Provide corner arms at fence corner posts unless extended posts are indicated.

3. Single-Arm Type: In accordance with SJAFB standards.

I. Tie Wires, Clips, and Fasteners: According to ASTM F 626.

1. Standard Round Wire Ties: For attaching chain-link fabric to posts, rails, and frames, according to the following:

a. Hot-Dip Galvanized Steel: 0.148-inch-; galvanized coating thickness matching coating thickness of chain-link fence fabric.

J. Finish:

1. Metallic Coating for Pressed Steel or Cast Iron: Not less than 1.2 oz./sq. ft. of zinc.

a. Polymer coating over metallic coating.

2. Aluminum: Mill finish.

2.06 PRIVACY SLATS

A. PVC Slats, color to be brown, redwood or Owner’s selection.

2.07 BARBED WIRE

A. Steel Barbed Wire: ASTM A 121, three-strand barbed wire, 0.099-inch-diameter line wire with 0.080-inch-diameter, four-point round barbs spaced not more than 5 inches o.c.

1. Zinc Coating: Type Z, Class 3.

2.08 GROUT AND ANCHORING CEMENT

A. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107/C 1107M. Provide grout, recommended in writing by manufacturer, for exterior applications.

B. Anchoring Cement: Factory-packaged, nonshrink, nonstaining, hydraulic-controlled expansion cement formulation for mixing with water at Project site to create pourable anchoring, patching, and grouting compound. Provide formulation that is resistant to erosion from water exposure without needing protection by a sealer or waterproof coating, and that is recommended in writing by manufacturer for exterior applications.

2.09 GROUNDING MATERIALS

A. Comply with requirements of existing SJAFB perimeter fence grounding requirements.

B. Connectors and Grounding Rods: Listed and labeled for complying with UL 467.

1. Connectors for Below-Grade Use: Exothermic welded type.

2. Grounding Rods: Copper-clad steel, 5/8 by 96 inches.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for a certified survey of property lines and legal boundaries, site clearing, earthwork, pavement work, and other conditions affecting performance of the Work.

1. Do not begin installation before final grading is completed unless otherwise permitted by Government.

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

3.02 PREPARATION

A. Stake locations of fence lines, gates, and terminal posts. Do not exceed intervals of 500 feet or line of sight between stakes. Indicate locations of utilities, lawn sprinkler system, underground structures, benchmarks, and property monuments.

3.03 CHAIN-LINK FENCE INSTALLATION

A. Installation shall be limited to fence companies that have had a minimum five years experience in installing commercial or industrial chain link fences.

B. Install chain-link fencing according to ASTM F 567 and more stringent requirements specified.

1. Install fencing where indicated on drawings.

C. Post Excavation: Drill or hand-excavate holes for posts to diameters and spacings indicated, in firm, undisturbed soil.

D. Post Setting: Set posts in concrete at indicated spacing into firm, undisturbed soil.

1. Verify that posts are set plumb, aligned, and at correct height and spacing, and hold in position during setting with concrete or mechanical devices.

2. Concrete Fill: Place concrete around posts to dimensions indicated and vibrate or tamp for consolidation. Protect aboveground portion of posts from concrete splatter.

a. Exposed Concrete: Extend 2 inches above grade; shape and smooth to shed water.

b. Concealed Concrete: Place top of concrete 2 inches below grade to allow covering with surface material.

c. Posts Set into Sleeves in Concrete: Use steel pipe sleeves preset and anchored into concrete for installing posts. After posts are inserted into sleeves, fill annular space between post and sleeve with nonshrink, nonmetallic grout or anchoring cement, mixed and placed according to anchoring material manufacturer's written instructions. Finish anchorage joint to slope away from post to drain water.

d. Posts Set into Holes in Concrete: Form or core drill holes to dimensions indicated on drawings. Clean holes of loose material, insert posts, and fill annular space between post and concrete with nonshrink, nonmetallic grout or anchoring cement, mixed and placed according to anchoring material manufacturer's written instructions. Finish anchorage joint to slope away from post to drain water.

3. Mechanically Driven Posts: Drive into soil to depth as indicated on drawings. Protect post top to prevent distortion.

E. Terminal Posts: Install terminal end, corner, and gate posts according to ASTM F 567 and terminal pull posts at changes in horizontal or vertical alignment as indicated on Drawings. For runs exceeding 500 feet, space pull posts an equal distance between corner or end posts.

F. Line Posts: Space line posts uniformly at 10 feet o.c.

G. Post Bracing and Intermediate Rails: Install according to ASTM F 567, maintaining plumb position and alignment of fence posts. Diagonally brace terminal posts to adjacent line posts with truss rods and turnbuckles. Install braces at end and gate posts and at both sides of corner and pull posts.

1. Locate horizontal braces at midheight of fabric 72 inches or higher, on fences with top rail, and at two-third fabric height on fences without top rail. Install so posts are plumb when diagonal rod is under proper tension.

H. Tension Wire: Install at top and bottom according to ASTM F 567, maintaining plumb position and alignment of fence posts. Pull wire taut, without sags. Fasten fabric to tension wire with 0.148-inch-diameter hog rings of same material and finish as fabric wire, spaced a maximum of 24 inches o.c. Install tension wire in locations indicated before stretching fabric. Provide horizontal tension wire at the following locations:

1. Extended along top and bottom of fence fabric. Install top tension wire through post cap loops. Install bottom tension wire within 6 inches of bottom of fabric and tie to each post with not less than same diameter and type of wire.

I. Top Rail: Install according to ASTM F 567, maintaining plumb position and alignment of fence posts. Run rail continuously through line post caps, bending to radius for curved runs and terminating into rail end attached to posts or post caps fabricated to receive rail at terminal posts. Provide expansion couplings as recommended in writing by fencing manufacturer.

J. Intermediate Rails. Secure to posts with fittings.

K. Chain-Link Fabric: Apply fabric to inside of enclosing framework. Leave 2-inch (3-inch maximum) bottom clearance between finish grade or surface and bottom selvage unless otherwise indicated. Pull fabric taut and tie to posts, rails, and tension wires. Anchor to framework so fabric remains under tension after pulling force is released.

L. Tension or Stretcher Bars: Thread through fabric and secure to end, corner, pull, and gate posts, with tension bands spaced not more than 15 inches o.c.

M. Tie Wires: Use wire of proper length to firmly secure fabric to line posts and rails. Attach wire at one end to chain-link fabric, wrap wire around post a minimum of 180 degrees, and attach other end to chain-link fabric according to ASTM F 626. Bend ends of wire to minimize hazard to individuals and clothing.

1. Maximum Spacing: Tie fabric to line posts at 15 inches o.c. and to braces at 24 inches o.c.

N. Fasteners: Install nuts for tension bands and carriage bolts on the side of fence opposite the fabric side. Peen ends of bolts or score threads to prevent removal of nuts.

O. Barbed Wire: Install barbed wire uniformly spaced, angled toward security side of fence as indicated on Drawings. Pull wire taut, install securely to extension arms, and secure to end post or terminal arms.

3.04 GROUNDING AND BONDING

A. Comply with requirements of existing SJAFB perimeter fence grounding requirements.

B. Fence and Gate Grounding:

1. Ground for fence and fence posts shall be a separate system from ground for gate and gate posts.

2. Install ground rods and connections at maximum intervals of 1500 feet.

3. Fences within 100 Feet of Buildings, Structures, Walkways, and Roadways: Ground at maximum intervals of 750 feet.

4. Ground fence on each side of gates and other fence openings.

a. Bond metal gates to gate posts.

b. Bond across openings, with and without gates, except openings indicated as intentional fence discontinuities. Use No. 2 AWG wire and bury it at least 18 inches below finished grade.

C. Protection at Crossings of Overhead Electrical Power Lines: Ground fence at location of crossing and at a ground rod located a maximum distance of 150 feet on each side of crossing.

D. Fences Enclosing Electrical Power Distribution Equipment: Ground according to IEEE C2 unless otherwise indicated.

E. Grounding Method: At each grounding location, drive a grounding rod vertically until the top is 6 inches below finished grade. Connect rod to fence with No. 6 AWG conductor. Connect conductor to each fence component at grounding location.

1. Make grounding connections to each barbed wire strand with wire-to-wire connectors designed for this purpose.

2. Make grounding connections to each barbed tape coil with connectors designed for this purpose.

F. Connections:

1. Make connections with clean, bare metal at points of contact.

2. Make aluminum-to-steel connections with stainless-steel separators and mechanical clamps.

3. Make aluminum-to-galvanized-steel connections with tin-plated copper jumpers and mechanical clamps.

4. Make above-grade ground connections with mechanical fasteners.

5. Make below-grade ground connections with exothermic welds.

6. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.

G. Bonding to Lightning Protection System: Ground fence and bond fence grounding conductor to lightning protection down conductor or lightning protection grounding conductor according to NFPA 780.

3.05 DEMONSTRATION

A. Engage a factory-authorized service representative to train Government's maintenance personnel to adjust, operate, and maintain chain-link fences and gates.

END OF SECTION

SECTION 329200
TURF AND GRASSES

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section Includes:

1. General Restoration.

2. Work Within North Carolina Department of Transportation Rights-of-Way

1.03 DEFINITIONS

A. Finish Grade: Elevation of finished surface of planting soil.

B. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. Pesticides include insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. They also includes substances or mixtures intended for use as a plant regulator, defoliant, or desiccant.

C. Pests: Living organisms that occur where they are not desired or that cause damage to plants, animals, or people. Pests include insects, mites, grubs, mollusks (snails and slugs), rodents (gophers, moles, and mice), unwanted plants (weeds), fungi, bacteria, and viruses.

D. Planting Soil: Existing, on-site soil; imported soil; or manufactured soil that has been modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth. See drawing designations for planting soils.

E. Subgrade: The surface or elevation of subsoil remaining after excavation is complete, or the top surface of a fill or backfill before planting soil is placed.

1.04 INFORMATIONAL SUBMITTALS

A. Qualification Data: For landscape Installer.

B. Certification of Grass Seed: From seed vendor for each grass-seed monostand or mixture, stating the botanical and common name, percentage by weight of each species and variety, and percentage of purity, germination, and weed seed. Include the year of production and date of packaging.

C. Product Certificates: For fertilizers, from manufacturer.

D. Pesticides and Herbicides: Product label and manufacturer's application instructions specific to Project.

1.05 QUALITY ASSURANCE

A. Installer Qualifications: A qualified landscape installer whose work has resulted in successful turf establishment.

1. Professional Membership: Installer shall be a member in good standing of either the Professional Landcare Network or the American Nursery and Landscape Association.

2. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress.

3. Personnel Certifications: Installer's field supervisor shall have certification in one of the following categories from the Professional Landcare Network:

    a. Landscape Industry Certified Technician - Exterior.

    b. Landscape Industry Certified Lawncare Manager.

    c. Landscape Industry Certified Lawncare Technician.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Seed and Other Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of compliance with state and Federal laws, as applicable.

B. Bulk Materials:

1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.

2. Provide erosion-control measures to prevent erosion or displacement of bulk materials; discharge of soil-bearing water runoff; and airborne dust reaching adjacent properties, water conveyance systems, or walkways.

3. Accompany each delivery of bulk materials with appropriate certificates.

1.07 FIELD CONDITIONS

A. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit planting to be performed when beneficial and optimum results may be obtained. Apply products during favorable weather conditions according to manufacturer's written instructions.

PART 2 PRODUCTS

2.01 PLANTING PERIOD: SEPTEMBER 15 – MARCH 1

A. Maintained/Established Lawns or road rights-of-way

1. 6# Kentucky Fescue No. 31

2. 2# Rye Grain

3. 30# Fertilizer (10-10-10)

4. 100# Line

5. 12# Superphosphate

B. Open Field (Anything other than an established lawn):

1. 4# Kentucky Fescue No. 31

2. 2# Rye Grain

3. 20# Fertilizer (5-10-10)

4. 100# Line

5. 12# Superphosphate

C. Open Field For Slopes 2:1 or greater or areas subject to erosion:

1. 2# Kentucky Fescue No. 31

2. 4# Sericea Lespedeza (Unscarified)

3. 2# Rye Grain

4. 30# Fertilizer (5-10-10)

5. 100# Line

6. 12# Superphosphate

D. The Engineer will be consulted prior to seeding for a determination of appropriate seed mixture. All rates are in pounds per 1000 square feet and any rates listed above may be cut by 1/2 for temporary erosion control measures only. Unless otherwise required by the North Carolina Department of Transportation or the Engineer, seeding within road rights-of-way will be as specified for established lawns.

2.02 PLANTING PERIOD: FEBRUARY 1 – OCTOBER 15

A. Maintained/Established Lawns or road rights-of-way:

1. 8# Kentucky Fescue No. 31

2. 30# Fertilizer (10-10-10)

3. 100# Line

4. 12# Superphosphate

B. Open Field (Anything other than an established lawn):

1. 6# Kentucky Fescue No. 31

2. 2# Sudangrass (May, June, and July only)

3. 20# Fertilizer (5-10-10)

4. 100# Line

5. 12# Superphosphate

C. Open Field For Slopes 2:1 or greater or areas subject to erosion:

1. 2# Kentucky Fescue No. 31

2. 4# Sericea Lespedeza (Scarified)

3. 2# Sudangrass (May, June, and July only)

4. 20# Fertilizer (5-10-10)

5. 100# Line

6. 12# Superphosphate

D. The Engineer will be consulted prior to seeding for a determination of appropriate seed mixture. All rates are in pounds per 1000 square feet and any rates listed above may be cut by 1/2 for temporary erosion control measures only. Unless otherwise required by the North Carolina Department of Transportation or the Engineer, seeding within road rights-of-way will be as specified for established lawns.

PART 3 EXECUTION

3.01 PREPARATION

A. Protect structures; utilities; sidewalks; pavements; and other facilities, trees, shrubs, and plantings from damage caused by planting operations.

1. Protect adjacent and adjoining areas from hydroseeding and hydromulching overspray.

2. Protect grade stakes set by others until directed to remove them.

B. Install erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

3.02 GENERAL

A. All surfaces and structures (both public and private) within and adjacent to the construction operations shall be restored to a condition comparable to that existing prior to construction or as specified in the special provisions.

B. All surplus materials shall be disposed of in a manner acceptable to the Engineer, and the construction area shall be left in a neat condition, with special attention called to proper drainage, smoothness of surface, and general clean up. No machinery or equipment shall be left or stored on the job site after the project is completed.

C. Unless otherwise specified, complete restoration to include fertilizing, seeding, and mulching of any and all areas disturbed during construction shall be completed within thirty (30) working days following the initial ground disturbing activity.

1. Water meters, valve boxes, drain pipes, and other structures encountered shall be reset or relaid to match or clear surface grade and/or water main pipe grade as applicable.

2. All shoulder areas shall be restored, stabilized, and maintained to their original condition. Concrete, asphalt, gravel, and dirt walks, drives and roadways are to be replaced to their original shape and serviceability. Unless otherwise approved by the Engineer all areas (shoulders, side streets, drive, parking areas, etc.) which exhibit a gravel surface at the time of construction will be re-graveled with a minimum depth of six (6) inches of C.A.B.C stone compacted-in-place for the width and length of the disturbed area and then feathered gradually into the existing cross section. When a driveway is finished with other than C.A.B.C stone, a one inch finish coating to match existing gravel gradation and appearance shall be placed. The Contractor should note that <u>all</u> existing side streets and drives which are either <u>dirt</u> or <u>gravel</u> will be restored as specified for graveled areas.

3. <u>Refuse Burial</u>: The Contractor shall not bury rock, broken concrete/asphalt, construction material, timber, etc. within the street or water main right-of-way.

4. <u>Rip-Rap</u>: The Contractor shall place stone rip-rap as specified in those areas subject to severe water action where directed by the Engineer. Placement of rip-rap as shown on the Construction Plans shall be considered a guide only, with final determination made at the time of construction by the Engineer. Either the addition or deletion of quantities may be required. Stone rip-rap will be placed as indicated on the Standard Details immediately following pipe installation and will be installed no steeper than a 2:1 slope except when specifically approved by the Engineer. Grading will be required as necessary to insure continuous even flow. The rip-rap installation shall include all earthwork necessary to stabilize the creek bankand to provide cover for the water line.

5. <u>Jute Netting/Erosion Blanket:</u> The Contractor shall install jute netting or Erosion Control Blanket in areas subject to high runoff velocities, areas subject to concentrated runoff and on steep slopes as shown on the plans and/or as directed by the Engineer.

6. <u>Fertilizing, Seeding, and Mulching</u>: Established lawns and landscaped areas damaged by construction shall be restored to their former condition by seeding, unless the type and condition of the existing sod warrants it being cut, removed, preserved, and replaced. All areas, regardless of previous condition, damaged by construction shall be fertilized, seeded, and mulched as outlined below.

a. <u>Seed Bed Preparation</u>: The seed bed shall be prepared by pulverizing the soil in an approved manner to a depth of three (3) inches for field conditions or slopes that are 3:1 or flatter and to a depth of one (1) to three (3) inches, as determined on site for slopes steeper than 3:1. The soil shall be tilled until a well pulverized, firm, reasonably uniform seed bed is prepared conforming substantially to ground elevations as shown on the Plans and/or as existed prior to construction. The disturbed area shall blend uniformly into adjacent topography. Good surface drainage must be provided, allowances for settlement made and ground elevations adjusted accordingly. Visible ponding will not be allowed. All stones, roots, sticks, rubbish, and other objectionable material shall be removed.

b. Soil Improvements: Soil additives shall be incorporated in an approved manner into the top soil at the following rates:

1) Fertilizer - 20 pounds per 1000 square feet of 5-10-10 fertilizer generally and 30 pounds per 1000 square feet of 10-10-10 fertilizer for established lawn areas.

2) Lime - 100 pounds per 1000 square feet.

3) Superphosphate (0-20-0) - 12 pounds per 1000 square feet.

c. Seeding: Seeding must be done within thirty (30) calendar days after the initial ground disturbing activity:

1) The seed bed must be in good, friable condition and not muddy or hard at the time seeding is performed.

2) Seed shall be applied at the rate specified and raked or tilled into the topsoil with the resulting furroughs running across the natural slope of the ground. Under no circumstances will any tilling activity be allowed parallel with said slope. Slopes steeper than 3:1 shall require the use of hydraulic seeding unless otherwise specifically approved by the Engineer.

d. Mulching: After fertilizing, seeding and raking, dried straw shall be spread uniformly over the area at a rate of 90 pounds per 1000 square feet. Approximately 1/4 of the ground should remain visible to avoid smothering seedlings. The straw shall be sprayed with liquid asphalt to bond it together and anchor it in place within road right-of-way and areas subject to erosion:

1) Liquid asphalt, thinned with kerosene, shall be used during freezing weather and shall be either rapid or medium curing. It shall be applied at a rate of 200 gallons per ton of straw or approximately 9 gallons per 1000 square feet.

2) Emulsified asphalt, thinned with water shall be used when temperatures are less severe, shall be rapid curing only, and shall be applied at a rate of 150 gallons per ton of straw or approximately 7 gallons per 1000 square feet.

e. Maintenance: The Contractor shall maintain the seeded areas until there is a uniform growth three (3) inches high. Maintenance shall consist of watering, weed and pest control within established lawns, fertilization, erosion repair, reseeding and all else necessary to establish a vigorous healthy and uniform stand of grass. All areas and spots which do not show a uniform stand of grass, for any reason, shall be treated repeatedly until a uniform stand is attained:

3.03 WORK WITHIN NORTH CAROLINA DEPARTMENT OF TRANSPORTATION RIGHTS-OF-WAY

A. Construction is permitted within the rights-of-way of the North Carolina Department of Transportation (DOT), Division of Highways in accordance with their Policies And Procedures For Accommodating Utilities On Highway Rights-Of-Way as amended. Town of Smithfield is required to enforce this entire document as it relates to this work. All bidders are required to become familiar with the document and any amendments which are available from the Manager of Right-of-Way, North Carolina Department of Transportation, Division of Highways, Raleigh, North Carolina.

1. Town of Smithfield has entered into an encroachment agreement with the North Carolina Department of Transportation (DOT) which grants the right for any work within the Department of Transportation's rights-of-way. The encroachment agreement for any work within DOT rights-of-way under this project is included as a special provision in this contract. A copy of the approved encroachment has been attached to this contract or will be supplied to the Contractor prior to construction. A copy of the encroachment agreement must be kept at the construction site at all times.

2. Certain notices are required in writing before any work can proceed within the Department of Transportation's rights-of-way. Upon notice by the Contractor, the Engineer will make this notification.

3. Proper signing before, during, and after construction in conformance with the manual on Uniform Traffic Control Devices for Streets and Highways will be required. In addition, warning signs as related to soft and/or low shoulders and broken pavement may be required by the Engineer.

4. Piling and/or storage of excavated material upon the pavement and on some types of shoulders is prohibited unless special permission is granted by the Department of Transportation's Division Engineer. Any material spilled, tracked or placed on the pavement is to be cleaned and damaged pavement repaired subject to stoppage of all work by Town of Smithfield. Drainage ditches are to be protected from siltation as specified in the EP Section and must be opened at the end of each workday or as weather conditions require.

5. Open trenches are prohibited between dusk and dawn and at designated peak traffic hours unless special permission is received from the Department of Transportation's Division Engineer.

6. When cutting of pavement is permitted, only one-half of the road width shall be opened at any time. Full traffic flow is to be maintained between dusk and dawn and at other peak hours of traffic as required by the encroachment agreement or other Special Provision.

7. The Contractor and his suppliers are directed to contact the North Carolina Department of Transportation to verify axle load limits on State maintained roads and bridges which will be used for hauling of equipment or materials for this project. The Contractor and his suppliers shall do all that is necessary to satisfy the Department of Transportation requirements and will be responsible for any damage to roads and bridges resulting from this project.

3.04 CLEANUP AND PROTECTION

A. Promptly remove soil and debris created by turf work from paved areas. Clean wheels of vehicles before leaving site to avoid tracking soil onto roads, walks, or other paved areas.

B. Remove surplus soil and waste material, including excess subsoil, unsuitable soil, trash, and debris, and legally dispose of them off Town of Smithfield's property.

C. Erect temporary fencing or barricades and warning signs as required to protect newly planted areas from traffic. Maintain fencing and barricades throughout initial maintenance period and remove after plantings are established.

D. Remove nondegradable erosion-control measures after grass establishment period.

END OF SECTION

SECTION 330509.13
COUPLINGS FOR UTILITY PIPE

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section Includes:

1. Dismantling Joint

1.03 SUBMITTALS

A. Submit detailed product data and descriptive literature including dimensions, weights, capacity data, pressure rating and materials of construction.

B. Provide shop drawings which clearly illustrate the general arrangement of the equipment and cross-sectional views of the components.

1.04 QUALITY ASSURANCE

A. Supplier shall have been manufacturing dismantling joints for a period of at least ten (10) years and shall, at the Engineer's request, provide a list of installations involving equipment of similar size and application.

PART 2 PRODUCTS

2.01 MANUFACTURER

A. Romac Industries Inc., Smith-Blair, Inc., or approved equal.

2.02 DISMANTLING JOINT

A. Provide Steel Follower made of Carbon Steel C1020 per ASTM A576 and A36 with factory applied fusion bonded epoxy finish.

B. Provide Sleeve Weldment consisting of Carbon Steel Sleeve per ASTM A283C with factory applied fusion bonded epoxy finish and Carbon Steel Flange per ASTM A36 and AWWA C207 Class D, meeting requirements of ANSI Class 125 and 150 bolt circles.

C. Provide Spool Weldment consisting of Carbon Steel Sleeve per ASTM A283C with factory applied fusion bonded epoxy finish and Carbon Steel Flange per ASTM A36 and AWWA C207 Class D, meeting requirements of ANSI Class 125 and 150 bolt circles.

D. Provide Nitrile (Buna-N) Gasket per ASTM D2000

E. Provide Carbon Steel Anchor Loop per ASTM A36.

F. Provide High Strength Low Alloy Bolts meeting requirements of ASTM A588 and AWWA C111/A21.11.

G. Provide Carbon Steel Nuts meeting requirements of ASTM A194 Grade 2H.

H. Provide Carbon Steel Washers meeting requirements of ASTM F844.

I. Provide High Strength Carbon Steel Tie/Restraint Rods meeting requirements of ASTM A193 B7.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine joint interior for cleanliness, freedom from foreign matter, and corrosion.

3.2 JOINT INSTALLATION

A. Dismantling Joint shall be installed in accordance with the manufacturer's written Installation and Operation Manual and approved submittals.

B. Install Dismantling Joint in locations as indicated on the construction drawings.

END OF SECTION

SECTION 330562
PRECAST CONCRETE MANHOLES AND VAULTS

PART 1 GENERAL

1.01 SUMMARY

A. The Contractor shall provide precast concrete manholes and vaults, complete and in place, in accordance with the Contract Documents.

1.02 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Reference Specifications

013300	Submittals
033000	Cast-in-Place Concrete

B. Reference Standards

American Society for Testing and Materials (ASTM) Standards	
ASTM A48	Gray Iron Castings
ASTM C150	Portland Cement
ASTM C443	Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets
ASTM C478/C478M	Standard Specifications for Circular Precast Reinforced Concrete Manhole Sections
ASTM C913	Standard Specification for Precast Concrete Water and Wastewater Structures
ASTM C923	Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes, and Laterals

1.03 CONTRACTOR SUBMITTALS

A. General: Furnish submittals in accordance with Section 01 33 00– Submittal Procedures.

B. Shop Drawings

1. Show dimensions, locations, lifting inserts, reinforcement, and joints.

2. Structural design calculations for vaults, signed by a registered engineer.

C. Manufacturer’s Certification for Vaults: Written certification that the vault complies with the requirements of this Section.

D. Manufacturer’s Test Results: Pull out force for manhole steps.

1.04 QUALITY ASSURANCE

A. Inspection: After installation, the Contractor shall demonstrate that manholes and vaults have been properly installed, level, with tight joints, at the correct elevations and orientations, and that the backfilling has been carried out in accordance with the Contract Documents.

PART 2 PRODUCTS

2.01 MANHOLES

A. The Contractor shall provide precast manhole sections and conical sections conforming to ASTM C478 and the requirements of this Section. Adjusting rings shall be standard items from the manufacturer of the manhole sections. Minimum wall thickness of rings shall be 4-inches if steel reinforced and 6-inches if not reinforced.

B. Axial length of sections shall be selected to provide the correct total height with the fewest joints.

C. Conical sections shall be designed to support cast iron frames and covers under an H-20 loading, unless indicated otherwise.

D. Where the manhole barrel diameter is greater than 48-inches (1200 mm), a flat slab-transition, either concentric or eccentric, shall be used to transition to 48-inches (1200 mm) diameter riser sections. Underside of the transition shall be at least 7-feet (2.0 m) above the top of the bench.

E. Where indicated on the Drawings, manholes supplied for 48-inches (1200 mm) and larger pipes shall be of a ”T” Base-style fabrication. The pipeline portion of the “Base T” section shall conform to ASTM C-76 and be of the same pipe class as the deepest connected sewer. The riser section shall conform to ASTM C478.

F. Design Criteria: Manhole walls, transitions, conical sections, and base shall be designed per ASTM C478 for the depths indicated and the following:

1. AASHTO H-20 loading applied to the cover.

2. Unit weight of soil of 120 pcf located above all portions of the manhole.

3. Lateral soil pressure based on saturated soil producing 100 pcf acting on an empty manhole.

4. Internal fluid pressure based on unit weight of 63 pcf with manhole filled from invert to cover with no balancing external soil pressure.

5. Dead load of manhole sections fully supported by the base and transition.

6. Additional reinforcing steel in walls to transfer stresses at openings.

7. The minimum clear distance between the edges of any 2 wall penetrations shall be 12-inches (300 mm) or one-half of the diameter of the smaller penetration, whichever is greater.

G. Joints shall be sealed with o-ring gaskets conforming to ASTM C443.

H. Concrete for base and channel formation shall be 4000 psi (27.5 MPa) concrete conforming to Section 03 30 00- Cast-In-Place Concrete.

I. Except were otherwise indicated on the Drawings, manholes shall have a precast concrete base and a factory installed bench.

J. Barrel section to sewer pipe connections shall be sealed with resilient connectors complying with ASTM C923. Mechanical devices shall be stainless steel.

K. [Manhole steps shall meet the requirements of ASTM C478 and be comprised of 1/2-inch grade 60 steel reinforcement rod encased in polypropylene copolymer plastic. Steps shall have tread width of 14-inches (350 mm). Furnish test results demonstrating step capability to resist a horizontal pull out force of 400 pounds (1.8 KN) and a vertical force of 800 pounds (3.6 KN). Provide PS2-PF Manhole Step by M.A. Industries or approved equal.]

1. Manhole Manufacturers, Atlantic Concrete Products, Inc.
2. Hanson Concrete Products, Inc.
3. Hardwall Fabricators, Inc.
4. Teichert Precast
5. Lafarge
6. or Approved Equal

2.02 FRAMES AND COVERS

A. Castings: Castings for manhole frames and covers shall be non-rocking and shall conform to the requirements of ASTM A48, Class 30. Unless otherwise indicated, cast iron covers and frames shall be heavy traffic type, 24-inches 30-inches in diameter, with embossed lettering saying "Sanitary Sewer". Frame and cover shall be designed for H-20 traffic loading.

B. Castings Manufacturers,

1. Alhambra Foundry Co., Ltd.
2. Neenah Foundry Co.
3. Vulcan Foundry, Inc
4. Trojan Industries
5. Norwood Foundry
6. or Approved Equal

2.03 VAULTS

A. The Contractor shall provide precast vaults designed for the indicated applications and of the sizes indicated.

B. The minimum structural member thickness for vaults shall be 5-inches. Cement shall be Type V portland cement as specified in ASTM C150. The minimum 28-day concrete compressive strength shall be 4,000 psi (27.5 MPa). All reinforcing steel shall be embedded in the concrete with a minimum clear cover as recommended by ACI 318.

C. Design Loading: Vaults in areas subject to vehicular traffic shall be designed for H-20 traffic loading. Vaults in other areas shall be designed for a vertical live load of 300 psf Lateral loads on vaults in all areas shall be calculated from:

L = 90 x h (27.44 x h), plus surcharge of 240 psf in areas of vehicular traffic

Where: L= loading in psf (kPa)

h = depth of fill in feet (meter)

D. Where joints are designed in pre-cast concrete vaults, such joints shall be interlocking to secure proper alignment between members and prevent migration of soil through the joint. Structural sections at joints shall be sized sufficiently to reinforce the section against localized distress during transportation and handling and against excess contact bearing pressures through the joint.

E. Where openings for access to the vault are required, the full clear space opening indicated shall be provided, without obstructions from brackets or supports. For large openings where brackets or supports are designed to protrude into the opening for support of required covers, such brackets or supports shall be designed to be easily removed and replaced with a minimum of effort and without cutting or welding.

F. Covers for access openings shall be provided. Frames for covers shall be fabricated from steel, galvanized after fabrication, and shall be integrally cast into the vault concrete sections. All covers shall be tight fitting to prevent the entrance of dirt and debris. Where edge seams are permitted, no gaps greater than 1/16-inch (1.6 mm) between edges will be accepted. All covers, except round, heavy weight, cast iron manhole covers, shall have securing mechanisms to hold the covers firmly in place against the effects of repetitious live loads such as pedestrian or vehicle traffic.

G. Where penetration of the pre-cast concrete vault is required for piping, conduit, or ducts, such penetrations shall be accommodated through pre-cast openings or thin-wall knock-out sections. All openings for penetrations shall be smooth and free of surface irregularities and without exposed steel reinforcing. Vaults need not be designed to resist thrust from piping passing through the vault.

H. Warning Signs

1. The entrance to every manhole and vault shall be fitted with a permanently affixed, plastic warning sign, located above and centered on the top step.

2. Sign Manufacturer,

    1) W. H. Brady Company

    2) Seton Nameplate Corporation

    3) or Approved Equal

PART 3 EXECUTION

3.01 GENERAL

A. Pre-cast concrete sections shall be transported and handled with care in accordance with the manufacturer’s written recommendations. Where lifting devices are provided in pre-cast sections, such lifting devices shall be used as intended. Where no lifting devices are provided, the Contractor shall follow the manufacturer’s recommendations for lifting procedures to provide proper support during lifting.

B. Buried pre-cast concrete vaults shall be assembled and placed in excavations on properly compacted soil foundations or bedding as indicated. Pre-cast concrete vaults shall be set to grade and oriented to provide the required dimensions and clearances from pipes and other structures.

C. Prior to backfilling, all cracks and voids in pre-cast concrete vaults shall be filled with non-shrink grout or polyurethane sealant, or both. Around pipe and conduit penetrations, openings shall be sealed with polyurethane sealant or link seal. With the authorization of the Engineer, grout or a closed-cell flexible insulation may be used as filler material prior to placing a final bed of polyurethane sealant.

END OF SECTION

SECTION 331400
WATER DISTRIBUTION PIPING

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section includes:

1. Water distribution piping and fittings
2. Water distribution valves
3. Tapping sleeves
4. Water meters
5. Backflow preventers
6. Fire hydrants

B. Utility-furnished products include water meters that will be furnished to the site, ready for installation.

1.03 DEFINITIONS

A. ANSI: American National Standards Institute

B. ASTM: American Society for Testing and Materials

C. AWWA: American Water Works Association

D. EPDM: Ethylene propylene diene terpolymer rubber.

E. LLDPE: Linear, low-density polyethylene plastic.

F. NSF: National Sanitation Foundation

G. PA: Polyamide (nylon) plastic.

H. PE: Polyethylene plastic.

I. PP: Polypropylene plastic.

J. PVC: Polyvinyl chloride plastic.

K. RTRF: Reinforced thermosetting resin (fiberglass) fittings.

L. RTRP: Reinforced thermosetting resin (fiberglass) pipe.

1.04 ACTION SUBMITTALS

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

1.05 INFORMATIONAL SUBMITTALS

A. Field quality-control test reports.

1.06 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For water valves and specialties to include in emergency, operation, and maintenance manuals.

1.07 QUALITY ASSURANCE

A. Regulatory Requirements:

1. Comply with requirements of utility company supplying water. Include tapping of water mains and backflow prevention.

2. Comply with standards of authorities having jurisdiction for potable-water-service piping, including materials, installation, testing, and disinfection.

3. Comply with standards of authorities having jurisdiction for fire-suppression water-service piping, including materials, hose threads, installation, and testing.

B. Piping materials shall bear label, stamp, or other markings of specified testing agency.

C. 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.

D. Comply with ASTM F 645 for selection, design, and installation of thermoplastic water piping.

E. Comply with FMG's "Approval Guide" or UL's "Fire Protection Equipment Directory" for fire-service-main products.

F. NFPA Compliance: Comply with NFPA 24 for materials, installations, tests, flushing, and valve and hydrant supervision for fire-service-main piping for fire suppression.

G. NSF Compliance:

1. Comply with NSF 61 Annex G for materials for water-service piping and specialties for domestic water.

1.08 DELIVERY, STORAGE, AND HANDLING

A. The Contractor shall be responsible for the safe storage of materials furnished by or to him, and accepted by him and intended for the work, until they have been incorporated in the completed project. The interior of all pipe, fittings and other accessories shall be kept free from dirt and foreign materials at all times.

B. Transportation of Materials and Equipment: The Contractor and his Suppliers are directed to contact the North Carolina Department of Transportation to verify axle load limits on State maintained roads (and bridges) which are to be used for hauling equipment and materials for this project. The Contractor and his Suppliers shall do all that is necessary to satisfy the Department of Transportation requirements and will be responsible for any damage to roads which may be attributed to this project. All materials required to construct this project shall be furnished by the contractor and shall be delivered and distributed at the site by the Contractor or his material supplier.

C. Loading/Unloading Materials: Ductile iron pipe and cast iron accessories shall be loaded and unloaded by lifting with hoists or skidding so as to avoid shock or damage. Concrete pipe, clay pipe, PVC pipe and precast manholes will be unloaded with hoists and/or as recommended by the respective manufacturers. Under no circumstances shall such materials be dropped. Pipe handled on skidways shall not be skidded or rolled against pipe already on the ground.

D. Responsibility for Materials on Site: In distributing the material at the site of the work, each piece shall be unloaded opposite or near the place where it is to be laid in the trench. Each piece shall be redundantly chocked at each end to prevent movement or rolling. Pedestrian or vehicular traffic shall not be unduly inconvenienced in placing of material along the streets or right-of-way, as applicable. The Contractor will string in advance no more than the amount of pipe and material that can be installed within two (2) weeks unless approved by the Engineer. All the materials shall be placed in such a manner as not to hinder access, endanger or impede traffic, create a public nuisance or endanger the public. Materials strung through residential areas (or any area with maintained lawns) shall be placed in such a manner as not to restrict normal lawn maintenance, and must either be installed within two (2) weeks or removed to an approved storage yard, as required by the Engineer.

E. Material and Equipment Storage: The Contractor will be responsible for locating and providing storage areas for construction materials and equipment. Unless prior written consent from the owner of the proposed storage area is received by this Department, the Contractor will be required to store all equipment and materials within the limits of the project site or the limits of the right-of-way and temporary construction easement provided. The materials and equipment storage shall comply with all local and state ordinances throughout the construction period. Material and equipment may only be stored within road right-of-way if approved by the controlling agency. Bulk storage of stacked materials shall not be permitted in or along road rights-of-way. Storage sites shall be fenced with adequate protection to reasonably prevent the public from entering the site. The Contractor shall be responsible for the safeguarding of materials and equipment against fire, theft, and vandalism and in a manner which does not place the public at risk, and shall not hold the City responsible in any way for the occurrence of same.

F. Care of Coatings and Linings: Pre-cast manholes, pipe and fittings, including rings and covers, steps, straps, etc., shall be so handled that the coating or lining will not be damaged. If, however, any part of the coating or lining is damaged, the repair shall be made by the Contractor at his expense in a manner satisfactory to the Engineer.

1.09 PROJECT CONDITIONS

A. Interruption of Existing Water-Distribution Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary water-distribution service according to requirements indicated:

1. Notify Engineer and Owner no fewer than three (3) days in advance of proposed interruption of service.

2. Do not proceed with interruption of water-distribution service without Owner's permission.

1.10 COORDINATION

A. Coordinate connection to water main with Town of Smithfield.

PART 2 PRODUCTS

2.01 DUCTILE-IRON PIPE AND FITTINGS

A. Ductile Iron Pipe: Ductile iron pipe shall conform to the requirements of AWWA Standard C-151 and shall have a cement-mortar lining of standard thickness in accordance with AWWA C-104. Unless otherwise shown on the construction plans, all ductile iron pipe shall be furnished with push on joints in accordance with AWWA C- 111. Sixteen (16) inch and larger diameter pipe shall be minimum Pressure Class 250. Also, the pipe class selection for 16-inch and larger pipe shall be based on the installation conditions. This pipe class shall be as shown on the plans and/or elsewhere in these specifications. Twelve-inch (12") and smaller diameter pipe shall be Pressure Class 350.

1. Mechanical Joint Accessories: Bolts and gaskets for mechanical joint pipe and fittings shall be furnished by the pipe/fitting manufacturer and shall conform to ANSI Specifications A21.11 (AWWA C-111).

2. Push-On Joint Material: Gaskets for push-on pipe shall be furnished by the pipe manufacturer. Gaskets and gasket lubricant shall meet the requirements of ANSI Specification A21.11 (AWWA C-111).

3. Flange Joints And Accessories: Flange joints shall be in accordance with ANSI A21.10 of either Class 125 or Class 250, as required. Flanges, flange bolts and nuts, and gaskets shall conform to the dimensional requirements of ANSI B16.1 for Class 125 or ANSI B16.2 for Class 250. Bolts shall have standard Hexagonal heads and shall be provided with standard hexagonal cold pressed nuts unless otherwise specified. Bolts and nuts shall be made of the best quality refined iron or mill steel and shall have sound, well fitting threads.

4. Restrained Joint Pipe: Flexible restrained joints shall be supplied by the pipe manufacturer. Gaskets with vulcanized internal stainless steel locking segments may be used for 6-inch through 12-inch Ductile Iron Pipe. The following manufacturers are approved, U. S. Pipe and Field Lok Gasket. Only designs using a welded retainer ring on the spigot will be allowed for 16-inch and larger diameter pipe. Push-on or mechanical joint designs may be used for the pipe and associated fittings. The following manufacturer's products are

approved, American Lok Ring, American Lok Fast, Griffin Snap Lok, Griffin BoltLok, and U.S. Pipe TR Flex.

B. Copper Tubing: Copper tubing shall be Type K, per ASTM B-88. End connections may be flared or compression. Copper services shall conform to AWWA C-800.

C. Cast Fittings: Cast fittings furnished for ductile iron or PVC pipe may be pressure Class 250, cast from ductile iron or gray iron, in accordance with AWWA C-110 or pressure Class 350 compact fittings, cast from ductile iron, in accordance with AWWA C-153. Fittings shall be furnished with mechanical or flanged joints as indicated on the construction plans. All mechanical joint fittings will be Bell and Bell unless otherwise indicated on the plans. All cast fittings shall have a cement mortar lining of standard thickness in accordance with AWWA C-104. All fittings, including glands and bolts, shall be manufactured in domestic foundries.

D. Restrained Mechanical Joint Fittings: Mechanical joint restraints may be through the use of a follower gland with restraining device that imparts a wedging action against the pipe. The restraining device shall have twist off nuts to ensure proper contact with the pipe. Glands and restraining devices shall be manufactured of Ductile Iron. The restraining devices shall be heat treated to a hardness of 370BHN. Gland dimensions shall be compatible with the MJ fittings hereinbefore specified. The restrained joint shall be rated for a minimum 250 PSI working pressure with a 2:1 safety factor. Mechanical joint restraints may be through the use of a specially machined ductile iron ring and follower gland that is used with standard mechanical joint gaskets and T- bolts. Retainer glands will not be permitted. Restrained mechanical joints will not be allowed on C-900 PVC pipe. Restrained mechanical joints shall be Megalug as manufactured by Ebaa Iron, Inc., GripRing as manufactured by Romac Industries, Inc., or approved equal. Restrained joints may be used where shown on the plan, standard details or as approved by the Engineer.

2.02 PVC PIPE AND FITTINGS

A. Polyvinyl Chloride (PVC) Pipe: Unless amended on the Construction Drawings or elsewhere in these specifications, all six, eight and twelve-inch water main pipe may be PVC 1120, in accordance with AWWA C-900. All 1-1/2" and 2" water main pipe shall be PVC 1120 in accordance with ASTM D-2241. The pipe shall be minimum Pressure Class 200 with a SDR of 14 or less for C-900 pipe and a SDR of 21 or less for ASTM 2241 pipe. PVC Pressure Pipe shall be made from white or blue pigmented virgin materials and shall be furnished in lengths of 20 feet. Lesser lengths will be accepted to allow the proper placement of fittings, valves, etc. All PVC Water Pipe will be shipped, stored, and strung at the project in such a manner as to be protected from total accumulated exposure to sunlight and possible ultraviolet radiation of no more than four (4) weeks.

1. Push on Joint: Pipe jointing will be by elastomeric joints only. Joints shall conform to ASTM D-3139 for two inch pipe and to AWWA C-900 for six, eight and twelve inch pipe. Pipe bells, with gasket seats, shall be formed as the pipe is extruded. Sleeve couplings are not permitted except as specified in the DS Section for connections to existing mains or as necessary for repairs during pressure/leakage tests.

B. PVC Fittings: All fittings for six, eight and twelve inch PVC pipe shall be cast iron or ductile iron. Fittings for two inch PVC pipe shall be push on joint PVC or threaded malleable iron. Malleable iron fittings shall be furnished with threaded PVC adapters to connect the fittings to the push on joint pipe. Elastomeric joints for PVC adapters and PVC fittings with push on joints shall conform to ASTM D-3139. PVC adapters and fittings shall have a minimum pressure rating of 200 PSI and shall, except for threaded areas on adapters, have a SDR of13.5.

2.03 GATE VALVES

A. Gate valves on water mains smaller than 16-inch in diameter shall be direct bury gatevalves and shall be furnished in concrete pads as specified. Gate valves shall be furnished with non rising stems only, and stem seals shall be of the "0" ring type only. Valves six (6") inches and larger shall be furnished with two inch square operating nuts and shall open by turning to the right or clockwise. Gate valves three (3") inches and smaller shall be furnished with T-Head operating nuts. Valve ends shall normally be mechanical joint with necessary glands, gaskets and bolts furnished with the valve. Flange ends shall be furnished for special installations as shown on the construction plans. Flange by mechanical joint ends shall be furnished for tapping sleeve & valve installations. Gate valves may be of the double disc parallel seat type in accordance with AWWA C- 500 or of the resilient seat type in accordance with AWWA C-509 with a working pressure of 200 PSI. Resilient seated gate valves must be furnished with durable opaque end shields to prevent ultra violet damage to the rubber discs. Only valves which have been specifically approved by Town of Smithfield may be furnished. The following MJ gate valves are approved for installation by Town of Smithfield for sizes 6", 8", and 12":

1. Mueller (A-2380-20 and A-2370-20)
2. American Darling (55 and CRS No. 80 thru 85)
3. Kennedy (571X and 4571X)
4. Waterous (300 series and 500 series)
5. Clow (5065 and F6100)

B. Gate valves smaller than three inches may also be of all bronze construction with iron pipe thread, screw ends, wedge gates and non-rising stems, shall open by turning to the right or clockwise, shall be furnished with a T-head unless a handwheel is specified and shall have a working pressure of 200 PSI. Materials for such gate valves shall be in accordance with the most recent edition of AWWA C-500 and such ASTM designations as apply with reference to chemical requirements as set forth in Table I of ASTM B-62.

2.04 GATE VALVE ACCESSORIES AND SPECIALTIES

A. Tapping-Sleeve Assemblies:

1. Tapping sleeves may be ductile/cast iron mechanical joint, stainless steel full gasket, or fabricated steel with wedge gasket around tap opening. Twelve-inch (12") and smaller sleeves shall be rated for 200 PSI working pressure. Sixteen-inch (16") and larger sleeves shall be rated for 150 PSI working pressure. Mechanical joint tapping sleeves shall be furnished complete with joint accessories including split glands, split end gaskets, bolts, etc., and shall be compatible with the type and class of pipe being tapped. The outlet flange shall be Class 125 per ANSI B16.1 compatible with approved tapping valves. Stainless steel tapping sleeves shall be manufactured from 18-8, type 304 stainless steel. The outlet flange may be ductile iron or stainless steel. The gasket shall be a grid pattern design and shall provide full circumferential sealing around the pipe to be

tapped. The sleeve shall include a test plug for pressure testing the installed sleeve prior to making the tap. All welds shall be passivated. The outlet flange shall be Class D per AWWA C-207-ANSI 150 lb. drilling compatible with approved tapping valves. Fabricated steel tapping sleeves shall be fusion bonded epoxy coated to a 12 mil thickness. The sleeve shall include a test plug for pressure testing the installed sleeve prior to making the tap. The steel outlet flange shall be Class D per AWWA C-207- ANSI 150 lb. drilling compatible with approved tapping sleeve.

2. Approved Tapping Sleeves:

   a. DI/CI Mechanical Joint: Clow, M&H Style 974/1174/1274, Mueller H615, American, Waterous Series 800, Kennedy Square Seal Style No. 921.

   b. Stainless Steel: Ford-FAST, Rockwell-663, Romac-SST, Smith Blair-663, JCM Industries-432, PowerSeal-3490AS-3480.

   c. Steel: Ford-STSC, Mueller-H-621, Rockwell-622, Romac-FTS 420, Smith Blair-622, JCM Industries-412, PowerSeal-3460.

B. Valve Boxes: All valve boxes shall conform to the dimensions shown on the plans and standard details. Valve boxes shall be of cast iron conforming to ASTM A-48, Class 30 and shall be manufactured in domestic foundries.

2.05 WATER METERS

A. Water meters will be furnished by Town of Smithfield.

2.06 WATER METER BOXES

A. Provide Town of Smithfield approved meter box, frame & cover for 2-inch diameter meter.

2.07 BACKFLOW PREVENTERS

A. Reduced-Pressure-Principle Backflow Preventers: Provide approved reduced pressure principle assemblies.

2.08 PROTECTIVE ENCLOSURES

A. Freeze-Protection Enclosures:

1. Description: Insulated enclosure designed to protect aboveground water piping, equipment, or specialties from freezing and damage, with heat source to maintain minimum internal temperature of 40 deg F (4 deg C) when external temperatures reach as low as minus 34 deg F (minus 36 deg C).

   a. Standard: ASSE 1060.

   b. Class I: For equipment or devices other than pressure or atmospheric vacuum breakers.

   c. Class I-V: For pressure or atmospheric vacuum breaker equipment or devices. Include drain opening in housing.

1) Housing: Reinforced fiberglass construction.

a) Size: Of dimensions indicated, but not less than those required for access and service of protected unit.

b) Drain opening for units with drain connection.

c) Access doors with locking devices.

d) Insulation inside housing.

e) Anchoring devices for attaching housing to concrete base.

2) Electric heating cable or heater with self-limiting temperature control.

2.09 FIRE HYDRANTS

A. Dry-Barrel Fire Hydrants:

1. Fire hydrants shall conform to AWWA C-502, and shall be constructed for 3'-0" minimum depth of trench. All fire hydrants shall be constructed with a bronze main valve seat which screws into a threaded bronze connection at the base of the hydrant. All fire hydrants shall be equipped with two 2 -inch hose nozzles with National Standard Threads, and one 4" (minimum opening) pumper nozzle. Standard Threads are as follows:

   a. 6 threads per inch

   b. O.D.: 4.875”

   c. Pitch Diameter: 4.777”

   d. Root: 4.653”

   e. Gauge: 2C

2. All hydrants shall open by turning to the right or clockwise, shall have a minimum valve opening size of 4 " and shall be furnished with a 6" mechanical joint inlet. The operating nut shall be 1 " pentagon. Any extensions required shall be as recommended and supplied by the hydrant manufacturer.

3. All fire hydrants and any portions of the hydrant assembly exposed to view (above adjacent ground elevation) shall be painted with two (2) or more evenly applied coats of yellow hydrant enamel paint. Hydrants will be retouched/repainted as necessary after installation and prior to acceptance.

4. All fire hydrants shall be one of the following models:

   a. Mueller (Super Centurion 200 No. 421)

   b. Kennedy (Guardian No. K81-A)

   c. American Darling (Mark 73-1)

d. Waterous (Trend WB-77)

5. Fire hydrant tees will be Griffin Swivel Hydrant tee, Tyler 5-125 swivel hydrant tee or approved equal. Swivel 90 bends will be Tyler 5-197 or approved equal.

6. Piping extensions for hydrant installations may be made with 6-inch ductile iron nipples with Tyler long swivel hydrant adapters, Megalug MJ Restraint, U. S. Pipe Field Lok Gaskets, Romac GripRing, or other approved method.

PART 3 EXECUTION

3.01 EARTHWORK

A. Refer to Section 312000 Earth Moving for excavating, trenching, and backfilling.

3.02 EXISTING UTILITIES

A. The Contractor will be required to excavate to determine the precise location of utilities, or other underground obstructions, which are shown on the Construction Plans. Such location and excavation shall be at least 500 feet ahead of construction or as noted in the Special Provision Section of this document.

B. All utility owners will be notified prior to excavation as required by the 1985 Underground Damage Prevention Act. Owners who are members of ULOCO may be notified in accordance with current ULOCO procedures. The Contractor will be fully responsible for damage to any utilities if the owners have not been properly notified as required by the Underground Damage Prevention Act.

C. Utility owners may, at their option, have representatives present to supervise excavation inthe vicinity of their utilities. The cost of such supervision, if any, shall be borne by the Contractor.

D. Conflicts with underground utilities may necessitate changes in alignment and/or grade of this construction. All such changes will be approved by the Engineer before construction proceeds.

E. When underground obstructions not shown on the Construction Plans are encountered, the Contractor shall promptly report the conflict to the Engineer and shall not proceed with construction until the conflict is resolved by the Engineer.

F. When a PVC water main crosses other buried pipeline utilities (storm drain, gas, encased or capped telephone conduit, etc.) 12-inches clearance must be maintained between the waterline and utility and the water main shall receive Type III stone bedding. If this clearance requires the water main to be deeper than 5 feet, the Contractor may install a DIP (galvanized steel pipe for 2-inch mains) water main over the utility with less than 12-inches clearance provided there is 3 feet cover over the water main.

3.03 WATER LINE / SEWER LIINE CLEARANCE

A. When a water main crosses or is parallel to an existing sewer main, the Contractor shall install ductile iron pipe for the water main and sewer main as described below.

1. Vertical Separation Of Water Lines & Sewer Lines: Whenever it is necessary for a water main to cross over a sewer main with less than 18-inches of vertical separation, the water main and sewer main shall be constructed of ductile iron pipe, for a distance of 10 feet on each side of the point of crossing. Whenever it is necessary for a water main to cross under a sewer main, the water main and sewer main shall be constructed of ductile iron pipe, for a distance of 10 feet on each side of the point of crossing.

2. Horizontal Separation Of Water Lines And Sewer Lines: Water mains shall be laid at least 10 feet horizontally from existing or proposed sewer mains unless local conditions or barriers prevent a 10-foot horizontal separation. In that case, the water main will be laid in a separate trench, with the elevation of the bottom of the water main at least 18-inches above the top of the sewer. When these conditions are not met, the water main and sewer main shall be constructed of Ductile Iron Pipe.

3.04 PIPE LAYING

A. In all instances, pipe shall be installed in a workmanlike manner and true to line and grade. The various pipes specified shall be handled and installed in accordance with the manufacturer's recommendations and good engineering practices. The following requirements and/or standards of Town of Smithfield shall govern this construction:

1. Pipe Bedding: Unless otherwise specified or noted on the Plans the following bedding classes are as commonly required by this Department. When granular material embedment is required, the Contractor will backfill above thegranular bedding as specified for Type I bedding to an elevation one (1) foot above the top of the pipe bell:

   a. Type I - Shaped Bottom Bedding: Shaped bottom bedding shall be such that the pipe bears uniformly upon undisturbed native earth. Soil is then backfilled by hand around the pipe and completely under the pipe haunches in uniform layers not exceeding six (6) inches in depth to an elevation one (1) foot above the top of the pipe bell. Each layer shall be placed; then carefully and uniformly tamped so that the pipe is not damaged nor the alignment disturbed.

   b. Type II - Granular Material Embedment: For Type II bedding, the trench bottom shall be undercut a minimum of six (6) inches below the pipe barrel grade and filled with an approved stone to an elevation such that the pipe will be completely and uniformly bedded to a vertical height of one-third the outside diameter of the pipe for the pipe's entire length and the entire width of the ditch. Type II embedment shall be used as directed by the Engineer.

   c. Type III - Granular Material Embedment: For Type III bedding, the trench bottom shall be undercut a minimum of six (6) inches below the pipe barrel grade and filled with an approved stone to an elevation such that the pipe will be completely and uniformly bedded to vertical height of one-half the outside diameter of the pipe for the pipe's entire length and width of the ditch. Type III Granular material embedment shall be used as directed by the Engineer.

   d. Concrete Encasement and Cradles: Concrete encasement or cradles will be used only as designed for individual cases or as directed by the Engineer and will be noted on the plans and in the Special Provisions when applicable.

e. Stone Stabilization: Stabilization stone shall be used when the trench must be undercut in excess of the six (6) inches required for Type II or Type III bedding, either due to excessive ground water or the existence of unsuitable material incapable of adequately supporting the pipe. The Contractor shall undercut the trench as necessary and shall place and compact the stone stabilization material required to establish a stable bottom to receive either the Type II or Type III granular bedding and pipe.

2. Depth of Pipe Installation: Unless otherwise indicated on Plans, or required by existing utility location, all pipe will be installed with the top of the pipe at least 3.0' below the edge of adjacent roadway pavement or 3.0' below the ground at the pipe, whichever is greatest. The Contractor is instructed to check the construction plans and blow-up views for additional requirements. The maximum depth of cover for the previously specified pressure classifications shall be as follows:

a. Type I Bedding: 10 feet

b. Type II Bedding: 15 feet

c. Type III Bedding: 20 feet

3. The Contractor may be required to vary the depth of pipe to achieve minimum clearance from existing utilities while maintaining the minimum cover specified whether or not the existing pipelines, conduits, cables, mains, etc. are shown on the Plans.

4. Alignment and Grade: The water mains shall be installed as shown on the plans unless an obstruction prevents such alignment or grade. The Contractor will be required to adjust the location of the water main where possible to avoid such conflicts as specified and as directed by the Engineer. All construction layout and surveying which may be required for construction shall be provided by the Contractor and any costs associated shall be included in the various pay items of the proposal. The Contractor is responsible for determining the amount of construction layout and surveying that may be required to complete construction.

3.05 INSTALLATION AND ASSEMBLY

A. Proper implements, tools, and facilities satisfactory to the Engineer shall be provided and used by the Contractor for the safe and convenient prosecution of the work. All pipe, fittings, valves and hydrants shall be carefully lowered into the trench piece by piece by means of a backhoe or other suitable means, in such a manner as to prevent damage to protective coatings and linings. Under no circumstances shall water main materials be dropped or dumped into the trench

1. Inspection of Material: The pipe and fittings shall be inspected for defects.

2. Cleaning Pipe and Fittings: All lumps, blisters and excess coatings shall be removed from the bell and spigot ends of each pipe, and the outside of the spigot and the inside of the bell shall be wire- brushed and wiped clean and dry and free from oil and grease before the pipe is laid.

3. Laying Pipe: Pipe shall be laid with bell ends facing in the direction of laying, unless otherwise approved by the Engineer. Every precaution shall be taken to prevent foreign

material from entering the pipe while it is being placed. If the pipe laying crew cannot put the pipe into the trench and in place without getting earth into it, the Engineer may require that before lowering the pipe into the trench, a heavy, tightly woven canvas bag of suitable size shall be placed over each end and left there until the connection is to be made to the adjacent pipe. During laying operations, no debris, tools, clothing or other materials shall be placed in the pipe. After placing a length of pipe in the trench, the spigot end shall be centered in the bell and the pipe forced home and brought to correct line and grade. The pipe shall be secured in place with approved backfill material tamped under it except at the bells. Precautions shall be taken to prevent dirt from entering the joint space. At times when pipe laying is not in progress, the open ends of pipe shall be closed by a watertight plug or other means approved by the Engineer. This provision shall applyduring the noon hours as well as overnight. If water is in the trench, the seal shall remain in place until the trench is pumped completely dry.

4. Permissible Deflection of Joints: Wherever it is necessary to deflect pressure pipe from a straight line, either in the vertical or horizontal plane, to avoid obstruction or plumb valve stems, or where long radius curves are permitted, the amount of deflection allowed shall not exceed that required for satisfactory sealing of the joint as recommended by the manufacturer, and shall be approved by the Engineer.

5. Installation of Push-On Joint Pipe: The gasket groove and bell socket shall be cleaned and lubricated, and the gasket inserted as specified by the pipe manufacturer. Sterile lubricant, as furnished or specified by the manufacturer shall be applied to the gasket and beveled spigot end of the pipe. The beveled spigot end of pipe shall be pushed straight into bell using either a bar, jack, lever puller, or backhoe. A timber header will be placed between the jack or backhoe bucket and the pipe to prevent damage to the pipe. At no time will the joint be made by swinging the pipe. The pipe will be deflected, if required, after the joint is made.

6. Installing Mechanical Joint Pipe and Fittings: All spigots shall be centrally located in the bell and adequate anchorage shall be provided where abrupt change in direction and dead ends occur. All pipe surfaces with which the rubber gasket seals come into contact will be brushed with a wire brush just prior to assembly in order to remove all loose rust or foreign material and to provide a clean surface for the installation of the gasket. The pipe surface with which the gasket comes into contact and the gasket will be brushed with soapy water just prior to the installation of the gasket and the making up of the joint. Torque loads shall be applied to the standard cast iron bolts used in making the joint as follows:

   a. 5/8” Bolt: 40-60 Ft lbs. of Torque

   b. 3/4” Bolt: 60-90 Ft lbs. of Torque

   c. 1” Bolt: 70-100 Ft lbs. of Torque

   d. 1-1/4” Bolt: 90-120 Ft lbs. of Torque

7. The above torque loads may be applied with torque measuring or indicating wrenches. Torque wrenches may be used to check the application of approximate torque loads applied by men trained to give an average pull on a definite length of regular socket wrench. The following lengths of wrenches should satisfactorily produce the above ranges of torques when used by the average man:

a. 5/8” Bolt: 8” wrench length

b. 3/4” Bolt: 10” wrench length

c. 1” Bolt: 12” wrench length

d. 1-1/4” Bolt: 14” wrench length

8. When tightening bolts, the gland will be brought up toward the pipe flange evenly, maintaining approximately the same distance between the gland and the face of the flange at all points around the socket.

9. Bend and Fitting Location: The Contractor is advised that the bends and fittings indicated on the plans are for a guide only. The Contractor will be required to furnish additional bends and fittings as needed to complete all installations.

10. Cutting Pipe: The cutting of pipe for inserting valves, fittings, or closure pieces shall be done in a neat and workmanlike manner without damage to the pipe or cement lining and so as to leave a smooth end at right angles to the axis of the pipe. Cut ends of a pipe shall be beveled before installation in a push-on joint bell. When making connections to existing mains which require water mains to be removed from service, automatic traveling pipe cutting machines will be required on pipe 16- inch and larger. At other times, hand-held pipe saws may be used provided the pipe is marked, prior to cutting, such as to provide a cut at right angles to the axis of the pipe. Handheld pipe saws may be used in all applications for cutting pipe smaller than 16- inch. Flame cutting of pipe with an acetylene torch will not be allowed.

11. PVC Pipe Installation: PVC pipe shall be installed in accordance with the Recommended Practice for the Installation of PVC Pressure Pipe UNI-B-3 and AWWA C-900. Backfill shall be as specified elsewhere in these specifications. Tracer wire or locator tape shall be installed as outlined below:

12. Unless otherwise indicated on the Plans, or required by existing utility locations, all PVC water pipe will be installed with a minimum cover of 3.0 feet. The maximum cover shall be as previously specified. Ductile Iron Pipe shall be installed when the minimum cover is less than 3.0 feet and in all crossings of other pipelines (storm drainage, gas, etc.) when the vertical distance between the water main and the other pipeline is less than 12-inches

3.06 JOINT CONSTRUCTION

A. Make pipe joints according to the following:

1. Ductile-Iron Piping, Gasketed Joints for Water-Service Piping: AWWA C600 and AWWA M41.

2. Ductile-Iron Piping, Gasketed Joints for Fire-Service-Main Piping: UL 194.

3. Ductile-Iron Piping, Grooved Joints: Cut-groove pipe. Assemble joints with grooved-end, ductile-iron-piping couplings, gaskets, lubricant, and bolts according to coupling manufacturer's written instructions.

4. PVC Piping Gasketed Joints: Use joining materials according to AWWA C900. Construct joints with elastomeric seals and lubricant according to ASTM D 2774 or ASTM D 3139 and pipe manufacturer's written instructions.

3.07 INSTALLING VALVES, HYDRANTS, AND FITTINGS

A. Valves, hydrants and fittings shall be installed in the manner specified for installation and assembly of pipe. Valves and hydrants shall be installed at locations shown on the plans and/or as directed by the Engineer

1. AWWA Gate Valves: Comply with AWWA C600 and AWWA M44. Install each underground valve with stem pointing up and with valve box.

2. AWWA Valves Other Than Gate Valves: Comply with AWWA C600 and AWWA M44.

3. Valve Boxes: A valve box conforming to the Standard Details shall be installed for every gate valve. The valve box shall not transmit shock or stress to the valve and shall be centered and plumb over the operating nut, with the box cover flush with the surface of the pavement or other existing surface. Where the box is not set in pavement, the top section shall be anchored by an 18" x 18" x 6" concrete pad, or an approved pre-cast concrete pad, set flush with the existing terrain. The top section will be grouted into the pre-cast concrete pad. The location of valves will be identified by the letter "V" imprinted into the curb adjacent to mainline or hydrant valve. All butterfly valves shall be installed with operating nuts plumb and centered beneath a manhole frame and cover, valve box top section and riser pipe as shown in the Standard Details. Extension stems as shown on the standard detail will be required on valves where the operating nut is more than 4.0 feet below the top of the frame and cover.

4. Valve Blocking: All end of line valves 12-inch and smaller installed on PVC or DIP water mains and all 12-inch valves installed along PVC water mains shall be securely wedge blocked with concrete bearing against, and cut into the excavated sides of the trench. Care shall be taken in forming and pouring the "wedge" blocking so the fitting joints will be accessible for repair and/or valve extraction.

5. Fire Hydrants: Hydrants shall be set with no less than three (3) foot bury on water mains 12" and smaller and with four (4) foot or more for water mains 16" and larger. Because of varying topography, extensions, and/or hydrants with greater bury may be required. Extensions will be made by the hydrant manufacturer. All hydrants and hydrant guard valves will be installed plumb and in accordance with the Standard Details. The appropriate plan view will be noted on the Plans or in the Special Provisions. Each hydrant installation will include a drainage bed of clean washed stone approximately 1 cubic foot in size at the "weep hole". Piping from the main to the hydrant shall be 6-inch DIP.

6. Blocking Fittings: All plugs, caps, tees, and bends deflecting 11-1/4 degree or more on pressure mains 6" in diameter or larger shall be provided with thrust blocking, placed as shown on the Plans and/or as directed by the Engineer, and consisting of ready mix

concrete having a compressive strength of not less than 3,600 lbs per square inch at 28 days. Bagged mix concrete may be used for blocking, anchorage, concrete valve pads, etc. on water mains and valves 12-inches and smaller, when less than 1/2 yard is required. Blocking shall be placed between solid ground and the fittings to be anchored. The area of bearing on the pipe and on the ground in each instance shall be that shown or directed by the Engineer. The blocking shall be so placed that the pipe and fittings will be accessible for repair.

7. Restrained joints shall be installed where shown on the plans, standard details or when approved by the Engineer, and may be installed in lieu of blocking. Installation shall be per manufacturer's recommendations, as shown on the plans, special provisions, and/or as directed by the Engineer. <u>Restrained joints will not be allowed on PVC pipe.</u>

3.08 CONNECTIONS TO EXISTING MAINS

A. Connections to the existing system shall be made in the presence of Town of Smithfield Inspection personnel. Valves, hydrants, blow offs, etc. will be operated by Town of Smithfield personnel and/or the Contractor if specifically directed by Town of Smithfield to do so. The Contractor shall provide all labor, materials, and equipment required for connection to the existing system. Only one (1) connection between the existing system and the new extension will be allowed until testing, chlorination, and successful sampling of the new extension is complete.

B. If connection to existing mains will necessitate an interruption of service, the Contractor will schedule the connection for a time that is most convenient to the affected customers as determined by the Engineer. Adequate notice will be provided to those customers who will be put out of service by the connection. When such interruption of service is approved, the Contractor will have all required labor, material and equipment at the site before beginning any work and the service interruption will be kept to an absolute minimum.

C. The Contractor shall verify blocking at existing valves prior to making connections and will be required to block, rod, or restrain existing and new pipe, fittings and valves as necessary.

3.09 WATER MAIN TAPS

A. <u>Installation Of Tapping Sleeves And Valves</u>: Tapping sleeves and valves will be installed only under inspection by the Engineering Division of Town of Smithfield and as recommended by the Manufacturer. No work will be done (including excavation of the existing main) except when Town of Smithfield Engineering personnel are present. Tapping valves shall be supported at all times to prevent the tapping sleeve from slipping on the main. Tapping sleeves and valves will be field pressure tested after installation on the pipe but before the tap is made. First, the tapping valve will be opened and the sleeve and valve filled with water and placed under the rated pressure of the sleeve (200 PSI for 12-inch and smaller, 150 PSI for 16-inch and larger). The pressure gauge shall be observed for five minutes with no loss of pressure. Then the pressure shall be released, the valve closed and procedure repeated with test pressure against the outside of the valve gate or wedge. When tapping sleeves are furnished with test plugs, the test may be made in a single step with the valve closed and pressure applied through the test plug.

B. <u>1-1/2-inch and larger water services</u>: All meters 1 -inch and larger shall be installed in precast concrete vaults conforming to the Standard Details. Vaults shall be approved for use within North Carolina Department of Transportation right-of-way and shall be designed for H-20 loading.

Vaults may be adjusted as shown on the standard details using standard size clay or concrete brick. Vaults shall have double leaf steel covers conforming to the Standard Details. All meters shall conform to American Water Works Association (AWWA) standards as specified below. The manufacturers meter serial number shall be imprinted on the outer case of the meter and on the register lid. All registers for the various types and sizes of meter specified shall be magnetic drive, straight reading, recording in cubic feet, equipped with a center-sweep test hand, dehumidified, air tight, and hermetically sealed. All meters where the register is separate or removable from the main case, and held in place by screws must have the head of each screw drilled two ways, and sealed with a copper wire and lead seal before delivery. The security of such registers must be guaranteed non- removable except by destruction of seal wire, or seal. The manufacturer must furnish with each meter a certificate of accuracy which references the particular meter serial number. The certificate of accuracy must be furnished to the Engineer before the meter is activated. The certificate must reference the job name or number. The number can be added by the supplier or contractor. The manufacturer shall guarantee that all meters furnished under this specification will meet the required new meter accuracy standards in accordance with AWWA standards.

3.10 BACKFLOW PREVENTER INSTALLATION

A. Install backflow preventers and enclosures of approved type, size, and capacity. Include valves and test cocks.

3.11 PIPE MARKING AND IDENTIFICATION

A. The installation of tracer wire is required on all underground pipe installed under this contract, including both sewer and water. Tracer wire shall be installed on all water and all wastewater pipe regardless of pipe material including: water distribution, wastewater collection, wastewater force main, low pressure sewer and gray water systems and shall also include all water and sewer service laterals.

B. Water service tracer wire: All water services regardless of size or pipe material shall be installed with a copper tracer wire as indicated on the Standard Details. The tracer wire shall be AWG #12 gauge solid copper tracer wire with 30 mils blue HDPE insulation. Install according to following:

1. Splicing or Joining: When joining two sections of tracer wire they are to be joined by a double overhand knot.

2. When joining two sections of tracer wire a weatherproof wire not will be used to connect each end.

3. Tracer wire will be placed at the crown of each pipe.

4. Tracer wire will be secured to the pipe every 10’.

5. A 24” pigtail will be provided in each manhole, vault, valve box or any structure exposed to daylight.

3.12 TESTING AND INSPECTION

A. Required testing of pipelines and valves shall be done under the direct supervision of the Project Inspector. Field testing shall not negate the requirements for material certifications ascontained in the material specification section of this contract. Unless otherwise directed by the Engineer, all testing and disinfection will be completed prior to connection to any existing line. The Contractor shall provide open ventilation of confined spaces. The Contractor shall be responsible for providing all equipment and personnel necessary to comply with OSHA confined spaces regulations.

1. Hydrostatic and Leakage Tests: On completion of the line or sections of the lines, connections and appurtenances, the line shall be filled and hydrostatically tested. The water for this purpose can be taken from existing lines under the supervision of the Engineer's Inspector and leakage will be measured by the Inspector with a meter furnished by Town of Smithfield. All leaks and any defective material shall be repaired or replaced to the satisfaction of the Engineer and the tests repeated until the requirements of this specification are met. Any special equipment, pumps, etc. required to make the test shall be furnished and operated by the contractor as directed by the Inspector. The Contractor shall use great care to be sure that all air is expelled from each section under test. If fire hydrants or other openings are not available for the purpose of expelling air, the Contractor shall provide air releases of sufficient size (as determined by the Engineer) in accordance with City Standard Drawings, at his expense. Specific procedures for testing mains are as follows:

   a. Test pressure will be 200 PSI at the low point of the section under test. When testing against butterfly valves, the differential pressure at the valve must not exceed 150 PSI for valves rated at 150 PSI. If the test cannot be made with differential pressure of 150 PSI, 250 PSI valves will be specified. Differential pressures across gate valves may be up to 200 PSI.

   b. Allowable leakage will be determined by Table 6, AWWA C-600 or by the formula L=.000106SD where S is the length of pipe under test and D is the pipe diameter. Add .0043 gal/hr. for each 3/4-inch service and .0057 gal/hr. for each 1-inch service.

   c. Pressure and leakage tests will be run concurrently and for a duration of four hours except as modified below

   d. The Contractor will pressurize the line and verify that it is within allowable leakage before the official test is started

   e. The Inspector will begin the test and remain at the job for the first hour, making sure that the test pressure is maintained within □ 5 PSI. The Contractor is to maintain the pressure within □ 5 PSI for the duration of the test period. At the end of the first hour, with the line pumped to full test pressure, he will read the meter and record the first hour leakage. If the first hour leakage is within allowable, he will return at the end of the fourth hour and again read the meter. If the total leakage for the four hour period does not exceed four times the first hour leakage, the test will be terminated. If the total leakage exceeds four times the first hour leakage, but is still within allowable, the test will be held an additional hour. If the fifth hour leakage does not exceed the average hourly leakage for the first four hours, the test will be terminated at the end of the fifth hour. Otherwise, the test will be held until the leakage is non-increasing and within allowable for two consecutive hours.

f. If leakage exceeds allowable for the four hour test, the test will be terminated and re-scheduled after the Contractor has verified that actual leakage is within the allowable leakage, but no earlier than the next work day.

g. If the first hour leakage does not exceed 10% of the allowable, or if the allowable leakage rate does not exceed .4 gal/hr., the test may be terminated at the end of two hours provided the second hour leakage does not exceed the first hour leakage. If the second hour leakage exceeds the first hour leakage, the test will be held for an additional period as described in Paragraph (e) above.

h. The maximum length of pipe tested in one test shall be 5,000 feet or as close to 5,000 feet as possible depending on valve spacing.

i. During the last stages of the test and without any reduction in pressure, first the hydrant guard valves will be closed, then progressing in an orderly manner from the end opposite the test pump, each main line valve will be closed and pressure released to determine if it is holding pressure (minimum 10 minutes per valve closing).

j. Unless otherwise directed by the Engineer, each Butterfly Valve will be tested to 150 PSI for a minimum of 10 minutes after the pipeline has been successfully tested.

k. When testing mains with Contractor installed water services, the Engineer mayon a random basis require jumpers in selected meter yokes with full test pressure applied to the property line valve. Such jumpers will be furnished by the Engineer and installed by the Contractor.

2. <u>Disinfection of Mains</u>: All of the water mains installed shall be thoroughly flushed and disinfected before being placed in service. This work shall be done under the direct supervision of the Engineer's Inspector. The Contractor shall supply all labor, equipment and materials necessary for carrying out this work. After a thorough flushing and cleaning out, sufficient chlorine compounds shall be introduced in the lines to produce a chlorine concentration of at least 50 parts per million. The chlorine solution shall be retained in the lines for at least twenty-four (24) hours. At the end of this period, the chlorine residual shall be at least 20 parts per million. The lines will then be flushed sufficiently to clear them of chlorine exceeding one part per million. Samples of water from the mains will then be taken and analyzed for bacteriological purity. If the mains fail to meet the bacteriological standard for purity, disinfecting and flushing will be repeated until such standards have been met. All analysis for chlorine and bacteriological purity will be by City Personnel.

3. <u>Drainage of Mains</u>: Drainage of mains and disposal of chlorinated water shall be in accordance with all Federal, State and local laws, ordinances and regulations. Mains shall be drained to sanitary sewers, where available. Drainage directly to surface waters (creeks, rivers, streams, lakes, ponds, etc.) will not be allowed. Drainage branches, blowoffs, air vents and appurtenances shall be provided with valves and shall be located and installed as shown on the Plans and Standard Details. Drainage of mains will be accomplished in such a manner as to minimize erosion and siltation to adjoining properties. Water velocity from

drainage and/or blow-off will be dissipated as necessary to prevent erosion. Drainage branches or blowoffs shall not be connected to any sewer, submerged in any streams, or installed in any other manner that will permit back siphonage into the distribution system.

3.13 PIPING REPAIRS

A. The Contractor shall make any needed repairs to newly installed inactivated mains. Repairs to existing and/or activated mains will be made by Town of Smithfield unless the Contractor is otherwise directed by the Engineer.

1. Repairs to New mains: Repairs shall be made by cutting out and removing the damaged/defective section and replacing those with new pipe using long pattern solid sleeves to connect plain ends. Bell clamps will not be allowed to repair newly installed.

2. Repairs to Existing Mains: The Contractor will not be required to repair existing mains unless specifically directed by the Engineer, or specified elsewhere in these specifications. Repair methods will be considered on a case by case basis.

3.14 CLEANING

A. Clean and disinfect water-distribution piping as follows:

1. Purge new water-distribution piping systems and parts of existing systems that have been altered, extended, or repaired before use.

2. Use purging and disinfecting procedure prescribed by authorities having jurisdiction or, if method is not prescribed by authorities having jurisdiction, use procedure described in NFPA 24 for flushing of piping. Flush piping system with clean, potable water until dirty water does not appear at points of outlet.

3. Use purging and disinfecting procedure prescribed by authorities having jurisdiction or, if method is not prescribed by authorities having jurisdiction, use procedure described in AWWA C651 or do as follows:

   a. Fill system or part of system with water/chlorine solution containing at least 50 ppm of chlorine; isolate and allow to stand for 24 hours.

   b. Drain system or part of system of previous solution and refill with water/chlorine solution containing at least 200 ppm of chlorine; isolate and allow to stand for 3 hours.

   c. After standing time, flush system with clean, potable water until no chlorine remains in water coming from system.

   d. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedure if biological examination shows evidence of contamination.

B. Prepare reports of purging and disinfecting activities.

END OF SECTION

SECTION 333000
SANITARY SEWERAGE UTILITIES

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section Includes:

1. Ductile-iron, gravity sewer pipe and fittings.
2. Ductile-iron, pressure pipe and fittings.
3. PVC pipe and fittings.
4. Nonpressure-type transition couplings.
5. Pressure-type pipe couplings.
6. Expansion joints and deflection fittings.
7. Manholes.
8. Steel Encasement.
9. Concrete.

1.03 DEFINITIONS

A. ANSI: American National Standards Institute

B. ASTM: American Society for Testing and Materials

C. AWWA: American Water Works Association

D. NSF: National Sanitation Foundation

1.04 ACTION SUBMITTALS

A. Product Data: For the following:

1. Pipe and fittings.
2. Non-pressure and pressure couplings
3. Expansion joints and deflection fittings.

B. Shop Drawings: For manholes. Include plans, elevations, sections, details, and frames and covers.

1.05 INFORMATIONAL SUBMITTALS

A. Product Certificates: For each type of pipe and fitting.

B. Field quality-control reports.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Do not store plastic manholes, pipe, and fittings in direct sunlight.

B. Protect pipe, pipe fittings, and seals from dirt and damage.

C. Handle manholes according to manufacturer's written rigging instructions.

D. The Contractor shall be responsible for the safe storage of materials furnished by or to him, and accepted by him and intended for the work, until they have been incorporated in the completed project. The interior of all pipe, fittings and other accessories shall be kept free from dirt and foreign materials at all times.

E. Transportation of Materials and Equipment: The Contractor and his Suppliers are directed to contact the North Carolina Department of Transportation to verify axle load limits on State maintained roads (and bridges) which are to be used for hauling equipment and materials for this project. The Contractor and his Suppliers shall do all that is necessary to satisfy the Department of Transportation requirements and will be responsible for any damage to roads which may be attributed to this project. All materials required to construct this project shall be furnished by the contractor and shall be delivered and distributed at the site by the Contractor or his material supplier.

F. Loading/Unloading Materials: Ductile iron pipe and cast iron accessories shall be loaded and unloaded by lifting with hoists or skidding so as to avoid shock or damage. Concrete pipe, clay pipe, PVC pipe and precast manholes will be unloaded with hoists and/or as recommended by the respective manufacturers. Under no circumstances shall such materials be dropped. Pipe handled on skidways shall not be skidded or rolled against pipe already on the ground.

G. Responsibility for Materials on Site: In distributing the material at the site of the work, each piece shall be unloaded opposite or near the place where it is to be laid in the trench. Each piece shall be redundantly chocked at each end to prevent movement or rolling. Pedestrian or vehicular traffic shall not be unduly inconvenienced in placing of material along the streets or right-of-way, as applicable. The Contractor will string in advance no more than the amount of pipe and material that can be installed within two (2) weeks unless approved by the Engineer. All the materials shall be placed in such a manner as not to hinder access, endanger or impede traffic, create a public nuisance or endanger the public. Materials strung through residential areas (or any area with maintained lawns) shall be placed in such a manner as not to restrict normal lawn maintenance, and must either be installed within two (2) weeks or removed to an approved storage yard, as required by the Engineer.

H. Material and Equipment Storage: The Contractor will be responsible for locating and providing storage areas for construction materials and equipment. Unless prior written consent from the owner of the proposed storage area is received by this Department, the Contractor will be required to store all equipment and materials within the limits of the project site or the limits of the right-of-way and temporary construction easement provided. The materials and equipment storage shall comply with all local and state ordinances throughout the construction period. Material and equipment may only be stored within road right-of-way if approved by the controlling agency. Bulk storage of stacked materials shall not be permitted in or along road rights-of-way. Storage sites shall be fenced with adequate protection to reasonably prevent the public from entering the site. The Contractor shall be responsible for the safeguarding of materials and equipment against fire, theft, and vandalism and in a manner which does not place the public at risk, and shall not hold the City responsible in any way for the occurrence of same.

I. Care of Coatings and Linings: Pre-cast manholes, pipe and fittings, including rings and covers, steps, straps, etc., shall be so handled that the coating or lining will not be damaged. If, however, any part of the coating or lining is damaged, the repair shall be made by the Contractor at his expense in a manner satisfactory to the Engineer.

1.07 FIELD CONDITIONS

A. Interruption of Existing Sanitary Sewerage Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:

1. Notify Engineer and Owner no fewer than three days in advance of proposed interruption of service.

PART 2 PRODUCTS

2.01 DUCTILE-IRON, GRAVITY SEWER PIPE AND FITTINGS

A. Pipe: ASTM A 746, for push-on joints.

B. Standard Fittings: AWWA C110/A21.10, ductile or gray iron, for push-on joints.

C. Compact Fittings: AWWA C153/A21.53, ductile iron, for push-on joints.

D. Gaskets: AWWA C111/A21.11, rubber.

2.02 DUCTILE-IRON, PRESSURE PIPE AND FITTINGS

A. Push-on-Joint Piping:

1. Pipe: AWWA C151/A21.51, pressure class 350 (12-inch diameter and smaller), pressure class 250 (16-inch diameter and larger).

2. Standard Fittings: AWWA C110/A21.10, ductile or gray iron, with cement mortar lining in accordance with AWWA C104.

3. Compact Fittings: AWWA C153/A21.53, with cement mortar lining in accordance with AWWA C104.

4. Gaskets: AWWA C111/A21.11, rubber, of shape matching pipe and fittings.

B. Mechanical-Joint Piping:

1. Pipe: AWWA C151/A21.51, with bolt holes in bell, pressure class 350 (12-inch diameter and smaller), pressure class 250 (16-inch diameter and larger).

2. Standard Fittings: AWWA C110/A21.10, ductile or gray iron, with bolt holes in bell, with cement mortar lining in accordance with AWWA C104.

3. Compact Fittings: AWWA C153/A21.53, with bolt holes in bells, with cement mortar lining in accordance with AWWA C104.

4. Glands: Cast or ductile iron; with bolt holes and high-strength, cast-iron or high-strength, low-alloy steel bolts and nuts.

5. Gaskets: AWWA C111/A21.11, rubber, of shape matching pipe, fittings, and glands.

2.03 PVC PIPE AND FITTINGS

A. PVC Corrugated Sewer Piping:

1. Pipe: ASTM F 949, PVC corrugated pipe with bell-and-spigot ends for gasketed joints.

2. Fittings: ASTM F 949, PVC molded or fabricated, socket type.

3. Gaskets: ASTM F 477, elastomeric seals.

B. PVC Profile Sewer Piping:

1. Pipe: ASTM F 794, PVC profile, PS 46 minimum stiffness, gravity sewer pipe with bell-and-spigot ends for gasketed joints.

2. Fittings: ASTM D 3034, PVC with bell ends.

3. Gaskets: ASTM F 477, elastomeric seals.

C. PVC Type PSM Sewer Piping:

1. Pipe: ASTM D 3034, SDR 26, PVC Type PSM sewer pipe with bell-and-spigot ends for gasketed joints.

2. Fittings: ASTM D 3034, PVC with bell ends.

3. Gaskets: ASTM F 477, elastomeric seals.

D. PVC Gravity Sewer Piping:

1. Pipe and Fittings: ASTM F 679, PS 46 minimum stiffness, PVC gravity sewer pipe with bell-and-spigot ends and with integral ASTM F 477, elastomeric seals for gasketed joints.

E. PVC Pressure Piping:

1. Pipe: AWWA C900, Class 200, SDR 14 or less, PVC pipe with bell-and-spigot ends for gasketed joints.

2. Fittings: AWWA C900, Class 200 PVC pipe with bell ends.

3. Gaskets: ASTM F 477, elastomeric seals.

2.04 EXPANSION JOINTS AND DEFLECTION FITTINGS

A. Ductile-Iron, Flexible Expansion Joints:

1. Flexible expansion joints shall be installed in the locations indicated on the drawings and shall be manufactured of ductile iron conforming to the material requirements of ASTM A536 and ANSI/AWWA C153/A21.53. Foundry certification of material shall be readily available upon request.

2. Each flexible expansion joint shall be pressure tested prior to shipment against its own restraint to a minimum of 350 psi (250 psi for flexible expansion joints 2 inch and 30 inches diameter and larger.) A minimum 2:1 safety factor, determined from the published pressure rating, shall apply. Factory Mutual Approval for the 3 inch through 12 inch sizes is required.

3. Each flexible expansion joint shall consist of an expansion joint designed and cast as an integral part of a ball and socket type flexible joint, having a minimum per ball deflection of: 20º, 2”-12”; 15º, 14”-36”;12º,42”-48” and 4-inches minimum expansion. Additional expansion sleeves shall be available and easily added or removed at the factory or in the field. Both standardized mechanical joint and flange end connections shall be available.

4. All internal surfaces (wetted parts) shall be lined with a minimum of 15 mils of fusion bonded epoxy conforming to the applicable requirements of ANSI/AWWA C213. Sealing gaskets shall be constructed of EPDM. The coating shall meet ANSI/NSF-61.

5. Exterior surfaces shall be coated with a minimum of 6 mils of fusion bonded epoxy conforming to the applicable requirements of ANSI/AWWA C116/A21.16.

6. Appropriately sized polyethylene sleeves, meeting ANSI/AWWA C105/A21.5, shall be included for direct buried applications.

B. Ductile-Iron Deflection Fittings:

1. Flexible ball joints shall be installed in the locations indicated on the drawings and shall be manufactured of ductile iron conforming to the material properties of ANSI/AWWA C153/A21.53.

2. Flexible joints shall consist of a ball and socket type joint capable of 15° minimum deflection. Each flexible ball joint shall be pressure tested against its own restraint to 350 PSI for sizes 3 inch through 24 inch and 250 PSI for sizes 30 inch or greater.

3. MEGALUG® joint restraint shall be provided with each mechanical joint connection. All internal surfaces (wetted parts) shall be lined with a minimum of 15 mils of fusion bonded epoxy conforming to the applicable requirements of ANSI/AWWA C213.

4. Sealing gaskets shall be constructed of EPDM. The coating shall meet ANSI/NSF-61.

5. Exterior surfaces shall be coated with a minimum of 6 mils of fusion bonded epoxy conforming to the applicable requirements of ANSI/AWWA C116/A21.16.

2.05 MANHOLES

A. Standard Precast Concrete Manholes:

1. All sewer manholes shall be constructed of precast concrete sections only in conformance with the following specifications and Town of Smithfield Standard Detail Drawings. Special cast in place manhole structures shall be as shown on the plans and shall comply with the various other applicable sections in these specifications.

2. Manholes shall be furnished with pre-cast bottom slabs and flexible watertight boots for 15-inch and smaller pipe. The boots shall be cast in as integral parts of the base or installed in cored openings with stainless steel compression bands, and shall conform to ASTM C-923.Manholes for 18-inch and larger pipe may be furnished with precast bottom slabs and flexible boots, flexible seals, or concrete collars. The flexible seals shall be A-Lok or Contour Seal. Flexible connectors shall conform to ASTM C-923. The concrete collars shall be according to the applicable Standard Detail.

3. Sections: All precast reinforced concrete manholes shall conform to specifications and plans and to ASTM C-478. The following minimum standards shall also apply:

   a. Wall thickness shall be 1/12th of the inside diameter with a minimum thickness of five (5") inches.

   b. Base sections shall be cast monolithically or have a waterstop cast in the cold joint between the walls and the base slab.

   c. Cone sections shall normally be eccentric with the inside face of one side vertical and flush with the inside face of the barrel section. Eccentric cones with bolt down frame and cover shall have a minimum vertical height, as measured from the top of the cone to the bottom of the bell, of 32 inches. Eccentric cones without bolt down frame and cover to be installed flush to finish grade may have a minimum vertical height of 24-inches. Concentric cones with a vertical height of 20-inches may be used on manholes less than five (5') feet deep (4' diameter manhole only). Transition cone sections may be provided for an eccentric transition from a 60-inch riser to a 48-inch cone section to be placed directly beneath the 48-inch cone.

   d. Transition slabs may be placed a minimum of five (5) feet above the invert shelf for six (6) feet and larger diameter manholes where the slab will be buried. Flat top slabs may be used for six (6) feet and larger diameter manholes, unless the manhole is located within pavement or maintained lawns.

   e. Joints between sections shall be manufactured in accordance with ASTM C-443. Joints may be sealed with rubber gaskets in accordance with ASTM C- 443 or with butyl rubber sealants conforming to Federal Specification SS-S- 210A and AASHTO M-198, Type B.

f. All markings required by ASTM C-478 shall be clearly stamped on the inside of each section.

g. Aggregate shall be sound, crushed, angular granitic stone only, substantially in accordance with ASTM C-33, except that the requirement for gradation in that standard shall not apply. Smooth or rounded stone (river rock) shall not be acceptable.

h. The cement shall be Type II with a maximum tricalcium aluminate (content 8%.) In lieu of Type II cement and granitic aggregate, precast manhole sections may be furnished of Type III cement with calcareous (limestone) aggregate. The manufacturer will submit lab tests certifying the amount of Alkalinity (minimum 78%) present in the complete mix.

i. Manhole riser sections, transition slabs, flat top slabs, and cone sections shall be designed for H-20 loadings.

j. The manufacturer shall furnish the Engineer with test results on compression and absorption for one section in every twenty-five sections poured, and certification from cement manufacturer and aggregate supplier certifying chemical content. The Engineer reserves the right to pick random sections for the required testing.

4. Steps: Manhole steps will be furnished in accordance with Standard Detail Drawings ASTM C-478 and current OSHA regulations. In addition to the testing requirements of ASTM C-478 each step installed in pre-cast manholes will be tested to resist a 1000 lb pullout. The manhole manufacturer will furnish certification of each test with each shipment showing manhole location, date of test, and results.

5. PVC Liner: Where indicated on the plans or elsewhere in these specifications, manholes shall be furnished with a PVC Liner for resistance to corrosive sewers. The liner shall be as hereinbefore specified for RCP.

B. Manhole Frames and Covers:

1. <u>Frames, Covers, And Grates:</u> All manhole frames and covers shall conform to ASTM A-48, Class 30 and shall be manufactured in domestic foundries. Dimensions shall conform to those indicated in specifications and plans.

2. Manhole frames and covers shall be furnished with the common contact surfaces between frame and cover machined. Frames and covers shall be Dewey Brothers RCR 2010, Vulcan VM-83, U.S. Foundry or approved equal

3. Where watertight frames and covers are specified, the watertight seal between frame and cover shall be accomplished by means of a rubber gasket. Watertight frames and covers shall be Dewey Brothers RCR 2010W, Vulcan VM 1383, U.S. Foundry or approved equal

2.06 MISCELLANEOUS STEEL

A. Steel Encasement Pipe

1. Steel Encasement Pipe: Steel pipe shall be welded or seamless, smooth wall or spiralweld, consisting of Grade "B" steel as specified in ASTM A-139.

2. Minimum yield strength shall be 35,000 PSI; and pipe thickness shall be as specified for each individual job.

3. All pipe shall be furnished with beveled ends prepared for field welding of circumferential joints. All burrs at pipe ends shall be removed.

4. Encasement pipe must be approved by the appropriate controlling agency (D.O.T., R.R., etc.) and the Engineer prior to ordering.

B. Steel Vent Pipe

1. Steel Vent Pipe: Unless otherwise specified, steel vents shall be Schedule 40 five- inch (5") diameter steel pipe, consisting of Grade "B" steel as specified in ASTM A- 139.

2. All steel shall be Grade "B" only, with a minimum yield strength of 35,000 P.S.I.

3. The steel pipe shall have an inside coal tar lining 3/32-inch minimum thickness in accordance with AWWA C-203 or a coal tar epoxy lining conforming to that required for steel (aerial creek crossing) pipe.

4. Outside surface of pipe shall be sand or grit blasted to commercial standard and have one (1) coat of zinc chromate primer applied in accordance with Federal Specification TT-86a.

5. Pipe shall be furnished with two (2) evenly applied coats of rust inhibiting enamel paint, either Koppers Glamortex No. 501 Enamel (Olive Green), Southern Coatings Rustaloy No. 0537 Enamel (Garden Green), or equal.

2.07 CONCRETE

A. Portland Cement: All concrete shall conform to the Standard Specifications for READY MIXED CONCRETE, ASTM C-94. An air-entraining admixture, conforming to ASTM C-260, shall be added to either Type I, Type II, or Type III Portland Cement. Fly Ash conforming to ASTM C-618 for Class C Fly Ash may be added to the concrete mix but shall not be considered as replacement for more than 10% of the cement therein (strengths shall not be less than hereinafter required).

1. Types I, IA, III and IIIA Portland Cement shall only be used for manhole inverts, concrete encasement, concrete blocking, and/or as directed by the Engineer, and shall conform to ASTM C-150.

2. Types II and IIA Portland Cement shall be used in precast manholes, cast in place manhole structures, reinforced concrete pipe, reinforced concrete piers and concrete or reinforced concrete rip-rap as directed by the Engineer, and shall conform to ASTM C-150 except that Tricalcium Aluminate content shall not exceed 8%.

B. Aggregates: All aggregates used for concreting shall conform to ASTM C-33 and shall be checked daily for any variances in moisture content. Said variances shall be corrected and/or taken into consideration for each batch

1. Coarse Aggregates: Shall be uniformly and evenly graded for each application in accordance with A.C.I. Standard 318. Unless otherwise approved, aggregate shall be sound, crushed, angular granitic stone. Smooth or rounded stone (river rock) shall not be acceptable.

2. Fine Aggregates: Shall consist of natural sand, manufactured sand or a combination thereof. Fine aggregates shall conform to the sieve analysis as specified in paragraph 4.1 of the standard except that the percent passing a No. 50 sieve shall not exceed 5% and the percent passing a No. 100 sieve shall be 0% as provided for in paragraph 4.2 of the standard.

C. Mix Design: Concrete shall be watertight, resistant to freeze-thaw cycles and moderate sulfate attack, abrasion resistant, workable, and/or finishable. These qualities may be met through the use of admixtures (if and only if approved in the mix design as hereinafter specified) conforming to the appropriate ASTM with the exception of the use of calcium chloride, which shall be limited to no more than 1% by cement weight - thoroughly mixed to insure uniform distribution within the mix. If the concrete is used with reinforcing steel, no calcium chloride will be allowed. The Contractor shall assume responsibility for concrete mixture. When required by the Engineer, and prior to beginning construction, the Contractor, at his expense, shall obtain from an approved commercial testing laboratory a design for a suitable concrete mix and submit same with his list of materials and material suppliers for approval. The concrete shall be proportioned to meet the following requirements: (Note: This mix does not apply "in total" to precast manhole or reinforced concrete pipe).

1. Compressive Strength: Minimum 3600 psi

2. Water-Cement Ratio By Weight: Maximum 0.50

3. Slump: Minimum 3”, Maximum 5”

4. Air Content (Entrained and Entrapped): Minimum 4%, Maximum 6%

5. Course Aggregate: ¾” - 1 ½” (as required by the application)

D. Curing Compound: All concrete curing compounds shall conform to the standard specifications for LIQUID MEMBRANE - FORMING COMPOUNDS FOR CURING CONCRETE, ASTM C-309, Type 2. Curing compounds shall be applied as forms are stripped.

E. Grouts: All grouts shall be of a non-shrink nature (as may be achieved through additives or proportioning) and depending upon application range from plastic to flowable cement water paste. Testing as specified above for concrete may be required for acceptance of grouts to include frequent checks for consistency by a time- of-flow measurement. Expansion grouts shall be either Gilco pre-mixed or Supreme non-metallic grout as manufactured by Gifford-Hill and Company, Incorporated, or Embeco 636 grout as manufactured by Master Builders or equal. Grouts shall be mixed (if applicable) and placed in accordance with the manufacturer's current recommendations, for each specific application. Expansion grouts shall be used only as directed by the Engineer. Acceptable range of testing requirements:

1. Compressive Strength: 10,500 psi to 12,500 psi.

2. Bond Strength: 1,350 psi to 1,700 psi.

3. Percent Expansion: + 0.025% to + 0.75%

F. Mortar: Mortar used in sanitary sewer manholes shall be hydraulic cement mortar in accordance with ASTM C-398. Mortar used in water meter vaults and water valve vaults shall be Type M mortar in accordance with ASTM C-270.

PART 3 EXECUTION

3.01 EARTHWORK

A. Excavating, trenching, and backfilling are specified in Section 312000 Earth Moving.

3.02 EXISTING UTILITIES

A. The Contractor will be required to excavate to determine the precise location of utilities, or other underground obstructions, which are shown on the Construction Plans. Such location and excavation shall be at least 500 feet ahead of construction or as noted in the Special Provision Section of this document.

B. All utility owners will be notified prior to excavation as required by the 1985 Underground Damage Prevention Act. Owners who are members of ULOCO may be notified in accordance with current ULOCO procedures. The Contractor will be fully responsible for damage to any utilities if the owners have not been properly notified as required by the Underground Damage Prevention Act.

C. Utility owners may, at their option, have representatives present to supervise excavation inthe vicinity of their utilities. The cost of such supervision, if any, shall be borne by the Contractor.

D. Conflicts with underground utilities may necessitate changes in alignment and/or grade of this construction. All such changes will be approved by the Engineer before construction proceeds.

E. When underground obstructions not shown on the Construction Plans are encountered, the Contractor shall promptly report the conflict to the Engineer and shall not proceed with construction until the conflict is resolved by the Engineer.

F. When a PVC water main crosses other buried pipeline utilities (storm drain, gas, encased or capped telephone conduit, etc.) 12-inches clearance must be maintained between the waterline and utility and the water main shall receive Type III stone bedding. If this clearance requires the water main to be deeper than 5 feet, the Contractor may install a DIP (galvanized steel pipe for 2-inch mains) water main over the utility with less than 12-inches clearance provided there is 3 feet cover over the water main.

G. Whenever a sewer main crosses over other utility lines (storm drain, gas, encased or capped telephone conduit, etc.) the following will apply:

1. For VCP sewer lines - The sewer line shall be DIP from one foot outside the utility trench with a minimum length of 10 feet.

2. For PVC sewer lines - There shall be one foot clearance from the top of the utility to the bottom of the sewer. If this clearance is not possible the sewer line shall be ductile iron pipe from one foot outside the utility trench with a minimum length of 10 feet.

3.03 SEWER LINE / WATER LINE CLEARANCE

A. When a sewer main or lateral crosses or is parallel to an existing water main, the Contractor shall install ductile iron pipe (including laterals) for the sewer main and water main as described below:

1. Vertical Separation Of Sewer Lines & Water Lines: Whenever it is necessary for a sewer main to cross under a water main with less than 18-inches of vertical separation, the sewer main and water main shall be constructed of ductile iron pipe, with joints meeting water main standards, for a distance of 10 feet on each side of the point of crossing. Whenever it is necessary for a sewer main to cross over a water main, the sewer main and water main shall be constructed of ductile iron pipe, with joints meeting water main standards, for a distance of 10 feet on each side of the point of crossing.

2. Horizontal Separation of Sewer Lines and Water Lines: Sewer mains shall be laid at least 10 feet horizontally from existing or proposed water mains unless local conditions or barriers prevent a 10-foot horizontal separation. In that case, the sewer main will be laid in a separate trench, with the elevation of the bottom of the water main at least 18-inches above the top of the sewer. When these conditions are not met, the sewer main and water main shall be constructed of Ductile Iron Pipe with joints meeting water main standards.

3. Horizontal Separation Of Sewer Lines and Water Wells: Sewer lines shall be installed at least 100 feet from water wells. Where this separation is not possible the sewer line shall be ductile iron pipe. Sewer lines shall not be installed within 25 feet of any private well or within 50 feet of any community well.

3.04 PIPING INSTALLATION

A. General Locations and Arrangements: Drawing plans and details to indicate general location and arrangement of underground sanitary sewer piping. Location and arrangement of piping layout take into account design considerations. Install piping as indicated, to extent practical. Where specific installation is not indicated, follow piping manufacturer's written instructions.

B. In all instances pipe shall be laid in a workmanlike manner, true to line and grade, with bell ends facing up-grade in the direction of laying. The various pipes referred to herein shall be handled, belled up and laid in accordance with the manufacturer's requirements and good engineering practices as defined in the various publications referenced in this document. The following requirements and/or standards of the Town of Smithfield Department shall govern this construction unless exceeded by other regulatory bodies.

C. Install manholes for changes in direction unless fittings are indicated. Use fittings for branch connections unless direct tap into existing sewer is indicated.

D. Install proper size increasers, reducers, and couplings where different sizes or materials of pipes and fittings are connected. Reducing size of piping in direction of flow is prohibited.

E. When installing pipe under streets or other obstructions that cannot be disturbed, use pipe-jacking process of microtunneling.

F. Pipe Bedding: Unless otherwise specified or noted on the Plans the following bedding classes are as commonly required by this Department. When granular material embedment is required, the Contractor will follow the layered procedure specified in Type I for soil placement, above the granular bedding, to an elevation one (1) foot above the top of the pipe bell.

1. Type I - Shaped Bottom Bedding: The trench bottom shall be shaped so the pipe bears uniformly upon undisturbed native earth. Soil shall then be placed by hand around the pipe and completely under the pipe haunches in uniform layers not exceeding six (6) inches in depth up to an elevation one (1) foot above the top of the pipe bell. Each layer shall be placed and then carefully and uniformly tamped, so that the pipe is not damaged nor the alignment disturbed.

2. Type II - Granular Material Embedment: The trench bottom shall be undercut a minimum of six (6) inches below the pipe barrel grade and filled with an approved stone to an elevation such that the pipe will be completely and uniformly bedded to a vertical height of one-third the outside diameter of the pipe bell for the pipe's entire length and for the entire width of the ditch. Depending upon soil and ground water conditions, greater depths (undercut) may be required to create a stable condition. Type II granular material embedment shall be used as directed by the Engineer.

3. Type III - Granular Material Embedment: The trench bottom shall be undercut a minimum of six (6) inches below the pipe barrel grade and filled with an approved stone to an elevation such that the pipe will be completely and uniformly bedded to vertical height of one-half the outside diameter of the pipe bell for the pipe's entire length and for the entire width of the ditch. Depending upon soil and ground water conditions, greater depths (undercut) may be required to create a stable condition. Type III granular material embedment shall be used as directed by the Engineer.

4. Stone Stabilization: When the bottom of the trench is not sufficiently stable to prevent vertical or lateral displacement of the pipe after installation with Type II or Type III bedding, stone stabilization will be required to develop a non- yielding foundation for the bedding and pipe. When such conditions are encountered, the trench will be excavated to a depth determined by the Engineer, and #467 crushed stone will be placed to an elevation six-inches below the bottom of the pipe. The pipe will then be laid with Type II or Type III bedding as directed by the Engineer.

5. Concrete Encasement and Cradles: Shall be as designed for each individual case and will be noted on the Plans and in the Special Provisions when applicable.

G. Install gravity-flow, non-pressure piping according to the following:

1. Installation Depth Limitations: The following are limitations and bedding requirements for supportive strength and shall be adhered to at all times. Granular material embedment may still be required for lesser depths of cover should groundwater and/or soil conditions warrant its use, as determined by the Engineer. Deviations from the standard trench width shall be as approved by the Engineer. Trench widths must be maintained constant as measured at the top of the pipe. Deviation from the standard trench width will necessitate an increase in the stone bedding around the pipe and/or a change in the type or class of pipe being installed at the Contractor's expense.

a. The standard trench width for 8"-15" pipe shall be limited to the nominal pipe size plus 30-inches.

b. The standard trench width for 18"-30" pipe shall be limited to the nominal pipe size plus 36-inches.

c. The standard trench width for 36" and larger pipe shall be limited to the nominal pipe size plus 42-inches.

2. All pipes regardless of bedding or pipe type shall require adequate tamping of backfill as specified for Type I, Shaped Bottom Bedding.

a. Ductile Iron Pipe: Installation of Ductile Iron Pipe shall be installed subject to the bedding limitations specified below, based on a deflection limit of three (3) percent for cement lining. Greater depths of cover may be achieved by using a higher pressure classification and/or using pipe with a flexible lining.

1) 10-inch diameter pipe (Class 350) maximum depth of cover: 20’ (Type I Bedding), 34’ (Type II Bedding), 50’ (Type III Bedding).

2) 16-inch diameter pipe (Class 250) maximum depth of cover: 15’ (Type I Bedding), 24’ (Type II Bedding), 34’ (Type III Bedding).

3) 24-inch diameter pipe (Class 250) maximum depth of cover: 15’ (Type I Bedding), 20’ (Type II Bedding), 29’ (Type III Bedding).

b. Poly Vinyl Chloride (PVC) Pipe: PVC pipe shall be installed with a minimum of 3.0 feet of cover and a maximum of 20 feet of cover. When the cover is less than 3.0 feet or more than 20 feet, Ductile Iron Pipe must be used subject to the specified limits. PVC pipe shall be installed in accordance with ASTM D-2321 with the following limitations:

1) All PVC pipe shall be installed using Type III Granular Embedment. The bedding shall extend from the pipe to the trench wall or to two and one half pipe diameters (OD) on each side of the pipe, whichever is less.

3. Grade and Line For Pipe: As a minimum, centerline hubs will be set at each manhole and offset stakes set at each manhole, and if required at 100 foot intervals between manholes. Cut sheets will show the vertical distance from the offset stakes to the inlet and outlet pipe invert at each manhole and to the pipe invert at each offset stake. Grade and line may be transferred to "batter boards" set at intervals not to exceed fifty (50) feet. Unless otherwise approved by the Engineer, three (3) batter boards will be in place at all times while pipe laying is in progress. Each joint shall be checked with a grade rod and plumb line with care being taken to keep the string line taut at all times. Laser beams may be used to set line and grade when the Contractor provides adequate and accurate equipment for the Engineer to check his line and grade at each cut stake (lock levels shall not be considered adequate). If laser equipment is used, the grade shall be checked at each manhole and at benchmarks every 500 feet. The Contractor shall keep close check of his laser for variations in line and grade. No variations between manholes shall be corrected without relaying that portion of line which has deviated from line or grade unless otherwise approved by the Engineer.

H. Install force-main, pressure piping according to the following:

1. Depth of Pipe Installation: Unless otherwise indicated on Plans, or required by existing utility location, all pipe will be installed with the top of the pipe at least 3.0' below the edge of adjacent roadway pavement or 3.0' below the ground at the pipe, whichever is greatest. The Contractor is instructed to check the construction plans and blow-up views for additional requirements. The maximum depth of cover for the previously specified pressure classifications shall be as follows:

   a. Type I Bedding: 10 feet

   b. Type II Bedding: 15 feet

   c. Type III Bedding: 20 feet

2. The Contractor may be required to vary the depth of pipe to achieve minimum clearance from existing utilities while maintaining the minimum cover specified whether or not the existing pipelines, conduits, cables, mains, etc. are shown on the Plans.

3. Alignment and Grade: The pipe shall be installed as shown on the plans unless an obstruction prevents such alignment or grade. The Contractor will be required to adjust the location of the pipe where possible to avoid such conflicts as specified and as directed by the Engineer. All construction layout and surveying which may be required for construction shall be provided by the Contractor and any costs associated shall be included in the various pay items of the proposal. The Contractor is responsible for determining the amount of construction layout and surveying that may be required to complete construction.

4. Installation and Assembly: Proper implements, tools, and facilities satisfactory to the Engineer shall be provided and used by the Contractor for the safe and convenient prosecution of the work. All pipe, fittings, valves and hydrants shall be carefully lowered into the trench piece by piece by means of a backhoe or other suitable means, in such a manner as to prevent damage to protective coatings and linings. Under no circumstances shall pipe materials be dropped or dumped into the trench.

5. Inspection of Material: The pipe and fittings shall be inspected for defects.

6. Cleaning Pipe and Fittings: All lumps, blisters and excess coatings shall be removed from the bell and spigot ends of each pipe, and the outside of the spigot and the inside of the bell shall be wire- brushed and wiped clean and dry and free from oil and grease before the pipe is laid.

7. Laying Pipe: Pipe shall be laid with bell ends facing in the direction of laying, unless otherwise approved by the Engineer. Every precaution shall be taken to prevent foreign material from entering the pipe while it is being placed. If the pipe laying crew cannot put the pipe into the trench and in place without getting earth into it, the Engineer may require that before lowering the pipe into the trench, a heavy, tightly woven canvas bag of suitable size shall be placed over each end and left there until the connection is to be made to the adjacent pipe. During laying operations, no debris, tools, clothing or other materials shall be placed in the pipe. After placing a length of pipe in the trench, the spigot end shall be centered in the bell and the pipe forced home and brought to correct line

and grade. The pipe shall be secured in place with approved backfill material tamped under it except at the bells. Precautions shall be taken to prevent dirt from entering the joint space. At times when pipe laying is not in progress, the open ends of pipe shall be closed by a watertight plug or other means approved by the Engineer. This provision shall applyduring the noon hours as well as overnight. If water is in the trench, the seal shall remain in place until the trench is pumped completely dry.

8. Permissible Deflection of Joints: Wherever it is necessary to deflect pressure pipe from a straight line, either in the vertical or horizontal plane, to avoid obstruction or plumb valve stems, or where long radius curves are permitted, the amount of deflection allowed shall not exceed that required for satisfactory sealing of the joint as recommended by the manufacturer, and shall be approved by the Engineer.

9. Installation of Push-On Joint Pipe: The gasket groove and bell socket shall be cleaned and lubricated, and the gasket inserted as specified by the pipe manufacturer. Sterile lubricant, as furnished or specified by the manufacturer shall be applied to the gasket and beveled spigot end of the pipe. The beveled spigot end of pipe shall be pushed straight into bell using either a bar, jack, lever puller, or backhoe. A timber header will be placed between the jack or backhoe bucket and the pipe to prevent damage to the pipe. At no time will the joint be made by swinging the pipe. The pipe will be deflected, if required, after the joint is made.

10. Installing Mechanical Joint Pipe and Fittings: All spigots shall be centrally located in the bell and adequate anchorage shall be provided where abrupt change in direction and dead ends occur. All pipe surfaces with which the rubber gasket seals come into contact will be brushed with a wire brush just prior to assembly in order to remove all loose rust or foreign material and to provide a clean surface for the installation of the gasket. The pipe surface with which the gasket comes into contact and the gasket will be brushed with soapy water just prior to the installation of the gasket and the making up of the joint. Torque loads shall be applied to the standard cast iron bolts used in making the joint as follows:

    a. 5/8” Bolt: 40-60 Ft lbs. of Torque

    b. 3/4” Bolt: 60-90 Ft lbs. of Torque

    c. 1” Bolt: 70-100 Ft lbs. of Torque

    d. 1-1/4” Bolt: 90-120 Ft lbs. of Torque

11. The above torque loads may be applied with torque measuring or indicating wrenches. Torque wrenches may be used to check the application of approximate torque loads applied by men trained to give an average pull on a definite length of regular socket wrench. The following lengths of wrenches should satisfactorily produce the above ranges of torques when used by the average man:

    a. 5/8” Bolt: 8” wrench length

    b. 3/4” Bolt: 10” wrench length

    c. 1” Bolt: 12” wrench length

d. 1-1/4” Bolt: 14” wrench length

12. When tightening bolts, the gland will be brought up toward the pipe flange evenly, maintaining approximately the same distance between the gland and the face of the flange at all points around the socket.

13. Bend and Fitting Location: The Contractor is advised that the bends and fittings indicated on the plans are for a guide only. The Contractor will be required to furnish additional bends and fittings as needed to complete all installations.

14. Cutting Pipe: The cutting of pipe for inserting valves, fittings, or closure pieces shall be done in a neat and workmanlike manner without damage to the pipe or cement lining and so as to leave a smooth end at right angles to the axis of the pipe. Cut ends of a pipe shall be beveled before installation in a push-on joint bell. When making connections to existing mains which require water mains to be removed from service, automatic traveling pipe cutting machines will be required on pipe 16- inch and larger. At other times, hand-held pipe saws may be used provided the pipe is marked, prior to cutting, such as to provide a cut at right angles to the axis of the pipe. Handheld pipe saws may be used in all applications for cutting pipe smaller than 16- inch. Flame cutting of pipe with an acetylene torch will not be allowed.

15. PVC Pipe Installation: PVC pipe shall be installed in accordance with the Recommended Practice for the Installation of PVC Pressure Pipe UNI-B-3 and AWWA C-900. Backfill shall be as specified elsewhere in these specifications.

16. Force main shall remain ductile iron pipe until outside of station fencing area.

I. Clear interior of piping and manholes of dirt and superfluous material as work progresses. Maintain swab or drag in piping, and pull past each joint as it is completed. Place plug in end of incomplete piping at end of day and when work stops.

3.05 PIPE JOINT CONSTRUCTION

A. Join gravity-flow, non-pressure, drainage piping according to the following:

1. Join hub-and-spigot, cast-iron soil piping with gasket joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.

2. Join hub-and-spigot, cast-iron soil piping with calked joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for lead and oakum calked joints.

3. Join hubless cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-coupling joints.

4. Join ductile-iron, gravity sewer piping according to AWWA C600 for push-on joints.

5. Join ABS sewer piping according to ASTM D 2321 for elastomeric-seal joints.

6. Join PVC cellular-core sewer piping according to ASTM D 2321 and ASTM F 891 for solvent-cemented joints.

7. Join PVC corrugated sewer piping according to ASTM D 2321.

8. Join PVC profile sewer piping according to ASTM D 2321 for elastomeric-seal joints or ASTM F 794 for gasketed joints.

9. Join PVC Type PSM sewer piping according to ASTM D 2321 and ASTM D 3034 for elastomeric-seal joints or ASTM D 3034 for elastomeric-gasket joints.

10. Join PVC gravity sewer piping according to ASTM D 2321 and ASTM D 3034 for elastomeric-seal joints or ASTM D 3034 for elastomeric-gasket joints.

11. Join fiberglass sewer piping according to ASTM D 4161 for elastomeric-seal joints.

12. Join nonreinforced-concrete sewer piping according to ASTM C 14 (ASTM C 14M) and ACPA's "Concrete Pipe Installation Manual" for rubber-gasket joints.

13. Join reinforced-concrete sewer piping according to ACPA's "Concrete Pipe Installation Manual" for rubber-gasket joints.

14. Join dissimilar pipe materials with non-pressure-type, flexible[**or rigid**] couplings.

B. Join force-main, pressure piping according to the following:

1. Join ductile-iron pressure piping according to AWWA C600 or AWWA M41 for push-on joints.

2. Join ductile-iron special fittings according to AWWA C600 or AWWA M41 for push-on joints.

3. Join PVC pressure piping according to AWWA M23 for gasketed joints.

4. Join PVC water-service piping according to ASTM D 2855.

5. Join dissimilar pipe materials with pressure-type couplings.

3.06 MANHOLE INSTALLATION

A. General: Install manholes complete with appurtenances and accessories indicated.

B. All manholes outside street rights-of-way or landscaped areas shall be constructed to a height of two (2) feet above the adjacent ground unless otherwise indicated on the Plans or by the Special Provisions. Manholes within street rights-of-way or landscaped areas shall have finished rim elevations flush with the pavement or adjacent finished grade. After final inspection is complete and all deficiencies have been corrected, the Contractor shall seal all manholes (rings to covers) with penetration type asphaltic cement No. AC-20 as manufactured by Exxon Oil Company or equal.

1. <u>Precast Reinforced Concrete Structures</u>: All precast manhole sections shall conform to the Material Specifications and Standard Details. Precast manholes shall be treated similar to reinforced concrete pipe for installation. That is, if ground water and/or soil conditions require stabilization for pipe installation comparable measures will be required for precast

manhole installation. Under no circumstances will a precast base section be placed on unstable soil as solely determined by the Engineer. Jointing of precast sections will be done in accordance with the manufactures recommendation, with special attention called to the amount of force used. All backfill around structures shall be thoroughly tamped in layers as specified for placing backfill. Regardless of the type manhole construction used, the Contractor will do that which is necessary to stabilize the soil intended to support the structure. A stable condition shall only be so adjudged by the Construction Engineer or his authorized representative. Any cost incurred by the Contractor in stabilizing the area to support a manhole shall be considered incidental to the manhole construction.

2. Outside Drops: When design considerations dictate a large elevation change across a manhole, an outside drop shall be constructed. Depending on the particular fittings used, elevation differences of 2.0 to 2.5 feet are required to accommodate an outside drop. When there is not sufficient elevation difference to permit construction of an outside drop, the grade of the influent pipe shall be lowered such that the vertical separation of the influent and effluent pipes is 0.2 feet, as measured at the center of the manhole when the grades of both pipes are projected to that point. Outside drops shall not enter the cone section of precast manholes.

3. Inside Drops: When connecting a proposed sewer main to an existing manhole at an elevation significantly higher than the existing invert elevation, and where safety considerations or working space limitations preclude building an outside drop, the connection may be made with an inside drop constructed in conformance with the Standard Details. Inside drops will be used only where shown on the plans or specifically approved by the Engineer. They may not be used in lieu of outside drops shown on the plans. Inside drops shall not enter the manhole in the cone section. Inside drops are not allowed on four (4) feet diameter manholes.

4. Installation Of Frames And Covers: The frame shall be installed on the manhole with anchor bolts on all manholes that are not flush with the ground. 8-inch tall or 4-inch tall frames may be used for manholes with bolt down frames. These frames shall have four (4) holes in the support flange to permit installation on the cone with anchor bolts. Holes shall be equally spaced in the flange. Complete anchor bolt assemblies shall be zinc plated steel and shall consist of a drive in type anchor sleeve, a threaded stud and two nuts. Anchors shall be installed in field drilled holes in the cone. Minimum diameter of the threaded stud shall be 1/2 inch. The Contractor shall seal the frame to the manhole by installing a length of butyl rubber joint sealant to form a gasket between frame and manhole. The butyl rubber joint sealant shall have a one inch cross section, and shall make two full circles when placed on the cone section, and shall be compressed by the frame with the anchor bolts. Butyl rubber joint sealant shall be "Rubber Seal" as manufactured by Ru Van, Inc., or approved equal. Cement mortar grouting of the frame shall be required. Brick may not be used to adjust rim elevations of above grade manholes. Manholes that are installed flush with pavement or grade shall have frames attached to the manhole with a bed of cement mortar grout. 8-inch tall frames are required for all manholes that are flush with pavement or finished grade unless otherwise approved. Standard size brick or reinforced concrete grade rings may be used to adjust the finished rim elevation of such manholes. This adjustment may not exceed 21-inches in height.

5. Manhole Step Testing: The Contractor will furnish a hydraulic driven system consisting of cylinder, connecting hose and above ground pump with gauge to test manhole steps to exceed 1000 lbs. of resistance of pullout. All field installed steps will be tested. In lieu of

field testing steps installed at the plant, certified shop reports by the manufacturer showing that each step passed the required 1000 lb. pullout will be accepted. The certificates will be furnished to the Inspector prior to field installation. Unless the Contractor can furnish the manufacturer's certification on step tests, the Contractor will be required to test 10% of the plant installed steps. An additional 10% will be tested for each failure.

6. False Walls: False walls shall be constructed in manholes when specified on the Plans. Holes of the appropriate size shall be cored or blocked out in the manhole wall at the elevation and alignment shown on the Plans. A four-inch thick masonry wall shall be constructed in the opening. Inverts shall be constructed to match proposed pipe elevations and alignments and permit installation of the future extension without demolition work other than removal of the false wall.

7. Steel Vent Pipes: Steel vent pipes will be installed in accordance with the Standard Details. Shop drawings of strap on vents, mounting straps, and anchor bolts will be subject to approval of the Engineer. Material shall be as specified in the Materials Specification Section.

C. Form continuous concrete channels and benches between inlets and outlet.

3.07 STEEL ENCASEMENT

A. Interpretation of soil investigation reports and data, investigating the site and determination of the site soil conditions prior to bidding is the sole responsibility of the Contractor. Any subsurface investigation by the Bidder or Contractor must be approved by the appropriate authority having jurisdiction over the site. Rock and/or water, if encountered, shall not entitle the Contractor to additional compensation.

B. Casing construction shall be performed so as not to interfere with, interrupt or endanger roadway surface and activity thereon, and minimize subsidence of the surface, structures, and utilities above and in the vicinity of the casing. Support the ground continuously in a manner that will prevent loss of ground and keep the perimeters and face of the casing, passages and shafts stable. The Contractor shall be responsible for all settlement resulting from casing operations and shall repair and restore damaged property to its original or better condition at no cost to the Owner.

C. Face Protection: The face of the excavation shall be protected from the collapse of the soil into the casing.

D. Casing Design: Design of the bore pit and required bearing to resist jacking forces is the responsibility of the Contractor. The excavation method selected shall be compatible with expected ground conditions. The lengths of the casing shown on the Drawings are the minimum lengths required. The length of the casing may be extended for the convenience of the Contractor, at no additional cost to the Owner.

E. Groundwater Control

1. The Contractor shall control the groundwater throughout the construction of the casing.

2. Methods of dewatering shall be at the option and responsibility of the Contractor. Maintain close observation to detect settlement or displacement of surface facilities due

to dewatering. Should settlement or displacement be detected, notify the Engineer immediately and take such action as necessary to maintain safe conditions and prevent damage.

3. When water is encountered, provide and maintain a dewatering system of sufficient capacity to remove water on a 24 hour basis keeping excavations free of water until the backfill operation is in progress. Dewatering shall be performed in such a manner that removal of soil particles is held to a minimum.

F. Safety

1. Provide all necessary bracing, bulkheads and shields to ensure complete safety to all traffic, persons and property at all times during the work. Perform the work in such a manner as to not permanently damage the roadbed or interfere with normal traffic over it.

2. Observe all applicable requirements of the regulations of the authorities having jurisdiction over this site. Conduct the operations in such a manner that all work will be performed below the level of the roadbed.

3. Perform all activities in accordance with the Occupational Safety and Health Act of 1970 (PL-596), as amended, applicable regulations of the Federal Government, OSHA 29CFR 1926 and applicable criteria of ANSI A10.16-81, "Safety Requirements for Construction of Tunnel Shafts and Caissons".

G. Boring and Jacking

1. Shaft

a. Conduct boring and jacking operations from a shaft excavated at one end of the section to be bored. Where conditions and accessibility are suitable, place the shaft on the downstream end of the bore.

b. The shaft shall be rectangular and excavated to a width and length required for ample working space. If necessary, sheet and shore shaft properly on all sides. Shaft sheeting shall be timber or steel piling of ample strength to safely withstand all structural loadings of whatever nature due to site and soil conditions. Keep preparations dry during all operations. Perform pumping operations as necessary.

c. The bottom of the shaft shall be firm and unyielding to form an adequate foundation upon which to work. In the event the shaft bottom is not stable, excavate to such additional depth as required and place a gravel sub-base or a concrete sub-base if directed by the Engineer due to soil conditions.

2. Jacking Rails and Frame

a. Set jacking rails to proper line and grade within the shaft. Secure rails in place to prevent settlement or movement during operations. The jacking rails shall cradle and hold the casing pipe on true line and grade during the progress of installing the casing.

b. Place backing between the heels of jacking rails and the rear of the shaft. The backing shall be adequate to withstand all jacking forces and loads.

c. The jacking frame shall be of adequate design for the magnitude of the job. Apply thrust to the end of the pipe in such a manner to impart a uniformly balanced load to the pipe barrel without damaging the joint ends of the pipe.

3. Boring and jacking of casing pipes shall be accomplished by the dry auger boring method without jetting, sluicing or wet-boring.

4. Auger the hole and jack the casing through the soil simultaneously.

5. Bored installations shall have a bored-hole diameter essentially the same as the outside diameter of the casing pipe to be installed.

6. Execute boring ahead of the casing pipe with extreme care, commensurate with the rate of casing pipe penetration. Boring may proceed slightly in advance of the penetrating pipe and shall be made in such a manner to prevent any voids in the earth around the outside perimeter of the pipe. Make all investigations and determine if the soil conditions are such as to require the use of a shield.

7. As the casing is installed, check the horizontal and vertical alignment frequently. Make corrections prior to continuing operation. For casing pipe installations over 100 feet in length, the auger shall be removed and the alignment and grade checked at minimum intervals of 60 feet.

8. Any casing pipe damaged in jacking operations shall be repaired, if approved by the Engineer, or removed and replaced at Contractor's own expense.

9. Lengths of casing pipe, as long as practical, shall be used except as restricted otherwise. Joints between casing pipe sections shall be butt joints with complete joint penetration, single groove welds, for the entire joint circumference, in accordance with AWS recommended procedures. Prior to welding the joints, the Contractor shall ensure that both ends of the casing sections being welded are square.

10. The Contractor shall prepare a contingency plan allowing the use of a casing lubricant, such as bentonite, in the event excessive frictional forces jeopardize the successful completion of the casing installation.

11. Once the jacking procedure has begun, it should be continued without stopping until completed, subject to weather and conditions beyond the control of the Contractor.

12. Care shall be taken to ensure that casing pipe installed by boring and jacking method will be at the proper alignment and grade.

13. The Contractor shall maintain and operate pumps and other necessary drainage system equipment to keep work dewatered at all times.

14. Adequate sheeting, shoring and bracing for embankments, operating pits and other appurtenances shall be placed and maintained to ensure that work proceeds safely and

expeditiously. Upon completion of the required work, the sheeting, shoring and bracing shall be left in place, cut off or removed, as designated by the Engineer.

15. All surplus material shall be removed from the right-of-way and the excavation finished flush with the surrounding ground.

16. Grout backfill shall be used for unused holes or abandoned pipes.

H. Ventilation and Air Quality: Provide, operate and maintain for the duration of casing project a ventilation system to meet safety and OSHA requirements.

I. Installation of Pipe

1. After construction of the casing is complete, and has been accepted by the Engineer, install the pipeline in accordance with the Drawings and Specifications.

2. Check the alignment and grade of the casing and prepare a plan to set the pipe at proper alignment, grade and elevation, without any sags or high spots.

3. The pipe shall be supported within the casing by use of casing spacers sized to limit radial movement to a maximum of 1-inch. Provide a minimum of two casing spacers per nominal length of pipe. Casing spacers shall be attached to the pipe at maximum 18 to 20 foot intervals. Casing spacers shall also be provided within two feet of each end of the casing.

4. Close the ends of the casing pipe with masonry brick and mortar seal, minimum 8-inches thick, at both ends of casing.

5. Leave a weephole opening at the bottom of the lowest bulkhead end for drainage of the annular space.

J. Sheeting Removal: Remove sheeting used for shoring from the shaft and off the job site. The removal of sheeting, shoring and bracing shall be done in such a manner as not to endanger or damage either new or existing structures, private or public properties and also to avoid cave-ins or sliding in the banks.

K. Coatings: Unless otherwise shown on the construction plans, casing pipe installed under State and/or City maintained roadways shall not require a protective coating.

3.08 CONCRETE PLACEMENT

A. Place cast-in-place concrete according to ACI 318.

B. Acceptance of Concrete: Concrete shall be accepted on the basis of its meeting the requirements listed under the Material Specifications and Detail Specifications Section of this contract. The Inspector will accept no ready mix concrete without the plant dispatch ticket. The Engineer shall make or require any tests as he deems necessary to insure that the concrete meets specifications. Such tests may be performed by materials technicians hired by the Contractor or the Engineer may require the test to be performed by an independent testing laboratory at the Contractor's expense.

C. Placement: Concrete will not be accepted if it cannot be placed within ninety (90) minutes of the dispatch time. Time requirements may fluctuate marginally due to temperature. Concrete shall be deposited in such a manner so as to prevent contamination by foreign material and segregation due to rehandling or flowing. Segregated concrete and/or concrete containing foreign material will not be accepted. Depositing will not be permitted when temperature has not exceeded 35 and rising by 10:00 A.M. Depositing shall cease when the descending air temperature in the shade falls below 40 F. It shall not resume until the ascending air temperature rises to 35 F. All concrete shall be kept from freezing by the Contractor. Frozen concrete shall be replaced at the Contractor's expense. Free fall shall not exceed 3 feet in any case.

D. Forms: Forms may be made of wood, plywood, metal, or any other material approved by the Engineer. Forms shall be mortar tight, of material strong enough to resist noticeable deflection or bulging between supports, and the interior dimensions of the forms shall be such that the finished concrete shall be of the form and dimensions shown on the Plans. The design of the forms shall take into account the effect of vibration of concrete as it is placed and also the rate of speed at which the forms will be filled. Forms shall be coated with a lubricant as approved by the Engineer. Mechanical vibrators, of an approved type, and continuous spading and/or rodding of concrete shall be used to produce proper contact of concrete with forms and reinforcing steel in piers and with forms and pipe in monolithic inverts insuring a compact, dense and impervious artificial stone of uniform texture.

E. Curing: All concrete will be cured for a seven (7) day period after placement according to the following procedure:

1. Forms will normally be left in place for the entire seven (7) day period. Exposed surfaces not covered by forms will be kept moist continuously for the entire seven day period or will be cured through use of an approved curing compound which will be applied after all surface water has disappeared.

2. At the discretion of the Engineer, forms may be removed after the initial set and before the end of the seven day period. In such cases, the areas previously covered by forms shall be cured as described above.

3. At the discretion of the Engineer, forms may be removed after the initial set and before the end of the seven day period. In such cases, the areas previously covered by forms shall be cured as described above.

F. At the discretion of the Engineer, forms may be removed after the initial set and before the end of the seven day period. In such cases, the areas previously covered by forms shall be cured as described above

G. Testing: The following tests will be performed by third party technicians to ensure the concrete quality

1. Compressive strength in accordance with ASTM C-31 and ASTM C-39. Test cylinders which are formed in the field will be left in the field until compression testing (7 day, 14 day, 28 day) is completed thereby more closely approximately the curing conditions of the field placed concrete.

2. Slump Test in accordance with ASTM C-143.

3. Air Content Test in accordance with either ASTM C-173 or ASTM C-231.

3.09 CONNECTIONS TO EXISTING SEWERS

A. Tie-ins to existing activated sewer lines will be allowed when proper precautions are taken to protect the existing main. Tie-ins to existing unactivated sewer lines not installed under the same contract will not be allowed without written approval from all parties involved (Town of Smithfield, contractors, contract holders, etc.). The Contractor will be required to install watertight masonry plugs in the proposed pipeline at the existing manhole and at the first proposed manhole until all construction is completed and testing begun. If the proposed sewer does not begin at an existing manhole, a straddle type manhole as shown on the Standard Details will be constructed over (and around) the undisturbed existing pipeline and the proposed pipeline plugged as specified. The existing pipeline will not be broken-out and the new invert formed until all testing has been successfully completed. Any connection with 18-inch and smaller pipe at an existing precast or cast-in-place manhole will require the Contractor to corethe necessary opening through the manhole wall. Connections to existing manholes with 21- inch and larger pipe may be cored or sawed as approved by theEngineer.

1. Temporary Watertight Plugs: The Contractor shall install temporary watertight plugs in the proposed sewer line at any manhole that is incomplete, at the open end of the pipeline prior to leaving the job site daily and elsewhere as dictated by good engineering and construction practices. All installed pipe shall be backfilled or otherwise securely tied down to prevent flotation in the event water enters or rises in the trench. The plugs as installed shall prevent infiltration or the introduction of any foreign material into either the existing or proposed systems. The City will not accept any pipeline or manhole which contains any silt, sedimentation or other foreign material, within. The Contractor shall at his own expense flush, or otherwise cause the line (and manholes) to be cleaned out without any discharge into the existing system. Upon completion of all construction, the Contractor will be responsible for the complete removal of all watertight plugs, in the sequence necessary to allow testing and subsequent activation, all under the direction of the Engineer.

2. Scheduling: When the flow of an existing sewer must be interrupted and/or bypassed, the Contractor shall, before beginning any construction, submit a work schedule which will minimize the interruption and/or bypassing of wastewater flow during construction. This schedule must be approved by the appropriate controlling agencies and Engineer and may require night, holiday, and/or weekend work.

3. Bypass Pumping: If pumping is required, an identical standby pump shall be on site in the event of failure of the primary pump. If, at any time during construction, effluent from the existing sewer is not fully contained by the bypass system, gravity service will be restored by a temporary tie to the new construction and work shall be suspended until the problem is resolved to the satisfaction of the Engineer. The Contractor shall be responsible for any fines levied as a result of effluent reaching the creek. The Contractor will be required to verify his method of handling sewer flows during construction by pumping at peak flows for 1 hour as approved by the Engineer.

3.10 CLOSING ABANDONED SANITARY SEWER SYSTEMS

A. The following requirements shall apply for proposed abandonment of existing facilities unless otherwise shown on the plans or approved by the Engineer. All areas disturbed by abandonment will be restored.

1. Abandonment Of Existing Manholes: Manholes which are to be abandoned will first have both influent and effluent lines plugged inside the manhole with watertight masonry. The manhole will then be filled with non-compressible material (#67 stone or as approved), to a point three feet (3'-0") below the finish grade. The remainder of the manhole shall be broken down and removed. Then the excavation shall be filled to finish grade with suitable soil compacted in place.

2. Abandonment Of Mains At Manholes Which Remain In Service: Abandoned mains at active manholes shall be completely disconnected from the manhole by cutting the pipe outside the manhole and then plugging the abandoned main and the manhole wall with watertight masonry. The invert shall then be rebuilt to conform with the standard details.

3. Abandonment Of Exposed Pipe: Exposed sections of abandoned mains shall be removed to a point not less than 5 feet into the adjacent banks. The remaining ends of the pipe shall be plugged with watertight masonry. Concrete piers or collars in the creek channel shall be removed completely. Concrete piers or collars not located in the creek channel shall be removed to a point three feet (3'-0") below the finish grade. Steel piers shall be cut off three feet (3'-0") below finish grade.

4. Abandonment Of Existing Pump Stations: Pumps, motors, controls, etc., shall be salvaged and transported by the Contractor to the sewer maintenance yard at 3001 Wilmont Road. All influent and effluent pipes shall be plugged with watertight masonry. The pump chamber and wetwell (if abandoned) will be filled with non- compressible material (#67 stone or as approved), to a point three feet (3'-0") below the finish grade. The remainder of the structure shall be broken down and removed. Then the excavation shall be filled to finish grade with suitable soil compacted in place. All above ground structures associated with the pump station, including fencing and the access road shall be removed and the area restored.

B. Backfill to grade according to Section 312000 Earth Moving.

3.11 PIPE MARKING AND IDENTIFICATION

A. The installation of tracer wire is required on all underground pipe installed under this contract, including both sewer and water. Tracer wire shall be installed on all water and all wastewater pipe regardless of pipe material including: water distribution, wastewater collection, wastewater force main, low pressure sewer and gray water systems and shall also include all water and sewer service laterals.

B. Sewer and force main tracer wire – all sewer and force mains, regardless of size or pipe material, shall be installed with a tracer wire. The tracer wire shall be AWG #12 gauge solid copper tracer wire with 30 mils green HDPE insulation. The wire shall begin at the connections to the pump station and shall extend along the entire length of new pipe installed.

1. Splicing or Joining: When joining two sections of tracer wire they are to be joined by a double overhand knot.

2. When joining two sections of tracer wire a weatherproof wire not will be used to connect each end.

3. Tracer wire will be placed at the crown of each pipe.

4. Tracer wire will be secured to the pipe every 10’.

5. A 24” pigtail will be provided in each manhole, vault, valve box or any structure exposed to daylight.

3.12 GRAVITY SEWER, MANHOLE, AND FORCE MAIN TESTING AND INTERNAL INSPECTION

A. Sewer Lines and Manholes: The Contractor shall provide proper ventilation of sewer lines and manholes during any test or inspection procedure. The Contractor shall be responsible for providing all equipment and personnel necessary to comply with OSHA confined spaces regulations.

1. Gravity Sewer Pipe Leakage Testing: No sooner than 10 days following completion of backfill, the Contractor along with the project inspector will be required to determine the level of the ground water table. If the level of ground water table is above the top of the pipe, the sewer line shall be tested for infiltration. If there is no ground water above the top of the pipe the sewer line shall be low pressure air tested. Each test shall be performed as follows:

   a. Infiltration: Weirs are to be furnished by Town of Smithfield and installed by the Contractor. The infiltration shall not exceed 100 gallons per day per inch diameter per mile as measured for a reach of pipe the same diameter up to one mile long. However, when excessive infiltration can be isolated to a particular section (manhole-manhole) the limit will be applied to that section. There shall be no visible points of infiltration. Any section (manhole-manhole) must be isolated and tested separately if so directed by the Engineer. The Town of Smithfield Department reserves the right to TV any sewer line to detect sources of infiltration.

   b. Low Pressure Air Test: Tests shall be performed in accordance with ASTM C- 828 and C-924 on sewer lines 42-inches in diameter and smaller. Test pressure will be measured by gauges furnished by Town of Smithfield and installed by the Contractor above ground at the manhole opposite the air supply. The Contractor shall furnish all other test equipment required including connecting hoses at the Town of Smithfield supplied gauge. Sewer lines larger than 42-inches in diameter shall be tested for infiltration as specified above and each joint shall be visually inspected by a Town of Smithfield representative.

2. Manhole Leakage Testing: Manholes shall be tested by plugging the inlet and outlet pipes with airtight plugs and using one of the following procedures:

   a. Exfiltration: Fill the manhole to the rim with water and allow the level to equalize due to saturation. Refill the manhole and mark the level to begin the test. The test shall last at least 2 hours and allowable leakage shall be 3 gallons per hour. The Engineer will select 25% of the manholes on the project to be tested. If any manhole fails, an additional manhole will be tested. Manholes that fail the test shall be repaired as specified and retested until theypass.

   b. Vacuum Air: Manhole vacuum air testing shall be performed in accordance with ASTM C-1244. The Engineer will select 25% of the manholes on the project to be tested. Manholes that fail the test shall be repaired as specified and retested until they pass. Manholes that show leaks and are repaired prior to testing shall be tested as specified.

3. Deflection Testing of PVC Pipe: Not less than 30 days following completion of backfill, the pipe shall be tested for deflection with a 5% mandrel sized as defined in ASTM D- 3034. Mandrels shall be furnished by Town of Smithfield. The mandrel shall be pulled through each section of pipe from manhole to manhole. The mandrel must slide freely through the pipe with only a nominal hand force applied. No mechanical device shall be used in pulling the mandrel. Any pipe which refuses the mandrel shall be removed and replaced or re-rounded and the bedding shall be properly constructed as specified to prevent excessive deflection. Such sections shall be re-tested for deflection after completion of backfill.

B. Force Mains: Required testing of pipelines and valves shall be done under the direct supervision of the Project Inspector. Field testing shall not negate the requirements for material certifications ascontained in the material specification section of this contract. Unless otherwise directed by the Engineer, all testing and disinfection will be completed prior to connection to any existing line. The Contractor shall provide open ventilation of confined spaces. The Contractor shall be responsible for providing all equipment and personnel necessary to comply with OSHA confined spaces regulations.

1. Hydrostatic and Leakage Tests: On completion of the line or sections of the lines, connections and appurtenances, the line shall be filled and hydrostatically tested. The water for this purpose can be taken from existing lines under the supervision of the Engineer's Inspector and leakage will be measured by the Inspector with a meter furnished by Town of Smithfield. All leaks and any defective material shall be repaired or replaced to the satisfaction of the Engineer and the tests repeated until the requirements of this specification are met. Any special equipment, pumps, etc. required to make the test shall be furnished and operated by the contractor as directed by the Inspector. The Contractor shall use great care to be sure that all air is expelled from each section under test. If fire hydrants or other openings are not available for the purpose of expelling air, the Contractor shall provide air releases of sufficient size (as determined by the Engineer) in accordance with City Standard Drawings, at his expense. Specific procedures for testing mains are as follows:

a. Test pressure will be 200 PSI at the low point of the section under test. When testing against butterfly valves, the differential pressure at the valve must not exceed 150 PSI for valves rated at 150 PSI. If the test cannot be made with differential pressure of 150 PSI, 250 PSI valves will be specified. Differential pressures across gate valves may be up to 200 PSI.

b. Allowable leakage will be determined by Table 6, AWWA C-600 or by the formula L=.000106SD where S is the length of pipe under test and D is the pipe diameter.

c. Pressure and leakage tests will be run concurrently and for a duration of four hours except as modified below.

d. The Contractor will pressurize the line and verify that it is within allowable leakage before the official test is started.

e. The Inspector will begin the test and remain at the job for the first hour, making sure that the test pressure is maintained within ± 5 PSI. The Contractor is to maintain the pressure within ± 5 PSI for the duration of the test period. At the end of the first hour, with the line pumped to full test pressure, he will read the meter and record the first hour leakage. If the first hour leakage is within allowable, he will return at the end of the fourth hour and again read the meter. If the total leakage for the four hour period does not exceed four times the first hour leakage, the test will be terminated. If the total leakage exceeds four times the first hour leakage, but is still within allowable, the test will be held an additional hour. If the fifth hour leakage does not exceed the average hourly leakage for the first four hours, the test will be terminated at the end of the fifth hour. Otherwise, the test will be held until the leakage is non-increasing and within allowable for two consecutive hours.

f. If leakage exceeds allowable for the four hour test, the test will be terminated and re-scheduled after the Contractor has verified that actual leakage is within the allowable leakage, but no earlier than the next work day.

g. If the first hour leakage does not exceed 10% of the allowable, or if the allowable leakage rate does not exceed .4 gal/hr., the test may be terminated at the end of two hours provided the second hour leakage does not exceed the first hour leakage. If the second hour leakage exceeds the first hour leakage, the test will be held for an additional period as described in Paragraph (e) above.

h. The maximum length of pipe tested in one test shall be 5,000 feet or as close to 5,000 feet as possible depending on valve spacing.

C. <u>Repairs</u>: All leaks shall be repaired by identifying and exposing the defective section of pipe and completing repairs as follows:

1. <u>PVC, VCP or Ductile Iron Pipe:</u> Defective or damaged pipe including leaking joints shall be removed and replaced with sound new pipe. The pipe shall be re-connected with approved couplings as specified in the MS Section of this document.

2. <u>Manholes:</u> Any damage to the interior wall of the manhole resulting from penetration of the lift holes shall be repaired with non-shrink cement grout. Leaks through manhole joints or walls or around pipe collars, may be repaired from inside the manhole with non-shrink cement grout. If the size of the leak, or the external water pressure, prevents such repairs, the manhole shall be excavated and repaired from outside. Leaks around boots or gaskets used to join pipe to manholes shall be repaired by external concrete collars or as approved by the Engineer.

3.13 PUMP STATION TESTING

A. Watertightness Testing

1. Wet wells and other wastewater-containing structures at the pump station shall be inspected and tested for watertightness. The watertightness test shall be performed in the presence of a Town of Smithfield authorized representative.

2. The watertightness test shall be performed in accordance with ACI (American Concrete Institute) 350.1R “Testing Reinforced Concrete Structures for Watertightness” for cast-in-place wetwells.

3. Pre-cast wetwells shall be filled with water and allowed to saturate over 24 hours. Then the level will be noted at two places 180 degrees apart on the perimeter. Over the next 24 hours the leakage must be one inch or less of wetwell depth. A vacuum test method, prior to backfilling, in accordance with ASTM C1244 “Standard Test Method for Concrete Sewer Manholes by Negative Test Pressure (Vacuum) Test” may be used in lieu of a hydraulic test.

   a. Testing shall not commence until the structure being tested has been fully assembled and backfilling is complete, unless the pump station wet well is constructed of cast-in-place concrete.

   b. All inlets and outlets in the structure shall be temporarily plugged and braced or otherwise sealed prior to initiating the test.

   c. Pump station wet wells that fail to meet the watertightness test requirements shall be inspected, made watertight, and retested until the test passage is assured.

4. The results of all watertightness testing shall be maintained as part of the construction record documentation.

3.14 CLEANING

A. Clean dirt and superfluous material from interior of piping.

END OF SECTION

SECTION 333001

TEMPORARY BYPASS PUMPING SYSTEMS

PART 1 - GENERAL

1.1 DESCRIPTION AND SCOPE

A. The Contractor shall furnish, construct, maintain and operate bulkheads, containment system, plugs, hoses, piping, and pumps to bypass sewage flow around the project area for the duration of the project. The bypass system shall, at all times, prevent backup or overflow onto streets, yards and unpaved areas or into buildings, adjacent ditches, storm sewers, and waterways. The Contractor shall design and provide the bypass system with sufficient firm pumping capacity to pump the existing sewer being bypassed flowing full and/or to convey the flows specified further herein. Firm capacity is defined as the capacity of the pumping system when the largest pump is out of service. The Contractor is advised that during rain events the flow in the existing sewers will increase rapidly and will fill the pipe and, in many cases, surcharge the pipe.

B. Spills of any type, including but not limited to all spills and/or leaks caused by the operation of bypass pumps or other operations of the Contractor, are strictly prohibited at all times; notwithstanding such prohibition, any such occurrence shall be reported to Town of Smithfield immediately after discovery and all costs, associated with the overflow and overflow clean up, including any fines and legal costs incurred by Town of Smithfield and costs associated with property damage as a result of the overflow, shall be paid for solely by the Contractor. Costs of damage to real or personal property as a result of an overflow, and any other direct, indirect, incidental or consequential damages resulting therefrom or related thereto, shall be the sole responsibility of the Contractor, for which the Contractor will defend, indemnify and hold Town of Smithfield harmless. In addition to these responsibilities of the Contractor, any spill that reaches a natural stream caused by the negligent operations of the Contractor may be deemed to be a substantial violation of the Contract Documents and a basis for termination under the General Conditions of this Contract.

C. The Contractor is forewarned of the potential for sewer surges which cause rapid increases in sewer discharges, in particular during rain events and from upstream pump station on/off operations. The Contractor’s bypass equipment and set up shall be adequate to prevent overflows under these surge conditions. The Contractor shall provide ample free board and wet well volume as required to contain the sewage. If risers to assist with sewage containment are proposed by the Contractor, the risers shall be coordinated with the upstream system to prevent any backups, overflows, or any other problems.

1.4 BYPASS PUMPING SYSTEM – DESIGN REQUIREMENTS

A. The bypass pumping systems shall have sufficient capacity to pump a peak flow of the line segment to be bypassed as specified herein. The Bypass Contractor shall provide all pipeline plugs, pumps of adequate size to handle peak flow during a 10-year storm event, and temporary discharge piping to ensure that the total flow of the main can be safely diverted around the project area. The bypass pumping system will be required to be operated 24 hours a day.

B. The Contractor shall provide back-up pump(s) equal in capacity to the largest primary pump. Back-up pumps shall be on-line but isolated from the primary system by a valve. Contractor and pump supplier shall determine system pressure requirements based on proposed bypass piping size and layout and shall submit the proposed system curve for the pumping system as designed.

C. The bypass pumping system shall pump the following flows:

1. The pumping system shall meet the firm capacity as defined as the capacity of the pumping system when the largest pump is out of service. This flow represents the peak flow during a 10-year rain event measured in the upstream sewer system over the last several years per flow metering data. If flow monitoring for the upstream sewer system is not available, it is the responsibility of the contractor to perform flow monitoring for a duration of up to 3 months minimum to size the pumping system. Flow projections shall be developed by licensed NC PE and submitted to Town of Smithfield for review and approval.

D. If multiple force mains are used, the discharge piping shall be manifolded so the flow can be diverted to each specific pipe or any combination of pipes by quickly opening and/or closing valves. This will also allow a pipe to be isolated to make any necessary repairs.

E. The Bypass Contractor shall have adequate standby equipment available and ready for immediate operation and tied into the bypass system for use in the event of an emergency or breakdown.

F. Flow from all connecting sewers must be accommodated. Connecting sewers larger than 24" shall utilize hard piping and must have primary and standby sound-attenuated diesel auto-priming pumps. If connecting to the main bypass discharge line, the connection must have an isolating gate valve.

G. Suction and Discharge Manholes: Existing manholes to be used as suction manholes and discharge manholes shall be modified by the Contractor as required. The suction manholes are subject to flooding during rain events - all modifications shall provide a leak tight manhole to prevent inflow into the manholes during flood conditions. The discharge manholes shall be sealed and protected per Paragraph 2.4C.

H. Plugging of Flows: A minimum of two (2) plugs shall be used at each location where sewers are being plugged for bypass operations, meaning one plug shall be installed in the outgoing pipe of the manhole where the plugging occurs and then a second plug installed in the next downstream manhole in the incoming pipe. This will provide redundancy in the plugging operation for added safety. All plugs shall be restrained and reinforced to prevent movement and blowouts. The contractor shall tie-off and/or anchor plugs such that in a blowout event, the plug cannot be transported downstream.

I. A light tower shall be provided at each suction manhole/pump setup for pump watch during overnight hours.

1.5 QUALITY ASSURANCE

A. Any violations resulting from sewage spills shall be the sole responsibility of the Contractor.

1.6 QUALIFICATIONS

A. The design, installation and operation of the temporary pumping system shall be the Contractor's responsibility. The Bypass Contractor (bypass pumping system contractor) shall demonstrate to the Engineer that they specialize in the design and operation of temporary bypass pumping systems. The Bypass Contractor shall provide a minimum of five references of temporary bypass pumping projects of at least 30 million gallons per day (mgd) with at least one of the projects over 50 mgd, of a similar size and complexity as this project, performed by their firm within the past five years. The references shall include project scope of work and contact numbers and names for the Town of Smithfield and General Contractor if the work was performed as a subcontractor. Town of Smithfield reserves the right to approve or disapprove of a bypass pumping contactor based on experience or performance on other similar projects.

B. The Bypass Contractor must have a physical location and service facility within 60 miles of the project site.

C. All bypass pumping equipment shall be owned and maintained by the Bypass Contractor. No subleasing of bypass pumps or piping shall be allowed, approved or acceptable. Proof of ownership shall be submitted to the Engineer for review and verification. Town of Smithfield will not approve the Bypass Contractor if he/she does not own the bypass pumping equipment being furnished for this project.

In addition, all pump set up and tear down and piping installation and removal shall be performed by employees of the Bypass Contractor as documented by employee records. Subcontracting of the set up and tear down shall not be allowed.

Further, all pump and piping maintenance, repairs, pump watch (manning of pumps 24 hours per day), etc. shall be performed by employees of the Bypass Contractor as documented by employee records. Subcontracting of these duties (and any other duties related to the bypass pumping system) shall not be allowed.

1.7 SUBMITTALS

A. The Contractor shall coordinate with the Engineer to determine the required Bypass System and the type and number of pumps to be used. For bypass pumping systems, Contractor shall submit, prior to installation, a detailed plan and description outlining all details and provisions of the temporary bypass pumping system. The plan shall be specific and complete, including such items as schedules, locations, elevations, type of plugs, plug restraints and blocking, temporary piping, capacities of equipment, instrumentation and controls, alarm systems, communication systems, soundproof enclosures, materials, precautions taken regarding handling the wastewater flow, and all other incidental items necessary and/or required to ensure proper operation of the bypass pumping system, including protection of the access and bypass pumping locations from damage due to the discharge flows, ability to pump dry weather and wet weather flows, and compliance with the requirements and permit conditions specified in these Contract Documents. No bypass pumping shall begin until all provisions and requirements have been reviewed and approved by Town of Smithfield.

B. The design of the temporary bypass system shall be sealed by a North Carolina licensed Professional Engineer. The bypass pumping plan shall include, but not be limited to, the following:

1. Overall sequence of construction for bypass pumping system;
2. General layout for the bypass pumping system including locations and staging areas for pumps and piping locations/routes;

3. Modifications to existing sewer manholes and structures to perform the bypass pumping and restoration to such structures upon completion;

4. Modifications to existing sewer manholes and structures such that the manhole covers are elevated to the 100-year base flood elevation plus 1-foot.

5. Suction and Discharge Piping:

   a. Drawings showing the alignment of the bypass pipes;

   b. Flow stoppage system, including pipe and channel plugging method, types of plugs, plug materials, size of plugs, plug restraints and blocking, location and number of proposed tie-off and/or anchors used to prevent movement or blowouts for plugs;

   c. Details of suction piping including number, size, materials, fittings including quick disconnects, connections to other piping, method of installation, and all other details related to the pump suction piping;

   d. Details of discharge piping including number, size, materials, fittings including quick disconnects, connections to other piping, method of installation, details of the discharge location and piping arrangement at that location, and all other details related to the pump discharge piping;

   e. Sections showing suction and discharge piping depth, embedment, select fill and special backfill;

   f. Restraint systems for piping including thrust and restraint block sizes and locations and/or retraining systems on the piping;

   g. Any temporary pipe supports and anchoring required;

   h. Show force main pipe material and thickness can withstand all normal operating and surge pressures with a safety factor of 2.0;

   i. Protection against main breaks and damage;

   j. Method of protecting discharge manholes or structures from erosion and damage;

   k. Schedule for installation of and maintenance of bypass pumping lines.

6. Bypass Pumps

   a. Bypass pump sizes, capacity, number of each size to be on site, basis of selection (calculations), and power requirements;

   b. Calculations of static lift, friction losses, and flow velocity (pump curves showing pump operating range shall be submitted) for each set up;

   c. Size and location of standby power generators and diesel storage and access plan if engine driven equipment is to be provided, or plan for suitable connection to existing electrical gear, if electrical power is to be provided;

   d. Elevation of bypass pumps, standby power generators and diesel storage base compared to the 100-year flood base elevation;

   e. Design plans for access to bypass pumping locations;

f. Method of noise control for each pump and/or generator including primary sound enclosures and sound blankets;

g. Fuel tank location, size, and containment systems;

h. Fuel consumption rate information (include for proposed pumps, at full capacity, include breakdown for one pump running, two pumps running, etc.);

i. Instrumentation and control system to determine flow levels and to eliminate the risk of spills due to improper installation and operations. The instrumentation and control system submitted by the Contractor for approval by Town of Smithfield shall include all equipment proposed (including redundant instrumentation and control equipment) and sequences of instrumentation activation as well as all alarms and fail-safe provisions.

7. Continuous on-site monitoring plan;

8. Traffic control requirements and measures are to be employed throughout the project.

9. General contact and emergency contact information for all personnel responsible for the operations and maintenance of the bypass pumping operations.

1.8 PLAN APPROVAL

A. Completed Bypass Pumping Plans shall be submitted to Town of Smithfield for review and approval 30 days prior to any proposed bypass pumping operations.

B. Contractor shall provide full list of employees on watch, schedule, and contact information for each. The list shall include a hierarchy of who is to be notified in the event of an emergency.

PART 2 - PRODUCTS

2.1 BYPASS PUMPING EQUIPMENT

A. The pumps used must be manufactured by a company that is ISO 9001 registered with a RAB (registration accreditation board) accredited third party registrar. The pump manufacturer shall to also be ISO 9001 certified for Engineering Design Services and After Market Service. A copy of the ISO 9001 certificate shall be included with the bypass pump submittal to the Engineer.

B. Pumps shall be dry self-priming type, in good working order, with a working pressure gauge on the discharge. All pumps used shall be fully automatic self-priming units that do not require the use of foot-valves or vacuum pumps in the priming system. All pumps used must be constructed to allow dry running for long periods of time to accommodate the cyclical nature of wastewater flows. The pumping equipment shall be sound attenuated as specified herein and be mounted on an environmental skid which has the capacity of containing any and all hazardous fluids utilized within the engine compartment. All diesel-driven engines must be Tier 3 or newer.

C. Pumps may either be engine driven equipment or electrically driven equipment. Contractor shall be responsible for all power costs associated with provision and operation of engine driven equipment including but not limited to purchase and delivery of fuel. Contractor shall be responsible for providing all equipment and connections required to provide electrically driven equipment and for protecting the power feed. If diesel powered pumps are provided, Contractor shall store sufficient fuel on site to allow for 72 hours of continuous operation without fuel delivery. 72 hours of continuous operation shall be based on 24 hours of operation at the system's firm capacity. The fuel shall be stored responsibly above the 100-year base flood elevation with self-containment and where possible shall not be located in a floodplain.

D. Pumps shall meet the requirements of the governing municipality's noise ordinance. All pumps shall be Quiet Flow™, Critically Silenced™ or sound attenuated to 68 dBA at 23 feet. Pumps shall be provided with a pre-engineered sound attenuation enclosure. Sound blankets shall not be acceptable for primary noise attenuation, but sound blankets may also be required around the entire bypass pumping system if noise becomes an issue. If required, the sound blankets shall be free standing and 12-ft high minimum, shall have Class 1 flammability per ASTM E-84 and shall reduce sound by at least 10 dB at 125 Hz.

E. Contractor shall provide the necessary stop/start controls for each pump. The stop/start control shall be an integral part of the engine control panel. For bypassing sewers greater than 24" and when using 6-inch pumps and larger, transducers are required to maintain the proper surcharge levels in the sewer line.

F. Contractor shall provide level control device to allow pumps to ramp up and down in response to incoming sewage flow. Provide standby level control device to alarm high liquid level and to start pumps. The level control devices shall be designed to operate for a minimum of 24 hours on battery backup in the event of power failure.

G. All pumps shall be manned 24 hours per day when operational. The Engineer will not consider allowing the use of auto dialers to report pumping system emergency conditions. Full time telemetry is required, and interface with Town of Smithfield may be required. All proposed auto-dialer information is to be submitted to Town of Smithfield for review and approval.

H. Alarm systems shall be local (flashing light) and shall also activate the auto dialer. At a minimum, the following alarms shall be reported:

1. High liquid level in the bypass pumping suction manhole with level control device.
2. Engine failure
3. Power failure

I. Town of Smithfield shall be notified immediately if the bypass pumping system is unable to keep up with the incoming flow, regardless of the reason.

J. The local alarm and level control devices shall be designed to operate for a minimum of 24 hours on battery backup in the event of power failure.

2.2 FORCE MAIN PIPING

A. All discharge piping shall be rigid piping with positive, restrained joints. Allowable piping materials shall be fused, high-density polyethylene pipe (HDPE) as manufactured by Phillips Driscopipe, Inc. or equal, with a minimum wall thickness equaling SDR26 or PVC Pressure Pipe as manufactured by Certa-Lok or approved equal. Under no circumstances will aluminum "irrigation" type piping, glued PVC pipe or soft (lay-flat) hose be allowed.

All fused joints shall be performed by a certified operator (certified by a manufacturer of pipe fusion equipment). An appropriately sized fusion machine shall remain on site throughout the duration of the project to address any emergency pipe repair issues.

B. The force main piping shall be designed and rated for at least 1.25 times the maximum system pressure. The maximum velocity in the suction and discharge piping shall be 10 feet per second. The Contractor shall be responsible for all design calculations and shall be responsible for securing and protecting all force main piping in any manner required by Town of Smithfield, Engineer or other controlling agency. The discharge piping shall be protected from pedestrian and vehicular traffic. Contractor shall add additional protection as deemed necessary to fully protect the piping at no additional cost to Town of Smithfield. Design of the force main piping in accordance with these specifications shall be documented, including calculations, and submitted to Town of Smithfield for approval.

C. Contractor shall provide a temporary cast iron or steel cover over the bypass pumping suction manhole and discharge manhole to safeguard the manholes, to prevent inflow and to minimize odors. At the discharge manhole, the Contractor shall route the discharge piping down into the manhole and shall install 90-degree bends on the end of the piping to direct the flow out of the discharge manhole and heading downstream. The piping arrangement shall be such that the flow is not vertically directed. This piping arrangement will help to direct the flow and minimize turbulence (and odors) in the discharge manhole.

D. A flow meter shall be installed on the discharge piping to continuously document the flow rate being pumped. The flow meter shall be continuously reviewed by the Contractor and compared to the pump curves submitted by the Contractor to confirm that the bypass pumping system is operating as designed and expected. If the bypass pumping system is not pumping as designed and submitted, the Contractor shall take immediate actions to modify and correct the situation in manner approved by the Engineer. If at any time the bypass pumps are not keeping up with the flow and the specified pumping rate is not being achieved and the situation cannot be immediately resolved, the Contractor shall cease all pumping operations, return the flow to gravity through the existing sewer, and re-design the pumping system.

PART 3 - EXECUTION

3.1 BYPASS SYSTEM

A. Town of Smithfield shall have the authority to increase normal working hours of the Contractor during bypass pumping operations.

B. Bypass System shall be comprised of a bypass pumping system combined with temporary piping to convey flow in the existing sewers.

C. It is essential to the operation of the existing sewerage system that there is no interruption in the flow of sewage throughout the duration of the project. To this end, the Contractor shall provide, maintain and operate all temporary facilities such as dams, plugs, pumping equipment (both primary and back-up units as required), piping, all necessary power, and all other labor and equipment necessary to intercept the sewage flow before it reaches the point where it would interfere with the work, carry it past the work, and return it to the existing sewer downstream of the work.

D. The Bypass Contractor shall provide all necessary means to safely convey the sewage past the work area. The Bypass Contractor will not be permitted to stop or impede the main flows under any circumstances. The Bypass Contractor shall maintain sewer flow around the work area in a manner that will protect public and private property from flooding and damage.

E. The Bypass System shall be leak free and shall (at a minimum) maintain the required firm pumping capacity. The Bypass System shall provide reliable and trouble free pumping of the existing wastewater flow. All local alarms shall be readily visible to and accessible by Town of Smithfield.

F. If, at any time during construction, effluent from the existing sewer is not fully contained by the bypass system and/or the bypass system is not keeping up with the flow, gravity service shall be restored immediately, and work shall be suspended until the problem is resolved to the satisfaction of the Engineer. Sewer system overflows will not be tolerated. All fines imposed on Town of Smithfield associated with overflows caused by the Contractor's work shall be paid by the Contractor.

G. Odor Issues: If odor complaints occur at any time during the Contract, the Contractor shall take immediate measures to minimize the odor. It will be the Contractor's sole responsibility and cost to do all that is necessary to resolve the odor issues, including revising any bypass pumping layouts/configurations and adding odor control measures (such as chemical additions).

3.2 FIELD QUALITY CONTROL AND MAINTENANCE

A. The Contractor shall provide at least one (1) trained employee to man the bypass pumping system continuously while the pumps are in use to monitor the system and check for alarms and leaks. At no time during the bypass pumping operations shall the system be unmanned.

B. System Testing:

1. The Bypass Contractor shall perform leakage and pressure tests of the bypass pumping discharge piping using clean water prior to actual operation. The Engineer shall be given 24 hours' notice prior to testing.

2. Test pressure shall be 1.25 times the maximum system operating pressure. The test must hold pressure for a minimum of 1 hour.

3. The bypass design operating pressure must not exceed 10 PSI below the max pressure rating of the HDPE.

C. Contractor shall inspect the bypass discharge piping system a minimum of every two (2) hours to ensure no damage or leaks. All leaks must be addressed immediately. Flow shall be diverted off of the leaking piping immediately until repairs are made. The Contractor shall document each inspection and shall submit the inspection logs to the Engineer at the end of each week (or more frequently as required by the Engineer).

D. Contractor shall inspect the pump operation a minimum of every two (2) hours to ensure trouble-free and leak free operation. A monitoring log shall be maintained by the Contractor and available for observation by the Engineer/Town of Smithfield upon request. All systems, piping, pumps, air vents, monitoring equipment, valves, plugs, security measures, level indicating devices and all related appurtenances associated with the bypass system shall be continuously and regularly monitored for proper and leak free operation.

E. Contractor shall record the following information every ½ hour in the monitoring log:

1. System Discharge Pressure

2. Pump RPM

3. Suction Manhole surcharge level

4. Plug Pressure
5. Fuel levels
6. Flow

F. Any time the bypass pumping system is operating, the Contractor shall continuously perform the following maintenance services:

1. The Bypass Contractor shall insure that the temporary pumping system is properly maintained. At least one (1) trained pump watch employee (with a fully stocked service vehicle) shall be onsite 24/7 when pumps are operating.
2. The trained employee shall be full time employees of the bypass contractor with at least one year experience with bypass pumping. No temporary employees are permitted to operate or watch the bypass.

G. Spare Parts and Extra Materials:

1. Spare parts for each type of pump and piping shall be kept on site.
2. HDPE repair bands for each size HDPE shall be kept on site.
3. At least one (1) extra plug of each size utilized in the bypass pumping setup.
4. At least one (1) fuel filter.
5. At least one (1) pipe repair clamp shall be on site at all times.

H. In the event of accidental spill or overflow, Contractor shall take all necessary actions immediately to stop the spill or overflow and take action to clean up, disinfect the spill and immediately notify Town of Smithfield. Disinfection shall include, but is not limited to, removal of all debris, pumping of any excess overflow back into the system, neutralization by raking and liming. Town of Smithfield will provide the Contractor with a call-down emergency list for contacts in the event of a spill or overflow. All bypass system abnormalities, operational changes, maintenance, and repairs shall be reported immediately to the Engineer and Town of Smithfield. All alarms shall be responded to in person by qualified Contractor's personnel immediately.

3.3 INSTALLATION AND REMOVAL

A. Contractor shall locate the bypass pipelines to minimize any disturbance to existing utilities and site areas (such as trees) and shall obtain approval of the pipeline locations from the Engineer.

B. The Contractor shall remove manhole sections or make connections to the existing sewer and construct temporary bypass pumping structures only at access locations as approved by the Engineer and as may be required to provide adequate suction conduit.

C. Plugging or blocking of sewage flows shall incorporate a primary and secondary plugging device. When plugging or blocking is no longer needed for performance and acceptance or work, it is to be removed in a manner that permits the sewage flow to slowly return to normal without surge, to prevent surcharging or causing other major disturbances downstream.

D. During all bypass pumping operation, the Contractor shall protect existing structures, equipment and piping from damage inflicted by any equipment. The Contractor shall be responsible for all physical damage to the existing structures, equipment and piping caused by human or mechanical failure.

E. When working inside existing structures, the Contractor shall exercise caution and comply with all federal, state, and local occupational safety and health standards when working in the presence of gases, combustible or oxygen-deficient atmospheres, and confined spaces.

F. The Contractor shall notify the Engineer at least 48 hours prior to initial startup and/or to any significant changes to the bypass system. This includes moving pumps and/or piping, installing or removing plugs, starting a new bypass location, ceasing an existing bypass location, reestablishing gravity flow, etc. The Engineer must inspect and approve the existing layout and all pumping equipment at each significant change to the bypass system. A bypass pumping checklist addressing all relevant features of the bypass system shall be generated by the Contractor and approved by the Engineer. The bypass pumping checklist shall be completed by both the Contractor and Engineer prior to the startup of any bypass pumping operations and/or to any significant changes to the bypass system.

G. When the bypass piping crosses local streets and private driveways, the Contractor must bury the bypass pipelines in trenches, cover with flowable fill or ABC stone, and install asphalt patches per the Standard Specifications and Details. Steel road plates may be used for short periods of time until the asphalt can be installed. Bypass road ramps will only be allowed if specifically approved by the Engineer. Upon completion of the bypass pumping operations, and after the receipt of written approval of the Engineer, the Contractor shall remove all the piping, restore all property to pre-construction condition and restore all pavement in accordance with the standard specifications and details.

H. When bypass pumping operations are complete, piping shall be drained and flushed into the sewer system prior to disassembly. The piping shall be flushed for a period long enough to ensure that all piping is clean and free from wastewater. All pumps, piping, fittings, thrust blocks, etc. shall be removed from the site upon project completion.

END OF SECTION

SECTION 333220
PUMP STATION ABANDONMENT

PART 1 - GENERAL

1.1 SUMMARY

A. This section includes requirements for abandonment of the Town of Smithfield Pump Station #1.

1.2 FIELD CONDITIONS

A. Interruption of Existing Sanitary Sewerage Service: Do not disconnect existing pump station until all bypass pumping operations have been installed, tested and approved by Engineer and Owner.

PART 2 - PRODUCTS – NOT USED

PART 3 - EXECUTION

3.1 PUMP STATION ABANDONMENT

A. The Town of Smithfield Pump Station #1 shall be abandoned as noted in the plans. The contractor is advised to make a site visit to the pump station prior to submitting his bid package. This may be coordinated by contacting the Owner. Pump station demolition and abandonment shall follow the following general requirements.

B. The following existing materials and equipment shall be removed and salvaged to Town of Smithfield having first right of refusal:

1. Pumps, motors, base elbows, guide rails, and rail brackets.
2. Valves, yard hydrant, backflow preventer, and enclosure.
3. Emergency generator, including enclosure, control panel, fuel tank and all accessories.
4. Electrical switch gear, including complete control cabinet, lights, panels, enclosures, devices, and meter.
5. Electrical cable tray system with all accessories.
6. Air-vacuum valves on force main
7. Dehumidifier and heater
8. Ladder
9. Pump stands
10. Dialer
11. Generator adaptor on safety switch panel.

C. All materials and equipment salvaged to Town of Smithfield. Schedule delivery time with Owner.

D. All materials removed and not salvaged to Town of Smithfield shall become the property of the contractor and shall be removed from the site.

E. All piping, wiring and conduit that is located less than 3-feet below existing grade and/or pre-existing contours shall be excavated and removed. Piping, wiring and conduit located 3-feet or more below existing grade and/or pre-existing contours shall be abandoned in place. The ends of all abandoned in place piping and conduit shall be plugged and sealed.

F. All wiring shall become the property of the contractor and shall be removed from the site.

G. The existing pad mounted transformer is the property of the electrical utility and will be removed by others. The transformer pad shall be removed under the contract. The contractor under this contract will coordinate the removal of the transformer with the electric utility.

H. Existing chain link fencing and poles to be removed.

I. Wet well:

1. Remove all equipment, controls, wiring, piping, and accessory items from inside the existing wet well and salvage materials as indicated above.
2. Excavate and remove existing concrete wet well complete, including top slab, walls, and foundation.
3. Backfill and compact excavation.

J. Valve vault & emergency pump connection:

1. Remove piping and valves. Salvage items specified above to Town of Smithfield.
2. Excavate and remove precast vaults.
3. Backfill and compact excavation.

K. Air vacuum valve and vault (on force main):

1. Remove piping and air vacuum valve. Salvage air vacuum valve as specified above.
2. Excavate and abandon existing precast manholes..
3. Backfill and compact excavation.
4. Also included in the abandonment is the physical disconnection of the force main from the receiving manhole, installing a masonry plug in the exterior manhole wall to prevent infiltration or introduction of foreign material into the existing system, and, if necessary, reworking the invert and shelf inside the manhole, locating and abandoning any existing air valves and manholes that may exist along the force main, including salvage and disposal of equipment and materials, as specified, and as required by the Engineer, excavation (including rock), pumping and disposal of all residual waters, furnishing select backfill materials, placing and compacting of backfill, traffic control and all work necessary to restore the surrounding area to a condition equal or better than before excavation.

L. Backflow preventer and yard hydrant:

1. Remove yard hydrant, backflow preventer, valves, piping and enclosure. Salvage items specified above to Town of Smithfield.

2. Remove concrete pads.
3. Remove riser piping to depth specified above and cap pipes to be abandoned in place.
4. Dismantle existing water service
5. Disconnect at main.
6. Return meter and other fittings to Town of Smithfield.

M. Electrical:

1. Remove all electrical switchgear, panels, control cabinet, cable trays, wiring devices, meter and aboveground wiring. Salvage items specified above to Town of Smithfield.
2. Remove unistrut rack and concrete foundation.

N. Emergency generator:

1. Remove emergency generator unit complete, including generator, engine, enclosure, silencer, fuel tank and all accessories. Salvage items specified above to Town of Smithfield.
2. Remove concrete foundation pad.

O. After removal of all structures, foundations, and equipment the entire site including access road shall be graded to pre- existing contours, provided with positive drainage, and shall match surrounding ground. If salvaged equipment and materials are damaged during removal or transport, the contractor shall replace with new identical make.

END OF SECTION

SECTION 400559.23
STAINLESS STEEL SLIDE GATES

PART 1 GENERAL

1.01 SCOPE OF WORK

A. The equipment provided under this section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with the drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer unless exceptions are noted by the engineer.

Gates and operators shall be supplied with all the necessary parts and accessories indicated on the drawings, specified or otherwise required for a complete and properly operating installation, and shall be the latest standard product of a manufacturer regularly engaged in the production of fabricated water control gates.

B. Unit Responsibility: To insure compatibility of all components directly related to the slide gates unit responsibility for the slide gates, actuators and accessories as described in this section shall be the responsibility of the slide gate manufacturer unless specified otherwise.

1.02 SUBMITTALS

A. Submittals shall include as a minimum:

1. Shop Drawings
2. Manufacturer’s operation and maintenance manuals and information.
3. Manufacturer’s installation certificate.
4. Manufacturer’s equipment warranty.
5. Manufacturer’s performance affidavit.
6. Design calculations demonstrating lift loads and deflection in conformance to the application requirements. Design calculations shall be approved by a licensed engineer (PE) and shall be available upon request.

1.03 QUALITY ASSURANCE

A. Qualifications

1. All of the equipment specified under this Section shall be furnished by a single manufacturer with a minimum of 5-years of experience designing and manufacturing slide gates. The manufacturer shall have manufactured stainless steel slide gates of the type described herein for a minimum of 10 similar projects.
2. The sealing system shall be certified and tested for operation and performance to leakage specifications compliant with AWWA C-561 for a minimum of 100,000 cycles.

3. The project design is based on the Waterman SS-250 Series Fabricated Slide Gate as manufactured by Waterman Industries of Exeter, California. Proposed alternates must be pre-approved, per addendum, at least 14-days prior to close of bid. Requests for alternates must be supplemented with detailed drawings, specifications, and references. Any/all additional costs for structure modifications or other changes associated with utilizing a brand other than Waterman are to be borne by the contractor.
4. To insure quality and consistency, the slide gates listed in this section shall be manufactured and assembled in a facility owned and operated by the slide gate manufacturer. Third-party manufacturers contracted for fabrication and assembly of the slide gates will not be permitted.

PART 2 PRODUCTS

2.01 GENERAL

A. The gates shall be either self-contained with yoke and bench stand operators, or non-self-contained with separate stem guides and operator, in accordance with the requirements of these specifications.

B. The gates shall be compliant with the latest version of AWWA C561, or as described below.

C. Specific configurations shall be as noted on the gate schedule or as shown on the plans.

D. Materials:

COMPONENTS	MATERIALS
Frame, Yoke, Cover Slide, Wall Thimbles	Stainless Steel ASTM A240, Type 316
Seat/Seals & Stem Sleeves	Ultra High Molecular Weight Polyethylene (UHMWPE) ASTM D-4020
Cord Seal	Neoprene ASTM D 2000
Flush Bottom Seals	Neoprene ASTM D 2000
Stems	Stainless Steel: ASTM A-276, AISI Type 316
Stem cover	Galvanized A-53 Steel
Stem Guides	Stainless Steel (ASTM A-240 – Type 316L) UHMW Bushed
Wall Brackets	Stainless Steel: ASTM A-240, AISI Type 316L

Pedestals	Stainless Steel: ASTM A-240/A-312, AISI Type 316
Fasteners and Anchor Bolts	Stainless Steel: ASTM A-593 and 594, Type 316 CW
Finish	Fusion bonded epoxy

E. Gate Schedule:

Equipment Number	Gate Size, inch[1]	Gate type[2]	Opening Direction[3]	Bottom Seating[4]	Design Head, feet		Operator Type
					Seating	Unseating	
1	16 x 18	W	U	FB			Nut
2	17 x 58	E	U	FB			Handwheel
3	16 x 58	E	U	FB			Handwheel

Notes:
1. Clear opening width by height.
2. E = embedded frame, W = wall mounted, Y = self-contained, F = flatback
3. U = upward, D = downward
4. FB = flush bottom

2.02 FRAME AND GUIDE RAILS

A. The gate frame shall be composed of stainless steel guide rails with UHMW seat/seals upstream and downstream. The seat/seals shall form a tight seal between the frame and the slide (disc). The guides will be of sufficient length to support ½ the height of the slide when in the full open position.

B. Yoke shall not deflect more than 1/360th of the span under full head break load.

C. Seals shall be replaceable without removing the frame from the wall. In the case of embedded gates, they shall be constructed in a manner that allows replacement of the seals without removal of the gate frame from the embedment.

2.03 STEM AND STEM GUIDE

A. Material

1. The stem shall be solid stainless steel of the specified grade.

B. Design

1. Guides shall be adjustable with split stem sleeves. Guides shall be spaced per the manufacturer's recommendations. The stem L/r ratio shall not exceed 200.
2. Stem threads shall be 29 degree full Acme or stub Acme type.
3. Nominal diameter of the stem shall not be less than the crest of the threaded portion.

2.04 SEALS

A. The seals shall be self-adjusting. Seals requiring periodic maintenance and adjustments to maintain specified leakage rates will not be permitted.

B. The top seal design on upward opening gates consisting of four side seals shall incorporate a self-cleaning wiping function that prevents debris from building-up above the top seal and causing premature wear of the seats, seals, and gate face.

C. The UHMW seats shall impinge on the slide (disc) by way of a continuous loop cord seal. Seal designs incorporating resilient seals such as "J-bulb" or "P" seals that come in direct contact with the friction surface of the slide will not be considered.

D. The cord seal shall function as a seal between the frame and the UHMW, and as a spring force to maintain contact between the UHMW and the slide (disc).

E. The resilient bottom seal shall be set into the invert member of the frame which shall be formed in a manor to protect 3 sides of the seal only exposing the side that will come in contact with the slide. Disc-mounted invert seals exposing additional surface area will not be permitted.

F. The self-adjusting seal system shall provide an allowable leakage rate of no more than ½ AWWA leakage rate per minute per peripheral foot of perimeter opening for seating and unseating heads.

2.05 SLIDE COVER (DISC)

A. The slide cover (disc) shall be stainless steel plate reinforced with structural shapes welded to the plate.

1. The slide cover shall not deflect more than 1/720th of the span, or 1/16" at the sealing surface of the gate under maximum specified head.
2. The stem to gate connection shall be either the clevis type, with structural members welded to the slide and a bolt or bolts to act as a securing method, or a threaded and bolted (or keyed) thrust nut supported in a welded nut pocket.
3. The clevis, or pocket and yoke, of the gate shall be capable of taking, without damage, at least twice the rated thrust output of the operator at 40 pounds of pull on a hand wheel or hand crank, and at locked-rotor stall of a motor operator.
4. The slide cover shall be constructed with vertical and horizontal reinforcement ribs.

5. All welds shall be performed by an AWS-certified welding technician.

2.06 ANCHOR BOLTS

A. Anchor hardware shall be provided by the slide gate manufacturer.

1. The size, quantity, and location of the anchor hardware shall be engineered by the slide gate manufacturer. Upon client request manufacturer shall provide calculations for anchor bolt sizing and quantity.
2. Anchor hardware consisting of studs, nuts and washers shall be provided by the manufacturer.

PART 3 EXECUTION

3.01 INSTALLATION

A. Installation of the gates shall be performed in accordance with standard industry practices. It shall be the responsibility of the CONTRACTOR to handle, store, and install the equipment specified in this Section in strict accordance with the Manufacturer's recommendations.

B. The CONTRACTOR shall review the installation drawings and installation instructions prior to installing the gates.

C. The gate frames shall be installed in a true vertical plane, square and plumb, with no twist, convergence, or divergence between the vertical legs of the guide frame.

D. The CONTRACTOR shall fill any void between the guide frames and the structure with non-shrink grout as shown on the installation drawing and in accordance with the grout manufacturer's recommendations.

E. The frame cross rail shall be adjusted as required to maintain consistent seal compression across the full width of the gate.

3.02 FIELD TESTING

A. After installation, all gates will be field tested in the presence of the ENGINEER and OWNER to ensure that all items of equipment are in full compliance with this Section. Each gate assembly shall be water tested by the CONTRACTOR at the discretion of the ENGINEER and OWNER, to confirm that leakage does not exceed the specified allowed leakage.

END OF SECTION

SECTION 400565
VALVES FOR PUMP CONTROL AND CHECK SERVICE

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section Includes:

1. Lever and Weight Swing Check Valve
2. Surge Relief Valve
3. Combination Air/Vacuum Release Valve
4. Plug Valve

1.03 DEFINITIONS

A.	(ANSI)	American National Standards Institute
B.	(ASTM)	American Society for Testing and Materials
C.	(AWWA)	American Water Works Association

1.04 SUBMITTALS

A. Submit detailed product data and descriptive literature including dimensions, weights, headloss data, pressure rating and materials of construction.

B. Provide shop drawings which clearly illustrate the general arrangement of the equipment and cross-sectional views of the components.

1.05 QUALITY ASSURANCE

A. Supplier shall have been manufacturing valves of the type specified for a period of at least ten (10) years and shall, at the Engineer's request, provide a list of installations involving equipment of similar size and application.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:

1. Protect internal parts against rust and corrosion
2. Protect threads, flange faces, grooves, and weld ends.
3. Set valves in either closed or open position.

B. Use the following precautions during storage:

1. Maintain valve end protection.
2. Store valves indoors and maintain at higher-than-ambient-dew-point temperature. If

outdoor storage is necessary, store valves off the ground in watertight enclosures.

C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

PART 2 PRODUCTS

2.01 LEVER AND WEIGHT SWING CHECK VALVE

A. Manufacturer

1. GA Industries Figure 220 Heavy Duty, or equal as manufactured by CCNE, APCO, or Val-Matic.

B. The check valve shall conform to the materials of construction, pressure rating and test requirements of AWWA C508.

C. All valve components/materials of construction to be Stainless Steel if optional materials are available.

D. The body shall be made of cast iron conforming to ASTM A126 Class B with a bolted steel cover allowing complete access to and removal of all internal components while the valve is in the line.

E. The valve body shall have integral flanges, flat faced and drilled per ANSI B16.1 Class 125, straight through, as shown on the plans or schedule.

F. The valve body shall have a removable Type 316 stainless steel body seat held in place with stainless steel pins.

G. The disc arm shall be ASTM A536 Grade 65-45-12 ductile iron and the disc shall be ASTM A126 Class B cast iron with a replaceable Buna-N (or other suitable material) disc seat held in place by a type 316 stainless steel follower ring and stainless steel screws. The disc shall be attached to the disc arm my means of a center pin, disc nut and washer providing 360 degree angular articulation but not rotate.

H. The disc arm shall be suspended from and keyed to a stainless steel shaft that is supported at each end by stainless steel bronze bushings. The shaft shall rotate freely without the need for external lubrication. The shaft shall be sealed where it passes through the body by means of a stuffing box and adjustable Teflon packing.

I. The valve shall be supplied with an outside lever and adjustable counterweight. Unless shown otherwise on the plans, the lever and weight shall be on the right hand side of the valve (looking at the inlet) but shall be field convertible to the left hand side without additional parts.

E. Shop paint shall be fusion bonded epoxy internal and external.

F. The valve shall swing open smoothly at pump start and close quickly upon pump shutdown to prevent flow reversal. When closed, the valve shall seat drop tight.

2.02 SURGE RELIEF VALVE

A. Manufacturer

1. GA Industries Figure 626 Wye Pattern, 6” diameter, as manufactured by GA Industries, Inc., Cranberry Twp., PA

B. Main valve body shall be wye pattern of cast iron conforming to ASTM A126 Class B, with integral flanges, faced and drilled per ANSI B16.1 Class 250. The valve body shall be inherently self-cleaning and have a net flow area through the valve no less than the area of its nominal pipe size. The valve body shall have a removable stainless steel seat.

C. The valve disc shall be cast iron or steel with a renewable, resilient seat ring of rubber or other suitable material and retained by a stainless steel follower and screws. The valve stem shall be stainless steel and guided in a long bronze bushing retained in the valve cover.

D. The valve stem shall be sealed where it passes through the body by dual seals separated by a lantern ring with external leak detection port. An integral hydraulic system shall permit quick opening and adjustable, slow closing without the need of pre-charged cylinders.

E. Sizes through 8" shall have dual compression stainless steel springs; 10" through 16" shall have a single compression stainless steel spring. Springs shall be encased in stainless steel cylinders; exposed springs or tension springs are not acceptable. The valve shall be fully capable of operating in any position.

F. The valve shall be factory tested and set to open at a pre-determined pressure. Springs shall permit field adjustment from near zero to 10 percent above factory setting.

G. Shop paint outside surfaces with fusion bonded epoxy.

H. The pressure relief valve shall quickly open when the system pressure exceeds the spring setting, remain open as long as the pressure exceeds this setting, and slowly close drop tight when the pressure subsides below the spring setting.

2.03 COMBINED AIR RELEASE AND VACUUM RELIEF VALVE

A. Manufacturer

1. Valves shall be as manufactured by Vent-O-Mat, International Valve, ARI, or approved equal.

B. Valve body and all inner metal parts shall be 316 stainless steel.

C. Valves shall be of the quick-opening, slow-closing type and may be standard height or short body design with a minimum 2-inch diameter screw-threaded inlet.

D. Valve body shall have a removable bonnet secured with 316 stainless steel fasteners to facilitate maintenance of the internal working parts. Outlet is to be screw-threaded.

E. Air and vacuum sewer valves shall be mounted to force main through the use of a bronze corporation stop and stainless steel tapping saddle followed by a stainless steel ball valve.

2.04 ECCENTRIC PLUG VALVE

A. Manufacturer

1. Plug valves shall be as manufactured by Dezurik only, due to standardization of spare parts.

B. Plug valves shall be non-lubricated, with a plug facing of a material specifically recommended by the valve manufacturer for the indicated service and shall have stainless steel permanently lubricated upper and lower plug stem bearings. Valve seats shall be nickel. Valves shall be designed with adjustable seals that are replaceable without removing the bonnet. The bearing and seal area shall be protected with grit seals. Valves shall be factory coated with fusion-bonded epoxy. Area of port opening for all valves shall be no less than 100% of full pipe area. Valves shall have a direct pressure rating of 100 psi with a working pressure of 175 psi for 12-inch and smaller valves and 150 psi for 14-inch and larger valves. Bi-directional shutoff is required.

C. All valve components/materials of construction to be Stainless Steel if optional materials are available.

D. Valves with flange ends shall be provided where indicated. Flanges shall be in accordance with ANSI B16.1 except that the four holes straddling the principal axis of the valve may be tapped and connected to the adjacent piping with cap screws of adequate size as recommended by the valve manufacturer and approved by the Engineer.

E. Plug valve operation shall be as indicated on the Plans and as follows:

1. All exposed valves in vaults shall have hand wheels and open to left.
2. Buried valves shall have 2-inch square operating nuts.
3. All valves require gearing in enclosed gear cases. Gearing shall be in accordance with the valve manufacturer's recommendations as required to permit easy operation of the valve by one man without excessively large hand wheel or cranks. Hand wheels shall not exceed 16 inches in diameter.

F. Extension stems, stem guides, operating levers, and other miscellaneous items required for a complete installation shall be provided in accordance with the requirements and recommendations of the valve manufacturer. Operating nut shall be within 12” of grade.

G. Discharge valves in vault shall be installed with adjustable aluminum pipe cradle and stainless steel standpipe. Buried valves shall be provided with a valve box. The valve box shall not transmit shock or stress to the valve and shall be centered and plumb over the operating nut, with the box cover flush with the surface of the pavement or other existing surface. Where the box is not set in pavement, the top section shall be anchored by a concrete pad, or an approved precast concrete pad, set flush with the existing terrain. The top section will be encased into the concrete pad.

H. Valves shall be LEFT opening and RIGHT closing.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

C. Examine threads on valve and mating pipe for form and cleanliness.

D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

E. Do not attempt to repair defective valves; replace with new valves.

3.02 VALVE INSTALLATION

A. Valves shall be installed in accordance with the manufacturer’s written Installation and Operation Manual and approved submittals.

B. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

C. Locate valves for easy access and provide separate support where necessary.

D. Install valves in horizontal piping with stem at or above center of pipe.

E. Install valves in position to allow full stem movement.

3.03 TESTING AND ADJUSTING

A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if leaking occurs.

B. Witness Testing: All Plug Valves shall be witness tested with TOWN OF SMITHFIELD staff present. All costs associated with witness testing shall be borne by the bidding contractor. The results of all witness testing shall be maintained as part of the construction record documentation.

END OF SECTION

SECTION 407113
MAGNETIC FLOW METERS

PART 1 GENERAL

1.01 REQUIREMENTS

A. The Contractor shall furnish, test, install and place in satisfactory operation the magnetic flow meters, with all spare parts, accessories, and appurtenances as herein specified and as shown on the Drawings.

1.02 RELATED DOCUMENTS

A. General Requirements

B. Electrical Specifications

1.03 TOOLS, SUPPLIES AND SPARE PARTS

A. Furnish one portable sensor simulator for calibration and testing of magnetic Flowmeter signal converters. The calibrator shall be furnished complete with rechargeable battery pack, test leads, spare battery pack, charger, carrying case and accessories. Calibrator shall be furnished by the Flowmeter manufacturer, and shall be fully matched to the instrumentation furnished.

PART 2 PRODUCTS

2.01 MAGNETIC FLOW METER SYSTEMS

A. Magnetic flow meter systems shall include a magnetic flow tube and a microprocessor-based "smart" transmitter that is capable of converting and transmitting a signal from the flow tube. Magnetic flow meters shall utilize the characterized field principle of electromagnetic induction, and shall produce DC signals directly proportional to the liquid flow rate.

B. Magnetic flow meter systems shall be manufactured by ABB, Siemens, or Rosemount, and shall meet the following minimum requirements:

1. Carbon steel flow tube
2. Class 150 carbon steel flanges with raised face
3. IP 68 (NEMA 6P) Flow tube and cable assembly rated for continuous submergence
4. Minimum of 200 feet of cable, factory assembled to flow tube and potted
5. Stainless steel bullet nose electrodes
6. PTFE (Teflon) liner
7. Two (2) Stainless steel grounding rings
8. FM Class I Div. 2 Rated
9. Temperature range -20 to 50 degrees C
10. 0.5 % Accuracy
11. Remote transmitter, wall mounted:
    a. 24 VDC powered

b. 4-20mA flow signal output
c. HART communications
d. ½-14 NPT conduit entry
e. Operator interface and display
f. IP 67 (NEMA 4X)

PART 3 EXECUTION

3.01 REQUIREMENTS

A. Install magnetic flow meter in location as indicated on Construction Drawings and in accordance with manufacturer’s installation guidelines.

B. Ground magnetic flow meter flow tubes and grounding rings in strict accordance with the manufacturer's recommendations.

C. Magnetic flow meter to be calibrated with written report documenting calibration procedure.

D. Witness Testing: Witness testing will be required by TOWN OF SMITHFIELD for the magnetic flow meter. All costs associated with witness testing shall be borne by the bidding contractor. The results of all witness testing shall be maintained as part of the construction record documentation

END OF SECTION

SECTION 46 24 33
OPEN CHANNEL-ELECTRIC GRINDER WITH ROTATING SCREEN DRUM

PART 1 GENERAL

1.01 SUMMARY

A. This section of the specification describes the grinder(s) and controller(s). The equipment shall be installed as shown on the plans, as recommended by the supplier, and in compliance with all OSHA, local, state and federal codes and regulations.

B. The number of Channel Monster(s) and controller(s) shall be 1.

C. All stainless steel will be 316 unless noted.

1.02 REFERENCES

A. Grinder(s) shall, as applicable, meet the requirements of the following industry standards:

1. American Society for Testing and Materials (ASTM) A36: Carbon Steel Plate
2. American Society for Testing and Materials (ASTM) A536-84: Ferritic Ductile Iron Castings
3. American Society for Testing and Materials (ASTM) A48-83: Grey Iron Casting
4. American Society for Testing and Materials (ASTM) A743 Stainless Steel Casting
5. American Iron and Steel Institute (AISI) 303 Stainless Steel
6. American Iron and Steel Institute (AISI) 304 Stainless Steel
7. American Iron and Steel Institute (AISI) 316 Stainless Steel
8. American Iron and Steel Institute (AISI) 4130 Heat Treated Alloy Steel
9. American Iron and Steel Institute (AISI) 4140 Heat Treated Alloy Steel
10. American Iron and Steel Institute (AISI) 8620 Heat Treated Alloy Steel
11. American Iron and Steel Institute (AISI) 17-4 Stainless Steel
12. Society of Automotive Engineers (SAE) 660 Bearing Bronze

B. Controllers shall, as applicable, meet the requirements of the following Regulatory Agencies:

1. National Electrical Manufacturer's Association (NEMA) Standards
2. National Electric Code (NEC)
3. Underwriters Laboratory (UL and cUL)
4. International Electrotechnical Commission (IEC)

1.03 DOCUMENTS

A. Submittals

1. Supplier shall submit six (6) sets of submittals. Submittals shall include equipment descriptions, functional descriptions, dimensional and assembly drawings, catalog data, and job specific drawings.

B. Operation and Maintenance Manuals.

1. The supplier shall provide three (3) Operation & Maintenance manuals. An electronic version shall be supplied to create additional copies. The manuals shall include equipment

descriptions, operating instructions, drawings, troubleshooting techniques, a recommended schedule, and the recommended lubricants.

1.04 QUALITY ASSURANCE

A. Identification

1. Equipment shall be identified with a corrosion resistant nameplate affixed in a conspicuous location.
2. Nameplate information shall include manufacturer's name and address, equipment model number, and serial number.

B. Manufacturer

1. Supplier shall have a minimum 10 years experience as a manufacturer of municipal waste water equipment and a minimum 500 prior installations of similar equipment.
2. Supplier shall provide a list of reference sites for similar equipment for verification by the Engineer or Owner's Representative.
3. Supplier shall conduct factory testing and verification of equipment prior to shipment.
4. Supplier shall have factory owned bi-coastal service centers.

C. Installation & Start-up

1. Supplier shall provide services of a factory trained representative to check installation and review start-up of equipment and controls.
2. Supplier Representative shall inspect and approve site installation and supervise a review of the operation of the equipment.
3. Supplier Representative shall provide training on operation and maintenance requirements of the equipment.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Packaging

1. Containers or skids shall be constructed for normal shipping, handling, and storage.
2. Containers shall provide adequate protection for the equipment in a dry indoor environment between +40º F (+4.5º C) and +100º F (+37.8º C).

1.06 WARRANTY

A. Manufacturer's standard 12-month limited warranty shall be provided on equipment.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Grinder(s) and controller(s) shall be in accordance with these specification and plans and shall be supplied by one of the following manufacturers:

1. JWC Environmental, 290 Paularino Ave, Costa Mesa, CA 92626; Tel: 800-331-2277
   www.jwce.com
   JWC Environmental Model 30005-32.

JWC Environmental Model PC2200 Controller.

2. Approved equal.

B. Manufacturers requesting to be selected as an approved equal shall submit certified documentation including installation lists with phone numbers, equipment drawings, flow performance curves, electrical schematics and cut sheets, O&M draft showing compliance with these specifications a minimum of ten (10) days prior to bid opening. Selected equipment manufacturers shall be added to the list of approved manufacturers.

C. Selected approved equal manufacturers shall conduct an onsite test within ten (10) days of installation demonstrating compliance with all areas of this specification.

2.02 GRINDER

A. General

1. Grinder shall reduce or shred influent solids for protection of downstream equipment. Grinder shall be two shafted design consisting of individual cutters and spacers, with cutters on drive and driven shafts of equal diameter. The grinder shall have two rotating screen drums that shall collect solids too large to pass through the screen drum and direct them to the cutters for solids reduction. Grinder shall have a single motor and speed reducer to drive both the cutters and the screen drum.

B. Components

1. Cutters and Spacers

   a. Cutting stack shall be a nominal height of 40-inches (1016.0 mm).
   b. Cutter shall be an individual disk constructed of AISI 4130 alloy steel surface ground to thickness of .438-inches +.000/-.001 (11.1 mm +.000/-.003).
   c. Cutters shall be heat treated to produce a hardness of 45-53 Rockwell C.
   d. Cutters shall have 7 cam shaped teeth. Tooth height shall not be greater than ½-inch (13 mm) above the root diameter of the cutter. OD shall be 4.71-inches (120 mm).
   e. Spacers shall be an individual disk constructed of AISI 4130 alloy steel surface ground to a thickness of .446-inches +.001/-.000 (11.3mm +.003/-.000).
   f. Spacers shall have a hardness of 34-38 Rockwell C.
   g. Spacers shall have a smooth outside diameter with no tooth profiles.

2. Shafts

   a. Shafts shall be constructed from AISI 4140 alloy steel with a minimum tensile strength of 170,000 PSI (1,172 kPA).
   b. Shafts shall be measure a nominal 2-inches (51 mm) across flats of hex.
   c. Shafts shall be hardened to 38-42 Rockwell C.

3. Intermediate Shaft Collars with Vertical Support Structure

   a. Intermediate shaft collars shall be constructed of ASTM A743 stainless steel, AISI 17-4 stainless steel and SAE 660 bearing bronze.
   b. Shaft collars shall be lubricated with high temperature marine grade grease at the factory.
   c. Grease fittings on the shaft collars shall be provided for periodic maintenance.

d. Intermediate shaft collars shall provide radial support to the shafts during severe grinding demands.
e. Vertical support structure shall be constructed of stainless steel.
f. Vertical support structure shall have brackets to locate and secure intermediate shaft collars within the cutter stack.
g. Vertical support structure shall have a shape that coincides with the radial profile of the cutters to allow for a close interface.
h. Vertical support structure shall have adjustable brackets for mounting to the top and bottom end housings.
J. Intermediate shaft collars and vertical support structures shall only be supplied on cutter stacks of 32-inches (813mm) and taller.

4. Seal Cartridges

a. Seal cartridges shall be rated to a maximum of 90 PSI (620 kPA).
b. Seal cartridges shall not require flushing.
c. Dynamic and rotating seal faces shall be constructed of tungsten carbide with 6% nickel binder.
d. O-rings shall be constructed of Buna-N (Nitrile).
e. Radial and axial loads shall be borne by sealed, oversized, deep-groove ball bearings.

5. Housings and Covers

a. End housings and top cover shall be constructed of ASTM A536-84 ductile iron.
b. End housings shall have integral bushing deflector to guide solids from seal cartridges.
c. Bottom cover shall be constructed of ASTM A-36 rolled steel.

6. Side Rails

a. Side rails shall be constructed of ASTM A536-84 ductile iron.
b. Drum side rail shall have a Brush type sealing strip for creating an adjustable interface between the side rail and the rotating drum.
c. Cutter side rail shall have evenly-spaced horizontal slots to increase flow and decrease water head loss through the grinder. Slots shall only be located on the upstream or influent side of the rail and the effluent side of the rail shall be void of slots to allow for unobstructed flow.
d. Inside profile of the cutter side rail shall be concave and follow the radial arc of the cutters.
e. Clearance between the outside diameter of cutters and concave arc of the cutter side rail shall not exceed 5/16-inch (7.9 mm).
f. Side rails shall have integral guide slot for installing into framework.

7. Perforated Screen Drum

a. Perforated screen drum shall be constructed of 11 gauge (.120”) AISI 316 stainless steel with ½-inch (12.7 mm) diameter holes.
b. Perforated screen drum shall have center ring supports, end flanges, and stub shafts to properly support the perforated screen.
c. Perforated screen drum shall have no shaft in center of drum.
d. Perforated screen drum shall be electropolished.

8. Speed Reducer

a. Reducer shall be manufactured by Sumitomo Machinery Corporation of America.
b. Reducer shall be internal planetary mechanism with trochoidal curved tooth profile.
c. Reducer shall be a vertically mounted with 29:1 single reduction.
d. Reducer shall be grease lubricated.

9. Motor

a. Motor shall be immersible 5 hp (3.7 kW), XPNV, 1770 rpm, 460 volt, 3 phase, 60 Hz and be supplied with a 40’ integral cable.
b. Motor shall be U.L. rated NEMA 6P, Class I, Div. I Groups C&D, Class II Div. II, Groups F&G, Class III Div. I
c. Motor shall have additional rating of 7 consecutive days of submergence at a maximum depth of 30 feet (9 m).
d. Motor shall not utilize fan cooling at any time during operation.
e. Motor shall utilize ceramic shaft seal requiring no oil lubrication.
f. Motor shall have a minimum service factor of 1.15, 91% minimum efficiency factor at full load, minimum 76% power factor at full load.

C. Performance

1. Grinder shall be capable of processing 4.32 MGD (681.4 m^3/h).
2. Grinder shall provide a minimum peak shaft torque of 3,981 lb-in/hp (603 Nm/kW).
3. Grinder shall provide a minimum peak force at cutter tip of 1,717 lb_f/hp (10,240 N/kW).

2.03 FRAME AND SUPPORTS

A. General

1. Frame and/or supports shall provide a method for properly securing the grinder in an open channel or wet well. The frame shall allow installation or removal without any disassembly of the frame or grinder.

B. Components

1. Frame and/or supports shall be constructed of AISI 304 stainless steel.
2. Frame shall provide proper support and interface to prevent unwanted bypass.
3. Frame shall utilize guides that insert into the grinders side rail slots to properly position and locate the grinder.

2.04 CONTROLLER

A. General

1. Controller shall provide control of the grinder and screen drum and be designed to control one (1) 5 hp (3.7 kW), 460 volts, 3 phase, 60 Hz. The controller shall have indicator lights, switches and other control devices, and shall be equipped with an integral disconnect switch.

B. Components

1. Enclosures

    a. Enclosure shall be stainless steel NEMA 4X.
    b. Enclosure shall house the control devices, motor starter, and PLC.

2. Grinder ON-OFF/RESET-REMOTE three-position 22mm type, NEMA 4X selector switch

    a. In the OFF/RESET position, the grinder shall not run.
    b. In the ON position, the grinder shall run continuously.
    c. In the REMOTE position, the grinder shall start and stop as controlled by an external device.
    d. Selector switch shall be the only method for resetting the controller after a failure.

3. Pilot Lights

    a. Lights shall be LED type 22 mm, rated NEMA 4X.
    b. Lights shall indicate POWER ON, RUN, and FAIL.

4. Programmable Logic Controller (PLC)

    a. PLC shall be manufactured by Panasonic.
    b. PLC shall have a minimum of 16K of memory.

5. Motor Starter

    a. Starter shall be a full-voltage reversing type with 120 volt operating coil.
    b. Overload relays shall be adjustable and sized to full load amperes (FLA) of the motor.

6. Control Transformer

    a. Control transformer shall be minimum 130 VA.
    b. Control transformer primary and secondary shall be fused for over current protection.

7. Current Transducer

    a. Current transducer shall be manufactured by Veris Industries.
    b. Current transducer shall have adjustable set point from 1-135A with 200ms or less response time.

C. Performance

1. When a grinder jam condition occurs, the controller shall stop the grinder and reverse the grinder rotation to clear the obstruction. If the jam is cleared, the controller shall return the grinder to normal operation. If three (3) reverses occur within a 30 second interval, the controller shall stop the grinder motor and activate the grinder FAIL indicator and relay.
2. When a power failure occurs while the grinder is operating, the grinder will resume operation once power is restored.
3. When a power failure occurs while the grinder is in a fail condition, once power is restored the fail indicator shall reactivate and remain until reset.
4. Reset of the grinder and shall be accomplished from the controller only.

PART 3 EXECUTION

3.01 INSTALLATION

A. Grinder(s) and controller(s) shall be installed in accordance with supplier's installation instructions, and in accordance with all OSHA, local, state, and federal codes and regulations.

3.02 TESTING

A. Test of grinder(s) shall demonstrate correct alignment, smooth operation. Test period shall demonstrate simulated jam conditions for both grinder and screen drums.

3.03 TRAINING

A. A field training course shall be provided for operation and supervisory staff members. Field instruction shall cover items for successful operation contained in the operation & maintenance manuals.

END OF SECTION

PERMITS

TOWN OF SMITHFIELD
PUMP STATION #1 IMPROVEMENTS
Town of Smithfield, North Carolina

NCDEQ Fast Track Sewer Extension

JOSH STEIN
Governor
D. REID WILSON
Secretary
RICHARD E. ROGERS, JR.
Director

NORTH CAROLINA
Environmental Quality

February 12, 2025

Ted Credle, Director of Public Utilities
Town of Smithfield
230 Hospital Road
Smithfield, NC 27577

Subject: Permit No. WQ0046037
Town of Smithfield
Town of Smithfield Pump Station #1 and Force Main Improvements
Wastewater Collection System Extension Permit
Johnston County

Dear Permittee:

In accordance with your application received December 3, 2024, and additional information received on January 31, 2025, we are forwarding herewith Permit No. WQ0046037 dated February 12, 2025, to the Town of Smithfield (Permittee) for the construction and operation upon certification of the subject wastewater collection system extension. This permit shall be effective from the date of issuance until rescinded, and shall be subject to the conditions and limitations as specified therein. This cover letter shall be considered a part of this permit and is therefore incorporated therein by reference.

This permit replaces various known and unknown permitted infrastructure for the pump station and force main, and adds additional force main lengths totaling 10,000 linear feet. Once the new facility is built, the permittee will request to rescind WQ0017594 before operation.

Please pay particular attention to the special conditions and following standard conditions contained in this permit:

Condition II.1: This permit shall not be automatically transferable; a request must be made and approved.

Condition II.4: Requires that the wastewater collection facilities be properly operated and maintained in accordance with 15A NCAC 02T .0403 or any individual system-wide collection system permit issued to the Permittee.

Condition II.7: Upon completion of construction and prior to operation of these permitted facilities, the completed Engineering Certification form with checklist attached to this permit shall be submitted with the required supporting documents to the address provided on the form. **Permit modifications are required for any changes resulting in non-compliance with this permit, regulations, or the Minimum Design Criteria.** [15A NCAC 02T.0116]

It shall be the responsibility of the Permittee to ensure that the as-constructed project meets the appropriate design criteria and rules. Failure to comply may result in penalties in accordance with North Carolina General Statute §143-215.6A through §143-215.6C, construction of additional or replacement wastewater collection facilities, and/or referral of the North Carolina-licensed Professional Engineer to the licensing board.

If any parts, requirements, or limitations contained in this permit are unacceptable, you have the right to request an adjudicatory hearing upon written request within 30 days following receipt of this permit. This request must be in the form of a written petition, conforming to Chapter 150B of North Carolina General Statutes, and filed with the Office of Administrative Hearings, 6714 Mail Service Center, Raleigh, NC 27699-6714. Unless such demands are made, this permit shall be final and binding.

If you need additional information concerning this matter, please contact the Raleigh Regional Office via e-mail at DEQ.DWR.RRO.FastTracks@deq.nc.gov or 919-791-4200.

Sincerely,

Signed by:
Michael Hall
372DCBCB61EE4A8...

Michael Hall, Regional Supervisor
Water Quality Regional Operations Section
Raleigh Regional Office
Division of Water Resources, NCDEQ

cc: Robert Bernard, PE; Stantec Consulting Services Inc
Johnston County
Johnston County Health Department
DWR Laserfiche

NORTH CAROLINA
Environmental Quality

WASTEWATER COLLECTION SYSTEM EXTENSION PERMIT

In accordance with the provisions of Article 21 of Chapter 143, General Statutes of North Carolina as amended, and other applicable Laws, Rules, and Regulations, permission is hereby granted to the

Town of Smithfield
Johnston County

for the construction and operation of a 2,200–gallon per minute pump station with duplex pumps, on-site audible and visual high water alarms, telemetry, and a permanent generator with automatic transfer switch; as well as approximately 10,000 linear feet of 20-inch force main to serve residential homes, schools, day cares, food and drink facilities, businesses, offices, retail stores, factories, and church as part of the Town of Smithfield Pump Station #1 and Force Main Improvements project, and the discharge of zero "0"gallons per day (flow is permitted under upstream connections) of collected domestic and commercial wastewater into the Johnston County's existing sewerage system, pursuant to the application received December 3, 2024, and additional information received on January 31, 2025 and in conformity with 15A NCAC 02T; the Division's Gravity Sewer Minimum Design Criteria adopted February 12, 1996 and updated in March 2008, as applicable; the Division's Minimum Design Criteria for the Fast-Track Permitting of Pump Stations and Force Mains adopted June 1, 2000 as applicable; and other supporting data subsequently filed and approved by the Department of Environmental Quality and considered a part of this permit.

This permit replaces the existing permit's (WQ0017594) 600-GPM duplex pumps with 2,200-GPM duplex pumps, replaces force main from an unknown permit, and add new force main totaling 10,000 linear feet. Once the new facility is built, the permittee will request to rescind WQ0017594 prior to operation.

This permit shall be effective from the date of issuance until rescinded and shall be subject to the specified conditions and limitations contained therein.

Signed by:
Michael Hall
372DCBCB61EE4A8...

Michael Hall, Regional Supervisor
Water Quality Regional Operations Section
Raleigh Regional Office
Division of Water Resources, NCDEQ

Permit Number: **WQ0046037**
Permit Issued: **February 12, 2025**

SUPPLEMENT TO PERMIT COVER SHEET

Town of Smithfield is hereby authorized to:

Construct, and then operate upon certification the aforementioned wastewater collection extension. The sewage and wastewater collected by this system shall be treated in the Johnston County's Central Johnston County Outfall 1 Wastewater Treatment Facility in accordance with Permit Number NC0030716.

Permitting of this project does not constitute an acceptance of any part of the project that does not meet 15A NCAC 02T; the Division's Gravity Sewer Minimum Design Criteria adopted February 12, 1996 as applicable; and the Division's Minimum Design Criteria for the Fast-Track Permitting of Pump Stations and Force Mains adopted June 1, 2000 as applicable, unless specifically mentioned herein. Division approval is based on acceptance of the certification provided by a North Carolina-licensed Professional Engineer in the application. It shall be the Permittee's responsibility to ensure that the as-constructed project meets the appropriate design criteria and rules.

Construction and operation is contingent upon compliance with the Standard Conditions and any Special Conditions identified below.

I. SPECIAL CONDITIONS

1. This permit shall become voidable unless the agreement between Town of Smithfield and Johnston County for the collection and final treatment of wastewater is in full force and effect. [15A NCAC 02T.0304(g)]

2. No flow in excess of the quantity permitted herein, zero additional GPD, shall be made tributary to the subject sewer system until an application for permit modification for an increase in flow or a new upstream application with flow has been submitted to and approved by the Division. [15A NCAC 02T.0304(b)]

3. Each pump station shall be clearly and conspicuously posted using a weatherproof sign with a pump station identifying name/number, 24-Hour Emergency telephone number, and name of the owner/operator of the sewer system/pump station and instructions to call the number in the event of alarm activation or other emergency. Simplex pump stations or vacuum sewer pits serving a single-family residence may have a placard or sticker on the control panel in lieu of a sign. [15A NCAC 02T .0305(h)(2)]

4. The abandonment of any existing wastewater facilities including septic systems being replaced by new sewer infrastructure shall be done in accordance with the applicable agency having compliance oversight on such facilities.

II. STANDARD CONDITIONS

1. This permit shall not be transferable. In the event there is a desire for the wastewater collection facilities to change ownership, or there is a name change of the Permittee, a formal permit request shall be submitted to the Division accompanied by documentation from the parties involved, and other supporting materials as may be appropriate. The approval of this request shall be considered on its merits and may or may not be approved. [15A NCAC 02T.0116; G.S 143-215.1(d3)]

2. This permit shall become voidable unless the wastewater collection facilities are constructed in accordance with the conditions of this permit; 15A NCAC 02T; the Division's Gravity Sewer Minimum Design Criteria adopted February 12, 1996 as applicable; the Division's Minimum Design Criteria for the Fast-Track Permitting of Pump Stations and Force Mains adopted June 1, 2000 as applicable; and other supporting materials unless specifically mentioned herein. [15A NCAC 02T.0110]

3. This permit shall be effective only with respect to the nature and volume of wastes described in the application and other supporting data. [15A NCAC 02T .0110]

4. The wastewater collection facilities shall be properly maintained and operated at all times. The Permittee shall maintain compliance with an individual system-wide collection system permit for the operation and maintenance of these facilities as required by 15A NCAC 02T .0403. If an individual permit is not required, the following performance criteria shall be met:

   a. The sewer system shall be effectively maintained and operated at all times to prevent discharge to land or surface waters, and to prevent any contravention of groundwater standards or surface water standards.

   b. A map of the sewer system shall be developed and shall be actively maintained.

   c. An operation and maintenance plan including pump station inspection frequency, preventative maintenance schedule, spare parts inventory and overflow response has been developed and implemented.

   d. Pump stations that are not connected to a telemetry system shall be inspected every day (i.e. 365 days per year). Pump stations that are connected to a telemetry system shall be inspected at least once per week.

   e. High-priority sewer lines shall be inspected at least once per every six-months and inspections are documented.

   f. A general observation of the entire sewer system shall be conducted at least once per year.

   g. Overflows and bypasses shall be reported to the appropriate Division regional office in accordance with 15A NCAC 2B .0506(a), and public notice shall be provided as required by North Carolina General Statute §143-215.1C.

   h. A Grease Control Program is in place as follows:

      1. For public owned collection systems, the Grease Control Program shall include at least biannual distribution of educational materials for both commercial and residential users and the legal means to require grease interceptors at existing establishments. The plan shall also include legal means for inspections of the grease interceptors, enforcement for violators and the legal means to control grease entering the system from other public and private satellite sewer systems.

      2. For privately owned collection systems, the Grease Control Program shall include at least bi-annual distribution of grease education materials to users of the collection system by the permittee or its representative.

      3. Grease education materials shall be distributed more often than required in Parts (1) and (2) of this Subparagraph if necessary to prevent grease-related sanitary sewer overflows.

   i. Right-of-ways and easements shall be maintained in the full easement width for personnel and equipment accessibility.

j. Documentation shall be kept for Subparagraphs (a) through (i) of this Rule for a minimum of three years with exception of the map, which shall be maintained for the life of the system.

5. The Permittee shall report by telephone to a water resources staff member at the Raleigh Regional Office, telephone number (919) 791-4200, as soon as possible, but in no case more than 24 hours, following the occurrence or first knowledge of the occurrence of either of the following:

   a. Any process unit failure, due to known or unknown reasons, that renders the facility incapable of adequate wastewater transport, such as mechanical or electrical failures of pumps, line blockage or breakage, etc.; or
   b. Any SSO and/or spill over 1,000 gallons; or
   c. Any SSO and/or spill, regardless of volume, that reaches surface water

   Voice mail messages or faxed information is permissible, but this shall not be considered as the initial verbal report. Overflows and spills occurring outside normal business hours may also be reported to the Division of Emergency Management at telephone number (800) 858-0368 or (919) 733-3300. Persons reporting any of the above occurrences shall file a spill report by completing and submitting Part I of Form CS-SSO (or the most current Division approved form) within five days following first knowledge of the occurrence. This report must outline the actions taken or proposed to be taken to ensure that the problem does not recur. Part II of Form CS-SSO (or the most current Division approved form) can also be completed to show that the SSO was beyond control. [G.S. 143-215.1C(a1)]

6. Construction of the gravity sewers, pump stations, and force mains shall be scheduled so as not to interrupt service by the existing utilities nor result in an overflow or bypass discharge of wastewater to the surface waters of the State. [15A NCAC 02T.0108(b)]

7. Upon completion of construction and prior to operation of these permitted facilities, the completed Engineering Certification form with checklist attached to this permit shall be submitted with the required supporting documents to the address provided on the form. A complete certification is one where the form is fully executed and the supporting documents are provided as applicable. Any wastewater flow made tributary to the wastewater collection system extension prior to completion of this Engineer's Certification shall be considered a violation of the permit and shall subject the Permittee to appropriate enforcement actions.

   If the permit is issued to a private entity with an Operational Agreement, then a copy of the Articles of Incorporation, Declarations/Covenants/Restrictions, and Bylaws that have been appropriately filed with the applicable County's Register of Deeds office shall be submitted with the certification.

   A complete certification is one where the form is fully executed and the supporting documents are provided as applicable. Supporting documentation shall include the following:

   a. One copy of the project construction record drawings (plan & profile views of sewer lines & force mains) of the wastewater collection system extension. Final record drawings should be clear on the plans or on digital media (CD or DVD disk) and are defined as the design drawings that are marked up or annotated with after construction information and show required buffers, separation distances, material changes, etc.

   b. One copy of the supporting applicable design calculations including pipe and pump sizing, velocity, pump cycle times, and level control settings, pump station buoyancy, wet well storage, surge protection, detention time in the wet well, and force main, ability to flush low points in force mains with a pump cycle, and downstream sewer capacity analysis. If a portable power source or pump is dedicated to multiple stations, an evaluation of all the pump stations' storage capacities and the rotation schedule of the portable power source or pump, include travel timeframes, shall be provided.

c. Changes to the project that do not result in non-compliance with this permit, regulations, or the Minimum Design Criteria should be clearly identified on the record drawings, on the certification in the space provided, or in written summary form.

Prior to Certification (Final or Partial): Permit modifications are required for any changes resulting in non-compliance with this permit (including but not limited to pipe length changes of 10% or greater, increased flow, pump station design capacity design increases of 5% or greater, and increases in the number/type of connections), regulations, or the Minimum Design Criteria. Requested modifications or variances to the Minimum Design Criteria will be reviewed on a case-by-case basis and each on its own merit. Please note that variances to the Minimum Design Criteria should be requested and approved during the permitting process prior to construction. After-construction requests are discouraged by the Division and may not be approved, thus requiring replacement or repair prior to certification & activation. [15A NCAC 02T .0116]

8. Gravity sewers installed greater than ten percent below the minimum required slope per the Division's Gravity Sewer Minimum Design Criteria shall not be acceptable and shall not be certified until corrected. If there is an unforeseen obstacle in the field where all viable solutions have been examined, a slope variance can be requested from the Division with firm supporting documentation. This shall be done through a permit modification with fee. Such variance requests will be evaluated on a case-by-case basis. Resolution of such request shall be evident prior to completing and submitting the construction certification. [15A NCAC 02T.0105(n)]

9. A copy of the individual permit and construction record drawings shall be maintained on file by the Permittee for the life of the wastewater collection facilities. [15A NCAC 02T .0116]

10. Failure to abide by the conditions and limitations contained in this permit; 15A NCAC 02T; the Division's Gravity Sewer Design Criteria adopted February 12, 1996 as applicable; the Division's Minimum Design Criteria for the Fast-Track Permitting of Pump Station and Force Mains adopted June 1, 2000 as applicable; and other supporting materials may subject the Permittee to an enforcement action by the Division, in accordance with North Carolina General Statutes §143-215.6A through §143-215.6C, construction of additional or replacement wastewater collection facilities, and/or referral of the North Carolina-licensed Professional Engineer to the licensing board. [15A NCAC 02T .0108(b-c)]

11. In the event that the wastewater collection facilities fail to perform satisfactorily, including the creation of nuisance conditions, the Permittee shall take immediate corrective action, including those as may be required by this Division, such as the construction of additional or replacement facilities. [15A NCAC 02T .0110; 15A NCAC 02T .0108(b)]

12. The issuance of this permit shall not exempt the Permittee from complying with any and all statutes, rules, regulations, or ordinances that may be imposed by the Division any other Federal, State, or Local government agencies which have jurisdiction or obtaining other permits which may be required by the Division or any other Federal, State, of Local government agencies. [G.S. 143-215.1(b)]

CERTIFICATION CHECKLIST

To be completed by the certifying engineer prior to operation of the permitted sewers, per 15A NCAC 02T.0116.

Certifying Engineer: ______________________________

Certification Review Date: ______________________________

Project Name: ______________________________

WQ00______________ **Project County:** ______________________________

1) Has permittee information changed since the permit was issued (or last modified): change of mailing address, change of ownership, transfer from developer to HOA/POA, etc. ☐ Yes ☐ No
    - If yes, please provide either a change of ownership form or new contact information. Note that transfer of permits from the developer to the HOA/POA must occur with the first certification.
2) Have the as-built drawings have been signed, sealed, and dated by an N.C. PE? ☐ Yes ☐ No
3) Final Engineering certification? ☐ Yes ☐ No
    - **If Partial Engineering certification, provide detailed narrative including what is being certified in the current phase, what was previously certified (if applicable), and what is left to be certified.**
4) Adequate information related to sewer lines: ☐ Yes ☐ No ☐ N/A
    - Three feet minimum cover has been provided for all sewers unless ferrous pipe was installed.
    - Minimum diameters for gravity sewers are 8-inches for public lines and 6-inches for private lines.
    - Manholes have been installed: At the end of each line, at all changes in grade, size, or alignment, at all intersections, and at distances not greater than 425 feet; minimum diameter shall be 4 feet (48-inches).
5) Adequate information related to pump stations: ☐ Yes ☐ No ☐ N/A
    - Ensure power reliability option was selected per 15A NCAC 02T.0305(h).
6) Was project construction completed in accordance with all of the following: ☐ Yes ☐ No ☐ N/A
    - 15A NCAC 02T, Minimum Design Criteria (MDC) for the permitting of Gravity Sewers (latest version), and MDC for the Permitting of Pump Stations and Force Mains (latest version)?

If not, a variance approval is required in accordance with 15A NCAC 02T.0105(b), **prior to certification and operation.**

- Contact the Central Office to discuss the variance to determine a course of action.
- Applicant must submit <u>two</u> copies of the variance request form, plans, specifications, calculations, and any other pertinent information to the Central Office (one hard copy, one digital copy).
- The central office will review the variance request, and if approvable, specific language regarding the variance will be incorporated into the permit, either via a special condition or a supplementary letter. A copy of the reissued permit with variance language or the variance letter must be maintained with the original documents.

7) Does the project contains high priority lines (15A NCAC 02T .0402(2))? ☐ Yes ☐ No
    - If yes, ensure that the permit already contains the necessary condition related to high priority lines 15A NCAC 02T.0403 (a)(5). If the permit does not include this language, the Fast Track reviewer will reissue the permit with the appropriate language.
8) Are Permit modifications are required for any changes resulting in non-compliance with this permit (including but not limited to pipe length changes of 10% or greater, change in flow, pump station design capacity design change of 5% or greater, and/or change in the number/type of connections)? ☐ Yes ☐ No
    - If yes, a permit modification request must be submitted to the appropriate Regional Office, and **a modified permit with revised certification must be issued prior to certification and operation**.

FAST TRACK SEWER ENGINEERING CERTIFICATION

PERMITTEE: Town of Smithfield
PERMIT #: WQ0046037
PROJECT: Town of Smithfield Pump Station #1 and Force Main Improvements
ISSUE DATE: February 12, 2025

This project shall not be considered complete nor allowed to operate in accordance with Condition 7 of this permit until the Division has received this Certification and all required supporting documentation. It should be submitted in a manner that documents the Division's receipt. Send the required documentation to the Regional Supervisor, Water Quality Regional Operations Section at the address at the bottom.

Any wastewater flow made tributary to the wastewater collection system extension prior to completion of this Certification shall be considered a violation of the permit and shall subject the Permittee to appropriate enforcement actions. The Permittee is responsible for tracking all partial certifications up until a final certification is received. A Final Certification shall be a complete set of record drawings and design calculations regardless of whether partials have been submitted.

PERMITTEE'S CERTIFICATION

I, the undersigned agent for the Permittee, hereby state that this project has been constructed pursuant to the applicable standards & requirements, the Professional Engineer below has provided applicable design/construction information to the Permittee, and the Permittee is prepared to operate & maintain the wastewater collection system permitted herein or portions thereof.

_________________________________ _______________________________ _________________

Printed Name, Title Signature Date

ENGINEER'S CERTIFICATION

I, ___________________________, as a duly registered Professional Engineer in the State of North Carolina, having been authorized to observe (☐ periodically, ☐ weekly, ☐ full time) the construction of the project name and location as referenced above for the above Permittee hereby state that, to the best of my abilities, due care and diligence was used in the observation of the following construction: **2,200–gallon per minute pump station with duplex pumps, on-site audible and visual high water alarms, telemetry, and a permanent generator with automatic transfer switch; as well as approximately 10,000 linear feet of 20-inch force main**; such that the construction was observed to be built within substantial compliance of this permit; 15A NCAC 02T; the Division of Water Resources' (Division) Gravity Sewer Minimum Design Criteria adopted February 12, 1996 as applicable; the Division's Minimum Design Criteria for the Fast-Track Permitting of Pump Stations and Force Mains adopted June 1, 2000 as applicable; and other supporting materials.

North Carolina Professional Engineer's Seal w/signature & date:

☐ **Final** ☐ **Partial (include description)**

Certification Comments/Qualifiers (attach if necessary):

Pump Station #1 Improvements

Geotechnical Engineering Report

November 20, 2024 | Terracon Project No. 70245249

Prepared for:

Stantec, Inc.
801 Jones Franklin Road, Suite 300
Raleigh, North Carolina 27606

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Terracon.com

November 20, 2024

Stantec, Inc.
801 Jones Franklin Road, Suite 300
Raleigh, North Carolina 27606

Attn: Mr. Robert Bernard, PE
P: (980) 297-7653
E: robert.bernard@stantec.com

Re: Geotechnical Engineering Report
Pump Station #1 Improvements
West Market Street
Smithfield, North Carolina
Terracon Project No. 70245249

Dear Mr. Bernard:

We have completed the scope of Geotechnical Engineering services for the above-referenced project in general accordance with Terracon Proposal No. P70245249 dated October 10, 2024. This report presents the findings of the subsurface exploration and provides geotechnical recommendations for the proposed project.

We appreciate the opportunity to be of service to you on this project. If you have any questions concerning this report or if we may be of further service, please contact us.

Sincerely,

Terracon

NORTH CAROLINA PROFESSIONAL SEAL 19331 ENGINEER THOMAS M. SCHIPPOREIT
11/20/2024

Gunnar H. Goslin
Project Manager

Tom Schipporeit, PE, BC.GE
Senior Geotechnical Engineer

Table of Contents

Figures

Attachments

Note: This report was originally delivered in a web-based format. **Blue Bold** text in the report indicates a referenced section heading. The PDF version also includes hyperlinks which direct the reader to that section and clicking on the Terracon logo will bring you back to this page. For more interactive features, please view your project online at **client.terracon.com**.

Refer to each individual Attachment for a listing of contents.

Introduction

This report presents the results of our subsurface exploration and Geotechnical Engineering services performed for the proposed wastewater pump station to be located on West Market Street in Smithfield, North Carolina. The purpose of these services was to provide information and geotechnical engineering recommendations relative to:

- Site Location and Exploration Plans
- Subsurface exploration procedures
- Exploration log
- Stratification based on visual soil and rock classification
- Groundwater levels measured in the explorations
- Seismic site class
- Earthwork recommendations, including:
  - Excavation considerations
  - Fill material types
  - Fill placement and compaction
  - Construction observation and testing
- Recommended foundation type, recommended engineering design parameters, and estimated foundation settlements
- Recommendations for the design of below-grade wet well walls, including lateral earth pressure soil parameters

The geotechnical engineering Scope of Services for this project included the advancement of SPT borings, laboratory testing, engineering analysis, and preparation of this report.

Drawings showing the site and SPT boring locations are shown on the **Site Location** and **Exploration Plan**, respectively. The results of the laboratory testing performed on soil samples obtained from the site during our field exploration are included on the SPT boring logs and as separate graphs and tables in the **Exploration Results** section.

Project Description

Our initial understanding of the project was provided in our proposal and was discussed during project planning. A period of collaboration has transpired since the project was initiated, and our final understanding of the project conditions is as follows:

Item	Description
Information Provided	This report is based on the following sources of information: ■ Geotechnical Engineering Report for Pump Station 1 Force Main Improvements, Terracon Project No. 70235284, dated March 1, 2024 ■ Emails between representatives of Stantec and Terracon between October 7 and 14, 2024 ■ Existing Pump Station Site Plan, prepared by Stantec, dated August 23, 2024 ■ Preliminary structural drawings prepared by Stantec dated August 23, 2024 ■ Preliminary pump station details, plans, and sections prepared by Stantec dated June 24, 2024
Project Description	The project includes three new structures at an existing wastewater pump station: ■ Wet well, cast-in-place concrete, 32 feet deep, bearing approximately 33 feet below finish grade, with 20 feet by 22 feet mat foundation ■ Precast concrete valve vault, approximately 7 feet deep, 14 feet wide, and 18 feet long ■ Precast concrete mag meter vault, approximately 7 feet deep, 7 feet wide, and 14 feet long The wet well and vaults will house pumps, pipes, valves, and a flow meter. The wastewater levels in the wet well are not shown on the drawings provided to us.
Maximum Unfactored Gross Bearing Pressures	We understand the structures will apply the following gross bearing pressures to the underlying soils: ■ Wet well: 2,400 psf ■ Valve vault: 850 psf ■ Mag meter vault: 500 psf

Terracon should be notified if any of the above information is inconsistent with the planned construction, as modifications to our recommendations may be necessary.

Site Conditions

The following description of site conditions is derived from our site visit in association with the field exploration and our review of publicly available topographic maps.

Item	Description
Site Location Information	The project is located along West Market Street in Smithfield, North Carolina. See **Site Location**
Existing Improvements	An existing wastewater pump station in a fenced compound.
Current Ground Cover	Gravel, grass, bare ground
Existing Topography	Based on the plan prepared by Stantec dated February 17, 2023, elevations vary between 124 and 126 feet across the site.

We also collected photographs at the time of our field exploration program. Representative photos are provided in our **Photography Log**.

Geotechnical Characterization

We have developed a general characterization of the subsurface conditions based upon our review of the previous subsurface explorations by Terracon, the recent Terracon subsurface explorations, laboratory data, geologic setting and our understanding of the project. This characterization, termed GeoModel, forms the basis of our geotechnical calculations and evaluation of the site. Conditions observed at each exploration point are indicated on the individual logs. The individual logs can be found in the **Exploration Results** and the GeoModel can be found in the **Figures** attachment of this report.

As part of our analyses, we identified the following model layers within the subsurface profile. For a more detailed view of the model layer depths at each boring location, refer to the GeoModel.

Model Layer	Layer Name	General Description
1	**Surficial Materials**	Topsoil (2 in.) and Gravel (8 in.)
2	**Existing Fill**	Very Loose Clayey Sand (SC) with gravel
3	**Sand 1**	Very Loose Clayey Sand (SC)
4	**Clay 1**	Very Soft to Soft Sandy Lean Clay (CL)
5	**Clay 2**	Medium Stiff to Stiff Lean Clay (CL)
6	**Sand 2**	Very Loose Clayey Sand (SC)
7	**Partially Weathered Rock**	Sampled as clayey sand and sandy silt
8	**Bedrock**	Indicated by drilling refusal

The site is located at the boundary of the Coastal Plain and the Piedmont physiographic provinces near the Neuse River. Near-surface existing fill materials are underlain by Coastal Plain deposits characterized by marine, alluvial, and aeolian sediments that were deposited during periods of fluctuating sea levels and moving shorelines. The Coastal Plain deposits overly relatively shallow foliated to massive granitic rock consisting of phyllite and schist.

Boring PS-1 encountered partially weathered rock and drilling refusal. PWR is defined as an intermediate geomaterial with rock-like structure that could be penetrated with the exploration method and drill rig used and which exhibited a Standard Penetration Test value of at least 100 blows per foot (i.e., 50 blows with 6 inches or less of penetration). Drilling refusal is typically considered to be the upper surface of relatively hard competent rock that would require rock coring to sample. Approximate depths (from existing ground surface) to PWR (Model Layer 7) and drilling refusal (Model Layer 8) are listed in the following table.

Depth to Partially Weathered Rock and Drilling Refusal

Boring Number	PWR Depth (Model Layer 6) (Feet)	Drilling Refusal Depth (Model Layer 7) (Feet)
PS-1	32	43.5

Groundwater was measured at depths ranging from about 4.7 feet to 6 feet. Groundwater conditions may be different at the time of construction. Mapping by the Natural Resources Conservation Service (NRCS) indicates a seasonal high groundwater level approximately 1 foot below the ground surface. Groundwater conditions may change because of seasonal variations in rainfall, runoff, and other conditions not apparent at the time of drilling. Long-term groundwater monitoring was outside the scope of services for this project.

Seismic Site Class

The seismic design requirements for buildings and other structures are based on Seismic Design Category. Site Classification is required to determine the Seismic Design Category for a structure. The Site Classification is based on the upper 100 feet of the site profile defined by a weighted average value of either shear wave velocity, standard penetration test (SPT) resistance (N-values), or undrained shear strength in accordance. Based on the soil and bedrock properties observed at the site and as described on the exploration logs and results, our professional opinion is that a **Seismic Site Classification of D** be considered for the project based on SPT N-values. Subsurface explorations at this site were extended to a maximum depth of 43.5 feet. The site properties below the boring depth to 100 feet were estimated based on our experience and knowledge of geologic conditions of the general area.

Our experience indicates that evaluation of seismic site class using SPT N-values can be overly conservative. If it is determined that advantage could be gained with an improved Site Class, additional site testing could be performed to measure shear wave velocities at the site

Geotechnical Overview

The site appears suitable for the proposed construction based upon geotechnical conditions encountered in the SPT borings, provided that the recommendations provided in this report are implemented in the design and construction phases of this project.

Construction excavations to install the wet well and vaults will require shoring or sloping back per OSHA requirements, in addition to dewatering.

Based on the conditions encountered and estimated load-settlement relationships, the proposed wet well can be supported on a mat foundation bearing on 8 inches of No. 57 stone wrapped in geotextile bearing on partially weathered rock. The precast valve vault should be supported on a 24-inch-thick layer of No. 57 stone wrapped in geotextile. The precast mag meter vault should be supported on a 12-inch-thick layer of No. 57 stone wrapped in geotextile.

The recommendations contained in this report are based upon the results of field and laboratory testing (presented in the **Exploration Results**), engineering analyses, and our current understanding of the proposed project. The **General Comments** section provides an understanding of the report limitations.

Earthwork

Earthwork is anticipated to include excavations and structural fill and backfill placement. The following sections provide recommendations for use in the preparation of specifications for earthwork. Recommendations include critical quality criteria, as necessary, to render the site in the state considered in our geotechnical engineering evaluation for foundations and below-grade wet well walls.

Excavation Considerations

Excavatability

We anticipate that excavation of soil can generally be accomplished with conventional earthmoving equipment. However, excavation of partially weathered rock to construct the wet well will require ripping, hammering, or blasting.

Required excavation techniques will vary based on weathering of the materials to be excavated, and the fracturing, jointing and overall stratigraphy of the feature. Actual field conditions usually display a gradual weathering progression with poorly defined and uneven boundaries between layers of different materials. We recommend that the following definition for rock in earthwork excavation be included in bid documents:

Excavation Type	Definition
Trench Excavation	Any material occupying an original volume of more than 1/2 cubic yard which cannot be excavated with a backhoe having a bucket digging force of not less than 35,000 pounds, using a rock bucket and rock teeth (a Caterpillar 330 or larger).

Excavation Safety

As a minimum, excavations should be performed in accordance with OSHA 29 CFR, Part 1926, Subpart P, "Excavations" and its appendices, and in accordance with any applicable local and/or state regulations.

Excavations or other activities resulting in ground disturbance have the potential to affect nearby structures, pavements, and utilities. Our scope of services does not include review of available final grading information or consider potential temporary grading performed by the contractor for potential effects such as ground movement beyond the project limits. A preconstruction/ precondition survey should be conducted to document nearby property/infrastructure prior to any site development activity. Excavation or ground disturbance activities should be monitored or instrumented for potential ground movements that could negatively affect nearby structures, pavements, and utilities.

Excavation should not be conducted below a downward 2H:1V projection from the bottom edges of existing wall footings or column footings without engineering review of shoring/underpinning requirements and geotechnical observation during construction.

Construction site safety is the sole responsibility of the contractor who controls the means, methods, and sequencing of construction operations. Under no circumstances shall the information provided herein be interpreted to mean Terracon is assuming responsibility for construction site safety or the contractor's activities; such responsibility shall neither be implied nor inferred.

Construction Dewatering

We anticipate that temporary construction excavations for this project will encounter groundwater, especially during seasonal high water table conditions. The contractor should design, furnish, install, test, operate, monitor, and maintain a dewatering system of sufficient scope, size, and capacity to control hydrostatic pressures and to lower, control, remove, and dispose of groundwater and permit excavation and construction to proceed on dry, stable subgrades. The contractor should accomplish dewatering without damaging any existing buildings, structures, and site improvements adjacent to and near the excavations.

Typical temporary dewatering measures used on similar projects in the project area consist of sump excavations, sump pumps, well points, wells, and/or sheet pile cutoff walls.

The responsibility for dewatering construction excavations and preventing excessive damage of existing and new buildings, structures, utilities, and other site improvements due to dewatering should lie solely with the contractor. This information is provided only as a service and under no circumstance should Terracon be assumed to be responsible for the effectiveness of the construction dewatering method(s) selected by the contractor.

Fill Material Types

Earthen materials used for structural fill and backfill should meet the following material property requirements:

Soil Type[1]	USCS Classification	Acceptable Location for Placement
Imported Soil	SC, SM, SP, SP-SM, SC-SM	All locations and elevations
On-Site Soils	SC (LL<50 or PI<30)	All locations and elevations

1. Structural fill and backfill should consist of approved materials free of organic matter and debris. Frozen materials should not be used, and fill should not be placed on frozen subgrade. A sample of each material type should be submitted to the Geotechnical Engineer for evaluation prior to use on this site.

Fine-grained soils such as clays (CL) should not be used as structural fill due to their moisture sensitivity when compared to the sandier soils available. Limited amounts of suitable fill material were encountered in the borings. Reuse of clayey sand (SC) materials could lead to delays in construction depending on moisture conditions at the site at that time. Clayey sand excavated from below the water table will likely be too wet to practically use as compacted structural fill or backfill.

The on-site soils to be excavated to install the wet well and vaults are primarily clayey sand and clay

Fill Placement and Compaction Requirements

Structural fill and backfill should meet the following compaction requirements.

Item	Structural Fill/Backfill
Maximum Lift Thickness	10 inches in loose thickness when heavy, self-propelled compaction equipment is used 6 inches in loose thickness when hand-guided equipment (i.e. jumping jack or plate compactor) is used
Minimum Compaction Requirements[1,2]	98% of max. within 1 foot of finished pump station subgrade 95% of max. above foundations, below slabs, and more than 1 foot below finished pavement subgrade
Water Content Range[1]	Coarse-grained soil: -3% to +3% of optimum

1. Maximum density and optimum water content as determined by the standard Proctor test (ASTM D 698).
2. Materials not amenable to density testing should be placed and compacted to a stable condition observed by the Geotechnical Engineer or representative.

Construction Observation and Testing

Terracon should be retained during the construction phase of the project to observe earthwork and to perform necessary tests and observations during foundation construction and backfilling of excavations.

Each lift of compacted backffill should be tested, evaluated, and reworked, as necessary, as recommended by the Geotechnical Engineer prior to placement of additional lifts. Each lift of fill should be tested for density and water content at a frequency of at least one test for every lift every 2,500 square feet.

In areas of foundation excavations, the bearing subgrade should be evaluated by the Geotechnical Engineer. A representative of the Geotechnical Engineer should use a combination of hand auger borings and dynamic cone penetrometer (DCP) testing to determine the suitability of the bearing materials for the design bearing pressure. DCP testing should be performed to a depth of 3 to 5 feet below the bottom of the foundation excavation. If unanticipated conditions are observed, the Geotechnical Engineer should recommend mitigation options.

In addition to the documentation of the essential parameters necessary for construction, the continuation of the Geotechnical Engineer into the construction phase of the project provides the continuity to maintain the Geotechnical Engineer's evaluation of subsurface conditions, including assessing variations and associated design changes.

Shallow Foundations

Design

Based on the conditions encountered and estimated load-settlement relationships, the proposed wet well can be supported on a mat foundation bearing on at least 8 inches of No. 57 stone wrapped in geotextile bearing on partially weathered rock. The precast valve vault should be supported on a 24-inch-minimum-thick layer of No. 57 stone wrapped in geotextile. The precast mag meter vault should be supported on a 12-inch-minimum-thick layer of No. 57 stone wrapped in geotextile. We estimate that the total post-construction settlement of these proposed wet well and vaults will be less than 1 inch total and ½ inch differential.

The wet well and vaults will be subject to uplift from groundwater pressures. We recommend that a worst-case, seasonal high water depth of 1 foot below the exiting ground surface be used for design of the structures. Uplift resistance of the structures can be developed from the weight of the structures.

Foundation Construction Considerations

As noted in **Earthwork**, the foundation excavations should be evaluated under the observation of the Geotechnical Engineer. The base of all foundation excavations should be free of water and loose soil prior to placing stone bedding. Stone bedding should be placed soon after excavating to reduce bearing soil disturbance. Care should be taken to prevent wetting or drying of the bearing materials during construction. Excessively wet or dry material or any loose/disturbed material in the bottom of the foundation excavations should be removed/reconditioned before bedding stone is placed.

If unsuitable bearing soils are observed at the base of the planned foundation excavation, the excavations should be extended deeper to suitable soils.

Overexcavation for additional bedding stone placement below foundations should be conducted as shown below. The overexcavation should be backfilled up to the structure's base elevation with No. 57 stone wrapped in a woven geotextile that can be used for both separation and filtration (e.g., Mirafi HP270).

Below-Grade Walls

The wet well and vault walls must be capable of resisting lateral earth pressures that will be imposed on them. Lateral earth pressures will be partially dependent upon the method of construction. For example, when temporary shoring is installed and the width of the backfill zone is less than the height of the wall, the properties of the in-situ soils should be used. If, however, the wall backfill zone is wider than the wall is high, the properties of the backfill can be used. We assume that temporary shoring will be used to install the wet well and the vaults, and the backfill zone widths will be less than the heights of the walls and the properties of the in-situ soils should be used. Since the wet well and vault walls are braced at the top, they should be designed using the "at-rest" lateral earth pressure condition and hydrostatic pressures. We recommend that a worst-case, seasonal high water depth of 1 foot below the exiting ground surface be used for design of the structures.

Based on our review of the field test data from this site and our laboratory test results, recommended soil parameters are given in the following table:

Soil Properties for Below-Grade Wall Design

GeoModel Layer	Description	Depth (feet)	Moist or Buoyant Unit Weight (pcf)	Friction Angle (degrees)	Cohesion (psf)	At-Rest Earth Pressure Coefficient Ko
2	Fill (Loose Clayey Sand)	0 to 1	120	32	0	0.48
2	Fill (Loose Clayey Sand)	1 to 6	58	32	0	0.48
3	Very Loose Clayey Sand	6 to 8	48	29	100	0.52
4	Soft Clay	8 to 17	53	22	250	0.63
5	Stiff Clay	17 to 27	58	24	350	0.59
6	Very Loose Clayey Sand	27 to 32	48	28	200	0.53
7	Partially Weathered Rock	32 to 44	68	30	500	0.5

Surcharge loads on the backfill behind the walls will produce additional lateral earth pressures than need to be included in wall design analyses.

General Comments

Our analysis and opinions are based upon our understanding of the project, the geotechnical conditions in the area, and the data obtained from our site exploration. Variations will occur between exploration point locations or due to the modifying effects of construction or weather. The nature and extent of such variations may not become evident until during or after construction. Terracon should be retained as the Geotechnical Engineer, where noted in this report, to provide observation and testing services during pertinent construction phases. If variations appear, we can provide further evaluation and supplemental recommendations. If variations are noted in the absence of our observation and testing services on-site, we should be immediately notified so that we can provide evaluation and supplemental recommendations.

Our Scope of Services does not include either specifically or by implication any environmental or biological (e.g., mold, fungi, bacteria) assessment of the site or identification or prevention of pollutants, hazardous materials or conditions. If the owner is concerned about the potential for such contamination or pollution, other studies should be undertaken.

Our services and any correspondence are intended for the sole benefit and exclusive use of our client for specific application to the project discussed and are accomplished in accordance with generally accepted geotechnical engineering practices with no third-party beneficiaries intended. Any third-party access to services or correspondence is solely for information purposes to support the services provided by Terracon to our client. Reliance upon the services and any work product is limited to our client and is not intended for third parties. Any use or reliance of the provided information by third parties is done solely at their own risk. No warranties, either express or implied, are intended or made.

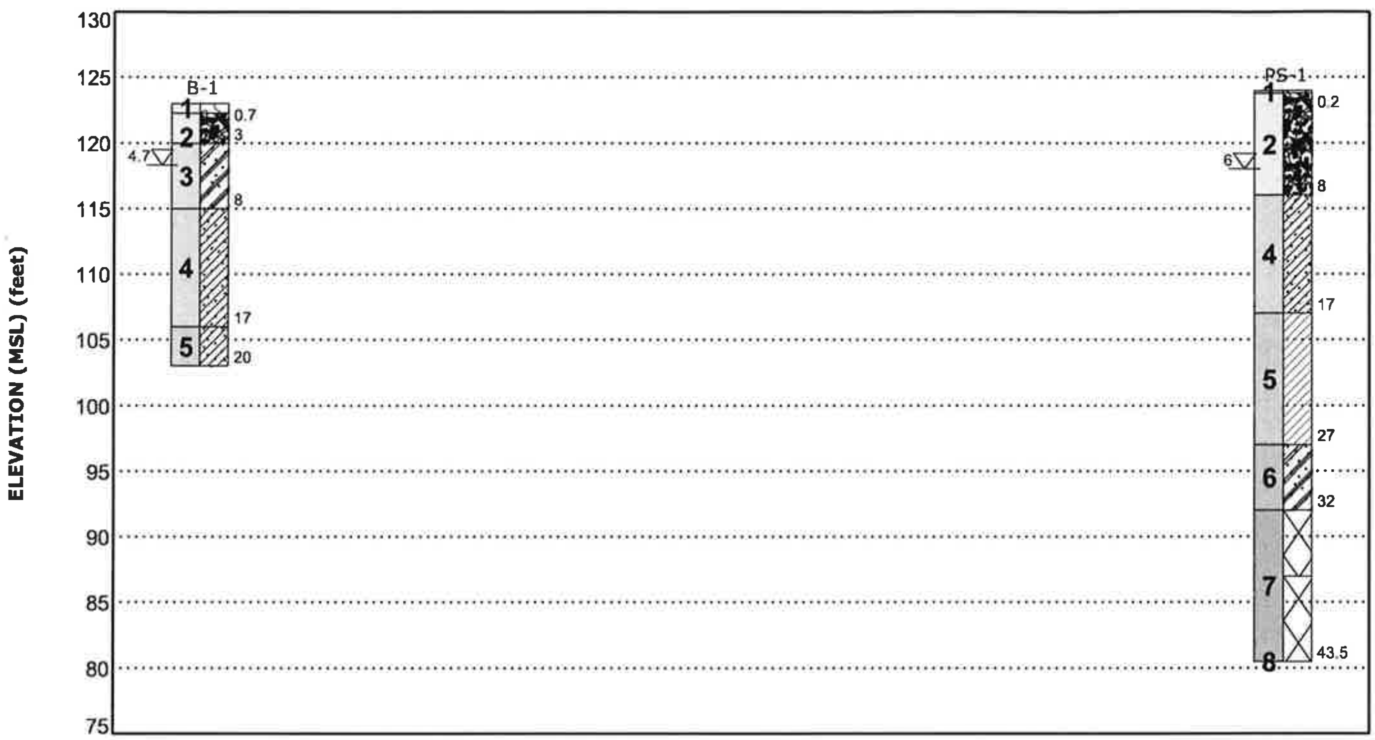
Site characteristics as provided are for design purposes and not to estimate excavation cost. Any use of our report in that regard is done at the sole risk of the excavating cost estimator as there may be variations on the site that are not apparent in the data that could significantly affect excavation cost. Any parties charged with estimating excavation costs should seek their own site characterization for specific purposes to obtain the specific level of detail necessary for costing. Site safety and cost estimating including excavation support and dewatering requirements/design are the responsibility of others. Construction and site development have the potential to affect adjacent properties. Such impacts can include damages due to vibration, modification of groundwater/surface water flow during construction, foundation movement due to undermining or subsidence from excavation, as well as noise or air quality concerns. Evaluation of these items on nearby properties are commonly associated with contractor means and methods and are not addressed in this report. The owner and contractor should consider a preconstruction/precondition survey of surrounding development. If changes in the nature, design, or location of the project are planned, our conclusions and recommendations shall not be considered valid unless we review the changes and either verify or modify our conclusions in writing.

Figures

Contents:

Terracon
3150 Spring Forest Rd Ste 100
Raleigh, NC

GeoModel



This is not a cross section. This is intended to display the Geotechnical Model only. See individual logs for more detailed conditions.

Model Layer	Layer Name	General Description
1	**Surficial materials**	Topsoil (2 in.) and Gravel (8 in.)
2	**Existing Fill**	Very Loose to Medium Dense Clayey Sand (SC) with gravel
3	**Sand 1**	Very Loose Clayey Sand (SC)
4	**Clay 1**	Very Soft to Soft Sandy Lean Clay (CL)
5	**Clay 2**	Medium Stiff to Stiff Lean Clay (CL)
6	**Sand 2**	Very Loose Clayey Sand (SC)
7	**Partially Weathered Rock**	Sampled as clayey sand and sandy silt
8	**Bedrock**	Indicated by driling refusal

Legend

- Aggregate Base Course
- Fill
- Clayey Sand
- Sandy Lean Clay
- Topsoil
- Lean Clay
- Weathered Rock

NOTES:
Layering shown on this figure has been developed by the geotechnical engineer for purposes of modeling the subsurface conditions as required for the subsequent geotechnical engineering for this project.

▽ First Water Observation

Groundwater levels are temporal. The levels shown are representative of the date and time of our exploration. Significant changes are possible over time.
Water levels shown are as measured during and/or after drilling. In some cases, boring advancement methods mask the presence/absence of groundwater. See individual logs for details.

Attachments

Exploration and Testing Procedures

Field Exploration

Borings	Approximate Boring Depth (feet)	Location
PS-1	43.5 (drilling refusal)	Pump station area
B-1[1]	20	Pump station area

1. Boring B-1 was performed as part of the Geotechnical Engineering Report for Pump Station 1 Force Main Improvements, Terracon Project No. 70235284, dated March 1, 2024

Boring Layout and Elevations: Terracon personnel provided the boring layout using handheld GPS equipment (estimated horizontal accuracy of about ±10 feet) and referencing existing site features. Approximate ground surface elevations were obtained by interpolation from the topographic plans prepared by Stantec dated February 17, 2023.

Subsurface Exploration Procedures: We advanced the borings with track-mounted, rotary drill rigs using mud rotary drilling techniques. Four samples were obtained in the upper 10 feet and at intervals of 5 feet thereafter. In the split-barrel sampling procedure, a standard 2-inch outer diameter split-barrel sampling spoon was driven into the ground by a 140-pound automatic hammer falling a distance of 30 inches. The number of blows required to advance the sampling spoon the last 12 inches of a normal 18-inch penetration is recorded as the Standard Penetration Test (SPT) resistance value. The SPT resistance values, also referred to as N-values, are indicated on the boring log at the test depths. For safety purposes, the borings were backfilled with bentonite chips or grout using tremie method after completion.

We also observed the boreholes while drilling and at the completion of drilling for the presence of groundwater. The groundwater levels are shown on the attached boring logs.

The sampling depths, penetration distances, and other sampling information were recorded on the field boring logs. The samples were placed in appropriate containers and taken to our soil laboratory for testing and classification by geotechnical staff. Our exploration team prepared field boring logs as part of the drilling operations. These field logs included visual classifications of the materials observed during drilling and our interpretation of the subsurface conditions between samples. Final boring logs were prepared from the field logs. The final boring logs represent our interpretation of the field logs and include modifications based on observations and tests of the samples in our laboratory.

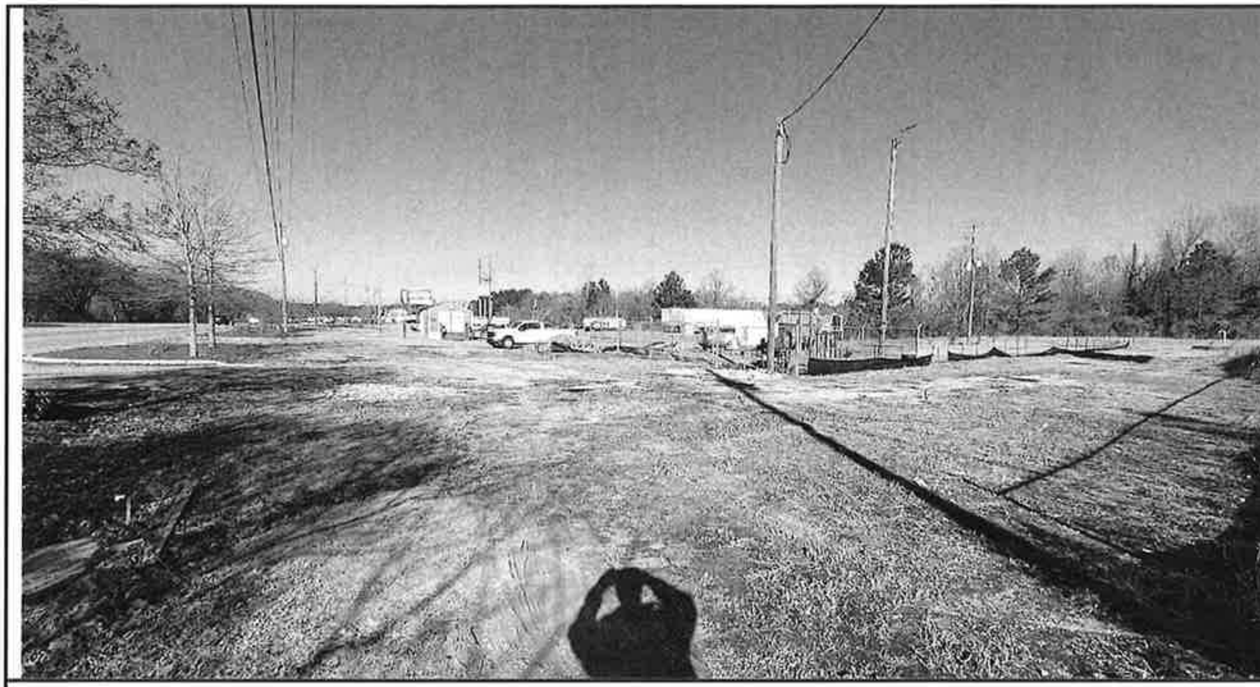
Laboratory Testing

Geotechnical staff reviewed the field data and assigned laboratory tests. The laboratory testing program included the following types of tests:

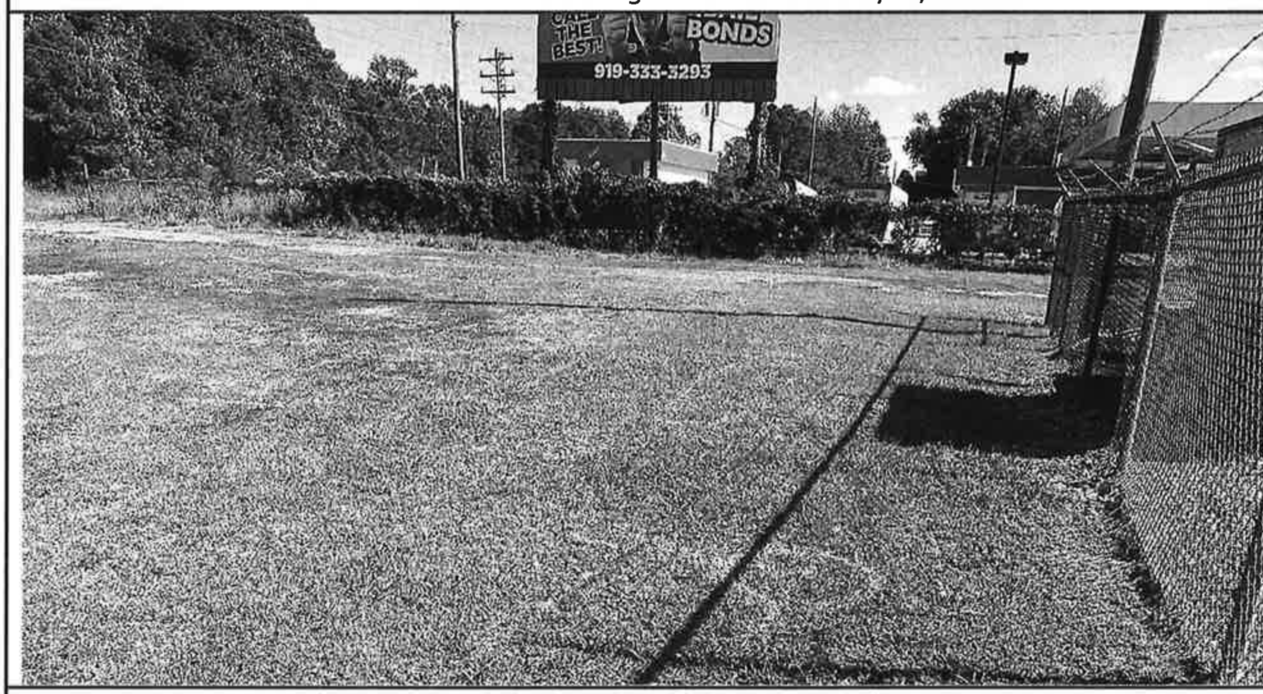
- Moisture Content
- Atterberg Limits
- Grain Size Analysis

The laboratory testing program included examination of soil samples by geotechnical staff. Based on the results of our field and laboratory programs, we described and classified the soil samples in accordance with the Unified Soil Classification System.

Photography Log



Near location B-1 looking north on January 4, 2024



Near location PS-1 looking southeast on October 14, 2024

Site Location and Exploration Plans

Contents:

Note: All attachments are one page unless noted above.

Site Location

DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES MAP PROVIDED BY MICROSOFT BING MAPS

Exploration Plan

Exploration and Laboratory Results

Contents:

Note: All attachments are one page unless noted above.

Terracon
3150 Spring Forest Rd Ste 100
Raleigh, NC

Boring Log No. B-1

Location: See Exploration Plan

Latitude: 35.5138° Longitude: -78.3514°

Model Layer	Graphic Log	Depth (Ft.)	Description	Depth (Ft.)	Water Level Observations	Sample Type	Field Test Results	Water Content (%)	Atterberg Limits LL-PL-PI	Percent Fines
1		0.7	**GRAVEL**, 8 inches							
2		3.0	**FILL - CLAYEY SAND WITH GRAVEL (SC)**, fine to coarse grained, gray and tan, medium dense				8-9-8 N=17	8.5	33-14-19	28
3			**CLAYEY SAND (SC)**, fine to coarse grained, brown and gray, very loose	5	▽		1-1-1 N=2	17.7	41-14-27	32
		8.0					WOH-WOH-WOH	30.3	40-14-26	25
4			**SANDY LEAN CLAY (CL)**, greenish gray, soft	10			2-1-2 N=3			
		17.0		15			1-2-2 N=4	29.7	36-17-19	51
5		20.0	**SANDY LEAN CLAY (CL)**, greenish gray, stiff	20			2-3-7 N=10			

Boring Terminated at 20 Feet

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevation Reference: Elevations were interpolated from a topographic site plan.

Samples obtained using a 2" O.D. split spoon sampler

Water Level Observations
▽ About 4 hours after drilling

Drill Rig
CME 45 - track

Hammer Type
Automatic

Driller
M. Radford - Bridger

Notes

Advancement Method
Mud rotary

Logged by
G. Goslin

Boring Started
02-01-2024

Abandonment Method
Boring backfilled with bentonite grout using tremie method upon completion

Boring Completed
02-01-2024

Terracon
3150 Spring Forest Rd Ste 100
Raleigh, NC

Boring Log No. PS-1

Location: See Exploration Plan

Latitude: 35.5139° Longitude: -78.3513°

Model Layer	Depth (Ft.)	Description	Water Level Observations	Field Test Results	Water Content (%)	Atterberg Limits LL-PL-PI	Percent Fines
1	0.2	**TOPSOIL**, 2 inches					
2	8.0	**FILL - CLAYEY SAND (SC)**, little gravel, fine to medium grained, tan, very loose		1-1-1 N=2	16.7	42-15-27	29
			▽	WOH-WOH-WOH			
				WOH-WOH-WOH	23.6	39-14-25	28
4	17.0	**SANDY LEAN CLAY (CL)**, trace gravel, greenish gray, very soft		WOH-WOH-WOH			
				WOH-WOH-WOH	30.2	27-15-12	67
5	27.0	**LEAN CLAY (CL)**, trace gravel, gray, brown, and tan, medium stiff to stiff		2-4-6 N=10			
				2-3-4 N=7	31.8	44-18-26	93
6	32.0	**CLAYEY SAND (SC)**, little gravel, fine to medium grained, tan and gray, very loose		WOH-WOH-WOH	28.1	28-15-13	48
7	37.0	**PARTIALLY WEATHERED ROCK**, Sampled as clayey sand, fine grained, few cemented sand nodules, gray and tan		50/2"			
	43.5	**PARTIALLY WEATHERED ROCK**, Sampled as sandy silt, greenish gray		50/3"			
8		***Refusal at 43.5 Feet***					

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevation Reference: Elevations were interpolated from a topographic site plan.

Samples obtained using a 2" O.D. split spoon sampler

Water Level Observations
▽ Estimated while drilling

Notes

Advancement Method
Mud rotary

Abandonment Method
Boring backfilled with soil cuttings and bentonite chips upon completion.

Drill Rig
3230DT GeoProbe

Hammer Type
Automatic

Driller
S. Harig

Logged by
G. Goslin

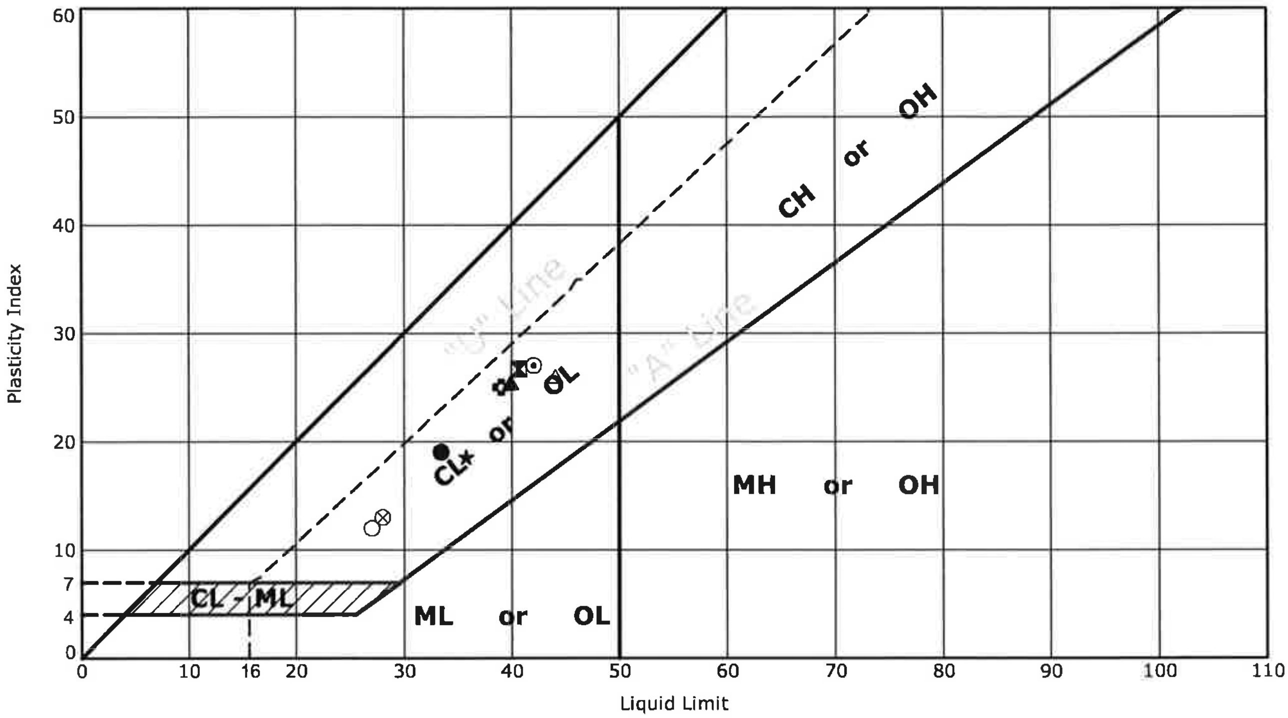
Boring Started
10-18-2024

Boring Completed
10-18-2024

Terracon
3150 Spring Forest Rd Ste 100
Raleigh, NC

Atterberg Limit Results

ASTM D4318



	Boring ID	Depth (Ft)	LL	PL	PI	Fines	USCS	Description
●	B-1	1 - 2.5	33	14	19	27.6	SC	CLAYEY SAND with GRAVEL
⊠	B-1	3.5 - 5	41	14	27	31.7	SC	CLAYEY SAND
▲	B-1	6 - 7.5	40	14	26	25.1	SC	CLAYEY SAND
★	B-1	13.5 - 15	36	17	19	51.4	CL	SANDY LEAN CLAY
⊙	PS-1	1 - 2.5	42	15	27	28.8	SC	CLAYEY SAND with GRAVEL
✿	PS-1	6 - 7.5	39	14	25	27.8	SC	CLAYEY SAND with GRAVEL
○	PS-1	13.5 - 15	27	15	12	66.7	CL	SANDY LEAN CLAY
△	PS-1	23.5 - 25	44	18	26	92.7	CL	LEAN CLAY
⊗	PS-1	28.5 - 30	28	15	13	47.6	SC	CLAYEY SAND

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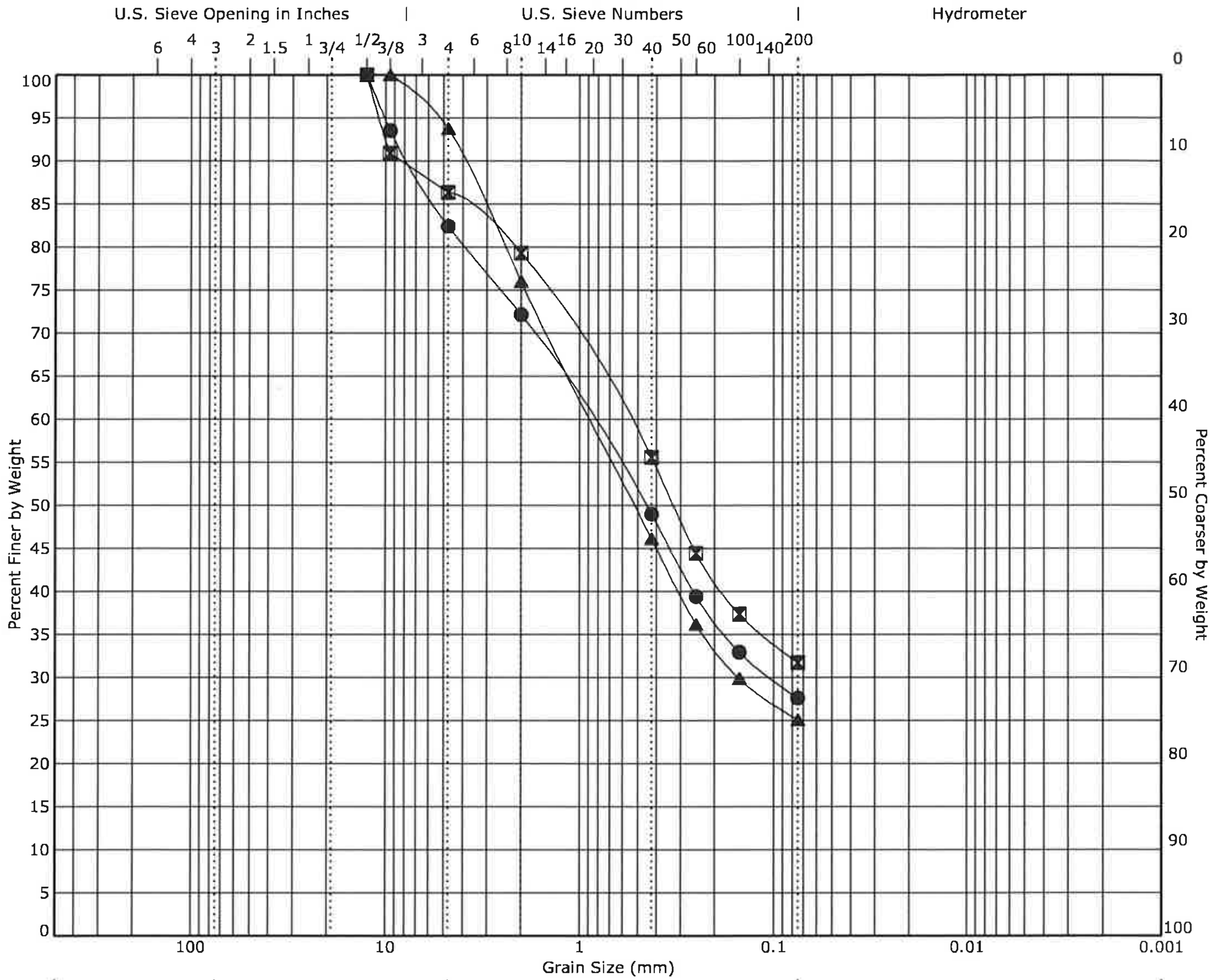
Grain Size Distribution

ASTM D422 / ASTM C136 / AASHTO T27



Cobbles	Gravel		Sand			Silt or Clay
	coarse	fine	coarse	medium	fine	

	Boring ID	Depth	% Cobbles	% Gravel	% Sand	% Fines	% Silt	% Clay	USCS
●	B-1	1 - 2.5	0.0	17.6	54.8	27.6			SC
⊠	B-1	3.5 - 5	0.0	13.7	54.6	31.7			SC
▲	B-1	6 - 7.5	0.0	6.3	68.6	25.1			SC

Description

● CLAYEY SAND with GRAVEL

⊠ CLAYEY SAND

▲ CLAYEY SAND

Remarks

●

⊠

▲

● Sieve	● % Finer	⊠ Sieve	⊠ % Finer	▲ Sieve	▲ % Finer
1/2"	100.0	1/2"	100.0	3/8"	100.0
3/8"	93.54	3/8"	90.9	#4	93.73
#4	82.41	#4	86.34	#10	76.01
#10	72.16	#10	79.31	#40	46.13
#40	49.0	#40	55.59	#60	36.16
#60	39.42	#60	44.41	#100	29.89
#100	32.96	#100	37.38	#200	25.09
#200	27.62	#200	31.72		

Grain Size

	●	⊠	▲
D_{60}	0.887	0.567	0.872
D_{10}			

Coefficients

	●	⊠	▲
C_c			
C_u			

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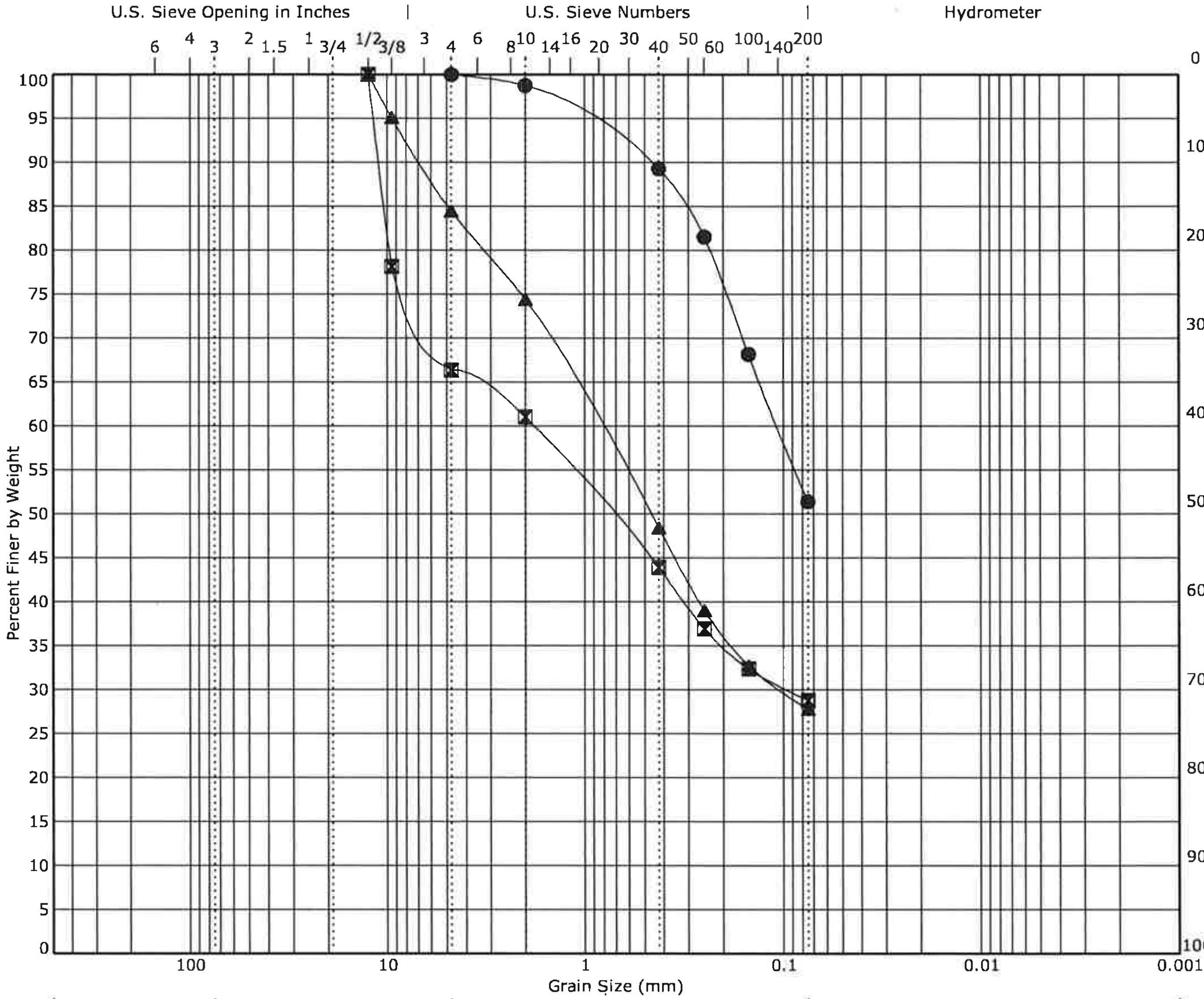
Grain Size Distribution

ASTM D422 / ASTM C136 / AASHTO T27



Cobbles	Gravel		Sand			Silt or Clay
	coarse	fine	coarse	medium	fine	

	Boring ID	Depth	% Cobbles	% Gravel	% Sand	% Fines	% Silt	% Clay	USCS
●	B-1	13.5 - 15	0.0	0.0	48.6	51.4			CL
⊠	PS-1	1 - 2.5	0.0	33.6	37.6	28.8			SC
▲	PS-1	6 - 7.5	0.0	15.5	56.7	27.8			SC

Description

● SANDY LEAN CLAY

⊠ CLAYEY SAND with GRAVEL

▲ CLAYEY SAND with GRAVEL

● Sieve	● % Finer	⊠ Sieve	⊠ % Finer	▲ Sieve	▲ % Finer
#4	100.0	1/2"	100.0	1/2"	100.0
#10	98.76	3/8"	78.13	3/8"	95.07
#40	89.29	#4	66.36	#4	84.47
#60	81.52	#10	61.02	#10	74.4
#100	68.17	#40	43.91	#40	48.44
#200	51.4	#60	36.89	#60	39.0
		#100	32.39	#100	32.75
		#200	28.8	#200	27.77

Grain Size

	●	⊠	▲
D_{60}	0.107	1.824	0.847
D_{10}			

Remarks

●

⊠

▲

Coefficients

	●	⊠	▲
C_c			
C_u			

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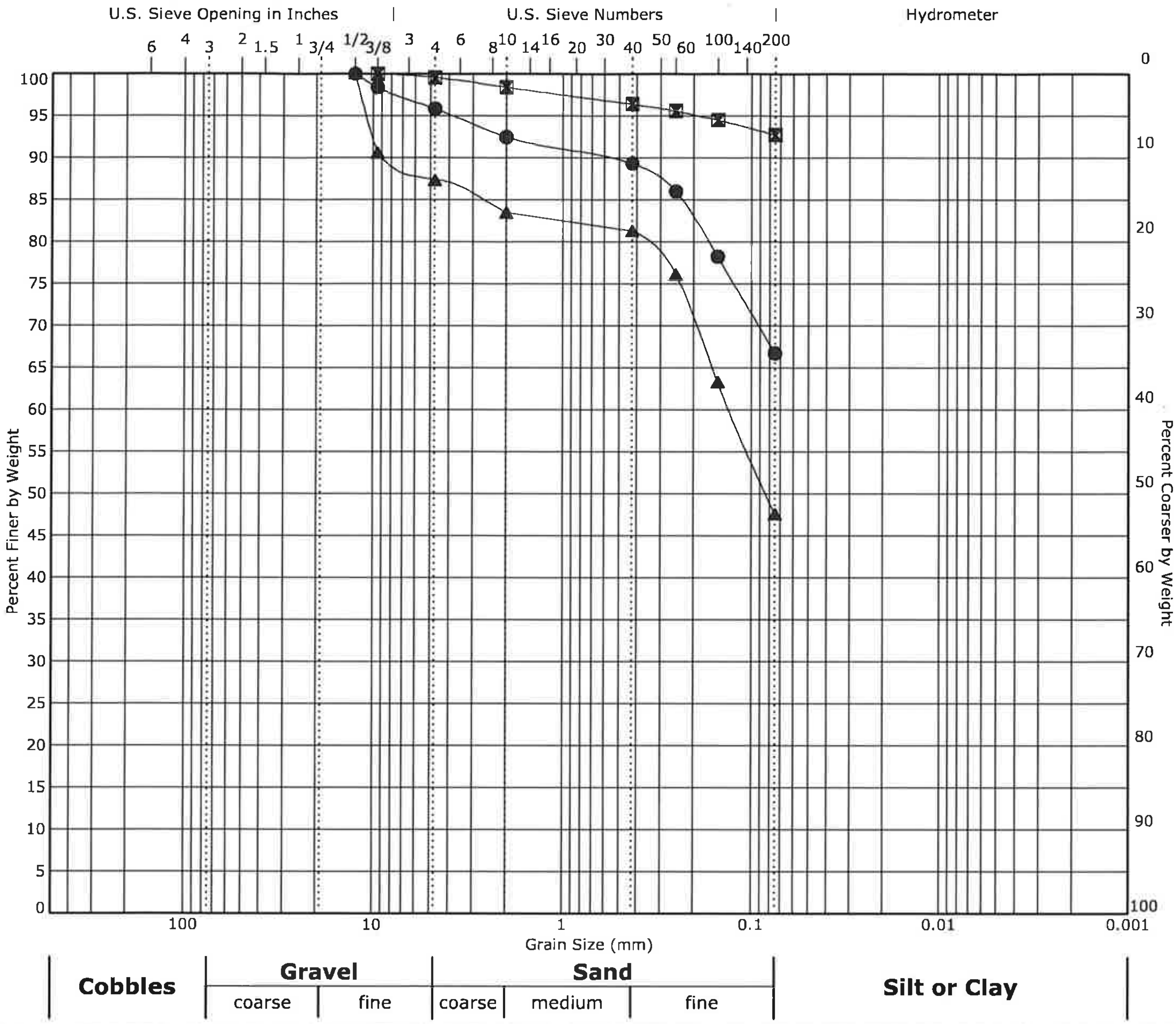
Grain Size Distribution

ASTM D422 / ASTM C136 / AASHTO T27



	Boring ID	Depth	% Cobbles	% Gravel	% Sand	% Fines	% Silt	% Clay	USCS
●	PS-1	13.5 - 15	0.0	4.2	29.1	66.7			CL
⊠	PS-1	23.5 - 25	0.0	0.4	6.8	92.7			CL
▲	PS-1	28.5 - 30	0.0	12.6	39.8	47.6			SC

Description

● SANDY LEAN CLAY

⊠ LEAN CLAY

▲ CLAYEY SAND

Remarks

●

⊠

▲

● Sieve	● % Finer	⊠ Sieve	⊠ % Finer	▲ Sieve	▲ % Finer
1/2"	100.0	3/8"	100.0	1/2"	100.0
3/8"	98.38	#4	99.58	3/8"	90.63
#4	95.85	#10	98.4	#4	87.36
#10	92.46	#40	96.38	#10	83.51
#40	89.33	#60	95.55	#40	81.3
#60	86.0	#100	94.47	#60	76.14
#100	78.25	#200	92.73	#100	63.29
#200	66.75			#200	47.58

Grain Size

	●	⊠	▲
D_{60}			0.13
D_{10}			

Coefficients

	●	⊠	▲
C_c			
C_u			

Supporting Information

Contents:

Terracon
2401 Brentwood Rd Ste 107
Raleigh, NC

General Notes

Sampling	Water Level		Field Tests	
Standard Penetration Test		Water Initially Encountered	N	Standard Penetration Test Resistance (Blows/Ft.)
		Water Level After a Specified Period of Time	(HP)	Hand Penetrometer
		Water Level After a Specified Period of Time	(T)	Torvane
		Cave In Encountered	(DCP)	Dynamic Cone Penetrometer
			UC	Unconfined Compressive Strength
			(PID)	Photo-Ionization Detector
			(OVA)	Organic Vapor Analyzer

Water levels indicated on the soil boring logs are the levels measured in the borehole at the times indicated. Groundwater level variations will occur over time. In low permeability soils, accurate determination of groundwater levels is not possible with short term water level observations.

Descriptive Soil Classification

Soil classification as noted on the soil boring logs is based Unified Soil Classification System. Where sufficient laboratory data exist to classify the soils consistent with ASTM D2487 "Classification of Soils for Engineering Purposes" this procedure is used. ASTM D2488 "Description and Identification of Soils (Visual-Manual Procedure)" is also used to classify the soils, particularly where insufficient laboratory data exist to classify the soils in accordance with ASTM D2487. In addition to USCS classification, coarse grained soils are classified on the basis of their in-place relative density, and fine-grained soils are classified on the basis of their consistency. See "Strength Terms" table below for details. The ASTM standards noted above are for reference to methodology in general. In some cases, variations to methods are applied as a result of local practice or professional judgment.

Location And Elevation Notes

Exploration point locations as shown on the Exploration Plan and as noted on the soil boring logs in the form of Latitude and Longitude are approximate. See Exploration and Testing Procedures in the report for the methods used to locate the exploration points for this project. Surface elevation data annotated with +/- indicates that no actual topographical survey was conducted to confirm the surface elevation. Instead, the surface elevation was approximately determined from topographic maps of the area.

Strength Terms

Relative Density of Coarse-Grained Soils (More than 50% retained on No. 200 sieve.) Density determined by Standard Penetration Resistance		**Consistency of Fine-Grained Soils** (50% or more passing the No. 200 sieve.) Consistency determined by laboratory shear strength testing, field visual-manual procedures or standard penetration resistance		
Relative Density	**Standard Penetration or N-Value (Blows/Ft.)**	**Consistency**	**Unconfined Compressive Strength Qu (tsf)**	**Standard Penetration or N-Value (Blows/Ft.)**
Very Loose	0 - 3	Very Soft	less than 0.25	0 - 1
Loose	4 - 9	Soft	0.25 to 0.50	2 - 4
Medium Dense	10 - 29	Medium Stiff	0.50 to 1.00	4 - 8
Dense	30 - 50	Stiff	1.00 to 2.00	8 - 15
Very Dense	> 50	Very Stiff	2.00 to 4.00	15 - 30
		Hard	> 4.00	> 30

Relevance of Exploration and Laboratory Test Results

Exploration/field results and/or laboratory test data contained within this document are intended for application to the project as described in this document. Use of such exploration/field results and/or laboratory test data should not be used independently of this document.

Unified Soil Classification System

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests [A]				Soil Classification	
				Group Symbol	Group Name [B]
Coarse-Grained Soils: More than 50% retained on No. 200 sieve	**Gravels:** More than 50% of coarse fraction retained on No. 4 sieve	**Clean Gravels:** Less than 5% fines [C]	$Cu \geq 4$ and $1 \leq Cc \leq 3$ [E]	GW	Well-graded gravel [F]
			$Cu < 4$ and/or $[Cc < 1$ or $Cc > 3.0]$ [E]	GP	Poorly graded gravel [F]
		Gravels with Fines: More than 12% fines [C]	Fines classify as ML or MH	GM	Silty gravel [F, G, H]
			Fines classify as CL or CH	GC	Clayey gravel [F, G, H]
	Sands: 50% or more of coarse fraction passes No. 4 sieve	**Clean Sands:** Less than 5% fines [D]	$Cu \geq 6$ and $1 \leq Cc \leq 3$ [E]	SW	Well-graded sand [I]
			$Cu < 6$ and/or $[Cc < 1$ or $Cc > 3.0]$ [E]	SP	Poorly graded sand [I]
		Sands with Fines: More than 12% fines [D]	Fines classify as ML or MH	SM	Silty sand [G, H, I]
			Fines classify as CL or CH	SC	Clayey sand [G, H, I]
Fine-Grained Soils: 50% or more passes the No. 200 sieve	**Silts and Clays:** Liquid limit less than 50	**Inorganic:**	PI > 7 and plots above "A" line [J]	CL	Lean clay [K, L, M]
			PI < 4 or plots below "A" line [J]	ML	Silt [K, L, M]
		Organic:	$\frac{LL\ oven\ dried}{LL\ not\ dried} < 0.75$	OL	Organic clay [K, L, M, N] Organic silt [K, L, M, O]
	Silts and Clays: Liquid limit 50 or more	**Inorganic:**	PI plots on or above "A" line	CH	Fat clay [K, L, M]
			PI plots below "A" line	MH	Elastic silt [K, L, M]
		Organic:	$\frac{LL\ oven\ dried}{LL\ not\ dried} < 0.75$	OH	Organic clay [K, L, M, P] Organic silt [K, L, M, Q]
Highly organic soils:	Primarily organic matter, dark in color, and organic odor			PT	Peat

[A] Based on the material passing the 3-inch (75-mm) sieve.
[B] If field sample contained cobbles or boulders, or both, add "with cobbles or boulders, or both" to group name.
[C] Gravels with 5 to 12% fines require dual symbols: GW-GM well-graded gravel with silt, GW-GC well-graded gravel with clay, GP-GM poorly graded gravel with silt, GP-GC poorly graded gravel with clay.
[D] Sands with 5 to 12% fines require dual symbols: SW-SM well-graded sand with silt, SW-SC well-graded sand with clay, SP-SM poorly graded sand with silt, SP-SC poorly graded sand with clay.
[E] $Cu = D_{60}/D_{10}$ $Cc = \frac{(D_{30})^2}{D_{10} \times D_{60}}$
[F] If soil contains ≥ 15% sand, add "with sand" to group name.
[G] If fines classify as CL-ML, use dual symbol GC-GM, or SC-SM.
[H] If fines are organic, add "with organic fines" to group name.
[I] If soil contains ≥ 15% gravel, add "with gravel" to group name.
[J] If Atterberg limits plot in shaded area, soil is a CL-ML, silty clay.
[K] If soil contains 15 to 29% plus No. 200, add "with sand" or "with gravel," whichever is predominant.
[L] If soil contains ≥ 30% plus No. 200 predominantly sand, add "sandy" to group name.
[M] If soil contains ≥ 30% plus No. 200, predominantly gravel, add "gravelly" to group name.
[N] PI ≥ 4 and plots on or above "A" line.
[O] PI < 4 or plots below "A" line.
[P] PI plots on or above "A" line.
[Q] PI plots below "A" line.