CLAYTON COUNTY WATER AUTHORITY
MORROW, GA

PROJECT MANUAL

FOR

BID NUMBER: 2025-SW-01

TARA BOULEVARD STORM DRAIN REHABILITATION
GEFA FUNDED PROJECT

JANUARY 2025

ISSUED FOR BID

VOLUME 2 OF 3
DIVISIONS 02 – 33

Jacobs

CLAYTON COUNTY WATER AUTHORITY
TARA BOULEVARD STORM DRAIN REHABILITATION

SECTION 00 01 07
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TECHNICAL SPECIFICATIONS

SECTION 02 41 00
DEMOLITION

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American National Standards Institute (ANSI): A10.6, Safety Requirements for Demolition Operations.
2. Occupational Safety and Health Administration (OSHA), U.S. Code of Federal Regulations (CFR) Title 29 Part 1926—Occupational Safety and Health Regulations for Construction.
3. Environmental Protection Agency (EPA), U.S. Code of Federal Regulations (CFR), Title 40:
    a. Part 61—National Emission Standards for Hazardous Air Pollutants.
    b. Part 82—Protection of Stratospheric Ozone.
    c. Part 273—Standards for Universal Waste Management.

1.02 DEFINITIONS

A. ACM: Asbestos-containing material.

B. Demolition: Dismantling, razing, destroying, or wrecking of any fixed building or structure or any part thereof. Demolition also includes removal of pipes, manholes tanks, conduit, and other underground facilities, whether as a separate activity or in conjunction with construction of new facilities.

C. Modify: Provide all necessary material and labor to modify an existing item to the condition indicated or specified.

D. Relocate: Remove, protect, clean and reinstall equipment, including electrical, instrumentation, and all ancillary components required to make the equipment fully functional, to the new location identified on the Drawings.

E. Renovation: Altering a facility or one or more facility components in any way.

F. Salvage/Salvageable: Remove and deliver, to the specified location(s), the equipment, building materials, or other items so identified to be saved from destruction, damage, or waste; such property to remain that of Owner. Unless otherwise specified, title to items identified for demolition shall revert to Contractor.

1.03 SUBMITTALS

A. Informational Submittals:

1. Submit proposed Demolition/Renovation Plan, in accordance with requirements specified herein, for approval before such Work is started.
2. Submit copies of any notifications, authorizations and permits required to perform the Work.

1.04 REGULATORY AND SAFETY REQUIREMENTS

A. When applicable, demolition Work shall be accomplished in strict accordance with 29 CFR 1926-Subpart T.

B. Comply with federal, state, and local hauling and disposal regulations. In addition to the requirements of the General Conditions, Contractor's safety requirements shall conform to ANSI A10.6.

C. Furnish timely notification of this demolition effort to applicable federal, state, regional, and local authorities in accordance with 40 CFR 61-Subpart M.

1.05 DEMOLITION/RENOVATION PLAN

A. Demolition/Renovation Plan shall provide for safe conduct of the Work and shall include:

1. Detailed description of methods and equipment to be used for each operation.
2. The Contractor's planned sequence of operations, including coordination with other work in progress.

1.06 SEQUENCING AND SCHEDULING

A. The Work of this Specification shall not commence until Contractor's Demolition/Renovation Plan has been approved by Engineer.

1.07 USE OF EXPLOSIVES

A. Use of explosives will be prohibited unless approved by the Engineer.

1.08 ENVIRONMENTAL PROTECTION

A. No demolition work is to begin until all initial erosion and sediment control measures are installed.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 EXISTING FACILITIES TO BE DEMOLISHED OR RENOVATED

A. Facilities: The existing Leslie Pool Building and adjacent designated areas scheduled for complete demolition are as shown.

B. Structures: Sidewalks, curbs, gutters, signs and street light bases shall be removed as indicated.

C. Utilities and Related Equipment:

1. Notify Owner or appropriate utilities to turn off affected services at least 48 hours before starting demolition or renovation activities.
2. Remove existing utilities as indicated and terminate in a manner conforming to the nationally recognized code covering the specific utility and approved by Engineer.
3. When utility lines are encountered that are not indicated on the Drawings, notify Owner prior to further work in that area.
4. Remove meters and related equipment and deliver to a location as determined by the Owner.
5. Excavate and remove utility lines serving buildings to be demolished to a point of connection at the main utility line.
6. Provide a permanent leak-proof closure for water and gas lines.
7. Plug sewer lines with concrete to a minimum plug length of 3 feet to prevent groundwater infiltration.

D. Paving and Slabs: Remove concrete and asphaltic concrete paving and slabs as required to perform the Work. Provide neat sawcuts at limits of pavement removal as indicated.

E. Air-Conditioning Equipment:

1. Remove air-conditioning equipment without releasing chlorofluorocarbon refrigerants to the atmosphere in accordance with the Clean Air Act Amendment of 1990.
2. Recover all refrigerants prior to removing air-conditioning equipment and dispose of as specified in Paragraph Ozone Depleting Substances (ODS).
3. Turn in salvaged Class I ODS refrigerants as specified in Article Salvaged Materials and Equipment.

F. Electrical: Remove existing electrical service to the building to be demolished. Coordinate termination point of electrical service with the service provider.

G. Universal Waste Lamps and Thermostats: Manage, contain, package, and label in strict accordance with 40 CFR 273.

3.02 PROTECTION

A. Dust and Debris Control: Prevent the spread of dust and debris at the Project Site and avoid the creation of a nuisance or hazard in the surrounding area. Do not use water if it results in hazardous or objectionable conditions such as, but not limited to, ice, flooding, or pollution.

B. Traffic Control Signs: Where pedestrian and driver safety is endangered in the area of removal Work, use traffic barricades with flashing lights.

C. Existing Work:

1. Survey the Site and examine the Drawings and Specifications to determine the extent of the Work before beginning any demolition or renovation.
2. Take necessary precautions to avoid damage to existing items scheduled to remain in place, to be reused, or to remain the property of Owner; any Contractor-damaged items shall be repaired or replaced as directed by Engineer.
3. Provide temporary weather protection during interval between removal of existing exterior surfaces and installation of new to ensure that no water leakage or damage occurs to structure or interior areas of existing building.
4. Ensure that structural elements are not overloaded as a result of or during performance of the Work. Responsibility for additional structural elements or increasing the strength of existing structural elements as may be required as a result of any Work performed under this Contract shall be that of the Contractor. Repairs, reinforcement, or structural replacement must have Engineer approval.
5. Do not overload pavements to remain.

D. Weather Protection: For portions of the building scheduled to remain, protect building interior and materials and equipment from weather at all times. Where removal of existing roofing is necessary to accomplish the Work, have materials and workmen ready to provide adequate and temporary covering of exposed areas so as to ensure effectiveness and to prevent loss.

E. Trees: Protect trees within the Site that might be damaged during demolition and are indicated to be left in place, by a 6-foot-high fence. The fence shall be securely erected a minimum of 5 feet from the trunk of individual trees or follow the outer perimeter of branches or clumps of trees. Any tree designated to remain that is damaged during the Work shall be replaced in kind, as approved by the Engineer.

F. Protection of Personnel:

1. During demolition, continuously evaluate the condition of the structure being demolished and take immediate action to protect all personnel working in and around the demolition site.
2. Provide temporary barricades and other forms of protection to protect Owner's personnel and the general public from injury due to demolition Work.
3. Provide protective measures as required to provide free and safe passage of Owner's personnel and the general public to occupied portions of the structure.

3.03 BURNING

A. The use of burning at the Site for the disposal of refuse and debris will not be permitted.

3.04 RELOCATIONS

A. Perform the removal and reinstallation of relocated items as indicated with workmen skilled in the trades involved. Clean all items to be relocated prior to reinstallation, to the satisfaction of Engineer. Repair items to be relocated which are damaged or replace damaged items with new undamaged items as approved by Engineer.

3.05 BACKFILL

A. Do not use demolition debris as backfill material.

B. Fill excavations and other hazardous openings to existing ground level or foundation level of new construction in accordance with Section 31 23 23, Fill and Backfill.

3.06 DISPOSITION OF MATERIAL

A. Do not remove equipment and materials without approval of Contractor's Demolition/Renovation Plan by Engineer.

B. Repair or replace, at the discretion of Engineer, items damaged during removal or storage.

3.07 UNSALVAGEABLE MATERIAL

A. Concrete, masonry, and other noncombustible material, except concrete permitted to remain in place, shall be disposed of offsite.

B. Universal Waste Lamps and Thermostats: Dispose of in strict accordance with 40 CFR 273.

3.08 CLEANUP

A. Debris and rubbish shall be removed from basement and similar excavations. Debris and rubbish shall be removed and transported in a manner that prevents spillage on streets or adjacent areas. Local regulations regarding hauling and disposal shall apply.

END OF SECTION

SECTION 03 10 00
CONCRETE FORMING AND ACCESSORIES

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Concrete Institute (ACI):
   a. 117, Specification for Tolerances for Concrete Construction and Materials.
   b. 318, Building Code Requirements for Structural Concrete.
2. NSF International (NSF): 61, Drinking Water System Components - Health Effects.

1.02 DEFINITIONS

A. Architectural Concrete: See definition in Section 03 30 10, Structural Concrete.

B. Defective Areas: See definition in Section 03 30 10, Structural Concrete.

C. Exposed Concrete: See definition in Section 03 30 10, Structural Concrete.

1.03 DESIGN REQUIREMENTS

A. Design formwork in accordance with ACI 301 and ACI 318 to provide concrete finishes specified in Section 03 30 10, Structural Concrete.

B. Unless otherwise specified, limit deflection of facing materials for concrete surfaces to comply with ACI 301 Limit deflection of facing materials to comply with tolerance limits established by Contract Documents and with tolerances required by equipment manufacturers. Coordinate tolerance requirements with equipment manufacturers.

C. Form liner and concrete mixtures shall be compatible. Coordinate compatibility between form liner manufacturer and concrete producer.

1.04 SUBMITTALS

A. Action Submittals: Submit manufacturer’s product data of intended forms including installation hardware, accessories, form ties and propose release agent for approval by the Engineer.

1.05 QUALITY ASSURANCE

A. Qualifications:

1. Formwork Designer: Formwork, falsework, and shoring design shall be designed by an engineer licensed in the state of Project.

PART 2 PRODUCTS

2.01 FORM MATERIALS

A. Wall Forms and Underside of Slabs and Beams:

1. Materials: Plywood, hard plastic finished plywood, overlaid waterproof particle board, or steel in “new and undamaged” condition, of sufficient strength and surface smoothness to produce specified finish. Use plywood forms when using form liners. Plywood may be of lower finish grade when used in conjunction with form liners.
2. Where steel forms or form liners are used, treat steel surfaces to prevent rusting using products approved for use on steel forms.

B. Column Forms:

1. Rectangular Columns: As specified for walls.
2. Circular Columns: Fabricated steel or fiber-reinforced plastic with bolted sections or spirally wound laminated fiber form. Internally treat with release agent for full height of column.

C. Sandblasted Surface Forms: Medium-density overlay plywood for flat concrete surfaces to be sandblasted.

D. Painted Surface Forms: High-density overlay plywood for flat concrete surfaces to be painted.

E. All Other Forms: Materials as specified for wall forms.

2.02 ACCESSORIES

A. Form Release Agent:

1. Material:
   a. Shall not bond with, stain, or adversely affect concrete surfaces.
   b. Shall not impair subsequent treatments of concrete surfaces when applied to forms or form liners.
   c. Ready-to-use water based material formulated to reduce or eliminate surface imperfections.
   d. Contain no mineral oil or organic solvents.

2. Manufacturers and Products: Not for surfaces exposed to potable water.
    a. BASF, Shakopee, MN; MBT MasterFinish RL 211.
    b. Cresset Chemical Company; Crete-Lease 20-VOC-Xtra.

B. Rustication Grooves and Beveled Edge Corner Strips: Nonabsorbent material, compatible with form surface, fully sealed on all sides prohibiting loss of paste or water between the two surfaces.

C. Form Snap-Ties:

1. Material: Steel.
2. Spreader Inserts:
    a. Conical or spherical type.
    b. Design to maintain positive contact with forming material.
    c. Furnish units that will leave no metal closer than 1.5 inches to concrete surface when forms, inserts, and tie ends are removed.
3. Wire ties not permitted.
4. Flat bar ties for panel forms; furnish plastic or rubber inserts with minimum 1.5-inch depth and sufficient dimensions to permit patching of tie hole.

D. Form Snap-Ties with Water Stop:

1. For water-holding structures, basements, pipe galleries, and accessible spaces below finish grade, furnish one of the following:
    a. Integral steel water stop 0.103-inch thick and 0.625-inch diameter tightly and continuously welded to tie.
    b. Neoprene water stop 3/16-inch thick and 15/16-inch diameter whose center hole is one-half diameter of tie, or molded plastic water stop of comparable size.
    c. Orient water stop perpendicular to tie and symmetrical about center of tie.
    d. Design ties to prevent rotation or disturbance of center portion of tie during removal of ends and to prevent water leaking along tie.

E. Through-Bolts:

1. At Contractor’s option, may be used as alternate to form snap-tie or form snap-tie with water stop.
2. Tapered minimum 1-inch diameter at smallest end.

PART 3 EXECUTION

3.01 FORM SURFACE PREPARATION

A. Prior to coating surface, thoroughly clean form surfaces that will be in contact with concrete or that have been in contact with previously cast concrete, dirt, and other surface contaminants.

B. Exposed Wood Forms in Contact with Concrete: Apply form release agent as recommended by manufacturer.

C. Steel Forms: Apply form release agent as soon as they are cleaned to prevent discoloration of concrete from rust.

3.02 ERECTION

A. General: In accordance with ACI 301, unless otherwise specified.

B. Beveled Edges (Chamfer):

1. Form 3/4-inch bevels at concrete edges, unless otherwise shown.
2. Where beveled edges on existing adjacent structures are other than 3/4 inch, obtain Engineer's approval of size prior to placement of beveled edge.

C. Wall Forms:

1. Do not reuse forms with damaged surfaces.
2. Locate form ties and joints in uninterrupted uniform pattern.
3. Inspect form surfaces prior to installation to ensure conformance with specified tolerances.

D. Form Tolerances: Provide forms in accordance with ACI 117 and ACI 318, and the following tolerances for finishes specified.

3.03 FORM REMOVAL

A. Nonsupporting forms, sides of beams, walls, columns, and similar parts of Work, may be removed after cumulatively curing at not less than 50 degrees F for 24 hours from time of concrete placement if:

1. Concrete is sufficiently hard so as not to sustain damage by form removal operations.
2. Curing and protection operations are maintained.

B. Form Ties: Remove conical inserts or through bolts and plug holes as specified in Section 03 30 10, Structural Concrete.

END OF SECTION

SECTION 03 15 00
CONCRETE JOINTS AND ACCESSORIES

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. ASTM International (ASTM):
   a. A36/A36M, Specification for Carbon Structural Steel.
   b. A615/A615M, Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
   c. A653/A653M, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
   d. A767/A767M, Specification for Zinc-Coated (Galvanized) Steel Bars for Concrete Reinforcement.
   e. C920, Specification for Elastomeric Joint Sealants.
   f. D226, Specification for Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing.
   g. D227, Specification for Coal-Tar Saturated Organic Felt Used in Roofing and Waterproofing.
   h. D994, Specification for Preformed Expansion Joint Filler for Concrete (Bituminous Type).
   i. D1056, Specification for Flexible Cellular Materials—Sponge or Expanded Rubber.
   j. D1171, Standard Guide for Evaluating Nonwoven Fabrics.
   k. D1751, Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types).
   l. D1752, Specification for Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction.
   m. D2240, Standard Test Method for Rubber Property – Durometer Hardness.

1.02 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. Waterstop: Details of splices, method of securing and supporting waterstop in forms to maintain proper orientation and location during concrete placement.

b. Construction Joints, Expansion Joints, and Control Joints: Layout and location for each type. Include joint locations shown on the Drawings, additional required joint locations, and any proposed alternate locations.

2. Product Data:
   a. Waterstops.
   b. Bond breaker.
   c. Premolded joint fillers.
   d. Pourable joint fillers.
   e. Preformed control joints.
   f. Epoxy-coated dowels.
   g. Roofing felt.
   h. Accessories not specified in other sections.
3. Samples: PVC waterstop splice, joint, and fabricated cross of each size, shape, and fitting of waterstop.

B. Informational Submittals:

1. Certification:
   a. Letter stating compatibility between liquids being contained and materials used for:
      1) Joint fillers.
   b. Manufacturer's application instructions for:
      1) Bonding agent.
      2) Bond breaker.
2. Manufacturer's written instructions for product shipment, storage, handling, installation/application, and repair for:
   a. Bond breaker.
   b. Bonding agent.
   c. Premolded joint fillers.
   d. Pourable joint fillers (sealant proportions not required as products used only as a filler).
   e. Preformed control joints.

1.03 DELIVERY, STORAGE, AND HANDLING

A. Acceptance at Site: Verify delivered materials are in accordance with Specifications, regulatory agencies, and Manufacturer's product data sheets prior to unloading and storing onsite.

B. Storage: Store materials under tarps to protect from oil, dirt, and sunlight or as required by Manufacturer.

PART 2 PRODUCTS

2.01 BOND BREAKER

A. Tape for Joints: Adhesive-backed glazed butyl or polyethylene tape. Same width as joint that will adhere to premolded joint material or concrete surface.

B. Use bond prevention material as specified in Section 03 30 10, Structural Concrete, except where bond breaker tape is specifically called for on the Drawings.

2.02 PREMOLDED JOINT FILLER

A. Bituminous Type: ASTM D994 or ASTM D1751.

B. Sponge Rubber:

1. Neoprene, closed cell, expanded; ASTM D1056, Type 2C5, with compression deflection, 25 percent deflection (limits), 17 psi to 24 psi minimum. Use in joints for potable and nonpotable water containment structures.
2. Manufacturer and Product: Monmouth Rubber and Plastics, Corp, Long Branch, NJ; Durafoam DK5151.

2.03 ACCESSORIES

A. Steel Reinforcement: As specified in Section 03 21 00, Steel Reinforcement.

B. Nails: Galvanized, as required for securing premolded joint filler.

PART 3 EXECUTION

3.01 GENERAL

A. Commence concrete placement after joint preparation is complete.

B. Time Between Concrete Pours: As specified in Section 03 30 10, Structural Concrete.

3.02 SURFACE PREPARATION

A. Construction Joints: Clean concrete surface prior to placement of abutting concrete.

1. Remove laitance and spillage from steel reinforcement and dowels.
2. Roughen surface to minimum of 1/4-inch amplitude:
   a. Sandblast after concrete has fully cured.
   b. Water blast after concrete has partially cured.

c. Green cut fresh concrete with high-pressure water and hand tools.

3. If present in joint, do not damage waterstop.

B. Expansion Joint:

1. Use wire brush or motorized device to mechanically roughen and thoroughly clean concrete surfaces on each side of joint from plastic waterstop to top of joint.
2. Use dry, high-pressure air to remove dust and foreign material, and dry joint.
3. Prime surfaces as required before placing joint filler.
4. If present in joint, do not damage waterstop.

C. Contraction Joint:

1. Coat concrete surfaces above and below plastic waterstop with bond breaker.
2. If present in joint, do not damage or coat waterstop.

3.03 EXPANSION JOINT INSTALLATION

A. Premolded Joint Filler:

1. Sufficient in width to completely fill joint space where shown.
2. Install per manufacturer's written instructions.
3. If waterstop is in joint, cut premolded joint filler to butt tightly against waterstop and concrete face.
4. Precut premolded joint filler to required depth at locations where joint filler or sealant is to be applied.
5. Form cavities for joint filler with either precut, premolded joint filler, or smooth removable accurately shaped material. Entire joint above waterstop, in slabs, shall be formed and removed so that entire space down to waterstop can be filled with the pourable joint filler.
6. Vibrate concrete thoroughly along joint form to produce dense, smooth surface.

B. Bituminous Type Premolded Joint Filler:

1. Drive nails approximately 1 foot 6 inches on center through filler, prior to installing, to provide anchorage embedment into concrete during concrete placement.
2. Secure premolded joint filler in forms before concrete is placed.

C. Sponge Rubber Joint Filler: Install per manufacturer's written instructions.

3.04 CONTRACTION JOINT INSTALLATION

A. Vibrate concrete thoroughly along the joint form to produce a dense, smooth surface. Do not roughen surface.

3.05 PREFORMED CONTROL JOINTS

A. Use only where specifically shown.

B. Locate slightly below top of slab.

C. Install in accordance with manufacturer's written instructions in straight, full-length pieces.

D. Steel Strip Type with Preformed Groove: Brace to withstand pressure of concrete during and after placement using only approved stakes and other secondary installation materials.

3.06 MANUFACTURER'S SERVICES

A. Provide manufacturer's representative at Site for installation assistance, inspection, and certification of proper installation for products specified.

END OF SECTION

SECTION 03 21 00
STEEL REINFORCEMENT

PART 1 GENERAL

1.01 GENERAL

A. Steel reinforcement shall comply with ACI 301 and as modified in the following.

1.02 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Concrete Institute (ACI):
   a. 117, Specification for Tolerances for Concrete Construction and Materials.
   b. 301, Specifications for Structural Concrete.
   c. SP-66, Detailing Manual.
2. American Welding Society (AWS): D1.4/D1.4M, Structural Welding Code - Reinforcing Steel.
3. ASTM International (ASTM):
   a. A615/A615M, Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
   b. A706/A706M, Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement.
   c. A767/767M, Standard Specification for Zinc-Coated (Galvanized) Steel bars for Concrete Reinforcement
   d. A775/A775M, Standard Specification for Epoxy-Coated Steel Reinforcing Bars.
   e. A1064/A1064M, Standard Specification for Carbon Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete.
4. Concrete Reinforcing Steel Institute (CRSI):
   a. Placing Reinforcing Bars.
   b. Manual of Standard Practice.
5. International Code Council (ICC): Evaluation Services Report.

1.03 SUBMITTALS

A. Action Submittals:

1. Shop Drawings prepared in accordance with ACI 301 and ACI SP-66:
   a. Bending lists.
   b. Placing drawings.
2. Welded, metallic sleeve splice, and mechanical threaded connection.

B. Informational Submittals:

1. Lab test reports for steel reinforcement showing stress-strain curves and ultimate strengths.
2. Mechanical Threaded Connections:
   a. Current ICC Evaluation Services Report or equivalent code agency report listing findings to include acceptance, special inspection requirements, and restrictions.
   b. Verification device threads have been tested and meet requirements for thread quality, in accordance with manufacturer's published methods.
   c. Manufacturer's instructions.
3. Test results of field testing.

1.04 QUALITY ASSURANCE

A. Welder Qualifications: Certified in accordance with AWS D1.4/D1.4M.

1.05 DELIVERY, STORAGE, AND HANDLING

A. In accordance with ACI 301 and recommendations of CRSI Placing Reinforcing Bars.

PART 2 PRODUCTS

2.01 MATERIALS

A. Reinforcing Bars:

1. Includes stirrups, ties, and spirals.
2. ASTM A615/A615M, Grade 60, where welding is not required.
3. ASTM A706/A706M, Grade 60, for reinforcing to be welded.
4. ASTM A767/767M, Grade 60, for galvanized bars.

B. Mechanical Splices and Connections:

1. Metal Sleeve Splice:
   a. Furnish with cast filler metal, capable of developing, in tension or compression, 125 percent of minimum tensile strength of bar.
   b. Manufacturer and Product: Erico Products, Inc., Cleveland, OH; Cadweld T-Series.
2. Mechanical Threaded Connections:
   a. Furnish metal coupling sleeve with internal threads engaging threaded ends of bars developing in tension or compression 125 percent of yield strength of bar.

b. Manufacturers and Products:
   1) Erico Products, Inc., Cleveland, OH; Lenton Reinforcing Steel Couplers.
   2) Erico Products, Inc., Cleveland, OH; Lenton Lock Mechanical Rebar Splicing System.
   3) Richmond Screw Anchor Co., Inc., Fort Worth, TX; Richmond DB-SAE Dowel Bar Splicers.

C. Welded Wire Fabric:

1. ASTM A1064, using wire of 75 ksi minimum tensile strength.
2. Furnish flat sheets only, rolled sheets not permitted.

2.02 ACCESSORIES

A. Tie Wire:

1. Black, soft-annealed 16-gauge wire.
2. Nylon-, epoxy-, or plastic-coated wire.

B. Bar Supports and Spacers:

1. Use precast concrete bar supports: or all-plastic bar supports and side form spacers, unless noted otherwise. Do not use other types of supports or spacers.
2. Bar supports shall have sufficient strength and stiffness to carry loads without failure, displacement, or significant deformation. Space bar supports so minimum concrete cover is maintained for reinforcing between supports.
3. Use only precast concrete bar supports where concrete surfaces are exposed to weather, earth, water, chloride intrusion, or corrosive chemicals. Bar supports shall be nonconductive and have geometry and bond characteristics that deter movement of moisture from the surface to the reinforcement.
4. Precast concrete supports shall have same minimum strength and shall be made from same materials as that of the concrete in which they are to be embedded. Precast concrete supports shall be cast and properly cured for at least 7 days before use and shall have a wire or other device cast into each block for the purpose of attaching them securely to steel reinforcement.
5. In Beams, Columns, Walls, and Slabs Exposed to View after Form Removal: Use small precast concrete blocks made of same color as concrete in which they are embedded. All-plastic bar supports and side form spacers may be used, except where surface is exposed as described above.

6. Design and fabricate special bar supports for top reinforcing bars in slabs where standard bar supports do not possess necessary geometry, strength, or stiffness.
7. Plastic Bar Supports: Manufactured by Aztec Concrete Accessories, Bloomington, CA.
8. Precast Concrete Supports:
    a. Total bond precast, high-performance concrete bar supports as supplied by:
        1) Dayton Superior, Miamisburg, OH, Dobies.

PART 3 EXECUTION

3.01 PREPARATION

A. Notify Engineer when reinforcing is ready for inspection and allow sufficient time for inspection prior to placing concrete.

B. Clean reinforcing bars of loose mill scale, oil, earth, and other contaminants.

C. Coat wire projecting from precast concrete bar supports with dielectric material, epoxy, or plastic.

3.02 INSTALLATION

A. Bundle or space bars, instead of field bending where construction access through reinforcing is necessary.

B. Splicing:

1. Minimum length of lap splices shall comply with table in Contract Documents.
2. Use lap splices, unless otherwise shown or permitted in writing by Engineer.
3. Welded Splices: Accomplish by full penetration groove welds and develop a minimum of 125 percent of yield strength of bar.
4. Stagger splices in adjacent bars where indicated.

C. Mechanical Splices and Connections:

1. Use only in areas specifically approved in writing by Engineer.
2. Install threaded rods as recommended by manufacturer with threads totally engaged into coupling sleeve and in accordance with ICC Evaluation Services Report or equivalent code agency report.
3. For metal sleeve splice, follow manufacturer’s installation recommendations.
4. Maintain minimum edge distance and concrete cover.

D. Tying Reinforcing Bars:

1. Tie every other intersection on mats made up of Nos. 3, 4, 5, and 6 bars to hold them firmly at required spacing.
2. Bend tie wire away from concrete surface to provide clearance of 1 inch from surface of concrete to tie wire.

E. Reinforcement Around Openings: On each side and above and below pipe or opening, place an equivalent area of steel bars to replace steel bars cut for opening. Extend steel reinforcing a standard lap length beyond opening at each end.

F. Welding Reinforcement:

1. Only ASTM A706/A706M bars may be welded.
2. Do not perform welding until welder qualifications are approved.

G. Straightening and Rebending: Field bending of steel reinforcement bars is not permitted.

H. Unless permitted by Engineer, do not cut reinforcing bars in field.

3.03 WELDED WIRE FABRIC INSTALLATION

A. Use only where specifically shown.

B. Extend fabric to within 2 inches of edges of slab and lap splices at least 1-1/2 courses of fabric or minimum 8 inches.

C. Tie laps and splices securely at ends and at least every 24 inches with tie wire.

D. Place welded wire fabric on concrete blocks and rigidly support equal to that provided for reinforced bars. Do not use broken concrete, brick, or stone.

E. Do not use fabric that has been rolled. Install flat sheets only.

3.04 TESTS AND INSPECTION

A. An independent testing agency will be retained to visually inspect and test reinforcing steel welds in accordance with AWS D1.4/D1.4M. An independent testing agency will be retained to inspect mechanical splices and verify components are installed in accordance with manufacturer’s instruction and ICC Evaluation Services Report or equivalent code agency report.

END OF SECTION

SECTION 03 30 10
STRUCTURAL CONCRETE

PART 1 GENERAL

1.01 GENERAL

A. Work shall conform to requirements of ACI 301, Specifications for Structural Concrete, unless otherwise specified.

1.02 REFERENCES

A. In accordance with ACI 301 and the following:

1. American Concrete Institute (ACI):
   a. 301, Specifications for Structural Concrete.
   b. 305.1, Specification for Hot Weather Concreting.
   c. 306.1, Specification for Cold Weather Concreting.
   d. 308.1, Specification for Curing Concrete.
   e. 350.1, Specification for Tightness Testing of Environmental Engineering Concrete Containment Structures and Commentary.
   f. SP-66, Detailing Manual.
2. ASTM International (ASTM):
   a. C1260, Standard Test Method for Potential Alkali Reactivity of Aggregates (Mortar-Bar Method).
   b. D1056, Specification for Flexible Cellular Materials—Sponge or Expanded Rubber.
3. Concrete Reinforcing Steel Institute (CRSI):
   a. Manual of Standard Practice.
   b. Placing Reinforcing Bars.
   c. ANSI/CRSI – RB 4.1, CRSI Standard for Supports for Reinforcement Used in Concrete.
4. Corps of Engineers (COE): CRD-C-572, Corps of Engineers Specifications for Polyvinylchloride Waterstop.
5. National Ready Mixed Concrete Association (NRMCA).

1.03 DEFINITIONS

A. Cold Weather: When ambient temperature is below 40 degrees F or is approaching 40 degrees F and falling.

B. Defective Area: Surface defects that include honeycomb, rock pockets, indentations, and surface voids greater than 3/16-inch deep, surface voids greater than 3/4 inch in diameter, cold joints, cracks in liquid containment structures and below grade habitable spaces that are 0.005-inch wide and wider, spalls, chips, embedded debris, sand streaks, mortar leakage from form joints, deviations in formed surface that exceed specified tolerances and include but are not limited to fins, form pop-outs, and other projections. At exposed concrete, defective areas also include texture irregularities, stains, and other color variations that cannot be removed by cleaning.

C. Exposed Concrete: Concrete surface that can be seen inside or outside of structure regardless of whether concrete is above water, dry at all times, or can be seen when structure is drained.

D. Hot Weather: As defined in ACI 305.1.

E. Hydraulic Structure: Liquid containment structure or below grade structure designed for hydrostatic forces.

F. New Concrete: Concrete less than 60 days old.

G. Top Bars: Horizontal bars placed such that 12 inches of fresh concrete is cast below in single placement.

1.04 SUBMITTALS

A. Action Submittals:

1. Mix Design:
   a. Contain proportions of materials and admixtures to be used on Project, signed by mix designer.
   b. Documentation of average strength for each proposed mix design in accordance with ACI 301.
   c. Manufacturer’s Certificate of Compliance, for the following:
      1) Portland cement.
      2) Fly ash.
      3) Slag cement.
      4) Aggregates, including specified class designation for coarse aggregate.
      5) Admixtures.
      6) Concrete producer has verified compatibility of constituent materials in design mix.
      7) Concrete mixture shall be certified in accordance with ANSI Standard 61 for contact with potable water.
   d. Test Reports:
      1) Cement: Chemical analysis report.

2) Supplementary Cementitious Materials: Chemical analysis report and report of other specified test analyses.
3) Aggregates:
a) Deleterious substances in fine aggregate per ASTM C33/C33M, Table 2.
b) Deleterious substances in coarse aggregate per ASTM C33/C33M, Table 4.
4) Water-Soluble Chloride-Ion Content in Hardened Concrete: One of the following:
a) Test report in accordance with ASTM C1218/C1218M at an age between 28 days and 42 days.
b) Calculation of water-soluble chloride content based on certified chloride content of each constituent material and proportion of constituent material in concrete mixture.
c) All of the following:
(1) Manufacturer's Certificate of Compliance that each admixture does not intentionally add chlorides and/or that the chloride content of each admixture does not exceed trace amounts.
(2) Verification that potable water is used in the concrete mix or test data documenting the chloride content of the water.
(3) Letter from the concrete supplier stating that fine and coarse aggregates are from sources that are not known to be susceptible to chlorides in the aggregates.
5) Alkali Aggregate Reactivity: Where required, in accordance with Article Concrete Mix Design. Include documentation of test results per applicable standards.
6) Shrinkage Test Results: In accordance with ASTM C157/C157M as modified herein.

e. Product Data:
1) Admixtures: Manufacturer's product data sheets for each admixture used in proposed mix designs.

2. Letter stating compatibility between liquids being contained and materials used for waterstops and joint fillers.
3. Detailed plan for curing and protection of concrete placed and cured in cold weather. Details shall include, but not be limited to, the following:
a. Procedures for protecting subgrade from frost and accumulation of ice or snow on reinforcement, other metallic embeds, and forms prior to placement.
b. Documentation of embeds that must be at a temperature above freezing prior to placement of concrete.

c. Procedures for measuring and recording temperatures of reinforcement and other embedded items prior to concrete placement.
d. Methods for temperature protection during placement.
e. Types of covering, insulation, housing, or heating to be provided.
f. Curing methods to be used during and following protection period.
g. Use of strength accelerating admixtures.
h. Methods for verification of in-place strength.
i. Procedures for measuring and recording concrete temperatures.
j. Procedures for preventing drying during dry, windy conditions.

4. Detailed plan for hot-weather placements including curing and protection for concrete placed in ambient temperatures over 80 degrees F. Plan shall include, but not be limited to, the following:
   a. Procedures for measuring and recording temperatures of reinforcement and other embedded items prior to concrete placement.
   b. Use of retarding admixture.
   c. Methods for controlling temperature of reinforcement and other embedded items and concrete materials before and during placement.
   d. Types of shading and wind protection to be provided.
   e. Curing methods, including use of evaporation retardant.
   f. Procedures for measuring and recording concrete temperatures.
   g. Procedures for preventing drying during dry, windy conditions.
5. Thermal Control Plan: For mass concrete sections.
6. Concrete repair techniques.

B. Informational Submittals:

1. Preinstallation Conference minutes.
2. Manufacturer’s application instructions for bonding agent and bond breaker.
3. Manufacturer’s Certificate of Compliance to specified standards:
   a. Bonding agent.
   b. Bond breaker.
   c. Repair materials.
4. Statement of Qualification:
   a. Batch Plant: Certification as specified herein.
   b. Mix designer.
   c. Installer.
   d. Testing agency.
5. Joint Filler(s) for Potable Water Structures: Copy of applicable NSF listing.

6. Manufacturer's written instructions for product shipment, storage, handling, installation/application, and repair for:
    a. Joint filler and primer.
    b. Preformed control joint.
7. Recorded temperature data from concrete placement where specified.
8. Tightness test results.
9. Concrete Delivery Tickets:
    a. For each batch of concrete before unloading at Site.
    b. In accordance with ASTM C94/C94M, including Requirement 14.2.1. through Requirement 14.2.10.
    c. Indicate amount of mixing water withheld and maximum amount that may be permitted to be added at Site.

1.05 QUALITY ASSURANCE

A. Qualifications:

1. Batch Plant: NRMCA Program for Certification of Ready-Mixed Concrete Production Facilities or approved equivalent program.
2. Mix Designer: Person responsible for developing concrete mixture proportions certified as NRMCA Concrete Technologist Level 2 or DOT certified mix designer in jurisdiction of the Work. Requirement may be waived if individual is Contractor's Licensed Design Engineer.
3. Flatwork Finisher: Unless otherwise permitted, at least one person on finishing crew shall be certified as an ACI Flatwork Finisher, or equivalent.
4. Testing Agency: Unless otherwise permitted, an independent agency, acceptable to authorities having jurisdiction, qualified according to ASTM C1077 and ASTM E329 for testing indicated.
    a. Where field testing is required of Contractor, 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.
    b. Personnel performing laboratory tests shall be ACI-certified Concrete Strength Testing Technician and Concrete Laboratory Testing Technician–Grade I. Testing Agency laboratory supervisor shall be an ACI-certified Concrete Laboratory Testing Technician–Grade II.

B. Preinstallation Conference:

1. Required Meeting Attendees:
    a. Contractor, including pumping, placing and finishing, and curing subcontractors.
    b. Ready-mix producer.
    c. Admixture representative.

d. Testing and sampling personnel.
e. Steel Reinforcement Installer
f. Owner and/or Owner's designee.

2. Schedule and conduct prior to incorporation of respective products into Project. Notify Owner of location and time.
3. Agenda shall include:
   a. Admixture types, dosage, performance, and redosing at Site.
   b. Mix designs, test of mixes, and Submittals.
   c. Placement methods, techniques, equipment, consolidation, and form pressures.
   d. Slump or slump flow and placement time to maintain slump and slump flow.
   e. Finish, curing, and water retention.
   f. Steel reinforcement details.
   g. Protection procedures for weather conditions.
   h. Other specified requirements requiring coordination.
4. Conference minutes as specified.

PART 2 PRODUCTS

2.01 FORMWORK

A. Form Materials:

1. For exposed areas, use hard plastic finished plywood, overlaid waterproof particle board, or steel in new and undamaged condition, of sufficient strength and surface smoothness to produce specified finish.
2. For unexposed areas, use new shiplap or plywood.
3. Earth cuts may be used for forming footings.

B. Beveled Edge Corner Strips: Nonabsorbent material, compatible with form surface, fully sealed on all sides prohibiting loss of paste or water between the two surfaces.

C. Form Ties:

1. Material: Steel.
2. Spreader Inserts:
   a. Conical or spherical type.
   b. Design to maintain positive contact with forming material.
   c. Furnish units that will leave no metal closer than 1-1/2 inches to concrete surface when forms, inserts, and tie ends are removed.
3. Wire ties not permitted.

2.02 CONCRETE

A. Materials:

1. Cementitious Materials:
   a. Cement:
      1) Portland Cement: Unless otherwise specified, conform to requirements of ASTM C150/C150M.
      2) Blended Hydraulic Cement:
         a) Unless otherwise specified, excluding Type IS (greater than 70), conforming to ASTM C595/C595M.
         b) Portland cement used in blended hydraulic cement; conform to requirements of ASTM C150/C150M.
      3) Performance-Based Cement: Conform to requirements of ASTM C1157/C1157M.
         a) For sections of structure that are assigned Exposure Class F3, submit certification on cement composition verifying that concrete mixture conforms to Table 4.2.1.1(b) of ACI 301.
      4) Furnish from one source.
   b. Supplementary Cementitious Materials (SCM):
      1) Fly Ash (Pozzolan): Class F fly ash in accordance with ASTM C618, except as modified herein:
         a) ASTM C618, Table 1, Loss on Ignition: Unless permitted otherwise, maximum 3 percent.
      2) Slag Cement: In accordance with ASTM C989/C989M, Grade 100 or Grade 120.
      3) Silica Fume: In accordance with ASTM C1240.
2. Aggregates: Unless otherwise permitted, furnish from one source for each aggregate type used in a mix design.
   a. Aggregates:
      1) In accordance with ASTM C33/C33M, except as modified herein.
         a) In accordance with ACI 301, except as modified herein.
         b) Free of materials and aggregate types causing popouts, discoloration, staining, or other defects on surface of concrete.
         c) Aggregates that are susceptible to alkali-carbonate reactions shall not be used.
         d) Alkali Silica Reactivity: See Article Concrete Mix Design.
      2) Fine Aggregates:
         a) In accordance with ASTM C33/C33M, except as modified herein.

b) In the event manufactured sand is included in the mix design, the material shall be from the same source as the coarse aggregate.
c) Limit deleterious substances in accordance with ASTM C33/C33M, Table 2 and as follows:
(1) Limit material finer than 75-µm (No. 200) sieve to 3 percent mass of total sample.
(2) Limit coal and lignite to 0.5 percent.
3) Coarse Aggregate:
a) Crushed gravels, crushed stone, or combination of these materials containing no more than 15 percent flat or elongated particles as determined by ASTM D4791.
b) Limit deleterious substances in accordance with ASTM C33/C33M, Table 4 for specified class designation.

3. Admixtures:
a. Characteristics:
1) Compatible with other constituents in mix.
2) Contain at most, only trace amount chlorides in solution.
3) Furnish type of admixture as recommended by manufacturer for anticipated temperature ranges.
b. Air-Entraining Admixture: ASTM C260/C260M.
c. Water-Reducing Admixture: ASTM C494/C494M, Type A or Type D.
d. Retarding Admixture: ASTM C 494/C 494M, Type B.
e. Accelerating Admixture: ASTM C 494/C 494M, Type C.
f. High-Range, Water-Reducing Admixture: ASTM C494/C494M, Type F or Type G.
g. Shrinkage Reducing Admixture:
1) Manufacturers and Products:
a) Master Builders Solutions,, Shakopee, MN; MasterLife SRA 20.
b) Euclid Chemical Co., Cleveland, OH; Eucon SRA Series.
c) W. R. Grace & Co., Cambridge, MA; Eclipse Series.
h. Admixtures with no standard, ASTM or other, designation may be used where permitted.

4. Water and Ice: Mixing water for concrete and water used to make ice shall be potable water, unless alternative sources of water are permitted.
a. Water from alternative sources shall comply with requirements of ASTM C1602/C1602M, and concentration of chemicals in combined mixing water shall be less than:
1) Chloride Content: 1,000 ppm.
2) Sulfate Content as SO_4: 3,000 ppm.
3) Alkalis as (Na_2O + 0.658 K_2O): 600 ppm.

4) Total Solids by Mass: Less than 50,000 ppm.

B. Concrete Mix Design:

1. General:
   a. When required concrete mixture shall be certified in accordance with ANSI Standard 61 for contact with potable water.
   b. Unless otherwise specified, refer to Supplement at the end of this section for mix design requirements for each class of concrete used on Project.
      1) Alternate product for small concrete placements:
         a) Concrete product intended for use on small concrete placements, such as equipment pads, in full depth form and pour applications. Use shall be approved by the Owner. Not to be used in water holding applications.
         b) One component cementitious concrete mix containing factory blended coarse aggregate.
         c) Self-consolidating with maximum pour depth compatible with the required placement depth.
         d) Contains integral corrosion inhibitor.
         e) Compressive Strength, ASTM C39:
            (1) 7 days, 4500 psi minimum.
            (2) 28 days, 5500 psi minimum.
         f) Drying Shrinkage, ASTM C157/C157M at 28 Days:
            (1) 0.07 percent maximum.
            (2) Chloride Ion Permeability Based on Charge Passed, ASTM C1202.
            (3) 1800 Coulombs maximum.
         g) Manufacturers and Products:
            (1) Master Builders Solutions, Shakopee, MN; MasterEmaco S 440CI.
            (2) Euclid Chemical Co. Cleveland, OH; EucoRepair SCC.
            (3) Sika Corp., Lyndhurst, NJ; Sikacrete 211 SCC Plus.
   c. Unless otherwise specified, prepare design mixtures for each type and strength of concrete, selecting and proportioning ingredients in accordance with requirements of ACI 301.
   d. Unless otherwise specified, selection of constituent materials and products in mix design are optional.
   e. Unless otherwise permitted, use water-reducing admixture or water-reducing admixture and high-range, or water-reducing admixture for the following:
      1) Pumped concrete.

2) Concrete with a water-cementitious materials ratio below 0.50.
3) Concrete mixtures used in walls.
4) When needed to achieve fresh properties that facilitate handling, placing, and consolidating of concrete mixtures, and to achieve specified hardened properties.
5) When anticipated high temperatures, low humidity, or other adverse placement conditions can adversely affect fresh properties of concrete.

f. Unless otherwise specified, desired fresh properties of concrete shall be determined by Contractor, and coordinated with concrete producer. Fresh properties of concrete shall remain stable to satisfaction of Contractor, for duration of placement and consolidation, and shall remain in conformance with requirements of Contract Documents.

g. Contractor is encouraged to consider using environmentally sustainable concrete mix design technologies such as use of supplementary cementitious materials and aggregate packing, and self-consolidating concrete.

2. Potential Alkali-Aggregate Reactivity of Concrete:

a. Do not use aggregates known to be susceptible to alkali-carbonate reaction (ACR).

b. Unless otherwise specified, or unless members are assigned to Exposure Class C0, use one of the three options below for qualifying concrete mixtures to reduce the potential of alkali-silica reaction. Option 3) shall not be used with natural pozzolans, or fly ash that has a CaO content more than 18 percent, or for aggregates with expansions greater than or equal to 0.24 percent when tested in accordance with ASTM C1293. Fly ash with an alkali content greater than 4.0 percent shall not be used in option 2) or 3).

1) For each aggregate used in concrete, the expansion result determined in accordance with ASTM C1293 shall not exceed 0.04 percent at 1 year.
2) For each aggregate used in concrete, the expansion result of the aggregate and cementitious materials combination determined in accordance with ASTM C1567 shall not exceed 0.10 percent at an age of 16 days. Submit supporting data for each aggregate showing expansion in excess of 0.10 percent at 16 days when tested in accordance with ASTM C1260.

3) Alkali content in concrete (LBA), excluding that from supplementary cementitious materials and the pozzolans and slags in blended cements, shall not exceed 4 lb/yd^3 for aggregates with expansions more than or equal to 0.04 percent and less than 0.12 percent or 3 lb/yd^3 for aggregates with expansions greater than or equal to 0.12 percent and less than 0.24 percent. Reactivity shall be determined by testing in accordance with ASTM C1293. Alkali content shall be calculated as follows:
   a) LBA = (cement content, lb/yd^3) × (equivalent alkali content of portland cement in percent/100 percent)

3. Proportions:
   a. Design mix to meet aesthetic, durability, and strength requirements.
   b. Where fly ash is included in mix, minimum fly ash content shall be a minimum of 15 percent of weight of total cementitious materials.
   c. Where silica fume is included in mix, minimum silica fume content shall be 5 percent of weight of total cementitious materials.
   d. Concrete Shrinkage Limits: Where shrinkage limits are specified, design mix for following shrinkage limits and test in accordance with ASTM C157/C157M, with the following modifications:
      1) Prisms shall be moist cured for 7 days prior to 28-day drying period.
      2) Comparator reading at end of 7-day moist cure shall be used as initial length in length change calculation.
      3) Reported results shall be average of three prisms.
      4) If shrinkage of a specimen departs from average of that test age by more than 0.004 percent, disregard results obtained from that specimen.
      5) Unless otherwise specified, results of 28-day drying period shall not exceed 0.040 percent if 3-inch prisms are used, or exceed 0.038 percent if 4-inch prisms are used. Aggregate will be rejected if test values exceed these limits.
4. Slump:
   a. Unless otherwise specified, and prior to submitting mix design, select a target slump at the point of delivery for concrete mixtures used for Work. Selected target slump shall not exceed 9 inches. Concrete shall not show visible signs of segregation. The target slump indicated on the submittal shall be used as the basis for acceptance during the Project. Determine the slump by ASTM C143/C143M.
   b. Slump tolerance shall meet requirements of ACI 117.

5. Self-Consolidating Concrete:
    a. Unless otherwise specified, select a target slump flow at the point of delivery for self-consolidating concrete mixtures. Selected target slump flow shall not exceed 30 inches. Concrete shall not show visible signs of segregation. The target slump flow value indicated on the submittal shall be used as the basis for acceptance during the Project. Determine slump flow in accordance with ASTM C1611/C1611M.
    b. Slump flow tolerances shall be in accordance with ASTM C94/C94M.
    c. If specified, evaluate during the mixture qualification stage, proposed concrete mixtures for passing ability in accordance with ASTM C1621/C1621M and for static segregation in accordance with ASTM C1610/C1610M to meet criteria indicated in Contract Documents.
6. Size of Coarse Aggregate:
    a. Unless otherwise specified, nominal maximum size of coarse aggregate shall not exceed:
        1) Three-fourths of minimum clear spacing between reinforcement.
        2) One-fifth of narrowest dimension between sides of forms.
        3) One-third of thickness of slabs or toppings.
7. Temperature Limits:
    a. Maintain concrete temperature below 95 degrees F at time of placement, or furnish test data or other proof that admixtures and mix ingredients do not produce flash set, plastic shrinkage, or cracking as a result of heat of hydration. Cool ingredients before mixing to maintain fresh concrete temperatures as specified or less.
    b. For mass concrete sections, provide documentation that maximum concrete temperature in structure will not exceed 160 degrees F, and maximum temperature differential between center of section and external surfaces of concrete will not exceed 35 degrees F.
    c. Accelerating admixture may not be used in mass concrete sections unless the thermal control plan specifically addresses the concrete mixtures with the same accelerating admixture, at a dosage equal to or greater than being proposed for the mass concrete.

2.03 REINFORCING STEEL

A. Deformed Steel Reinforcing Bars: ASTM A615/A615M, Grade 60. Welding of reinforcing bars is not permitted.

B. Fabrication: Follow CRSI Manual of Standard Practice.

2.04 ANCILLARY MATERIALS

A. Bonding Agent:

1. Unless otherwise specified, in accordance with the following:
   a. ASTM C881/C881M, Type V.
   b. Two-component, moisture-insensitive, 100 percent solids epoxy.
   c. Consult manufacturer for surface finish, pot life, set time, vertical or horizontal application, and forming restrictions.
   d. Manufacturers and Products:
      1) Master Builders Solutions, Shakopee, MN; MasterInject 1500.
      2) Euclid Chemical Co., Cleveland, OH; Euco # 352 Epoxy System LV.
      3) Prime Resins, Conyers, GA; Prime Bond 3000 to 3900 Series.
      4) Sika Chemical Corp., Lyndhurst, NJ; Sikadur 32 Hi-Mod.

B. Bond Breaker:

1. Nonstaining type, providing positive bond prevention.
2. Manufacturers and Products:
   a. Dayton Superior Corporation, Miamisburg, OH; Sure Lift J6WB.
   b. Nox-Crete Products Group, Omaha, NE; Silcoseal Select.

C. Reinforcing Steel Accessories:

1. Plastic Protected Wire Bar Supports: In compliance with ANSI/CRSI – RB 4.1 Class 1 Reinforcement Supports.
2. Stainless Steel Protected Wire Bar Supports: In compliance with ANSI/CRSI – RB 4.1 Class 2 Reinforcement Supports, except legs shall be made wholly from stainless steel wire.
3. Bar Supports With No Special Requirements for Corrosion Resistance: In compliance with ANSI/CRSI – RB 4.1 Class 3 Reinforcement Supports.
4. Precast Concrete Bar Supports: In compliance with ANSI/CRSI – RB 4.1 Cementitious (Precast) Reinforcement Supports.
   a. Precast concrete bar supports shall have equal or greater strength than the surrounding concrete.
   b. Precast concrete bar supports shall be four square inches minimum, in plan.
   c. Precast concrete bar supports shall have tie wires.

D. Tie Wire:

1. Black, soft-annealed 16-gauge wire.
2. Nylon-coated, epoxy-coated, or plastic-coated wire.

E. Premolded Joint Filler:

1. Bituminous Type: ASTM D994/D994M or ASTM D1751.
2. Sponge Rubber:
    a. Neoprene, closed-cell, expanded; ASTM D1056, Type 2C5, with compression deflection, 25 percent deflection (limits), 119 kPa to 168 kPa (17 psi to 24 psi) minimum.
    b. Manufacturer and Product: Monmouth Rubber and Plastics Corporation, Long Branch, NJ; Durafoam DK515IHD.
3. Self-Expanding Cork:
    a. ASTM D1752, Type III.
    b. Manufacturer and Product: WR Meadows, Inc., Hampshire, IL; Self-expanding cork. (800) 342-5976.

F. Curing Compound:

1. Water-based, high-solids content, nonyellowing, curing compound meeting requirements of ASTM C1315 Type I, Class A.
2. Manufacturers and Products:
    a. Euclid Chemical Co., Cleveland, OH; Super Diamond Clear VOX.
    b. WR Meadows, Inc., Hampshire, IL; VOCOMP-30.
    c. Vexcon Chemical, Inc., Philadelphia, PA; Starseal 1315.
    d. Dayton Superior; Safe Cure and Seal 1315 EF.

G. Evaporation Retardant:

1. Optional: Fluorescent fugitive dye color tint that disappears completely upon drying.
2. Manufacturers and Products:
    a. Master Builders Solutions,, Shakopee, MN; MasterKure ER 50.
    b. Euclid Chemical Co., Cleveland, OH; Eucobar.

H. Nonshrink Grout:

1. Nonmetallic, nongas-liberating.
2. Prepackaged natural aggregate grout requiring only the addition of water.
3. Aggregate shall show no segregation or settlement at fluid consistency at specified times or temperatures.
4. Test in accordance with ASTM C1107/C1107M:
    a. Fluid consistency 20 seconds to 30 seconds in accordance with ASTM C939.
    b. Temperatures of 40 degrees F, 80 degrees F, and 100 degrees F.
5. Pass fluid grout through flow cone with continuous flow 1 hour after mixing.

6. Minimum Strength of Fluid Grout:
    a. 3,500 psi at 1 day.
    b. 4,500 psi at 3 days.
    c. 7,500 psi at 28 days.
7. Maintain fluid consistency when mixed in 1 yard to 9 yard loads in ready-mix truck.
8. Manufacturers and Products:
    a. Master Builders Solutions,, Shakopee, MN; MasterFlow 928.
    b. Five Star Products Inc., Fairfield, CT; Five Star Fluid Grout 100.
    c. Euclid Chemical Co., Cleveland, OH; Hi Flow Grout.
    d. Dayton Superior Corp., Miamisburg, OH; Sure Grip High Performance Grout.

I. Repair Material:

1. Contain only trace amounts of chlorides and other chemicals that can potentially cause steel to oxidize.
2. Where repairs of exposed concrete are required, prepare mockup using proposed repair materials and methods, for confirmation of appearance compatibility prior to use.
3. Obtain Manufacturer's Certificate of Compliance that products selected are appropriate for specific applications.
4. Repair mortar shall be Site mixed.
5. Prepare concrete substrate and mix, place, and cure repair material in accordance with manufacturer's written recommendations.
6. Manufacturers and Products:
    a. Master Builders Solutions, Shakopee, MN; MasterEmaco S Series products.
    b. Sika Chemical Corp., Lyndhurst, NJ; SikaTop Series.

J. Crack Repair:

1. Obtain Letter of Certification from manufacturer's technical representative, that products selected are appropriate for the specific applications.
2. Prepare concrete substrate and mix, place, and cure repair material in accordance with manufacturer's written recommendations.
3. Use part epoxy injection resin for structural crack repairs.
    a. Manufacturers:
        1) Master Builders Solutions,, Shakopee, MN; MasterInject Series.
        2) Euclid Chemical Co., Cleveland, OH.; Euco Series (#452).
        3) Sika Chemical Corp., Lyndhurst, NJ.; Sikadur Series.

4. Use hydrophilic polyurethane injection resin for non-structural crack repairs.
    a. Manufacturers:
        1) Master Builders Solutions, Shakopee, MN; MasterInject 1210 IUG.
        2) Euclid Chemical Co., Cleveland, OH; Dural Aqua-Fil.
        3) Sika Chemical Corp., Lyndhurst, NJ; SikaFix HH Hydrophilic.
        4) Prime Resins, Inc., Conyers, GA; Prime Flex 900 XLV.

2.05 SOURCE QUALITY CONTROL

A. Source Quality Control Inspection: Owner shall have access to and have right to inspect batch plants, cement mills, and supply facilities of suppliers, manufacturers, and subcontractors, providing products included in this section.

PART 3 EXECUTION

3.01 FORMWORK

A. Form Construction:

1. Construct forms and provide smooth-form finish.
2. Form 3/4-inch bevels at concrete edges, unless otherwise shown.
3. Make joints tight to prevent escape of mortar and to avoid formation of fins.
4. Brace as required to prevent distortion during concrete placement.
5. On exposed surfaces, locate form ties in uniform pattern or as shown.
6. Construct so ties remain embedded in the member with no metal within 1 inch of concrete surface when forms, inserts, and tie ends are removed.

B. Form Removal:

1. Nonsupporting forms (walls and similar parts of Work) may be removed after cumulatively curing at not less than 50 degrees F for 24 hours from time of concrete placement if:
    a. Concrete is sufficiently hard so as not to sustain damage by form removal operations.
    b. Curing and protection operations are maintained.
2. Remove forms with care to prevent scarring and damaging the surface.
3. Prior to form removal, provide thermal protection for concrete being placed under the requirements of cold weather concreting.

3.02 PLACING REINFORCING STEEL

A. Unless otherwise specified, in accordance with ACI 301.

B. Accessories:

1. Bar Supports in Contact with Ground: Provide precast concrete block supports.
   a. Do not use brick, broken concrete masonry units, spalls, rocks, construction debris, or similar material for supporting reinforcing steel.
2. Bar Supports in Contact with Forms: Unless otherwise noted, bar supports shall be plastic protected wire bar supports, stainless steel protected wire bar supports, or precast concrete block bar supports.
   a. Use stainless steel protected wire bar supports or precast concrete block bar supports at formed surfaces that will receive abrasive blasting, hydro-blasting, or grinding.
3. Bar Supports With No Special Requirements for Corrosion Resistance: Class 3 bar supports may be used in the following facilities, where the concrete surface in the finished construction will be in a dry conditioned space and will be concealed by architectural treatment such as ceiling or wall treatment, but not including sealer, paint, or other membrane coating.
4. Bar supports shall have sufficient strength and stiffness to carry loads without failure, displacement, or significant deformation. Space bar supports so minimum concrete cover is maintained for reinforcing between supports, and location of reinforcement remains within tolerance throughout work.

C. Splices and Laps:

1. Lap Splice Reinforcing: Refer to Structural General Notes on the Drawings for additional information.
2. Tie splices with 18-gauge annealed wire as specified in CRSI Standard.

3.03 CONCRETE PLACEMENT INTO FORMWORK

A. Inspection: Notify Owner and Special Inspector at least 1 work day in advance before starting to place concrete.

B. Placement into Formwork:

1. Reinforcement: Secure in position before placing concrete.
2. Place concrete as soon as possible after leaving mixer, without segregation or loss of ingredients, without splashing forms or steel above, and in layers not over 1.5 feet deep, except for slabs that shall be placed full depth. Place and consolidate successive layers prior to initial set of first layer to prevent cold joints.

3. Placement frequency shall be such that lift lines will not be visible in exposed and architectural concrete finishes.
4. Use means and methods that prevent segregation.
5. Provide sufficient illumination in the interior of forms so concrete deposition is visible, permitting confirmation of consolidation quality.
6. Trowel and round off top exposed edges of walls with 1/4-inch radius steel edging tool.

C. Conveyor Belts and Chutes:

1. Design and arrange ends of chutes, hopper gates, and other points of concrete discharge throughout conveying, hoisting, and placing system for concrete to pass without becoming segregated.
2. Do not use chutes longer than 50 feet.
3. Wipe clean with device that does not allow mortar to adhere to belt.
4. Cover conveyor belts and chutes.

D. Retempering: Not permitted for concrete where cement has partially hydrated.

E. Pumping of Concrete:

1. Provide standby pump, conveyor system, crane and concrete bucket, or other system onsite during pumping, for adequate redundancy to ensure completion of concrete placement without cold joints in case of primary placing equipment breakdown.
2. Minimum Pump Hose (Conduit) Diameter: 4 inches.
3. Replace pumping equipment and hoses (conduits) that are not functioning properly.

F. Maximum Size of Concrete Placements:

1. Limit size of each placement to allow for strength gain and volume change as a result of shrinkage.
2. Locate expansion, control, and contraction, joints where shown.
3. Construction Joints:
    a. Unless otherwise shown or permitted, locate construction joints as follows:
        1) Locate construction joints as shown on the Drawings or where approved in the joint location submittal.
        2) Locate expansion, control, and contraction joints where shown on the Drawings.
        3) Provide vertical construction joints at maximum spacing of 40 feet unless shown or approved otherwise.
        4) When vertical expansion, contraction, or control joint spacing does not exceed 60 feet, intermediate construction joints are not required.

5) Uniformly space vertical construction joints within straight sections of walls, avoiding penetrations.

4. Consider beams, girders, brackets, column capitals, and haunches as part of floor or roof system and place monolithically with floor or roof system.
5. Should placement sequence result in cold joint located below finished water surface, install waterstop in joint.

G. Minimum Time between Adjacent Placements:

1. Typical Unless Noted Otherwise: As soon as can safely be done without damaging previously cast concrete or interrupting curing thereof, but not less than 24 hours.
2. Expansion or Contraction Joints: 1 day.
3. If continuous placement of beams, girders, or slabs with columns or walls is indicated in Contract Documents, do not place horizontal elements until the underlying concrete is consolidated and bleed water is not on the surface of the supporting member, unless otherwise specified.

3.04 CONSOLIDATION AND VISUAL OBSERVATION

A. Provide at least one standby vibrator in operable condition at placement site prior to placing concrete.

3.05 COLD WEATHER PLACEMENT

A. Unless otherwise permitted, shall be in accordance with requirements of ACI 301, ACI 306.1, and as follows:

1. Cold weather requirements shall apply when ambient temperature is below 40 degrees F or approaching 40 degrees F and falling.
2. Do not place concrete over frozen earth or against surfaces with frost or ice present. Frozen earth shall be thawed to acceptance of Owner.
3. Unless otherwise permitted, do not place concrete in contact with surfaces less than 35 degrees F; requirement is applicable to all surfaces including reinforcement and other embedded items.
4. Provide supplemental external heat as needed when other means of thermal protection are unable to maintain minimum surface temperature of concrete as specified in ACI 306.1.
5. Maintain minimum surface temperature of concrete as specified in ACI 306.1 for no less than 3 days during cold weather conditions.
6. Protect concrete from freezing until end of curing period and until concrete has attained a compressive strength of 3,500 psi or design compressive strength if less than 3,500 psi.

B. Provide maximum and minimum temperature sensors placed on concrete surfaces spaced throughout Work to allow monitoring of concrete surface temperatures representative of Work. Unless otherwise permitted, record surface temperature of concrete at least once every 12 hours during specified curing period.

C. External Heating Units: Do not exhaust heater flue gases directly into enclosed area as it causes concrete carbonation as a result of concentrated carbon dioxide.

D. Cure as specified.

3.06 HOT WEATHER PLACEMENT

A. Prepare ingredients, mix, place, cure, and protect in accordance with ACI 301, ACI 305.1, and as follows:

1. Maintain concrete temperature below 95 degrees F at time of placement, or furnish test data or other proof that admixtures and mix ingredients do not produce flash set plastic shrinkage, or cracking as a result of heat of hydration. Cool ingredients before mixing to maintain fresh concrete temperatures as specified or less.
2. Internal concrete temperature in structure shall not exceed 160 degrees F, and maximum temperature differential between center of section and external surfaces of concrete shall not exceed 35 degrees F.
3. Provide for windbreaks, shading, fog spraying, sprinkling, ice, wet cover, or other means as necessary to maintain concrete at or below specified temperature.
4. Cure as specified.

3.07 PREMOLDED JOINT FILLER INSTALLATION

A. Sufficient in width to completely fill joint space where shown.

B. Drive nails approximately 1 foot 6 inches on center through filler, prior to installing, to provide anchorage embedment into concrete during concrete placement.

C. Secure premolded joint filler in forms before concrete is placed.

3.08 FINISHING FORMED SURFACES

A. Provide surface finish 2.0 (SF-2.0) in accordance with ACI 301 and as herein specified.

B. Tie Holes:

1. Unless otherwise specified, fill with specified repair material.
    a. Prepare substrate and mix, place, and cure repair material per manufacturer's written recommendations.
2. If required, color of tie-hole patch must match adjacent concrete.
    a. Clean and dampen tie holes before applying mortar. Do not use separate bonding agent.
    b. Fill with site-mixed portland cement repair mortar in accordance with ACI 301.
    c. Cure repair mortar with water.

C. Repair defective areas of concrete.

1. Cut edges perpendicular to surface at least 1/2-inch deep. Do not feather edges. Soak area with water for 24 hours.
2. Patch with specified repair material.
3. Repair concrete surfaces using specified materials. Select system, submit for review, and obtain approval from Owner prior to use.
4. Develop repair techniques with material manufacturer on surface that will not be visible in final construction prior to starting actual repair work and show how finish color will blend with adjacent surfaces. Obtain approval from Owner.
5. Obtain quantities of repair material and manufacturer's detailed instructions for use to provide repair with finish to match adjacent surface or apply sufficient repair material adjacent to repair to blend finish appearance.
6. Repair of concrete shall provide structurally sound surface finish, uniform in appearance or upgrade finish by other means until acceptable to Owner.

D. Inject cracks that meet the definition of defective area.

1. When crack repair is deemed by Owner as requiring a structural repair, use part epoxy injection resin.
2. When crack repair is deemed by Owner as requiring a nonstructural repair, use hydrophilic polyurethane injection resin.

3.09 FINISHING UNFORMED SURFACES

A. General:

1. Use manual screeds, vibrating screeds, or roller compacting screeds to place concrete level and smooth.
2. Do not use "jitterbugs" or other special tools designed for purpose of forcing coarse aggregate away from surface and allowing layer of mortar, which will be weak and cause surface cracks or delamination, to accumulate.
3. Do not dust surfaces with dry materials nor add water to surfaces.

4. Cure concrete as specified.

B. Slab Tolerances:

1. Exposed Slab Surfaces: Comprise of flat planes as required within tolerances specified.
2. Slab Finish Tolerances and Slope Tolerances: Crowns on floor surface not too high as to prevent 10-foot straightedge from resting on end blocks, nor low spots that allow block of twice the tolerance in thickness to pass under supported 10-foot straightedge.
3. Steel gauge block 5/16-inch thick.
4. Finish Slab Elevation: Slope slabs to floor drain and gutter, and shall adequately drain regardless of tolerances.
5. Thickness: Maximum 1/4 inch minus or 1/2 inch plus from thickness shown. Where thickness tolerance will not affect slope, drainage, or slab elevation, thickness tolerance may exceed 1/2 inch plus.

C. Exterior Slab Finish:

1. Provide broom finish unless specified otherwise.
2. Finish exposed edges with steel edging tool.
3. Mark sidewalks transversely at 5-foot intervals with jointing tool.

3.10 EXPOSED METAL OBJECTS

A. Remove metal objects not intended to be exposed in as-built condition of structure including wire, nails, and bolts, by chipping back concrete to depth of 1 inch and then cutting or removing metal object.

B. Repair area of chipped-out concrete as specified for defective areas.

3.11 BLOCKOUTS AT PIPES OR OTHER PENETRATIONS

A. Where shown, install in accordance with requirements of Drawings.

3.12 PROTECTION AND CURING

A. Protect and cure concrete in accordance with requirements of ACI 301, ACI 308.1, and as follows:

1. Protect fresh concrete from direct rays of sunlight, drying winds, and wash by rain.
2. Continuously wet cure concrete surfaces of hydraulic structures for a 7-day period. Intermittent wetting is not acceptable.
3. Use curing compound only where approved by Owner.

4. Cure formed surfaces with curing compound applied in accordance with manufacturer's written instructions as soon as wet curing and finishing are completed.
5. Remove and replace concrete damaged by freezing.
6. Repair areas damaged by construction, using specified repair materials and approved repair methods.

3.13 NONSHRINK GROUT

A. General: Mix, place, and cure nonshrink grout in accordance with grout manufacturer's written instructions.

B. Grouting Machinery Foundations:

1. Block out original concrete or finish off at distance shown below bottom of machinery base with grout. Prepare concrete surface by sandblasting, chipping, or by mechanical means to remove any soft material. Surface roughness in accordance with manufacturer's written instructions.
2. Clean metal surfaces of all paint, oil, grease, loose rust, and other foreign material that will be in contact with grout.
3. Set machinery in position and wedge to elevation with steel wedges, or use cast-in leveling bolts. Remove wedges after grout is set and pack void with grout.
4. Form with watertight forms at least 2 inches higher than bottom of plate.
5. Fill space between bottom of machinery base and original concrete in accordance with manufacturer's written instructions.

3.14 BACKFILL AGAINST STRUCTURES

A. Do not backfill against walls until concrete has obtained specified 28-day compressive strength.

B. Refer to General Structural Notes on the Drawings for additional requirements, including elevated slab and diaphragm completion prior to backfill.

C. Unless otherwise permitted, place backfill simultaneously on both sides of structure, where such fill is required, to prevent differential pressures.

3.15 FIELD QUALITY ASSURANCE AND QUALITY CONTROL

A. General:

1. Owner-Furnished Quality Assurance, in accordance with IBC Chapter 17 requirements and as specified.
2. Contractor-Furnished Quality Control: Inspection and testing as required.
3. Provide adequate facilities for safe storage and proper curing of concrete test specimens onsite for first 24 hours and for additional time as may be required before transporting to test lab.

4. Unless otherwise specified, sample concrete for testing for making test specimens, from point of delivery.
5. When concrete is pumped, sample and test air content at point of delivery and at point of placement.
    a. For Each Concrete Mixture: Provided results of air content tests for first load of the day are within specified limits, testing need only be performed at point of delivery for subsequent loads of that concrete mixture except that testing should be performed at point of placement every 4 hours.
6. Evaluation will be in accordance with ACI 301 and Specifications.
7. Test specimens shall be made, cured, and tested in accordance with ASTM C31/C31M and ASTM C39/C39M.
8. Frequency of testing may be changed at discretion of Owner.
9. Pumped Concrete: Take concrete samples for slump, ASTM C143/C143M, and test specimens, ASTM C31/C31M and ASTM C39/C39M.
10. If measured air content at delivery is greater than specified limit, check test of air content will be performed immediately on a new sample from delivery unit. If check test fails, concrete has failed to meet requirements of Contract Documents. If measured air content is less than lower specified limit, adjustments will be permitted in accordance with ASTM C94/C94M, unless otherwise specified. If check test of adjusted mixture fails, concrete has failed to meet requirements of Contract Documents. Concrete that has failed to meet requirements of Contract Documents shall be rejected.

B. Concrete Strength Test:

1. Unless otherwise specified, one specimen at age of 7 days for information, and two 6-inch diameter or when permitted three 4-inch diameter test specimens at age of 28 days for acceptance.
2. If result of 7-day concrete strength test is less than 50 percent of specified 28-day strength, extend period of moist curing by 7 additional days.
3. Provide a minimum of one spare test specimen per sample. Test spare cylinder as directed by Owner.
4. Segregation Test Objective: Concrete shall stay together when slumped. Segregation is assumed to cause mortar to flow out of mix even though aggregate may stay piled enough to meet slump or slump flow test.
    a. Test Procedure: Make slump or slump flow test and check for excessive slump or slump flow. Observe to see if mortar or moisture flows from slumped concrete.
    b. Reject concrete if mortar or moisture separates and flows out of mix.

C. Cold Weather Placement Tests:

1. During cold weather concreting, cast cylinders for field curing as follows. Use method that will produce greater number of specimens:
   a. Six extra test cylinders from last 100 cubic yards of concrete.
   b. Minimum three specimens for each 2 hours of placing time or for each 100 cubic yards.
2. These specimens shall be in addition to those cast for lab testing.
3. Protect test cylinders from weather until they can be placed under same protection provided for concrete of structure that they represent.
4. Keep field test cylinders in same protective environment as parts of structure they represent to determine if specified strength has been obtained.
5. Test cylinders in accordance with applicable sections of ASTM C31/C31M and ASTM C39/C39M.
6. Use test results to determine specified strength gain prior to falsework removal.

D. Slab Finish Tolerances and Slope Tolerances:

1. Support 10-foot-long straightedge at each end with steel gauge blocks of thicknesses equal to specified tolerance.
2. Compliance with designated limits in four of five consecutive measurements is satisfactory, unless defective conditions are observed.

3.16 MANUFACTURER'S SERVICES

A. Provide representative at Site for installation assistance, inspection, and certification of proper installation for concrete ingredients, mix design, mixing, and placement.

B. Concrete Producer Representative:

1. Observe how concrete mixes are performing.
2. Assist with concrete mix design, performance, placement, weather problems, and problems as may occur with concrete mix throughout Project, including instructions for redosing.
3. Establish control limits on concrete mix designs.
4. Provide equipment for control of concrete redosing for air entrainment or high-range, water-reducing admixture, superplasticizers, at Site to maintain proper slump or slump flow, and air content when specified.

C. Admixture Manufacturer's Representative: Available for consultations as required to ensure proper installation and performance of specified products.

D. Bonding Agent Manufacturer's Representative: Available for consultations as required to ensure proper installation and performance of specified products.

3.17 SUPPLEMENTS

A. Requirements of concrete mix designs following “End of Section,” are a part of this Specification and supplement requirements of Part 1 through Part 3 of this section:

1. Concrete Mix Design, Class 4500F2S1P1C1.

END OF SECTION

CONCRETE MIX DESIGN, CLASS 4500F2S1P1C1

A. Mix Locations: Where specified in Contract Documents.

B. Exposure Categories and Classifications: F2S1P1C1.

C. Mix Properties:

1. Limit water to cementitious materials ratio (W/Cm) in mix design to maximum value of 0.45.
2. Minimum concrete compressive strength (f'c) shall be 4,500 psi at 28 days.
   a. Designed to conform to shrinkage limits.
   b. Air-entraining admixtures are prohibited in concrete mixtures and total air content shall not be greater than 3 percent, for the following:
      1) Slabs to receive a hard-troweled finish.
      2) Slabs to receive a dry shake floor hardener.
      3) Slabs to receive a topping placed monolithically as a two-course floor on top of plastic concrete.
   c. Unless otherwise specified, provide air content based on nominal maximum size of aggregate as follows:

Nominal Maximum Aggregate Size in. ‡	**Air Content (%)***
3/8	7.5
1/2	7.0
3/4	6.0
1	6.0
1-1/2	5.5
2§	5.0
3§	4.5

‡See ASTM C33/C33M for tolerance on oversize for various nominal maximum size designations.
*Tolerance of air content is ±1-1/2 percent.
§Air contents apply to total mixture. When testing concretes, however, aggregate particles larger than 1-1/2 inches are to be removed by sieving and air content will be measured on sieved fraction (tolerance on air content as delivered applies to this value). Air content of total mixture is computed from value measured on sieved fraction passing 1-1/2-inch sieve in accordance with ASTM C231/C231M.

3. Provide cementitious materials in accordance with one of the following:
    a. ASTM C150/C150M Type II; inclusion of supplementary cementitious materials in design mix is optional.
    b. ASTM C150/C150M types other than Type II, plus supplementary cementitious materials in accordance with one of the following:
        1) Tricalcium Aluminate Content of Total Cementitious Materials: Maximum 8 percent by weight.
        2) Provide documentation of test results in accordance with ASTM C1012/C1012M, for combinations of cementitious materials providing sulfate resistance with expansion less than 0.10 percent at 6 months.
        3) ASTM C595/C595M Type IP or Type IS (less than 70), tested to comply with moderate sulfate resistance option (MS).
4. Limit water-soluble, chloride-ion content in hardened concrete to 0.30 percent, unless otherwise specified.
    a. Limits are stated in terms of chloride ions in percent by weight of cement.
    b. Unless otherwise permitted, provide documentation from concrete tested in accordance with ASTM C1218/C1218M at an age between 28 days and 42 days.

D. Refer to PART 1 through PART 3 of this section for additional requirements.

SECTION 03 39 00
CONCRETE CURING

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Concrete Institute (ACI): 308.1, Specification for Curing Concrete.
2. ASTM International (ASTM):
   a. C309, Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
   b. C1315, Standard Specification for Liquid Membrane-Forming Compounds Having Special Properties for Curing and Sealing Concrete.
3. NSF International: 61, Drinking Water System Components – Health Effects.

1.02 SUBMITTALS

A. Action Submittals:

1. Manufacturers' data indicating compliance with the requirements specified herein for the following products:
   a. Exposed aggregate finish retardant on formed surface.
   b. Evaporation retardant.
   c. Curing compound.
   d. Penetrating water repellent sealer.
   e. Clear liquid densifier.
2. Curing methods proposed for each type of element such as slab, walls, beams, and columns in each facility.

B. Informational Submittals:

1. Manufacturer's Certificate of Compliance, for the following:
   a. Curing compound showing moisture retention requirements.
   b. Retardants for exposed aggregate finish.

PART 2 PRODUCTS

2.01 MATERIALS

A. Curing Compound:

1. Water-based, high-solids content, nonyellowing, curing compound meeting requirements of ASTM C309 Class A.
2. Manufacturers and Products:
   a. Euclid Chemical Co., Cleveland, OH; Super Diamond Clear VOX.
   b. WR Meadows, Inc., Hampshire, IL; VOCOMP-30.
   c. Vexcon Chemical, Inc.; Philadelphia, PA; Starseal 1315.
   d. Dayton Superior; Safe Cure and Seal 1315 EF.
   e. BASF Construction Chemicals., Shakopee, MN; MasterKure CC 200WB.
   f. Euclid Chemical Co., Cleveland, OH; EucoCure VOX.
   g. Euclid Chemical Co., Cleveland, OH; Kurez VOX White Pigmented.

B. Evaporation Retardant:

1. Optional: Fluorescent fugitive dye color tint that disappears completely upon drying.
2. Manufacturers and Products:
   a. BASF Construction Chemicals, Shakopee, MN; MasterKure ER 50.
   b. Euclid Chemical Co., Cleveland, OH; Eucobar.

C. Penetrating Water Repellent Sealer: Water based, ready to use, single component, silane/siloxane, penetrating, clear water repellant sealer.

1. Viscosity: 50 cps.
2. Flash Point: 200 degrees F.
3. NCHRP No. 244 Reduction in Chloride Content:
   a. Average: 82 percent.
   b. Minimum Required: 75 percent.
4. NCHRP No. 244 Reduction in Weight Gain:
   a. 21 Days: 85 percent.
   b. VOCs: 50 g/l.
   c. Depth of Penetration: 1/4 inch.
5. Manufacturers and Products:
   a. BASF Construction Chemicals, Shakopee MN; MasterProtect H 400.
   b. Euclid Chemical Co.; Baracade WB 244.

D. Clear Liquid Densifier:

1. Colorless, aqueous solution of magnesium fluorosilicate.
2. Each gallon of solution shall contain a minimum of 2 pounds of fluorosilicate compound.
3. Manufacturers and Products:
    a. BASF Construction Chemicals, Shakopee, MN; MasterKure HD 300WB.
    b. Euclid Chemical Co., Cleveland, OH; Surfhard.

E. Retardant for Exposed Aggregate Finish on Slabs:

1. Manufacturers and Products:
    a. Sika Chemical Corp., Lyndhurst, NJ; Rugasol.
    b. Conrad Sovig Co., San Francisco, CA; Conreveal Top Surface.
    c. Burke Co., San Mateo, CA; Burke True Etch Surface Retarder.
    d. Euclid Chemical Co., Cleveland, OH; Surface Retarder S.

F. Retardant for Exposed Aggregate Finish on Formed Surface:

1. Manufacturers and Products:
    a. L. M. Scofield Co., Los Angeles, CA; Lithotex Top Surface Retarder.
    b. Conrad Sovig Co., San Francisco, CA; Control Set.
    c. Burke Co., San Mateo, CA; Burke True Etch Surface Retarder.
    d. Euclid Chemical Co., Cleveland, OH; Surface Retarder F.

G. Water: Clean and potable, containing less than 500 ppm of chlorides.

PART 3 EXECUTION

3.01 CONCRETE CURING

A. General:

1. Cure all concrete in accordance with Project Specifications and ACI308.1.
2. Where surfaces are to receive coatings, painting, cementitious material, or other similar finishes, use only water curing procedures. Refer to Interior Finish Schedule for surfaces to receive coatings.
3. Use only water curing on potable water structures.
4. Where curing compound cannot be used, water curing as described below or special methods using moisture shall be agreed upon by Engineer prior to placing concrete.

5. As required in Section 03 30 10, Structural Concrete, if result of 7-day concrete strength test is less than 50 percent of specified 28-day strength, extend period of moist curing specified below, by 7 additional days.

B. Use one of the following methods as approved by Engineer:

1. Vertical Surfaces
   a. Method 1: Leave concrete forms in place and keep surfaces of forms and concrete wet for 7 days.
   b. Method 2: Continuously sprinkle with water 100 percent of exposed surfaces for 7 days starting immediately after removal of forms.
   c. Method 3: Apply curing compound, where allowed, immediately after removal of forms.
2. Horizontal Surfaces:
   a. Method 1: Protect surface by water ponding for 7 days.
   b. Method 2: Cover with burlap or cotton mats and keep continuously wet for 7 days.
   c. Method 3: Cover with 1-inch layer of wet sand, earth, or sawdust, and keep continuously wet for 7 days.
   d. Method 4: Continuously sprinkle exposed surface for 7 days.
   e. Method 5: Apply curing compound, where allowed, immediately after final finishing when surface will no longer be damaged by traffic.

3.02 EVAPORATION RETARDANT APPLICATION

A. Use on flatwork when environmental conditions are anticipated to cause rapid drying of the concrete surface. Do not use evaporation retardant on potable water structures, unless product is NSF 61 approved.

B. Spray onto surface of fresh flatwork concrete immediately after screeding to react with surface moisture.

C. Reapply as needed to ensure a continuous moist surface until final finishing is completed.

3.03 PRESTRESSED TANK CONCRETE CURING

A. Keep concrete surfaces and form continuously wet for 7 days where portland cement is used, or 3 days where high-early-strength cement is used.

B. Begin curing immediately after initial concrete set has occurred.

C. Do not use curing compounds.

3.04 PENETRATING WATER REPELLENT SEALER APPLICATION

A. Before application and with Work above completed, water cure concrete walls and floors for a minimum of 28 days to receive sealer, keep clean, unpainted, and free from membrane curing compounds.

B. Concrete to receive penetrating sealer shall be dry for a minimum 24 hours immediately prior to application.

C. Apply per manufacturer's recommendations utilizing low pressure airless spray equipment.

1. Actual coverage and number of coats to be determined by field test sample application and water absorption testing. Final approval by Owner is required.

D. Apply at a coverage rate of 125 square feet per gallon to 200 square feet per gallon. Cure penetrating sealer on slabs for the minimum time recommended by manufacturer prior to allowing foot or vehicular traffic.

3.05 CLEAR LIQUID DENSIFIER APPLICATION

A. Before application and with Work above completed, water cure concrete walls and floors for a minimum of 28 days to receive sealer, keep clean, unpainted, and free from membrane curing compounds.

B. Apply liquid densifier evenly, using three coats, allowing 24 hours between coats.

1. First coat 1/3 strength, second coat 1/2 strength, and third coat 2/3 strength, mix with water.
2. Apply each coat so as to remain wet on surface for 15 minutes.
3. Apply approved liquid densifier in accordance with manufacturer's instructions.
4. After final coat is completed and dry, remove surplus liquid densifier from surface by scrubbing and mopping with water.

3.06 RETARDANT FOR EXPOSED AGGREGATE SURFACES

A. Apply in accordance with manufacturer's product instructions.

3.07 MANUFACTURER'S SERVICES

A. Provide manufacturer's representative at Site for installation assistance, inspection, and certification of proper installation for products specified.

B. Provide penetrating water repellent sealer manufacturer's representative to demonstrate proper application of product.

C. Provide clear liquid densifier manufacturer's representative to demonstrate proper mixing and application of product.

D. Provide curing compound manufacturer's representative to demonstrate proper application of curing compound to show coverage in one coat.

E. Provide retardant for exposed aggregate surfaces manufacturer's representative to demonstrate proper application and surface mortar removal procedures.

END OF SECTION

SECTION 03 62 00
GROUTING

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. ASTM International (ASTM):
   a. C230, Standard Specification for Flow Table for Use in Tests of Hydraulic Cement.
   b. C307, Standard Test Method for Tensile Strength of Chemical-Resistant Mortar, Grouts, and Monolithic Surfacings.
   c. C531, Standard Test Method for Linear Shrinkage and Coefficient of Thermal Expansion of Chemical-Resistant Mortars, Grouts, Monolithic Surfacings, and Polymer Concretes.
   d. C579, Standard Test Methods for Compressive Grout Strength of Chemical-Resistant Mortars, Grouts, Monolithic Surfacings, and Polymer Concretes.
   e. C882, Standard Test Method for Bond Strength of Epoxy-Resin Systems Used With Concrete By Slant Shear.
   f. C939, Standard Test Method for Flow of Grout for Preplaced-Aggregate Concrete (Flow Cone Method).
   g. C940, Standard Test Method for Expansion and Bleeding of Freshly Mixed Grouts for Preplaced-Aggregate Concrete in the Laboratory.
   h. C1107/C1107M, Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink).
   i. C1181, Standard Test Methods for Compressive Creep of Chemical-Resistant Polymer Machinery Grouts.
   j. D4263, Standard Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method.

1.02 SUBMITTALS

A. Action Submittals:

1. Product data of grouts.
2. Proposed method for keeping existing concrete surfaces wet prior to placing nonshrink grout.
3. Forming method for fluid grout placements.
4. Curing method for grout.

B. Informational Submittals:

1. Manufacturer's Written Instructions: Mixing of grout.
2. Manufacturer's proposed training schedule for grout work.
3. Manufacturer's Certificate of Compliance as specified:
    a. Grout free from chlorides and other corrosion-causing chemicals.
    b. Nonshrink grout properties of Category II and Category III, verifying expansion at 3 days or 14 days will not exceed the 28-day expansion and nonshrink properties are not based on gas or gypsum expansion.
4. Manufacturer's Certificate of Proper Installation.
5. Statements of Qualification: Grout manufacturer's representative.
6. Test Reports:
    a. Test report for 24-hour evaluation of nonshrink grout.
    b. Test results and service report from demonstration and training session.
    c. Field test reports and laboratory test results for field-drawn Samples.
7. List of Contractor's installation staff trained by grout manufacturer's representative in:
    a. Nonshrink grout installation and curing.
    b. Epoxy grout installation and curing.

1.03 QUALIFICATIONS

A. Grout Manufacturer's Representative: Authorized and trained representative of grout manufacturer. Minimum of 1-year experience that has resulted in successful installation of grouts similar to those for this Project.

B. For grout suppliers not listed herein, provide completed 24-hour Evaluation of Nonshrink Grout Test Form, attached at the end of this section. Provide independent testing laboratory test results for testing conducted within last 18 months.

PART 2 PRODUCTS

2.01 NONSHRINK GROUT AND EPOXY GROUT SCHEDULE

A. Furnish nonshrink grout (Category I, II, and III) and epoxy grout for applications as indicated in the following schedule:

Application	Temperature Range	Max. Placing Time	
	40 deg F to 100 deg F	20 Min.	Greater Than 20 Min.
Blockouts for gate guides	I or II		II
Precast joints	I or II		II
Column baseplates single-story	I or II		II
Machine bases 25 hp or less	II	II	II
Bases for precast wall sections	II	II	II
Baseplates for columns over one story	II	II	II
Baseplates for legs of tanks, pipe supports, nonvibratory equipment	II	II	II
Welded steel tanks	II	II	II
Precast base joints higher than one story	II	II	II
Form Tie-Through bolt openings	II	II	II
Machine bases 26 hp and up	III or Epoxy Grout	III or Epoxy Grout	III or Epoxy Grout
Baseplates and/or soleplates with vibration, thermal movement, etc.	III or Epoxy Grout	III or Epoxy Grout	III or Epoxy Grout

2.02 NONSHRINK GROUT

A. Category I:

1. Nonmetallic and nongas-liberating.
2. Prepackaged natural aggregate grout requiring only the addition of water.
3. Test in accordance with ASTM C1107/C1107M:
   a. Grout shall have flowable consistency.
   b. Flowable for 15 minutes.
4. Grout shall not bleed at maximum allowed water.
5. Minimum strength of flowable grout, 3,000 psi at 3 days, 5,000 psi at 7 days, and 7,000 psi at 28 days.
6. Manufacturers and Products:
   a. Master Builders Solutions, Shakopee, MN; MasterFlow 100.
   b. Euclid Chemical Co., Cleveland, OH; NS Grout.
   c. Dayton Superior Corp., Miamisburg, OH; 1107 Advantage Grout.
   d. US MIX Co., Denver, CO; US SPEC GP Grout.
   e. Five Star Products Inc., Fairfield, CT; Five Star Grout.

B. Category II:

1. Nonmetallic, nongas-liberating.
2. Prepackaged natural aggregate grout requiring only the addition of water.
3. Aggregate shall show no segregation or settlement at fluid consistency at specified times or temperatures.
4. Test in accordance with ASTM C1107/C1107M:
   a. Fluid consistency 20 seconds to 30 seconds in accordance with ASTM C939.
   b. Temperatures of 40 degrees F, 80 degrees F, and 90 degrees F.
5. One hour after mixing, pass fluid grout through flow cone with continuous flow.
6. Minimum strength of fluid grout, 3,500 psi at 1 day, 4,500 psi at 3 days, and 7,500 psi at 28 days.
7. Maintain fluid consistency when mixed in 1-yard to 9-yard loads in ready-mix truck.
8. Manufacturers and Products:
   a. Master Builders Solutions, Shakopee, MN; MasterFlow 928.
   b. Five Star Products Inc., Fairfield, CT; Five Star Fluid Grout 100.
   c. Euclid Chemical Co., Cleveland, OH; Hi Flow Grout.
   d. Dayton Superior Corp., Miamisburg, OH; Sure-Grip High Performance Grout.
   e. US MIX Co., Denver, CO; US SPEC MP Grout.

C. Category III:

1. Metallic and nongas-liberating.
2. Prepackaged aggregate grout requiring only the addition of water.
3. Aggregate shall show no segregation or settlement at fluid consistency at specified times or temperatures.
4. Test in accordance with ASTM C1107/C1107M:
   a. Fluid consistency 20 seconds to 30 seconds in accordance with ASTM C939.
   b. Temperatures of 40 degrees F and 100 degrees F.
5. One hour after mixing, pass fluid grout through flow cone with continuous flow.
6. Minimum strength of fluid grout, 4,000 psi at 1 day, 5,000 psi at 3 days, and 9,000 psi at 28 days.
7. Maintain fluid consistency when mixed in 1-yard to 9-yard loads in ready-mix truck.
8. Manufacturer and Product:
   a. Master Builders Solutions, Shakopee, MN; MasterFlow 885.
   b. Euclid Chemical Co, Cleveland, OH; Hi-Flow Metallic Grout.

2.03 EPOXY GROUT

A. High-strength, nonshrink, high-temperature epoxy grouting material developed for the support of heavy equipment with vibratory loads.

B. Three-component mixture of a two-component epoxy resin system (100 percent solids) with a graded, precision aggregate blend.

C. Premeasured, prepackaged system.

D. Flowable.

E. Minimum compressive strength in accordance with ASTM C579 Method B, 9,500 psi at 75 degrees F at 7 days, 11,000 psi at post cure.

F. Maximum creep resistance in accordance with ASTM C1181 at 600 psi, 140 degrees F; 6.0 by 10^{-3} in/in.

G. Minimum bond strength in accordance with ASTM C882, 2,000 psi.

H. Minimum tensile strength in accordance with ASTM C307, 2,000 psi.

I. Maximum coefficient of thermal expansion in accordance with ASTM C531 at 73 degrees F to 210 degrees F, 23.0 by 10^{-6} in/in/degrees F.

J. Working Time: Minimum 2 hours at 50 degrees F; 1.5 hours at 70 degrees F; 50 minutes at 90 degrees F.

K. Good chemical resistance.

L. Good effective bearing area.

M. Noncorrosive.

N. Moisture insensitive.

O. Modify resin and aggregate content where recommended by epoxy grout manufacturer to provide desired epoxy grout flow properties.

P. Manufacturer and Product:

1. Master Builders Solutions, Shakopee MN; MasterFlow 648.
2. Euclid Chemical Co., Cleveland, OH; E^3-Series.
3. Dayton Superior Corp., Miamisburg, OH; Pro-Poxy 2000 Normal Set.
4. Five Star Products Inc., Fairfield, CT; DP Epoxy Grout.

PART 3 EXECUTION

3.01 GENERAL

A. Unless otherwise specified, prepare and condition concrete substrate in accordance with grout manufacturer's training instructions.

B. Mix, place, and cure grout in accordance with grout manufacturer's representative's training instructions.

C. Epoxy Grout: Concrete slab shall be fully cured for 28 days to ensure excess water has evaporated. Test concrete surface for moisture in accordance with ASTM D4263 before epoxy grout is placed.

D. Form Tie-Through Bolt Holes: Provide nonshrink grout, Category II, fill space with dry pack dense grout hammered in with steel tool and hammer. Through-bolt holes; coordinate dry pack dense grout application with vinyl plug in Section 03 10 00, Concrete Forming and Accessories, and bonding agent in Section 03 30 10, Structural Concrete.

E. Form Snap-Tie Hole: Fill tie hole in accordance with requirements of Section 03 30 10, Structural Concrete.

3.02 GROUTING MACHINERY FOUNDATIONS

A. Block out original concrete or finish off at distance shown below bottom of machinery base with grout. Prepare concrete surface by sandblasting, chipping, or by mechanical means to remove any soft material. Surface roughness in accordance with manufacturer's written instructions.

B. Clean metal surfaces of all paint, oil, grease, loose rust, and other foreign material that will be in contact with grout.

C. Sandblast to bright metal all metal surfaces in contact with epoxy grout in accordance with manufacturer's written instructions.

D. Set machinery in position and wedge to elevation with steel wedges, or use cast-in leveling bolts. Remove wedges after grout is set and pack void with grout.

E. Form with watertight forms at least 2 inches higher than bottom of plate.

F. Fill space between bottom of machinery base and original concrete in accordance with manufacturer's representative's training instructions.

G. If grout cannot be placed from one edge and flowed to the opposite edge, air vents shall be provided through the plate to prevent air entrapment.

H. Radius corners of grout pad.

I. Install expansion joints for epoxy grout placement in accordance with manufacturer's written instructions.

3.03 WELDED STEEL TANKS

A. Prepare concrete surface by sandblasting, chipping, or by mechanical means to remove any soft material. Surface roughness in accordance with manufacturer's written instructions.

B. Clean metal surfaces of paint, oil, grease, loose rust, and other foreign material that will be in contact with grout.

C. Set tank base in position and support using shims as needed.

D. Moisture condition existing concrete surfaces that will be in contact with grout.

1. Moisture condition surfaces of concrete substrate that will be covered by grout, plus 3 inches beyond edges of grout.
2. Saturate existing concrete substrate with water as required by grout manufacturer.
3. Surface of concrete substrate shall be damp but free of standing water at time of placement of grout.

E. Form with watertight forms at least 2 inches higher than bottom of plate.

F. Fill space between bottom of tank base and concrete substrate in accordance with manufacturer's representative's training instructions.

G. Cure grout in accordance with grout manufacturer's written instructions.

3.04 FIELD QUALITY CONTROL

A. General:

1. Performed by Project representative's inspection staff.
2. Perform the following quality control inspections. Grout manufacturer's representative shall accompany the Project representative's inspection staff on the first installation of each size and type of equipment.

B. Evaluation and Acceptance of Nonshrink Grout:

1. Inspect surface preparation of concrete substrates onto which nonshrink grout materials are to be applied, for conformance to the specified application criteria including, but not limited to, substrate profile, degree of cleanliness, and moisture.
2. Inspect preparation and application of nonshrink grout form work for conformance to the manufacturer's recommendations.
3. Conduct a final review of completed nonshrink grout installation for conformance to these Specifications.
4. Provide a flow cone and cube molds with restraining plates onsite. Continue tests during Project as demonstrated by grout manufacturer's representative.
5. Perform flow cone and bleed tests, and make three 2-inch by 2-inch cubes for each 25 cubic feet of each type of nonshrink grout used. Use restraining caps for cube molds in accordance with ASTM C1107/C1107M.
6. For large grout applications, make three additional cubes and one more flow cone test. Include bleed test for each additional 25 cubic feet of nonshrink grout placed.
7. Consistency: As specified in Article Nonshrink Grout. Flow cone test in accordance with ASTM C939. Grout with consistencies outside range requirements shall be rejected.
8. Segregation: As specified in Article Nonshrink Grout. Grout when aggregate separates shall be rejected.
9. Nonshrink grout cubes shall test equal to or greater than minimum strength specified.
10. Strength Test Failures: Nonshrink grout work failing strength tests shall be removed and replaced.
11. Perform bleeding test in accordance with ASTM C940 to demonstrate grout will not bleed.
12. Store cubes at 70 degrees F.
13. Independent testing laboratory shall prepare, store, cure, and test cubes in accordance with ASTM C1107/C1107M.

14. All grout, already placed, which fails to meet the requirements of these Specifications, is subject to removal and replacement at no additional cost to the Owner.

C. Evaluation and Acceptance of Epoxy Grout:

1. Inspect ambient conditions during various phases of epoxy grouting installation for conformance with the epoxy grout manufacturer's requirements.
2. Inspect the surface preparation of concrete substrates onto which epoxy grout materials are to be applied, for conformance to the specified application criteria including, but not limited to, substrate profile, degree of cleanliness, and moisture.
3. Inspect the surface preparation of the metallic substrates onto which the epoxy primer is to be applied.
4. Inspect the epoxy-primed metallic substrate for coverage and adhesion.
5. Inspect preparation and application of epoxy grout form work for conformance to the manufacturer's recommendation.
6. Verify consistency obtained is sufficient for the proper field placement at the installed temperatures.
7. Inspect and record that the "pot life" of epoxy grout materials is not exceeded during the installation.
8. Inspect epoxy grout for cure.
9. Inspect and record that localized repairs made to grout voids are in conformance with the specification requirements.
10. Conduct a final review of completed epoxy grout installation for conformance to these Specifications.
11. Compression tests and fabrication of specimens for epoxy grout shall be made in accordance to ASTM C579, Method B, at intervals during construction as selected by the Project representative. Set of three specimens shall be made for testing at 7 days, and each earlier time period as appropriate.
12. Independent testing laboratory shall prepare, store, cure, and test cubes in accordance with ASTM C579.
13. Grout, already placed, which fails to meet the requirements of these Specifications, is subject to removal and replacement at no additional cost to the Owner.

3.05 MANUFACTURER'S SERVICES

A. General:

1. Coordinate demonstrations, training sessions, and applicable Site visits with grout manufacturer's representative. Allow 2-week notice to grout manufacturer's representative for scheduling purposes.

2. Provide and conduct onsite, demonstration and training sessions for bleed tests, mixing, flow cone measurement, cube testing, application, and curing for each category and type of grout.
3. Necessary equipment and materials shall be available for demonstration.
4. Conduct training prior to equipment mount installation work on equipment pads.
5. Training for each type of grout shall be not less than 4 hours' duration.

B. Nonshrink Grout Training:

1. Training is required for all grout installations.
2. Provide nonshrink grout installation training by the qualified grout manufacturer's representative for Contractor's workers that will be installing nonshrink grout for baseplates and equipment mounts. Schedule training to allow Engineer's attendance.
3. Mix nonshrink grouts to required consistency, test, place, and cure on actual Project, such as, baseplates and form tie-through bolt holes to provide actual on-the-job training.
4. Use minimum of two bags for each grout Category II and Category III. Mix grout to fluid consistency and conduct flow cone and two bleed tests, make a minimum of six cubes for testing of two cubes at 1 day, 3 days, and 28 days. Use remaining grout for final Work.
5. Include recommended grout curing methods in the training.
6. Transport test cubes to independent test laboratory and obtain test reports.
7. Training by manufacturer's representative does not relieve Contractor of overall responsibility for this portion of the Work.
8. Submit a list of attendees that have been satisfactorily trained to perform epoxy grout installation for equipment mounting.

C. Epoxy Grout Training:

1. Provide epoxy grout installation training by the qualified epoxy grout manufacturer's representative for Contractor's workers that will be installing epoxy grout for equipment mounts. Schedule training to allow Engineer's attendance.
2. Include training in:
   a. Performance testing such as compressive strength testing of epoxy grout.
   b. All aspects of using the products, from mixing to application.
3. Transport test cubes to independent test laboratory and obtain test reports.
4. Training by manufacturer's representative does not relieve Contractor of overall responsibility for this portion of the Work.
5. Submit a list of attendees that have been satisfactorily trained to perform epoxy grout installation for equipment mounting.

3.06 SUPPLEMENTS

A. The supplement listed below, following “End of Section,” is part of this Specification.

1. 24-hour Evaluation of Nonshrink Grout Test Form and Grout Testing Procedures.

END OF SECTION

SUPPLEMENT 1

_____

(Test Lab Name)

_____

(Address)

_____

(Phone No.)

24-HOUR EVALUATION OF NONSHRINK GROUT TEST FORM

OBJECTIVE: Define standard set of test procedures for an independent testing laboratory to perform and complete within a 24-hour period.

SCOPE: Utilize test procedures providing 24-hour results to duplicate field grouting demands. Intent of evaluation is to establish grout manufacturer's qualifications.

PRIOR TO TEST: Obtain three bags of each type of grout.

1. From intended grout supplier for Project.
2. Three bags of grout shall be of same lot number.

ANSWER THE FOLLOWING QUESTIONS FOR GROUT BEING TESTED FROM LITERATURE, DATA, AND PRINTING ON BAG:

A.	Product data and warranty information contained in company literature and data?	Yes_____ No_____
B.	Literature and bag information meet specified requirements?	Yes_____ No_____
C.	Manufacturer guarantees grout?	Yes_____ No_____
D.	Guarantee extends beyond grout replacement value and allows participation with Contractor in replacing and repairing defective areas?	Yes_____ No_____
E.	Water demands and limits printed on bag?	Yes_____ No_____
F.	Mixing information printed on the bag?	Yes_____ No_____
G.	Temperature restrictions printed on bag?	Yes_____ No_____

*Rejection of a grout will occur if one or more answers are noted NO.

GROUT TESTING PROCEDURES

A. Bagged Material:

1. List lot numbers. _____
2. List expiration date. _____
3. Weigh bags and record weight. _____

Owner's Representative will disqualify grout if bag weights have misstated measure plus or minus 2 pounds by more than one out of three bags. (Accuracy of weights is required to regulate amount of water used in mixing since this will affect properties.)

B. Mixing and Consistency Determination:

1. Mix full bag of grout in 10-gallon pail.
2. Use electric drill with a paddle device to mix grout (jiffy or jiffler type paddle).
3. Use maximum water allowed per water requirements listed in bag instructions.
4. Mix grout to maximum time listed on bag instructions.
5. In accordance with ASTM C939 (flow cone) determine time of mixed grout through the flow cone. _____ seconds
6. Add water to attain 20-second to 30-second flow in accordance with ASTM C939.
7. Record time of grout through cone at new water demand. _____ seconds
8. Record total water needed to attain 20- to 30-second flow. _____ pounds
9. Record percent of water. _____ percent

C. When fluid grout is specified and additional water is required beyond grout manufacturer's listed maximum water, ASTM C1107/C1107M will be run at new water per grout ratio to determine whether grout passes using actual water requirements to be fluid. Use new water per grout ratio on remaining tests.

D. Bleed Test:

1. Fill two gallon cans half full of freshly mixed grout at ambient temperatures for each category and at required consistency for each.
2. Place one can of grout in tub of ice water and leave one can at ambient temperature.
3. Cover top of both cans with glass or plastic plate preventing evaporation.
4. Maintain 38 degrees F to 42 degrees F temperature with grout placed in ice and maintain ambient temperature for second container for 1 hour.
5. Visually check for bleeding of water at 15-minute intervals for 2 hours.

6. Perform final observation at 24 hours.

If grout bleeds a small amount at temperatures specified, grout will be rejected.

E. Extended Flow Time and Segregation Test (for Category II and Category III):

1. Divide the remaining grout into two 3-gallon cans. Place the cans into the 40-degree F and 90-degree F containers and leave for 20, 40, and 60 minutes. Every 20 minutes remove and check for segregation or settlement of aggregate. Use a gloved hand to reach to the bottom of the can, if more than 1/4 inch of aggregate has settled to the bottom or aggregate has segregated into clumps reject the grout.

2. Right after the settlement test mix the grout with the drill mixer for 10 seconds. Take an ASTM C939 flow cone test of grout and record flow time. Maintain this process for 1 hour at ambient temperatures of 40 degrees F and 90 degrees F.

   a. 20 min _____, sec. @ 40 degrees F.

   b. 40 min _____, sec. @ 40 degrees F.

   c. 60 min _____, sec. @ 40 degrees F.

   d. 20 min _____, sec. @ 90 degrees F.

   e. 40 min _____, sec. @ 90 degrees F.

   f. 60 min _____, sec. @ 90 degrees F.

All Category II and Category III grout that will not go through the flow cone with continuous flow after 60 minutes will be disqualified.

_____ _____

Qualified Disqualified

F. 24-hour Strength Test:

1. Using grout left in mixing cans in accordance with ASTM C1107/C1107M for mixing and consistency determination test and for extended time flow test, make minimum of nine cube samples.

2. Store cubes at 70 degrees F for 24 hours.

3. Record average compressive strength of nine cubes at 24 hours.

Grout will be disqualified if 24-hour compressive strengths are less than 2,500 psi for grouts claiming fluid placement capabilities.

Grouts that have not been disqualified after these tests are qualified for use on the Project for the application indicated in Nonshrink Grout Schedule.

_____ _____

Signature of Independent Testing Laboratory Date Test Conducted

SECTION 31 10 00
SITE CLEARING

PART 1 GENERAL

1.01 DEFINITIONS

A. Interfering or Objectionable Material: Trash, rubbish, and junk; vegetation and other organic matter, whether alive, dead, or decaying; topsoil.

B. Clearing: Removal of interfering or objectionable material lying on or protruding above ground surface.

C. Grubbing: Removal of vegetation and other organic matter including stumps, buried logs, and roots greater than 2-inch caliper to a depth of 6 inches below subgrade.

D. Stripping: Removal of topsoil remaining after applicable scalping is completed.

E. Project Limits: Areas, as shown or specified, within which Work is to be performed.

1.02 SUBMITTALS

A. Action Submittals: Drawings clearly showing clearing, grubbing, and stripping limits.

1.03 QUALITY ASSURANCE

A. Obtain Engineer’s approval of staked clearing, grubbing, and stripping limits, prior to commencing clearing, grubbing, and stripping.

1.04 SCHEDULING AND SEQUENCING

A. Prepare Site only after adequate erosion and sediment controls are in place. See the Drawings for Erosion and Sediment Control Notes.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 GENERAL

A. Clear, grub, and strip areas actually needed for waste disposal, borrow, or Site improvements within limits shown or specified.

B. Do not injure or deface vegetation that is not designated for removal.

C. Remove rubbish, trash, and junk from entire area within Project limits.

3.02 CLEARING

A. Clear areas within limits shown or specified.

B. Fell trees so that they fall away from facilities and vegetation not designated for removal.

C. Cut stumps not designated for grubbing flush with ground surface.

D. Cut off shrubs, brush, weeds, and grasses flush with ground surface.

3.03 GRUBBING

A. Grub areas within limits shown or specified.

3.04 STRIPPING

A. Strip areas within limits to minimum depths shown or specified. Do not remove subsoil with topsoil.

3.05 TREE REMOVAL OUTSIDE CLEARING LIMITS

A. Remove Within Project Limits: Dead, dying, leaning, or otherwise unsound trees that may strike and damage Project facilities in falling.

B. Cut stumps off flush with ground, remove debris, and if disturbed, restore surrounding area to its original condition.

3.06 DISPOSAL

A. Clearing and Grubbing Debris:

1. Dispose of debris offsite.
2. Debris may be buried in designated onsite disposal areas to minimum depth of 3 feet below final grade. In lieu of onsite burial, dispose of debris offsite.
3. Burning of debris onsite will not be allowed.
4. Woody debris may be chipped. Chips may be sold to Contractor's benefit or used for landscaping onsite as mulch or uniformly mixed with topsoil, provided that resulting mix will be fertile and not support combustion. Dispose of chips that are unsaleable or unsuitable for landscaping or other uses with unchipped debris.

5. Limit offsite disposal of clearing and grubbing debris to locations that are approved by federal, state, and local authorities, and that will not be visible from Project.

B. Scalpings: As specified for clearing and grubbing debris.

C. Strippings:

1. Dispose of strippings that are unsuitable for topsoil or that exceed quantity required for topsoil offsite or at a location offsite approved by Engineer.
2. Stockpile topsoil in sufficient quantity to meet Project needs. Dispose of excess strippings as specified for clearing and grubbing.

END OF SECTION

SECTION 31 23 16
EXCAVATION

PART 1 GENERAL

1.01 DEFINITIONS

A. Common Excavation: Removal of material not classified as rock excavation.

B. Rock Excavation:

1. General: Any material which cannot be excavated with a single-tooth ripper drawn by a crawler tractor having a draw bar pull rated at not less than 74,000 pounds (Caterpillar D9K or equivalent) or excavated by a front-end loader with a minimum bucket breakout force of 58,000 pounds (Caterpillar 973 “Or-equal.”).
2. Trench: Any material which cannot be excavated with a backhoe having a bucket curling force rated at not less than 55,000 pounds (Caterpillar 325 or equivalent).
3. Term “rock excavation” indicates removal of solid material, as specified above, and does not necessarily correspond to “rock” as implied by names of geologic formations.
4. Removal of boulders larger than 1/2 cubic yard will be classified as rock excavation, if drilling and blasting or breaking them apart with power-operated hammer, hydraulic rock breaker, expansive compounds, or other similar means is both necessary and actually used for their removal.

1.02 SUBMITTALS

A. Informational Submittals:

1. Excavation Plan, Detailing:
   a. Methods and sequencing of excavation.
   b. Proposed locations of stockpiled excavated material.
   c. Proposed onsite and offsite spoil disposal sites.
   d. Numbers, types, and sizes of equipment proposed to perform excavations.

1.03 QUALITY ASSURANCE

A. Provide adequate survey control to avoid unauthorized over excavation.

1.04 WEATHER LIMITATIONS

A. Material excavated when frozen or when air temperature is less than 32 degrees F shall not be used as fill or backfill until material completely thaws.

B. Material excavated during inclement weather shall not be used as fill or backfill until after material drains and dries sufficiently for proper compaction.

1.05 SEQUENCING AND SCHEDULING

A. Demolition: Complete applicable Work specified in Section 02 41 00, Demolition, prior to excavating.

B. Clearing, Grubbing, and Stripping: Complete applicable Work specified in Section 31 10 00, Site Clearing, prior to excavating.

C. Dewatering: Conform to applicable requirements of Section 31 23 19.01, Dewatering, prior to initiating excavation.

D. Excavation Support: Install and maintain, as specified in Section 31 41 00, Shoring, as necessary to support sides of excavations and prevent detrimental settlement and lateral movement of existing facilities, adjacent property, and completed Work.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 GENERAL

A. Excavate to lines, grades, and dimensions shown and as necessary to accomplish Work. Excavate to within tolerance of plus or minus 0.1 foot, except where dimensions or grades are shown or specified as maximum or minimum. Allow for forms, working space, granular base, topsoil, and similar items, wherever applicable. Trim to neat lines where concrete is to be deposited against earth.

B. Do not over excavate without written authorization of Engineer.

C. Remove or protect obstructions as shown and as specified.

D. Use of explosives shall not be allowed.

3.02 UNCLASSIFIED EXCAVATION

A. Excavation is unclassified. Complete all excavation regardless of the type, nature, or condition of the materials encountered.

3.03 CLASSIFIED EXCAVATION

A. Excavation is classified; see Article Definitions for classifications. Notify Engineer whenever rock is encountered.

B. Before beginning rock excavation, comply with following requirements:

1. Remove overlying material as common excavation and expose rock surface for examination by Engineer.
2. Demonstrate that removal of remaining material classifies as rock excavation unless waived by Engineer.
3. Assist Engineer with measurement and documentation of rock excavation.

C. Predrilling and blasting may be allowed prior to removal of overburden if, in Engineer's opinion, top-of-rock line can be clearly defined after excavation. Acceptance of this method will be based on the following demonstration:

1. Predrill, blast, and excavate initial 100-foot long test section.
2. Excavate minimum of two 20-foot long trenches to apparent rock line immediately adjacent to predrilled section for comparison.

D. In event of disputed quantities, excavate additional correlation trenches to apparent rock as considered necessary by Engineer to resolve dispute. Engineer reserves right to stop predrilling and blasting if, in Engineer's opinion, experience indicates that accurate determination of rock quantities is not possible by this method.

3.04 TRENCH WIDTH

A. Minimum Width of Trenches:

1. Single Pipes, Conduits, Direct-Buried Cables, and Duct Banks:
   a. Greater than 4-inch Outside Diameter or Width: 18.
2. Increase trench widths by thicknesses of sheeting/shoring.

B. Maximum Trench Width: Unlimited, unless otherwise shown or specified, or unless excess width will cause damage to existing facilities, adjacent property, or completed Work.

3.05 EMBANKMENT AND CUT SLOPES

A. Shape, trim, and finish cut slopes to conform with lines, grades, and cross-sections shown, with proper allowance for topsoil or slope protection, where shown.

B. Remove stones and rock that exceed 3-inch diameter and that are loose and may roll down slope. Remove exposed roots from cut slopes.

C. Round tops of cut slopes in soil to not less than a 6-foot radius, provided such rounding does not extend offsite or outside easements and rights-of-way, or adversely impacts existing facilities, adjacent property, or completed Work.

3.06 STOCKPILING EXCAVATED MATERIAL

A. Stockpile excavated material that is suitable for use as fill or backfill until material is needed.

B. Post signs indicating proposed use of material stockpiled. Post signs that are readable from all directions of approach to each stockpile. Signs should be clearly worded and readable by equipment operators from their normal seated position.

C. Confine stockpiles to within easements, rights-of-way, and approved work areas. Do not obstruct roads or streets.

D. Do not stockpile excavated material adjacent to trenches and other excavations, unless excavation side slopes and excavation support systems are designed, constructed, and maintained for stockpile loads.

E. Do not stockpile excavated materials near or over existing facilities, adjacent property, or completed Work, if weight of stockpiled material could induce excessive settlement.

3.07 DISPOSAL OF SPOIL

A. Dispose of excavated materials, which are unsuitable or exceed quantity needed for fill or backfill, offsite.

B. Dispose of debris resulting from removal of underground facilities as specified in Section 02 41 00, Demolition, for demolition debris.

C. Dispose of debris resulting from removal of organic matter, trash, refuse, and junk as specified in Section 31 10 00, Site Clearing, for clearing and grubbing debris.

END OF SECTION

SECTION 31 23 19.01
DEWATERING

PART 1 GENERAL

1.01 SUBMITTALS

A. Informational Submittals: Water control plan.

1.02 WATER CONTROL PLAN

A. As a minimum, include:

1. Descriptions of proposed groundwater and surface water control facilities including, but not limited to, equipment; methods; standby equipment and power supply, pollution control facilities, discharge locations to be utilized, and provisions for immediate temporary water supply as required by this section.
2. Drawings showing locations, dimensions, and relationships of elements of each system.
3. Design calculations demonstrating adequacy of proposed dewatering systems and components.

B. If system is modified during installation or operation revise or amend and resubmit Water Control Plan.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 GENERAL

A. Remove and control water during periods when necessary to properly accomplish Work.

3.02 SURFACE WATER CONTROL

A. Remove surface runoff controls when no longer needed.

3.03 DEWATERING SYSTEMS

A. Provide, operate, and maintain dewatering systems of sufficient size and capacity to permit excavation and subsequent construction in dry and to lower and maintain groundwater level a minimum of 2 feet below the lowest point of excavation. Continuously maintain excavations free of water, regardless of source, and until backfilled to final grade.

B. For box culvert and wingwall installation, dewatering systems shall include wells or well points, and other equipment and appurtenances installed outside limits of excavations and sufficiently below lowest point of excavation, or to maintain specified groundwater elevation.

C. Design and Operate Dewatering Systems:

1. To prevent loss of ground as water is removed.
2. To avoid inducing settlement or damage to existing facilities, completed Work, or adjacent property.
3. To relieve artesian pressures and resultant uplift of excavation bottom.

D. Provide sufficient redundancy in each system to keep excavation free of water in event of component failure.

E. Provide 100 percent emergency power backup with automatic startup and switchover in event of electrical power failure.

F. Provide supplemental ditches and sumps only as necessary to collect water from local seeps. Do not use ditches and sumps as primary means of dewatering.

3.04 DISPOSAL OF WATER

A. Obtain discharge permit for water disposal from authorities having jurisdiction.

B. Treat water collected by dewatering operations, as required by regulatory agencies, prior to discharge.

C. Discharge water as required by discharge permit and in manner that will not cause erosion or flooding, or otherwise damage existing facilities, completed Work, or adjacent property.

D. Provide filtration as necessary to minimize the turbidity of discharge.

E. Remove solids from treatment facilities and perform other maintenance of treatment facilities as necessary to maintain their efficiency.

3.05 PROTECTION OF PROPERTY

A. Make assessment of potential for dewatering induced settlement.

B. Securely support existing facilities, completed Work, and adjacent property vulnerable to settlement due to dewatering operations. Support shall include, but not be limited to, bracing, underpinning, or compaction grouting.

END OF SECTION

SECTION 31 23 23
FILL AND BACKFILL

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. ASTM International (ASTM):
   a. C117, Standard Test Method for Materials Finer Than 75-Micrometers (No. 200) Sieve in Mineral Aggregates by Washing.
   b. C136, Standard Method for Sieve Analysis of Fine and Coarse Aggregates.
   c. D75, Standard Practice for Sampling Aggregates.
   d. D698, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft^3 (600 kN-m/m^3)).
   e. D1556, Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method.
   f. D1557, Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft^3 (2,700 kN-m/m^3)).
   g. D4253, Standard Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table.
   h. D4254, Standard Test Method for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density.
   i. D6938, Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

1.02 DEFINITIONS

A. Relative Compaction:

1. Ratio, in percent, of as-compacted field dry density to laboratory maximum dry density as determined in accordance with ASTM D698.
2. Apply corrections for oversize material to either as-compacted field dry density or maximum dry density, as determined by Engineer.

B. Optimum Moisture Content:

1. Determined in accordance with ASTM Standard specified to determine maximum dry density for relative compaction.
2. Determine field moisture content on basis of fraction passing 3/4-inch sieve.

C. Relative Density: Calculated in accordance with ASTM D4254 based on maximum index density determined in accordance with ASTM D4253 and minimum index density determined in accordance with ASTM D4254.

D. Prepared Ground Surface: Ground surface after completion of required demolition, clearing and grubbing, scalping of sod, stripping of topsoil, excavation to grade, and subgrade preparation.

E. Completed Course: A course or layer that is ready for next layer or next phase of Work.

F. Lift: Loose (uncompacted) layer of material.

G. Geosynthetics: Geotextiles, geogrids, or geomembranes.

H. Well-Graded:

1. A mixture of particle sizes with no specific concentration or lack thereof of one or more sizes.
2. Does not define numerical value that must be placed on coefficient of uniformity, coefficient of curvature, or other specific grain size distribution parameters.
3. Used to define material type that, when compacted, produces a strong and relatively incompressible soil mass free from detrimental voids.

I. Influence Area: Area within planes sloped downward and outward at 60-degree angle from horizontal measured from:

1. 1 foot outside outermost edge at base of foundations or slabs.
2. 1 foot outside outermost edge at surface of roadways or shoulder.
3. 0.5 foot outside exterior at spring line of pipes or culverts.

J. Borrow Material: Material from required excavations or from designated borrow areas on or near Site.

K. Selected Backfill Material: Materials available onsite that Engineer determines to be suitable for specific use.

L. Imported Material: Materials obtained from sources offsite, suitable for specified use.

M. Structural Fill: Fill materials as required under structures, pavements, and other facilities.

N. Embankment Material: Fill materials required to raise existing grade in areas other than under structures.

1.03 SUBMITTALS

A. Informational Submittals:

1. Manufacturer’s data sheets for compaction equipment.
2. Certified test results from independent testing agency.

1.04 QUALITY ASSURANCE

A. Notify Engineer when:

1. Structure or tank is ready for backfilling, and whenever backfilling operations are resumed after a period of inactivity.
2. Soft or loose subgrade materials are encountered wherever embankment or site fill is to be placed.
3. Fill material appears to be deviating from Specifications.

1.05 SEQUENCING AND SCHEDULING

A. Complete applicable Work specified in Section 02 41 00, Demolition; Section 31 10 00, Site Clearing; and Section 31 23 16, Excavation, prior to placing fill or backfill.

B. Backfill against concrete structures only after concrete has attained compressive strength, specified in Section 03 30 10, Structural Concrete. Obtain Engineer’s acceptance of concrete work and attained strength prior to placing backfill.

PART 2 PRODUCTS

2.01 EARTHFILL

A. Excavated material from required excavations shall be free from rocks larger than 3 inches, from roots and other organic matter, ashes, cinders, trash, debris, and other deleterious materials.

B. Material containing more than 10 percent gravel, stones, or shale particles is unacceptable.

C. Provide imported material of equivalent quality, if required to accomplish Work.

2.02 GRANULAR FILL

A. 1-inch minus crushed gravel or crushed rock.

B. Free from dirt, clay balls, and organic material.

C. Well-graded from coarse to fine and containing sufficient fines to bind material when compacted, but with maximum 8 percent by weight passing No. 200 sieve.

2.03 SAND

A. Free from clay, organic matter, or other deleterious material.

B. Gradation as determined in accordance with ASTM C117 and ASTM C136:

Sieve Size	Percent Passing by Weight
1/4-inch	100
No. 4	95 - 100
No. 200	0 - 8

2.04 WATER FOR MOISTURE CONDITIONING

A. Free of hazardous or toxic contaminates, or contaminants deleterious to proper compaction.

PART 3 EXECUTION

3.01 GENERAL

A. Keep placement surfaces free of water, debris, and foreign material during placement and compaction of fill and backfill materials.

B. Place and spread fill and backfill materials in horizontal lifts of uniform thickness, in a manner that avoids segregation, and compact each lift to specified densities prior to placing succeeding lifts. Slope lifts only where necessary to conform to final grades or as necessary to keep placement surfaces drained of water.

C. During filling and backfilling, keep level of fill and backfill around each structure and buried tank even.

D. Do not place fill or backfill, if fill or backfill material is frozen, or if surface upon which fill or backfill is to be placed is frozen.

E. If pipe, conduit, duct bank, or cable is to be laid within fill or backfill:

1. Fill or backfill to an elevation 2 feet above top of item to be laid.
2. Excavate trench for installation of item.
3. Install bedding, if applicable, as specified in Section 31 23 23.15, Trench Backfill.
4. Install item.

5. Backfill envelope zone and remaining trench, as specified in Section 31 23 23.15, Trench Backfill, before resuming filling or backfilling specified in this section.

F. Tolerances:

1. Final Lines and Grades: Within a tolerance of 0.1 foot unless dimensions or grades are shown or specified otherwise.
2. Grade to establish and maintain slopes and drainage as shown. Reverse slopes are not permitted.

G. Settlement: Correct and repair any subsequent damage to structures, pavements, curbs, slabs, piping, and other facilities, caused by settlement of fill or backfill material.

3.02 FILL

A. Outside Influence Areas beneath Structures, Tanks, Pavements, Curbs, Slabs, Piping, and Other Facilities: Unless otherwise shown, place earthfill as follows:

1. Allow for 6-inch thickness of topsoil where required.
2. Maximum 8-inch thick lifts.
3. Place and compact fill across full width of embankment.
4. Compact to minimum 96 percent relative compaction as determined in accordance with ASTM D698.
5. Dress completed embankment with allowance for topsoil, crest surfacing, and slope protection, where applicable.

3.03 SITE TESTING

A. Gradation:

1. One sample from each 1,000 tons of finished product or more often as determined by Engineer, if variation in gradation is occurring, or if material appears to depart from specifications.
2. If test results indicate material does not meet Specification requirements, terminate material placement until corrective measures are taken.
3. Remove material placed in Work that does not meet specification requirements.

B. In-Place Density Tests: In accordance with ASTM D1556 During placement of materials, test as follows:

1. Granular Fill Under Structures: One test for every 5,000 square feet of minimum of one test per lift.
2. Earthfill for Backfill Stream Channel: One test every 100 feet along the channel.

3.04 REPLACING OVEREXCAVATED MATERIAL

A. Replace excavation carried below grade lines shown or established by Engineer as follows:

1. Beneath Footings: Granular fill.
2. Beneath Fill or Backfill: Same material as specified for overlying fill or backfill.
3. Beneath Slabs-On-Grade: Granular fill.
4. Permanent Cut Slopes (Where Overlying Area is Not to Receive Fill or Backfill):
   a. Flat to Moderate Steep Slopes (3:1, Horizontal Run: Vertical Rise or Flatter): Earthfill.

END OF SECTION

SECTION 31 23 23.15
TRENCH BACKFILL

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Public Works Association (APWA): Uniform Color Code.
2. ASTM International (ASTM):
   a. C33/C33M, Standard Specification for Concrete Aggregates.
   b. C94/C94M, Standard Specification for Ready-Mixed Concrete.
   c. C117, Standard Test Method for Materials Finer than 75 Micrometer (No. 200) Sieve in Mineral Aggregates by Washing.
   d. C136, Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
   e. C150/C150M, Standard Specification for Portland Cement.
   f. C618, Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.
   g. C1012/C1012M, Standard Test Method for Length Change of Hydraulic-Cement Mortars Exposed to a Sulfate Solution.
   h. D698, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft^3 (600 kN-m/m^3)).
   i. D1140, Standard Test Methods for Amount of Material in Soils Finer than No. 200 (75 micrometer) Sieve.
   j. D1557, Standard Test Methods for Laboratory Compaction Characteristics of Soil using Modified Effort (56,000 ft-lbf/ft^3 (2,700 kN-m/m^3)).
   k. D2487, Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System).
   l. D4253, Standard Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table.
   m. D4254, Standard Test Methods for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density.
   n. D4318, Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
   o. D4832, Standard Test Method for Preparation and Testing of Controlled Low Strength Material (CLSM) Test Cylinders.
3. National Electrical Manufacturers Association (NEMA): Z535.1, Safety Colors.

1.02 DEFINITIONS

A. Base Rock: Granular material upon which manhole bases and other structures are placed.

B. Bedding Material: Granular material upon which pipes, conduits, cables, or duct banks are placed.

C. Imported Material: Material obtained by Contractor from source(s) offsite.

D. Lift: Loose (uncompacted) layer of material.

E. Pipe Zone: Backfill zone that includes full trench width and extends from prepared trench bottom to an upper limit above top outside surface of pipe, conduit, cable or duct bank.

F. Prepared Trench Bottom: Graded trench bottom after excavation and installation of stabilization material, if required, but before installation of bedding material.

G. The ratio, in percent, of the as-compacted field dry density to the laboratory maximum dry density as determined by corrections for oversize material may be applied to either as-compacted field dry density or maximum dry density, as determined by Engineer. Relative Density: As defined by ASTM D4253 and ASTM D4254.

H. Selected Backfill Material: Material available onsite that Engineer determines to be suitable for a specific use.

I. Well-Graded: A mixture of particle sizes that has no specific concentration or lack thereof of one or more sizes producing a material type that, when compacted, produces a strong and relatively incompressible soil mass free from detrimental voids. Satisfying both of the following requirements, as defined in ASTM D2487:

   1. Coefficient of Curvature: Greater than or equal to 1 and less than or equal to 3.
   2. Coefficient of Uniformity: Greater than or equal to 4 for materials classified as gravel, and greater than or equal to 6 for materials classified as sand.

1.03 SUBMITTALS

A. Action Submittals:

   1. Samples:
      a. Trench stabilization material.
      b. Bedding and pipe zone material.
      c. Granular drain.

d. Granular backfill.
e. Earth backfill.
f. Sand(s).

B. Informational Submittals:

1. Catalog and manufacturer's data sheets for compaction equipment.
2. Certified Gradation Analysis: Submit not less than 30 days prior to delivery for imported materials or anticipated use for excavated materials, except for trench stabilization material that will be submitted prior to material delivery to Site.
3. Controlled Low Strength Material: Certified mix design and test results. Include material types and weight per cubic yard for each component of mix.

PART 2 PRODUCTS

2.01 GEOTEXTILE

A. As specified in Section 31 32 19.16, Geotextile.

2.02 TRENCH STABILIZATION MATERIAL

A. Clean gravel or crushed rock, reasonably well-graded from coarse to fine.

B. Meeting the requirements of the Georgia Department of Transportation.

C. Particle Size: GDOT No. 57 stone.

2.03 BEDDING MATERIAL AND PIPE ZONE MATERIAL

A. Unfrozen, friable, and no clay balls, roots, or other organic material.

B. Clean or gravelly sand with less than 5 percent passing No. 200 sieve, as determined in accordance with ASTM D1140, or gravel or crushed rock within maximum particle size and other requirements as follows unless otherwise specified.

1. Pipe 18-Inch Diameter and Greater: 1-1/2-inch maximum particle size for ductile iron pipe, concrete pipe, welded steel pipe, and pretensioned or prestressed concrete cylinder pipe.

2.04 GRANULAR DRAIN MATERIAL

A. As specified in Section 31 23 23, Fill and Backfill.

2.05 EARTH BACKFILL

A. As specified in Section 31 23 23, Fill and Backfill.

2.06 CONTROLLED LOW STRENGTH MATERIAL (CLSM)

A. Select and proportion ingredients to obtain compressive strength between 50 psi and 150 psi at 28 days in accordance with ASTM D4832.

B. Materials:

1. Cement: ASTM C150/C150M, Type I or Type II.
2. Aggregate: ASTM C33/C33M, Size 7.
3. Fly Ash (Pozzolan): ASTM C618, Class C.
4. Water: Clean, potable, containing less than 500 ppm of chlorides.

2.07 TOPSOIL

A. As specified in Section 32 91 13, Soil Preparation.

2.08 SOURCE QUALITY CONTROL

A. Perform gradation analysis in accordance with ASTM C136 for:

1. Earth backfill, including specified class.
2. Trench stabilization material.
3. Bedding and pipe zone material.

B. Certify Laboratory Performance of Mix Designs:

1. Controlled low strength material.
2. Concrete.

PART 3 EXECUTION

3.01 TRENCH PREPARATION

A. Water Control:

1. Promptly remove and dispose of water entering trench as necessary to grade trench bottom and to compact backfill and install manholes, pipe, or box culverts. Do not place concrete, lay pipe or box culvert.
2. Remove water in a manner that minimizes soil erosion from trench sides and bottom.
3. Provide continuous water control until trench backfill is complete.

B. Remove foreign material and backfill contaminated with foreign material that falls into trench.

3.02 TRENCH BOTTOM

A. Firm Subgrade: Grade with hand tools, remove loose and disturbed material, and trim off high areas and ridges left by excavating bucket teeth. Allow space for bedding material if shown or specified.

B. Soft Subgrade: If subgrade is encountered that may require removal to prevent pipe settlement, notify Engineer. Engineer will determine depth of over excavation, if any required.

3.03 GEOTEXTILE INSTALLATION

A. Where shown and as specified in Section 31 32 19.16, Geotextile, except as follows:

1. Extend geotextile for full width of trench bottom and up the trench wall to the top of the pipe zone, or base material for manholes and miscellaneous structures.
2. Anchor geotextile trench walls prior to placing trench stabilization or bedding material.
3. Provide 24-inch minimum overlap at joints.

3.04 TRENCH STABILIZATION MATERIAL INSTALLATION

A. Rebuild trench bottom with trench stabilization material.

B. Place material over full width of trench in 6-inch lifts to required grade, providing allowance for bedding thickness.

C. Compact each lift so as to provide a firm, unyielding support for the bedding material prior to placing succeeding lifts.

3.05 BEDDING

A. Furnish imported bedding material where, in the opinion of Engineer, excavated material is unsuitable for bedding or insufficient in quantity.

B. Place over full width of prepared trench bottom in two equal lifts when required depth exceeds 8 inches.

C. Hand grade and compact each lift to provide a firm, unyielding surface.

D. Minimum Thickness: As follows, except increase depths listed by 2 inches in areas of rock excavation: 4 inches.

1. Pipe 18 Inches to 36 Inches: 6 inches.
2. Pipe 42 Inches and Larger: 8 inches.

E. Check grade and correct irregularities in bedding material. Loosen top 1 inch to 2 inches of compacted bedding material with a rake or by other means to provide a cushion before laying each section of pipe, conduit, direct-buried cable, or duct bank.

F. Install to form continuous and uniform support except at bell holes, if applicable, or minor disturbances resulting from removal of lifting tackle.

G. Bell or Coupling Holes: Excavate in bedding at each joint to permit proper assembly and inspection of joint and to provide uniform bearing along barrel of pipe or conduit.

3.06 BACKFILL PIPE ZONE

A. Upper limit of pipe zone shall not be less than following:

1. Pipe: 12 inches, unless shown otherwise.

B. Restrain pipe, conduit, cables, and duct banks as necessary to prevent their movement during backfill operations.

C. Place material simultaneously in lifts on both sides of pipe and, if applicable, between pipes, conduit, cables, and duct banks installed in same trench.

1. Pipe 10-Inch and Smaller Diameter: First lift less than or equal to 1/2 pipe diameter.
2. Pipe Over 10-Inch Diameter: Maximum 6-inch lifts.

D. Thoroughly tamp each lift, including area under haunches, with handheld tamping bars supplemented by “walking in” and slicing material under haunches with a shovel to ensure voids are completely filled before placing each succeeding lift.

E. Do not use power-driven impact compactors to compact pipe zone material. After full depth of pipe zone material has been placed as specified, compact material by a minimum of three passes with a vibratory plate compactor only over area between sides of pipe and trench walls.

3.07 BACKFILL ABOVE PIPE ZONE

A. General:

1. Process excavated material to meet specified gradation requirements.
2. Adjust moisture content as necessary to obtain specified compaction.
3. Do not allow backfill to free fall into trench or allow heavy, sharp pieces of material to be placed as backfill until after at least 2 feet of backfill has been provided over top of pipe.

4. Do not use power driven impact type compactors for compaction until at least 4 feet of backfill is placed over top of pipe.
5. Backfill to grade with proper allowances for topsoil, crushed rock surfacing, and pavement thicknesses, wherever applicable.
6. Backfill around structures with same class backfill as specified for adjacent trench, unless otherwise shown or specified.

B. Class A Backfill:

1. Place in lifts not exceeding thickness of 9 inches.
2. Mechanically compact each lift to a minimum of 98 percent relative compaction.

C. Class A Backfill:

1. Place in lifts of suitable thickness.
2. Mechanically compact each lift prior to placing succeeding lifts.
3. Determine proper lift thickness, type of compaction equipment, method to use, and amount of compaction necessary to prevent settlement.

D. Concrete Backfill:

1. Place above bedding.
2. Minimum Concrete Thickness: 6 inches on top and sides of pipe.
3. Do not allow dirt or foreign material to become mixed with concrete during placement.
4. Allow sufficient time for concrete to reach initial set before additional backfill material is placed in trench.
5. Prevent flotation of pipe.
6. Begin and end concrete backfill within 4 inches of a pipe joint on each end.
7. Do not encase pipe joints except within the limits of the concrete backfill.

E. Controlled Low Strength Material:

1. Discharge from truck mounted drum type mixer into trench.
2. Place in lifts as necessary to prevent uplift (flotation) of new and existing facilities.
3. In traveled areas fill entire trench section to pavement finish grade for a temporary driving surface, and screed off excess and finish with a float.

3.08 REPLACEMENT OF TOPSOIL

A. Replace topsoil in top 6 inches of backfilled trench.

B. Maintain finished grade of topsoil even with adjacent area and grade as necessary to restore drainage.

3.09 MAINTENANCE OF TRENCH BACKFILL

A. After each section of trench is backfilled, maintain surface of backfilled trench even with adjacent ground surface until final surface restoration is completed.

B. Gravel Surfacing Rock: Add gravel surfacing rock where applicable and as necessary to keep surface of backfilled trench even with adjacent ground surface, and grade and compact as necessary to keep surface of backfilled trenches smooth, free from ruts and potholes, and suitable for normal traffic flow.

C. Topsoil: Add topsoil where applicable and as necessary to maintain surface of backfilled trench level with adjacent ground surface.

D. Other Areas: Add excavated material where applicable and keep surface of backfilled trench level with adjacent ground surface.

3.10 SETTLEMENT OF BACKFILL

A. Settlement of trench backfill, or of fill, or facilities constructed over trench backfill will be considered a result of defective compaction of trench backfill.

END OF SECTION

SECTION 31 32 19.16
GEOTEXTILE

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards that may be referenced in this section:

1. ASTM International (ASTM):
   a. D737, Standard Test Method for Air Permeability of Textile Fabrics.
   b. D4355, Standard Test Method for Deterioration of Geotextiles by Exposure to Light, Moisture and Heat in a Xenon Arc Type Apparatus.
   c. D4491, Standard Test Methods for Water Permeability of Geotextiles by Permittivity.
   d. D4533, Standard Test Method for Trapezoid Tearing Strength of Geotextiles.
   e. D4595, Standard Test Method for Tensile Properties of Geotextiles by the Wide-Width Strip Method.
   f. D4632, Standard Test Method for Grab Breaking Load and Elongation of Geotextiles.
   g. D4716, Test Method for Determining the (In-Plane) Flow Rate per Unit Width and Hydraulic Transmissivity of a Geosynthetic Using a Constant Head.
   h. D4751, Standard Test Method for Determining Apparent Opening Size of a Geotextile.
   i. D4833, Standard Test Method for Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products.
   j. D4884, Standard Test Method for Strength of Sewn or Thermally Bonded Seams of Geotextiles.
   k. D4886, Standard Test Method for Abrasion Resistance of Geotextiles (Sand Paper/Sliding Block Method).
   l. D5199, Standard Test Method for Measuring the Nominal Thickness of Geosynthetics.
   m. D5261, Standard Test Method for Measuring Mass per Unit Area of Geotextiles.
   n. D6193, Standard Practice for Stitches and Seams.

1.02 DEFINITIONS

A. Fabric: Geotextile, a permeable geosynthetic comprised solely of textiles.

B. Maximum Average Roll Value (MaxARV): Maximum of series of average roll values representative of geotextile furnished.

C. Minimum Average Roll Value (MinARV): Minimum of series of average roll values representative of geotextile furnished.

D. Nondestructive Sample: Sample representative of finished Work, prepared for testing without destruction of Work.

E. Overlap: Distance measured perpendicular from overlapping edge of one sheet to underlying edge of adjacent sheet.

F. Seam Efficiency: Ratio of tensile strength across seam to strength of intact geotextile, when tested according to ASTM D4884.

1.03 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. Manufacturer material specifications and product literature.
   b. Installation drawings showing geotextile sheet layout, location of seams, direction of overlap, and sewn seams.
   c. Description of proposed method of geotextile deployment, sewing equipment, sewing methods, and provisions for holding geotextile temporarily in place until permanently secured.
2. Samples:
   a. Geotextile: One-piece, minimum 18 inches long, taken across full width of roll of each type and weight of geotextile furnished for Project. Label each with brand name and furnish documentation of lot and roll number from which each Sample was obtained.
   b. Field Sewn Seam: 5-foot length of seam, 12 inches wide with seam along center, for each type and weight of geotextile.
   c. Securing Pin and Washer: One each.

B. Informational Submittals:

1. Certifications from each geotextile manufacturer that furnished products have specified property values. Certified property values shall be either minimum or maximum average roll values, as appropriate, for geotextiles furnished.
2. Field seam efficiency test results.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Deliver each roll with sufficient information attached to identify it for inventory and quality control.

B. Handle products in manner that maintains undamaged condition.

C. Do not store products directly on ground. Ship and store geotextile with suitable wrapping for protection against moisture and ultraviolet exposure. Store geotextile in way that protects it from elements. If stored outdoors, elevate and protect geotextile with waterproof cover.

1.05 SCHEDULING AND SEQUENCING

A. Where geotextile is to be laid directly upon ground surface, prepare subgrade as specified in Section 31 23 13, Subgrade Preparation, first.

B. Notify Engineer whenever geotextiles are to be placed. Do not place geotextile without Engineer's approval of underlying materials.

PART 2 PRODUCTS

2.01 WOVEN GEOTEXTILE

A. Composed of polymeric yarn interlaced to form planar structure with uniform weave pattern.

B. Calendared or finished so yarns will retain their relative position with respect to each other.

C. Polymeric Yarn: Long-chain synthetic polymers (polyester or polypropylene) with stabilizers or inhibitors added to make filaments resistant to deterioration due to heat and ultraviolet light exposure.

D. Sheet Edges: Salvaged or finished to prevent outer material from separating from sheet.

E. Unseamed Sheet Width: Minimum 6 feet.

F. Nominal Weight per Square Yard: 4 ounce per ASTM D5261.

G. Physical Properties: Conform to requirements in Table No. 1.

Table No. 1
Physical Property Requirements for Woven Geotextile

Property	Requirement	Test Method
Apparent Opening Size (AOS)	40 U.S. Standard Sieve Size	ASTM D4751
Water Permittivity	0,05 $sec.^{-1}$, MinARV	ASTM D4491 (Falling Head)
Vertical Waterflow Rate	200 gpm/sq ft, MinARV	ASTM D4491 (Falling Head)

Table No. 1 Physical Property Requirements for Woven Geotextile		
Property	**Requirement**	**Test Method**
Grab Tensile Strength	200 lb, MinARV	ASTM D4632
Grab Elongation	15 percent, MaxARV	ASTM D4632
Trapezoidal Tear Strength	50 lb, MinARV	ASTM D4533
Puncture Strength	310 lb, MinARV	ASTM D4833
Ultraviolet Radiation Resistance	70 percent strength retention, MinARV after 500 hours	ASTM D4355

2.02 NONWOVEN GEOTEXTILE

A. Pervious sheet of polyester, polypropylene, or polyethylene fabricated into stable network of fibers that retain their relative position with respect to each other. Nonwoven geotextile shall be composed of continuous or discontinuous (staple) fibers held together through needle-punching, spun-bonding, thermal-bonding, or resin-bonding.

B. Geotextile Edges: Salvaged or otherwise finished to prevent outer material from pulling away from geotextile.

C. Unseamed Sheet Width: Minimum 6 feet.

D. Nominal Weight per Square Yard: 4 ounce per ASTM D5261.

E. Nominal Thickness (mils): 1.0 per ASTM D5199.

F. Physical Properties: Conform to requirements in Table No. 2.

Table No. 2 Physical Property Requirements for Nonwoven Geotextile		
Property	**Requirement**	**Test Method**
Water Permittivity	1.7 $sec.^{-1}$, MinARV	ASTM D4491 (Falling Head)
Apparent Opening Size (AOS)	70 U.S. Standard Sieve Size	ASTM D4751
Grab Tensile Strength, Machine Direction	120 lb/in, MinARV	ASTM D4632
Grab Elongation, Machine Direction	50 percent, MaxARV	ASTM D4632
Puncture Strength	310 lb, MinARV	ASTM D4833
Trapezoid Tear Strength	50 lb, MinARV	ASTM D4533
Ultraviolet Radiation Resistance	70 percent strength retention, MinARV after 500 hours	ASTM D4355

2.03 SEWING THREAD

A. Polypropylene, polyester, or Kevlar thread.

B. Durability: Equal to or greater than durability of geotextile sewn.

2.04 SECURING PINS

A. Steel Rods or Bars:

1. 3/16-inch diameter.
2. Pointed at one end.
3. With head on other end sufficiently large to retain washer.
4. Minimum Length: 12 inches.

B. Steel Washers for Securing Pins:

1. Outside Diameter: Not less than 1.5 inches.
2. Inside Diameter: 1/4 inch.
3. Thickness: 1/8 inch.

C. Steel Wire Staples:

1. U-shaped.
2. 10 gauge.
3. Minimum Length: 6 inches.

PART 3 EXECUTION

3.01 LAYING GEOTEXTILE

A. Lay and maintain geotextile smooth and free of tension, folds, wrinkles, or creases.

3.02 SHEET ORIENTATION ON SLOPES

A. Orient geotextile with long dimension of each sheet parallel to direction of slope.

B. Geotextile may be oriented with long dimension of sheet transverse to direction of slope only if sheet width, without unsewn seams, is sufficient to cover entire slope and anchor trench and to extend at least 18 inches beyond toe of slope.

3.03 JOINTS

A. Unseamed Joints:

1. Overlapped.
2. Overlap, unless otherwise shown:
    a. Foundation/Subgrade Stabilization: Minimum 18 inches.
    b. Riprap: Minimum 18 inches.
    c. Drain Trenches: Minimum 18 inches, except overlap shall equal trench width if trench width is less than 18 inches.
    d. Other Applications: Minimum 12 inches.

B. Sewn Seams: Made wherever stress transfer from one geotextile sheet to another is necessary. Sewn seams, as approved by Engineer, also may be used instead of overlap at joints for applications that do not require stress transfer.

1. Seam Efficiency:
    a. Minimum 70 percent.
    b. Verified by preparing and testing minimum of one set of nondestructive Samples per acre of each type and weight of geotextile installed.
    c. Tested according to ASTM D4884.
2. Types:
    a. Preferred: “J” type seams.
    b. Acceptable: Flat or butterfly seams.
3. Stitch Count: Minimum three to maximum seven stitches per inch.
4. Stitch Type: Double-thread chainstitch according to ASTM D6193.
5. Sewing Machines: Capable of penetrating four layers of geotextile.
6. Stitch Location: 2 inches from geotextile sheet edges, or more, if necessary to develop required seam strength.

3.04 SECURING GEOTEXTILE

A. Secure geotextile during installation as necessary with sandbags or other means approved by Engineer.

B. Secure Geotextile with Securing Pins or Staples:

1. Insert securing pins with washers through geotextile.
2. Securing Pin Alignment:
    a. Midway between edges of overlaps.
    b. 6 inches from free edges.

3. Spacing of Securing Pins:

Slope	Maximum Pin Spacing
Steeper than 3:1	2 feet
3:1 to 4:1	3 feet
Flatter than 4:1	5 feet

4. Install additional pins across each geotextile sheet as necessary to prevent slippage of geotextile or to prevent wind from blowing geotextile out of position.
5. Push each securing pin through geotextile until washer bears against geotextile and secures it firmly to subgrade.
6. Where staples are used instead of securing pins, install in accordance with alignment and spacing above. Push in to secure geotextile firmly to subgrade.

3.05 PLACING PRODUCTS OVER GEOTEXTILE

A. Before placing material over geotextile, notify Engineer. Do not cover installed geotextile until after Engineer provides authorization to proceed.

B. If tears, punctures, or other geotextile damage occurs during placement of overlying products, remove overlying products as necessary to expose damaged geotextile. Repair damage as specified in Article Repairing Geotextile.

3.06 INSTALLING GEOTEXTILE IN TRENCHES

A. Place geotextile in a way to completely envelope granular drain material to be placed in trench and with specified overlap at joints. Overlap geotextile in direction of flow. Place geotextile in a way and with sufficient slack for geotextile to contact trench bottom and sides fully when trench is backfilled.

B. After granular drain material is placed to required grade, fold geotextile over top of granular drain material, unless otherwise shown. Maintain overlap until overlying fill or backfill is placed.

3.07 RIPRAP APPLICATIONS

A. Overlap geotextile at each joint with upstream sheet of geotextile overlapping downstream sheet.

B. Sew joints where wave run-up may occur.

C. Limit height of riprap fall onto geotextile to prevent damage.

1. Drop Height: 3 feet for less than 200-pound rock.

3.08 GEOTEXTILE-REINFORCED EARTH WALL APPLICATIONS

A. Sew exposed joints; extend sewn seams minimum 3 feet behind face of wall.

B. Protect exposed geotextile from damage, ultraviolet light exposure, and deterioration until permanent facing is applied.

3.09 SILT FENCE APPLICATIONS

A. Install geotextile in one piece, or continuously sewn to make one piece, for full length and height of fence, including portion of geotextile buried in toe trench.

B. Install bottom edge of sheet in toe trench and backfill in a way that securely anchors geotextile in trench.

C. Securely fasten geotextile to wire mesh backing and each support post in a way that will not result in tearing of geotextile when fence is subjected to service loads.

D. Promptly repair or replace silt fence that becomes damaged.

3.10 REPAIRING GEOTEXTILE

A. Repair or replace torn, punctured, flawed, deteriorated, or otherwise damaged geotextile.

B. Repair Procedure:

1. Place patch of undamaged geotextile over damaged area and at least 18 inches in all directions beyond damaged area.
2. Remove interfering material as necessary to expose damaged geotextile for repair.
3. Sew patches or secure them with heat fusion tacking or with pins and washers, as specified above in Article Securing Geotextile, or by other means approved by Engineer.

3.11 REPLACING CONTAMINATED GEOTEXTILE

A. Protect geotextile from contamination that would interfere, in Engineer’s opinion, with its intended function. Remove and replace contaminated geotextile with clean geotextile.

END OF SECTION

SECTION 31 37 00
RIPRAP

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. ASTM International (ASTM):
   a. C94/C94M, Standard Specification for Ready-Mixed Concrete.
   b. C136, Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
   c. C150, Standard Specification for Portland Cement.
   d. C535, Standard Test Method for Resistance to Degradation of Large-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.

1.02 DEFINITIONS

A. Refer to applicable definitions in Section 31 23 23, Fill and Backfill.

1.03 SUBMITTALS

A. Action Submittals:

1. Shop Drawings: Description and location of proposed sources of riprap bedding and riprap.

B. Informational Submittals:

1. Quarry Certificate of Conformance and supporting documentation showing proposed riprap bedding or riprap meet Standard Specification gradation and materials requirements for the Class or Type specified.
2. Certified Test Results:
   a. Riprap Bedding:
      1) Gradation.
      2) Abrasion resistance.
   b. Riprap:
      1) Gradation.
      2) Abrasion resistance.
      3) Bulk density.
3. Trip tickets showing source, type, and weight of each load of material delivered to Site.

1.04 QUALITY ASSURANCE

A. Riprap Source: Quarry that has produced riprap and has performed satisfactorily on other projects for at least 5 years.

B. Site Visit: Make arrangements for Engineer to visit quarry site to observe materials proposed for riprap and riprap bedding.

1.05 SCHEDULING AND SEQUENCING

A. Complete geotextile installation as specified in Section 31 32 19.16, Geotextile, prior to placing riprap bedding or riprap.

PART 2 PRODUCTS

2.01 AGGREGATE RIPRAP BEDDING

A. Gravel with Cobbles or Crushed Rock with Cobble-Sized Pieces:

1. Gradation, as determined in accordance with ASTM C136:
   a. Well-graded from coarse to fine.
   b. All pieces pass a 6-inch square opening.
   c. Minimum 85 percent by weight passes 4-inch square opening.
   d. Minimum 10 percent by weight passes No. 4 U.S. standard sieve.
2. Abrasion Resistance: Maximum 35 percent wear when tested in accordance with ASTM C535.

B. Free of roots and other organic or deleterious matter.

C. Onsite material from excavations or designated borrow sources that meets or is processed to meet requirements specified above may be used as riprap bedding in lieu of importing material.

2.02 GEOTEXTILE RIPRAP BEDDING

A. Bedding geotextile (woven) as specified in Section 31 32 19.16, Geotextile.

2.03 RIPRAP

A. Hard and durable quarry stone free from fractures, bedding planes, pronounced weathering, and earth or other adherent coatings.

B. Stone Rip Rap: Use sound, tough, durable stones resistant to the action of air and water. Slabby or shaley pieces will not be acceptable. Specific gravity shall be 2.0 or greater. Rip rap shall have less than 66 percent wear when tested in accordance with AASHTO T-96. Unless shown or specified otherwise, stone rip rap shall be Type 1 rip rap.

1. Type 1 Rip Rap: The largest pieces shall have a maximum volume of two cubic feet. At least 35 percent of the mass shall be comprised of pieces which weigh 125 pounds or more. The remainder shall be well graded down to the finest sizes. Rock fines shall comprise a maximum of 10 percent of the total mass. Rock fines are defined as material passing a No. 4 sieve. Rip rap size shall conform to Georgia Department of Transportation Section 805.01 Stone Dumped Rip Rap, Type 1.
2. Type 3 Rip Rap: The largest pieces shall have a maximum approximate volume of one cubic foot. At least 35 percent of the mass shall be comprised of pieces which weigh 15 pounds or more. The remainder shall be well graded down to the finest sizes. Rock fines shall comprise a maximum of 10 percent of the total mass. Rock fines are defined as material passing a No. 4 sieve. Rip rap size shall conform to Georgia Department of Transportation Section 805.01 Stone Dumped Rip Rap, Type 3.

PART 3 EXECUTION

3.01 PLACING RIPRAP BEDDING

A. Where shown or required, place riprap bedding over prepared subgrade or geotextile to lines and grades shown.

B. No mechanical compaction of riprap bedding is required; however, work riprap bedding as necessary to distribute it and to eliminate detrimental voids. Avoid overworking or long pushes that result in segregation of particle sizes.

C. Grade surface of riprap bedding free from irregularities and to tolerances of 0.2 feet from established grade.

D. Place and grade riprap bedding in a manner that avoids subgrade disturbance and displacement or damage to geotextile. Do not push riprap bedding down slope. If wrinkles form in geotextile as riprap bedding is placed, correct them as specified in Section 31 32 19.16, Geotextile.

E. Place riprap bedding on geotextile without puncturing or damaging geotextile. If accidentally damaged, repair geotextile prior to proceeding.

3.02 PLACING RIPRAP ON RIPRAP BEDDING

A. Place riprap over riprap bedding to uniform thickness shown. If riprap bedding is underlain with geotextile, place riprap from bottom to top of slope.

B. Intermix different sizes of pieces to eliminate segregation and to fill voids between larger pieces with smaller pieces and work surface free from irregularities.

C. Use placement and intermixing methods that avoid disturbing prepared subgrade riprap bedding and underlying geotextile or damaging existing facilities, completed Work, or adjacent property.

END OF SECTION

SECTION 31 41 00
SHORING

PART 1 GENERAL

1.01 SUBMITTALS

A. Informational Submittals:

1. Excavation support plan.
2. Movement monitoring plan.
3. Trench excavation plan.
4. Movement measurement and data and reduced results indicating movement trends.

1.02 QUALITY ASSURANCE

A. Provide surveys to monitor movements of critical facilities.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 GENERAL

A. Design, provide, and maintain shoring, sheeting, and bracing as necessary to support the sides of excavations and to prevent detrimental settlement and lateral movement of existing facilities, adjacent property, and completed the Work.

3.02 EXCAVATION SUPPORT PLAN

A. Prepare excavation support plan addressing following topics:

1. Details of shoring, bracing, sloping, or other provisions for worker protection from hazards of caving ground.
2. Design assumptions and calculations.
3. Methods and sequencing of installing excavation support.
4. Proposed locations of stockpiled excavated material.
5. Minimum lateral distance from the crest of slopes for vehicles and stockpiled excavated materials.
6. Anticipated difficulties and proposed resolutions.

3.03 MOVEMENT MONITORING PLAN

A. Prepare movement monitoring plan addressing following topics:

1. Survey control.
2. Location of monitoring points.
3. Plots of data trends.
4. Interval between surveys.

3.04 REMOVAL OF EXCAVATION SUPPORT

A. Remove excavation support in a manner that will maintain support as excavation is backfilled.

B. Do not begin to remove excavation support until support can be removed without damage to existing facilities, completed Work, or adjacent property.

C. Remove excavation support in a manner that does not leave voids in the backfill.

3.05 TRENCHES

A. Provide trench excavations exceeding 4 feet in depth with adequate safety systems meeting the requirements of the Washington Industrial Safety and Health Act, Chapter 49.17 RCW.

B. For trench excavation exceeding 5 feet in depth, provide adequate safety system meeting requirements of California Labor Code Section 6707, applicable local construction safety orders, and federal requirements.

C. For trench excavation exceeding 5 feet in depth, provide adequate safety system meeting requirements of applicable state and local construction safety orders, and federal requirements.

END OF SECTION

SECTION 32 31 19
ORNAMENTAL STEEL FENCE SYSTEM

PART 1 GENERAL

1.01 WORK INCLUDED

A. The Contractor shall provide all labor, materials and appurtenances necessary for installation of the welded ornamental steel fence system defined herein at the Tara Boulevard Storm Drainage Rehabilitation Site at 8405 Tara Boulevard, Jonesboro, GA 30236.

1.02 RELATED WORK

A. Section 31 23 16, Excavation.

B. Section 03 30 10, Structural Concrete.

1.03 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. ASTM International (ASTM):
   a. A653/A653M, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy Coated (Galvannealed) by the Hot-Dip Process.
   b. B117, Practice for Operating Salt-Spray (Fog) Apparatus.
   c. D523, Test Method for Specular Gloss.
   d. D714, Test Method for Evaluating Degree of Blistering in Paint.
   e. D822, Practice for Conducting Tests on Paint and Related Coatings and Materials using Filtered Open-Flame Carbon-Arc Light and Water Exposure Apparatus.
   f. D1654, Test Method for Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments.
   g. D2244, Test Method for Calculation of Color Differences from Instrumentally Measured Color Coordinates.
   h. D2794, Test Method for Resistance of Organic Coatings to the Effects of Rapid Deformation (Impact).
   i. D3359, Test Method for Measuring Adhesion by Tape Test.
   j. F2408, Ornamental Fences Employing Galvanized Steel Tubular Pickets.

1.04 SUBMITTAL

A. The manufacturer’s literature shall be submitted prior to installation.

1.05 QUALITY ASSURANCE

A. The Contractor shall provide laborers and supervisors who are thoroughly familiar with the type of construction involved and materials and techniques specified.

1.06 PRODUCT HANDLING AND STORAGE

A. Upon receipt at the Job Site, all materials shall be checked to ensure that no damage occurred during shipping or handling. Materials shall be stored in such a manner to ensure proper ventilation and drainage, and to protect against damage, weather, vandalism and theft.

1.07 PRODUCT WARRANTY

A. All structural fence components (i.e. rails, pickets, and posts) shall be warranted within specified limitations, by the manufacturer for a period of 20 years from date of original purchase. Warranty shall cover any defects in material finish, including cracking, peeling, chipping, blistering or corroding.

B. Reimbursement for labor necessary to restore or replace components that have been found to be defective under the terms of manufactures warranty shall be guaranteed for 5 years from date of original purchase.

PART 2 PRODUCTS

2.01 MANUFACTURER

A. The ornamental steel fence system shall be equal to Montage Industrial (Classic) by Ameristar Fence Products, Inc.

2.02 MATERIAL

A. Steel material for fence panels and posts shall conform to the requirements of ASTM A653/A653M, with a minimum yield strength of 45,000 psi (344 MPa) and a minimum zinc (hot-dip galvanized) coating weight of 0.60 oz/ft^2 (184 g/m^2), Coating Designation G-60.

B. Material for pickets shall be 1-inch square by 16 Ga. tubing. The rails shall be steel channel, 1.75-inch by 1.75-inch by 105-inch. Picket holes in the rail shall be spaced 4.715 inches o.c. Fence posts and gate posts shall meet the minimum size requirements as follows:

1. Fence Post for 6-foot Fence Panel – 2-1/2 inches (14 gauge).
2. Gate Post for 6-foot - 0-inches gate height – 4 inches (11 gauge).

2.03 FABRICATION

A. Pickets, rails and posts shall be pre-cut to specified lengths. Rails shall be pre-punched to accept pickets.

B. Pickets shall be inserted into the pre-punched holes in the rails and shall be aligned to standard spacing using a specially calibrated alignment fixture. The aligned pickets and rails shall be joined at each picket-to-rail intersection by Ameristar's proprietary fusion welding process, thus completing the rigid panel assembly (Note: The process produces a virtually seamless, spatter-free good-neighbor appearance, equally attractive from either side of the panel).

C. The manufactured panels and posts shall be subjected to an inline electrodeposition coating (E-Coat) process consisting of a multi-stage pretreatment/wash, followed by a duplex application of an epoxy primer and an acrylic topcoat. The minimum cumulative coating thickness of epoxy and acrylic shall be 2 mils. The color shall be Black. The coated panels and posts shall be capable of meeting the performance requirements for each quality characteristic shown in Table 1 below.

Table 1
Coating Performance Requirements

Quality Characteristics	ASTM Test Method	Performance Requirements
Adhesion	D3359 – Method B	Adhesion (Retention of Coating) over 90% of test area (Tape and knife test).
Corrosion Resistance	B117, D714 and D1654	Corrosion Resistance over 1,500 hours (Scribed per ASTM D1654; failure mode is accumulation of 1/8" coating loss from scribe or medium No. 8 blisters).
Impact Resistance	D2794	Impact Resistance over 60 inch lb. (Forward impact using 0.625" ball).
Weathering Resistance	D822 D2244, D523 (60˚ Method)	Weathering Resistance over 1,000 hours (Failure mode is 60% loss of gloss or color variance of more than 3 delta-E color units).

D. The manufactured fence system shall be capable of meeting the vertical load, horizontal load, and infill performance requirements for Industrial weight fences under ASTM F2408.

E. Swing gates shall be fabricated using 1.75-inch by 14 Ga. Forerunner double channel rail, 2-inch sq by 12 Ga. gate ends, and 1-inch sq by 14 Ga. pickets. Gates that exceed 6 feet in width will have a 1.75-inch sq by 14 Ga. intermediate upright. All rail and upright intersections shall be joined by welding. All picket and rail intersections shall also be joined by welding. Gusset plates will be welded at each upright to rail intersection. Cable kits will be provided for additional trussing for all gates leaves over 6 feet.

PART 3 EXECUTION

3.01 PREPARATION

A. All new installation shall be laid out by the Contractor in accordance with the construction plans.

3.02 FENCE INSTALLATION

A. Fence posts shall be spaced at approximately 8 feet – 0 inches. Actual spacing will be dependent on manufacturer's fence panel dimensions and brackets required. For installations that must be raked to follow sloping grades, the post spacing dimension must be measured along the grade. Fence panels shall be attached to posts with brackets supplied by the manufacturer. Posts shall be set in concrete footers having a minimum depth of 36 inches. Posts setting by other methods such as plated posts or grouted core-drilled footers are permissible only if shown by engineering analysis to be sufficient in strength for the intended application.

3.03 FENCE INSTALLATION MAINTENANCE

A. When cutting/drilling rails or posts adhere to the following steps to seal the exposed steel surfaces; 1) Remove all metal shavings from cut area. 2) Apply zinc-rich primer to thoroughly cover cut edge and/or drilled hole; let dry. 3) Apply 2 coats of custom finish paint matching fence color. Failure to seal exposed surfaces per steps 1-3 above will negate warranty. Ameristar spray cans or paint pens shall be used to prime and finish exposed surfaces; it is recommended that paint pens be used to prevent overspray. Use of non-Ameristar parts or components will negate the manufactures' warranty.

3.04 GATE INSTALLATION

A. Gate posts shall be spaced according to the manufacturers' gate drawings, dependent on standard out-to-out gate leaf dimensions and gate hardware selected. Type and quantity of gate hinges shall be based on the application, weight, height, and number of gate cycles. The manufacturers' gate drawings shall identify the necessary gate hardware required for the application. Gate hardware shall be provided by the manufacturer of the gate and shall be installed per manufacturer's recommendations.

3.05 CLEANING

A. The Contractor shall clean the Job Site of excess materials; post-hole excavations shall be scattered uniformly away from posts.

END OF SECTION

SECTION 32 91 13
SOIL PREPARATION

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. ASTM International (ASTM):
   a. C33/C33M, Standard Specification for Concrete Aggregates.
   b. C602, Standard Specification for Agricultural Liming Materials.
   c. D2974, Standard Test Methods for Moisture, Ash, and Organic Matter of Peat and Other Organic Soils.
   d. D5268, Standard Specification for Topsoil Used for Landscaping Purposes.

1.02 SUBMITTALS

A. Informational Submittals:

1. Certified Topsoil Analysis Reports:
   a. Indicate quantities of materials necessary to bring onsite or imported topsoil into compliance with textural/gradation requirements.
   b. Indicate quantity of lime, quantity and analysis of fertilizer, and quantity and type of soil additive.

1.03 SEQUENCING AND SCHEDULING

A. Perform Work specified in Section 31 10 00, Site Clearing, prior to performing Work specified under this section.

PART 2 PRODUCTS

2.01 TOPSOIL

A. General: Natural, friable, sandy loam, obtained from well-drained areas, free from objects larger than 1-1/2 inches maximum dimension, and free of subsoil, roots, grass, other foreign matter, hazardous or toxic substances, and deleterious material that may be harmful to plant growth or may hinder grading, planting, or maintenance.

B. Composition: In general accordance with ASTM D5268:

1. Gravel-Sized Fraction: Maximum 5 percent by weight retained on a No. 10 sieve.
2. Sand-Sized Fraction: Minimum 20 to 60 percent passing No. 10 sieve.
3. Silt and Clay-Sized Fraction: Minimum 35 to 70 percent.

C. Organic Matter: Minimum 1.5 percent by dry weight as determined in accordance with ASTM D2974.

D. pH: Range 5.0 to 7.0.

E. Textural Amendments: Amend as necessary to conform to required composition by incorporating sand, peat, manure, or sawdust.

F. Source: Stockpile material onsite, in accordance with Section 31 10 00, Site Clearing. Import topsoil if onsite material is insufficient in quantity.

2.02 LIME

A. Composition: Ground limestone with not less than 85 percent total carbonates, ASTM C602.

B. Gradation:

1. Minimum 50 percent passing No. 100 sieve.
2. Minimum 90 percent passing No. 20 sieve.
3. Coarser material acceptable provided rates of application are increased proportionately on basis of quantities passing No. 100 sieve.

2.03 SOIL ADDITIVES

A. Sawdust or Ground Bark:

1. Nontoxic, of uniform texture, and subject to slow decomposition when mixed with soil.
2. Nitrogen-treated, or if untreated mix with minimum 0.15 pound of ammonium nitrate or 0.25 pound of ammonium sulfate per cubic foot of loose material.

B. Peat:

1. Composition: Natural residue formed by decomposition of reeds, sedges, or mosses in a freshwater environment, free from lumps, roots, and stones.
    a. Organic Matter: Not less than 90 percent on a dry weight basis as determined by ASTM D2974.

b. Moisture Content: Maximum 65 percent by weight at time of delivery.

C. Fertilizer: As shown on the Drawings.

D. Sand: Fine Aggregate: Clean, coarse, well-graded, ASTM C33/C33M.

2.04 SOURCE QUALITY CONTROL

A. Topsoil Analysis/Testing: Performed by county or state soil testing service or approved certified independent testing laboratory.

PART 3 EXECUTION

3.01 SUBGRADE PREPARATION

A. Apply lime at the rate of 50 pounds per 1,000 square feet to subgrade before tilling.

B. Scarify subgrade to minimum depth of 6 inches where topsoil is to be placed.

C. Remove stones over 2-1/2 inches in any dimension, sticks, roots, rubbish, and other extraneous material.

D. Limit preparation to areas which will receive topsoil within 2 days after preparation.

3.02 TOPSOIL PLACEMENT

A. Do not place topsoil when subsoil or topsoil is frozen, excessively wet, or otherwise detrimental to the Work.

B. Mix soil amendments, lime, and other soil additives, identified in analysis reports with topsoil before placement or spread on topsoil surface and mix thoroughly into entire depth of topsoil before planting or seeding. Delay mixing of fertilizer if planting or seeding will not occur within 3 days.

C. Place one-half of the total depth of topsoil and work into top 4 inches of subgrade soil to create a transition layer. Place remainder of topsoil to depth of 6 inches where seeding and planting are scheduled.

D. Uniformly distribute to within 1/2 inch of final grades. Fine grade topsoil eliminating rough or low areas and maintaining levels, profiles, and contours of subgrade.

E. Remove stones exceeding 1-1/2-inch diameter, roots, sticks, debris, and foreign matter during and after topsoil placement.

F. Remove surplus subsoil and topsoil from Site. Grade stockpile area as necessary and place in condition acceptable for planting or seeding.

END OF SECTION

SECTION 32 92 00
TURF AND GRASSES

PART 1 GENERAL

1.01 DEFINITIONS

A. Maintenance Period: Begin maintenance immediately after each area is planted (seed, sod, or sprig) and continue for a period of 52 weeks after all planting under this section is completed.

B. Satisfactory Stand: Grass that has:

1. No bare spots larger than 3 square feet.
2. Not more than 10 percent of total area with bare spots larger than 1 square foot.
3. Not more than 15 percent of total area with bare spots larger than 6 square inches.

1.02 SUBMITTALS

A. Action Submittals: Product labels/data sheets.

B. Informational Submittals:

1. Seed: Certification of seed analysis, germination rate, and inoculation:
   a. Certify that each lot of seed has been tested by a testing laboratory certified in seed testing, within 6 months of date of delivery. Include with certification:
      1) Name and address of laboratory.
      2) Date of test.
      3) Lot number for each seed specified.
      4) Test Results: (i) name, (ii) percentages of purity and of germination, and (iii) weed content for each kind of seed furnished.
   b. Mixtures: Proportions of each kind of seed.
2. Seed Inoculant Certification: Bacteria prepared specifically for legume species to be inoculated.
3. Certification of sod; include source and harvest date of sod, and sod seed mix.
4. Certification of sprig type and name.
5. Description of required maintenance activities and activity frequency.

1.03 DELIVERY, STORAGE, AND PROTECTION

A. Seed:

1. Furnish in standard containers with seed name, lot number, net weight, percentages of purity, germination, and hard seed and maximum weed seed content, clearly marked for each container of seed.
2. Keep dry during storage.

B. Hydroseeding Mulch: Mark package of wood fiber mulch to show air dry weight.

1.04 WEATHER RESTRICTIONS

A. Perform Work under favorable weather and soil moisture conditions as determined by accepted local practice.

1.05 SEQUENCING AND SCHEDULING

A. Complete Work and prepare topsoil as specified in Section 32 91 13, Soil Preparation, before starting Work of this section.

B. Complete Work under this section within 3 days following completion of soil preparation.

C. Notify Engineer at least 7 days in advance of:

1. Each material delivery.
2. Start of planting activity.

D. Planting Season: Between March 15 and September 15.

1.06 MAINTENANCE SERVICE

A. Contractor: Perform maintenance operations during maintenance period to include:

1. Watering: Keep surface moist.
2. Washouts: Repair by filling with topsoil, liming, fertilizing, seeding, and mulching.
3. Mulch: Replace wherever and whenever washed or blown away.
4. Reseed unsatisfactory areas or portions thereof immediately at the end of the maintenance period if a satisfactory stand has not been produced.
5. Reseed/replant during next planting season if scheduled end of maintenance period falls after October 15.
6. Reseed/replant entire area if satisfactory stand does not develop by July 1 of the following year.

PART 2 PRODUCTS

2.01 FERTILIZER

A. Commercial, uniform in composition, free-flowing, suitable for application with equipment designed for that purpose. Minimum percentage of plant food by weight.

B. Application Rates: Determined by soil analysis results.

C. Mix:

1. Nitrogen: 10.
2. Phosphoric Acid: 10.
3. Potash: 10.
4. Bonemeal: Commercial, raw, finely ground, with minimum analysis of 4 percent nitrogen and 20 percent phosphoric acid.
5. Superphosphate: Soluble mixture of phosphate obtained from treated mineral phosphates with minimum analysis of 20 percent available phosphoric acid.

D. Top Dress Type: As recommended by local authority.

2.02 TEMPORARY SEED

Species	Rates per 1000 sq. ft.	Rates per Acre	Planting Date By Zone		
			1 & 2	2	3 & 4
Rye (Grain)	3.9 lbs	168 lbs	8/1 - 11/30	8/15 - 12/1	9/1 - 2/28
Ryegrass	0.9 lbs	40 lbs	8/1 - 11/30	9/1 - 12/15	9/15 - 1/1
Rye & Annual Lespedeza	0.6 lbs 0.6 lbs	28 lbs 24 lbs	3/1 - 4/1	2/1 - 3/1	2/1 - 3/1
Weeping Lovegrass	0.1 lbs	4 lbs	3/15 - 6/15	3/15 - 7/15	3/15 - 7/15
Sudangrass	1.0 lbs	60 lbs	4/1 - 8/31	4/1 - 8/31	3/15 - 8/1
Browntop Millet	1.1 lbs	50 lbs	4/1 - 6/30	4/1 - 7/15	4/1 - 7/15
Wheat	3.9 lbs	168 lbs	9/1 - 12/31	9/1 - 12/31	9/15 - 1/31

A. When stage construction or other conditions prevent installation of permanent plant material within 7 days of final grading, apply temporary grassing to control erosion. Temporary grassing is used to stabilize disturbed areas for more than 60 calendar days. Temporary grass may be applied any time of the year, utilizing the appropriate seed species and application rate as shown in the chart above. Apply mulch to areas planted in temporary grass at the rate of 3/4 inch to 1.5 inches. Do not place slope mats on areas planted in temporary grass.

2.03 PERMANENT SEED

A. Prepare seed and sow as follows: Inoculate each kind of leguminous seed separately with the appropriate commercial culture according to the manufacturer's instructions for the culture. When hydroseeding, double the inoculation rate. Protect inoculated seed from the sun and plant it the same day it is inoculated.

B. Weather permitting, sow seed within 24 hours after preparing the seed bed and applying the fertilizer and lime. Sow seed uniformly at the rates specified by the manufacturer. Use approved mechanical seed drills, rotary hand seeders, hydroseeding equipment, or other equipment to uniformly apply the seed. Do not distribute by hand. To distribute the seeds evenly sow seed types separately, except for similarly sized and weighted seeds. They may be mixed and sown together. Do not sow during windy weather, when the prepared surface is crusted, or when the ground is frozen, wet, or otherwise non-tillable.

2.04 STRAW MULCH

A. Threshed straw of oats, wheat, barley, or rye, free from (i) seed of noxious weeds or (ii) clean salt hay.

2.05 HYDROSEEDING MULCH

A. Wood Cellulose Fiber Mulch:

1. Specially processed wood fiber containing no growth or germination inhibiting factors.
2. Dyed a suitable color to facilitate inspection of material placement.
3. Manufactured such that after addition and agitation in slurry tanks with water, the material fibers will become uniformly suspended to form homogenous slurry.
4. When hydraulically sprayed on ground, material will allow absorption and percolation of moisture.

2.06 TACKIFIER

A. Derived from natural organic plant sources containing no growth or germination-inhibiting materials.

1. Capable of hydrating in water, and to readily blend with other slurry materials.
2. Wood Cellulose Fiber: Add as tracer, at rate of 150 pounds per acre.
3. Manufacturers and Products:
   a. Chevron Asphalt Co.; CSS 1.
   b. Terra; Tack AR.
   c. J Tack; Reclamare.

2.07 FENCE

A. 2-inch by 2-inch posts 4 feet high, spaced 10 feet on center, and strung with single strand of No. 12 gauge wire marked with cloth strips at 3-foot intervals.

2.08 WEED BARRIER

A. 6 mils (0.006 inch) black polyethylene sheet.

PART 3 EXECUTION

3.01 PREPARATION

A. Grade areas to smooth, even surface with loose, uniformly fine texture.

1. Roll and rake, remove ridges, fill depressions to meet finish grades.
2. Limit such Work to areas to be planted within immediate future.
3. Remove debris, and stones larger than 1-1/2-inch diameter, and other objects that may interfere with planting and maintenance operations.

B. Moisten prepared areas before planting if soil is dry. Water thoroughly and allow surface to dry off before seeding. Do not create muddy soil.

C. Restore prepared areas to specified condition if eroded or otherwise disturbed after preparation and before planting.

3.02 FERTILIZER

A. Apply evenly over area in accordance with manufacturer’s instructions. Mix into top 2 inches of topsoil, when applied by broad cast method.

3.03 SEEDING

A. Start within 2 days of preparation completion.

B. Hydroseed slopes steeper than 3H:1V Flatter slopes may be mechanically seeded.

C. Mechanical: Broadcast seed in two different directions, compact seeded area with cultipacter or roller.

1. Sow seed at uniform rate as specified by the manufacturer. Use Brillion type seeder.
2. Broadcasting will be allowed only in areas too small to use Brillion type seeder. Where seed is broadcast, increase seeding rate 20 percent.
3. Roll with ring roller to cover seed, and water with fine spray.

D. Hydroseeding:

1. Application Rate: As specified by the manufacturer.
2. Apply on moist soil, only after free surface water has drained away.
3. Prevent drift and displacement of mixture into other areas.
4. Upon application, allow absorption and percolation of moisture into ground.
5. Mixtures: Seed and fertilizer may be mixed together, apply within 30 minutes of mixing to prevent fertilizer from burning seed.

E. Cover Crop Seeding: Apply seed at rate of 120 pounds per acre to areas that are bare or incomplete after September 15.

F. Mulching: Apply uniform cover of straw mulch at a rate of 2 tons per acre.

G. Netting: Immediately after mulching, place over mulched areas with slopes steeper than 3:1, in accordance with manufacturer's instructions. Locate strips parallel to slope and completely cover seeded areas.

H. Tackifier: Apply over mulched areas with slopes steeper than 4:1 at rate of 5 gallons per 1,000 square feet in accordance with the manufacturers recommended requirements.

I. Water: Apply with fine spray after mulching to saturate top 4 inches of soil.

3.04 FIELD QUALITY CONTROL

A. 8 weeks after seeding is complete and on written notice from Contractor, Engineer will, within 15 days of receipt, determine if a satisfactory stand has been established.

B. If a satisfactory stand has not been established, Engineer will make another determination after written notice from Contractor following the next growing season.

3.05 PROTECTION

A. Protect from pedestrian traffic by erecting temporary fence around each newly seeded area.

END OF SECTION

SECTION 33 05 13
MANHOLES

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards that may be referenced in this section:

1. American Association of State Highway and Transportation Officials (AASHTO): M198, Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants.
2. ASTM International (ASTM):
   a. A36/A36M, Standard Specification for Carbon Structural Steel.
   b. A48/A48M, Standard Specification for Gray Iron Castings.
   c. A123/A123M, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
   d. A536, Standard Specification for Ductile Iron Castings.
   e. A615/A615M, Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
   f. B139/B139M, Standard Specification for Phosphor Bronze Rod, Bar, and Shapes.
   g. C14, Standard Specification for Nonreinforced Concrete Sewer, Storm Drain, and Culvert Pipe.
   h. C31/C31M, Standard Practice for Making and Curing Concrete Test Specimens in the Field.
   i. C39/C39M, Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
   j. C150/C150M, Standard Specification for Portland Cement.
   k. C192/C192M, Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory.
   l. C387/C387M, Standard Specification for Packaged, Dry, Combined Materials for Mortar and Concrete.
   m. C443, Standard Specification for Joints for Concrete Pipe and Manholes Using Rubber Gaskets.
   n. C478, Standard Specification for Precast Reinforced Concrete Manhole Sections.
   o. C923, Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes, and Laterals.
   p. C990, Standard Specification for Joints in Concrete Pipe, Manholes, and Precast Box Sections using Preformed Flexible Joint Sealants.
   q. C1311, Standard Specification for Solvent Release Sealants.

r. C1244, Standard Test Method for Concrete Sewer Manholes by the Negative Air Pressure (Vacuum) Test Prior to Backfill.
s. D698, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft^3 (600 kN-m/m^3)).
t. D4101, Standard Specification for Propylene Injection and Extrusion Materials.
u. F593, Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
v. F594, Standard Specification for Stainless Steel Nuts.

1.02 SUBMITTALS

A. Action Submittals:

1. Shop Drawings including details of construction, reinforcing and joints, anchors, lifting, erection inserts, and other items cast into members.
2. Product Data:
   a. Concrete mix design.
   b. Manhole frame to structure seals.
   c. Manhole frame to structure anchor bolt.
   d. Rubber gaskets and sealants.
   e. External joint wrap.

B. Informational Submittals:

1. Experience Record:
   a. Precast concrete production capabilities.
   b. Evidence of current PCI plant certification.
2. Calculations: Proposed details and design calculations for stresses in precast concrete members for loading conditions including earth pressures and transportation, handling, and erection. Calculations shall be stamped by engineer registered in the same state as the Project.
3. Certificate of Compliance: Certify admixtures and concrete do not contain calcium chloride.
4. Test Reports:
   a. Precast manufacturer’s concrete test cylinders.
   b. Core compression test.
   c. Absorption test.
5. Certified load test data for precast manhole steps.
6. Manufacturer’s recommended installation instructions.
7. Field quality control report.

1.03 QUALITY ASSURANCE

A. Manufacturer Qualifications:

1. Precast Concrete and Precast Prestressed Concrete: Product of manufacturer with 3 years' experience producing precast concrete products of quality specified.
2. Precast Plant: PCI certified plant with current certification.

PART 2 PRODUCTS

2.01 GENERAL

A. Materials of Construction and Service Conditions:

1. Screws, Bolts, or Nuts: Type 304 stainless steel conforming to ASTM F593 and ASTM F594.
2. Gaskets: Internal and external seals shall be made of materials that have been proven to be resistant to the following exposures and conditions:
   a. Sanitary sewage.
   b. Corrosion or rotting under wet or dry conditions.
   c. Gaseous environment in sanitary sewers and at road surfaces including common levels of ozone, carbon monoxide, and other trace gases at installation site.
   d. Biological environment in soils and sanitary sewers.
   e. Chemical attack by road salts, road oil, and common street spillages or solvents used in street construction or maintenance.
   f. Temperature ranges, variations, and gradients in construction area.
   g. Variations in moisture conditions and humidity.
   h. Fatigue failure caused by a minimum of 30 freeze-thaw cycles per year.
   i. Vibrations because of traffic loading.
   j. Fatigue failure because of repeated variations of tensile, compressive and shear stresses, and repeated elongation and compression. Material shall remain flexible allowing repeated movement.
3. Materials shall be compatible with each other and manhole materials.
4. Designed to provide a 20-year service life.

B. Structures shall meet requirements of ASTM C478, this specification and the following:

1. Concrete:
   a. Cement: Meet requirements of ASTM C150/C150M.
   b. Compressive Strength:
      1) Minimum 4,000 psi.

2) Minimum strength shall be confirmed at 7 days by making two standard cylinders per manhole for testing.

c. Concrete mix design shall include Xypex C-500 or C-1000 based upon mix design at dosage recommended by manufacturer for installation.

2. Reinforcement: Grade 60, unless otherwise specified.
3. Ring: Custom made with openings to meet indicated pipe alignment conditions and invert elevations.
4. Floor: Minimum 4 inches below pipe to provide clearance for grouting channels.
5. Joint:
   a. Form joint contact services with machined castings.
   b. Surfaces shall be parallel with nominal 1/16-inch clearing and tongue equipped with recess for installation of O-ring rubber gasket.
6. Gasket: Meet requirements of ASTM C443.

2.02 PRECAST MANHOLES

A. Riser Sections:

1. Fabricate in accordance with ASTM C478.
2. Diameter: Minimum 48 inches.
3. Wall Thickness: Minimum 4 inches or 1/12 times inside diameter, whichever is greater.
4. Top and bottom surfaces shall be parallel.
5. Joints: Tongue-and-groove and confined O-ring with rubber gaskets meeting ASTM C443.

B. Cone Sections:

1. Eccentric.
2. Same wall thickness and reinforcement as riser section.
3. Top and bottom surfaces shall be parallel.

C. Base Sections and Base Slab:

1. Base slab integral with sidewalls.
2. Fabricate in accordance with ASTM C478.

D. Manhole Extensions:

1. Concrete grade rings; maximum 6 inches high.
2. Fabricate in accordance with ASTM C478.

E. Joint Seal Manufacturers and Products:

1. Butyl Gaskets:
   a. Hamilton Kent, Sparks, NV; Kent-Seal No. 2.
   b. Henry Company, Houston, TX; Ram-Nek.
   c. Trelleborg Engineered Solutions, Park Hills, MO; NPC Bidco C-56.
2. Confined Plastic or Rubber O-Ring:
   a. As recommended by precasting manufacturer.
   b. Meet requirements of ASTM C443.
3. External Wrap:
   a. Sealing Systems, Inc., Loretto, MN; Gator Wrap.
   b. Henry Company, Houston, TX; RU116 Rubr-Nek External Joint Wrap.
   c. Trelleborg Engineered Solutions, Park Hills, MO; NPC External Joint Wrap.
   d. Cretex Specialty Products, Waukesha, WI; Cretex Wrap.

F. Polypropylene Steps:

1. Fabricate from minimum 1/2 inch, Grade 60, steel bar meeting ASTM A615/A615M.
2. Polypropylene encasement shall conform to ASTM D4101.
3. Minimum Width: 13 inches, center-to-center of legs.
4. Embedment: 3-1/2-inch minimum and 4-1/2-inch minimum projection from face of concrete at point of embedment to center of step.
5. Cast in manhole sections by manufacturer.
6. Load Test: Capable of withstanding ASTM C478 vertical and horizontal load tests.

2.03 RECTANGULAR PRECAST MANHOLES

A. Riser Sections: Precast concrete sections shall meet the requirements of ASTM C913. The minimum 28 day compressive strength of the concrete in precast sections shall be 4,000 psi.

B. The design of each structure shall be the responsibility of the manufacturer and shall conform to ACI-318 and the minimum structural design loading requirements as defined in ASTM C890. The minimum design dead load shall be based on the depth shown on the Drawings or in Table 1 of this section. The minimum design live load shall be A-16.

C. Precast sections shall be manufactured such that the spigot end is at the top of each section.

2.04 MANHOLE FRAMES AND COVER

A. Castings:

1. Tough, close-grained gray iron, sound, smooth, clean, free from blisters, blowholes, shrinkage, cold shuts, and defects.
2. Cast Iron: ASTM A48/A48M Class 30B.
3. Ductile Iron: ASTM A536, Grade 60-40-12.
4. Plane or grind bearing surfaces to ensure flat, true surfaces.

B. Cover: Owner's Standard.

C. Capscrews for Tamper-Proof Covers: High temper phosphor bronze with 60,000 psi minimum tensile strength meeting ASTM B139/B139M.

D. Watertight Cover Gasket: Molded from high-quality rubber such as nitrile or EPDM.

2.05 MANHOLE FRAME CONNECTION TO STRUCTURE

A. Butyl Sealant:

1. Conform to ASTM C1311, or AASHTO M198 and ASTM C990.
2. Trowelable or cartridge applied.
3. Manufacturers and Products:
   a. Tremco Commercial Sealants and Waterproofing, Beachwood, OH; Tremco Butyl Sealant.
   b. Bostik, Middleton, MA; Chem-Calk 300.
   c. Press-Seal Gasket Company, Fort Wayne, IN; EZ-Stik #3.

B. External Wrap:

1. Meet requirements of ASTM C923.
2. Construct of high quality rubber that will provide flexible watertight seal around joint.
3. Thickness: Minimum 60 mils.
4. Consist of a top and bottom section and be sealed to structure, frame top, and bottom with mastic as applicable.
5. Length: Extend from manhole frame and extension ring to cone section.
6. Bands: If required, constructed of minimum 16-gauge sheet if channeled, or 5/16-inch diameter if round.
7. Manufacturers and Products:
   a. Sealing Systems, Inc., Loretto, MN; Infi-Shield.
   b. Trelleborg Engineered Systems, Milford, NH; NPC Flexrib Frame-Chimney Seals.
   c. Cretex Specialty Products, Waukesha, WI; X-85 Seal.

C. Internal Wrap or Sealing Membrane:

1. Meet requirements of ASTM C923.
2. Minimum internal thickness of 3/16 inch or as recommended by manufacturer for installation climate.
3. Designed for application and have a demonstrated history of accommodating differential expansion between frame and concrete.
4. Width: Minimum 8 inches.
5. Expansive type wraps shall be fabricated of high quality rubber or urethane.
6. Bands: If required, constructed of minimum 16-gauge sheet if channeled, or 5/16-inch diameter if round.
7. Wrap shall not restrict access to manhole.
8. Manufacturers and Products:
    a. Sealing Systems, Inc., Loretto, MN; Flex-Seal Utility Sealant.
    b. Trelleborg Engineered Systems, Milford, NH; NPC Flexrib Frame-Chimney Seals.
    c. Cretex Specialty Products, Waukesha, WI; Internal Manhole Chimney Seal.

D. Frame to Structure Anchor Bolts:

1. 3/4-inch-diameter HAS stainless steel bolts; minimum 6-5/8-inch embedment.
2. Manufacturer and Product: Hilti; HVA Capsules Adhesive Anchoring System.

2.06 MORTAR

A. Standard premixed in accordance with ASTM C387/C387M, or proportion one part Portland cement to two parts clean, well-graded sand that will pass a 1/8-inch screen.

B. Admixtures: May be included; do not exceed the following percentages of weight of cement:

1. Hydrated Lime: 10 percent.
2. Diatomaceous Earth or Other Inert Material: 5 percent.

C. Mix Consistency:

1. Tongue-and-Groove Type Joint: Such that mortar will readily adhere to pipe.
2. Confined Groove (Keylock) Joint: Such that excess mortar will be forced out of groove and support is not provided for section being placed.

2.07 BACKFILL AROUND AND UNDER MANHOLE

A. Structural fill as specified in Section 31 23 23, Fill and Backfill.

2.08 FLEXIBLE JOINTS FOR SEALING PIPES IN MANHOLE

A. Manufacturers and Products:

1. NPC, Inc., Milford, New Hampshire; Kor-N-Seal flexible rubber boot with stainless steel accessories.
2. A-LOK Products, Inc., Tullytown, PA; Z-LOK XP or A-LOK flexible connectors.

B. Doghouse Manhole/Manhole Over Existing Pipe (where use of a boot is not possible):

1. Green Streak; hydrophilic waterstop CJ-0725-3k.

2.09 SOURCE QUALITY CONTROL

A. Prior to delivery of precast manhole sections to Site, yard permeability tests may be required at point of manufacture. Engineer or Owner will select precast sections not to exceed 5 percent of the total project quantity to test from material which is to be supplied to Project. Test specimens shall be mat tested and meet permeability test requirements of ASTM C14.

B. Concrete Testing: Test two concrete test cylinders for each manhole. Compressive strength shall be tested in accordance with ASTM C31/C31M, ASTM C39/C39M, and ASTM C192/C192M.

C. Inspection:

1. Material Quality:
   a. Manufacturing process and finished sections shall be subject to inspection and approval by Owner and Engineer.
      1) Inspections may take place at manufacturer’s plant, at Site after delivery, or at both.
      2) Sections not meeting requirements of this Specification or that are determined to have defects which may affect durability of structure are subject to rejection.
      3) Sections rejected after delivery shall be removed and replaced.
      4) Sections damaged after delivery will be rejected and if already installed shall be repaired to satisfaction of Owner and Engineer.
      5) If structure cannot be repaired it shall be removed and replaced entirely at Contractor’s expense.

2. At the time of inspection the sections will be carefully examined for compliance with ASTM C478 and with manufacturer's drawings. Sections will be inspected for general appearance, dimensions, scratch strength, blisters, cracks, roughness, and soundness. Surface shall be dense and close textured.
3. Imperfections may be repaired, subject to approval of Engineer, after demonstration by manufacturer that strong and permanent repairs result.

PART 3 EXECUTION

3.01 GENERAL

A. Prior to installation inspect materials:

1. Sections not meeting requirements of this specification or that are determined to have defects which may affect durability of structure are subject to rejection.
2. Sections damaged after delivery will be rejected and if already installed shall be repaired to satisfaction of Owner and Engineer.
3. Remove and replace structure that cannot be repaired.

B. If needed, dewater excavation during construction and testing operations.

3.02 EXCAVATION AND BACKFILL

A. Excavation: As specified in Section 31 23 16, Excavation.

B. Backfill:

1. As specified in Section 31 23 23, Fill and Backfill.
2. Place structural fill under manhole in 6-inch maximum lifts; minimum of 12 inches unless otherwise specified on the Drawings. Compact each lift to 98 percent relative compaction as determined in accordance with ASTM D698.
3. Backfill around structure with earth fill to lines and grades shown; allow for topsoil thickness where shown. Place in 8-inch thick maximum lifts. Compact each lift to 92 percent relative compaction as determined in accordance with ASTM D698.

3.03 INSTALLATION OF PRECAST MANHOLES AND STRUCTURES

A. Concrete Base:

1. Precast:
   a. Place on compacted structural fill.
   b. Properly locate, ensure firm bearing throughout, and plumb first section.

2. Cast-in-Place:
    a. Invert: Minimum 8 inches below lowest connecting pipe.
    b. First section of manhole shall be cast in concrete base.

B. Sections:

1. Inspect precast manhole sections to be joined.
2. Clean ends of sections to be joined.
3. Do not use sections with chips or cracks in tongue.
4. Locate precast steps in line with each other to provide continuous vertical ladder.

C. Preformed Plastic Gaskets or Rubber O-Ring:

1. Use only pipe primer furnished by gasket manufacturer.
2. Install gasket material in accordance with manufacturer's instructions.
3. Completed Manhole: Rigid and watertight.

D. External Joint Wraps: Install in accordance with manufacturer's instructions.

E. Extensions:

1. Provide on manholes in streets or other locations where change in existing grade may be likely.
2. Install to height not exceeding 12 inches.
3. Lay grade rings in mortar with sides plumb and tops level.
4. Seal joints with mortar as specified for sections and make watertight.

3.04 MANHOLE INVERT

A. Construct with smooth transitions to ensure unobstructed flow through manhole. Remove sharp edges or rough sections that tend to obstruct flow.

B. Where full section of pipe is laid through manhole, break out top section and cover exposed edge of pipe completely with mortar. Trowel mortar surfaces smooth.

3.05 MANHOLE FRAMES AND COVERS

A. Install concrete grade rings as required to set covers flush with surface of adjoining pavement or ground surface, unless otherwise shown or directed.

B. Set frames in three equally spaced beads of butyl sealant that run full circumference of frame.

C. Anchor frame to manhole with specified bolts.

D. Install exterior manhole frame to structure seals in accordance with manufacturer's instructions. Seal shall cover grade rings.

3.06 WATERTIGHT MANHOLES

A. Unless otherwise noted, manholes covers shall be bolted down with sealing gasket.

3.07 MANHOLE PIPING

A. Drop Assembly: See Drawings for detail of installation requirements.

B. Flexible Joints:

1. Provide in pipe not more than 1-1/2 feet from manhole walls.
2. Where last joint of pipe is between 1-1/2 feet and 6 feet from manhole wall, provide flexible joint in manhole wall.

C. Permanent Plugs: Clean interior contact surfaces of pipes to be cut off or abandoned as shown, and construct plug as follows:

1. Pipe 18 Inches or Less in Diameter: Concrete plug in end, minimum 2 feet long.
2. Pipe 20 Inches and Larger: Concrete plug in end, minimum 4 feet long.
3. Plugs shall be watertight and capable of withstanding internal and external pressures without leakage.

3.08 FIELD QUALITY CONTROL

A. Conduct negative air pressure (vacuum) test on all manholes in accordance with ASTM C1244. Conduct tests in presence of Engineer.

B. Hydrostatic Testing:

1. When, in Engineer’s opinion, groundwater table is too low to permit visual detection of infiltration leaks, hydrostatically test all manholes.
2. Procedure: Plug inlets and outlets and fill manhole with water to height determined by Engineer.
3. Manhole may be filled 24 hours prior to time of testing, if desired, to permit normal absorption into pipe walls to take place.
4. Leakage in each manhole shall not exceed 0.1 gallon per hour per foot of head above invert.
5. Repair manholes that do not meet leakage test, or do not meet specified requirements from visual inspection.
6. If more than 25 percent of manholes tested fail the hydrostatic test, test all or as many manholes as Engineer deems necessary.

END OF SECTION

SECTION 33 41 01
STORM DRAIN PIPING

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section and any supplemental Data Sheets:

1. ASTM International (ASTM):
   a. C1433, Standard Specification for Precast Reinforced Concrete Monolithic Box Sections for Culverts, Storm Drains, and Sewers.
   b. C1443, Standard Specification for Glasses, Portlight, Circular, Fully Tempered.
2. American Association of State Highway and Transportation Officials (AASHTO):
   a. HS-20, truck axle loading of 32,000 pounds or a single point wheel load of 16,000 pounds.
   b. M-198, Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants.

1.02 SUBMITTALS

A. Informational Submittals: Manufacturer's Certification of Compliance.

PART 2 PRODUCTS

2.01 REINFORCED CONCRETE PIPE

A. Reinforced Concrete Pipe shall be as specified in the Data Sheets following "End of Section."

2.02 PRECAST REINFORCED BOX CULVERT SECTIONS

A. Precast reinforced concrete box sections shall be single-cell units meeting the requirements of ASTM C1433 and these Specifications.

B. Box sections shall be designed and manufactured in accordance with ASTM C1433 Table 1 – Design Requirements for Precast Concrete Box Sections Under Earth Dead and HS20 Live Load Conditions. The manufacturer may interpolate the steel area requirements for fill heights between noted design earth cover increments.

C. Box sections shall be designed for external loads equal to the sum of the dead load plus live load for the following conditions:

1. The minimum dead load shall be that created by the depth of cover indicated on the Drawings, the depth of cover based on difference in elevation of near edge of pavement and top of box section, or 8 feet, whichever is greater.
2. The minimum live load shall be equal to AASHTO HS-20 loading created by the depth of cover indicated on the Drawings or the depth of cover based on difference in elevation of near edge of pavement and top of box section, which ever creates the higher loading.
3. Special Design: The manufacturer may request the Engineer's approval of modified designs which differ from the designs of Section 7 of ASTM C1443. The Engineer reserves the right to reject modified designs for any or no reasons.
4. Joints: The precast reinforced concrete box sections shall be manufactured with tongue and groove ends. Seal joints between sections by means flexible butyl rubber sealant. Butyl rubber sealants shall meet the requirements of AASHTO M-198. Sealant shall be pre-formed type with a minimum nominal diameter of 1-inch. Butyl rubber sealant shall be equal to Kent Seal No. 2 or Concrete Sealants CS202.

PART 3 EXECUTION

3.01 INSTALLATION OF PIPE, FITTINGS, AND APPURTENANCES

A. General:

1. Pipe laying shall proceed upgrade with spigot ends pointing in direction of flow.
2. Excavate bell holes at each joint to permit correct assembly and inspection of entire joint.
3. Pipe invert may deviate from line or grade up to 1/2-inch for line and 1/4-inch for grade, provided that finished pipe line will present a uniform bore, and such variation does not result in a level or reverse sloping invert, or less than minimum slope shown.
4. Pipe bedding shall form continuous and uniform bearing and support for pipe barrel between joints. Pipe shall not rest directly on bell or pipe joint.
5. Prevent entry of foreign material into gasketed joints.
6. Plug or close off pipes that are stubbed off for manhole, concrete structure, or for connection by others, with temporary watertight plugs.

3.02 REPAIR AND RETESTING

A. Sections of pipe not meeting the pressure test requirements shall be replaced or have individual joints tested and sealed.

B. Following repairs, sections shall be retested as specified.

3.03 SEWER CLEANING

A. Prior to final acceptance and final manhole-to-manhole inspection of the sewer system by Engineer, flush and clean all parts of the system. Remove all accumulated construction debris, rocks, gravel, sand, silt, and other foreign material from the sewer system at or near the closest downstream manhole. If necessary, use mechanical rodding or bucketing equipment.

B. Upon Engineer's final manhole-to-manhole inspection of the sewer system, if any foreign matter is still present in the system, reflush and clean the sections and portions of the lines as required.

3.04 SUPPLEMENTS

A. Data Sheets.

Number	Title
-.05	Reinforced Concrete

END OF SECTION

SECTION 33 41 01.05 REINFORCED CONCRETE	
Item	**Description**
Pipe	ASTM C76, Wall B, class as shown. Mark each joint with pipe class. Rotating packer or platform not allowed.
Cement	ASTM C150, Type II, or ASTM C150, Type I, with fly ash; maximum 12 percent Tricalcium Aluminate, or ASTM C595 Rev A, Type IP, with fly ash; Cement: ASTM C150. Minimum 564 pounds per cubic yard without fly ash. Minimum 479 pounds per cubic yard with fly ash.
Ratio: Water to Cementitious Materials	Not over 0.49.
Fly Ash	ASTM C618, Class C or Class F, Tables 1 and 2 modified as follows: Loss on Ignition: Maximum 3 percent. Water Requirement: Maximum 100 percent of control. Ratio Percent CaO/Fe_2O_3: Maximum 1.5. or test cement fly ash mix in accordance with ASTM C1012. Mix: Equal to or better than ASTM C150, Type II cement. 85 pounds per cubic yard minimum, 160 pounds per cubic yard maximum. Test: ASTM C311 and ASTM C618.
Joints	ASTM C443 Rev A. Captive gasket in groove.
Rubber Gaskets	ASTM C443.
Tee Fittings	Reinforced concrete, rubber gasketed. Provide plug when service piping is not required.
Plugs	Removable. Removal shall provide a socket suitable for making a flexible jointed lateral connection or extension.
Circumferential Reinforcement	Not closer than 1 inch to inside surface of pipe. Area of outer circular reinforcing cage not less than 75 percent of inner cage.
Elliptical Reinforcement	Not allowed.

SECTION 33 41 01.05 REINFORCED CONCRETE	
Item	**Description**
Source Quality Control Testing	Load Bearing 0.01-inch Crack, Compressive Strength and Absorption: ASTM C76. Load Bearing Ultimate: ASTM C76. Permeability: ASTM C497. Voids: Longitudinally sawcut one pipe from each 100 lengths of pipe manufactured in half with saw that will not damage the concrete or reinforcing steel. Inspect for voids adjacent to circumferential bars. Voids will be considered continuous if a 1/16-inch diameter pin can be inserted 1/4-inch deep. If voids exist adjacent to more than 10 percent of the circumferential bars, two additional pipes shall be tested. If either of the two pipes fail, the entire 100 lengths will be rejected.

END OF SECTION

ATTACHMENTS

ATTACHMENT 1

ACCURA GEOTECHNICAL ENGINEERING AND SUBSURFACE INVESTIGATION REPORT

ACCURA

GEOTECHNICAL ENGINEERING AND SUBSURFACE INVESTIGATION REPORT

Culvert Rehabilitation Project
Jonesboro, Clayton County, Georgia

Submitted to:
JACOBS ENGINEERING GROUP INC.
Attn: Craig Hensley, PE
Project Manager
10 Tenth Street, Suite 1400
Atlanta, GA 30309

Submitted by:

Accura Engineering and Consulting Services, Inc.
3200 Presidential Drive
Atlanta, GA 30340

August 2022

8/9/2022

Jacobs
Craig Hensley, PE
Project Manager
10 Tenth Street, Suite 1400
Atlanta, GA 30309

Email: Craig.Hensley@jacobs.com

Subject: Subsurface Exploration and Geotechnical Engineering Services
Culvert Rehabilitation Project
Clayton County, Georgia

Mr. Hensley:

The enclosed report presents the results of the subsurface exploration program and geotechnical engineering evaluation undertaken by Accura Engineering and Consulting Services, Inc. (Accura) in connection with the above referenced project. Our services were performed in general accordance with Accura Proposal dated September 28, 2021. This report presents our understanding of the project, reviews our exploration procedures, describes the general subsurface conditions at the boring locations, and presents our evaluations, conclusions, and recommendations.

We have enjoyed working with you on this project, and we are prepared to assist you with the recommended quality assurance monitoring and testing services during construction. Please contact us if you have any questions regarding this report or if we may be of further service.

Sincerely,
ACCURA ENGINEERING AND CONSULTING SERVICES, INC.

Ken Khanidokht, P.E.
Geotechnical Group Leader-Senior Engineer

Henok Tesfamariam
Staff Geotechnical Engineer

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APPENDICES

1.0 SITE LOCATION AND PROJECT INFORMATION

The project site is located an approximately 300 feet southwest of intersection between Tara Boulevard and Veterans Parkway in Clayton County, Georgia. The client provided a site plan overlaid on an aerial photograph; via-email dated February 8, 2022. The provided plan showed the client's desired boring locations and the proposed culvert locations. This site plan was used as a guide to locate the boundaries of the project site and to estimate the topographic elevations at the site. The locations of the project site and borings are shown on the attached Test Location plan (Drawing No. 02). The surrounding areas of the project site consisted of several commercial buildings with associated sidewalks, parking lot, grass area, and roads. Based on the provided information, the project site is along an existing pipeline from Tara Boulevard (East end) and run to the west direction between previous demolished Emission Testing Building location and Leslie's Pool Supplies toward an existing creek. Based on our site visit, two large sinkholes have developed along this pipeline and around the existing associated manhole. We also observed some cracks in sidewalks, the exterior walls of Leslie's Pool Supplies building, parking lot, and significant erosion/drainage issues and raveling of soils near of the subject alignment were noted. Project surroundings are shown on the attached Site Vicinity Map in Appendix I, Drawing No. 01.

Based on our visual observations, the topography at the site generally sloped down from eastern area of the site to the western areas of the site. Based on the provided topographic plan, the existing site topographic conditions vary generally from a high elevation of 854± feet above Mean Sea Level (MSL) top of the manhole near the eastern areas and low elevation of 827± feet bottom of the existing creek near the western areas of the site. Total relief across the site is approximately 27 feet.

Based on the provided site plan overlaid on an aerial photograph, we understand that the planned development will consist of replacing an existing 24-inche corrugated metal pipe with a new concrete box culvert and wing walls.

Based on the site observations, we estimate maximum cuts and fills on the order of 25 feet or so might be required to achieve existing pipe invert and final grades.

If the actual grading information differs significantly from the assumed values state herein, Accura must be notified and provided the opportunity to re-evaluate our recommendations, based on the actual planned construction.

2.0 PURPOSE & SCOPE OF SERVICE

The purpose of our involvement on this project was to: 1. provide general descriptions of the subsurface soil, rock, and groundwater conditions along the existing sewer pipeline, 2. obtain laboratory tests, and 3. provide a geotechnical report. In order to accomplish these objectives, we undertook the following scope of services:

- Visited the site to observe existing surface conditions, marked the proposed boring locations,and coordinate utility clearance with 811.

- Executed the requested subsurface exploration program consisting of three Standard Penetration Test (SPT) soil borings drilled up to 15-foot depth below the existing pipe invert or auger refusal.

- Reviewed and summarized readily available geologic information relative to the project site.

- Representative samples collected from the subsurface investigation was visually classified by a qualified member of our geotechnical staff. In addition, some of those samples was subjected to soil index testing to assist in and verify the classifications, and for use in engineering analysis and design. We proposed two (2) Moisture Content (ASTM D 2216) tests, two (2) Grain Size Analysis (ASTM D 422), and two Atterberg Limits (ASTM D 4318).

- Prepare a written geotechnical report for the project summarizing our work on the project, providing descriptions of the subsurface conditions encountered, laboratory testing program, visual classifications in accordance with USCS and classifications and adjusted based on the results of the laboratory testing, logs of all borings should delineate the limits of stratum encountered (Fill and Embankment materials, Residuum, Saprolite, Partially Weathered Rock, etc.), the results of all field and laboratory testing, and recommendations regarding the repair/stabilization of the sinkhole.

- The geotechnical report will be provided via email unless otherwise noted.

Accura's geotechnical services did not include development of quantity estimates, preparation of plans and specifications, or the identification and evaluation of wetlands or other environmental aspects of the project site.

3.0 EXPLORATION PROCEDURES

Three SPT borings were drilled at the approximate locations indicated on the attached Test Location Plan (Drawing No. 02) provided in Appendix I. The borings were drilled within the project site area to respective boring termination depths up to 40 feet.

The SPT borings were performed in general accordance with ASTM D 1586. Soil samples obtained using the split spoon sampler were visually evaluated by the Project Engineer and classified according to the visual-manual procedure described in ASTM D 2488. A narrative of field operations is included in Appendix II.

The boring locations were determined in the field by our engineering representative who measured distances and estimated angles with a measurement tape and a hand-held compass from existing site features. The approximate boring locations are indicated on the attached Test Location Plan (Drawing No. 02). The elevations on the logs were interpolated from the provided elevations within the area of the site and should be considered very approximate and subject to error. The borings were backfilled with auger cuttings upon completion of drilling.

4.0 REGIONAL GEOLOGY

The project site is located in the Piedmont physiographic province of Georgia, which is characterized by medium- to high-grade metamorphic rocks and scattered igneous intrusions. The metamorphic rocks comprising the Piedmont were formed when older “parent” rocks were subjected to high temperatures and/or pressures during regional metamorphism that occurred during the creation of the Appalachian Mountains. The same high temperatures and pressures also caused some “parent” rocks to fully melt and subsequently recrystallize as intrusive igneous rocks. Topography in the province is variable and ranges from gently rolling hills in the south to moderate to steep hills in the north.

The boundary between soil and rock is typically not sharply defined. A transitional zone termed partially weathered rock (PWR) is normally found overlying bedrock. Partially weathered rock is defined for engineering purposes as residual material that can be penetrated with soil drilling equipment, but which has a standard penetration resistance exceeding 100 blows per foot (bpf). Differential weathering of the parent rock has resulted in highly variable subsurface conditions over short horizontal distances. Lenses and boulders of hard rock and zones of partially weathered rock may be present within the soil above the general bedrock level. The upper surface of rock is irregular.

According to the *Geologic Map of Georgia*, the rock types underlying the project site have been mapped as Mica Schist, Gneiss and Amphibolite.

5.0 SUBSURFACE CONDITIONS

The subsurface conditions discussed in the following paragraphs and those shown on the attached boring logs represent an estimate of the subsurface conditions based on interpretation of the field using normally accepted geotechnical engineering judgments. Given the spacing between boring locations, it is anticipated that subsurface conditions may vary between each boring location. Strata breaks designated on the boring logs represent approximate boundaries between soil types. The transitions between different soil strata are usually less distinct than those shown on the boring logs. Although individual soil test borings are representative of the subsurface conditions at the boring locations on the dates shown, they are not necessarily indicative of subsurface conditions at other locations or at other times. Data from the specific soil test borings are shown on the individual boring logs included in Appendix II.

Borings B-1 through B-3 drilled along the proposed culvert areas initially encountered 4 inches of topsoil's or 4 inches of an asphalt surface layer.

Existing Fill: Borings B-1, B-2, and B-3 encountered fill soils to a depth of 29 feet, 28 feet, and 2 feet below existing grades, respectively. The fill soils encountered generally consisted of very loose to loose silty sand (SM) or soft to stiff sandy silt (ML) with varying amounts of mica, rock fragments, and trace to some clay. The standard penetration resistances (N-values) in the fill ranged from 3 to 9 blows per foot (bpf).

Residual Soils: Residual soils typical of the Piedmont Physiographic Region were encountered below the fill in the borings. The residual soils generally consisted of loose to dense silty sand (SM) with varying amounts of clay, mica, and rock fragments with Standard Penetration Test resistance (N-values) ranging from 6 to 34 blows per foot (bpf).

Partially Weathered Rock (PWR): PWR was encountered in borings B-1, B-2, and B-3 at a depth of 38 feet, 38 feet, and 13 feet, respectively. PWR is a term for the residuum that can be penetrated by soil drilling techniques and has standard penetration resistance values (N-values) in excess of 100 bpf.

Rock: Rock was encountered in boring B-3 to an auger refusal depth of 20 feet. No bed rock was encountered in borings B-1 and B-2 to the termination depths of up to 40 feet.

Groundwater: Groundwater was encountered in borings B-1 and B-2 at a depth of 20 feet and 18 feet after completion of drilling, respectively.

A summary of subsurface conditions encountered at the test locations is provided in the following Table 1.

TABLE 1 – SUMMARY OF SUBSURFACE CONDITIONS

Boring Location	Existing Ground Elevation (ft)	Groundwater Elevation after completion of Drilling (ft)	Existing Fill (ft)	Structure Location
B-1	953	933	28	Along the proposed Culvert
B-2	953	935	28	Along the proposed Culvert
B-3	940	N/E	2	Along the proposed Culvert
N/E – Not Encountered				

The elevations indicated on table 1 are interpolated from the provided topographic plan and should be considered very approximate. The provided elevations are for general informational purposes only. Subsurface conditions can vary considerably within short horizontal distances in this geology.

The borings were backfilled with the auger cuttings upon completion of drilling for safety considerations. For a more precise description of the condition**s** encountered within the borings, please refer to the Boring Logs provided in The Appendix II.

6.0 DESIGN RECOMMENDATIONS

6.1 General

The following findings and recommendations are based on our observations at the site, interpretation of the field obtained during our subsurface exploration, provided information on existing grades, level bearing of the proposed culvert, and our experience with similar subsurface conditions and projects. Subsurface conditions in unexplored locations may vary from those encountered.

Determination of an appropriate foundation system for the proposed culvert box is dependent on the soil conditions, settlement, and construction constraints such as proximity to other structures, etc. The subsurface exploration aids the geotechnical engineer in determining the soil stratum appropriate for structural support. This determination includes considerations with regard to both allowable bearing capacity

and compressibility of the soil strata. In addition, since the method of construction greatly affects the soils intended for structural support, consideration must be given to the implementation of suitable methods of site preparation, fill compaction, and other aspects of construction. Please refer to the Construction Recommendations included in Section 7 of this report.

6.2 Existing Soft and Loose Soils

Low consistency and density soils were encountered in borings B-1 and B-2 in the top of 28 feet that performed within the proposed culvert areas and affected area. Based on the anticipated foundation bearing elevation and existing ground elevation, we expect most of the existing soft and moist soil will be excavated and removed to achieve the proposed foundation level elevation (approximately EL 830.0 feet). We recommend the soils to a depth of 12 inches from below the planned culvert foundation bearing elevation be undercut to allow for a bedding material consisting of a coarse aggregate (No. 57 stone in accordance with GDOT Standard Specifications) to be used to restore the excavation to the design bearing elevation. The gravel bedding material should be fully enveloped with filter fabric.

6.3 Seismic Design Criteria

The seismic soil site class evaluations presented herein reference American Society of Civil Engineers (ASCE) 7-10 as specified by Section 1613.2.2 of the International Building Code (IBC) 2018. Chapter 20 of ASCE 7-10 entails an evaluation of the top 100 feet of the subsurface soil profile in order to determine the seismic site class; however, the deepest soil boring for this project was terminated at a depth of 40 feet for foundation design consideration.

Based on the average SPT N-values obtained and extrapolated to a depth of 100 feet, the subsurface conditions at the project site correspond most closely with those of Site Classification “D.”

6.4 Shallow Foundation Design Recommendations

Based on the available project information, our evaluations, and provided the site is prepared as recommended, spread footings on bedding material, prepared in accordance with Section 7.3 of this report, would be suitable for proposed culvert footings. Elastic settlement associated with spread footings founded on bedding material underlain by very dense residual soil and PWR is estimated to be less than ½-inch.

Foundations bearing on appropriate material should be sized for maximum net allowable bearing pressure of 3,000 pounds per square foot (psf). Continuous foundations should have a minimum width of 18 inches to reduce the possibility of a "punching" shear failure. The structural elements should be centered on the foundations to provide uniform load transfer, unless the foundations are proportioned for eccentric loads.

The base of all foundation excavations should be inspected by qualified geotechnical personnel prior to placing bedding material in order to confirm the above noted bearing pressure.

6.5 Lateral Earth Pressure

Earth pressures on the side of the culvert and the wing walls are influenced by the structural design of the walls, conditions of wall restraint, methods of construction or compaction, and the strength of the materials being restrained. The most common conditions assumed for earth retaining wall design are the active and at-rest conditions. Active conditions apply to relatively flexible earth retention structures, such as freestanding walls, where some movement and rotation may occur to mobilize soil shear strength. We recommend that the lateral earth pressure coefficients and other parameters for culvert and wing wall design noted in below Table 2 be utilized. Crushed coarse graded aggregate parameters noted below would apply where this free draining material should be utilized behind the walls where groundwater is present.

Table 2: Estimated Retaining Wall Soil Design Parameters

Design Parameters	ML	SM	Crushed Stone
Moist Unit Weight of Backfill	115 pcf	120 pcf	105 pcf
Cohesive Strength (c)	0 psf	0 psf	0 psf
Angle of Internal Friction (ø)	24°	30°	36°
Coefficient of Earth Pressure at Rest (K_o)	0.59	0.5	0.41
Coefficient of Passive Earth Pressure (K_p)	2.37	3.0	3.85
Coefficient of Active Earth Pressure (K_a)	0.42	0.33	0.26
Coefficient of Friction [Concrete on Soil or Gravel](μ)	0.35	0.45	0.5

6.6 Causes of the Sinkholes

It appears that significant storm water runoff from the site and possibly the roadway to the east is generally directed toward the area of the pipeline where the sinkhole problem has occurred. Accura believes that concentrated stormwater runoff directed toward the pipeline in the area where the sinkhole occurred likely contributed to the sinkhole.

Our opinion as to potential causes of the sinkholes at the site are based on the locations and previous construction within the existing creek, the results of our investigation of the subsurface conditions in the vicinity of the existing metal pipe, and measurements of groundwater levels. We believe that the recurring sinkholes are the result of the following three factors:

- Surface runoff is channeled to the location above the existing metal pipe sometimes resulting in ponded water that infiltrates down, around, and into the pipe and mobilizes overlying soil particles along with it.

- The relatively low density of soils encountered during geotechnical investigation. The low density allows groundwater movement to mobilize the soil particles more easily.

- Possibly the existence of holes or separations between some joints in the existing pipe due to deformation and deterioration that allow water and soils to infiltrate the pipe.

We noted that without immediate remedial measures, the existing sinkholes will continue to deteriorate and could jeopardize the adjacent Leslie's Pool Supplies building. We understand that the Leslie's Pool Supplies building will not be demolished. As such, we recommend that the side of the building closest to the affected area should be underpinned as soon as reasonably possible prior to any repair of existing sinkhole. Immediate underpinning of the building will "buy time" while a permanent solution to repairing the sinkhole areas at the site can be designed and implemented.

6.7 Civil/Drainage Considerations

it is imperative that site grading and storm water collection improvements be designed and implemented such that concentrated storm water flows, including surface drainage that occurs near the pipeline, are collected and discharged to appropriate locations well away from the pipeline at the site. This applies not only to the area where the sinkhole

occurred, but also to the overall area at the site. We note that these improvements must be implemented prior to or concurrent with repair of the sinkhole. If it is a drainage pipe that has become disconnected at the western end, it should be repaired. Also the location of the storm drain tends to indicate that stormwater is directed to this area, which is considered to be problematic, regardless of whether the storm drain is functioning properly. Accura recommends that a registered civil engineer be contracted to evaluate the drainage conditions around the site and design appropriate repairs.

6.8 Repair of the Sinkhole

We note that filling the sinkhole prior to implementing civil grading and drainage improvements could result in the sinkhole opening back up or could cause the problem to migrate along the pipeline, adjacent to or away from the repaired area.

After or concurrent with the grading and drainage improvements, we recommend that some minor excavation be performed to remove excessively soft or loose material that might have accumulated within the sinkhole area. The area of the sinkhole should be cleaned out and safely braced or laid back in accordance with OSHA excavation regulations. We recommend that the excavation work be observed by the geotechnical engineer to document that the sinkhole area is relatively stable and to probe the bottom of the sinkhole to assess the possibility that yet undetected voids or drainage paths might be present. Upon approval of the geotechnical engineer, the sinkhole should then be filled with engineered fill as we discussed in Section 7.5 of this report.

7.0 CONSTRUCTION RECOMMENDATIONS

7.1 General

The principal purpose of this section is to comment in general on the items related to earthwork and associated geotechnical engineering aspects of construction that should be expected for this project. It is recommended that Accura's geotechnical engineer be retained to provide soil-engineering services during the construction phases of the project and perform appropriate evaluations to help assure that conditions encountered during construction are similar to conditions encountered in the borings. The geotechnical engineer can also assist in interpretation of differing subsurface conditions that may be encountered and recommend remedial work, if needed.

7.2 Existing Fill Considerations

Borings B-1, B-2, and B-3 generally encountered fill soils to a depth of 28 feet, 28 feet, and 2 feet below the ground surface, respectively. Most of the fill generally appeared to be relatively clean, however, the fill was highly variable in consistencies, with zones of

very loose or very soft soils. Based on anticipated bearing elevations, we expect that some of the fill soils within the area of the proposed structures will remain.

As is the case with any previously filled site, existing fill may contain zones of soft soils, buried trash, organics, boulders, or other unsuitable materials. Unsuitable materials, if encountered, shall be removed and replaced and/or stabilized per geotechnical engineer's recommendations. For construction over an undocumented fill and/or previously developed site, the owner must assume the risk of greater than normal settlement due to the possible presence of burial pits, soft soils, or unsuitable materials within the fill. SPT borings alone are not well suited to evaluate existing fill. The only true way to determine the condition of an existing fill is to completely remove and replace the fill. Accura recommends that fill within the sinkhole areas and fill placement top of the proposed culvert box be evaluated by the geotechnical engineer during construction, and the project budget include contingency funds in the event that soft soils, buried trash, or other unsuitable materials requiring removal are encountered during construction.

7.3 Site Preparation

We recommend removing the disturbed soil, vegetation and debris that has slid down the sinkhole and accumulated within the sinkhole. Once the failed material has been removed, a geotechnical engineer must evaluate the remaining soils exposed along the bottom of the sinkhole. Based on the borings and our visual observations, much of the existing fill within the sinkhole area is likely soft or loose soil. As such, significant additional excavation of fill containing unsuitable materials and/or stabilization of soft or loose soils within the affected area should be expected and budgeted for. Accura recommends that the soft or otherwise unsuitable soils within the sinkhole area and along the proposed alignment be completely removed. However, the actual extent of the soils to be removed should be determined based on the conditions observed and the recommendation of the geotechnical engineer at the time of construction.

7.4 Moisture Sensitive Soils

The on-site soils, such as Sandy Silt or Silty Sand are expected to be moisture-sensitive and will become unstable if exposed to significant moisture increases. If the subgrade becomes unstable due to moisture infiltration, it will be necessary to remove the soils and replace them with engineered fill or stabilize the soils in an acceptable manner. Some increasing and or decreasing of the moisture content of fill soils should be anticipated prior to re-placement and compaction. Drying soils can be achieved by spreading and disking in sunny, dry weather or by mixing with dryer soils. If the soils are

allowed to become saturated during wet weather, drying may not be feasible. We recommend that the contractor be equipped for both during and wetting of soils.

Positive drainage should be maintained at all times to prevent saturation of exposed soils in case of sudden rains. Rolling the surface of disturbed soils will also improve runoff and reduce the potential for construction delays. The degree of soil stability problems will also be dependent upon the precautions taken by the contractor to help protect these moisture sensitive soils.

7.5 Structural Fill Placement and Compaction

Prior to fill placement, representative samples of each structural fill material should be collected and tested by Accura Engineering and Consulting to determine the material's moisture-density characteristics (including the maximum dry density, optimum water content, gradation and Atterberg limits). These tests are needed for quality control of the structural fill and to determine if the fill material meets project specification requirements.

Fill in structural areas should be free of organics, roots, or other deleterious materials; should not contain more than five percent (by weight) organic material; should not have a plasticity index (PI) greater than 25, and; should not have a maximum dry density less than 90 pounds per cubic foot. Soils not meeting these criteria may be used in landscaped or non-structural areas. Compacted structural fill should consist of material classified as CL, ML, SC or SM per ASTM D2487, or others as approved by the geotechnical engineer. Soils imported from off-site sources should also meet similar classification requirements and be approved by the geotechnical engineer prior to use. Successful reuse of the excavated, on-site soils as compacted structural fill will depend on the water content and the plasticity of the soils encountered during excavation.

Once fill placement begins, a qualified soils technician should perform field density tests to document the degree of compaction being obtained in the field. Structural fills should be placed in thin (8- to 10-inch) loose lifts and compacted to the following recommendations:

- Upper 18 inches below the final subgrade elevation:
    - 98% of the soil's standard Proctor maximum dry density (ASTM Test Method D698) at or near optimum water content: maximum deviation of ±3 percent.
- Depths below 18 inches:

- 95% of the soil's standard Proctor maximum dry density (ASTM Test Method D698) at or near optimum water content: maximum deviation of ±3 percent.

Some manipulation of the water content (such as wetting or drying) may be required during the filling operation to obtain the required degree of compaction. The manipulation of the water content is highly dependent on weather conditions and site drainage conditions. Therefore, the grading contractor should be prepared to both dry and wet the fill materials to obtain the specified compaction during grading. Regular one-point Proctor tests should be conducted in an attempt to verify that the most representative Proctor curve is being selected. Sufficient density tests should be performed to confirm the required compaction of the fill material.

7.6 Surface Water Control

If free water is allowed to stand on stable subgrade soils, particularly the sandy silt materials, these soils can absorb water, swell, and experience a reduction in their support capability. As a result, we recommend that the subgrade surface be graded to provide positive drainage away from the construction areas and towards suitable drainage handling areas, such as a perimeter ditch, French drain, culvert, or retention pond.

Due to the presence of moisture-sensitive soils, trapped or perched water conditions could develop during periods of inclement weather and during seasonally wet periods. Such conditions could cause seepage into excavations and deeper cuts. Therefore, grading of the project should be performed in such a manner to prevent ponding of water and promote runoff away from construction areas. In addition, if site grading is performed during the seasonally wet months or after extended periods of inclement weather, wet and water softened near surface soil conditions should be expected.

7.7 Groundwater Conditions

In the borings hole caving was observed and was noted to occur between about 18 and 20 feet below the ground surface. This can be indicative of the presence of groundwater. Based on the caving depth, groundwater may be encountered at depths shallower than those recorded in the borings.

Surface water or groundwater should be anticipated for the footing excavations in wing wall and foundation excavations. We recommend the foundation contractor be prepared to dewater the bottom of foundation excavations during construction to

insure a competent foundation is placed. Dewatering will be required to control the stream flow and groundwater infiltration during construction of the planned culvert. The stream flow may be controlled by constructing a temporary dam upstream of the construction zone and pumping the water past the construction area to a downstream outlet. Further dewatering can be achieved at the time of construction through the use of ditches and swales along the bottom edges of excavations leading to sump pumps. During construction, proper measures such as silt fencing, settling ponds etc., should be undertaken for erosion and sediment control. Discharge of water from the site must be conducted in accordance with applicable regulatory agency requirements.

Groundwater levels tend to fluctuate with seasonal and climatic variations as well as with some types of construction operations. Generally, the highest groundwater levels occur in late winter and early spring and the lowest levels occur in late summer and early fall. Depending on time of construction, groundwater may be encountered at shallower depths and locations not explored during this study. If encountered during construction, engineering personnel from our office should be notified immediately.

7.8 Excavation Characteristics

We anticipate a majority of the low consistency and density soils at the culvert location or bottom of the existing sinkholes can be excavated with backhoes, front-end loaders or other similar equipment using conventional means and methods. However, where weathered rock is encountered at shallow depths, increased effort such as jack hammering or ripping will be necessary to excavate the weathered rock. Typically, material with an N-value of 50 blows per 3 to 6 inches of penetration can be excavated with moderate to heavy effort using appropriately sized equipment, such as a large track-hoe (e.g., Caterpillar 330 with rock teeth). Material that exhibits less than 3 inches of penetration per 50 blows and material causing auger refusal will likely require jack hammering, or drilling to facilitate removal.

7.9 Excavations

Mass excavations and other excavations required for construction of this project must be performed in accordance with the United States Department of Labor, Occupational Safety and Health Administration (OSHA) guidelines (29 CFR 1926, Subpart P, Excavations) or other applicable jurisdictional codes for permissible temporary side-slope ratios and or shoring requirements. The OSHA guidelines require daily inspections of excavations, adjacent areas and protective systems by a “competent person” for

evidence of situations that could result in cave-ins, indications of failure of a protective system, or other hazardous conditions.

If the wing wall foundations and culvert base foundation are excavated to a depth close to the creek elevation, adequate benching should be performed in order to provide slopes that are stable throughout the wall and culvert construction process. If creek flow is not diverted around the excavation area, added sloughing of the excavated face can be anticipated.

The contractor is responsible for providing the "competent person" and all aspects of site excavation safety.

8.0 LIMITATIONS

This report has been prepared for **Jacobs** in accordance with generally accepted soil and foundation engineering practices. No other warranty, express or implied, is made. Our conclusions and recommendations are based on design information furnished to us at the time the work was performed; the data obtained from the previously described subsurface exploration program, and generally accepted geotechnical engineering practice. The findings and recommendations do not reflect variations in subsurface conditions, which could exist in unexplored areas of the site. In areas where variations from the available subsurface data become apparent during construction, it will be necessary to re-evaluate our conclusions and recommendations based upon on-site observations of the conditions.

Regardless of the thoroughness of a subsurface exploration, there is the possibility that conditions in other areas will differ from those at the boring locations, that conditions are not as anticipated by the designers, or that the construction process has altered the soil conditions. Therefore, our experienced geotechnical engineers should evaluate foundation construction to verify that the conditions anticipated in design actually exist. Otherwise, we assume no responsibility for construction compliance with the design concepts, specifications, or recommendations.

ACCURA ENGINEERING AND CONSULTING SERVICES, INC.

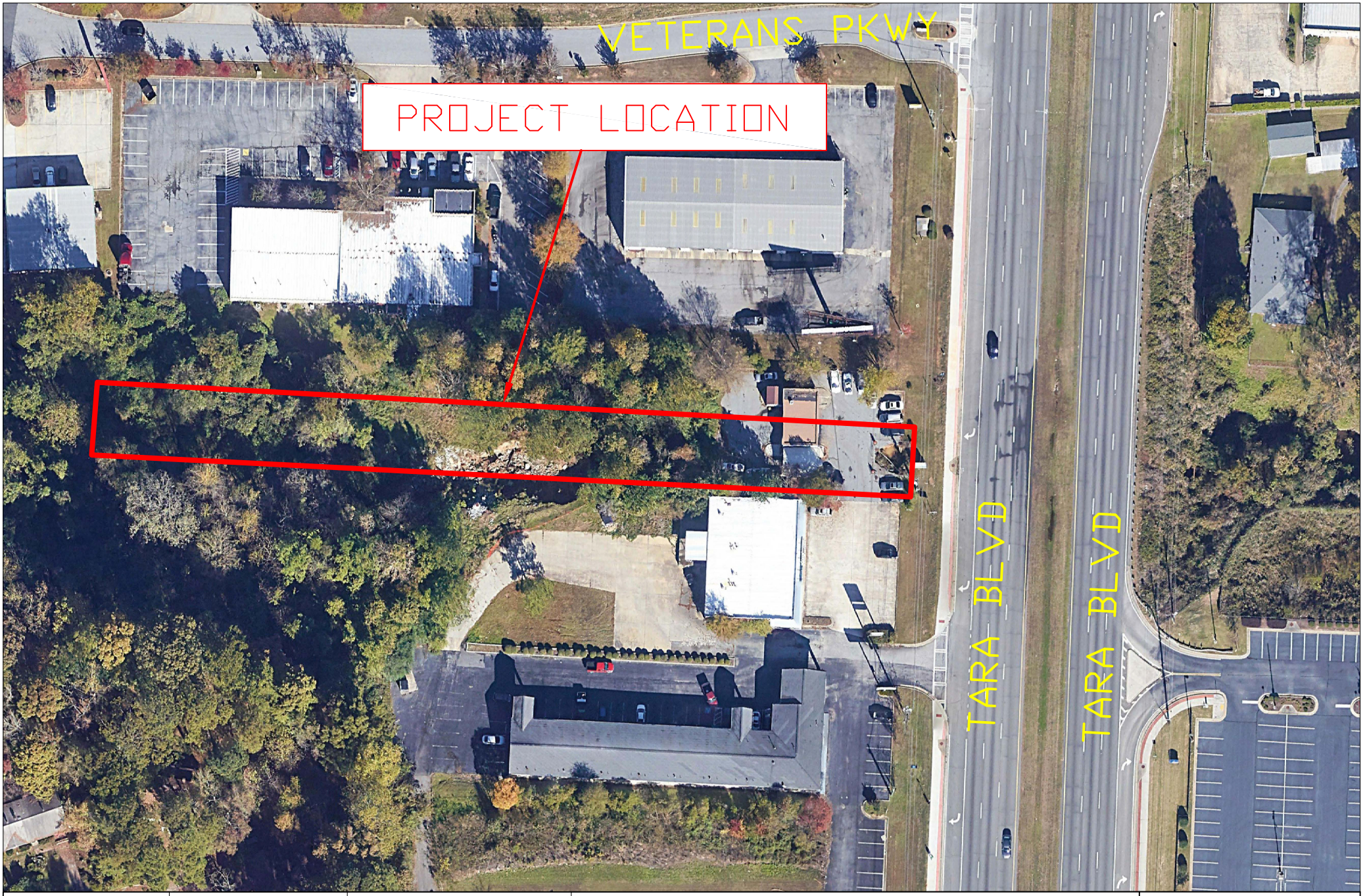
Ken Khanidokht, P.E.
Geotechnical Group Leader-Senior Engineer

APPENDIX I

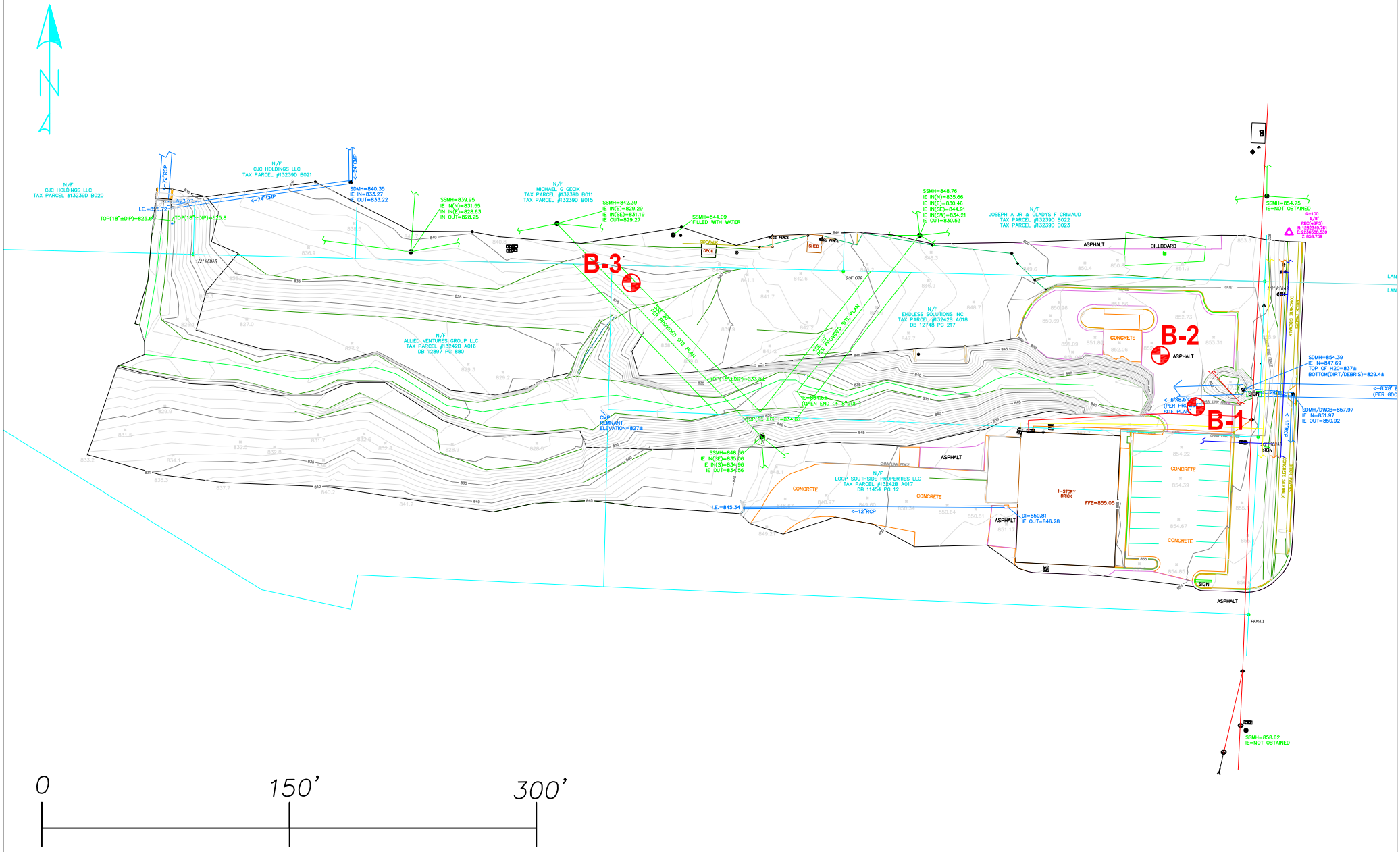
Site Vicinity Map (Drawing No. 01)

Test Location Plan (Drawing No. 02)

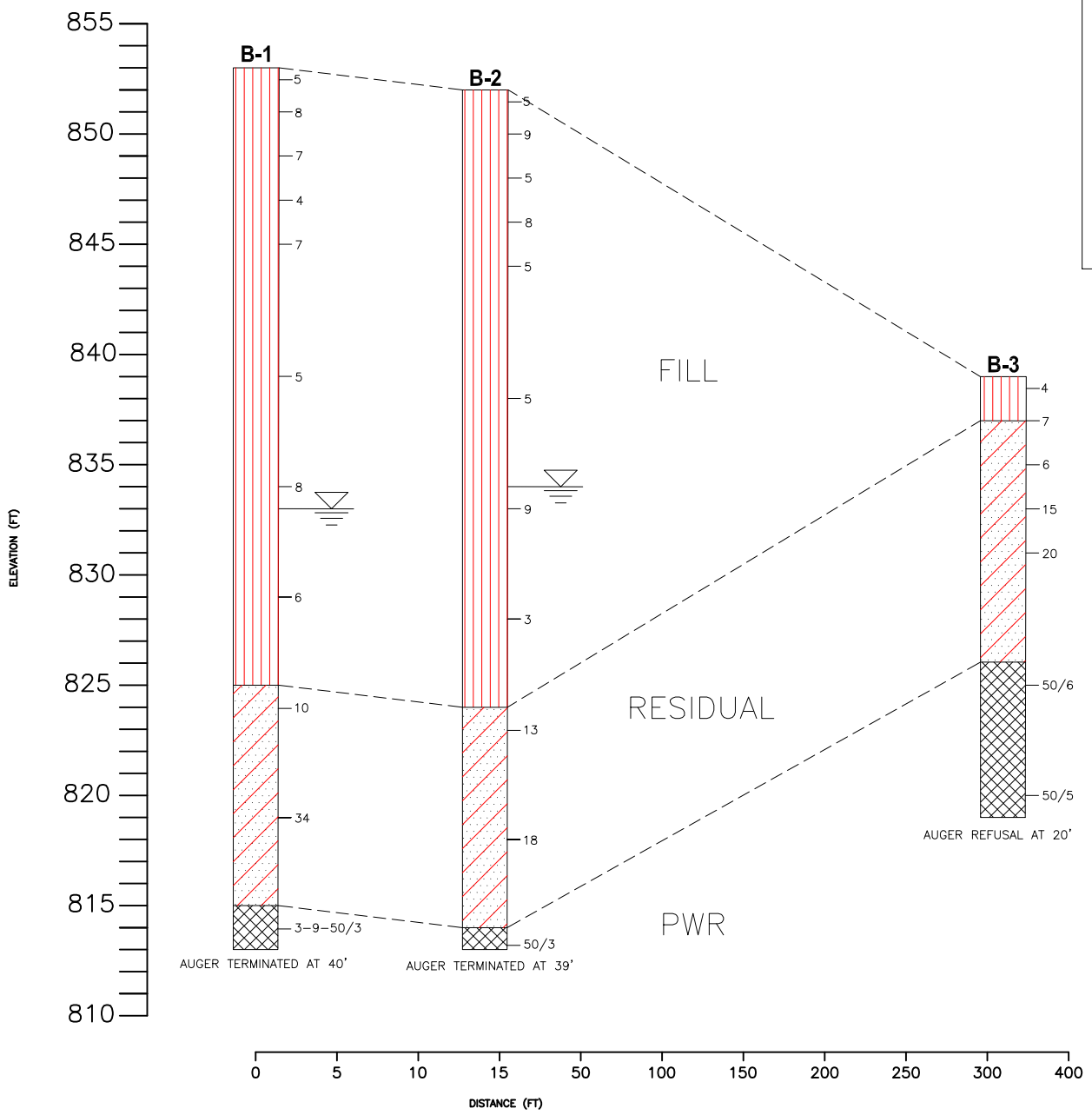
Subsurface Profile (Drawing No. 03)



SCALE: NTS	DATE: 06/01/2022	PROJECT NO: 10232	**TITLE:**	**SITE VICINITY MAP** CULVERT REHABILITATION PROJECT JONESBORO, CLAYTON COUNTY, GEORGIA
PREPARED: HT	CHECKED: KK	REVISIONS:		
CLIENT: **JACOBS ENGINEERING GROUP INC.**			**ACCURA ENGINEERING AND CONSULTING SERVICES, INC.** 3200 PRESIDENTIAL DR ATLANTA, GA 30340 PHONE:404.241.8722 FAX:404.241.4577	**DRAWING NO. 01**



SCALE:AS SHOWN	DATE:08/08/2022	PROJECT NO:10232	**TITLE:**	**TEST LOCATION PLAN** CULVERT REHABILITATION PROJECT JONESBORO, CLAYTON COUNTY, GEORGIA
PREPARED: HT	CHECKED: KK	REVISIONS:		
CLIENT: **JACOBS ENGINEERING GROUP INC.**			**ACCURA ENGINEERING AND CONSULTING SERVICES, INC.** 3200 PRESIDENTIAL DR ATLANTA, GA 30340 PHONE:404.241.8722 FAX:404.241.4577	**DRAWING NO. 02**



SCALE:AS SHOWN	DATE:08/05/2022	PROJECT NO: 10232	**TITLE:**	**SUBSURFACE PROFILE** CULVERT REHABILITATION PROJECT JONESBORO, CLAYTON COUNTY, GEORGIA
PREPARED: HT	CHECKED: KK	REVISIONS:		
CLIENT: **JACOBS ENGINEERING GROUP INC.**			**ACCURA ENGINEERING AND CONSULTING SERVICES, INC.** 3200 PRESIDENTIAL DR ATLANTA, GA 30340 PHONE:404.241.8722 FAX:404.241.4577	**DRAWING NO. 03**

APPENDIX II

Boring Logs (B-1 through B-3)

Key to Soil Classification

Soil Classification Chart

Photographs of Site (4 pages)

Laboratory Testing Results (5 pages)

Laboratory Test Procedures

Accura Engineering and Consulting Services, Inc.
3200 Presidential Drive
Atlanta, GA 30340
Office: 404.241.8722

BORING LOG

CONTRACTED WITH: JACOBS ENGINEERING GROUP INC. BORING NO.: B-1
PROJECT NAME: CULVERT REHABILITATION PROJECT DATE: 7/27/2022
JOB NO.: 10232 DRILLER: GEORGE RIG: CME45C LOGGED BY: HT

ELEV.	DESCRIPTION	DEPTH in FEET	SAMPLES NO.	TYPE	BLOWS/6"	RECOV.	W	NOTES
	4" ASPHALT	0						
	FILL:Sand-silty, trace mica, brown, loose (SM)		1		2-2-3-4	22		Lat: 33.524890 Long: -84.363734
850	-trace rock fragments		2		2-3-5-6	20		
	Silt-sandy, some mica, brown, firm (ML)	5	3		2-3-4-3	22		
	Sand-silty, trace clay, brown, very loose (SM)		4		2-1-3-3	22		
845	-some rock fragments, dark grey, loose		5		1-3-4-4	20		
		10						
840								
		15	6		2-2-3	12	26	LL=NP,PL=NP,PI=NP
835	-		7		2-4-4	14		
		20 ▽						Groundwater encountered at 20 feet after completion of drilling
830	-		8		2-3-3	14		
		25						
825	RESIDUAL: Sand-silty, brown, loose, moist (SM)		9		2-4-6	12		
		30						
820	-trace rock fragments and mica, grey, dense		10		5-10-24	12		
		35						
815	Partially Weathered Rock sampled as Sand-silty, trace mica, brown, very dense		10		3-9-50/3	10		LL=Liquid Limit PL=Plastic Limit PI=Plasticity Index NP=None Plastic
		40						
	AUGER TERMINATED AT 40 FEET							

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3200 Presidential Drive
Atlanta, GA 30340
Office: 404.241.8722

BORING LOG

CONTRACTED WITH: JACOBS ENGINEERING GROUP INC. BORING NO.: B-2
PROJECT NAME: CULVERT REHABILITATION PROJECT DATE: 7/27/2022
JOB NO.: 10232 DRILLER: GEORGE RIG: CME45C LOGGED BY: HT

ELEV.	DESCRIPTION	DEPTH in FEET	SAMPLES NO.	TYPE	BLOWS/6"	RECOV.	W	NOTES
	4" ASPHALT	0						
	FILL:Sand-silty, some mica, brown, loose (SM)		1		2-2-3-3	20	22	Lat: 33.5249123 Long: -84.3637738
850	-some rock fragments		2		8-4-5-5	14		LL=NP,PL=NP,PI=NP
		5	3		2-2-3-3	16		
	-some clay, tan		4		2-4-4-4	16		
845	-		5		2-2-3-4	20		
		10						
840								
	Silt-sandy, some mica, brown, firm (ML)		6		2-2-3	12		
		15						
835		▽						
	-some rock fragments, grey, moist, stiff		7		1-3-6	14		
		20						Groundwater encountered at 18 feet after completion of drilling
830								
	-dark grey, soft		8		1-1-2	12		
		25						
825								
	RESIDUAL: Sand-silty, some rock fragments, orange, medium dense (SM)		9		10-7-6	12		
		30						
820								
	-grey		10		3-8-10	12		
		35						
815								
	Partially Weathered Rock sampled as Sand-silty, trace mica, brown, very dense		10		50/5	4		LL=Liquid Limit PL=Plastic Limit PI=Plasticity Index NP=None Plastic
	AUGER TERMINATED AT 39 FEET	40						

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BORING LOG

CONTRACTED WITH: JACOBS ENGINEERING GROUP INC. BORING NO.: B-3
PROJECT NAME: CULVERT REHABILITATION PROJECT DATE: 7/27/2022
JOB NO.: 10232 DRILLER: GEORGE RIG: CME45C LOGGED BY: HT

ELEV.	DESCRIPTION	DEPTH in FEET	SAMPLES NO.	TYPE	BLOWS/6"	RECOV.	W	NOTES
840	4" TOPSOILS	0						
	FILL: Sand-silty, some clay and mica, brown, very loose (SM)		1		2-1-3-4	20		Lat: 33.5250481 Long:-84.3647930
	RESIDUAL: Sand-silty, some clay, brown, loose (SM)		2		3-3-4-5	18		
835	-	5	3		2-2-4-4	20		
	-some rock fragments, medium dense		4		6-6-9-11	20		
	-grey		5		4-9-11-10	14		
830		10						
	Partially Weathered Rock sampled as Sand-silty, brown, very dense		6		50/6	10		
825		15						
	-grey and white		7		50/5	8		
820		20						
	AUGER REFUSAL AT 20 FEET							No groundwater was encountered after completion of drilling
815		25						
810		30						
805		35						
800		40						

KEY TO BORING LOG SOIL CLASSIFICATION

Particle Size and Proportion

Verbal descriptions are assigned to each soil sample or stratum based on estimates of the particle size of each component of the soil and the percentage of each component of the soil.

Particle Size Descriptive Terms		Proportion Descriptive Terms		
Soil Component	Particle Size	Component	Term	Percentage
Boulder	> 12 inch	Major	Uppercase Letters (e.g., SAND, CLAY)	>50%
Cobble	3 – 12 inch			
Gravel-Coarse	¾ - 3 inch			
-Fine	#4 – ¾ inch	Secondary	Adjective (e.g. sandy, clayey)	20%-50%
Sand-Coarse	#10 - #4			
-Medium	#40 - #10			
-Fine	#200 - #40	Minor	Some	15%-25%
Silt (non-cohesive)	< #200		Little	5%-15%
Clay (cohesive)	< #200		Trace	0%-5%

Notes:
1. Particle size is designated by U.S. Standard Sieve Sizes
2. Because of the small size of the split spoon sampler relative to the size of gravel, the true percentage of gravel may not be accurately estimated.

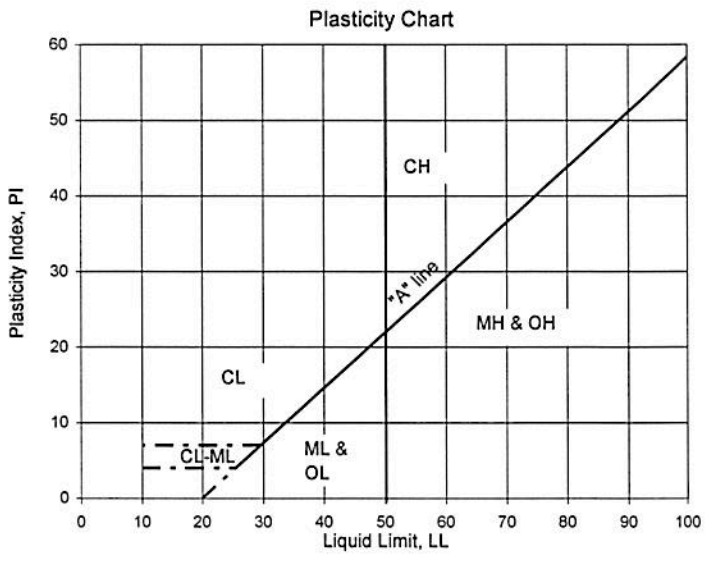
Density or Consistency

The standard penetration resistance values (N-values are used to describe the density of coarse-grained soils (GRAVEL, SAND) or the consistency of fine-grained soils (SILT, CLAY). Sandy silts of very low plasticity may be assigned a density instead of a consistency.

DENSITY		CONSISTENCY	
Term	N-Value	Term	N-Value
Very Loose	0 – 4	Very Soft	0 – 1
Loose	5 – 10	Soft	2 – 4
Medium-Dense	11 – 30	Medium Stiff	5 – 8
Dense	31 – 50	Stiff	9 – 15
Very Dense	> 50	Very Stiff	16 – 30
		Hard	>30

Notes:
1. The N-value is the number of blows of a 140 lb. hammer freely falling 30 inches required to drive a standard split-spoon sampler (2.0 in. O.D., 1-3/8 in. I.D.) 12 inches into the soil after properly seating the sampler 6 inches.
2. When encountered, gravel may increase the N-value of the standard penetration test and may not accurately represent the in-situ density or consistency of the soil sampled.

UNIFIED SOIL CLASSIFICATION SYSTEM (ASTM D-2487)

Major Divisions			Group Symbols	Typical Names	Laboratory Classification Criteria		
Coarse-grained soils (More than half of material is larger than No. 200 sieve size)	Gravels (More than half of coarse fraction is larger than No. 4 sieve size)	Clean gravels (little or no fines)	GW	Well-graded gravels, gravel-sand mixtures, little or no fines	Determine percentages of sand and gravel from grain-size curve. Depending on percentage of fines (fraction smaller than No. 200 Sieve), coarse-grained soils are classified as follows: Less than 5 per cent GW, GP, SW, SP; More than 12 per cent GM, GC, SM, SC; 5 to 12 per cent Borderline cases requiring dual symbols	$C_u=D_{60}/D_{10}$ greater than 4; $C_c=(D_{30})^2/(D_{10}xD_{60})$ between 1 and 3	
			GP	Poorly graded gravels, gravel-sand mixtures, little or no fines		Not meeting all gradation requirements for GW	
		Gravels with fines (Appreciable amount of fines)	GM	Silty gravels, gravel-sand-silt mixtures		Atterberg limits below "A" line or PI less than 4	Above "A" line with PI between 4 and 7 are borderline cases requiring use of dual symbols
			GC	Clayey gravels, gravel-sand-clay mixtures		Atterberg limits below "A" line or PI greater than 7	
	Sands (More than half of coarse fraction is smaller than No.4 sieve size)	Clean sands (little or no fines)	SW	Well-graded sands, gravelly sands, little or no fines		$C_u=D_{60}/D_{10}$ greater than 6; $C_c=(D_{30})^2/(D_{10}xD_{60})$ between 1 and 3	
			SP	Poorly graded sands, gravelly sands, little or no fines		Not meeting all gradation requirements for SW	
		Sands with fines (Appreciable amount of fines)	SM	Silty sands, sand-silt mixtures		Atterberg limits above "A" line or PI less than 4	Above "A" line with PI between 4 and 7 are borderline cases requiring use of dual symbols
			SC	Clayey sands, sand-clay mixtures		Atterberg limits above "A" line or PI greater than 7	
Fine-grained soils (More than half material is smaller than No. 200 sieve	Silts and clays (Liquid limit less than 50)		ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands, or clayey silts with slight plasticity			
			CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays			
			OL	Organic silts and organic silty clays of low plasticity			
	Silts and clays (Liquid limit greater than 50)		MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts			
			CH	Inorganic clays of high plasticity, fat clays			
			OH	Organic clays of medium to high plasticity			
	Highly organic soils		Pt	Peat and other highly organic soils			

View of sinkhole and B1/B2 area.

View of sinkhole and Leslie's Pool Supplies building.

View of sinkhole, facing west.

View of sinkhole around manhole, facing Tara Blvd.

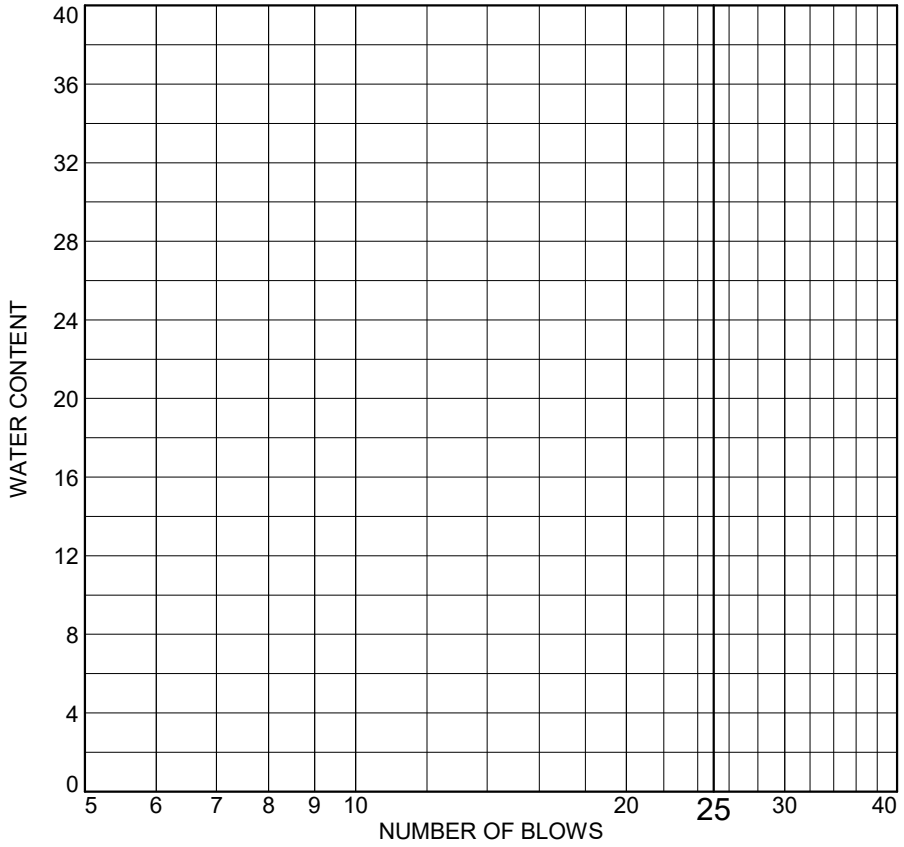
Showing of borehole operation near sinkhole.

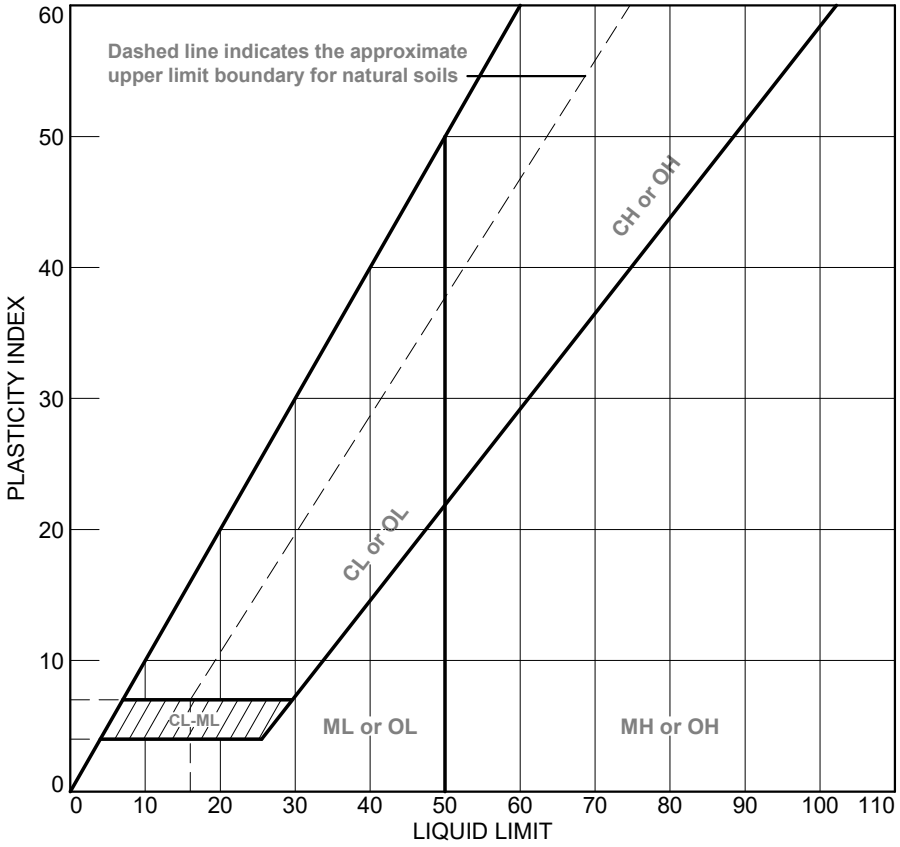
Showing of B-3 area behind of Veterans community center building.

Front view of Veterans community center building and parking lot.

View of removed Emission Testing building north of sinkhole.

LIQUID AND PLASTIC LIMITS TEST REPORT





	SOURCE	SAMPLE #	DEPTH/ELEV.	DATE SAMPLED	USCS	MATERIAL DESCRIPTION	NM %	LL	PI
●	B-1	N/A	13.5-15'	07/28/2022	SM	Brown Silty Sand	25.7	NV	NP

Client Accura Engineering and Consulting

Project CCWA Culvert Rehabilitation

Project No. 6162191251.28 Figure

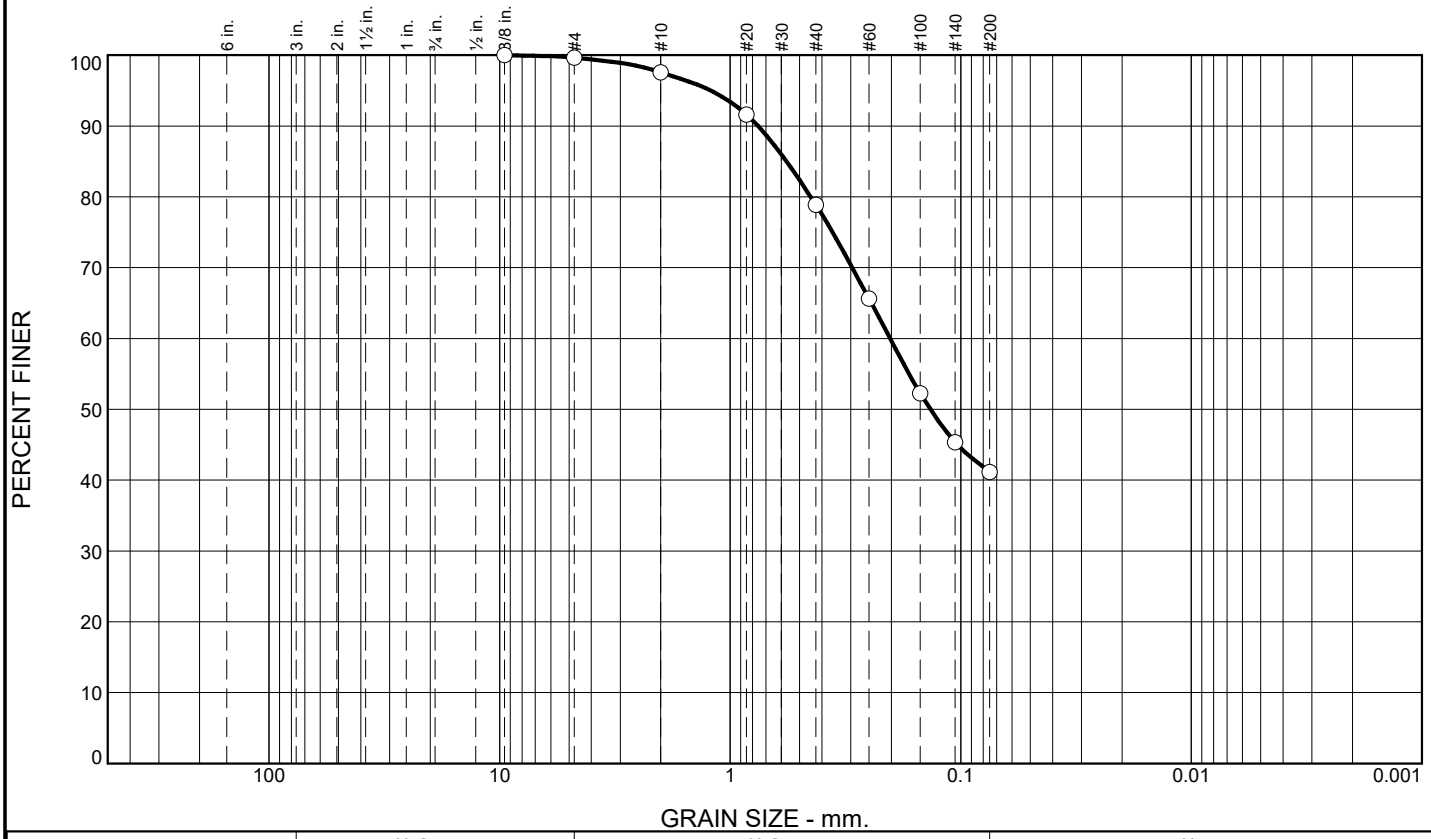
wood.

● Lab No 22116

Tested By: TZ **Checked By:** TZ

Sieve Analysis

ASTM D6913



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.4	2.0	18.7	37.7	41.2	

Test Results (ASTM D6913)

Sieve Size or Diam. (in.)	Finer (%)	Spec.* (%)	Out of Spec. (%)	Pct. of Fines
0.375"	100.0			
#4	99.6			
#10	97.6			
#20	91.6			
#40	78.9			
#60	65.6			
#100	52.3			
#140	45.4			
#200	41.2			

* (no specification provided)

Material Description

Brown Silty Sand

Atterberg Limits

PL= NP LL= NV PI= NP

Coefficients

D_{90}= 0.7570 D_{85}= 0.5699 D_{60}= 0.2024
D_{50}= 0.1354 D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= SM AASHTO= A-4

Test Remarks

Lab No 22116

Source of Sample: B-1 **Depth:** 13.5-15'
Sample Number: N/A **Sample Date:** 07/28/2022

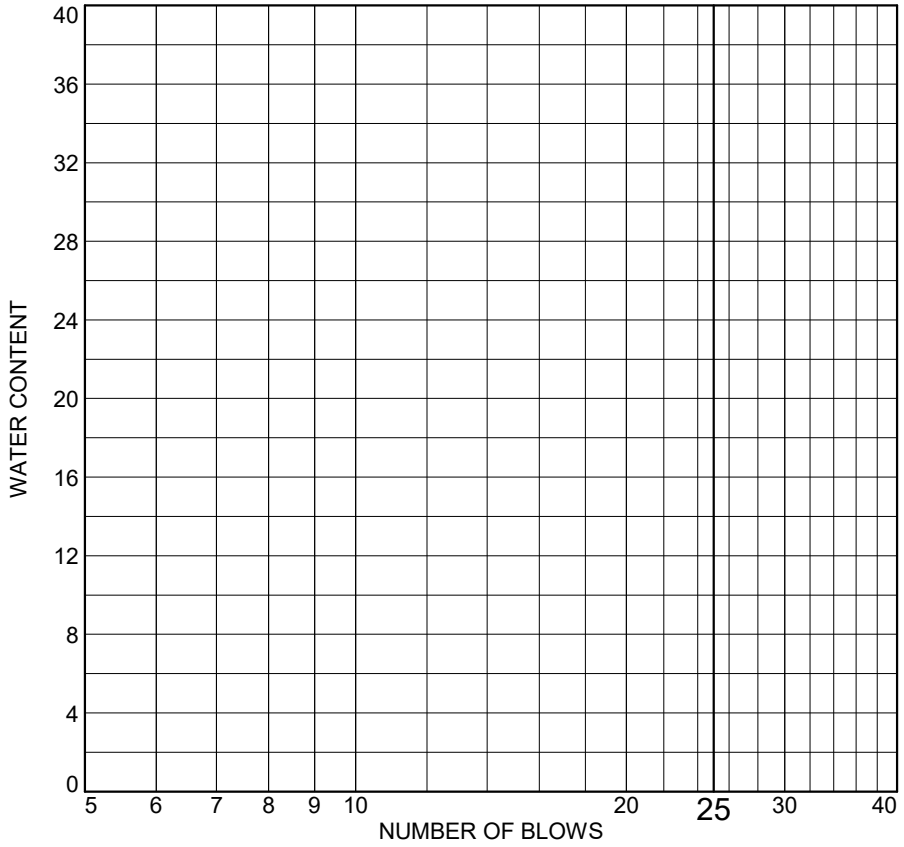
wood.

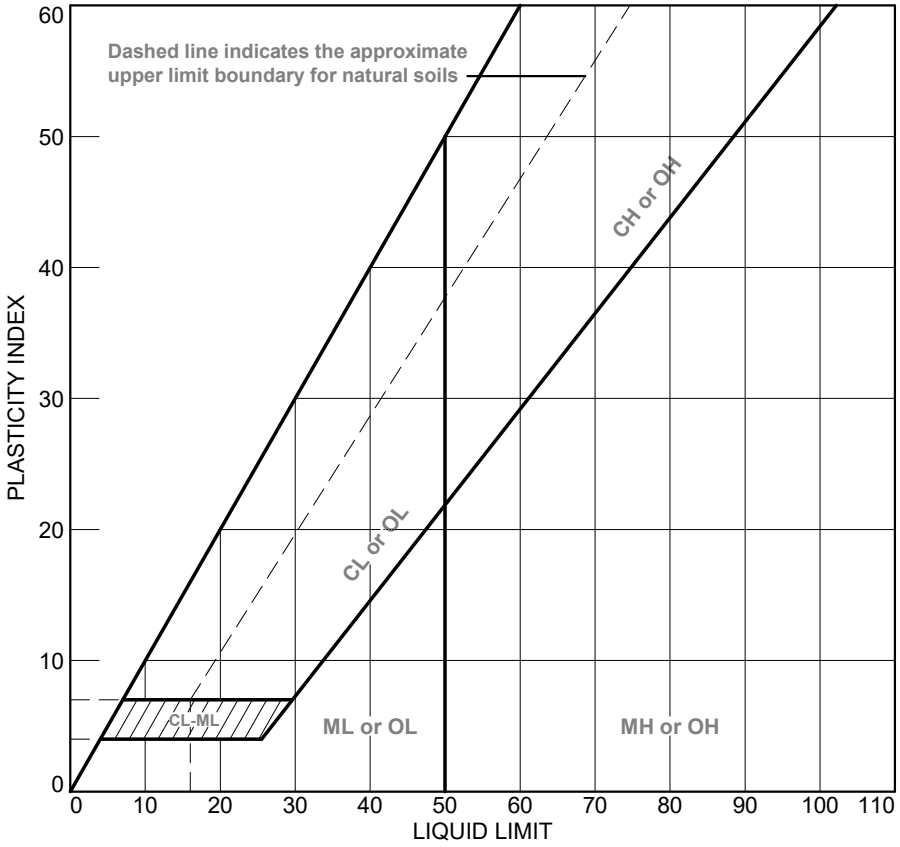
Client: Accura Engineering and Consulting
Project: CCWA Culvert Rehabilitation

Project No: 6162191251.28 **Figure**

Tested By: FF **Checked By:** TZ

LIQUID AND PLASTIC LIMITS TEST REPORT





	SOURCE	SAMPLE #	DEPTH/ELEV.	DATE SAMPLED	USCS	MATERIAL DESCRIPTION	NM %	LL	PI
●	B-2	N/A	0-2'	07/28/2022	SM	Light Brown Silty Sand	21.6	NV	NP

Client Accura Engineering and Consulting

Project CCWA Culvert Rehabilitation

Project No. 6162191251.28 Figure

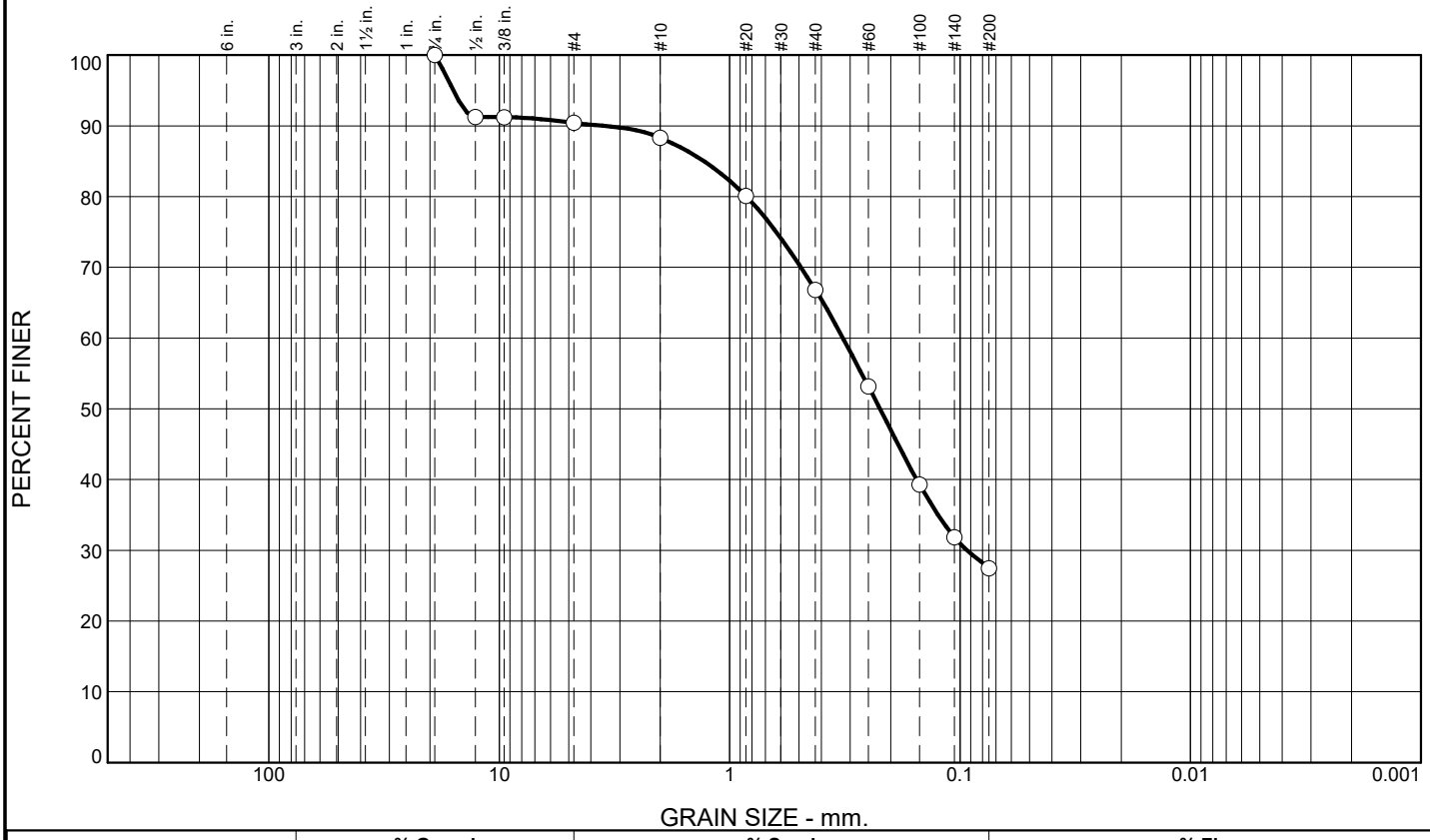
wood.

● Lab No 22117

Tested By: AM **Checked By:** TZ

Sieve Analysis

ASTM D6913



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	9.6	2.1	21.5	39.3	27.5	

Test Results (ASTM D6913)

Sieve Size or Diam. (in.)	Finer (%)	Spec.* (%)	Out of Spec. (%)	Pct. of Fines
0.750"	100.0			
0.500	91.2			
0.375"	91.2			
#4	90.4			
#10	88.3			
#20	80.1			
#40	66.8			
#60	53.2			
#100	39.3			
#140	31.8			
#200	27.5			

* (no specification provided)

Material Description

Light Brown Silty Sand

Atterberg Limits

PL= NP LL= NV PI= NP

Coefficients

D_{90}= 3.4732 D_{85}= 1.2922 D_{60}= 0.3226
D_{50}= 0.2224 D_{30}= 0.0933 D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= SM AASHTO= A-2-4

Test Remarks

Lab No 22117

Source of Sample: B-2 **Depth:** 0-2'
Sample Number: N/A **Sample Date:** 07/28/2022

wood.

Client: Accura Engineering and Consulting
Project: CCWA Culvert Rehabilitation

Project No: 6162191251.28 **Figure**

Tested By: AM **Checked By:** TZ

MOISTURE CONTENT

ASTM D2216-19

Project Name CCWA Culvert Rehabilitation **Project No.** 6162191251

Tested By AM **Reviewed By** TZ

Test Date 7/28/2022 **Review Date** 8/2/2022

Boring No.	Sample No.	Depth (Ft)	Lab No.	Tare No.	Tare Wt. (grams)	Wet Soil + Tare (grams)	Dry Soil + Tare (grams)	Dry Soil Wt (grams)	Moisture Content (%)
B-1	N/A	13.5-15	22116	SS-45	142.97	284.83	255.84	112.87	25.7
B-2	N/A	0-2'	22117	LS-53	93.02	242.51	215.97	122.95	21.6

LABORATORY TESTING PROCEDURES

Moisture Content

The moisture content soil samples were obtained from undisturbed Shelby tubes samples. A representative portion of each sample was weighed and then placed in an oven and dried at 110 degrees Centigrade for at least 15 to 16 hours. After removal from the oven, the soil was again weighed. The weight of the moisture lost during drying thus was determined. From this data, the moisture content of the sample was then calculated as the weight of moisture divided by dry weight of the soil, expressed as a percentage. This test was conducted according to ASTM D 2216. Moisture content is a useful index of a soil's compressibility.

Grain Size (Sieve) Analysis with or without Hydrometer

Grain Size Analysis tests were performed to determine the particle size distribution of selected samples tested. The grain size distribution of soils coarser than a number 200 sieve was determined by passing the samples through a standard set of nested sieves. Materials finer than the number 200 sieve were suspended in water and the grain size distribution computed from the time rate of settlement of the different size particles. Air-dried soil passed through #200 sieve. 50 grams of that must soak in s/c agent for a minimum of 8 hours. Soil is then put in graduated cylinder with a hydrometer. Readings are taken at specified times. A graph is drawn from data. These tests were similar to those described by ASTM D 421 and D 422. The results are included in the Appendix.

Liquid and Plastic Limits (Atterberg Limits)

Liquid Limit and Plastic Limit tests aid in the classification of the soils and provide an indication of the soil behavior with moisture change. The Plasticity Index is calculated by subtracting the Plastic Limit (PL) from the Liquid Limit (LL). The Liquid Limit is the moisture content at which the soil will flow as a heavy viscous fluid and is the upper limit of the plastic range, as determined in accordance with ASTM D 4318. The Plastic Limit is the moisture content at which the soil begins to lose its plasticity, as determined in accordance with ASTM D 4318. The Liquidity Index is the ratio of the difference between the in-place moisture and the plastic limit to the Plasticity Limit. Soil is air-dried and pulverized to pass through # 4 sieve prior to running the test. The results are shown on the attached Liquid and Plastic Limits reports in the Appendix.

DRAWINGS