GREENVILLE UTILITIES COMMISSION
GREENVILLE, NORTH CAROLINA

FOUNDATION
SPECIFICATIONS FOR THE
GREENVILLE WEST SUBSTATION

PRELIMINARY – DO NOT USE FOR CONSTRUCTION

ISSUED FOR BIDS

November 28, 2018

BOOTH & ASSOCIATES, LLC

GREENVILLE UTILITIES COMMISSION
GREENVILLE, NORTH CAROLINA

FOUNDATION
SPECIFICATIONS FOR THE
GREENVILLE WEST SUBSTATION

SEAL
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TECHNICAL SPECIFICATIONS

1.0 General

The Foundation Specifications, Oil Containment Specifications, and Drawings are complementary, each to the other.

The Contractor shall furnish and install the reinforced concrete foundations as shown on the drawings, complete with excavation, off-site disposal of excavated spoils, grading, backfilling, and compaction of all excavations to restore existing grade levels, foundation layout, concrete, rebar, tie wire, and forming materials.

The reinforced concrete foundations, footings, piers and pads shall be installed as indicated on the Drawings, and to undisturbed earth. Dimensions indicated for anchor bolt settings shall be checked against the manufacturer's erection drawings, structural steel and/or equipment to be installed prior to the construction of the formwork.

1.1. Special Conditions

The contractor is responsible to review and become familiar with the soil boring report by Titan Atlantic Group, Inc. for the Greenville West Substation, Project No. 019907-80, attached in appendices of the project specifications.

1.2. Concrete

This section specifies the minimum materials, workmanship, and performance standards for cast-in-place concrete including reinforcing steel, forms, finishing, curing, and other associated work.

Cast-in-place concrete shall be in accordance with the latest applicable requirements of the ACI, ASTM, and CRSI, except as modified by these Specifications. For the purposes of mix design, cast-in-place concrete is considered to be of Exposure Category F2 as defined by ACI 318.

Requirements for Concrete By Exposure Class

Exposure Class	**Max *w/cm***	**Minimum Compressive Strength**	**Air Content**	**Cement Type**
F2	0.45	4,500	6 ± 1	I

**Source: ACI 318-11, Table 4.3.1

The Owner shall be informed at least 24 hours in advance of the times and places at which concrete will be placed.

1.3. Materials

1.3.1. Cement

Only one (1) brand of cement shall be used for exposed concrete. Cement reclaimed from cleaning bags or leaking containers shall not be used. Cement shall be used in the sequence of receipt of shipments, unless otherwise directed by the Engineer. Cement will be accepted on the basis of the manufacturer's mill certificate of compliance with the Specification requirements. Portland cement shall conform to the "Standard Specifications for Portland Cement", serial designation C150, Type I of the ASTM.

1.3.2. Cementitious Materials

Fly ash shall conform to the latest edition of ASTM C 618 and be of type Class F.

1.3.3. Fine Aggregate

Fine aggregate shall consist of washed natural siliceous sand, composed of clean, hard and durable grains, and shall be of a quality and gradation approved by the Engineer. Manufactured sand will not be accepted. All fine aggregate shall be free from injurious amounts of alkaline and organic impurities. Fine aggregate shall be graded from coarse to fine and shall conform to ASTM C33.

1.3.4. Coarse Aggregate

Coarse aggregate shall consist of crushed stone or other approved inert material with similar characteristics. It shall be clean, hard, durable, and free from injurious amounts of deleterious matter. Clay and shale particles shall not exceed 1 percent (1%). Course aggregate shall be graded from coarse to fine and shall conform to ASTM C33.

1.3.5. Water

Water shall be clean, fresh, and free from injurious amounts of mineral and organic substances. Iron in water shall not exceed 0.25 ppm.

1.3.6. Admixtures

All admixtures are to be supplied by a single approved manufacturer, such as: Master Builders, WR Grace & Co., or Sika Chemical. Admixtures shall conform to the following standards:

Water Reducing (plasticizer)	ASTM C494, Type A
Water Reducing and Retarding	ASTM C494, Type D
High Range Water Reducer	ASTM C494, Type F
High Range Water Reducer and Retarder	ASTM C494, Type G
Air-Entraining Agent	ASTM C260

1.3.7. Reinforcing Steel

a. Reinforcing Bars - All reinforcing steel bars shall be of the deformed type conforming to the requirements of the "Standard Specifications for Bars, Deformed, and Plain, Billet-Steel for Concrete Reinforcement". Steel shall be Type A615 or A996-Grade 60.

b. Welded Wire Fabric – Welded wire fabric reinforcement used in slabs shall conform to the requirements of ASTM A1064. It shall be continuous, shall have joints lapped at least one full mesh, and shall be supported at proper elevations by standard accessories. Lapping of sheets shall be staggered to avoid continuous lap in either direction.

c. Accessories – Accessories such as chairs, ties, bolsters, spacers, etc., shall be of suitable type, as approved, adequate to prevent displacement during construction.

d. Mechanical Splices – Classified Type 2 in accordance with ACI 318-11 and approved by Engineer. Dayton/Richmond "Dowel Bar Splicer" or "Coupler Splice" system, Bar-Lock "Coupler Systems" or Barsplice Products.

1.3.8. Forms

Forms shall be made of rigid, straight, and uniform material that is free of injurious chemicals or organic matter.

Plywood	Product Standard PS1, waterproof, resin-bonded, exterior type Douglas fir; face adjacent to concrete Grade B plywood or better.
Metal	Of sufficient gauge to resist deformation.
Fiberboard	Fed Spec LLL-B-810, Type II; tempered, waterproof, screenback.
Lumber	Straight, uniform width and thickness, and free from knots, offsets, holes, dents, and other surface defects.
Chamfer strips	Clear pine, surface against concrete shall be planed.
Form coating	Nonstaining and nontoxic after 30 days, VOC compliant; Burke "Form Release (WB)," L&M Chemical "E Z Strip," Nox-Crete "Form Coating," or Symons "Thrift Kote E."
Polyethylene film	Fed Spec L-P-378D, Type I; 6 mil.

1.3.9. Finishing Compounds

Bonding compound	Epoxy - ASTM C881; Sika Chemical "Sikadur Hi-Mod"; or acceptable equal Latex - ASTM C1059; Dayton Acrylic Bonding Agent J40; or acceptable equal
Membrane Curing compound	ASTM C1315, Type I, Class A, maximum VOC 5.8 lb/gal (700 g/L), minimum 25 percent solids, acrylic, nonyellowing, unit moisture loss 0.40 kg/m^2 maximum in 72 hours; L&M Chemical

	"Dress & Seal 30," Sonneborn "Kure-N-Seal 30," or Symons "Cure & Seal 30%."

1.4. Submittals

Three copies of all reports shall be submitted to the Owner and Engineer within fifteen (15) days of contract award and prior to any concreting operations. The Engineer will provide approval within ten days (10 days) of receipt of submittals. All submittals shall be provided to the Owner and Engineer as a single packet. A Submittal Log is provided in Appendix A.

1.4.1. Material Reports

The report should include the source and quality of concrete materials and the concrete proportions proposed for the work. Complete certified reports covering the materials and proportions proposed and tested in accordance with ACI 318 shall be submitted to the Owner and Engineer. Reports shall be prepared by an independent testing laboratory. Owner and Engineer review of these reports will be for general acceptability only; continued compliance with all contract provisions will be required.

Reports on cement shall include the type, brand, manufacturer, composition, and method of handling (sack or bulk).

Reports on admixtures shall include the ASTM C260 or ASTM C494 classification, brand, manufacturer, and active chemical ingredients. All admixtures shall be the products of one manufacturer.

Reports on aggregates shall include the source, type, gradation, deleterious substances, soundness, potential for harmful materials, and potential for alkali reactivity. The results of all tests and field service records to verify potential reactivity are required to verify compliance with ASTM C33, including Appendix XI.

A certification that the reinforcing steel furnished complies with the requirements specified in the section titled “Materials” shall be furnished to the Owner and Engineer. The certification shall be signed by the Contractor and the reinforcing steel fabricator.

1.4.2. Mix Design Reports

A tentative concrete mix shall be designed and tested for each size and gradation of aggregates and for each mix class specified. Mix Design Reports shall be provided to the Owner and Engineer for each mix class to be utilized in the project and intended use identified on each mix report. Design quantities and test results of each mix shall be submitted to Owner and Engineer for review. With Engineer’s and/or Owner's approval, acceptable mixes may be field adjusted as necessary to meet the requirements of these Specifications.

The report for each tentative concrete mix submitted shall contain the following information:

a. Intended use and placement method.
b. Design Slump.
c. Total gallons of water per cubic yard.
d. Cement content.
e. Cementitious materials content.
f. Ratio of fine to total aggregates.
g. Weight (surface dry) of each aggregate per cubic yard.
h. Quantity of each admixture.
i. Air content.
j. Compressive strength based on 7 day and 28 day compression test.
k. Times of initial set.
l. Documentation of required average compressive strength or mix proportioning data per ACI 318.

Initial set tests shall be made at ambient temperatures of 70º F and 90º F to determine compliance with the initial set time specified hereinafter. The test at 70º F shall be made using concrete containing the specified plasticizing and air-entraining admixtures. The test at 90º F shall be made using concrete containing the specified plasticizing retarder and air-entraining admixtures. The initial set shall be determined in accordance with ASTM C403.

1.4.3. Mix Class

Each concrete mix class shall be designed and controlled within the limits specified in the following table:

<table>
<tr><th colspan="6">Mix Class Table
Coarse</th></tr>
<tr><th>Usage</th><th>28 Day Strength (psi)</th><th>Nominal Maximum Aggregate Size No. 4 Sieve</th><th>Slump ± 1"</th><th>Min Cement (lb/cu yd)</th><th>Max Water/ Cement Ratio</th></tr>
<tr><td>General Usage</td><td>4,500</td><td>1"</td><td>4"</td><td>535</td><td>0.45</td></tr>
<tr><td>Drilled Piers (dry, uncased, or permanent casing)</td><td>4,500</td><td>3/4"</td><td>5" (1)</td><td>560</td><td>0.45</td></tr>
<tr><td>Drilled Piers (temporary casing)</td><td>4,500</td><td>3/4”</td><td>7” (1)</td><td>560</td><td>0.45</td></tr>
<tr><td>Drilled Piers (slurry displacement)</td><td>4,500</td><td>3/4”</td><td>8” (1)</td><td>560</td><td>0.45</td></tr>
<tr><td>Underwater</td><td>5,000</td><td>3/4"</td><td>8"</td><td>658</td><td>0.41</td></tr>
<tr><td colspan="6">Note: A plasticizer or plasticizing retarder shall be included in all general usage and drilled piers concrete mixes. High range water reducer (Type F or G) shall be included in all underwater mixes.</td></tr>
</table>

(1) Slump requirement during placement with any admixtures.

**Source: ACI 318-11, Table 4.3.1; ACI 336.1-01, Table 2.4.3; ACI 350-06, Table 4.1.2.1

Concrete shall not be deposited under water, except with specific permission of the Owner and Engineer.

1.5. Mix Requirements

The acceptability of concrete will be judged on compliance with the specified requirements listed in the Mix Class Table and not on the basis of strength alone.

1.5.1. Total Water Content

Total water content of concrete shall not exceed the amount calculated using the maximum water to cement ratio in the Mix Class Table.

1.5.2. Slump

Slump shall not be greater than that indicated in the Mix Class Table for each mix, unless otherwise authorized by the Owner.

1.5.3. Total Air Content

The total volumetric air content of concrete after placement shall be six percent plus or minus one percent (6% ± 1%).

1.5.4. Admixtures

The admixture content, batching method, and time of introduction to the mix shall be in accordance with the manufacturer’s recommendations for compliance with these Specifications.

A plasticizing or plasticizing retarder admixture shall be included in all concrete, unless otherwise accepted by the Owner.

Plasticizing retarder admixture shall be adjusted as specified under the initial set.

1.5.5. Strength

The minimum 28 day acceptable compressive strength for each mix class as determined by ASTM C39 shall not be less than that indicated in the Mix Class Table.

All concrete shall exceed the specified minimum compressive strengths. Each test cylinder will be evaluated separately, and the Owner will be the sole judge of the validity and representative qualities of the tests.

In cases where the strength of the test cylinders for any portion of the work falls below the requirements specified herein, the Owner or Engineer may require the Contractor to secure test specimens of the hardened concrete represented by these cylinders. Specimens shall be secured and tested in accordance with ASTM C42 and shall have a minimum diameter of 3 inches.

Dependent upon the location of the concrete section in question, the Owner or Engineer may approve low frequency ultrasonic testing or other nondestructive techniques as an alternate to cone drilling and testing.

If the additional investigation verifies the existence of defective concrete, one of the following remedial actions shall be implemented as determined by the Owner:

a. Assume the costs to remove and replace all defective concrete.
b. Assume the cost of design and construction changes necessary to incorporate the inferior concrete.
c. Provide satisfactory reimbursement or allowance to the Owner for the acceptance of the lower quality concrete.

1.5.6. Initial Set

The initial set as determined by ASTM C403 shall not be attained until at least 2.5 hours after the water and cement are added to the aggregates. The quantity of retarding admixture shall be adjusted as necessary to compensate for variations in temperature and job conditions.

1.6. Storage of Materials

Cement shall be stored in suitable moisture proof enclosures. Reclaimed cement or cement that has become caked or lumpy shall not be used.

Aggregates shall be stored so that segregation and the inclusion of foreign materials are prevented. The bottom 6 inches of aggregate piles that have been in contact with the ground shall not be used.

Reinforcing steel and embedments shall be carefully handled and stored on supports that will keep the steel from contact with the ground.

1.7. Batching and Mixing

Batching and mixing may be performed at the jobsite with suitable equipment, or by an acceptable ready-mix concrete supplier. Personnel performing the batching and mixing shall be qualified and experienced. Mixing and transporting concrete shall be in accordance with ASTM C94 unless otherwise indicated herein.

1.7.1. Batching

Aggregates and cement shall be measured by weight. Aggregate weights shall be adjusted for moisture content.

Each admixture shall be dispensed by a mechanical device that will ensure accurate and automatic measurement.

The minimum amount of water required to produce the desired slump shall be batched automatically. Any additional water required to produce and maintain a uniform slump shall be added manually by the mixer operator. Slump shall be kept uniform. Aggregates shall float uniformly throughout the mass and the concrete shall flow sluggishly when vibrated.

1.7.2. Mixing

Concrete shall be mixed in a rotating drum as specified in ASTM C94 until all ingredients are uniformly distributed throughout the batch. Mixers shall not be loaded in excess of their rated capacities. Each batch shall be completely discharged before the mixer is recharged.

1.7.3. Ready-Mix Concrete

Ready-mixed concrete shall conform to ASTM C94, except as otherwise specified herein.

Truck mixers shall be revolving drum type and shall be equipped with a mixing water tank. Only the prescribed amount of mixing water shall be placed in the tank for any one batch, unless the tank is equipped with a device by which the amount of water added to each batch can be readily verified by the Owner.

A delivery ticket shall be prepared for each load of ready-mixed concrete delivered. The truck operator shall hand a copy of each ticket to the Owner at the time of delivery. Tickets shall indicate the mix identification, the number of yards delivered, the quantities of each material in the batch, the outdoor temperature in the shade, the time at which the cement was added, and the numerical sequence of the delivery.

When a truck mixer or agitator is used for transporting concrete, the concrete shall be delivered to the jobsite and completely discharged within 90 minutes, or before the drum has revolved 300 revolutions, whichever comes first, after the introduction of the mixing water to the cement and aggregates, or the introduction of the cement to the aggregates. Longer time periods must be approved by the Engineer. In hot weather, or under conditions contributing to quick stiffening of the concrete, a time less than that specified above may be required by the Engineer. When a truck mixer is used for the complete mixing of the concrete, the mixing operation shall begin within 30 minutes after the cement has been mixed with the aggregates.

1.8. Placement Temperature

The temperature of concrete, when being placed, shall be checked in accordance with ASTM C1064 and be as follows:

a. Not less than 40°F in moderate weather.
b. Not less than 50°F in weather during which the mean daily temperature drops below 40°F.
c. Not greater than 90°F during hot weather.

1.9. Hot Weather Concreting

Except as modified herein; hot weather concreting shall comply with ACI 305R. A water-reducing retarder shall be added to the concrete mix when the placement temperature of the concrete exceeds 75°F.

At air temperatures of 90°F or above, special procedures shall be applied to keep the concrete as cool as possible during placement and curing. The temperature of the concrete during placement shall not exceed 90°F.

1.10. Cold Weather Concreting

Cold weather concreting shall comply with ACI 306R.

1.11. Field Control Testing

The Contractor shall engage an independent professional testing company and laboratory to provide all necessary equipment and personnel to perform all concrete testing at the Contractor's expense. The testing company and laboratory must be approved by the Owner and Engineer, prior to commencing work. Personnel performing tests shall be certified ACI Grade 1 Concrete Field Testing Technician. Copies of the test results shall be sent directly from the testing company to the Engineer for review. Structures or equipment shall not be placed on the foundations until acceptance of test results by the Engineer.

The frequency hereinafter specified for each field control test is a minimum. If directed to do so by the Owner, any additional field control tests required shall be made.

1.11.1. Sampling

All concrete used for testing purposes shall be obtained in accordance with ASTM C172.

1.11.2. Slump

Consistency will be determined in the field by the slump test in accordance with ASTM C143. A minimum of one (1) slump test shall be performed on each load of concrete. If water is added at the job site to increase the slump, the recorded slump shall be tested after the addition of water. The specified slump for each class and usage of concrete can be found in the Mix Class Table.

1.11.3. Air Entrainment

Air entrained concrete shall be used in all applications where concrete will be exposed to moisture and cycles of freezing and thawing. Air content shall be determined in accordance with ASTM C231 or ASTM C173. A minimum of one (1) air entrainment test shall be performed for each batch of concrete used on the project and from which concrete compression test cylinders are made. The specified air content shall be between five and seven percent (5% and 7%).

1.11.4. Compression Test Cylinders

A set of compression test cylinders is required for each batch of concrete used on the project. Each set will consist of five (5), four inch by eight inch (4” x 8”) compressive test cylinders prepared, cured, and delivered in accordance with ASTM C31. Each cylinder shall be labeled with the project name, date, and cylinder identification number. An information card or field report shall be completed for each set of cylinders and shall include the following:

a. Date sampled
b. Time batched
c. Time sampled
d. Ticket number
e. Air temperature
f. Concrete temperature
g. Gallons of water added
h. Specified 28-day strength
i. Slump
j. Air Content
k. Admixtures
l. Concrete mix identification
m. Specific location of pour

The test cylinders shall be transported to a professional testing laboratory at least 8 hours after final set and within 20 to 24 hours from the time they were made. Transportation time of test cylinders shall not exceed 4 hours.

Testing of the cylinders shall be handled by the Contractor through a qualified testing laboratory in accordance with ASTM C39 in accordance with the following schedule:

a. One (1) cylinder at seven (7) days
b. Three (3) cylinders at twenty-eight (28) days
c. One (1) cylinder reserved for a fifty-six (56) day test, if necessary

The Contractor shall require the laboratory to send three sets of compressive test reports to the Owner, in addition to those copies furnished to the Contractor. One (1) copy of the test reports shall be forwarded directly to the Engineer for review within two (2) working days after the tests are performed.

In the event a test fails to meet the specified compressive strength requirements, the Engineer may require the Contractor to obtain core samples of the hardened concrete in question. Core samples shall be secured and tested in accordance with ASTM C42 and shall have a minimum diameter of three inches (3”). If tests further substantiates that the concrete represented by the cylinders and core samples is below the strength requirements specified herein, the Engineer may order such concrete removed and replaced at the expense of the Contractor.

At the location of pole foundations one of the cylinders shall be taken from the concrete used in the top 5 feet of each pole foundation. Such cylinders shall be individually identified by pole number and tested prior to pole erection.

1.11.5. Test Reports

Certified reports of all tests made by the testing laboratory shall be promptly furnished to the Owner and Engineer, and all other persons designated by the Owner.

1.12. Compaction

The contractor shall engage an independent professional Geotechnical engineering company to provide all necessary equipment and personnel to perform excavation inspections of foundation subgrade. If unsuitable material is encountered at the proposed subgrade elevation shown on the drawings, the contractor shall, under the direction of the geotechnical engineer, remove the unsuitable material and backfill with well compacted six inch (6″) layers of stone or gravel base material, or concrete. Compacted sub grade shall be approved for 3,000 lbs per square foot bearing capacity by the Geotechnical engineer.

1.13. Protection Against Moisture Loss

Immediately after placing or finishing, concrete surfaces not covered by forms shall be protected against moisture loss (cured) for not less than seven (7) days by covering with white opaque polyethylene sheets lapped four inches (4”) at edges and ends. Burlap may be used only for unexposed concrete surfaces and shall be in at least two (2) layers. Surface from which forms are removed before the curing period has elapsed shall be protected as specified for surfaces not covered by forms. All materials used for prevention of moisture loss shall be in accordance with ASTM C171.

1.14. Curing

Curing of concrete shall be by methods which will keep the concrete surfaces adequately wet during the specified curing period and in accordance with ACI 308R. Troweled surfaces shall be cured, except those which will receive a separate finish or coating, with the membrane curing compound specified in the article titled “Materials” in this section. Float finished surfaces shall be cured, except those which will receive a separate finish, with either the membrane curing compound specified or with water. Only water curing will be permitted on surfaces that will receive a separate finish or coating.

Water saturation of concrete surfaces shall begin as quickly as possible, but no later than 12 hours in dry weather and 24 hours in damp weather after initial set of the concrete. The rate of water application shall be regulated to provide complete surface coverage with a minimum of runoff. The application of water to formed surfaces may be interrupted for surface rubbing only over the areas being rubbed at the time. The concrete surface shall not be allowed to become dry during such interruption.

After rubbing has been completed, rubbed surfaces shall be covered with saturated burlap for the remainder of the curing period.

Membrane curing compound shall be applied within 30 minutes after final finishing of the surface. Membrane curing compound shall be spray applied at a coverage of not more than 300 square feet per gallon. Membrane curing shall not be used on surfaces that will be covered at a later date with grout, mortar, concrete, or other coating.

1.15. Protection

The Contractor shall protect all concrete against injury until final acceptance by Owner. The Contractor shall be prepared to protect all concrete in accordance with the requirements of this paragraph. Temperature shall be controlled by controlling the temperature of aggregate and mixing water. Mixing time shall be kept at a minimum and elapsed time between mixing and placing shall be minimized. The interior surfaces of forms and ground upon which concrete is to be placed shall be thoroughly wetted before concrete is poured. After the first frost and until the mean daily temperature in the vicinity of the work rises above 40°F for more than 1 day, the concrete shall be protected against freezing for not less than 48 hours after it is placed.

1.16. Earthwork

1.16.1. Surveying

Prior to commencing earthwork, the Owner shall provide staking at the site. This will include substation centerline, transmission line center line, including points of intersection (PIs) and line of sight points, and new structure pole and anchor locations. Excavation work shall not proceed until Owner approves staked structure locations.

The Contractor shall be responsible for all necessary environmental and roadway surveying necessary to complete the project. The Contractor shall perform all subsequent layout work necessary to ensure that the foundation is constructed to the correct dimensions and in the locations specified on the Drawings. If the Contractor finds that any staking has been disturbed, is missing or is in error, he shall notify the Engineer promptly. The Contractor shall exercise caution to protect all reference staking.

1.16.2. Subsurface Conditions

The Contractor shall familiarize himself with the subsurface conditions as shown on the boring logs, and exercise his own judgment as to the nature and difficulty of the proposed work. It should be noted in particular that the ground water level may change from the level existing at the time of the test borings.

1.16.3. Excavations

All excavation will be classified as “common excavation.” All excavation, including soft shale, gravel or other material, which can be moved by hand or machine, is defined as common excavation. Owner shall be notified if excavated material is significantly different from that indicated in the soil borings. Excavation work shall include the removal and subsequent handling of all materials excavated or otherwise removed in performance of the contract work, regardless of the type, character, composition, or condition thereof. Over-excavation shall be backfilled with well compacted six inch (6″) layers of stone or gravel base material, or concrete. If the over-excavation is unnecessary, the

cost of the backfill shall be borne by the Contractor. The quality of the soil and the adequacy of its bearing value shall be decided by the Engineer before backfill or concrete is placed in any excavation. Where water is encountered, the excavation shall be kept dry by pumping during the installation of the structure and during the backfilling process. If unsuitable material is encountered at the proposed bearing surface under the concrete foundation, the Geotechnical Engineer may require further excavation to reach sound bearing. Proposed washed stone or no frost structural fill indicated under foundations is required as an integral part of the foundations. The dimensions indicated on the drawings are a minimum and required for adequate foundations.
All existing underground pipes, conduits, drains, and other underground facilities uncovered or otherwise affected by the excavation work shall be located, protected, shored, braced, supported, and maintained.

Excavation for structures shall be performed according to lines and elevations indicated on the drawings and to the limits required to perform the line construction work. Machine excavation shall be controlled to prevent undercutting the proper subgrade elevations. Machine excavation shall not be used within 5 feet of existing permanent structures and facilities. Only hand tools shall be used for excavation around existing permanent structures and facilities.

Work shall be performed so that construction areas will be as free as possible from obstructions and from interference with the transportation, storage, or handling of materials. Excavated materials free of trash, rocks, roots, and other foreign materials, and that meet the specified requirements, may be used as required for backfills constructed under these Specifications.

Excavations shall be maintained in a safe, clean, and sound condition up to the time of placement of concrete. All excavations shall be suitably protected when not attended. Whenever necessary, the Contractor shall re-excavate materials which have accumulated in previously prepared excavations. Any muck or other unsatisfactory bearing material resulting from frost, action or entrance of water into excavations previously prepared to the required bearing shall be removed and replaced with well-compacted stone or gravel, backfill or concrete at the Contractor’s expense.

Subgrades for structures shall be firm, dense, and thoroughly compacted and consolidated; shall be free from mud and muck; and shall be sufficiently stable to remain firm and intact under the feet of the workers.

Subgrades that are otherwise solid but become mucky on top due to construction operations shall be reinforced with one or more layers of crushed rock or gravel subgrades.

The finished elevation of stabilized structure subgrades shall not be above the subgrade elevations indicated on the drawings.

1.16.4. Backfill (Other than subgrade)

Material for backfill shall be composed of earth free of wood, grass, roots, broken concrete, large stones, trash, or debris of any kind.

A Standard Proctor Compaction Test shall be performed on the proposed backfill material samples. The samples should be tested to determine the maximum, dry density, optimum moisture content and natural moisture content. These test results are to be used to ensure proper compaction during backfilling procedures.

All fill material shall be placed in lifts not to exceed eight inches (8″) in un-compacted thickness and be free of all organic material. Fill shall not be placed in heavy rain or placed on frozen ground. Frozen material shall not be used as backfill.

Field compaction tests shall be taken by the approved geotechnical engineer from each fill volume measuring 2,000 feet^2 maximum by twelve inches (12″) deep. If testing results indicate that compaction does not meet specified requirements, fill materials shall be removed, replaced as required, and compacted and retested until acceptable.

All fill areas shall be compacted to at least ninety-five percent (95%) of the Standard Proctor maximum dry density.

1.16.5. Rock Excavation

The Contractor shall be responsible for the removal and proper disposal of solid rock when encountered in holes for concrete foundations. Solid rock shall be defined as solid, naturally-occurring mineral formations that cannot be effectively removed by conventional trenchers, backhoes, or pressure augers. Loose rock or limestone in intermittent layers that result in “difficult digging” shall not be defined as solid rock excavations. “Solid rock” shall require the use of air hammers, blasting or other specialized equipment (Note: Blasting must be approved by the Owner or Engineer in accordance with local ordinances). When solid rock, boulders, or detached stones are encountered and cannot be removed by normal power-driven drills or augers, the Owner shall be notified. Rock excavation techniques shall be used to achieve the desired excavated dimensions. Rock excavation shall consist of igneous, metamorphic, and sedimentary stones, each having a volume of 1/2 cubic yard or more, as determined by physical or visual measurements and approved by Owner.

If rock is encountered, it shall be removed and replaced with suitable materials in such a manner as to provide fully compacted earth in all areas disturbed external to foundations. In the event that rock is encountered in the excavation, the Contractor shall be compensated for such rock removal, based upon unit price as set forth by the Contractor in the Form of Proposal. In the event such rock is encountered, it shall be the duty of the Contractor to notify the Engineer and/or Owner and arrange a meeting to agree upon the approximate total cost for the removal of the rock, prior to any removal of the rock. Quantities will be agreed upon jointly by the Contractor and the Owner (or Engineer) as excavations occur. Over-excavation to remove rock will not be counted in the quantity of rock excavations.

An accurate record shall be kept of the dates and amounts of rock excavation at each location. The Owner will authorize payment for rock excavation at each location by signing the Contractor's record as excavations occur. Payment will be on a cubic yard basis as measured in place in the hole requiring rock excavation. This measurement will be based on the foundation excavation or normal trench width and depth, as if no rock were encountered.

In cases where the extent of rock excavation is questioned, the Engineer and/or Owner may require the Contractor to prove that material should be classified as rock excavation. The Contractor shall provide a demonstration that the material cannot be removed with a backhoe equipped with a minimum one-half (1/2) cubic yard heavy-duty trenching bucket placed on a machine capable of a lifting capacity of 7,500 pounds at a trench depth of ten feet (10'). The Contractor may be required to provide equipment specification data verifying that the above minimum-rated equipment will be used for demonstration purposes. The equipment is to be in good repair and in proper working condition.

1.16.6. Blasting

Blasting or other use of explosives will not be permitted without Owner's approval.

1.16.7. Sheeting and Shoring

The Contractor shall do all bracing, sheeting, and shoring necessary to perform and protect all excavations as required for safety and to conform to laws and regulations of all governmental bodies having jurisdiction. When sheeting is used, it shall be removed during or upon completion of backfilling.

The stability of previously constructed structures and facilities shall not be impaired or endangered by new excavation work. Previously constructed structures and facilities include those existing when this construction begins and those provided under these Specifications.

Adequate sheeting and shoring shall be provided as required to protect and maintain the stability of previously constructed structures and facilities and the sides of excavations until they are backfilled. Sheeting, bracing, and shoring shall be designed and built to withstand all loads that might be caused by earth movement or pressure. Sheeting and shoring shall maintain the shape of the excavation under all circumstances.

2.0 Slabs on Grade and Mat Foundations

2.1. General

This section covers general installation of concrete slabs on grade, mat foundations, and vertical surfaces; formwork; testing of concrete for slabs on grade and mat foundations; and other appurtenant work. All work shall be in accordance with the Plans, Specifications, and Assembly Drawings.

2.2. Concrete

The Contractor shall supply ready mixed concrete prepared in accordance with ASTM C94, "Standard Specification for Ready-Mixed Concrete" with a minimum compressive strength of 4,500 psi at twenty-eight (28) days when tested in accordance with ASTM C39. Concrete shall conform to specifications in Mix Class Table. Air content for concrete in slabs on grade and mat foundations shall be six percent plus or minus one percent (6% ± 1%).

2.3. Subgrade

The subgrade shall be brought to an even plane and compacted solid. Washed stone or no frost structural fill shall be installed, at a minimum, as indicated on the drawings and properly compacted. All slabs on grade and mat foundations shall be placed on a minimum six inch (6") thick layer of compacted washed stone. An independent professional Geotechnical engineering company shall inspect all subgrades for adequate bearing capacity as specified on the Foundation Drawings.

2.4. Formwork

Forms shall be constructed to the shape, form, line, and grade required and shall be maintained sufficiently rigid to prevent deformation under the load imposed by supported inserts or by wet concrete. The top edges of forms shall be finished to a specified elevation, slope, or contour. They shall be brought to a true line and grade so that the top concrete surface can be finished with a screed or template resting on the top edges of the forms.

Design and construction tolerances shall be in accordance with ACI 117. Forms shall be designed and constructed in proper position and accurate alignment. Formed surfaces exposed to view shall have a Class C finish, and concealed surfaces may have a Class D finish as defined by ACI 301.

Concrete shall be placed against job-built plywood forms or forms that are lined with plywood or fiberboard, except as otherwise specified. At Owner's discretion, prefabricated forms or metal frames may be permitted only for surfaces that are not normally exposed to view when construction has been completed. Plywood and fiberboard shall be new when brought to the construction site and shall be properly coated, protected, and maintained throughout its use. All plywood and fiberboard materials that are damaged, cracked, weathered, or otherwise unsuitable, in the Owner's opinion, for producing smooth, uniformly textured formed surfaces will be rejected as form material.

Vertical surfaces of footings extended above grade shall be formed.

Form ties shall be of the removable end, permanently embedded body type, and shall have sufficient strength, stiffness, and rigidity to support and maintain the form in proper position and alignment without the use of auxiliary spreaders. Outer ends of the permanently embedded portions of form ties shall be at least 1 inch back from adjacent outer concrete faces. Permanently embedded portions of form ties that are not provided with threaded ends shall be constructed so that the removable ends can be broken off by twisting, without chipping or spalling the concrete surface. The type of form ties used shall be acceptable to the Owner.

Form ties shall be uniformly spaced in exposed surfaces and aligned in horizontal and vertical rows.

After removal of form ties, the resulting voids in the outer concrete face shall be filled with grout and finish flush with surface of concrete.

Chamfer strips shall be placed in forms to bevel all salient edges and corners except edges which are to be buried and edges which are indicated on the drawings as requiring special treatment. Foundations shall have formed beveled salient edges for all vertical and horizontal corners unless specifically indicated otherwise on the drawings. Bevel dimensions shall be 3/4 by 3/4 inch unless indicated otherwise on the drawings.

2.4.1. Coating

Forms shall be coated with form oil before reinforcement is placed.

2.4.2. Removal

Forms shall not be removed until permission of the Engineer has been obtained.

2.5. Expansion Joints

Expansion joints and joints between slabs and vertical surfaces shall be installed according to the Drawings. Premolded fibrated asphalt expansion joint material shall be in accordance with ASTM 1751 and shall be one-half inch (½") wide and extend from the bottom of the slab to one half inch (½") from the top of the slab. The premolded fibrated asphalt expansion joint material shall then be covered by a one-half inch (1/2") wide strip of polyethylene bond breaker tape. The tape shall be installed along the top of the asphalt expansion joint material only and not on the vertical walls of the slabs. The polyethylene bond breaker tape shall then be covered with one-half inch (½") wide by one-half inch (½") thick by required length of Vulkem #45 polyurethane sealant for horizontal joints and Dymonic FC Polyurethane sealant for vertical joints according to the manufacturer's installation guidelines.

2.6. Construction Joints

Construction joints not indicated on the Drawings shall be so made and located as to least impair the strength of the structure. Where a joint is to be made, the surface of the placed concrete shall be thoroughly wetted and slushed with a coat of neat cement grout immediately before placing the new concrete. All laitance shall first be removed from the placed concrete.

2.7. Reinforcement

Reinforcements shall be accurately formed. Unless otherwise indicated on the drawings or specified herein, the details of fabrication shall conform to ACI 318.

All bar supports, ties, spacers, bolsters, inserts, screeds, and other concrete accessories required shall be provided to maintain reinforcing in its proper position and permit proper placement of concrete.

Responsibility for the design of all bar support systems shall be assumed by the contractor.

Except where indicated on the drawings, welding of reinforcement for any purpose, and tack welding in particular, is expressly prohibited. Reinforcements upon which unauthorized welding has been performed will be presumed to be damaged and such reinforcing shall be removed and replaced at Contractor's expense. Replacement materials shall conform to all applicable requirements of these specifications.

Welded chairs and supports may be used provided they are clamped or wired to the reinforcement.

Except as otherwise indicated on the drawings, metal reinforcement for concrete shall have the concrete protective cover specified in Chapter 7 of ACI 318.

Steel reinforcing bars shall be placed in the concrete wherever shown on the drawings. Unless otherwise shown on the drawings or directed, measurements made in placing the bars shall be to the center lines of the bars. Before the reinforcing bars are placed, the surfaces of the bars and the surfaces of any metal bar supports shall be cleaned of heavy flaky rust, loose mill scale, dirt, grease, or other foreign substances. After being placed, the reinforcing bars shall be maintained in a clean condition until they are completely embedded in the concrete. Main reinforcement shall have a minimum clear protective cover to the surface of the concrete as shown on the drawings. Reinforcing bars shall be accurately placed and secured in position so that they will not be displaced during the placing of the concrete, and special care shall be exercised to prevent any disturbance of the reinforcing bars in concrete that already has been place. Rustproof metal chairs, metal hangers, metal spacers, or other satisfactory metal supports may be used for supporting reinforcing bars. No metallic reinforcement supports will be allowed to break the plane at the edge of concrete. Precast concrete blocks may be used for supporting reinforcing bars.

With the exception of lapped portions of spliced bars that are wired or clamped together, the clear distance between parallel bars shall be not less than 1.5 times the maximum size of coarse aggregate in the concrete, or less than 2 inches.

Unless otherwise required by the Specifications or drawings, splices shall conform to ACI 318. Splices shall be Class B or C tension-lapped splices unless a different class is indicated on the drawings.

Splices shall not be used in regions of maximum bending stress. Welded splices shall not be used.

Mechanical splices are acceptable if approved by the Owner.

All reinforcement shall be shop bent cold. No field bends in reinforcement will be permitted.

2.8. Installation of Anchorage Items

Anchorage items, including bolts, dowels, and other similar devices, shall be of sufficient number and size and so located to ensure anchorage sufficient for the purpose intended. Anchorage items shall be checked against equipment base plates and Drawings prior to placing of concrete.

Anchor bolts shall be securely fastened in a template in the dimensions / orientation / spacings to match the structural steel base plate as shown on the Drawings. The template shall be secured to support the anchor bolts independent of the concrete being placed and cast in place during the concrete placement around the anchor bolts to ensure the proper bonding to the concrete.

In the event the anchor bolts are installed and require re-alignment and/or spacing correction, the Contractor shall contact the Owner and Engineer promptly for permission to proceed prior to any realignment methods. Anchor bolt projection shall be installed per the dimensions as shown on the detail drawings.

2.9. Placing

Water shall be removed from excavations before concrete is deposited. Hardened concrete, debris, and other foreign materials shall be removed from the interior of forms and from the inside of mixing and conveying equipment; reinforcement secured in position will be subject to inspection and approval by the Engineer. Runways for buggies or wheelbarrows shall not be supported on reinforcement or formwork

Concrete shall be conveyed from mixer to forms as rapidly as practicable without segregation or loss of ingredients. Concrete shall be deposited in its final position without moving it laterally in the forms for a distance greater than 5 feet.

Concrete having attained its initial set or having contained its water content for more than one and one half (1 ½) hours shall not be used in the work. Concrete shall not be dropped freely more than five feet (5’) in unexposed work nor more than three feet (3’) in exposed work. Unless approved by the Engineer, concrete shall be mixed and placed only when the temperature is at least 40°F; concrete footings shall be placed upon surfaces free from frost, ice, mud, loose or unsound rock, and other detrimental substances.

All concrete shall be thoroughly vibrated with appropriate vibrating equipment while concrete is being placed. Settling concrete with shovels only will not be accepted. Vibrators shall not be used as a method to move concrete laterally.

Concrete shall be deposited to the required thickness and finished monolithically to a smooth, level surface by floating and troweling.

2.10. Bonding and Grouting

Before depositing new concrete on or against concrete that has set, the existing surfaces shall be roughened and cleaned. Horizontal construction joints shall be given a brush coat of grout consisting of cement and fine aggregate in the same proportion as the concrete to be placed, following by approximately three inches (3”) of concrete of regular mix, except that the proportion of coarse aggregate shall be reduced fifty percent (50%). Grout for setting bearing plates and other items shall be composed of equal parts of sand and Portland Cement.

2.11. Finishes of Concrete Other Than Floors and Slabs

Slight honeycomb and minor defects shall be patched with cement mortar made with one (1) part cement and two (2) parts fine aggregate. Exposed surfaces shall be given a rubbed finish. Fins and other projections shall be carefully removed, offsets leveled, and surface damage repaired. The surfaces then shall be rubbed with cement or carborundum bricks and water, leaving the surface uniformly smooth and clean. Projecting ends of all form ties shall be removed and recessed a minimum of 1 inch. The resulting recesses shall be cleaned, wetted, and filled with patching mortar.

No surface treatment will be required for buried or permanently submerged concrete not forming an integral part of a structure except that required to obtain the surface elevations or contours and surfaces free of laitance. The unformed surfaces of all other concrete shall be screeded and given an initial float finish, followed by additional floating and troweling where required.

Float finished surfaces shall be finished to provide a flat profile per ACI 347 Class C Finishing.

Screeding shall provide a concrete surface conforming to the proper elevation and contour with all aggregates completely embedded in adjacent mortar. Surface irregularities in screeded surfaces shall be limited as required to produce finished surfaces within the tolerances specified. If no further finishing is required, surface irregularities shall not exceed ACI 347 Class C.

Screeded surfaces shall be given an initial float finish as soon as the concrete has stiffened sufficiently for proper working. Any piece of coarse aggregate that may be disturbed by the float or that causes a surface irregularity shall be removed and replaced with mortar. Initial floating shall produce a surface of uniform texture and appearance with no unnecessary working of the surface with the float.

The initial floating shall be followed with a second floating at the time of initial set. The second floating shall produce a smooth, uniform, and workmanlike float finish of uniform texture and color. Unless additional finishing is specifically required, the completed finish for all unformed surfaces shall be a float finish as produced by the second floating.

Floating shall be performed with hand floats or suitable mechanical compactor floats.

Any surfaces designated on the drawings to be troweled shall be steel trowel finished. Troweling shall be performed after the second floating when the surface has hardened sufficiently to prevent an excess of fines being drawn to the surface. Troweling shall produce a dense, smooth, uniform surface free from blemishes and trowel marks.

2.12. Clean-Up

All forms shall be completely removed. All materials, equipment, and rubbish shall be removed and the premises left in a neat condition.

3.0 Drilled Cylindrical Foundations

3.1. General

This section covers general requirements for the installation of drilled cylindrical foundations and other appurtenant work. All work shall be in accordance with the Plans, Specifications, Plan & Profile Sheets, and Assembly Drawings. Work shall conform to all requirements of ACI 336.1-01 published by the American Concrete Institute, except as modified by these Contract Documents.

3.2. Concrete

The Contractor shall supply ready mixed concrete prepared in accordance with ASTM C94, "Standard Specification for Ready-Mixed Concrete" with a minimum compressive strength of 4,500 psi for surface mounted structures and 3,000 psi for direct embedded structures at twenty-eight (28) days when tested in accordance with ASTM C39. Concrete shall conform to specifications in Mix Class Table. Air content shall be six percent plus or minus one percent (6% ± 1%).

3.3. Excavations

The diameter and depth of each hole shall be as required for structures to be placed according to the Plans and Drawings. Holes shall be drilled with such types of drilling equipment that will produce the excavation shown on the drawings. Drill rigs, which do not run true, will not be acceptable.

Holes for direct embedded structures shall be as required for compaction of backfill around the pole, but shall not be less than the pole diameter at the butt plus 12 inches.

Holes for caissons shall be as shown on the Plans and Drawings. The depth noted on the drawings is to be considered minimum. If unsuitable materials affecting required bearing value are encountered, the excavation shall be continued to whatever depth is necessary to obtain suitable material per the approval of the geotechnical engineer on site. When depth required by the Owner is greater than depth shown on the drawings, the neat line excavation and volume of reinforced concrete to fill it will be paid for by the Owner.

Hole excavation shall include removal of stumps, roots, and other obstructions necessary to provide a clean vertical hole to the depth specified on the drawings. Excavation shall be performed with a power driven auger. As soon as the auger is withdrawn, any direct embedded structures shall be set to the depth specified on the drawings and in accordance with these specifications.

Excavated holes shall be covered and protected when the associated structures will not be set during the same working day.

Holes may be excavated by the drilling and mud slurry technique. Prior to start of construction, Owner's approval shall be submitted for a drilling mud procedure for wet hole excavation when sufficient side wall pressure cannot be obtained by use of water void of additives. Drilling mud shall be Super Mud manufactured by Polymer Drilling Systems or acceptable equal. Drilling mud shall be mixed in accordance with manufacturer's recommendations and to the proper consistency for maintaining the sides of the hole. With the Owner's approval, attapulgite clay type drilling mud may be substituted for Super Mud on holes where Super Mud will not provide sufficient side wall pressure to maintain the sides of the hole excavation.

Under no circumstances can bentonitic or kaolinitic clay products be used.

3.4. Removal of Water

Adequate dewatering equipment shall be provided and maintained to remove and dispose of all surface and groundwater entering excavations and other parts of the work. Each excavation shall be kept dry during subgrade preparation and continually thereafter until construction to be provided therein is completed to the extent that no damage from hydrostatic pressure, flotation, or other cause will result. Disposal of water shall be in accordance with federal, state, and local regulations.

If infiltration of groundwater exceeds a rise of one-quarter inch (1/4”) per minute or the total height of water in the bottom of the pier exceeds two inches (2”), the pier shall be considered a wet pier and wet pier concrete placement methods shall be used. Wet pier placement methods shall be approved by the Engineer and Owner, prior to the commencement of work.

3.5. Temporary Casing

Temporary casing will be required at all excavations where workmen are required to do hand excavation or remove obstructions in the lower portions of the caissons or to re-clean the bottoms of caissons prior to the placement of concrete. Temporary casings will also be required at locations where the soil will not stand without support or where, because of ground water or soil conditions, sloughing of the sides of caissons may seriously delay or endanger the satisfactory completion of excavation and placement of concrete. The Contractor shall have immediately available for use on the job an ample supply of casing for each size that will be required for use in the caissons and shall provide additional amounts, if required, to ensure orderly progress of the job. Such casing may be in short pieces but with jointing pieces of sufficient strength that assembled sections of casing may be pulled complete as concrete is placed or immediately thereafter. The casing shall also be of such strength and rigidity as to maintain the required excavation lines against the pressure of sloughing material from the sides of the caissons. All temporary casing shall be removed from caissons as concrete is placed or immediately thereafter, and in such a manner as to prevent sloughing material from dropping to the bottoms of caissons, falling on top of freshly placed concrete or intruding into the concrete mass.

Permanent casing will not be permitted except by special permission of the Owner or as shown on the drawings.

3.6. Permanent Casing

Smooth wall metal pipe casing shall be installed as indicated on the drawings or as permitted by special permission of the Owner.

The casing shall not extend more than 6 inches below the top of the hole. Any part of the casing extending above this elevation shall be cut off. Casings shall be installed as drilling proceeds or immediately after the auger is withdrawn as required to prevent sloughing or caving of the excavation walls.

3.7. Dimensional Tolerances

The location and dimensions of the drilled caisson shall be as exact as possible to the locations shown on the drawings and staked in the field. The maximum allowable tolerance will be as follows.

Top of the drilled caisson shall be set to the elevation shown on drawings, except where otherwise directed by the Owner or Engineer.

The variation in elevation of the bottom of the drilled caisson from the specified depth shall be from 0 to +6 inches, except where required to be deeper due to soil conditions.

Maximum deviation of the axis of the hole from the vertical shall be no more than 1 inch in 8 feet.

The diameter of any drilled caisson shall not be less than specified or more than 4 inches greater than specified.

3.8. Pier Installation Record

Accurate pier installation records shall be maintained and shall contain the following information for each pier:

a. Contractor's name.
b. Drill rig operator's name.
c. Location/Structure Number.
d. Shaft diameter.
e. Elevation of shaft above grade.
f. Depth of rock.
g. Depth of shaft.
h. Depth of ground water.
i. Caving or sloughing of excavation.
j. Drilling difficulties.
k. Casing insertion, size and length, and whether or not removed.
l. Date and time of start and finish excavation.
m. Length and diameter of reinforcing bar cage.
n. Date and time concrete placed.
o. Calculated volume of excavation based on diameter of shaft.
p. Total quantity of concrete placed.
q. Test Cylinder Numbers in order of placement in foundation (bottom to top)

3.9. Reinforcement

Steel reinforcing bars shall be placed in the concrete wherever shown on the drawings. Unless otherwise shown on the drawings or directed, measurements made in placing the bars shall be to the center lines of the bars. Before the reinforcing bars are placed, the surfaces of the bars and the surfaces of any metal bar supports shall be cleaned of heavy flaky rust, loose mill scale, dirt, grease, or other foreign substances. After being placed, the reinforcing bars shall be maintained in a clean condition until they are completely embedded in the concrete. Main reinforcement shall have a minimum clear protective cover to the surface of the concrete as shown on the drawings. Reinforcing bars shall be accurately placed and secured in position so that they will not be displaced during the placing of the concrete, and special care shall be exercised to prevent any disturbance of the reinforcing bars in concrete that already has been place.

All reinforcement shall be shop bent cold. No field bends in reinforcement will be permitted.

3.10. Concrete Placement General

The handling, depositing, and compacting of concrete shall conform to these Specifications subject to adjustment by the Owner for weather or placement conditions.

Concrete shall not be pumped through aluminum pipe or aluminum alloy pipe.

Before concrete is placed, forms and anchor bolts shall be rigidly secured in their proper position; all dirt, mud, water, and debris removed from the space to be occupied by the concrete; and all surfaces cleaned that may have become encrusted with dried mortar or concrete from previous placement operations. The entire installation shall be acceptable to the Owner.

Anchorage items shall be checked against equipment base plates and Drawings prior to placing of concrete. In the event the anchor bolts are installed and require re-alignment and/or spacing correction, the Contractor shall contact the Owner and Engineer promptly for permission to proceed prior to any realignment methods. Anchor bolt projection shall be installed per the dimensions as shown on the detail drawings.

Cold joints are not allowed unless specifically approved by the Owner and Engineer. When a cold joint is approved the surface of hardened concrete upon which fresh concrete is to be placed shall be rough and clean. An epoxy bonding compound shall be applied in accordance with the manufacturer's recommendation.

Concrete shall be brought to the point of final deposit by methods that prevent the separation or loss of the ingredients. Concrete shall not be allowed to free fall, uncontrolled, more than 5 feet. Concrete shall be deposited in its final position without moving it laterally in the forms for a distance greater than 5 feet.

3.11. Concrete Placement – Dry Hole

Concrete shall be placed in the drilled caisson as soon after excavation as possible. Immediately prior to the placement of concrete, the caisson shall be cleaned of water, debris, or other materials harmful to concrete including ice, clods, and piles of loose earth. Surfaces against which concrete is being placed shall be free of frost, and in cold weather shall be enclosed or heated, if necessary, prior to placing concrete to ensure this requirement is met. Water in bottom of caissons must be removed or absorbed. Equipment shall include a pump and two vibrators in good working condition, hoppers and elephant trunks for directing the flow of concrete down the caissons, and an ample supply of sacked cement for use in drying the bottom of caissons. The Contractor shall not place any concrete until the excavation and embedded items are checked and approved by the Owner or Engineer. In a drilled caisson where the Contractor can free fall the concrete down the center of the caisson without having the concrete come in contact with the embedded items, which may cause segregation of the aggregate, the Contractor may place the concrete with the use of an elephant trunk or drop chutes and shall use vibrators. The maximum free fall distance shall be no more than 5 feet. If the Owner or Engineer sees the above method cannot be implemented, then the Contractor shall place the concrete for the first lift using hoppers and sections of elephant trunk or drop chutes. Normal procedure expected to be followed by the Contractor will be to place the concrete to an elevation approximately 5 feet above the bottom of the caissons and vibrate this deposit with one pass of the vibrator down to the bottom of the caisson and back to the top of concrete. Following this, the remainder of the concrete may be poured in two or more lifts of equal height with one pass of the vibrator down to the bottom of the lift and back up on each lift. In placing concrete, internally operated vibrators of a minimum diameter of 2-1/4 inches and having a speed of 5,000 rpm or more are to be used. On the upper lifts of the piles, elephant trunks will not be required, but the placing of the concrete shall be done in such a manner as to prevent segregation of the aggregates.

3.12. Concrete Placement – Wet Hole

Where sufficient groundwater is encountered during excavation to result in standing water in the caisson, the Contractor shall provide pumps with sumps just large enough for pump sections or special pumps, which can extract water from the bottom of the caisson without the requirement of a sump. Immediately prior to the start of the concrete placement, water shall be pumped from the caisson to the elevation of the bottom of the caisson or, if a sump is used, leaving a depth of water not exceeding 4 inches in the sump. The use of dry cement to “dry up” the water left in the sump will then be permissible provided the rate of inflow is sufficiently slow to permit placement of concrete without increasing the water-cement ratio. To follow this procedure, the Contractor must have dry cement ready to place into the caisson immediately after pumping is terminated and also have adequate concrete at the site. If, in the opinion of the Owner or Engineer, the rate of inflow of ground water is too great to obtain concrete of acceptable quality, it will be necessary for the Contractor to place concrete using the tremie method.

3.13. Concrete Placement – Tremie Method

Where the inflow of water into a caisson is too rapid to permit placement of concrete in the dry, the Contractor shall place the concrete underwater by the tremie method. In such cases, a special mix of concrete will be required with coarse aggregate (gravel), ¾ inch maximum size, and a minimum of seven bags of cement per yard. A retarding agent, approved by the Owner and Engineer, may be used. No vibration of the tremie concrete will be required or permitted, but it will be permissible to vibrate the tremie pipe under certain conditions when the flow of concrete becomes sluggish, and it will also be permissible to vibrate the casing, if used, when the caisson is filled with concrete at the time the casing pull is started. The tremie pipe shall have the minimum diameter of 8 inches and shall be equipped with a foot valve or gate at the bottom end, which is watertight and can be positively controlled from the ground surface. If joints are required in the tremic pipe, they shall be watertight. The entire assembly shall be watertight, and under no circumstances will concrete be permitted to flow through water in the tremie. In placing concrete, the lower end of the tremie shall be placed as close to the bottom as possible and no more than 6 inches to the bottom of the caisson and shall not be raised until a seal has been established between the tremie pipe and the concrete sufficient to prevent entry of water into the tremie. The discharge end of the tremie shall be kept submerged in the concrete a sufficient depth to maintain, at all times, an adequate seal during underwater placement. The placing of concrete by tremie in any caisson shall not be started until a sufficient supply of concrete is at the site to complete placing of concrete in the caisson up to the ground surface. Once started, the underwater placement shall proceed without interruption until the top of the concrete has been brought to the above-mentioned elevation. As soon as the level of concrete has reached the above-mentioned level over the tremie pipe, the Contractor shall remove the water being displaced by the concrete. Concrete may be placed by tremie only when authorized by the Owner or Engineer.

3.14. Consolidation

During and immediately after depositing, concrete shall be consolidated thoroughly and worked around reinforcements, embedments, and into the corners of the forms.

Concrete shall be consolidated by means of mechanical vibrating equipment supplemented by hand rodding, spading, and/or tamping. Unless otherwise accepted by the Owner, mechanical vibrators shall be spud type immersion vibrators which will maintain at least 9,000 cycles per minute when immersed in concrete. The number and type of vibrators shall be subject to the acceptance of the Owner.

The vibrator shall be constantly relocated and placed in each location only once for each lift. Lower lifts shall be vibrated with the one immediately above it.

3.15. Finishes of Concrete Other Than Floors and Slabs

Slight honeycomb and minor defects shall be patched with cement mortar made with one (1) part cement and two (2) parts fine aggregate. Exposed surfaces shall be given a rubbed finish. Fins and other projections shall be carefully removed, offsets leveled, and surface damage repaired. The surfaces then shall be rubbed with cement or carborundum bricks and water, leaving the surface uniformly smooth and clean. Projecting ends of all form ties shall be removed. The resulting recesses shall be cleaned, wetted, and filled with patching mortar.

No surface treatment will be required for buried or permanently submerged concrete not forming an integral part of a structure except that required to obtain the surface elevations or contours and surfaces free of laitance. The unformed surfaces of all other concrete shall be screeded and given an initial float finish, followed by additional floating and troweling where required.

Float finished surfaces shall be finished to provide a flat profile per ACI 347 Class C Finishing.

Screeding shall provide a concrete surface conforming to the proper elevation and contour with all aggregates completely embedded in adjacent mortar. Surface irregularities in screeded surfaces shall be limited as required to produce finished surfaces within the tolerances specified. If no further finishing is required, surface irregularities shall not exceed ACI 347 Class C.

Screeded surfaces shall be given an initial float finish as soon as the concrete has stiffened sufficiently for proper working. Any piece of coarse aggregate that may be disturbed by the float or that causes a surface irregularity shall be removed and replaced with mortar. Initial floating shall produce a surface of uniform texture and appearance with no unnecessary working of the surface with the float.

The initial floating shall be followed with a second floating at the time of initial set. The second floating shall produce a smooth, uniform, and workmanlike float finish of uniform texture and color. Unless additional finishing is specifically required, the completed finish for all unformed surfaces shall be a float finish as produced by the second floating.

Floating shall be performed with hand floats or suitable mechanical compactor floats.

Any surfaces designated on the drawings to be troweled shall be steel trowel finished. Troweling shall be performed after the second floating when the surface has hardened sufficiently to prevent an excess of fines being drawn to the surface. Troweling shall produce a dense, smooth, uniform surface free from blemishes and trowel marks.

3.16. Clean-Up

All forms shall be completely removed. All materials, equipment, and rubbish shall be removed and the premises left in a neat condition.

3.17. Repairing Defective Concrete

Defects in formed concrete surfaces shall be repaired to the satisfaction of the Owner within 24 hours, and defective concrete replaced within 48 hours after the adjacent forms have been removed. All concrete that is porous, honeycombed, or otherwise defective to a depth in excess of 1 inch shall be cut out and removed to sound concrete, with edges square cut to avoid feathering. Surfaces shall be coated with epoxy bonding compound before the repair concrete is placed.

Concrete repair work shall be performed in a manner that will not interfere with thorough curing of surrounding concrete. Mortar and concrete used in repair work shall be adequately cured and finished to match adjacent surfaces.

4.0 **References**

4.1. American Concrete Institute

1. ACI 117 – Specifications for Tolerances for Concrete Construction and Materials
2. ACI 318 – Building Code Requirements for Structural Concrete and Commentary
3. ACI 301 – Specifications for Structural Concrete
4. ACI 305R –Hot Weather Concreting
5. ACI 306R –Cold Weather Concreting
6. ACI 308R – Guide to Curing Concrete
7. ACI 336.1 – Specification for the Construction of Drilled Piers
8. ACI 347 – Guide to Formwork for Concrete
9. ACI 350 – Code Requirements for Environmental Engineering Concrete Structures and Commentary

4.2. ASTM International

1. ASTM A1064 – Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete
2. ASTM C31 – Standard Practice for Making and Curing Concrete Test Specimens in the Field
3. ASTM C33 – Standard Specification for Concrete Aggregates
4. ASTM C39 – Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
5. ASTM C42 – Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
6. ASTM C94 – Standard Specification for Ready Mixed Concrete
7. ASTM C143 – Standard Test Method for Slump of Hydraulic-Cement Concrete
8. ASTM C150 – Standard Specification for Portland Cement
9. ASTM C171 – Standard Specification for Sheet Materials for Curing Concrete
10. ASTM C172 – Standard Practice for Sampling Freshly Mixed Concrete
11. ASTM C173 – Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method
12. ASTM C231 - Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
13. ASTM C260 – Standard Specification for Air-Entraining Admixtures for Concrete
14. ASTM C403 – Standard Test Method for Time of Setting of Concrete Mixtures by Penetration Resistance
15. ASTM C494 – Standard Specification for Chemical Admixtures for Concrete
16. ASTM C1064 – Standard Test Method for Temperature of Freshly Mixed Hydraulic-Cement Concrete

17. ASTM C1315 – Standard Specification for Liquid Membrane-Forming Compounds Having Special Properties for Curing and Sealing Concrete
18. ASTM D1751 – Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)

APPENDIX A
SOIL REPORT

December 4, 2001

Greenville Utilities Engineering Center
PO Box 1847
Greenville, North Carolina 27825-1847

Attention: Mr. Edward C. Askew, CLGPO
Director of Support Services

Subject: Geotechnical Engineering Report
Greenville West and MacGregor Downs Substations
Greenville, North Carolina
Titan Project No. 019907-80

Dear Mr. Askew:

Titan Atlantic Group, Inc. (Titan) is pleased to present this geotechnical report for the proposed substations in Greenville, North Carolina. Our services were provided in accordance with Titan Proposal No. P-1-075-80 dated October 22, 2001. Findings, conclusions, and recommendations given in this report are subject to the limitations presented in the Appendix.

Please contact us if you have any questions or comments regarding this report. We are available to discuss our recommendations with you and to provide additional services as necessary during the final design and construction phases of this project. We have enjoyed assisting you and look forward to serving as your consultant on the remainder of this project and future projects.

Sincerely,

TITAN ATLANTIC GROUP, INC.

G. Ryan Bridger, E.I.
Staff Geotechnical Professional

Carl F. Bonner, P.E.
Greenville Office Manager
Registered, North Carolina 16252

Reviewed by: Barney C. Hale, P.E.
Vice President -- Chief Engineer
Registered, North Carolina 11285

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Attachments

1.0 PURPOSE OF GEOTECHNICAL STUDY

The purpose of this geotechnical study was to explore the general subsurface conditions at the project site and to evaluate these conditions with respect to the design and construction of foundations for the project. Our scope of services included drilling soil test borings, performing engineering analyses, and preparing this report of our findings and recommendations.

2.0 PROJECT INFORMATION

Mr. Edward Askew of Greenville Utilities Engineering Center provided project information to Titan. We understand that two substations are planned for a site in Greenville, North Carolina. The site is at the approximate location shown on Drawing No. 1 in the Appendix.

We received a site plan which shows the locations of existing site features, the proposed substations, and the boring locations from Booth and Associates, Inc. The project includes the construction of two substations side by side.

Design grades have not been provided. However, based on the existing topography and our experience with similar projects, we assume that cut and fill depths will be less than 2 to 3 feet.

3.0 SUBSURFACE EXPLORATION AND TESTING

3.1 Field Exploration

In order to explore the general subsurface conditions at the project site, Titan subcontracted Carolina Drilling to drill 10 soil test borings (B-1 through B-10) to a depth of 30 feet below existing grades. The borings were advanced at the approximate locations shown on Drawing No. 2 in the Appendix. The number of borings and their locations were selected by Greenville Utilities Engineering Center.

The borings were located in the field by Titan personnel by pacing distances and estimating right angles relative to existing site features. The soil test borings were performed by a trailer-mounted and track-mounted power drilling rig utilizing rotary wash drilling procedures. Standard Penetration Tests were performed in the soil test borings at 2.5 to 5.0 feet intervals in general accordance with ASTM D 1586. Titan personnel visually classified the split-spoon soil samples in general accordance with the Unified Soil Classification System.

Boring Logs are included in the Appendix of this report.

4.0 SITE AND SUBSURFACE CONDITIONS

4.1 Site Description

The site is located on the north side of MacGregor Downs Road, west of the intersection of MacGregor Downs Road and B's Barbeque Road. The majority of the site is currently an overgrown abandoned cultivated field.

A drainage ditch is located along MacGregor Downs Road. No surface water was observed at the site at the time of our exploration.

4.2 Regional Geology

The project site is located in the Coastal Plain Physiographic Province. The Coastal Plain consists mainly of marine sediments which were deposited during successive periods of fluctuating sea level and moving shoreline. The soils in this province are typical of those laid down in a shallow sloping sea bottom; sands, silts, and clays with irregular deposits of shells. Alluvial sands, silts, and clays are typically present near rivers and creeks.

According to the 1985 Geologic Map of North Carolina, the site overlies the Yorktown formation. This Tertiary marine formation consists primarily of fossiliferous clay with varying amounts of fine-grained sand and bluish-gray shell material commonly concentrated in lenses.

4.3 Soil Conditions

A 10-inch-thick layer of cultivated soil was encountered at the ground surface in all of the borings. The cultivated soil is generally underlain by silty and clayey fine sand to a depth of 30 feet. These soils visually classify as SM and SC, respectively, in accordance with the Unified Soil Classification System. Standard penetration test values (N-values) range from 0 to 16 blows per foot (bpf) with an average of 6 bpf, indicating a very loose to medium dense relative density.

More detailed descriptions of the subsurface conditions encountered at each boring location are given on the boring logs in the Appendix. For example, Borings B-8 and B-9 encountered a layer of very soft to soft, high and low plasticity silt (MH and ML) at a depth of 12 to 22 feet below grade.

4.4 Groundwater Conditions

Groundwater levels were measured in the open boreholes at the completion of drilling operations and after a stabilization period of approximately 9 days. Groundwater was measured at depths of 8.5 to 15.7 feet below existing grades.

Fluctuations in the groundwater table on the order of 1 to 2 feet are typical in the Coastal Plain, depending on variations in precipitation, evaporation, and surface water runoff. Seasonal high groundwater levels are expected to occur during or just after the typically wetter months of the year (November through April).

5.0 GEOTECHNICAL RECOMMENDATIONS

5.1 Site Preparation

All cultivated soil, vegetation, debris, and other unsuitable material should be removed from the construction areas. We anticipate an average stripping depth of 8 inches to remove the cultivated soil. Cultivated soil may be re-used in areas to be landscaped.

ROLLING
MAY NOT
BE BEST
METH.
SINCE
SUBSTATIONS
SHOULD
IT JUST
BE
DCP?

After stripping of cultivated soil is completed, the exposed subgrade soils in areas to receive fill or at the subgrade elevation in cut areas should be proofrolled to detect loose soils. Proofrolling should be performed with a moderately loaded dump truck or similar construction equipment. The geotechnical engineer's representative should observe this operation to aid in delineating unstable soil areas. Proofrolling should be performed after a suitable period of dry weather to avoid degrading an otherwise acceptable subgrade. Any soils which continue to rut or deflect excessively under the rolling operations should be undercut as directed by the geotechnical engineer and replaced with compacted fill material.

Based on the borings, we anticipate that undercutting of near-surface soils may be required in the vicinity of Boring B-4. However, localized undercutting of loose or soft soils may be necessary between the boring locations. Potential undercutting can be reduced if the site preparation work is performed during a period of dry weather.

5.4 Earthwork

Structural fill and backfill placed at the site should consist of a low to moderate plasticity soil (liquid limit less than 50 and plasticity index less than 20) that is free of organic material or debris. Fill soils should classify as CL, ML, SM, or SC in accordance with the Unified Soil Classification System. Highly plastic clays and silts (CH, MH) should not be used as surface fill because they are very moisture sensitive and subject to shrinking or swelling with seasonal changes in moisture content.

With the exception of cultivated soil, occasional soft near-surface soils, and highly plastic clays, the on-site soils may be reused as structural fill, but they will require careful moisture control. Excess cultivated soil may be placed in areas to be landscaped.

Structural fill should be placed in 8- to 10-inch thick loose lifts at a moisture content within three percent of the optimum moisture content of the material as determined by ASTM D 698 (Standard Proctor). Each lift of fill should be uniformly compacted to a dry density of at least 95 percent of the maximum dry density of the material determined according to ASTM D 698 (Standard Proctor). The upper 18 inches in substations areas should be compacted to at least 98 percent of the standard Proctor maximum dry density.

The geotechnical engineer's representative should perform in-place field density tests to evaluate the compaction of the structural fill and backfill placed at the site. We recommend a testing frequency of one test per lift per 2,500 square feet of fill area within the footprints of the substations.

5.5 Foundations

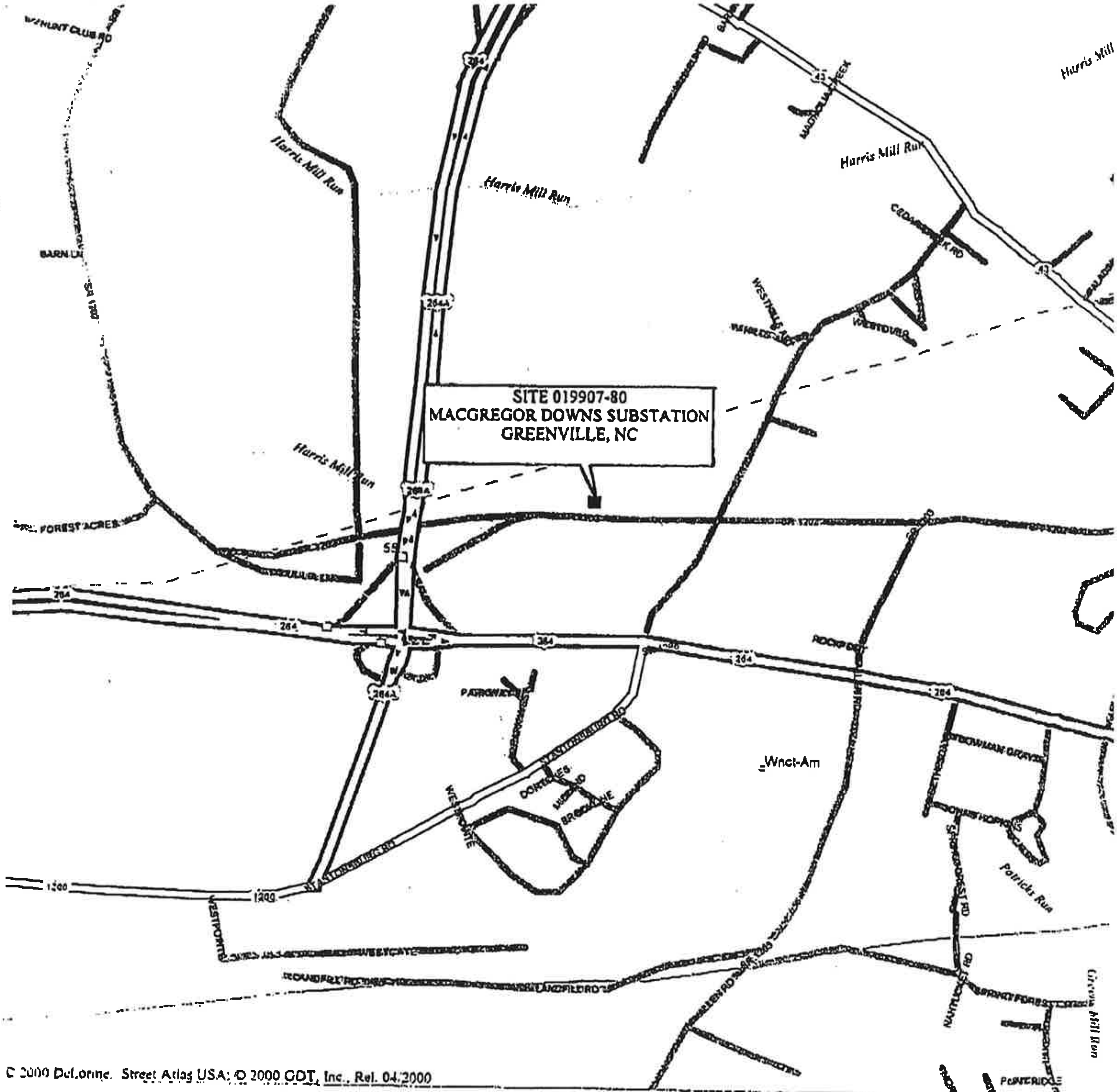
We recommend that the proposed substations be supported on shallow foundations bearing on suitable natural soil or properly compacted fill. A net allowable bearing pressure of 2,000 pounds per square foot (psf) should be used for design of the footings. The net allowable bearing pressure is that pressure which may be transmitted to the soil in excess of the surrounding overburden pressure.

Shallow foundations should be designed to bear at least 12 inches below finished grades for frost protection and protective embedment.

We estimate the total settlement for the substations will be less than 1-inch. Differential settlement should also be tolerable (less than about ½-inch).

We recommend that the footing excavations be observed by the geotechnical engineer's representative to verify that suitable soils are present at and below the proposed bearing elevation. If soft or unsuitable materials are encountered in the footing excavations, they should be undercut and replaced to the bottom of footing elevation with washed crushed stone (NCDOT No. 57 or 67). Based on the borings, we anticipate that undercutting of footings may be required in the vicinity of Boring B-4.

Prepared bearing surfaces for foundations should not be disturbed or left exposed during inclement weather. Saturation of the footing subgrade can cause a loss of strength and increased compressibility. If construction occurs during inclement weather, and concreting of foundations is not possible at the time they are excavated, a layer of lean concrete should be placed on exposed bearing surfaces for protection. Also, concrete should not be placed on frozen subgrades. The bottom of the foundation excavation should be clean and free of any loose soil, mud, or debris prior to placing concrete.



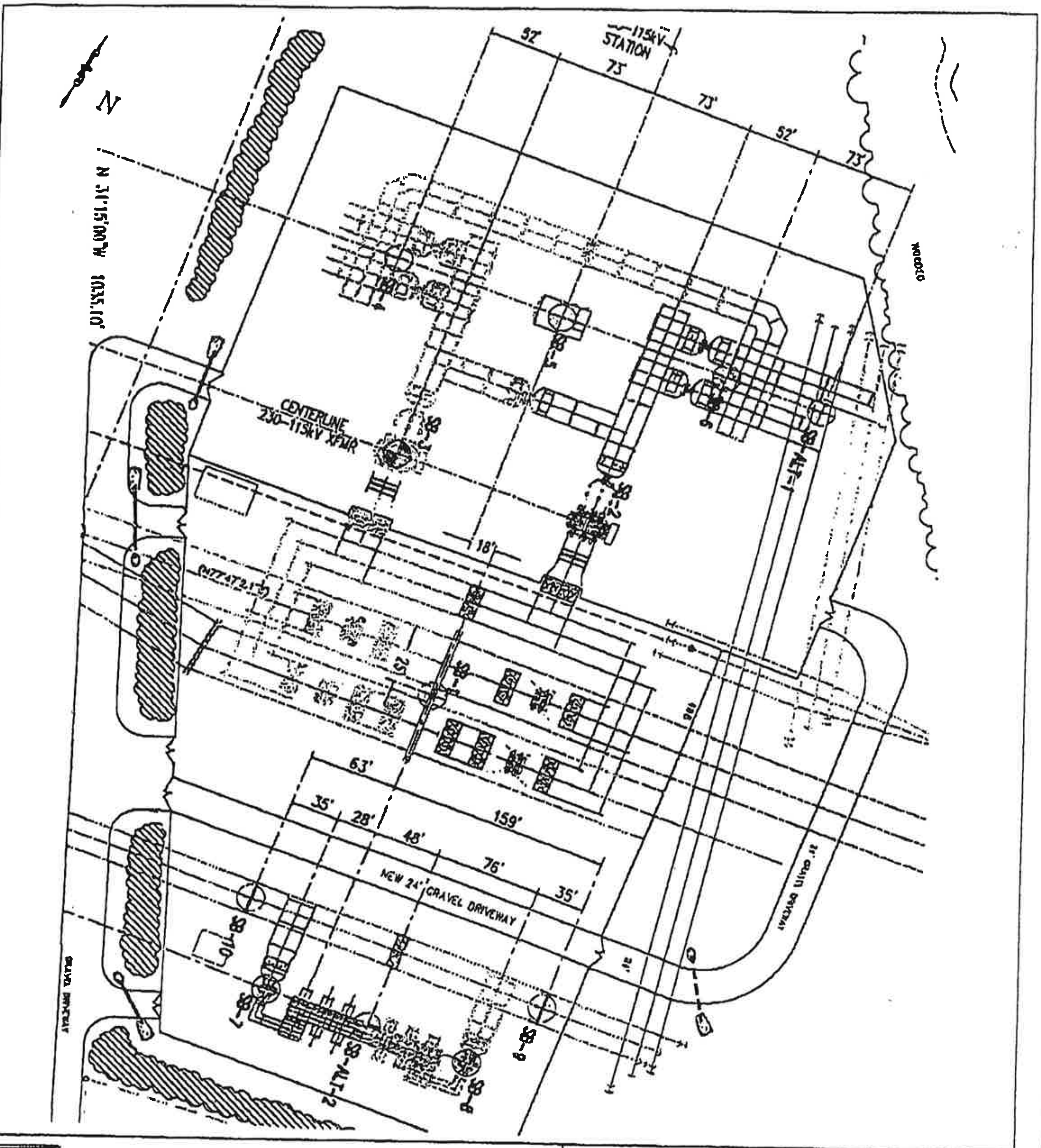
Mag 15.00
Thu Nov 15 08:54 2001
Scale 1:18,750 (at center)
2000 Feet
500 Meters

— Local Road
▭ US Highway
▭ Interstate/Limited Access
— Major Connector
— State Route
☐ Exit
- - Utility/Pipe
· · · Railroad

☐ Point of Interest
Land
Water
River/Canal
Intermittent River

TITAN Atlantic Group
Engineering, Construction and Consulting

SITE LOCATION PLAN
MACGREGOR DOWNS SUBSTATION
GREENVILLE, NC
019907-80
DRAWING NO. 1



TITAN *Atlantic Group*

ENGINEERING ▲ CONSTRUCTION ▲ CONSULTING

111-C WEST FIRETOWER ROAD
WINTERVILLE, NC 28590
PHONE: (252) 353-1600
FAX: (252) 353-0002

BORING LOCATION PLAN MACGREGOR DOWNS SUBSTATIONS GREENVILLE, NC

TITAN PROJ NO. 019908-80

CHECK: CFB	DRAWN: GRB	DATE: 11/30/01	SCALE: 1'=100'	DWG. NO. 2

C:\Titan\Projects\2001\80-019908\Boring Location.dwg

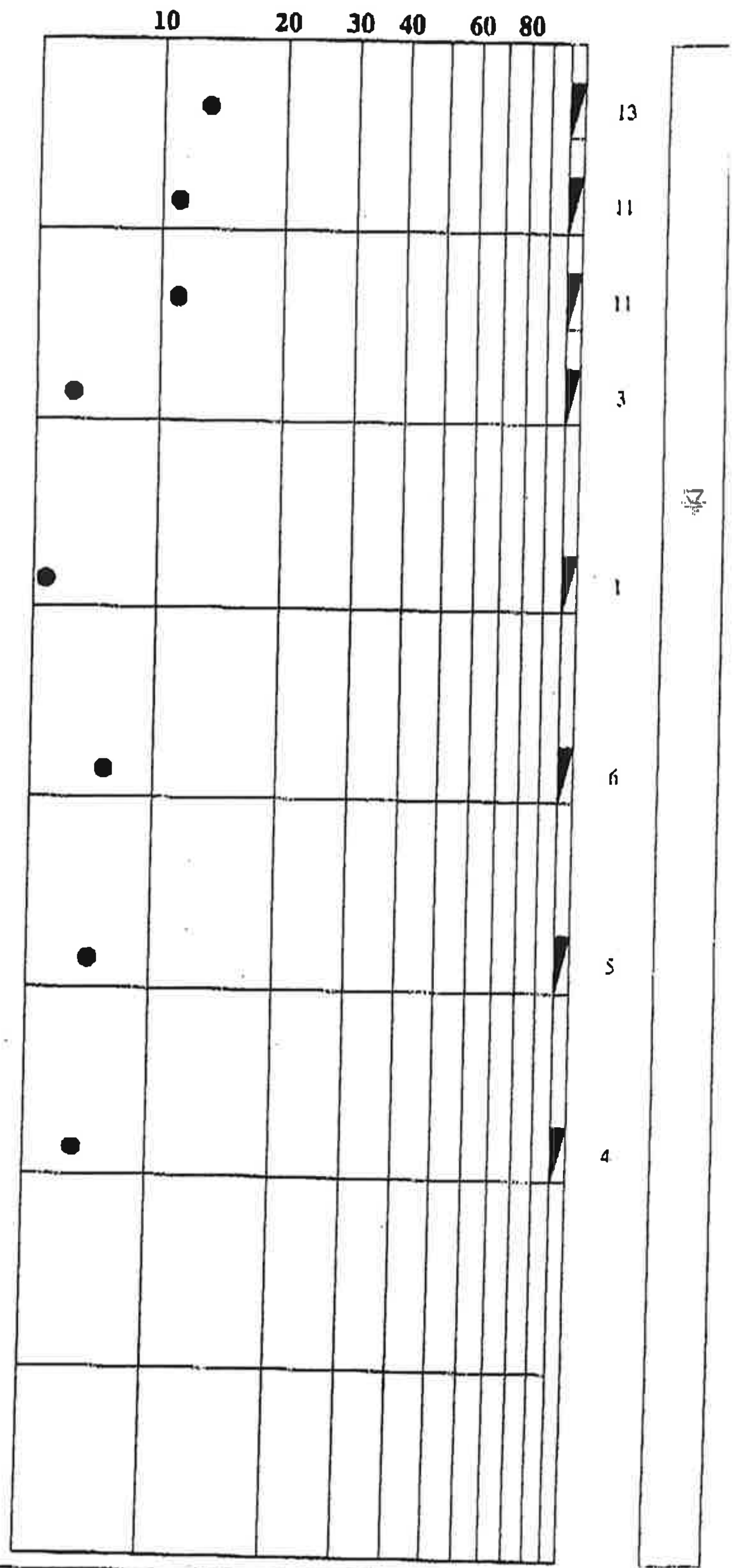
(FT.)

0.8 Cultivated soil (approx. 10").

Medium dense moist tan red and grey silty clayey fine SAND (SC).

8.0 Very loose to loose wet to saturated light grey and grey clayey silty fine SAND (SM).

30.0 Boring terminated at 30 feet.



Classified By: R. BRIDGER
Driller: CAROLINA DRILLING
Drill Rig: CME 45
Boring Type: MUD ROTARY

GROUNDWATER READINGS

DATE	TIME	DEPTH	ELEVATION	STABILIZATION TIME
11/21/01	--	12.0'	--	8 DAYS

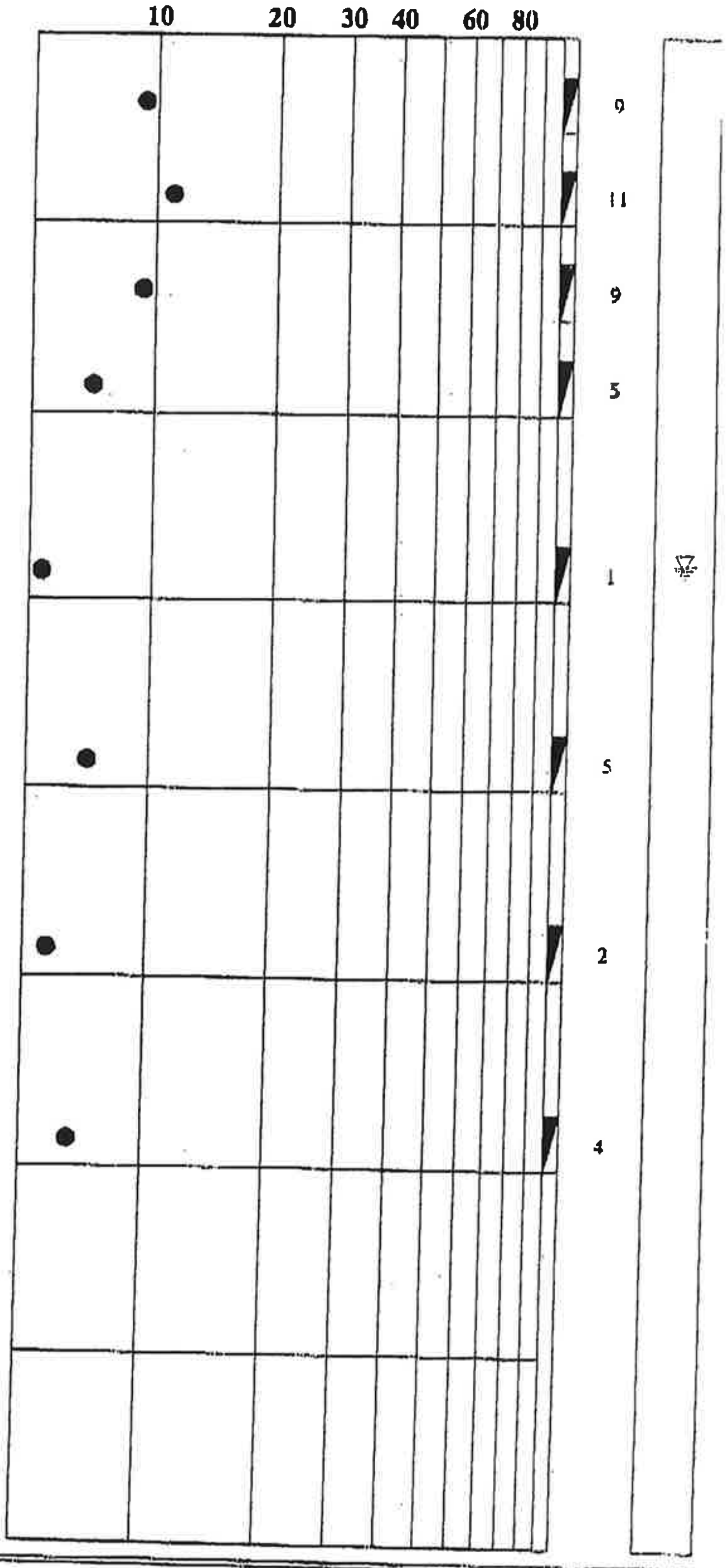
SEE KEY SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS

BORING LOG

BORING NUMBER	B-1
DATE DRILLED	11/12/01
PROJECT NUMBER	019907-80
PROJECT	MACGREGOR DOWNS SUBSTATIONS
PAGE 1 OF 1	

TITAN ATLANTIC GROUP

	Cultivated soil (approx. 10").
0.8	Loose moist tan silty fine SAND (SM) with organics.
3.0	Medium dense moist to wet light grey tan clayey fine SAND (SC) with trace organics.
12.0	Very loose to loose saturated grey orange silty fine SAND (SM).
30.0	Boring terminated at 30 feet.



Classified By: R. BRIDGER
Driller: CAROLINA DRILLING
Drill Rig: CME 45
Boring Type: MUD ROTARY

GROUNDWATER READINGS

DATE	TIME	DEPTH	ELEVATION	STABILIZATION TIME
11/21/01	--	14.0'	--	9 DAYS

SEE KEY SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS

BORING LOG

BORING NUMBER B-2
DATE DRILLED 11/12/01
PROJECT NUMBER 019907-80
PROJECT MACGREGOR DOWNS SUBSTATIONS
PAGE 1 OF 1

TITAN ATLANTIC GROUP

(FT.)

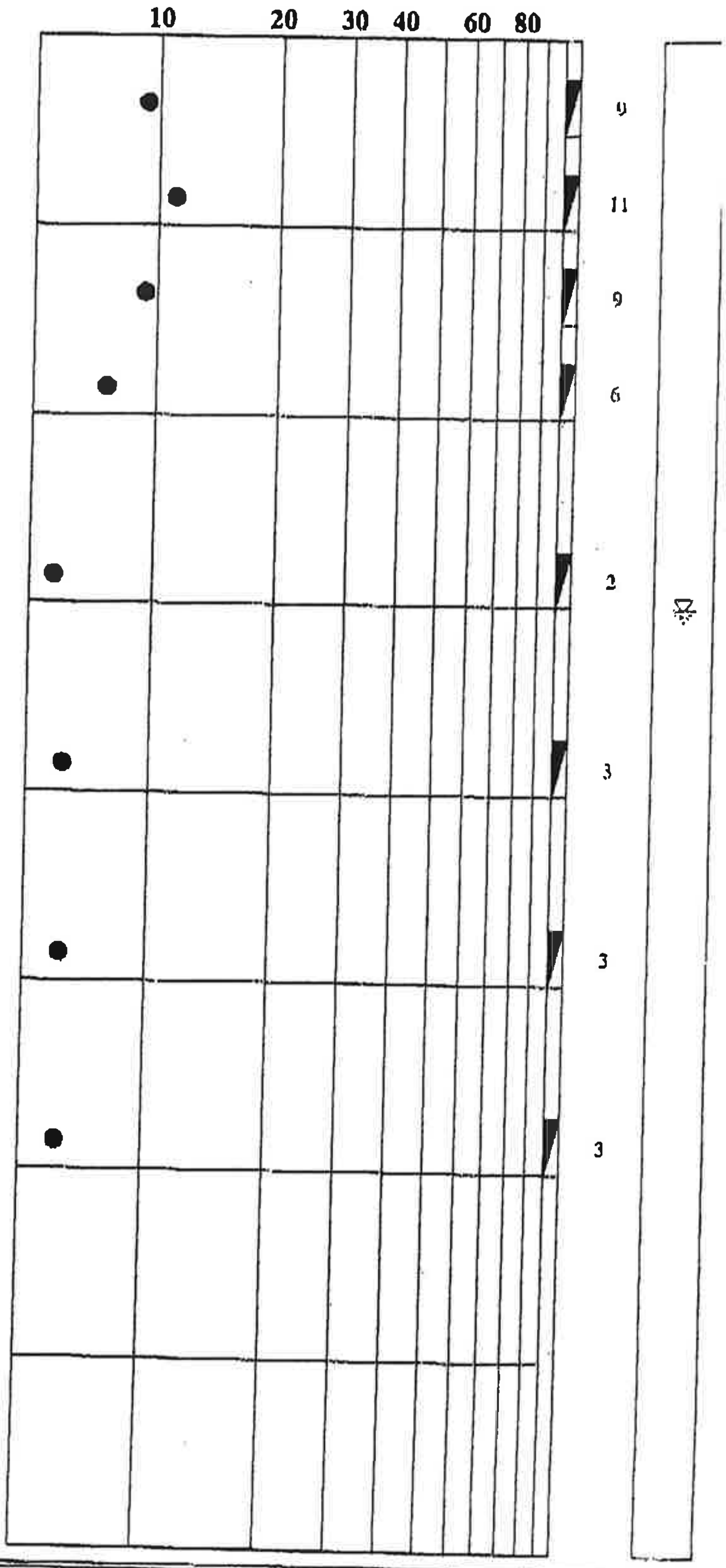
Cultivated soil (approx. 10").

0.8 Loose moist tan brown silty fine SAND (SM) with organics.

3.0 Medium dense loose moist to wet red grey and orange clayey fine SAND (SC) with trace organics.

12.0 Very loose wet to saturated tan orange silty fine SAND (SM).

30.0 Boring terminated at 30 feet.



Classified By: R. BRIDGER
Driller: CAROLINA DRILLING
Drill Rig: CME 45
Boring Type: MUD ROTARY

GROUNDWATER READINGS

DATE	TIME	DEPTH	ELEVATION	STABILIZATION TIME
11/21/01	--	15.0'	–	9 DAYS

SEE KEY SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS

BORING LOG

BORING NUMBER	B-3
DATE DRILLED	11/12/01
PROJECT NUMBER	019907-80
PROJECT	MACGREGOR DOWNS SUBSTATIONS
PAGE 1 OF 1	

TITAN ATLANTIC GROUP

(FT.)

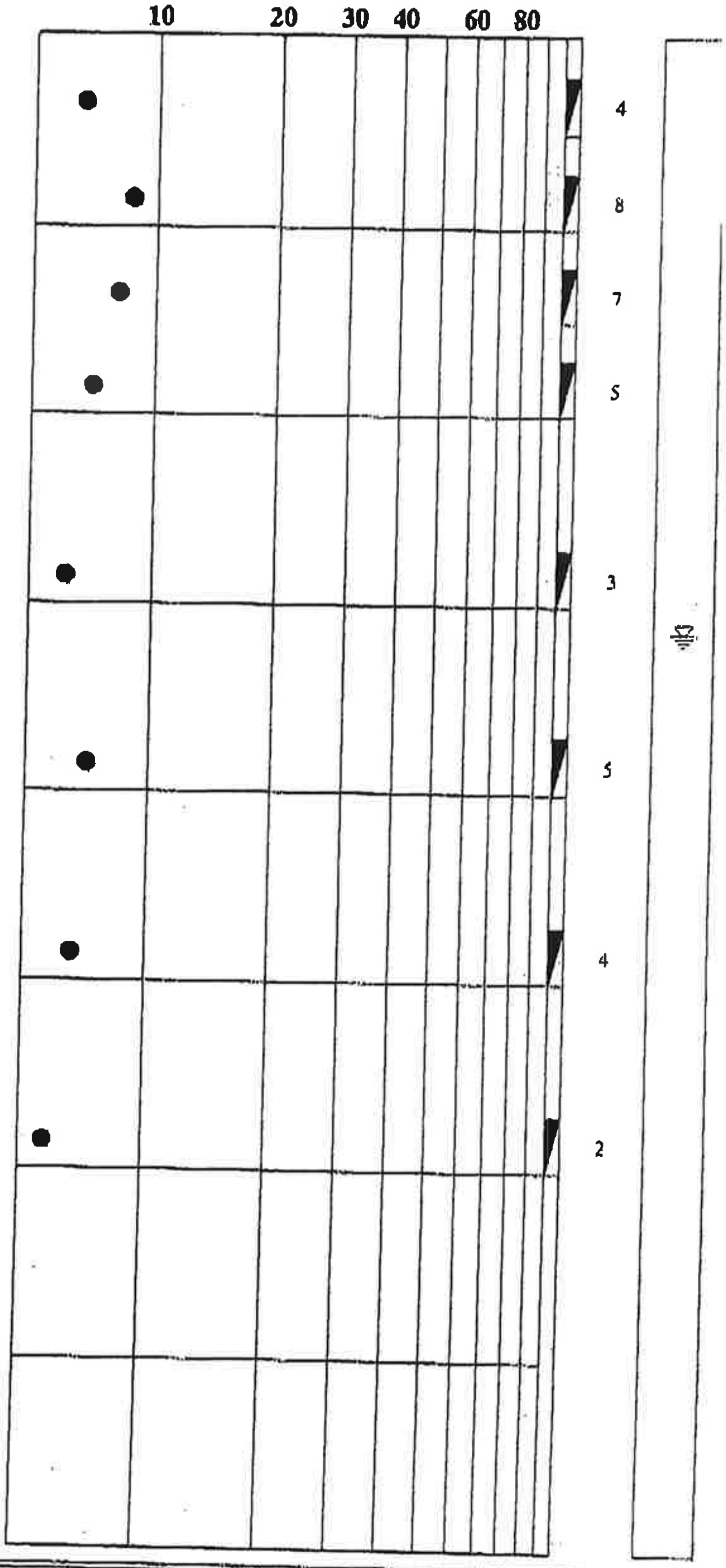
0.8 Cultivated soil (approx. 10").

0.8 Very loose moist tan orange and dark brown silty fine SAND (SM) with organics.

3.0 Loose to very loose moist to saturated grey tan and orange clayey fine SAND (SC).

17.0 Loose to very loose saturated tan orange and grey silty fine SAND (SM).

30.0 Boring terminated at 30 feet.



Classified By: R. BRIDGER
Driller: CAROLINA DRILLING
Drill Rig: CME 45
Boring Type: MUD ROTARY

GROUNDWATER READINGS

DATE	TIME	DEPTH	ELEVATION	STABILIZATION TIME
11/21/01	--	15.7'	--	8 DAYS

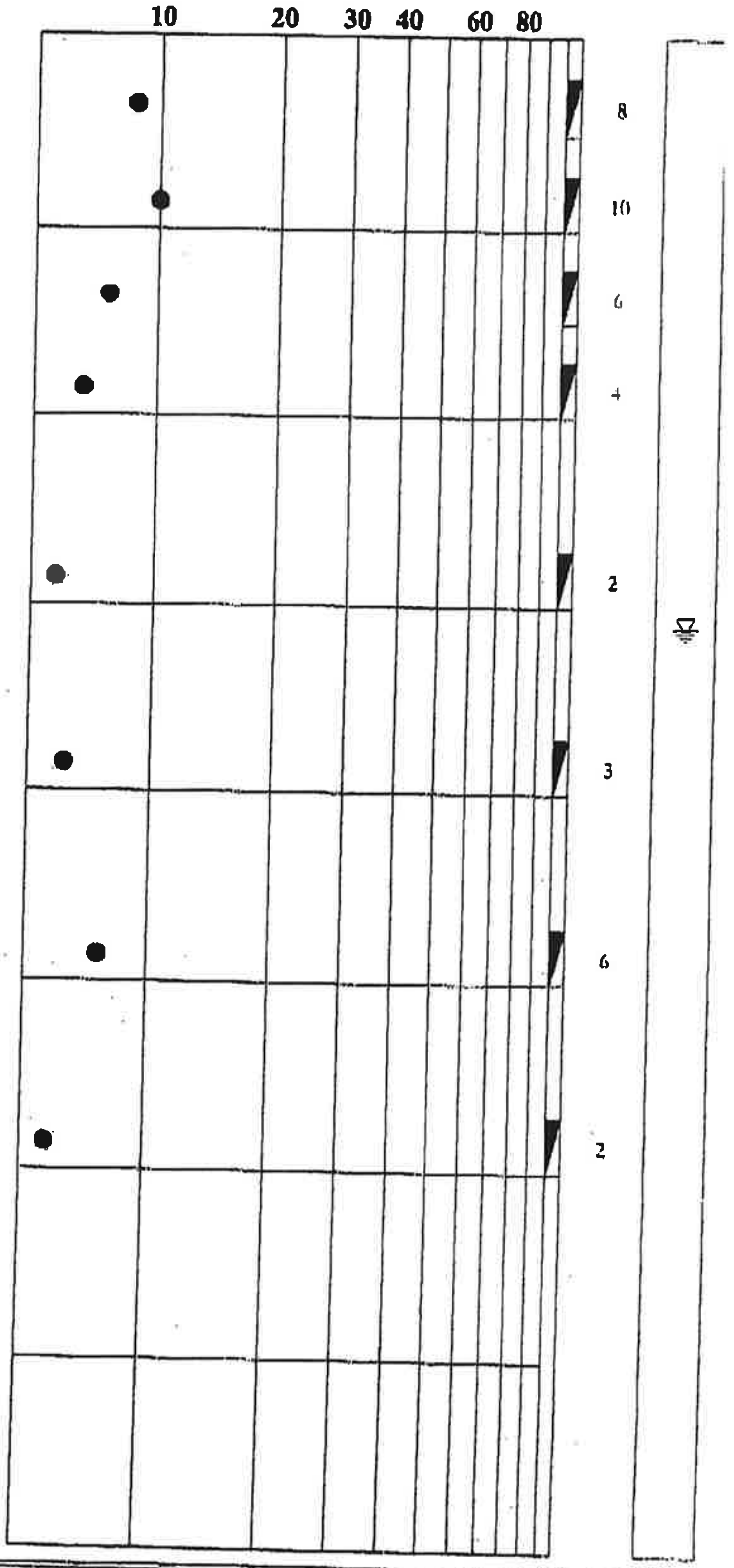
SEE KEY SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS

BORING LOG

BORING NUMBER B-4
DATE DRILLED 11/12/01
PROJECT NUMBER 019907-80
PROJECT MACGREGOR DOWNS SUBSTATIONS
PAGE 1 OF 1

TITAN ATLANTIC GROUP

	Cultivated soil (approx. 10").
0.8	Loose moist tan silty fine SAND (SM) with organics.
3.0	Loose moist grey red very clayey fine SAND (SC).
5.5	Loose to very loose wet orange tan silty clayey fine SAND (SC).
12.0	Very loose wet to saturated grey tan and orange clayey silty fine SAND (SM).
30.0	Boring terminated at 30 feet.



Classified By: R. BRIDGER
Driller: CAROLINA DRILLING
Drill Rig: CME 45
Boring Type: MUD ROTARY

GROUNDWATER READINGS

DATE	TIME	DEPTH	ELEVATION	STABILIZATION TIME
11/21/01	--	15.5'	--	9 DAYS

SEE KEY SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS

BORING LOG

BORING NUMBER	B-5
DATE DRILLED	11/12/01
PROJECT NUMBER	019907-80
PROJECT	MACGREGOR DOWNS SUBSTATIONS
PAGE 1 OF 1	

TITAN ATLANTIC GROUP

(FT.)

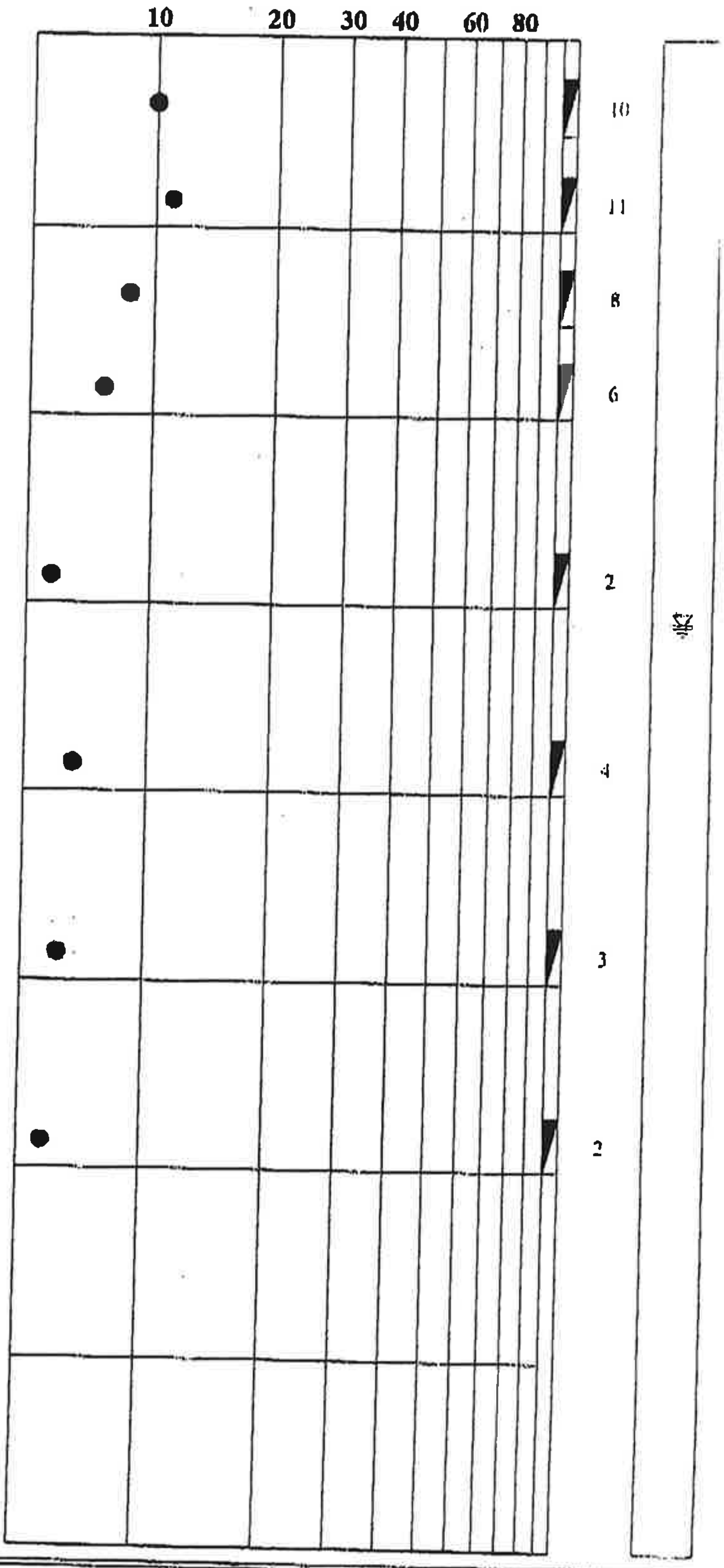
0.8 Cultivated soil (approx. 10").

3.0 Loose moist tan silty fine SAND (SM) with organics.

12.0 Medium dense to loose moist to wet grey tan and orange clayey fine SAND (SC).

30.0 Very loose to loose wet to saturated grey orange clayey silty fine SAND (SM).

Boring terminated at 30 feet.



Classified By: R. BRIDGER
Driller: CAROLINA DRILLING
Drill Rig: CME 45
Boring Type: MUD ROTARY

GROUNDWATER READINGS

DATE	TIME	DEPTH	ELEVATION	STABILIZATION TIME
11/21/01	–	15.4'	–	9 DAYS

SEE KEY SHEET FOR EXPLANATION
OF SYMBOLS AND ABBREVIATIONS

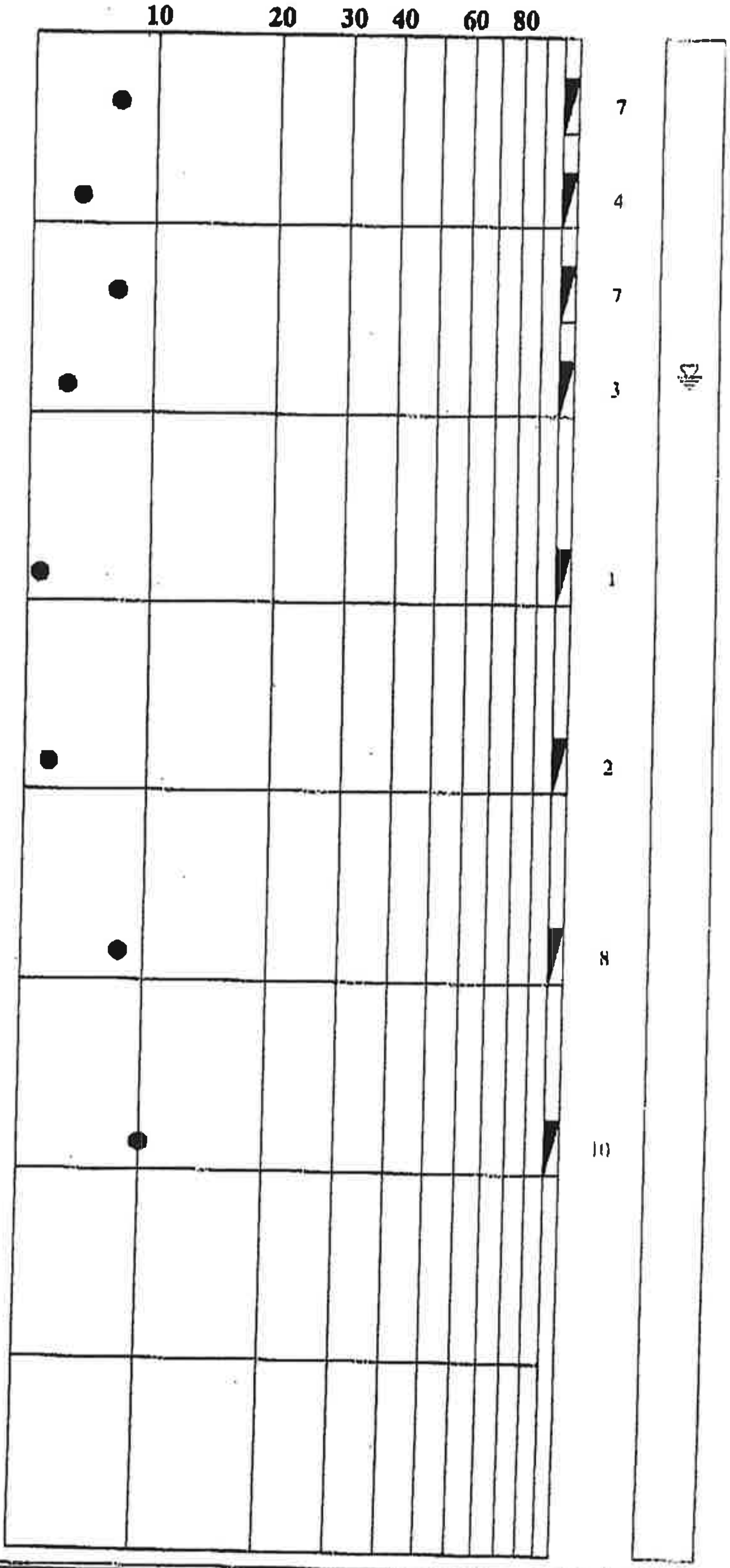
BORING LOG

BORING NUMBER	B-6
DATE DRILLED	11/12/01
PROJECT NUMBER	019907-80
PROJECT	MACGREGOR DOWNS SUBSTATIONS
PAGE 1 OF 1	

TITAN ATLANTIC GROUP

(FT.)

	Cultivated soil (approx. 10").
0.8	Loose moist brown orange clayey fine SAND (SC) with organics.
3.0	Very loose to loose moist to saturated orange light grey and brown silty clayey fine SAND (SC).
12.0	Very loose to loose saturated dark blue grey silty fine SAND (SM).
30.0	Boring terminated at 30 feet.



Classified By: R. BRIDGER
Driller: CAROLINA DRILLING
Drill Rig: CME 45
Boring Type: MUD ROTARY

GROUNDWATER READINGS

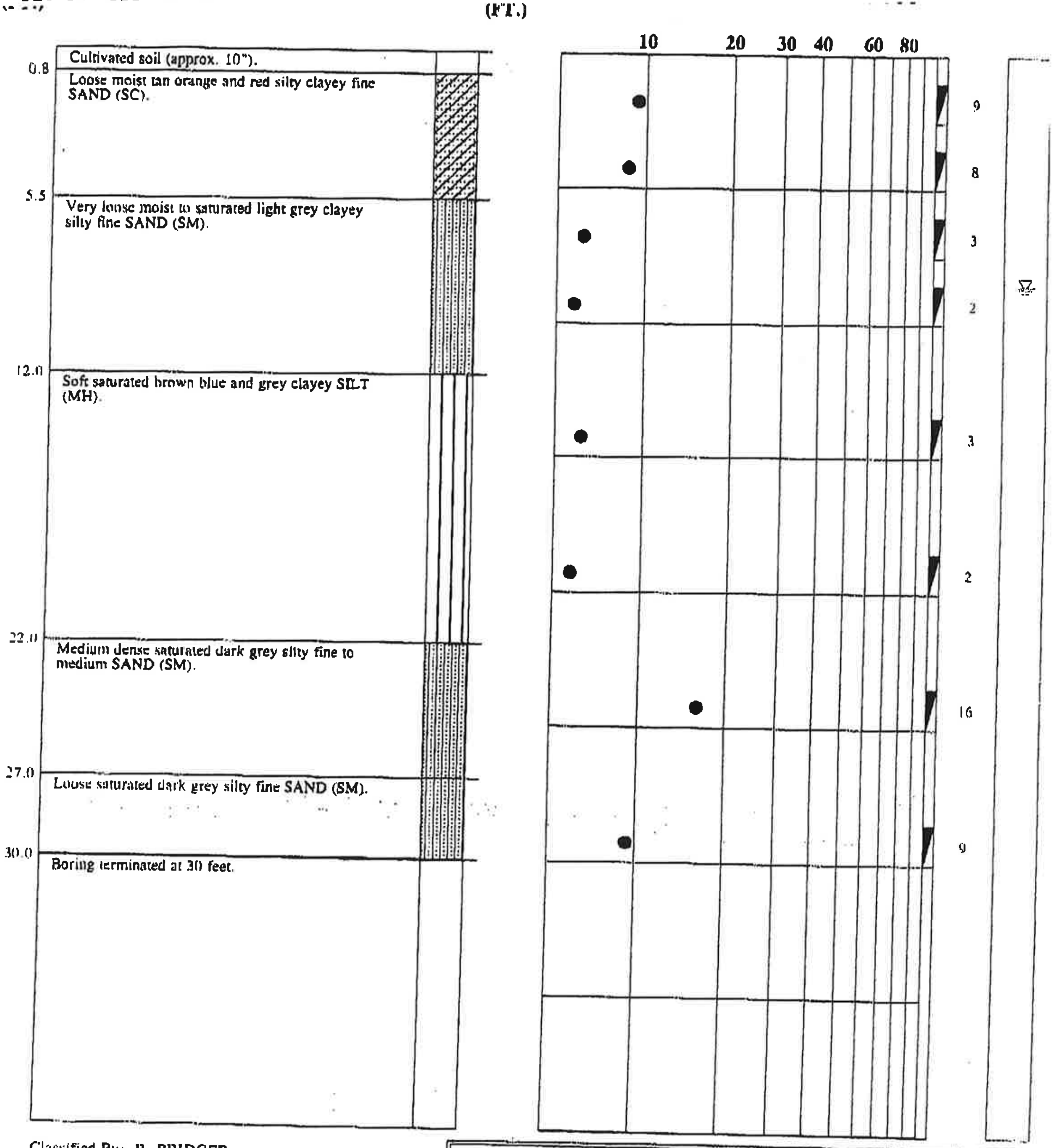
DATE	TIME	DEPTH	ELEVATION	STABILIZATION TIME
11/21/01	--	6.9'	--	9 DAYS

SEE KEY SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS

BORING LOG

BORING NUMBER	B-7
DATE DRILLED	11/12/01
PROJECT NUMBER	019907-80
PROJECT	MACGREGOR DOWNS SUBSTATIONS
PAGE 1 OF 1	

TITAN ATLANTIC GROUP



	Cultivated soil (approx. 10").
0.8	Loose moist tan orange and red silty clayey fine SAND (SC).
5.5	Very loose moist to saturated light grey clayey silty fine SAND (SM).
12.0	Soft saturated brown blue and grey clayey SILT (MH).
22.0	Medium dense saturated dark grey silty fine to medium SAND (SM).
27.0	Loose saturated dark grey silty fine SAND (SM).
30.0	Boring terminated at 30 feet.

Classified By: R. BRIDGER
Driller: CAROLINA DRILLING
Drill Rig: CME 45
Boring Type: MUD ROTARY

GROUNDWATER READINGS

DATE	TIME	DEPTH	ELEVATION	STABILIZATION TIME
11/21/01	--	8.5'	–	9 DAYS

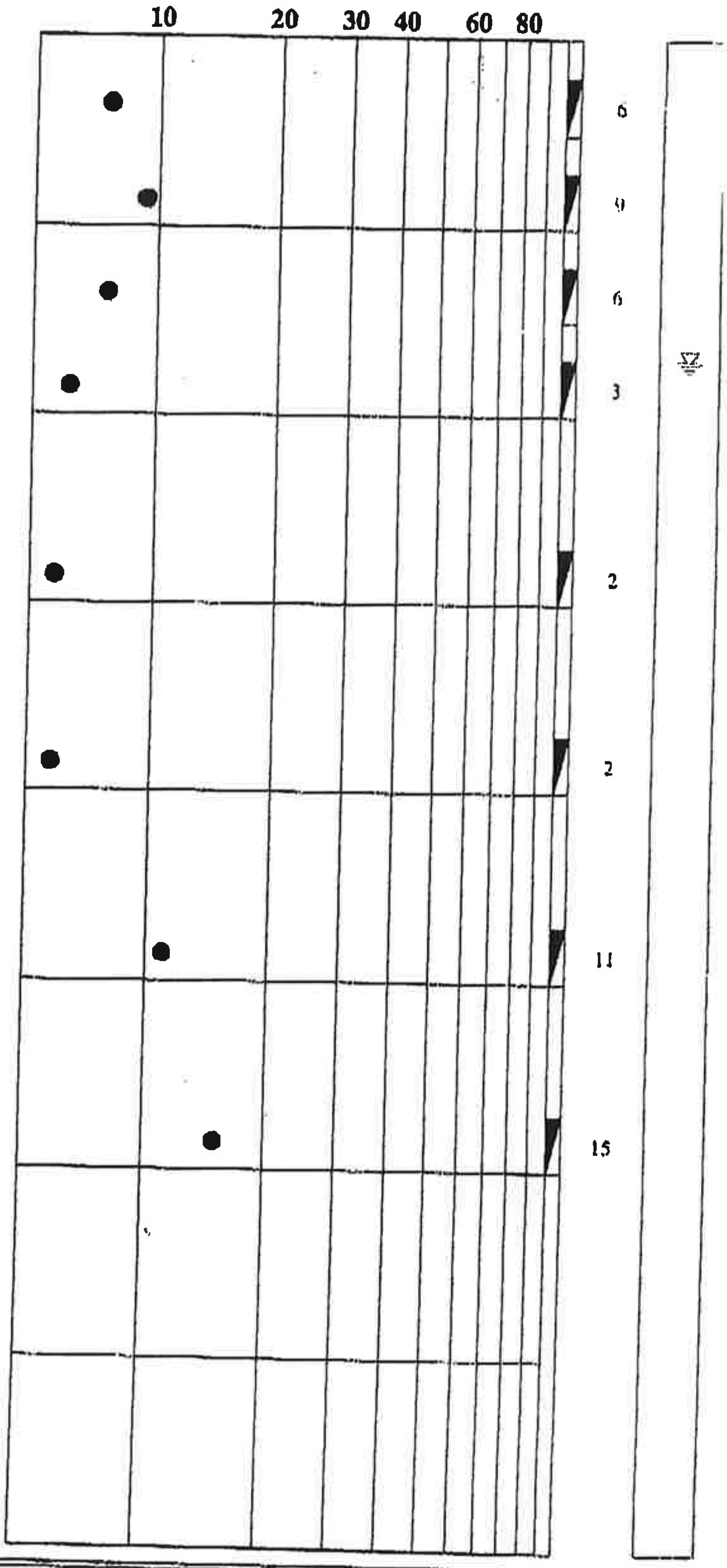
SEE KEY SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS

BORING LOG

BORING NUMBER B-8
DATE DRILLED 11/12/01
PROJECT NUMBER 019907-80
PROJECT MACGREGOR DOWNS SUBSTATIONS
PAGE 1 OF 1

TITAN ATLANTIC GROUP

	Cultivated soil (approx. 10").
0.8	Loose moist orange tan silty clayey fine SAND (SC) with trace organics.
8.0	Very loose moist to saturated orange light grey clayey silty fine SAND (SM).
12.0	Very soft saturated brown blue and grey clayey SILT (MH) with trace fine sand.
17.0	Very soft saturated brown blue and grey clayey fine sandy SILT (ML).
22.0	Medium dense saturated dark grey silty fine to medium SAND (SM).
27.0	Medium dense saturated dark grey silty fine SAND (SM).
30.0	Boring terminated at 30 feet.



Classified By: R. BRIDGER
Driller: CAROLINA DRILLING
Drill Rig: CME 45
Boring Type: MUD ROTARY

GROUNDWATER READINGS

DATE	TIME	DEPTH	ELEVATION	STABILIZATION TIME
11/21/01	--	8.5'	--	8 DAYS

SEE KEY SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS

BORING LOG

BORING NUMBER B-9
DATE DRILLED 11/12/01
PROJECT NUMBER 019907-80
PROJECT MACGREGOR DOWNS SUBSTATIONS
PAGE 1 OF 1

TITAN ATLANTIC GROUP

(FT.)

0.8 Cultivated soil (approx. 10").

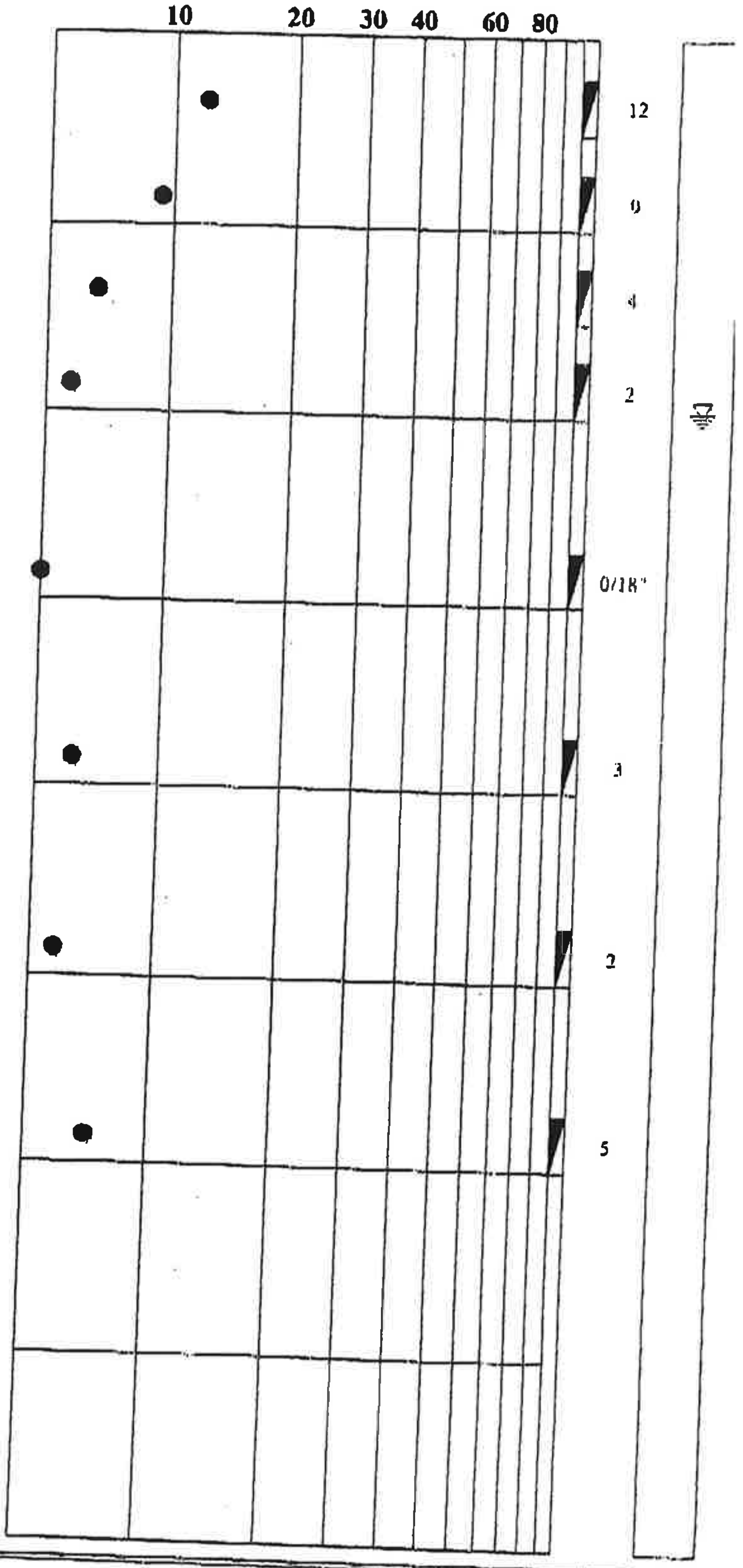
Medium dense brown orange clayey fine SAND (SC) with oraganics.

3.0 Loose orange red and grey mottled clayey SAND (SC).

5.5 Very loose light grey brown silty clayey fine SAND (SC).

12.0 Very loose dark grey silty fine SAND (SM).

30.0 Boring terminated at 30 feet.



Classified By: R. BRIDGER
Driller: CAROLINA DRILLING
Drill Rig: CME 45
Boring Type: MUD ROTARY

GROUNDWATER READINGS

DATE	TIME	DEPTH	ELEVATION	STABILIZATION TIME
11/21/01	--	9.8'	--	9 DAYS

SEE KEY SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS

BORING LOG

BORING NUMBER	B-10
DATE DRILLED	11/12/01
PROJECT NUMBER	019907-80
PROJECT	MACGREGOR DOWNS SUBSTATIONS
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TITAN ATLANTIC GROUP

APPENDIX B

SUBMITTAL LOG

Project Submittals

Owner: Greenville Utilities Commission
Contractor:
Project: Greenville West Substation
Scope: Foundations and Oil Containment

DESCRIPTION	SUBM. #	RECEIVED	REJECTED	APPROVED	NOTES
Concrete					
Pad Mix Design					
Pad Concrete Materials (Cement, Stone, etc.)					
Pad Admixtures (Air, Plasticizers, etc.)					
Pier Mix Design					
Pier Concrete Materials (Cement, Stone, etc.)					
Pier Admixtures (Air, Plasticizers, etc.)					
Reinforcement					
Curing Compounds					
Concrete Testing Firm with Contacts					
Geotechnical Firm with Contacts					
Oil Containment					
PVC Pipe					
Reinforced Concrete Pipe					
Joint Sealants					
Ground Clamps					
Waterstop Materials					
Pump					
Oil Sensing Device					
Grating					
Grating Materials					
Support Materials					
Support Layout					
Grating Layout					