Test Boring and Sub-Surface Investigation

PROJECT:	Colleton County Fire Station – Round O Road
	Colleton County, SC
CLIENT:	R. W. Chambers, Architect, GGP
REPORT No. :	5-21-13-1

Whitaker Laboratory, Inc.

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May 21, 2013

R.W. Chambers, Architect, GGP
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roscoechambers5256@gmail.com

Referencing: Report of Geotechnical Evaluation Services
Proposed Fire Station
Round O Road, Colleton County, SC
Report No.: 5-21-13-1

Dear Mr. Chambers:

As requested, Whitaker Laboratory, Inc. has conducted a geotechnical investigation for the above referenced project. Authorization to perform this investigation was provided by your acceptance of our proposal dated April 23, 2013. Our findings and recommendations for design and construction are attached and it is important that you read the report in its entirety.

It is a pleasure to continue service to you and we look forward to further opportunities to assist you on this and other projects.

Respectfully submitted,
WHITAKER LABORATORY, INC.

Jason H. Follo, P.E.
SC Registered Engineer
#20225

Joseph M. Whitaker
President

513063rpt

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Proposed Fire Station
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INTRODUCTION

At any time, we will be glad to discuss the contents of this report. This includes insuring that you fully consider potential problems for design and construction procedures in respect to interpretations of the data.

WHITAKER LABORATORY, INC. has completed this field investigation of the surface and subsurface conditions at this site. The preliminary conditions found, and how those conditions could affect the design and construction of foundations for the structures planned, form the basis for this report. Regardless of the thoroughness of any geotechnical investigation, there are limitations, and deviations from the conditions found in this investigation could be subsequently disclosed. We recommend that this report be provided to all parties involved in the planned development to include but not necessarily limited to the Owner, Architect, Design Engineers, General Contractor and sub-contractors. Unanticipated circumstances often arise during sitework, earthwork and foundation construction. Accordingly, we recommend that our firm be retained to provide the construction surveillance, inspection, and testing on the project, thereby being readily available to assist in the evaluation of any conditions encountered that differ from those anticipated.

We understand a fire station building structure and associated pavements are planned for construction on this site.

We have not been provided foundation loads or site grading requirements at this time, however for the purpose of this repot we will assume that foundation loads will not exceed 50 kips per column and/or 3 kips per linear foot for walls/strip loads. We will further assume that site grades will not be elevated by more than 3 feet above existing ground surface elevations to achieve finished grade elevations for the slab-on-grade within the building pad area. If our assumptions are incorrect, we should be contacted immediately, provided the correct information and allowed an opportunity to change and/or modify the recommendations contained within this report if necessary.

The scope of this investigation included a visual reconnaissance, the drilling of two standard penetration test borings and the advancement of three auger borings.

Please note that this evaluation only applies to the foundation and pavements planned for construction. This evaluation does not apply to any future improvements, which may be made to the site. In particular, if at any time should additional fill be placed, adjacent to or nearby the structures referenced in this report, additional geotechnical borings and a follow up geotechnical analysis will be required. Standard billing rates will apply for this work.

AREA GEOLOGY

This project is located in Colleton County, SC. This overall project area lies near the eastern edge of the South Atlantic Coastal Plain. In South Carolina and Georgia, this broad, gently sloping region extends southeastward from the Fall Line (Chesterfield - Columbia - Augusta - Macon - Columbus) to the Atlantic Ocean. The soils encountered are sedimentary in origin, and consist of layered marine deposits of sands, silts, and clays. These deposits have since been subjected to successive erosion and re-deposition, by fluctuations of sea levels, storm tides, and winds. Many of the surface sands are the result of depositional forces along ancient beaches, which formed during the changing shoreline and river conditions. Intermittent deposits of shells occur within the strata at irregular intervals. The surface soils in a majority of this Coastal Plain area were deposited during the Pleistocene Era, however surface soils near the coast are likely of the Holocene Era.

TEST BORINGS AND SUBSURFACE CONDITIONS

The field exploration to determine the characteristics of the subsurface materials included a reconnaissance of the project site, and the drilling of exploratory borings. Standard penetration test borings were performed using rotary head drilling equipment and advancing hollow stem augers. Sampling and Standard Penetration Testing, (SPT), was performed in accordance with ASTM-D-1586. SPT samples were taken at 2.5 foot intervals of depth for the first 10 feet, and at 5.0 foot intervals thereafter. Standard Penetration testing is done with a 140-pound hammer falling 30 inches and a two inch diameter sampling spoon. Standard Penetration Testing (SPT N values) provides an indication of the relative consistency, density and in-situ strengths of the tested soils.

Soil samples from SPT testing and from the auger cuttings have been used for identification and visual classification. The subsurface stratification and the profile as presented in the boring log, represent approximate boundary lines between the strata and materials encountered. These boundary lines are usually gradual and not clearly defined, and it is sometimes difficult to record changes in stratification precisely. It should be noted that underlying soil conditions, can, and do, vary considerably within short lateral distances. It is possible that conditions may be revealed outside the boring location that is different from those found by our boring and used for our analysis.

The approximate locations of the borings are shown on the attached BORING LOCATION PLAN. Our drilling crews based on landmarks and features available at the time of drilling have estimated the location of the borings in the field. If the precise location of the boreholes is critical, this can be determined by employing a land surveying firm to plot the true locations. Such survey should be completed promptly and before any disturbance to the area has occurred. If desired, WHITAKER LABORATORY, INC. will be glad to coordinate surveying arrangements for an additional fee.

At the time of our site visit, the site was over grown with underbrush and small trees. Pathways were cleared with a bulldozer for our equipment to access planned boring locations. Near surface soils within the pathways were not stable to our truck mounted drilling equipment during our initial visit due to recent heavy rainfall. Once the site was allowed to dry after a period of dry weather, the near surface soils became stable to our truck-mounted drilling equipment and we were able to access the site. Ground surface topography was relatively flat. Soil test borings were advanced within the planned building pad area to depths reaching 25 feet each below the ground surface. Auger borings were advanced to depths reaching 5 feet each below the ground surface within planned paved areas.

Below the surface vegetation and 7 to 12 inches of organic topsoil, the near surface soils predominately consist of firm to very stiff clays (CL and CH) extending to depths reaching 8 to 13 feet below existing grades. Below the surface clay stratification, inter-bedded stratifications of very soft to hard sand clays (SC) and firm to dense sands (SP-SM and SM) were encountered and extended to the termination depths of the soil test borings at 30 feet below existing grades.

The above description of the subsurface profile should be considered a general description intended to highlight the major strata encountered. More detailed profiles can be observed within the attached boring logs. Please note that boring logs are only representative of their location. Stratification transitions should be expected to occur outside and between boring locations. Taking into account that sampling was not performed on a continuous basis, lines drawn representing elevations of stratification changes shown on the boring logs were estimated.

GROUNDWATER TABLE

The apparent groundwater table was measured at each boring location at the time of boring. Groundwater was measured to range from 3 to 6 feet below the ground surface at the time the test borings were performed. The ground water elevation can be expected to fluctuate with the season of the year, surrounding ground surface conditions, and with recent rainfall amounts. Thus, groundwater elevations shown on the boring logs should be considered valid only for the date of observation.

WHITAKER LABORATORY, INC. recommends that the contractor determine a groundwater level just prior to site work begins. We have addressed groundwater concerns within the Earthwork and Foundations Design Considerations section of this report.

SEISMIC SITE CLASSIFICATION AND RECOMMENDED DESIGN COEFFICIENTS

Liquefaction Potential:

Whitaker Laboratory, Inc. performed a liquefaction analysis on the soils encountered within soil test boring B-2. Liquefaction typically occurs when very loose to loose non-cohesive soils encountered below the groundwater table experience a significant loss of shear strength due to the increase in porewater pressure resulting from seismic vibrations.

The design earthquake utilized in our analysis (Charleston, SC earthquake with magnitude 7.3 and a 2% probability of exceedance in 50 years) yielded peak horizontal ground surface accelerations of 0.335g on this site. Based upon the design earthquake and characteristics of subsurface soils within Boring B-1, the liquefaction analysis indicated that the encountered sand stratifications present below the groundwater table have potential to liquefy during the design seismic event.

The amount of settlement estimated during and shortly after a seismic event of this magnitude approximates 1 inch.

Settlements of this magnitude could cause minor damage to the structure. If the risk of anticipated settlements due to liquefaction are unacceptable to the owner, extensive ground modification would need to be performed on the liquefiable soil stratums or supporting the structure on pile foundation systems bearing below the potentially liquefiable soil zones would be required. Whitaker Laboratory should be contacted if this risk is unacceptable. Additional recommendations will be required to provide foundation recommendations capable of guarding the structure against liquefaction induced settlements.

Seismic Parameters:

Assuming the structure has a period of vibration under 0.5 second and disregarding liquefaction potential, this site would be defined as a Site Class "D". The classification is determined by average soil properties in the top 100 feet of the soil profile, including standard penetration test N values, shear wave velocities, in-situ shear strengths and moisture contents, as specified by IBC 2006. Both short and long period, Mapped Spectral Response Accelerations have been determined.

0.2 Sec. Period Mapped Response Acceleration

$S_s = 1.255$

Sec. Period Mapped Response Acceleration

$S_1 = 0.310$

The long and short period site coefficients, F_a and F_v, have been calculated for this site, utilizing mapped spectral response accelerations shown above, the procedures established by The U. S.

Geological Survey (USGS) and The Federal Emergency Management Agency (FEMA), and software from the National Seismic Hazard Mapping Project.

0.2 Sec. Period Site Coefficient
$F_a = 1.0$

Sec. Period Site Coefficient
$F_v = 1.781$

Design spectral response acceleration parameters S_{DS} and S_{D1}, are then determined by multiplying S_{MS} and S_{M1} by 2/3rds.

$S_{MS} = 1.255$ and $S_{DS} = 0.837$
and
$S_{M1} = 0.551$ and $S_{D1} = 0.367$

The design spectrum is attached in the Appendix. If the period of vibration for the planned structure is in excess of 0.5 second or the size and design of this structure justifies additional investigation, a Site Specific Geotechnical Investigation and dynamic site response analysis should be performed. Our firm has the ability to provide our clients such testing and evaluation, and we will be available to discuss the cost, and potential benefit, if any, of such if you desire.

EARTHWORK AND FOUNDATION DESIGN CONSIDERATIONS

The foundation design for the envisioned structure can use individual, or strip spread footings with a slab-on-grade (or monolithic slab-on-grade) if our assumed foundation loads and site grading assumptions are not exceeded, risk of liquefaction induced settlements are not of concern to the owner and/or structural engineer and when the design, site preparation, and construction is in accordance with the recommendations of this report.

Please note that plastic clays (CH) were encountered on this site immediately below the topsoil. These CH soils are typical of the surrounding area and are extremely moisture sensitive. These clays have caused serious foundation and pavement problems in nearby developments. These clays have a potential for significant change in volume and shear strength with fluctuations in soil moisture content. In an effort to mitigate the detrimental effects of the CH shrink/swell potential, it is important that foundation elements and pavement sections be separated by a 24 inch compacted and approved coarse-grained sand layer from the clay strata.

In an effort to provide this 24-inch sand layer below footings and pavement sections, Whitaker recommends raising grades on this site without further excavation below bottom of stripping depths. Raising site grades will also allow for superior drainage and long term stability of subgrade soils.

If this 24-inch sand layer is achieved by undercutting below stripping depths and backfilling, permanent under drain systems will be required to guard the site against perched water collecting within the sand backfill.

- We recommend that the entire building site plus a minimum of 10 feet beyond the perimeter of all structural areas be stripped of any organics and unsuitable surface soils. Stripping depths should be anticipated to extend 7 to 12 inches or more to effectively remove all surface organic soils.

- After stripping, the exposed subgrade soils should be thoroughly compacted in-place to 95% of ASTM-D-1557 and pass proof-rolling inspections prior to filling operations begin. The exposed clay surface after stripping shall be graded to promote positive surface drainage away from structural areas. If necessary, under drains shall be installed at the low-point outside the structural area to remove water likely to collect as perched groundwater within the sandy backfill/fill material.

- Areas failing compaction and/or found to pump or deflect under proof rolling should be undercut to a competent material and backfilled with an approved compacted material. Geo grid (Tensar TX 160) can be placed on exposed subgrade soils within pavement areas to achieve stability for placement of fill soil. The exposed subgrade soils should be inspected, tested and approved by Whitaker Laboratory personnel prior to fill placement begins.

- Fill material required to replace the stripped areas and to raise the pad area to achieve finished subgrade elevations, should consist of granular soils and be placed and compacted in accordance with the SITE WORK section of this report.

- Bottom of footing excavations should be thoroughly compacted to meet or exceed 95% of the soils modified proctor maximum dry density in accordance with ASTM-D-1557. **Footing inspections should also be conducted by performing dynamic cone penetrometer to verify adequate bearing material is present below bottom of footing elevations.** Subsurface bearing soils deemed unsuitable based upon dynamic cone penetrometer testing or visual classification should be undercut to a competent material and backfilled with an approved material.

- If site grades are raised (as recommended above) to achieve 24 inches of sandy soil below bottom of footing elevations, the necessity for undercutting footings will be greatly reduced.

If the above mentioned recommendations are followed and verified by Whitaker personnel during construction, individual spread footings, strip footings, or bearing edges of slabs-on-grade could be designed to bear in compacted and approved coarse grained structural fill, as outlined above and soil bearing pressures of 1500 psf may be used. Overall and differential settlements are anticipated to be on the order of one inch and one half inch respectively or less due to fill heights (max 3 feet) and foundation loads. Any individual or strip footing should have a minimum plan dimension of 24 inches. Bearing elevations of foundations should be at least 12 inches below grade, above the groundwater table and a minimum of 24 inches above CH soils.

On-site soils for use as structural fill:

The subsurface soils on this site extending to depths reaching 8 ½ + feet below the ground surface consist of plastic clays (CH). These CH soils are unsuitable for use as structural fill and/or backfill. The CH soils excavated from below the ground surface on this site should not be re-utilized in construction as fill and/or backfill within structural areas (within building pad and pavement areas).

SITE WORK RECOMMENDATIONS

We will be pleased to discuss these recommendations with the owner and the site work contractor selected to do the work. We believe it will be beneficial to the project, for the owner and the contractor to have a clear understanding of our recommendations.

1. Prior to construction, all building areas, plus at least 10 feet on each side and all areas to be paved, should be stripped of all vegetation, topsoil and root systems. Site drainage during construction should be considered prior to this clearing and stripping. Preventing the ponding of storm water is of particular importance.

2. Topsoil, organics, root-mat and other surface materials will likely vary across the site. Individual test borings may not accurately reflect the presence of, or the thickness of such materials due to site variability and/or surfacing clearing to facilitate access for drilling equipment. Site clearing and grubbing, when unsupervised, and particularly in areas of wet soils and times of wet weather, may push organic debris into otherwise stable soils. Undercutting and clearing with a track hoe in lieu of bulldozers can minimize this.

    a. Developers, designers and contractors must be aware that the clay strata found at and just below the ground surface, will loose strength and degrade rapidly under construction traffic and repetitive construction operations **when worked during wet periods. It is imperative that a positive site drainage plan be conceived and implemented prior to site clearing, utility construction, and earthwork operations beginning.** This near surface clay strata has a strong affinity for free water, and when disturbed under wet conditions are difficult, if not impossible, to adequately dry-out for reuse in construction and/or stabilize to start placing fill. **We recommend grading all subgrades to promote positive drainage away from structural areas.**

3. Any stump holes or other depressions should be cleared of loose material and debris, and should then be back-filled with approved fill. The backfill should be placed in 6-inch thick lifts and compacted to 95% density in accordance with ASTM D-1557.

4. Any existing utilities that underlie the site should be relocated and their trenches back-filled with approved soil. The backfill should be placed in 6-inch lifts and compacted to 95% density according to ASTM D-1557.

5. Prior to fill placement, the subgrade should be proof rolled with a loaded dump truck to locate unstable or soft areas. Any unstable areas should then be investigated to determine the cause of the instability. If due to unsuitable soils, such as highly organic soils or soft clays, the areas should be undercut to firm soil and replaced with approved fill compacted in 6-inch lifts to minimum density of 95% in accordance with ASTM D-1557. If the instability is due to excess moisture in otherwise stable soil, the area should be drained and compacted to 95% density.

6. Any fill or backfill required to level or raise the site should be placed in 8 to 10 inch thick, loose lifts and compacted by appropriate compaction equipment to 95% density in accordance with ASTM D-1557.

7. All of the fill and backfill (including utility line backfill) for this project should consist of clean, free draining granular soils. The fill should be free of objectionable roots, clay lumps, organics and other debris. The fill should be readily compactable during placement. Soils classified as SW, SP, SP-SM or SM with a maximum of 15% passing a #200 sieve may be acceptable. Soils with the minus #200 fraction classified as MH, CH, OH, ML, CL or SC may be rejected. Soils with a maximum plasticity index of 25 and a maximum liquid limit 40 may be acceptable for use only beneath building pads which are situated well above the groundwater table with approval from the geotechnical engineer. Soils classified as SC or CL, exhibiting moisture sensitivity, soils with excessive clay content, or excessive moisture should not be used without approval from the geotechnical engineer. Approved sands will also need to be moisture conditioned as necessary to facilitate proper compaction throughout its entire depth. If utility trenches cannot be sufficiently dewatered to readily allow compaction of the specified pipe bedding material, then a class I (ASTM-D-2321) gravel or gravel mixture will be required.

8. To assist in reducing moisture beneath the structure, and to reduce the potential for mold growth, the site shall be graded and filled as necessary to direct drainage away from the structure. If sub drains are installed, these alone may not prevent moisture vapor beneath the structure that can cause mold growth. (Also refer to paragraph 10 below). Care must be taken to not place concrete on top of wet soils. For example, if fill or natural soils experience heavy rain, the soils should be properly drained and dried, prior to placement of concrete. Otherwise moisture migration through the slab will occur.

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9. Compact all footing excavations and slab subgrades to a minimum density of 95% in accordance with ASTM-D-1557, prior to placement on concrete. The footing excavations, and all prepared slab subgrade, should be maintained in a dry and compacted condition until the concrete is placed. Areas that are softened by water or that are disturbed by construction activity should be re-worked, re-compacted, or appropriately repaired to the required bearing and density. If necessary, stone backfill or other corrective measures may be implemented to stabilize footings.

10. All slabs-on-grade should be supported on a minimum of 4-inches of granular, free-draining gravel or coarse sand to reduce moisture migration by capillarity. A vapor retarding membrane, overlying this granular base, is recommended to further reduce moisture migration into finished areas of the structure. Note that the use of these measures will not totally prevent moisture under or on top of slabs or beneath structures. (Also refer to paragraph 8 above).

11. Any footing excavations that are directly adjacent to the existing foundations should be done in small increments to avoid undermining them and causing a loss of support to the existing structure. If necessary, the excavations should be sheeted and braced or grouting should stabilize the soil in the immediate area.

PAVEMENT DESIGN RECOMMENDATIONS

Subgrade for driveways and parking areas should consist of a minimum of 24-inches of clean sand subgrade compacted to a density of 95% of its maximum dry density as determined by ASTM-D-1557. Pavement designs should also provide a minimum of 24-inches separation between the bottom of the base course material and the seasonal high ground water table. Undercutting, re-compacting, and/or replacing of existing surface soils will be required unless subgrade consists of organic free, virgin sandy soils that are proven to be a minimum of 24-inches thick, 24-inches above the seasonal high ground water table, compacted to 95% of ASTM D-1557 and passes a proof-roll. Final grades and elevations will determine the extent of any filling, undercutting and backfilling that may be required.

As recommended above, site grades should be raised to accommodate 24 inches of sandy soil below bottom of pavement section elevations without undercutting further below the bottom of topsoil stripping depths. Under drains will be required in the site design if excavations extend below bottom of topsoil stripping depths (approximately 12 inches below existing grades).

Exposed clay surface shall be graded to promote positive surface drainage away from the pavement areas and/or toward an under drain system if deemed necessary.

As recommended above, Geo grid (Tensar TX 160) can be placed on exposed subgrade soils at bottom of stripping depths (instead of further undercutting and replacement) if determined necessary to achieve stability for placement and compaction of the sandy fill soil.

The pavement design must provide for the sandy pavement subgrade soils to drain and not ever become saturated by surface water, perched groundwater or groundwater table. If the design requires the installation of subgrade drains, permanent under drains or sub-drains, these systems should be provided for the full length of the pavement section.

Depending on the pavement section (crown, inverted crown, curb & gutter) and adjacent landscaping, islands, medians, or irrigation sprinkler plans, under drains may need to be provided along the centerline, at the low point, on both sides of the pavement, adjacent to all curb, adjacent to all irrigated areas and/or along the entire perimeter of all parking areas.

Under drains should be designed to promote continuous positive drainage away from the pavement area and day-lighted to a drainage feature that will not restrict or back up the flow of water. The site design will require setting pavement grades, pond elevations and/or drainage features to accommodate gravity flow under drains with invert elevations residing a minimum of 2 ½ feet below bottom of pavement section elevations (slightly into the clay layer).

All proof rolling, construction observations, compaction testing of paved areas must be in accordance with the SITE WORK section above.

If a rain event of 0.5 inches or more, occurs after initial proof rolling and prior to subsequent placement of base or surface wearing course, the proof roll testing must be repeated just prior to additional work.

The below recommended pavement sections should be considered standard and typical for the area. We have not been provided traffic data and/or been instructed to perform CBR testing on subgrade soils, therefore these pavement sections should not be considered a pavement design. The below recommended pavement sections are based upon the assumption that the sandy subgrade soils will yield a minimum CBR value of 8 if compacted to 95% ASTM D-1557 for a full 24-inch depth. In addition, the below recommended light duty pavement sections should be considered for car traffic areas only. Below recommended heavy duty sections should be utilized for all areas receiving truck traffic (trucks with 18-kip axle loads). In addition the heavy duty sections recommended below are for low volume truck traffic (15 to 20 trucks per day).

LIGHT DUTY PAVEMENT (CARS ONLY)

SUBGRADE:	Minimum – 24-inches of drained, compacted, coarse grained soil
BASE COURSE:	Minimum - 6 inches of graded aggregate base course
SURFACE COURSE:	Minimum - 2 inches of Hot Mix Asphalt Surface Course Type 1C

HEAVY DUTY PAVEMENT (TRUCKS WITH 18+ kip AXLE LOADS)

SUBGRADE: Minimum – 24-inches of drained, compacted, coarse grained soil

BASE COURSE: Minimum - 8 inches of graded aggregate base course

BINDER COURSE: Minimum - 2.0 inches of Hot Mix Asphalt Binder Course Type 1

SURFACE COURSE: Minimum - 2.0 inches of Hot Mix Asphalt Surface Course Type 1C

In all projects, a minimum mat temperature of 185° F must be maintained through final roller pass.

Please note that specifications for above mentioned base course, binder course and surface course can be found under division 300, 402 and 403 respectively of the South Carolina Department of Transportation Standard Specification for Highway Construction, Edition of 2000. The mix design must include "lime".

PORTLAND CEMENT CONCRETE PAVEMENT

SUBGRADE: Minimum – 24-inches of drained, compacted, coarse grained soil

HEAVY DUTY: 8 inches of Portland cement concrete with minimum compressive strength of 4000 psi.

LIGHT DUTY: 5 inches of Portland cement concrete with minimum compressive strength of 4000 psi

Whitaker Laboratory recommends incorporating a minimum of 4-inches of graded aggregate base course below the above concrete pavement sections for maintaining a smooth and level surface during placement of the pavement section.

Joints must be placed a MAXIMUM spacing in FEET of 2.5 times the pavement thickness in inches, and in no case more distant apart than 15 feet.

Pavement Design should include:

- Requirements to seal all pavement joints to prevent surface water entry into base / subgrade. Such provision should minimize pumping failures at joints.
- Requirements that pavement sections and panels subject to repetitive braking and/or acceleration should be designed with lug anchors or tie-bars to minimize separation or misalignment at the joints.
- Provisions for load transfer across construction joints by dowels or other acceptable means.

- In general, the design should follow the recommendations and practices for all components as described in ACI 330.1 and/or ACI 330R as applicable.

QUALITY CONTROL AND TESTING

Documented inspections and/or testing performed by Whitaker Laboratory personnel, at the following critical milestones during construction, will be required for the recommendations contained within this report to be validated:

- After stripping and prior to fill or backfill placement: Perform proofrolling and density testing on exposed subgrade soil to verify exposed subgrade soils are stable enough to begin receiving backfill or fill. Verify exposed subgrade is graded to promote positive surface drainage away from structural areas and/or toward an under drain system.

- Collect sample of proposed backfill & fill material, perform laboratory testing and determine suitability for use (approve or disapprove).

- During backfill & fill placement: Perform density testing on each lift of backfill and/or fill soil.

- Shallow Foundations:

    a. Perform footing inspections within open footing excavations incorporating DCP testing. Provide recommendations for undercutting and replacement if deemed necessary.

At the appropriate time, please contact Whitaker Laboratory, Inc. for budgetary and scheduling purposes for the performance of the above required inspection and testing services.

We further offer concrete, asphalt, masonry, and structural steel inspections and testing. Whitaker Laboratory, Inc. also performs observational services for mold mitigation, including observation of installation of vapor retarding membranes, subdrains, overall site drainage, and regularly scheduled observations after construction of site and landscape drainage, and monitoring of humidity and moisture in slabs and basement walls.

QUALIFICATIONS OF REPORT

Any recommendations or opinions offered in this report are based on our interpretation of the data obtained from this investigation. It should be noted that underlying subsurface and soil conditions can, and do, vary considerably within short lateral distances. Regardless of the thoroughness of any subsurface investigation, it is possible that conditions may be revealed between boring locations that are different from those found by our borings and used for our analysis. For this reason, we recommend that the site preparation and foundation construction for this project be monitored closely. If deviations of the soil conditions from those presented in this report appear, we will be glad to furnish any additional analyses and recommendations that may be required.

This report was made to investigate subsurface properties of the site and is not intended to serve as a wetlands survey, toxic mold assessment, or environmental site assessment. No effort has been made to define, delineate, or designate any area as wetlands or an area of environmental concern or contamination. Any references to low areas, poorly drained areas, etc. are related to geotechnical applications. Any recommendations regarding drainage and earthwork are made on the basis that such work can be permitted and performed in accordance with the current laws pertaining to wetlands, storm water runoff, and environmental contamination.

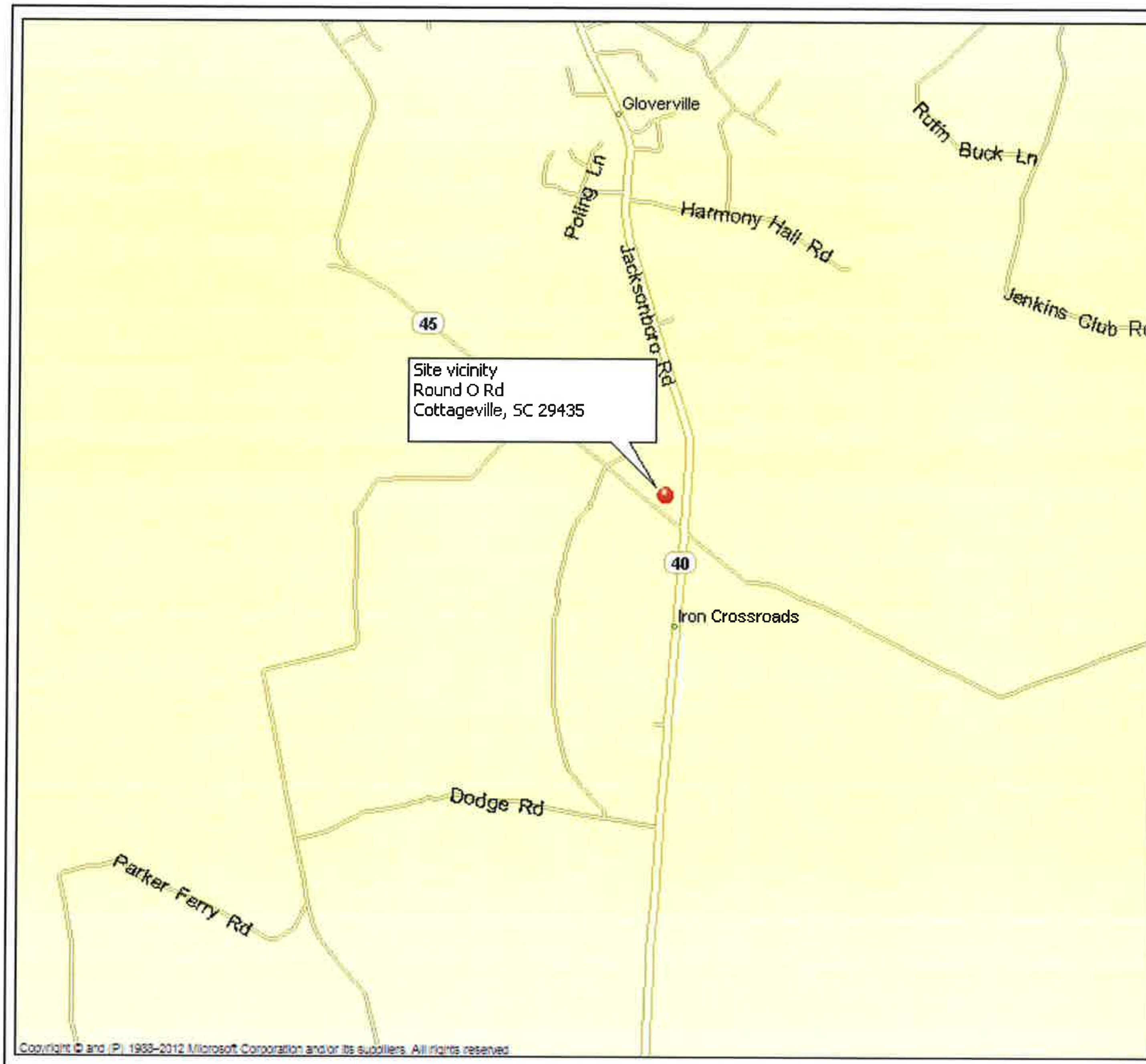
This report does not attempt to define or represent any FEMA, or otherwise designated, flood, erosion, scour, or other hazardous zones; nor does it presume to reflect that governmental or other authorities will grant approval of the project and issue appropriate permits.

WARRANT: WHITAKER LABORATORY, INC. and its professional engineers strive to perform all services in a manner consistent with that level of care and skill ordinarily exercised by members of the engineering profession practicing in the same locality and under similar conditions. No other warranty or representation, expressed or implied, is included or intended in this agreement, in any report, opinion, document, or otherwise. We carry commercial general liability insurance, including completed operations, and professional liability insurance in aggregate amounts deemed adequate, and we comply with the statutory requirements for workmen's compensation insurance. Accordingly, by accepting and relying on the contents of this report, the liability of WHITAKER LABORATORY, INC. and its professional engineers, to the client, owner, or any other party, for any loss or damage, resulting from any cause, including professional acts, errors, omissions, negligence, toxic mold and other environmental claims, breach of warranty or breach of contract, shall not exceed the total compensation received by us for services related to this project; and client will defend, settle, and discharge any claims or allegations of liability for same against us by others. If client desires higher monetary limits of our liability, we will be pleased to discuss such higher limits and the impact on liability and fees. In the event the client makes a claim against us, at law or otherwise, for any alleged act, error, omission, negligence, breach of warranty or breach of contract, arising from the performance of our services, it is mutually agreed that initially, the client and Whitaker Laboratory, Inc. will attempt to resolve such dispute through direct negotiations between the appropriate representatives of each party. Secondly, if such negotiations are not fully successful, the parties agree to resolve any remaining disputes by formal nonbinding arbitration mediation in accordance with the rules and procedures to be agreed upon by the parties. Mediation is a pre-condition to litigation. The exclusive venue for any disputes relating to Whitaker Laboratory's service shall be in Chatham County, GA. Furthermore, if the client fails to prove such claim, then client shall pay all costs accrued by us in defending ourselves.

TITLE: The ownership of opinions, technical ideas, methods and means, drawings, calculations, and other data developed by us during the course of preparing proposals or rendering engineering services remains exclusively with us. It is a condition of this report or proposal that the client agrees not to use the opinions, technical ideas, methods and means, drawings, calculations or any other data for projects or locations, other than those specifically addressed in the report, and that no one other than the client may use this report, without the written permission of WHITAKER LABORATORY, INC.

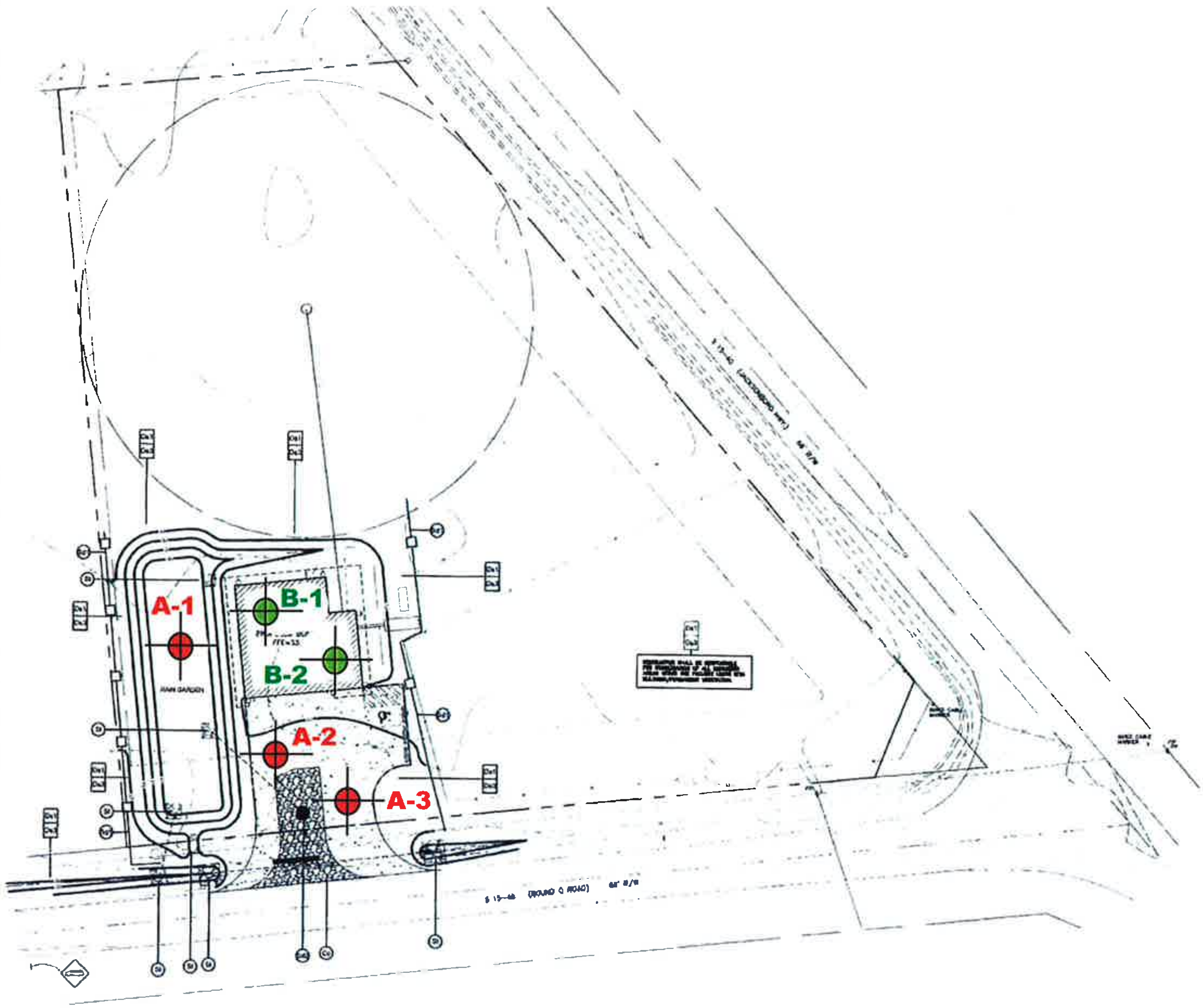
APPENDIX I

SITE VICINITY & BORING LOCATION PLANS



Site Vicinity Map

Iron Cross Roads Fire & Rescue Substation
Round O Road
Colleton County, South Carolina



Boring Location Plan

Iron Cross Roads Fire & Rescue Substation
Round O Road
Colleton County, South Carolina

ALL BORING LOCATIONS ARE APPROXIMATE, & ARE BASED ONLY ON FIELD ESTIMATES.

WHITAKER LABORATORY, INC.

APPENDIX II

BORING RECORDS

Client: R. W. Chambers, Architect

Boring No. B-1

Project: Round D - Road
Fire and Rescue Station

Date: 5/16/13

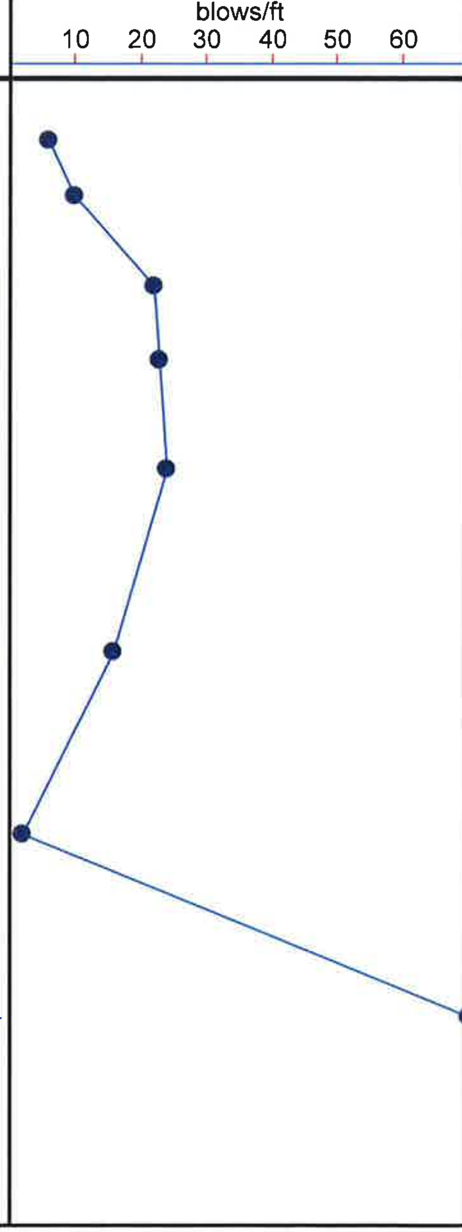
Location: Colloton County, SC

Engineer: Follo

SUBSURFACE PROFILE

Depth (ft)	Description	Sample Number	Blows/ft
0	Ground Surface		
0–1.5	**SC-PT** Brown clayey topsoil	1	6
1.5–6	**CH** Stiff to very stiff, red-gray clay	2	10
		3	22
6–8.5	**CH** Very stiff, tan-gray clay	4	23
8.5–13	**SC** Very stiff, tan fine sand clay	5	24
13–17	**SP-SM** Firm, orange coarse to fine sand	6	16
17–22	**SC** Very soft, orange-tan fine sand clay	7	2
22–25	**SC** Hard, gray-green fine sand clay	8	100+
25	End of Borehole		

Standard Penetration Test



Water Table

Remarks

Drilled By: Wilkerson

Drill Method: H. S. Auger

Drill Date: 5/16/13

WHITAKER LABORATORY
INC.
2500 Tremont Road
Savannah, GA 31405

Hole Size: 6.5"

Datum:

Sheet: 1 of 1

Client: R. W. Chambers, Architect

Boring No. B-2

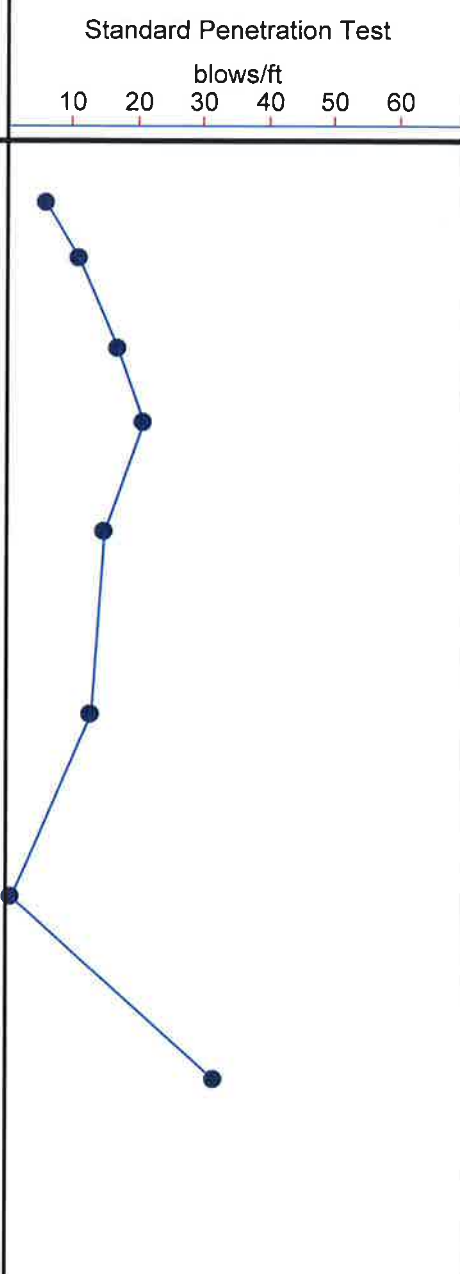
Project: Round D - Road
Fire and Rescue Station

Date: 5/16/13

Location: Colloton County, SC

Engineer: Follo

Description (Subsurface Profile)	Sample Number	Depth	Blows/ft	Water Table	Remarks
Ground Surface		0			
CH Firm to stiff, orange gray clay	1		6		7" topsoil
	2		11		
CH Very stiff, red-gray clay	3	5	17	▼	
CH Very stiff, orange-gray clay	4		21		
CH Stiff, tan-gray clay	5	10	15		
SP-SM Firm, tan coarse to fine sand	6	15	13		
SC Very soft, tan fine sand clay	7	20	1		
SM Dense, gray-green fine silty sand	8	25	32		
End of Borehole		30			



Drilled By: Wilkerson

Drill Method: H. S. Auger

Drill Date: 5/16/13

WHITAKER LABORATORY INC.
2500 Tremont Road
Savannah, GA 31405

Hole Size: 6.5"

Datum:

Sheet: 1 of 1

AUGER BORING RECORD

PROJECT: Round D Road - Fire and Rescue Station DATE: 5/16/13

HOLE NO.	DEPTH Ft.	SOIL DESCRIPTION	CLASS.
A1	0-1	Brown, silty topsoil	SM-PT
	1-2.5	Orange, silty clay	CL
	2.5-5	Red-gray clay	CH
A2	0-0.58	Brown, silty topsoil	SM-PT
	0.58-1.5	Brown, fine silty sand	SM
	1.5-3	Orange-gray clay	CH
	3-5	Red-gray clay	CH
A3	0-0.66	Brown, silty topsoil	SM-PT
	0.66-3	Orange-gray clay	CH
	3-5	Red-gray clay	CH

APPENDIX III

SEISMIC SPECTRAL PARAMETERS

LIQUEFACTION ANALYSIS

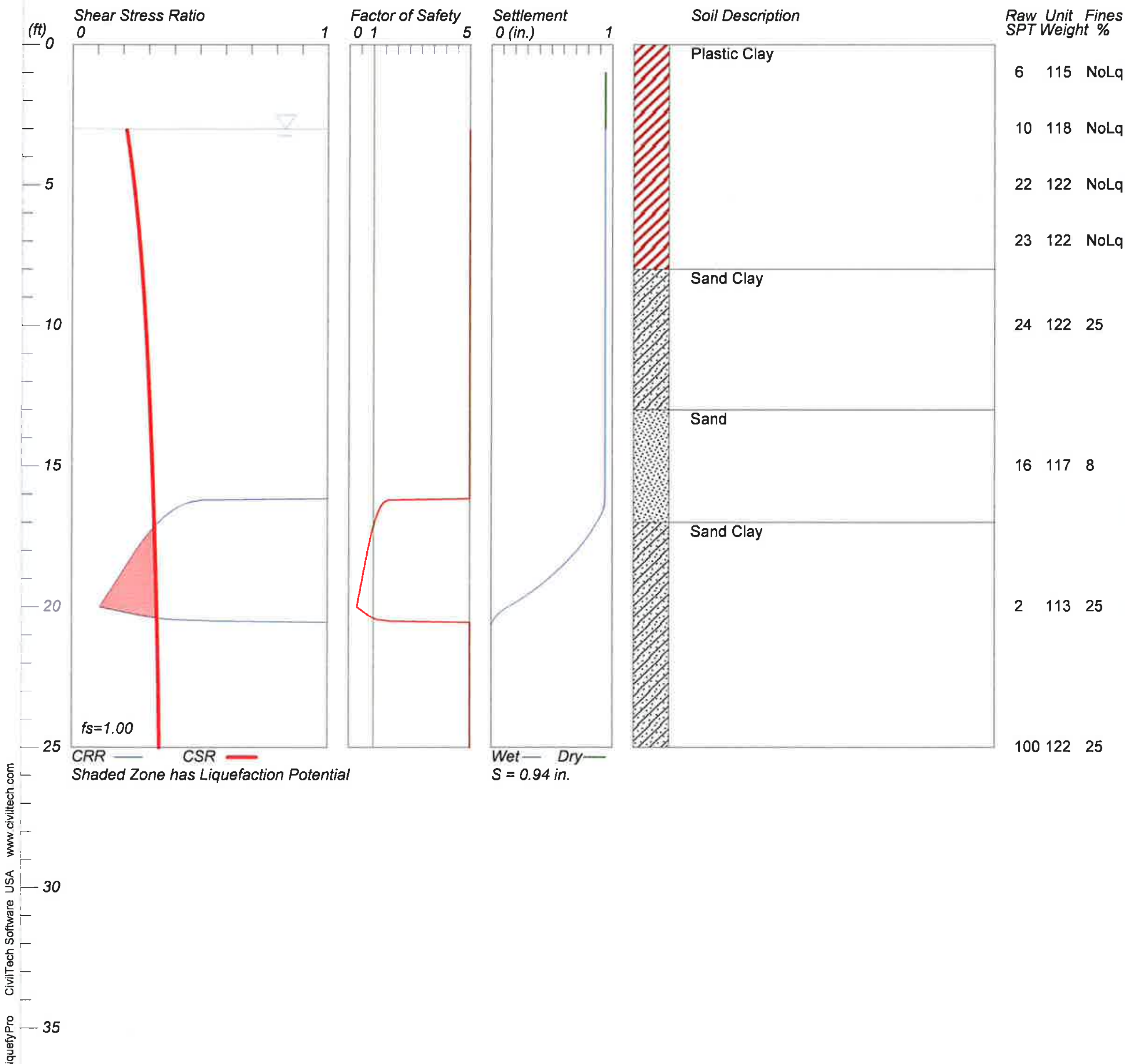
Colleton County Fire Station

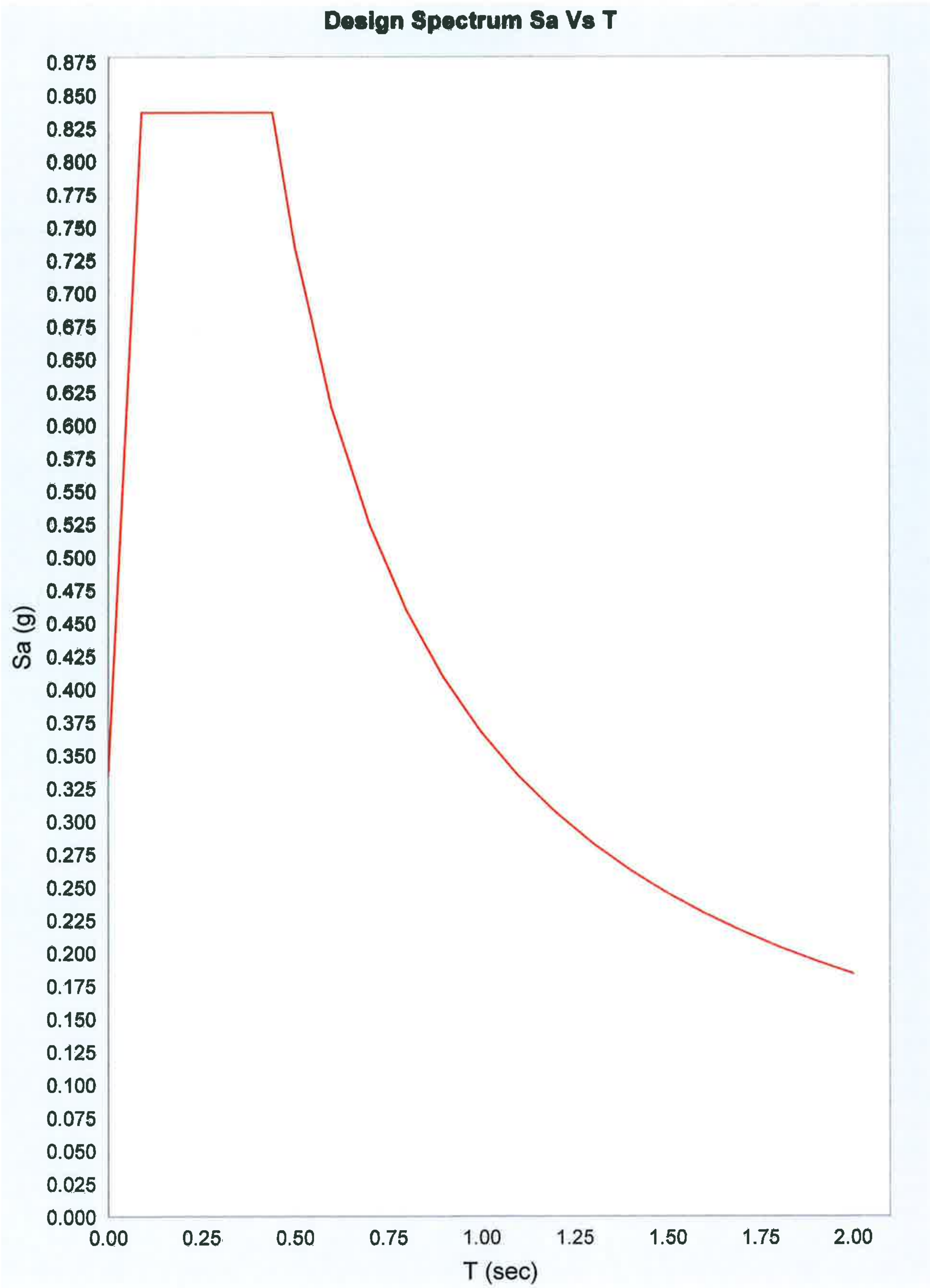
Hole No.=B-1 Water Depth=3 ft

Ground Improvement of Fill=3 ft

Magnitude=7.1

Acceleration=0.3348g





Design Spectrum Sa Vs T
Sa (g)
0.875
0.850
0.825
0.800
0.775
0.750
0.725
0.700
0.675
0.650
0.625
0.600
0.575
0.550
0.525
0.500
0.475
0.450
0.425
0.400
0.375
0.350
0.325
0.300
0.275
0.250
0.225
0.200
0.175
0.150
0.125
0.100
0.075
0.050
0.025
0.000
0.00
0.25
0.50
0.75
1.00
1.25
1.50
1.75
2.00
T (sec)

Conterminous 48 States
2006 International Building Code
Latitude = 32.8747
Longitude = -80.4896
Spectral Response Accelerations Ss and S1
Ss and S1 = Mapped Spectral Acceleration Values
Site Class B - Fa = 1.0 ,Fv = 1.0
Data are based on a 0.05 deg grid spacing

Period (sec)	Sa (g)
0.2	1.255 (Ss, Site Class B)
1.0	0.310 (S1, Site Class B)

Conterminous 48 States
2006 International Building Code
Latitude = 32.8747
Longitude = -80.4896
Spectral Response Accelerations SMs and SM1
SMs = Fa x Ss and SM1 = Fv x S1
Site Class D - Fa = 1.0 ,Fv = 1.781

Period (sec)	Sa (g)
0.2	1.255 (SMs, Site Class D)
1.0	0.551 (SM1, Site Class D)

Conterminous 48 States
2006 International Building Code
Latitude = 32.8747
Longitude = -80.4896
Design Spectral Response Accelerations SDs and SD1
SDs = 2/3 x SMs and SD1 = 2/3 x SM1
Site Class D - Fa = 1.0 ,Fv = 1.781

Period (sec)	Sa (g)
0.2	0.837 (SDs, Site Class D)

APPENDIX IV

IMPORTANT GENERAL NOTES

GENERAL NOTES

The "standard" penetration resistance is an indication of the density of cohesion less soils and of the strength of cohesive soils. The "standard" penetration test is measured with a 1.4 inch I.D., 2 inch O.D., sampler driven one (1) foot with a 140 pound hammer falling 30 inches.

RELATIVE DENSITY OF SOIL THAT IS PRIMARILY SAND

Number of Blows	Relative Density
0 - 4	Very loose
5 - 10	Loose
11 - 20	Firm
21 - 30	Very firm
31 - 50	Dense
Over 51	Very dense

CONSISTENCY OF SOIL THAT IS PRIMARILY SILT OR CLAY

Number of Blows	Consistency
0 - 2	Very soft
3 - 4	Soft
5 - 8	Firm
9 - 15	Stiff
16 - 30	Very stiff
Over 31	Hard

While individual test boring records are considered to be representative of subsurface conditions at the respective boring locations on the dates shown, it is not warranted that they are representative of subsurface conditions at other locations and times.

The subsoil stratification shown on these profiles is not warranted but is estimated based on accepted soil engineering principles and practices and reasonable engineering judgment.

Unless notified, samples will be disposed of after 60 days.

MAJOR DIVISIONS	GROUP SYMBOLS	TYPICAL NAMES
COARSE-GRAINED SOILS More than 50% retained on No. 200 Sieve*		
GRAVELS 50% or more of coarse fraction retained on No. 4 sieve		
CLEAN GRAVELS	GW	Well-graded gravels and gravel-sand mixtures, little or no fines
	GP	Poorly graded gravels and gravel-sand mixtures, little or no fines
GRAVELS WITH FINES	GM	Silty gravels, gravel-sand-silty mixtures
	GC	Clayey gravels, gravel sand clay mixtures
SANDS More than 50% of coarse fraction passes No. 4 sieve		
CLEAN SANDS	SW	Well graded sand and gravelly sands, little or no fines
	SP	Poor graded sands and gravelly sands, little or no fines
SANDS WITH FINES	SM	Silty sands, sand-silt mixtures
	SC	Clayey sands, sand clay mixtures
FINE GRAINED SOILS 50% or more passes No. 200 Sieve*		
SILTS AND CLAYS Liquid Limit 50% or less		
	ML	Inorganic silts, very fine sands, rock flour, silty or clayey fine sands
	CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays
	OL	Organic silts and organic silty clays of low plasticity
SILTS AND CLAYS Liquid Limit greater than 50%		
	MH	Inorganic silts, micaceous or diatomaceous fine sands or silts, elastic silts
	CH	Inorganic clays of high plasticity, fat clays
	OH	Organic clays of medium to high plasticity
HIGHLY ORGANIC SOILS	PT	Peat, muck and other highly organic soils

*Based on the material passing the 3 in. (75 mm) sieve.