Alpha Geotechnical
and Testing Services, Inc.
PEF004552

Foundation Evaluations
Environmental Studies
Construction Materials Testing

March 16, 2005
File No. 05-1375

Mr. Jim D. York, PE
York & Associates Engineering, Inc.
300 E. Broughton Street
Bainbridge, Georgia 39817

Subject: Preliminary Subsurface Exploration for *Potential Industrial/Distribution Center* at Commodore Industrial Park, Bainbridge, Georgia

Dear Mr. York:

As authorized by you on March 4, 2005, Alpha Geotechnical and Testing Services, Inc. has completed a preliminary subsurface soil exploration for the subject project. The purposes of this exploration were to evaluate subsurface conditions encountered in our test borings within an area around the abandoned airport in anticipation of construction of a possible industrial or distribution facility.

As a summary of our findings and recommendations, much of the near surface site soils are manmade fills that are generally loose to medium dense silty and clayey sands until about 2' to 3½' deep, then naturally occurring fat clays were penetrated until about 6½' to 10' deep, underlain by predominately fine to medium sands until termination of the borings at 15' or 25' deep. Owing to the uncertainty of composition of the fill and the loose condition of the fill, construction areas should receive intensive vibratory compaction of the cleared and cut surface to aid in detection of possible "weak" areas. Due to the occurrence of expansive clay near the surface, we recommend that all building foundation elements should be specially stiffened so as to mitigate possible future differential settlements. With these recommendations accomplished, a safe allowable bearing capacity of 2,500 psf should be realized. In areas where pavements are to be constructed, undercutting the old fill and fat clay to provide a minimum separation of 48" could be needed in heavy traffic, but only 18" separation in light duty pavements, depending upon planned grading. Also, perched groundwater occurs in some locations that would need to be addressed with respect to pavement stability.

The recommendations submitted in this report are based upon the data obtained from the soil borings presented on Figure 1 and should be considered only preliminary until additional exploration is conducted. This report does not reflect any variations that may occur between or away from the borings. Possible variations may not become evident until during the course of additional investigation or construction. If variations then appear evident, it will be necessary to reevaluate the recommendations of this report after performing a site visit. If modifications in the design or location of the facility are made, we should be notified to review the applicability of the conclusions and recommendations in this report. **Finally, we recommend a review of final design drawings and specifications by our office, to determine if recommendations made herein have been properly interpreted and implemented.** This exploration only deals with the near surface soil deposits. It is not intended to include analysis of deeper soil or rock strata where cavities and caverns may exist. Sinkholes do occur in the Bainbridge area; however, this report does not address the possibility of sinkhole occurrence at the site. This report documents our findings and recommendations and was prepared exclusively for use by our Client and their Consultants only for this project. We appreciate the opportunity to be of assistance on this phase of your project. When we may be of further service or if you have questions, please call.

Yours truly,
Alpha Geotechnical and Testing Services, Inc.

Stephen P. Shanley, PE
GA #22376

1.0 PROJECT DESCRIPTION

We understand that an undisclosed industrial or distribution facility is potentially planned for the subject site. You have told us that approximately 23 acres will be covered with buildings and 77 acres would be parking and drives. Up to 1,400 heavy truck trips would be made into or out of the facility each day. You supplied us a copy of a drawing showing the planned construction with six boring locations identified. A digital copy of the site plan was later furnished to us, a portion of which is included in our Figure 1 drawing at the end of this report.

2.0 FIELD EXPLORATION

To evaluate subsurface conditions, six soil test borings were conducted at the site, each advanced to 15' below the existing land surface in possible future pavement areas or to 25' deep in potential building areas. In order to evaluate the consistency (relative hardness) of the soils, we measured blow counts (N-values) by driving a split-spoon sampler with a 140-pound sliding hammer by the Standard Penetration Test (SPT) method (ASTM D 1586).

The locations of the borings are shown on the attached Figure 1. The locations were determined by others prior to our arrival on the site. Because of very wet, "soft" soil conditions at two of the locations (B-1 and B-5 as shown on Figure 1) use of a track mounted earth moving tractor to position our drill rig was required for access.

3.0 SUBSURFACE CONDITIONS

3.1 General

Subsurface conditions encountered during our field exploration are shown on the soil boring profiles presented on Figure 1. The stratification lines represent the approximate boundaries between the soil layers, but subtle changes in the soil matrix may make these changes more gradual than the boundary lines tend to illustrate.

The soil descriptions shown adjacent to the boring profiles on Figure 1 are based on a visual/manual classification procedure in accordance with the methodology presented in ASTM D 2488. We supplemented these with a few laboratory classification tests to confirm our classifications in accordance with the Unified Soil Classification System (ASTM D 2487).

3.2 Soil Conditions

A generalization of subsurface soil conditions encountered in the borings is described below:

- At least three of the bores (B-2, B-4 and B-6, and possibly B-1 and B-4) penetrated probable manmade fill consisting of a mixture of red, orange or brown silty or clayey sand until depths of up to 4½' below the existing surface. From the N-values obtained by driving the sampling device, the consistency of these soil layers is generally loose to medium dense.

- Next, somewhat variable layers of red, orange and gray fat clays were encountered until about 6½' to as much as10' below the surface. These strata were typically found to be medium stiff to very stiff. This layer could be problematic for construction of buildings and pavements since this clay has the propensity to shrink and swell as its moisture condition changes, such as at times of drought or prolonged rainy periods. This stratum is also relatively impervious, causing a perched groundwater table to occur atop the layer.

- Beneath the clay, most of the borings advanced into fine to medium sand in a loose to medium dense condition.

As an exception, boring B-5 at the far west end of the site did not encounter the fat clay layer found in the other bores.

The reader should examine the individual boring profiles on Figure 1 for a more detailed description of the subsurface conditions at the locations drilled.

3.3 Groundwater Conditions

A groundwater table was found in some of the borings at the time of drilling. Recently this portion of south Georgia has experienced somewhat "below normal" rainfall, so we would expect the water table to be slightly below average. From boring B-4, it appears that a "normal" groundwater table may exist within the deeper sandy soil layer about 15' below the surface. Also, owing to the impervious nature of the fat clay, isolated "perched" groundwater was also apparent at some locations (*e. g.* B-1 and B-3). Such an occurrence should be transient however, dissipating within a few days after heavy rain events. Nonetheless, this condition could be problematic with respect to pavement stability unless adequate drainage is provided.

4.0 LABORATORY TESTING PROGRAM

Laboratory testing was performed on selected samples to aid in soil classification and to further define the engineering properties of the soils. The laboratory tests included Natural Moisture Content (ASTM D 2216), Percent Finer than the U.S. No. 200 Sieve (ASTM D 1140, to assess percent silt and clay), and Atterberg Limits tests (ASTM D 4318, to evaluate plasticity characteristics). The test results are presented on Figure 1 adjacent to the soil boring profiles, at the depth from which the samples were recovered.

5.0 ENGINEERING EVALUATION AND RECOMMENDATIONS

5.1 General

In view of our preliminary findings, subsurface soil conditions appear adequate to satisfactorily support the possible planned industrial/distribution center building. However, owing to the presence of highly expansive fat clay (locally referred to as "pipe clay"), **we recommend that the foundations should be stiffened to resist potential differential settlements that could result from volume changes in the clay**. Further discussion relating to this is included in the following section 5.3. In pavement areas, the clay should be no closer that 48" below pavement base layers in heavy truck traffic areas or 18" in light duty areas. Depending upon grading elevations, this could require some undercutting and replacement with more suitable sandy soils.

Also, due to the presence of some manmade fills consisting of fairly loose silty and clayey sands near the surface, **intensive vibratory compaction <u>must be performed</u>** to improve bearing capacity, reduce anticipated settlements, and to help detect any soft, weak areas not discovered in the borings. Detailed discussion in this regard is included in the following section 5.2.

Finally, shallow perched groundwater should be adequately drained away from pavements to maintain pavement life. In no case should groundwater be allowed to intrude within 24" of pavement base materials. Drainage ditches or sub-drains could be needed to control groundwater.

5.2 Site Preparation

The following are our preliminary recommendations for site soil preparation and foundation design. Upon confirmation of similar conditions with additional, more extensive borings, these recommendations should be **incorporated into the project specifications.**

1. The entire structure area "footprint" and planned pavement areas, plus a minimum margin of five feet laterally, should be stripped and grubbed of all surface vegetation, debris and other deleterious material, as encountered. During the clearing and grubbing operation, roots with a diameter greater than one-inch or small roots in high density should be completely removed. These materials should be disposed in areas designated by the Owner.

2. The cleared and/or cut surface in building construction areas must be proof-rolled using a heavy vibratory roller-compactor (does not apply to storm pond footprint). Adjust the moisture content of the soil, as necessary, to aid compaction. We recommend using a nominal 15,000-pound static weight; 30,000-pounds (±) dynamic force, single drum vibratory roller. The vibratory roller should be operated on a minimum frequency of 1700 vibrations per minute, and each compaction lane must overlap the adjacent compaction lane by 2 feet. We recommend 5 passes in one direction, and 5 passes in a perpendicular direction in the building area. More passes could be needed however. The objective is to achieve a minimum 95% percent Modified Proctor maximum dry density (ASTM D 1557) to a depth of at least 18" below the compacted surface.

   We recommend performance of at least one field density test for each 5,000 square feet of prepared area (but a minimum of three tests, regardless of the size). **It is important to contact the testing laboratory at least a few days prior to proof-rolling, so that they can obtain proctor test samples, and perform the proctor tests in the laboratory, so that the maximum proctor dry density values will be available at the time of proof-rolling and density testing.**

3. If any areas <u>yield</u> during proof-rolling, they must be explored in a few small test pits to evaluate the condition of the soils. Should yielding result from excessive soil moisture, two corrective alternatives may be considered.

   a. If the existing soils are sands or clayey sands (less than 50% clay), dry the soils until the moisture content is 2 to 3 percent below the optimum moisture content as determined from the Modified Proctor test. The soils may be harrowed and air-dried to obtain the desired moisture for compaction.
   b. Replace the wet material with soils conforming to that stated in Item 5, below.

   Replace any materials, if determined to be deleterious, in areas that "yield" during the proof-rolling operation, with suitable fill material conforming to that stated in Item 5, below.

4. After satisfactory proof-rolling of the cleared and/or cut surfaces in accordance with the above, filling with suitable, well-compacted soil may proceed. Fill material should conform to that stated in Item 5 below, and should be placed in level lifts not exceeding 12 inches in uncompacted thickness. Each lift should be compacted by repeated passes with appropriate compaction equipment, to achieve at least 95 percent of the Modified Proctor maximum dry density. The filling and compaction operations should continue until the desired elevation is achieved. Again, at least one field density test for each 5,000 square feet of prepared fill area should be performed (minimum 3 tests).

5. Fill materials required to elevate the slab area should consist of select fills, which are uniformly graded clean sands to slightly silty or slightly clayey sands, free of organics and other deleterious materials, **with less than 35 percent passing the No. 200 sieve**. These soil types are less sensitive to moisture problems and are less likely to experience time related settlement than more silty or clayey soils, so the use of select fill tends to reduce earthwork delays caused by seasonal rains and minimize the potential for differential settlement of foundations. **Most of the near surface soils encountered in our borings do not comply with these recommendations**; therefore, an off site borrow source should be considered.

5.3 Shallow Foundation Design

We recommend that the perimeter and interior footings should be stiffened with a top and bottom layer of reinforcing steel so as to resist possible differential movements caused by volume changes in the clays. We believe the potential for volume change in the clays to be moderate to high. Alternatively, a post-tensioned slab could be constructed to resist such movements. An edge moisture variation distance $\mathbf{e_m}$ of 7’, plastic limit of 30, and plastic index of 50 (consider soil montmorillonite) may be used for calculations for post-tensioned slabs. Another alternative would be to construct a deep foundation system penetrating beneath the clays.

In no case should lean or fat clays exist within 24” of bottom of concrete footings. If present close to foundations, these problematic soils should be undercut and replaced with well-compacted sandy soils.

Foundation soils prepared in accordance with the above recommendations (natural soils or fills) should be suitable for supporting the proposed structures with a design soil contact pressure of 2,500 pounds per square foot (psf) or less. The weight of the concrete may be neglected when computing the contact pressure. Footings should be embedded at least 18" below surrounding ground. Isolated footings should be at least 18" on each side to prevent punching shear failures.

Based on the information gathered during our exploration and the loading conditions previously estimated, the recommended soil contact pressure will yield a minimum factor of safety greater than 2.0 against bearing capacity failure. The total settlement is estimated to be one inch or less, and load related differential settlement across the slab is estimated to be one-half inch or less in 25 feet.

5.4 Pavement Section Design

In order to prepare the site to support a semi-flexible pavement section, follow the site preparation recommendations in Section 5.2 of this report, items 1 through 5.

The following additional requirements must be applied. Typically, the top 24 inches of sub-grade soil should be AASHTO classification (M-145) types A-1, A-3, or A-2-4, which are low plasticity to non-plastic soils, with no more than 35 percent passing the U.S. No. 200 sieve, liquid limit less than 40, and plasticity index less than 10. Therefore, site soils that do not meet these criteria should not be used, and/or must be over-excavated, if present within 24 inches of bottom of base elevation. However, undercutting can sometimes be limited to 18” below sub-grade surface in low traffic areas and could be addressed on a case-by-case basis.

Also, any soils within 12 inches elevation of the bottom of base grade must meet the following California Bearing Ratio (CBR) requirement.

The top 12 inches of the pavement sub-grade must exhibit a minimum laboratory CBR value of 30. CBR testing of the proposed sub-grade soils must be performed well in advance of pavement section construction, to determine if stabilization and/or off-site soils are required. If deficient, then stabilization must be performed in accordance with the Georgia Department of Transportation *Standard Specifications For Road and Bridge Construction* (GDOT Standard Specifications), latest edition.

Following are recommendations to develop a pavement section for support of light to medium vehicular traffic.

1. Compact the top 12 inches of the pavement sub-grade to at least 98 percent of the Modified Proctor maximum dry density (AASHTO T180 or ASTM D 1557). Again, the CBR requirement is 30 minimum.

2. Install a 6-inch (minimum) thick limerock base or sand-clay base (GDOT Standard Specifications). The base must be compacted to at least 98 percent of the Modified Proctor maximum dry density.

3. After placement of a prime coat or tack coat, install 1 ½ inches (minimum) of asphaltic concrete.

Regardless of the pavement section base type selected, we recommend that the civil design features of the project be planned such that the site groundwater table cannot reach an elevation higher than 24 inches below bottom of the base elevation. Such features can include perimeter ditches, and if required, sub-drains. Please refer to Section 3.3 of this report for discussion of groundwater conditions at the site.

The latest version of the Georgia Department of *Transportation Standard Specification for Road and Bridge Construction* shall govern the design and placement of the base course and asphaltic concrete wearing surface.

The above minimum requirements will satisfactorily support light to medium vehicular traffic, but not tractor-trailer or garbage truck traffic. In these heavier traffic pattern areas, the design section should be increased accordingly, or a concrete pavement should be installed in such areas. Normally, increasing the base thickness by 2 inches, and increasing the asphaltic concrete thickness by 1 inch is adequate for support of a moderate frequency of heavy truck traffic. A more detailed design section could be made with knowledge of traffic patterns and load frequency.

END OF REPORT

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