

November 29, 2024

Prestige Contracting Services LLC
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Attn: Mr. Tommy Benasco

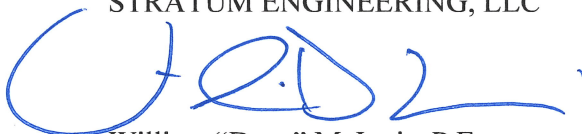
Re: Geotechnical Investigation
Proposed AFB Slab
NAS JRB New Orleans
Belle Chasse, Louisiana
SE Project No. G24-088R
Revised December 9, 2024

Dear Mr. Benasco:

Stratum Engineering, LLC (SE) is pleased to submit our revised Geotechnical Engineering Report for the above referenced project. The report includes the results of our field exploration and laboratory testing as well as recommendations for foundation design.

We appreciate the opportunity to perform this geotechnical study and look forward to continued participation during the design and construction phases of this project. If you have any questions pertaining to this report, or if we may be of further service, please contact our office.

Respectfully submitted,
STRATUM ENGINEERING, LLC



William "Dean" McInnis, P.E.
Vice President

WDM/TYM:sqw



Tony Y. Maroun, P.E.
Principal

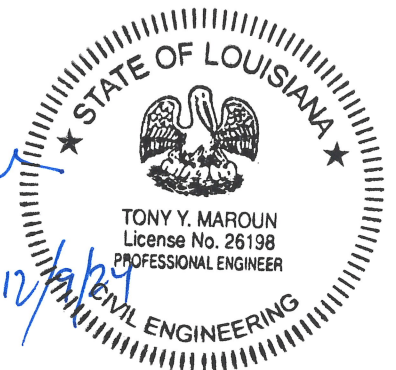


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PROJECT INFORMATION

Project Authorization

Stratum Engineering, LLC (SE) has completed a geotechnical exploration for the proposed AFB Slab to be constructed at the Naval Air Station (NAS) Joint Reserve Base (JRB) New Orleans located in Belle Chasse, Louisiana. The exploration was accomplished in general accordance with SE Proposal No. G24-129, dated September 13, 2024.

Project Description

We understand that the project will include the construction of an open area slab or mat foundation with tie-down points installed throughout to support a Mobile Van layout consisting of 4 units which weigh 10,000 pounds each. Electrical and communications lines will be extended from the existing hangar to the slab for temporary or semi-permanent connection of the modular units. The concrete slab will have a footprint of approximately 64 feet by 60 feet.

The geotechnical recommendations presented in this report are based on the available project information, slab location, and the subsurface materials described in this report. If any of the noted information is incorrect, please inform SE in writing so that we may amend the recommendations presented in this report if appropriate and if desired by the client. SE will not be responsible for the implementation of its recommendations when it is not notified of changes in the project.

Purpose and Scope of Services

The purpose of this study was to explore the subsurface conditions at the site to enable an evaluation of acceptable foundation systems for the proposed AFB Slab. One (1) boring was drilled to a depth of 40 feet below the existing ground surface within the proposed slab area. Our scope of services included a reconnaissance of the project site, drilling the soil boring, select laboratory testing, and preparation of this geotechnical report. The report briefly outlines the testing procedures, presents available project information, describes the site and subsurface conditions, and presents recommendations regarding the following:

- Foundation types, allowable bearing capacities, allowable pile capacities, and estimates of settlement;
- Seismic site classification;
- Site preparation, including subgrade preparation and compaction requirements;
- Factors influencing construction and performance of the proposed improvements.

The scope of geotechnical services did not include an environmental assessment for determining the presence or absence of wetlands, or hazardous or toxic materials in the soil, surface water, groundwater, or air on or below, or around this site. Any statements in this report or on the boring logs regarding odors, colors, and unusual or suspicious items or conditions are strictly for informational purposes.

SITE AND SUBSURFACE CONDITIONS

Site Location and Description

The new slab will be located near the northwest corner of Hangar 263 adjacent to the flight line on the west side of the base. The area is currently occupied by a small structure which will be removed to accommodate the new construction. Detailed grading information was not provided at the time of this report, but it was assumed that minimal cut and/or fill will be needed to achieve the design grade.

Drilling, Sampling, and Laboratory Testing Procedures

The boring was drilled with an All-Terrain Vehicle (ATV) mounted drill rig. Wet rotary drilling techniques were used to advance the boring. Samples were generally obtained continuously from the ground surface to a depth of ten feet and at maximum five foot intervals thereafter. Drilling and sampling techniques were accomplished in general accordance with ASTM Standards.

Undisturbed samples of cohesive soils were generally obtained using thin-wall tube sampling procedures in general accordance with the procedures for “Thin-Walled Tube Geotechnical Sampling of Soils” (ASTM D1587). These samples were extruded in the field with a hydraulic ram and were wrapped in aluminum foil prior to placement in a plastic wrapping to preserve moisture. The samples were transported to the laboratory in containers to prevent disturbance.

The laboratory testing program included supplementary visual classification and water content tests on all of the soil samples. In addition, selected samples were subjected to unconfined compression testing, percent passing the #200 sieve and Atterberg Limits determination. Additional estimates of unconfined compressive strength and undrained shear strength were made using a hand penetrometer and a torvane, respectively. The laboratory testing was performed in general accordance with ASTM Standard Procedures.

Subsurface Conditions

Based on the boring, the surface is covered with about 10 inches of silty topsoil with organics underlain by loose silty sand to around 2 feet. The sand was followed by firm to stiff fat clay to a depth of 4 feet at which depth the clay became very soft to firm extending to a depth of around 22 feet. A layer of soft to firm sandy lean clay was noted between 22 and 27 feet where the material transitioned back to soft to firm fat clay which persisted to a depth of at least 40 feet, the maximum depth explored.

The above subsurface description is of a generalized nature to highlight the major subsurface stratification features and material characteristics. The boring log included in the Appendix should be reviewed for specific information at the boring location. The record includes soil descriptions, stratification, penetration resistances, and locations of the samples and laboratory test data. The stratification shown on the boring log represents the conditions only at the actual boring location. Variations may occur and should be expected across the site. The stratification represents the approximate boundary between subsurface materials and the actual transition may be gradual. Water level information obtained during field operations is also shown on the boring log. The samples, which were not altered by laboratory testing, will be retained for 60 days from the date of this report and then will be discarded.

Groundwater Conditions

Groundwater was initially encountered in the boring at a depth of about 8 feet during the drilling operations and was later measured at a depth of approximately 6 feet upon completion of the drilling. However, it should be noted that groundwater levels will fluctuate with seasonal variations in rainfall, extended periods of drought and surface runoff. Therefore, it is recommended that the actual groundwater levels at the site be determined by the contractor at the time of the construction activities, if needed.

IBC Site Classification

The International Building Code (IBC), 2021 Edition, was reviewed to determine the site classification for seismic design. Based on the soils encountered in the boring and our experience in the general vicinity, the site can be classified as Site Class “E”, as outlined in Section 1613.2.2 of the Building Code.

EVALUATION AND RECOMMENDATIONS

General

The type and depth of foundation suitable for a given structure primarily depends on several factors including the subsurface conditions, the function of the structure, the loads it may carry, the cost of the foundation and the criteria set by the Design Engineer with respect to vertical and differential movement which the structure can withstand without damage.

The results of the exploration indicate that the near surface soils present at the site are poor in bearing quality and will experience some settlement with the addition of fill or application of sustained loading. Provided some settlement can be tolerated, the planned slab structure may be supported on a shallow foundation system. Otherwise, a deep pile foundation system is recommended for support of the slab as detailed in subsequent sections of the report.

Foundation Settlement

Analyses were made to estimate the settlement under a uniformly loaded slab area with a footprint of 64 feet by 60 feet. Based on a concrete slab thickness of 8 inches and a sustained slab load of 50 psf, equivalent to about 150 psf, settlement at the center of the filled area was estimated to be about 2 ½ to 3 inches. Settlements at the edge and corner were estimated to be about 1 ½ inches and 1 inch, respectively. These estimates do not take into account settlement of any required fill due to poor compaction.

Slab Preparation

Slab preparation is expected to include, but not be limited to, demolishing and removing any existing structures or pavement in the area as well as stripping any topsoil or other unsuitable material from the construction area. Existing utilities should be located and re-routed as necessary.

The subgrade should be proofrolled with a tandem axle dump truck or a similar heavily loaded rubber tired vehicle. Soils, which are observed to rut or deflect excessively under the moving load, should be undercut and replaced with properly compacted structural fill. The proofrolling and undercutting activities should be witnessed by a representative of the Geotechnical Engineer and should be performed during a period of dry weather.

After the subgrade preparation and observation have been completed, the structural fill should be placed in a relatively uniform horizontal lift and should be adequately keyed into the stripped and scarified soils. If needed, locally available “pumped” river sand is recommended for use as structural fill. The sand should be free of organics or other deleterious materials and have a maximum of 10 percent passing the #200 sieve. The fill should be compacted to at least 95 percent of the fill’s maximum dry density as determined by ASTM D698 (Standard Proctor).

The structural fill should be placed in maximum lifts of 8 inches of loose material and should be compacted within the range of one (1) percentage point below to three (3) percentage points above the optimum moisture content value. If water must be added, it should be uniformly applied and thoroughly mixed into the soil by disking or scarifying. Each lift of compacted structural fill should be tested by a representative of the Geotechnical Engineer prior to placement of subsequent lifts. In-place density measurements should be taken to assure that the above degree of compaction is achieved. If a deep foundation is used, proofrolling of the subgrade and compaction of the fill in the pile supported area may be waived.

Shallow Foundations

Provided some settlement can be tolerated, the soil supported slab should bear on a minimum of 12 inches of compacted structural fill overlaid by 6 inches of limestone base. Placement of the new fill and preparation of the subgrade should be performed in accordance with the Site Preparation section of the report to identify any soft or unstable soils which should be removed from the slab area prior to additional fill placement and/or slab construction.

For design purposes, a Modulus of Subgrade Reaction (k) of 250 pci can be used with the addition of 6 inches of aggregate base which will better distribute the load to the underlying subsurface soils and provide a good working surface during construction. The aggregate base under the slab should consist of 610 crushed limestone conforming to the following grading requirements:

| <u>U.S. Standard Sieve Size</u> | <u>% Passing, by Weight</u> |
|--|------------------------------------|
| 1 ½" | 100 |
| 1" | 90-100 |
| ¾" | 70-100 |
| No. 4 | 35-65 |
| No. 40 | 12-32 |
| No. 200 | 5-12 |

The crushed limestone should be compacted to 95 percent of its maximum dry density as determined by ASTM D698. The slab should have an adequate number of joints to reduce cracking resulting from any differential movement and shrinkage.

Alternate Deep Foundation Recommendations

Should the estimated settlements not be tolerated, a deep foundation system was considered to support the proposed slab. Small and large treated timber piles were evaluated for support of the structure. Furthermore, due to the proximity of the existing hangar, an alternate deep foundation system consisting of drilled helical piles was also evaluated to minimize the impact of driven pile induced vibrations on the adjacent structure.

Driven Timber Piles

Analyses were made based on the field data and laboratory test results with regard to a pile foundation for support of the proposed structure. Consideration was given to small and large treated timber piles to support the new slab.

Since a competent sand layer was not encountered in the boring, the piles at the site will generally derive their support through "skin friction" along their embedded lengths. The small timber piles should have minimum tip and butt diameters of 6 and 8 inches, respectively; while the large timber piles should have a minimum tip diameter of 7 inches and minimum butt diameter of 12 inches. The piles should conform to ASTM D25 and the American Wood Protection Association (AWPA) Standards for quality and treatment, respectively.

The recommended pile lengths and corresponding capacities, which are from the existing ground surface, are presented in the following table:

| Estimated Allowable Single Pile Load Capacity in Tons* | | | | |
|--|--|---------|---|---------|
| F.S. = 2.0 in Compression | | | | |
| F.S. = 3.0 in Tension | | | | |
| Pile Penetration in feet** | Small Treated Timber Pile (6" Tip – 8" Butt) | | Large Treated Timber Pile (7" Tip – 12" Butt) | |
| | Compression | Tension | Compression | Tension |
| 35 | 6 | 4 | 9 | 6 |
| 40 | 7 | 5 | 10 | 7 |

* Capacities are soil pile related capacities and consideration should be given to the structural integrity of the pile member.

** Piles measured from the existing ground surface.

The recommended capacities are soil/pile related and the final design capacity should be governed by the building code for the type of pile used. The estimated capacities include a factor of safety of two (2) in compression and three (3) in tension.

Drilled Helical Piles

In order to minimize potential vibrations, consideration may be given to supporting the new slab on drilled helical piles. Analysis of the soil parameters within the explored depth indicates that drilled helical piles installed to a depth of at least 40 feet could provide an allowable compression capacity on the order of 2 tons. This estimation is based on a three helix configuration consisting of an anchor with a 10-inch diameter lower helix, a 12-inch diameter middle helix and an upper portion incorporating a 14-inch diameter helix. The three helical plates should be separated by a minimum vertical distance of 2 ½ feet each. To support the required load, and considering the required length of the anchor, we recommend the use of a Chance SS125 shaft.

It should be noted that the estimated capacity assumes the pile will be embedded in the soft to firm clay layer encountered at the boring location. Consequently, the pile capacity presented in the report is an estimation and is provided for budgetary purposes only. Furthermore, since the capacity of the helical piles depend on several factors including the number and size of the helix used, the ultimate design of the helical piles should be optimized and finalized by the installation contractor at which time the final installation torque can be determined.

Pile Settlement

It is estimated that long term settlement of piles loaded to their allowable capacities will be less than one (1) inch. Differential settlement is anticipated to be on the order of 50 percent of the total settlement.

Spacing and Group Effect

A group of piles subjected to vertical loads may not necessarily have the same capacity as the sum of the capacities of the individual piles. For axially loaded piles, published results indicate that the ratio of capacity per pile in a group to that of a single isolated pile typically ranges from 0.5 to 1.0. This efficiency factor depends on the spacing or distance between each pile. In planning groups of driven piles, a minimum center-to-center spacing of 3D (where D is the pile diameter) is recommended to avoid the reduction in capacity and maximize the pile group efficiency.

Pile Installation

Driven Piles

Pile driving hammers used to drive foundation piles should be selected according to pile type, length, size and weight of pile, as well as potential vibrations resulting from pile driving operations. Care should be taken to assure that the hammer selected is capable of achieving the desired penetration without causing damage to the piles or causing excessive vibrations which could damage existing, nearby structures.

Hammers having a rated energy in the range of 7,000 to 12,000 foot-pounds would be appropriate for the small treated timber piles, while hammers having a rated energy in the range of 15,000 to 20,000 foot-pounds are recommended for the large timber piles.

Driving of the center piles in the cluster first will better facilitate the driving operations. Accurate records of the final tip elevation and driving resistances should be obtained during the pile driving operations. Some pile heaving may be experienced during installation of adjacent displacement type piles. It is therefore recommended that the tip elevation of the piles be recorded and if significant heave is noted after driving of subsequent piles, provisions must be made for reseating them.

Drilled Helical Piles

Successful pile installation will depend upon the expertise of the contractor and the techniques employed. While this type of installation can be monitored to determine that the piles are installed in general accordance with the project specifications, and accepted practices, it is not possible to make an accurate determination of the capacity of each individual pile. Consequently, the pile installation contractor and the on-site personnel should have at least five years of continuous experience in the technique employed, including a successful track record of installing similar types of piles in the area.

The end bearing pressure of drilled helical piles is dependent on the properties of the helix size selected and the torque applied to install the piles. The piles should be advanced to a torque required to accommodate the end bearing pressure specified by the Structural Engineer. Manufacturers' recommendations regarding the torque and bearing relationship should be followed. A minimum factor of safety of 2 is required. The piles should be installed as close to vertical as possible.

The connection between the helical pile and grade beam should be designed to resist lateral earth pressure, if any, against the grade beams. The connection should be designed by the Structural Engineer. The helical piles should be attached to the existing grade beams using brackets that allow the pier to be pre-loaded during construction. It is recommended that a representative of the Geotechnical Engineer observe the installation of the helical piles to confirm the depth and the installation torque.

Pile Driving Monitoring

We recommend that pile driving be monitored by the Geotechnical Engineer or his representative. Sometimes premature refusal occurs due to poor performance of the hammer rather than from soil resistance. Any changes in hammer blow counts should be carefully examined before making any decisions about the pile penetration.

Pile Load Test

It is recommended that the pile capacity be verified by a field load test conducted on the type of pile to be used to verify the capacity and evaluate pile drivability as well as induced vibrations. The pile should be load tested to failure in accordance with ASTM D1143 Standard Procedure. The pile load test should be performed under the guidance of the Geotechnical Engineer so that the data may be interpreted and the recommended pile capacity be adjusted, if necessary, according to the load test results. A factor of safety of 2 may be used with a static load test. Should a field load test not be performed due to space or time limitations, then a higher factor of safety of 3 should be applied to the ultimate capacity to use in the foundation design.

Vibration Monitoring

Thresholds of vibration induced cracking are generally site specific and depend on the type and age of the structure, the frequency of ground vibration, and the type of soil supporting the structure. Research by the U.S. Bureau of Mines (USBM) and other investigative groups have established criteria relating the occurrence of structural damage to certain frequencies and level of ground motion. According to the USBM, within the range of four (4) to 12 hertz, the maximum particle velocity recommended to preclude the threshold damage to plaster-on-wood old structures is 0.5 inch per second (ips).

Peak particle velocities of 0.25 ips are perceived to be uncomfortable to humans. Furthermore, peak particle velocities in excess of 0.25 ips could densify near surface cohesionless soils resulting in cosmetic cracks in structures supported on these soils. Therefore, if sustained peak particle velocities exceed 0.25 ips, the construction activities causing these vibration levels should be halted and the construction procedures altered to maintain a safe level of vibration and minimize potential damage to adjacent structures.

Although the threshold of 0.25 ips is adopted by the local engineering community, it is presented as a guide for consideration by the design engineer. The determination of site specific vibration thresholds involves a more detailed study of the structure in question as well as an evaluation of typical pre-construction background vibration levels in the area. As such, a lower threshold may be necessary should construction take place near historic structures. These services are beyond the scope of this study, and if desired, should be completed by others prior to commencement of construction activities.

Furthermore, a pre-construction survey of nearby structures as well as development of base line of vibration induced by normal daily activities in the area is highly recommended prior to construction. This could allow for a fair settlement of third party property damage claims. While Stratum Engineering is providing this general information as a guide, SE does not assume responsibility for the impact of construction vibrations on nearby structures.

CONSTRUCTION CONSIDERATIONS

It is recommended that SE be retained to provide observation and testing of construction activities involved in the foundations and related activities of this project. SE cannot accept any responsibility for any conditions which deviate from those described in this report, nor for the performance of the foundations and pavements, if not engaged to also provide construction observation and testing for this project.

Moisture Sensitive Soils/Weather Related Concerns

The upper soils encountered at this site are relatively sensitive to disturbances caused by construction traffic and changes in moisture content. During wet weather periods, an increase in the moisture content of the soil can cause significant reduction in the soil strength and support capabilities. In addition, soils that become wet may be slow to dry and thus significantly retard the progress of grading and compaction activities. It will, therefore, be advantageous to perform earthwork and foundation construction activities during dry weather.

Drainage and Groundwater Concerns

Water should not be allowed to collect in the foundation excavation, slab area or on the prepared subgrade in the construction area either during or after construction. Undercut or excavated areas should be sloped toward one corner to facilitate removal of any collected rainwater, groundwater, or surface runoff. Positive site surface drainage should be provided to reduce infiltration of surface water around the slab.

Groundwater was measured at an approximate depth of 6 feet upon completion of the drilling operations. However, it is possible that seasonal variations will cause fluctuations of the water table. Additionally, perched water may be encountered in discontinuous zones within the overburden soils, particularly after extended periods of rain. Any water accumulation should be removed from the excavation by pumping. If excessive and uncontrolled amounts of seepage occur, the Geotechnical Engineer should be consulted.

Excavations

In Federal Register, Volume 54, No. 209 (October 1989), the United States Department of Labor, Occupational Safety and Health Administration (OSHA) amended its “Construction Standards for Excavations, 29 CFR, Part 1926, Subpart P”. This document was issued to better ensure the safety of workmen entering trenches or excavations. It is mandated by this federal regulation that excavations, whether they be utility trenches, basement excavation or footing excavation, be constructed in accordance with the new OSHA guidelines. It is our understanding that these regulations are being strictly enforced and if they are not closely followed, the owner and the contractor could be liable for substantial penalties.

The contractor is solely responsible for designing and constructing stable, temporary excavations and should shore, slope or bench the sides of the excavations as required to maintain stability of both the excavation sides and bottom. The contractor’s “responsible person”, as defined in 29 CFR, Part 1926, should evaluate the soil exposed in the excavations as part of the contractor’s safety procedures. In no case should slope height, slope inclination, or excavation depth, including utility trench excavation depth, exceed those specified in local, state, and federal safety regulations.

We are providing this information solely as a service to our client. SE does not assume responsibility for construction site safety or the contractor’s or other parties’ compliance with local, state, and federal safety or other regulations.

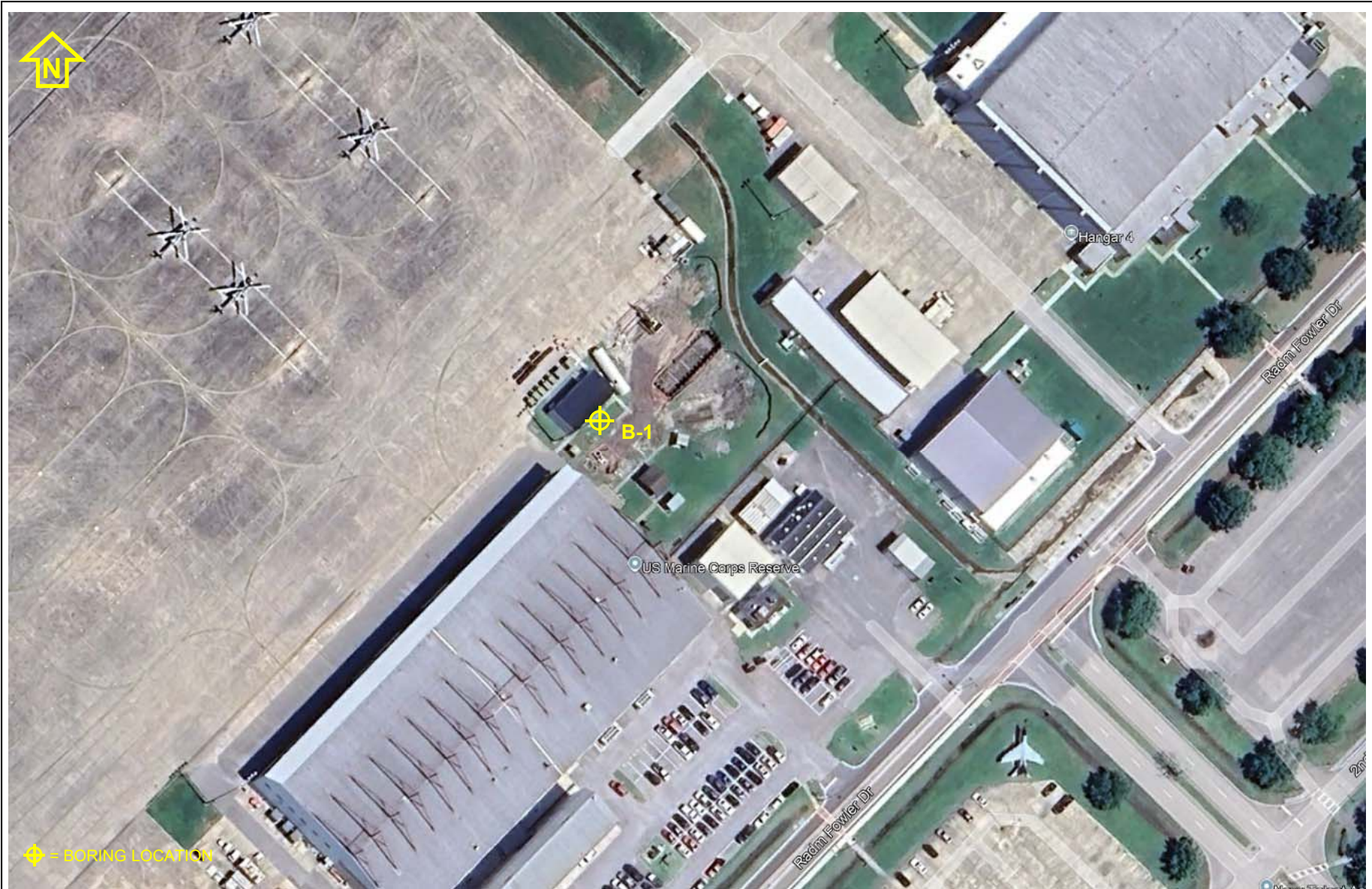
REPORT LIMITATIONS

The recommendations submitted in this report are based on the available subsurface information obtained by SE and design details furnished by Prestige Contracting Services, LLC and Dammon Engineering, Inc. If there are any revisions to the plans for this project, or if deviations from the subsurface conditions noted in this report are encountered during construction, SE should be notified immediately to determine if changes in the foundation recommendations are required. If SE is not notified of such changes, SE will not be responsible for the impact of those changes on the project.

The Geotechnical Engineer warrants that the findings, recommendations, specifications, or professional advice contained herein have been made in accordance with generally accepted professional geotechnical engineering practices in the local area. No other warranties are implied or expressed.

After the plans and specifications are more complete, the Geotechnical Engineer should be retained and provided the opportunity to review the final design plans and specifications to check that our engineering recommendations have been properly incorporated in to the design documents. At that time, it may be necessary to submit supplementary recommendations. If SE is not retained to perform these functions, SE will not be responsible for the impact of those conditions on the project. This report has been prepared for the exclusive use of Prestige Contracting Services, LLC for the specific application to the proposed AFB Slab to be constructed at the Naval Air Station (NAS) Joint Reserve Base (JRB) New Orleans located in Belle Chasse, Louisiana.

APPENDIX



BORING LOCATION PLAN
SE PROJECT NO. G24-088

GEOTECHNICAL ENGINEERING SERVICES
PROPOSED AFB SLAB
NAS JRB NEW ORLEANS
BELLE CHASSE, LOUISIANA



LOG OF BORING B-1
PROPOSED AFB SLAB
NAS JRB NEW ORLEANS
BELLE CHASSE, LOUISIANA

TYPE OF BORING: WET ROTARY

LOCATION: SLAB AREA

PROJECT NO.: G24-088

| DEPTH, FT. | SOIL TYPE | SAMPLES | DESCRIPTION | N-BLOWS/FT. | UNCONFINED COMPRESSIVE STRENGTH tsf | HAND PENETROMETER tsf | TORVANE tsf | UNIT DRY WEIGHT pcf | MOISTURE CONTENT % | LIQUID LIMIT | PLASTICITY INDEX | % PASSING #200 SIEVE |
|------------|-----------|---------|--|-------------|-------------------------------------|-----------------------|-------------|---------------------|--------------------|--------------|------------------|----------------------|
| | | | 10" Silty Topsoil with organics | | | | | | 15 | | | |
| | | | Gray Silty Sand | | | | | | | | | |
| | | | Firm to stiff gray Fat Clay | | 0.85 | 1.00 | | 85 | 35 | | | |
| 5 | | | - becomes soft to firm with organics at 4' | | | 0.50 | | | 62 | | | |
| | | | | | 0.36 | 0.50 | | 54 | 81 | 116 | 85 | 96 |
| | | | | | | | 0.15 | | 88 | | | |
| 10 | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| 15 | | | - very soft to soft at 13' | | 0.18 | | 0.15 | 54 | 87 | | | |
| | | | | | | | | | | | | |
| 20 | | | | | | | 0.20 | | 68 | | | |
| | | | | | | | | | | | | |
| 25 | | | Soft to firm gray Sandy Lean Clay | | 0.25 | 0.50 | | 73 | 46 | 39 | 19 | |
| | | | | | | | | | | | | |
| 30 | | | Soft to firm gray Fat Clay | | | | 0.20 | | 48 | | | |
| | | | | | | | | | | | | |
| 35 | | | | | 0.41 | | 0.25 | 60 | 70 | | | |
| | | | | | | | | | | | | |
| 40 | | | | | | | 0.25 | | 63 | | | |
| | | | | | | | | | | | | |
| | | | Boring Terminated at 40 Feet | | | | | | | | | |
| 45 | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| 50 | | | | | | | | | | | | |

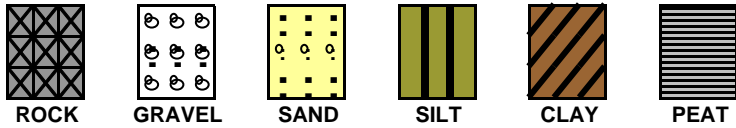
DEPTH OF BORING: 40 Feet
 DATE: 11/5/2024

GROUNDWATER: Measured at 6 Feet Upon Completion of Drilling

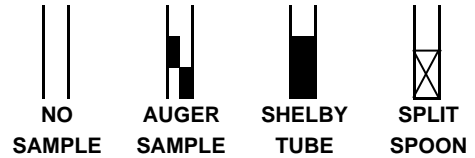


KEY TO TERMS AND SYMBOLS USED ON LOGS

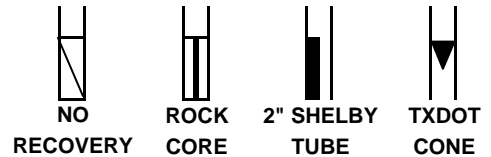
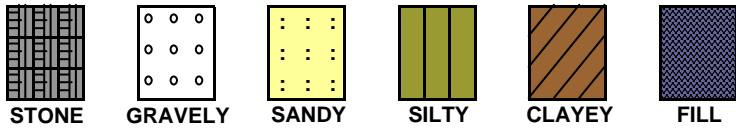
SOIL TYPE



SAMPLER TYPE



MODIFIERS



UNIFIED SOIL CLASSIFICATION SYSTEM - ASTM D 2487 (1980)

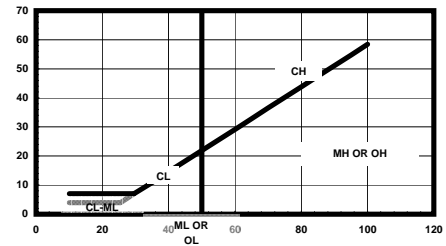
| MAJOR DIVISIONS | | | LETTER SYMBOL | TYPICAL DESCRIPTIONS | |
|---|---|--|---|--|--|
| COARSE GRAINED SOILS | GRAVEL & GRAVELLY SOILS | CLEAN GRAVEL (LITTLE OR NO FINES) | GW | WELL GRADED GRAVEL, GRAVEL-SAND MIXTURES WITH LITTLE OR NO FINES | |
| | | LESS THAN 50% PASSING NO. 4 SIEVE | GP | POORLY GRADED GRAVEL, GRAVEL-SAND MIXTURES WITH LITTLE OR NO FINES | |
| | 50% PASSING NO. 4 SIEVE | SANDS | CLEAN SANDS (LITTLE FINES) | SW | WELL GRADED SAND, GRAVELY SAND (LITTLE FINES) |
| | | | MORE THAN LITTLE FINES | SP | POORLY GRADED SANDS, GRAVELY SAND (L-FINES) |
| | 50% PASSING NO. 200 SIEVE | SANDS WITH APPREA. FINES | W/ APPREA. BLE FINES | GM | SILTY GRAVEL, GRAVEL-SAND-SILT MIXTURES |
| | | | CLAYEY GRAVELS, GRAVEL-SAND-CLAY MIXTURES | GC | CLAYEY GRAVELS, GRAVEL-SAND-CLAY MIXTURES |
| | FINE GRAINED SOILS | SILTS AND CLAYS | WELL GRADED SAND, GRAVELY SAND (LITTLE FINES) | SM | SILTY SANDS, SAND-SILT MIXTURES |
| | | | POORLY GRADED SANDS, GRAVELY SAND (L-FINES) | SC | CLAYEY SANDS, SAND-CLAY MIXTURES |
| | | | CLAYEY SANDS, SAND-CLAY MIXTURES | ML | INORGANIC SILTS & VERY FINE SANDS, ROCK FLOUR SILTY OR CLAYEY FINE SANDS OR CLAYEY SILT W/ LOW PI |
| | | LIQUID LIMIT LESS THAN 50 | INORGANIC CLAY OF LOW TO MEDIUM PI LEAN CLAY GRAVELY CLAYS, SANDY CLAYS, SILTY CLAYS | CL | |
| ORGANIC SILTS & ORGANIC SILTY CLAYS OF LOW PI | | | OL | | |
| LIQUID LIMIT GREATER THAN 50 | | INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SANDY OR SILTY SOILS, ELASTIC SILTS | MH | | |
| | INORGANIC CLAYS OF HIGH PLASTICITY FAT CLAYS | CH | | | |
| | ORGANIC CLAYS OF MED TO HIGH PI, ORGANIC SILT | OH | | | |
| HIGHLY ORGANIC SOIL | | | PT | PEAT AND OTHER HIGHLY ORGANIC SOILS | |
| UNCLASSIFIED FILL MATERIALS | | | | ARTIFICIALLY DEPOSITED AND OTHER UNCLASSIFIED SOILS AND MAN-MADE SOIL MIXTURES | |

CONSISTENCY OF COHESIVE SOILS

| CONSISTENCY | SHEAR STRENGTH IN TONS/FT ² |
|-------------|--|
| VERY SOFT | 0. TO 0.125 |
| SOFT | 0.125 TO 0.25 |
| FIRM | 0.25 TO 0.5 |
| STIFF | 0.5 TO 1.0 |
| VERY STIFF | 1.0 TO 2.0 |
| HARD | > 2.0 OR 2.0+ |

RELATIVE DENSITY - GRANULAR SOILS

| CONSISTENCY | N-VALUE (BLOWS/FOOT) |
|--------------|----------------------|
| VERY LOOSE | 0-4 |
| LOOSE | 4-9 |
| MEDIUM DENSE | 10-29 |
| DENSE | 30-49 |
| VERY DENSE | > 50 OR 50+ |



ABBREVIATIONS

- HP - HAND PENETROMETER
- TV - TORVANE
- MV - MINIATURE VANE
- UC - UNCONFINED COMPRESSION TEST
- UU - UNCONSOLIDATED UNDRAINED TRIAXIAL
- CU - CONSOLIDATED UNDRAINED

NOTE: PLOT INDICATES SHEAR STRENGTH AS OBTAINED BY ABOVE TESTS



CLASSIFICATION OF GRANULAR SOILS

U.S. STANDARD SIEVE SIZE(S)

| | | | | | | | | | |
|------------------|---------|--------|------|--------|--------|------|-------|------|-------|
| | 6" | 3" | 3/4" | 4 | 10 | 40 | 200 | | |
| BOUL- -DERS | COBBLES | GRAVEL | | SAND | | | SILT | CLAY | |
| | | COARSE | FINE | COARSE | MEDIUM | FINE | | | |
| | 152 | 76.2 | 19.1 | 4.76 | 2.0 | 0.42 | 0.075 | | 0.002 |
| GRAIN SIZE IN MM | | | | | | | | | |