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# Exhibit AA. Martial Farms Preliminary Geotechnical Engineering Report

January 5, 2021

# Martial Farms Preliminary Geotechnical Engineering Report

Mr. Chris Richard, PE
**Domingue, Szabo & Associates, Inc.**
102 Asma Boulevard, Suite 305
Lafayette, Louisiana 70508

**RE: Preliminary Geotechnical Engineering Investigation**
**Proposed Billeaud Site**
**Old Spanish Trail Highway**
**Lafayette and St. Martin Parishes, Louisiana**
**SITE Engineering Project: 20-G098-01**

Dear Mr. Richard:

SITE Engineering, Inc. is pleased to transmit our Preliminary Geotechnical Engineering Investigation for the above referenced project. The investigation was performed in general accordance with SITE Engineering Proposal Number 20-333G dated November 23, 2020. Authorization to proceed with the investigation was provided by Mr. Chris Richard, PE of Domingue, Szabo & Associates, Inc. on November 23, 2020 by signing our proposal.

The purpose of this exploration was to investigate and analyze the existing subsurface conditions at the site to enable the provision of general and preliminary foundation and pavement design recommendations for the proposed project. This report includes the results of our field and laboratory testing and presents preliminary recommendations for site preparation, foundation and pavement design, and construction considerations.

We appreciate the opportunity to provide our services to your project and look forward to working with you in the future. If you have any questions pertaining to this report, or if we may be of further service, please do not hesitate to contact our office.

Sincerely,
SITE ENGINEERING, INC.

Clint S. McDowell, P.E.
President

Distribution: 3 – Above

SITE ENGINEERING, INC.

# GEOTECHNICAL ENGINEERING SERVICES REPORT

**PROPOSED BILLEAUD SITE**
**OLD SPANISH TRAIL HIGHWAY**
**LAFAYETTE/ST. MARTIN PARISH, LOUISIANA**

**SITE ENGINEERING REPORT NUMBER: 20-G098-01**

Prepared For

Mr. Chris Richard, PE
**Domingue, Szabo & Associates, Inc.**
102 Asma Boulevard, Suite 305
Lafayette, Louisiana 70508

January 5, 2021

By

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Project Engineer

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President

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# 1.0 EXECUTIVE SUMMARY

SITE Engineering, Inc. has completed an exploration and preliminary evaluation of the subsurface conditions at the proposed “Billeaud Site” industrial development located on Old Spanish Trail Highway. The site is located on the parish line of Lafayette and St. Martin parishes with the majority of the site falling in Lafayette Parish, Louisiana. The project will consist of an industrial development encompassing approximately 36.66 acres. It should be noted that the project is in the extreme early stages of development and the actual types, sizes and locations of any proposed infrastructure has not been provided. Therefore, the recommendations provided should be considered preliminary in nature. For final recommendations to be provided, additional borings will need to be performed.

The subsurface conditions were explored by the performance of soil test borings. Our scope of services included drilling three (3) borings extending to depths ranging from 25 to 50 feet below the existing ground surface. At the time of the field exploration, the subject site was occupied by agricultural fields (sugarcane) and associated headlands. The furrows throughout the site were approximately 12 to 18 inches in depth.

Borings B-1 and B-2, which were performed on existing headlands, generally encountered 12 to 24 inches of lean clay and silty clay soils containing trace amounts of organic materials. Boring B-3, which was performed on the top of an existing furrow, encountered approximately 18 inches of highly organic, lean clay topsoil. These surficial materials were underlain by very stiff to soft lean clay soils to depths ranging from 17 to 22 feet followed by hard to stiff fat clay and sandy lean clay soils to the boring completion depth of 25 feet within borings B-2 and B-3 and to a depth of about 32 feet within boring B-1. Below this depth, boring B-1 encountered medium dense to dense clayey sands and sands extending to a depth of at least 50 feet, the maximum depth explored.

Groundwater was not encountered during the drilling operations within the upper 25 feet of the borings performed at this site. Due to the use of wet rotary drilling techniques utilized below a depth of 25 feet within boring B-1, an accurate groundwater reading below this depth was not possible. Furthermore, immediately after completion of the drilling and prior to demobilization of our equipment, the boreholes were plugged and abandoned. Therefore, delayed groundwater measurements were also not possible. The boring logs included in the appendix of this report should be reviewed for specific soil and groundwater information at each boring location.

The near surface soils encountered in the borings performed at this site are considered good in strength and support capabilities and are believed to be low in shrink/swell potential. As previously mentioned, site development information was not provided due to the extremely preliminary nature of this project. Therefore, this report will provide general recommendations for potential foundation types including shallow foundation systems consisting of isolated spread footings, continuous wall footings, and grade beams, and deep foundation systems such as drilled cast-in-place concrete shafts. Furthermore, general recommendations are being provided for various flexible and rigid pavement systems.

Preliminary recommendations and details related to site development, foundation and pavement design, and construction considerations are included in subsequent sections of this report. Again, the recommendations provided within this report should be considered preliminary in nature due to the limited number of borings performed in relation to the size of the subject site. It should be noted that the soil characteristics within an isolated construction area may be drastically different than those described in this report and should be determined with additional soil borings once specific project information is ascertained.

# 2.0 PROJECT INFORMATION

## 2.1 Project Authorization

SITE Engineering, Inc. has completed a preliminary geotechnical investigation at the proposed "Billeaud Site" industrial development located on Old Spanish Trail Highway in Lafayette and St. Martin Parishes in Louisiana. The investigation was performed in general accordance with SITE Engineering Proposal Number 20-333G dated November 23, 2020. Authorization to proceed with the investigation was provided by Mr. Chris Richard, PE of Domingue, Szabo & Associates, Inc. on November 23, 2020 by signing our proposal.

## 2.2 Project Description

The project will consist of an industrial development encompassing approximately 36.66 acres of currently undeveloped land. It should be noted that the project is in the extreme early stages of development and the actual types, sizes and locations of proposed infrastructure has not been provided.

## 2.3 Purpose and Scope of Services

The purpose of this preliminary geotechnical investigation was to explore the subsurface conditions at the site to enable an evaluation of various foundation and pavement systems. Our scope of services included drilling two (2) borings to a depth of 25 feet and one (1) boring to a depth of 50 feet below the existing ground surface, select laboratory testing of the sampled subsurface soils, and preparation of this geotechnical report.

This report briefly outlines the testing procedures, presents available project information, describes the site and subsurface conditions, and presents general recommendations regarding the following:

- Foundation design recommendations including recommended bearing depths and load bearing values for shallow foundation elements;
- Allowable compression and tension capacities for drilled cast-in-place concrete shafts/piers as a feasible deep foundation option;
- Estimates of settlements for the recommended foundation types and estimates of settlement due to the weight of any structural fill required above existing grade to reach design elevations;
- Recommendations for design and construction of both rigid (concrete) and flexible (asphalt) pavement systems, and;
- General site preparation criteria including organic and unstable soil removal and structural fill criteria and compaction requirements.

Our scope of 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.

# 3.0 SITE AND SUBSURFACE CONDITIONS

## 3.1 Project Location and Site Description

The proposed “Billeaud Site” industrial development is located on Old Spanish Trail Highway. Most of the subject site is in Lafayette Parish with a small portion on the eastern side being in St. Martin Parish. The location of the site can be seen on the aerial photograph provided in the appendix of this report.

At the time of the field exploration, the subject site was occupied by agricultural fields (sugarcane) and associated headlands. The furrows throughout the site were approximately 12 to 18 inches in depth. The majority of the subject site was dry and in a firm condition. Our all-terrain drilling rig and support pick-up truck experienced little difficulty in accessing the boring locations.

Existing site topographic information was not provided. However, based on our review of Google Earth imagery, the site appears to range from about EL +19 feet to EL +29 feet across the 36.66-acre tract. Based on visual observations, the elevation difference between the boring locations was likely only 2 to 3 feet.

## 3.2 Subsurface Conditions

The subsurface conditions were explored with three (3) soil test borings drilled to depths ranging from 25 to 50 feet below the existing ground surface. The number, depth, and locations of the borings were determined by SITE Engineering, Inc. The borings were located on the subject site by a representative of SITE Engineering using a surveyor’s wheel and based on a preliminary site plan provided by Domingue, Szabo & Associates, Inc. The approximate location of each boring can be seen on the Boring Location Diagram included in the appendix of this report.

The borings were advanced utilizing continuous flight auger and wet rotary drilling techniques. Soil samples were obtained continuously in the upper ten feet of the borings and on five-foot centers thereafter to the boring completion depths. Drilling and sampling methods were accomplished in general accordance with ASTM procedures. Upon completion of the drilling, the borings were plugged and abandoned in accordance with the regulations of the Louisiana Department of Natural Resources.

Undisturbed samples of cohesive soils were generally obtained using three-inch diameter thin-wall tube samplers (Shelby tube) 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.

For cohesionless soils and soils that could not be sampled by the above procedure, Standard Penetration Tests (SPT) were performed in accordance with ASTM D-1586 (Penetration Test and Split-Barrel Sampling of Soils) to obtain standard penetration values of the soil. The standard penetration value (N-value) is defined as the number of blows of a 140-pound hammer falling 30 inches required to advance the split-barrel sampler 1 foot into the soil. To perform the SPT test and obtain a sample, the sampler is lowered to the bottom of the previously cleaned drill hole and advanced by blows from the hammer. The number of blows is recorded for each of three successive increments of six inches penetration. The "N" value is obtained by adding the second and third incremental numbers. The results of the standard penetration test indicate the relative density of cohesionless soils and thereby provide a basis for estimating the relative strength and compressibility of the soil profile components.

Undisturbed and representative disturbed samples were wrapped in foil, placed in polyethylene plastic bags to protect against moisture loss, identified according to boring number and depth, and transported to the laboratory in special containers to prevent disturbance. All of the samples obtained from the field exploration were identified and evaluated by experienced geotechnical personnel upon arrival at the laboratory.

In addition to the field exploration, a supplemental laboratory-testing program was conducted to evaluate additional pertinent engineering characteristics of the subsurface materials. The laboratory-testing program included supplementary visual classification and water content tests on all soil samples. In addition, selected samples were subjected to unconfined compressive strength testing, Atterberg Limits determinations, and percent passing a number 200 sieve analysis. Additional estimates of shear strength were also determined through the use of a pocket penetrometer and hand torvane.

Borings B-1 and B-2, which were performed within existing headlands, generally encountered 12 to 24 inches of lean clay and silty clay soils containing trace amounts of organic materials. Boring B-3, which was performed on the top of an existing furrow, encountered approximately 18 inches of highly organic, lean clay topsoil. These surficial materials were underlain by very stiff to soft lean clay soils to depths ranging from 17 to 22 feet followed by hard to stiff fat clay and sandy lean clay soils to the boring completion depth of 25 feet within borings B-2 and B-3 and to a depth of about 32 feet within boring B-1. Below this depth, boring B-1 encountered medium dense to dense clayey sands and sands to a depth of 50 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 logs included in the appendix should be reviewed for specific subsurface information at individual boring locations. These records include soil descriptions, stratifications, penetration resistances (where applicable), locations of the samples and laboratory test data. The stratifications shown on the boring logs represent the conditions only at the actual boring locations. Variations may occur and should be expected between boring locations and elsewhere on the site. The stratifications represent the approximate boundary between subsurface materials and the actual transition may be gradual. The samples which were not altered by laboratory testing will be retained for 60 days from the date of this report and then discarded.

## 3.3 Groundwater Information

Groundwater was not encountered during the drilling operations within the upper 25 feet of the borings performed at this site. Due to the use of wet rotary drilling techniques utilized below a depth of 25 feet within boring B-1, an accurate groundwater reading below this depth was not possible. Furthermore, immediately after completion of the drilling and prior to demobilization of our equipment, the boreholes were plugged and abandoned. Therefore, delayed groundwater measurements were also not possible. The boring logs included in the appendix of this report should be reviewed for specific soil and groundwater information at each boring location.

The groundwater information provided above were the levels recorded at the time of our field investigation. In addition, it may take several days for the groundwater level to become static in an open borehole. Therefore, it should be noted, that it is possible for a groundwater table to be present at a later time depending upon climatic and rainfall conditions. We recommend that the Contractor determine the actual groundwater levels at the site at the time of the construction activities.

## 3.4 Site Specific Seismic

As provided in Section 1613 of the International Building Code (IBC) and in Chapter 20 of ASCE 7, a seismic site classification should be determined utilizing soil characteristics obtained within the upper 100 feet of the site subsoil profile. However, the maximum depth explored during this investigation was only 50 feet. Nevertheless, the aforementioned manuals also specify where site-specific data are not available to a depth of 100 feet, appropriate soil properties are permitted to be estimated. Therefore, based on the soil characteristics obtained within the upper 50 feet and our experience in the general vicinity, it appears that a Site Class of D could be assigned to the subject property. Other parameters for seismic design should be determined by the structural engineer based on IBC Section 1613 using a Site Class designation of D.

# 4.0 EVALUATION AND RECOMMENDATIONS

## 4.1 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 near surface soils encountered in the borings performed at this site are considered good in strength and support capabilities and are believed to be low in shrink/swell potential. Provided the site preparation recommendations presented in this report are followed, lightly-loaded structures may be supported on relatively shallow foundation systems consisting of isolated spread footings, continuous wall footings, and grade beams.

However, if shallow foundation systems do not provide adequate support or tolerable settlements, deep foundation systems should be utilized. Therefore, we have also provided recommendations for drilled cast-in-place concrete shafts as a common and cost-effective deep foundation alternative. Specific details related to foundation design and construction considerations will be presented in subsequent paragraphs.

Once again, the recommendations provided within this report should be considered preliminary in nature due to the limited number of borings performed in relation to the size of the subject site. It should be noted that the soil characteristics within an isolated construction area may be drastically different than those represented in this report and should be determined with additional soils borings once specific project information is ascertained.

## 4.2 Site Preparation

We recommend that all topsoil, organics, and any soft, loose or deleterious soils in the areas intended for construction and for a distance of at least 5 feet beyond the perimeter of any building and 2 feet beyond the perimeter of the any pavement area be stripped from the site and either wasted or stockpiled for later use in landscaping.

As previously mentioned, at the time of the field exploration, the majority of the subject site was occupied by crop rows. The furrows throughout the site were approximately 12 to 18 inches in depth. Boring B-3 was drilled at the top of a furrow and encountered approximately 18 inches of highly organic lean clay topsoil. Based on our experience with similar sites, it is anticipated that once the furrows are leveled, the actual depth of stripping necessary to ensure removal of all excessively organic or otherwise deleterious materials will be on the order of one-half of the existing row height plus a few inches. For bidding purposes, stripping on the order of 10 to 18 inches after leveling of the rows should be anticipated. However, the actual stripping depth should be determined and verified by the geotechnical engineer to ensure adequate removal of deleterious materials.

Where trees or brush will be removed from the site, over-excavation of the root zones should continue until all roots greater than ½-inch in diameter are removed. Deep over-excavations required for the removal of root zones should be backfilled in thin lifts with adequately compacted structural fill meeting the material characteristics and compaction guidelines as described later in this report. If a tree will be allowed to remain in-place and a structure is to be placed within the drip line of the tree, consideration should be given to the placement of a root barrier adjacent to the new foundation.

After stripping and excavation to the proposed subgrade, all areas intended for construction should be proofrolled with a partially-loaded tandem axle dump truck or similar heavy rubber-tired vehicle/equipment weighing approximately 15 to 20 tons. Soils which are observed to rut or deflect excessively under the moving load should be undercut and replaced with properly compacted structural fill. The proof-rolling, undercutting and filling activities should be witnessed by a representative of the geotechnical engineer and should be performed during a period of dry weather.

It should be noted that the surficial soils encountered within the borings at this site are considered moisture sensitive. If wet at the time of construction, it will likely be necessary to further undercut and replace the near surface soils prior to the placement of any required structural fill. In lieu of extensive undercutting and replacement, surficial soft, wet or otherwise unstable soils could be stabilized or chemically dried by the addition of lime, fly ash or cement. If a chemical stabilization option is considered, SITE Engineering should be contacted to provide additional recommendations.

After subgrade preparation and observation have been completed and a stable subgrade is confirmed/provided, structural fill placement may begin. The first layer of fill should be placed in a relatively uniform horizontal lift and be adequately keyed into the stripped and scarified subgrade soils. Fill soils should be free of organic or other deleterious materials, have a maximum particle size less than 2 inches, have a liquid limit of 42 or less, a plasticity index between 10 and 22, and classify as CL in accordance with the Unified Soil Classification System (ASTM D-2487). Soils which classify as ML (silt) or CL-ML (silty-clay) are not recommended for use as structural fill. More stringent plasticity requirements may be warranted in the pavement areas depending on the type of base chosen. This will be further discussed in the pavement recommendations section of this report.

All structural fill within the proposed construction areas and for a distance of at least 5 feet beyond the perimeter of the building and 2 feet beyond the edges of pavements should be compacted to at least 95 percent of standard Proctor maximum dry density as determined by ASTM Designation D-698. Structural fill should be placed in maximum lifts of 8 to 9 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.

Close moisture content control will be required to achieve the recommended degree of compaction. 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 the geotechnical engineer or his representative prior to placement of subsequent lifts. After adequate compaction of each lift has been verified, light scarification of the surface of the lift should be performed prior to placement of additional fill to ensure an adequate bond between lifts. Furthermore, the edges of compacted structural fill should extend at least 5 feet beyond the edges of the building and 2 feet beyond the edges of pavements prior to sloping. Care should be taken to apply compactive effort throughout the structural fill and structural fill slope areas.

We also recommend that water not be allowed to collect in the foundation excavations or on prepared subgrades of the construction areas 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 perimeter of the building and beneath the floor slabs.

## 4.3 Fill-Induced Settlement

As previously mentioned, due to the preliminary nature of this project, topographic information including existing site grades and potential finished elevations was not provided. Therefore, the following table provides estimated settlements due to the weight of various fill thicknesses placed above existing grade.

| Settlement Due to the Weight of Potential Fill Placed Above Existing Grade | |
|---|---|
| **Fill Thickness (feet)*** | **Estimated Settlement (inches)** |
| 1 | ≈ ½ |
| 2 | ≈ ¾ |
| 3 | ≈ 1½ |
| 4 | ≈ 1¾ |
| 5 | ≈ 2¼ |

*Above Existing Grade

Values were derived from empirical equations using average soil characteristics from laboratory testing performed on samples of the subsurface soils of the borings performed at this site. Therefore, it is anticipated that settlements throughout subject site will likely vary.

It should be noted that all subsequent foundation induced settlement estimates provided in this report do not include the settlement induced by the weight of the fill. The settlement due to the weight of the fill provided in the above table should be added to any settlements which were estimated for any proposed structures being constructed on the aforementioned fill thicknesses.

If possible, we recommend placing any required fill at least 60 days prior to construction of the foundations. This will allow approximately 90 percent of the estimated fill-induced settlement to occur prior to construction of the foundation elements. If the above recommended time is not feasible, additional fill could be placed above the elevation of required fill for a temporary period to decrease the amount of time necessary for consolidation due to the weight of the required fill. This is referred to as a surcharge program. Recommendations for a surcharge program can be provided at your request.

## 4.4 Shallow Foundation Recommendations

Provided the site preparation recommendations given in this report are followed, lightly-loaded structures constructed at this site may be supported on a relatively shallow foundation system bearing at a minimum depth of 2 feet below final grade, but no greater than 2 feet below existing grade. Foundation elements bearing on stable, naturally occurring soils or within newly imported compacted structural fill at the recommended depth can be proportioned utilizing a maximum net allowable soil bearing pressure of 2,000 pounds per square foot for isolated spread footings and 1,600 pounds per square foot for continuous (wall) footings.

The recommended bearing pressures include a factor of safety of 3.0 against bearing capacity failure. However, minimum dimensions of 18 inches for continuous footings and 24 inches for spread footings should be used for design, even if the resulting bearing pressure is less than the allowable bearing pressure, to minimize the possibility of a local bearing capacity failure.

Consolidation of the soils resulting from the foundation loads will result in measurable but tolerable increments of soil settlements. Based on the results of field and laboratory tests, and assuming the foundation elements will be loaded to the maximum net allowable bearing capacity provided above, it is estimated that settlement of square footings up to 4½ feet by 4½ feet in plan dimension and continuous footings up to 3 feet in width will be less than one (1) inch. Differential settlement between adjacent columns spaced no more than 50 feet apart should be less than ½-inch.

It should be noted that the aforementioned bearing capacities are maximum allowable values. For isolated spread footings, a lower bearing capacity can be utilized in conjunction with a larger footing size. As a result, a higher applied point load can be supported with equal or lower settlements. The following table provides settlement estimates for anticipated footing sizes and maximum applied pressures.

**ESTIMATED SETTLEMENT FOR SQUARE SPREAD FOOTINGS (INCHES)**

| Square Footing Size (feet) | | 3 | 3½ | 4 | 4½ | 5 | 5½ | 6 | 6½ |
|---|---|---|---|---|---|---|---|---|---|
| Actual Applied Pressure (psf) | 1,400 | 0.59 | 0.66 | 0.72 | 0.79 | 0.84 | 0.89 | 0.94 | 0.99 |
| | 1,600 | 0.65 | 0.72 | 0.79 | 0.86 | 0.91 | 0.97 | - | - |
| | 1,800 | 0.70 | 0.78 | 0.85 | 0.93 | 0.99 | - | - | - |
| | 2,000 | 0.75 | 0.83 | 0.91 | 0.99 | - | - | - | - |

*Note: A graphical representation of this table is provided in the appendix of the report. The values presented above are based on spread footings bearing at a depth of 2 feet below final grade.*

The above table should be utilized for footing design only if the aforementioned maximum net allowable bearing capacity and corresponding limiting footing size does not provide adequate support of the anticipated structural loads. Furthermore, a single applied pressure should be chosen and used for design of all spread footings within a given structure.

The settlements provided above are estimates. Values were derived from empirical equations using <u>average</u> soil characteristics from laboratory testing performed on samples of the subsurface soils of the borings performed at this site. Therefore, it is anticipated that settlements throughout subject site will likely vary. Furthermore, the settlement estimates provided in the above table do not include the settlement induced by the proposed fill. The estimates are additive to the estimated settlement due to the proposed fill. Therefore, proper time will be required to be given to allow the proposed fill to consolidate before foundation construction occurs, as discussed in the previous section of this report.

It should be noted that total settlements on the order of one (1) inch and differential settlement of ½-inch or less are generally considered moderate. It is highly recommended that the design of masonry walls, if planned, include provisions for liberally spaced, vertical control joints to minimize the effects of cosmetic “cracking”. Furthermore, it is recommended that good rigidity of the structure foundations be provided. This could consist of stiffening the slab with grade beams and tying the individual foundation elements together to form a “waffle” pattern or by the use of post-tensioned reinforcement.

The foundation excavations should be observed by a representative of SITE Engineering, Inc. prior to placement of reinforcing steel or concrete to assure that the foundation soils are consistent with the materials discussed in this report. Soft or loose soil zones encountered at the bottom of the footing excavations should be removed to the level of suitable bearing material and replaced with adequately compacted structural fill as directed by the Geotechnical Engineer. After opening, the footing excavations should be observed and concrete placed as quickly as possible to avoid exposure of the footing bottoms to wetting and drying. Surface run-off water should be drained away from the excavations and not be allowed to pond. If it is required that footing excavations be left open for more than one day, they should be protected to reduce evaporation or entry of moisture.

The provided recommendations should be considered preliminary. The actual bearing capacity and estimated settlements should be determined utilizing additional subsurface soil characteristics obtained within each proposed construction area once further project information is established.

## 4.5 Uplift Resistance of Shallow Foundation Elements

Uplift resistance of shallow footings will be limited to the weight of the foundation concrete and the soil above the extensions of spread footings. For design purposes, the ultimate uplift resistance can be based on unit weights of 140 pcf for the concrete in the footings and 110 pcf for the soil above the spread footings. A factor of safety of at least 1.1 should be applied to the calculated uplift resistance to account for potential variations in the concrete and soil unit weights. The size and depth of foundation should be checked by the structural engineer to assure that it is capable of supporting the uplift forces.

If adequate uplift resistance cannot be achieved, consideration should be given to supporting the proposed structures on a deep foundation system. Recommendations for the design of drilled cast-in-place concrete shafts are provided in subsequent sections of this report.

## 4.6 Drilled Shaft Foundation System

Although shallow foundation elements may perform adequately for the proposed project, structures may also be supported on drilled cast-in-place concrete shafts. The following paragraphs provide preliminary recommendations for design and installation of drilled cast-in-place concrete shafts or piers for support of the structures at this site. The shafts should be installed by contractors having adequate experience in the methods of installation in similar soil conditions. In addition, it should be noted that drilled shaft installation involves removing the existing soil. Consideration needs to be given to soil removal and disposal.

The axial compression capacities of drilled concrete shafts have been computed using a factor of safety of 2.0 against failure at the pile/soil interface (skin friction) and a factor of safety of 3.0 against end bearing failure. The following tables present the allowable compressive capacities of various diameter drilled shafts installed to various tip embedments below the existing ground surface elevation. The provided capacities include the effective weight of the shaft.

| ESTIMATED ALLOWABLE COMPRESSION CAPACITY OF DRILLED CAST-IN-PLACE CONCRETE SHAFTS IN KIPS (Factor of Safety = 2.0 for Skin Friction and 3.0 for End Bearing) | | | | | |
|---|---|---|---|---|---|
| Installation Depth* (feet) | Shaft Diameter | | | | |
| | 18-inch | 24-inch | 30-inch | 36-inch | 42-inch |
| 15 | 12 | 16 | 19 | 21 | 23. |
| 20 | 20 | 27 | 34 | 40 | 47 |
| 25 | 31 | 42 | 53 | 64 | 76 |
| 30 | 39 | 53 | 66 | 80 | 94 |

*Below existing grade

The following table presents the allowable uplift or tension capacities of various diameter drilled shafts installed to depths ranging from 15 to 30 feet below the existing ground surface elevation. The uplift or tension capacities of the shafts have been computed using a factor of safety of 2.5 against failure at the shaft/soil interface. The effective weight of the shaft has not been included in the allowable uplift capacities.

| ESTIMATED ALLOWABLE UPLIFT CAPACITY OF DRILLED CAST-IN-PLACE CONCRETE SHAFTS IN KIPS (Factor of Safety = 2.5) | | | | | |
|---|---|---|---|---|---|
| Installation Depth* (feet) | Shaft Diameter | | | | |
| | 18-inch | 24-inch | 30-inch | 36-inch | 42-inch |
| 15 | 11 | 15 | 19 | 23 | 27 |
| 20 | 17 | 22 | 28 | 34 | 39 |
| 25 | 24 | 32 | 40 | 48 | 56 |
| 30 | 31 | 42 | 52 | 62 | 73 |

*Below existing grade

It should also be noted that the shaft capacity estimates were calculated using average strength values from laboratory testing performed on samples of the subsurface soils from all of the borings performed at this site. Therefore, the actual shaft capacities throughout the site will vary and should be determined utilizing additional subsurface soil characteristics obtained within each proposed construction area once further project information is established.

Furthermore, the capacities provided above are based on geotechnical properties and soil-shaft relationship only. Consideration should be given to the structural integrity of the shaft itself under the design load conditions. Again, the effective weight of the shaft has been included in the compression capacities and excluded in the uplift capacities provided above. As a conservative approach, the weight of the shaft should not be added to the uplift capacities provided in the above table.

The values presented above assume each shaft is isolated from any influence of nearby foundation loading. Center-to-center spacing between shafts should be at least 3 shaft diameters. Settlement of the drilled shafts up to 42 inches in diameter designed in accordance with the recommendations provided above should be less than 1-inch. Differential settlement across the foundation area should be slightly less than the realized total settlement of an individual shaft provided all shafts are installed to the same tip elevation.

Due to the soft soils encountered between the depths of about 8 and 12 feet within boring B-3, installation of shafts may require the use of a drilling slurry and/or casing during augering followed by placement of concrete with a closed tremie. During installation, the slurry level in the shaft, if required, should be maintained even with the ground surface. As concrete is being placed the tremie should be kept at least three feet below the top of the concrete in the shaft. Concrete should be placed with a slump range of six (6) to eight (8) inches and be designed to achieve the required strength at the recommended slump.

Installation of the shafts should be carried out in accordance with the National Highway Institute Course No. 132014 entitled “Drilled Shafts: Construction Procedures and Design Methods”, Publication Number FHWA-NHI-18-024 published in September 2018. Care should be taken to ensure concrete is not allowed to strike the reinforcing steel or sides of the shaft excavation. We recommend that the geotechnical engineer or his representative observe the installation of the shafts to verify that, among other things: 1) the subsurface conditions are as anticipated from the borings, 2) the shafts are constructed to the proper diameter, penetration, plumbness, and with appropriate concrete slump, 3) reinforcing steel is properly placed and spaced in the open shaft, and 4) a tremie is properly used for concrete placement. These critical items are fundamental to proper performance of shafts in accordance with design recommendations.

## 4.7 Load Testing of Deep Foundation Elements

The load carrying capacity of deep foundation elements utilized at this site should be verified by a field load test(s) performed in accordance with ASTM D1143. The installed test shaft(s) shall be allowed to “rest” for a period of at least 14 days after installation or until proper concrete strength is achieved prior to commencement of the load test. The load tests should be performed under the guidance of the Geotechnical Engineer so that the data may be interpreted and the recommended capacities adjusted, if necessary, according to the load test results.

## 4.8 Lateral Capacity of Deep Foundations

For deep foundations, the lateral loads are resisted by the soil as well as the rigidity of the pier or shaft. Analyses can be performed by methods ranging from chart solutions to finite difference methods. It is recommended that our office be contacted to perform lateral load analysis for the proposed foundation system once the shaft sizes and group dimensions are determined.

## 4.9 Other Foundation Types

It should be noted that foundation types other than those discussed in this report could be used for support of the structure at this site. These foundation systems include but are not limited to auger cast-in-place piles, driven piles of various materials, and screwed helical piles. Ground improvement techniques such as aggregate piers (stone columns) or rigid inclusions may also offer an increase in bearing capacity while minimizing settlements without the expense of a typical deep foundation system. Some of these foundation types and ground improvement systems are patented and should be designed by the manufacturer or distributor. SITE Engineering, Inc. can provide recommendations for various foundation alternatives at your request.

## 4.10 Floor and Grade-Supported Slab Recommendations

Floor slab loads are commonly distributed to grade (either existing or finished soil grade) by slab-on-grade type construction. Otherwise, a structural floor is used to carry the floor loads independent of the grade. Common types of slabs-on-grade are reinforced slabs, which may or may not include interior ribs, and post-tensioned slabs. The ribbed slab and post-tensioned slab provide rigidity against differential movement and minimize slab cracking. Where deep foundations are utilized, the floor slab loads are commonly transferred to the foundation elements and do not rely on the soil for support. In some cases, the column loads could be supported on deep foundations while the floor slab is soil supported resulting in a “floating” slab and the slab is isolated from the foundation elements with control joints and/or pour-back strips.

Recommendations for a ribbed slab and post-tensioned slab are provided in the following paragraphs in the event they are preferred over a structural concrete slab:

*Ribbed Floor Slab*: The ribbed slab should be designed by a registered and qualified structural engineer. However, certain design criteria are suggested. Interior grade beams should be at least 18 inches deep from the top of the slab. The spacing of the ribs should be determined by the structural engineer based on the thickness of the slab but should in no case be greater than 20 feet. Where practical, these ribs should be arranged to coincide with non-load bearing interior walls. A minimum beam width of 12 inches is recommended to allow adequate bearing area. The floor slab and interior grade beams should be a monolithic unit with no joints. If concrete cannot be placed monolithically, it should be doweled to provide continuity and good rigidity.

*Post-Tensioned Floor Slab:* An alternative to a reinforced ribbed slab foundation is post-tensioned reinforcement. Post-tensioning involves providing tensile steel reinforcement in the slab system by stressing high strength steel tendons after the concrete has achieved sufficient strength. A post-tension ribbed slab is a specialized structural design and should be designed by a qualified structural engineer who is competent and familiar with this type of reinforcement.

In either case, soil supported floor slabs for this project can be designed utilizing a modulus of subgrade reaction (spring constant), k, of 75 psi per inch for the adequately stripped and proofrolled, naturally occurring lean clay soils or compacted structural fill. If a higher modulus of subgrade reaction is required, a k value of 110 pci can be obtained by provided a minimum of 4 inches of clean sand (less than 10 percent fines) directly beneath the floor slab. A k value of 145 pci may be required for design of interior floor slabs where forklift traffic is anticipated. This may be achieved by the placement of a minimum of 4 inches of crushed limestone, crushed concrete or washed gravel.

Furthermore, if moisture sensitive floor coverings are used on the interior slab, consideration should be given to the use of barriers (either polyethylene or a thin sand, graded gravel, or limestone) to minimize potential vapor rise through the slab. Other design and construction considerations, as outlined in the American Concrete Institute (ACI) Design manual, Section 302.1R are recommended. Positive separations and/or isolation joints should be provided between the grade slab and all foundations and walls/columns to allow independent movement.

# 5.0 PAVEMENT RECOMMENDATIONS

We have evaluated both rigid and flexible pavement systems for this project. Although specific traffic information was not provided to us, we have assumed that traffic in the proposed light duty areas will consist mainly of passenger vehicles (cars and small trucks) with occasional passes of medium to large trucks for deliveries, etc. The heavy-duty pavement areas will experience heavy truck loads and possibly some forklift traffic.

It should be noted that the recommended pavement thicknesses presented below are considered preliminary for the assumed parameters in the general site area. The actual pavement thicknesses should be determined utilizing specific traffic information and additional subsurface soil characteristics obtained within each proposed construction area once further project information is established.

The general pavement design information presented in this report is based on information published by AASHTO and the Portland Cement Association as well as past experience in this area. The published information was utilized in conjunction with the available field and laboratory test data to develop general pavement recommendations.

Although extensive evaluation, including California Bearing Ratio (CBR) testing of the near surface soils or potential sources of imported structural fill was not performed, a CBR value of 3.0 and a modulus of subgrade reaction, k, of 75 psi/inch for the adequately stripped and proofrolled naturally occurring soils or compacted structural fill were used for the design of the pavement sections. Therefore, it is assumed that the site preparation criteria presented in the report will be followed and all topsoil and any isolated soft or loose areas encountered during proofrolling of the subgrade will be removed and replaced with compacted fill or stabilized as previously discussed. Specific design parameters considered in the pavement analyses are as follows:

| | |
|---|---|
| CBR | 3.0 |
| Modulus of Subgrade Reaction, k | 75 pci |
| Reliability | 85% |
| Concrete Modulus of Elasticity | $3.99 \times 10^6$ |
| Deviation | 0.45 Asphalt, 0.35 Rigid |
| Initial Serviceability | 4.2 Asphalt, 4.5 Rigid |
| Terminal Serviceability | 2.5 |
| Modulus of Rupture (concrete) | 630 psi |
| Load Transfer | 3.0 Dowels or Keys |
| Drainage Coefficient | 1.0 |
| Layer Coefficients (Asphalt Pavements) | 0.42 Asphalt |
| | 0.14 Base Course |

## LIGHT-DUTY PAVEMENTS

**(Areas not subject to repetitive 3-axle vehicle loads)**

| LIGHT-DUTY FLEXIBLE PAVEMENT | | |
|---|---|---|
| **Pavement Materials** | **Minimum Thickness (Inches)** | |
| | **Parking Stalls** | **Drives** |
| Asphaltic Concrete Wearing Course | 2½ | 3½ |
| Compacted Crushed Limestone Base | 10 | 12 |
| Geotextile Fabric Separator | YES* | YES* |
| Adequately Stripped & Proofrolled Subgrade, Compacted Structural Fill or Cement Stabilized Subgrade Soils | -- | -- |

*Note: If the pavement supporting soils are treated with cement the fabric separator may be omitted.

The compacted crushed limestone base for light-duty flexible pavements should consist of crushed limestone meeting LSSRB, Section 1003.03.1. Crushed limestone base for flexible pavements should be compacted to at least 98 percent of the maximum dry density as determined by ASTM D-698 at moisture contents within 2 percent of optimum.

The compacted crushed limestone base for light-duty flexible pavements may be replaced with a cement stabilized base course. The thickness of the soil-cement layer and percentage of cement will vary depending on grading plans and the type of material to be stabilized. However, it is estimated that a soil-cement layer approximately 12 inches in thickness stabilized with approximately 8 to 10 percent cement by volume should be sufficient. The actual amount of cement should be determined in the field at the time of construction based on the type of soil to be stabilized.

| LIGHT-DUTY RIGID PAVEMENT | | |
|---|---|---|
| **Pavement Materials** | **Minimum Thickness (Inches)** | |
| | **Parking Stalls** | **Drives** |
| Portland Cement Concrete | 5 | 6 |
| Compacted Granular Base | 4 | 4 |
| Adequately Stripped & Proofrolled Subgrade or Compacted Structural Fill | -- | -- |

The compacted granular base for light-duty rigid pavements should consist of crushed limestone or crushed concrete meeting LSSRB, Section 1003.03.1 or 1003.03.2, or relatively clean sands with less than 15 percent fines (material passing a number 200 sieve). Granular base for rigid pavements should be compacted to at least 98 percent of the maximum dry density as determined by ASTM D-698 at moisture contents within 2 percent of optimum.

## HEAVY-DUTY PAVEMENTS

**(Truck Drives/Parking & Dumpster Areas)**

| HEAVY-DUTY FLEXIBLE PAVEMENT | | |
|---|---|---|
| **Pavement Materials** | **Minimum Thickness (Inches)** | |
| | **Option #1** | **Option #2** |
| Asphaltic Concrete Wearing Course | 2 | 2 |
| Asphaltic Concrete Base Course | 2 | 2 |
| Compacted Crushed Limestone Base | 12 | -- |
| Geotextile Fabric Separator | YES | NO |
| Cement Stabilized Subbase (treated with 8 to 9% cement by volume) | -- | 12 |
| Adequately Stripped & Proofrolled Subgrade or Compacted Structural Fill | -- | -- |

**Note: An asphalt pavement section is not recommended for pavements that will experience forklift traffic.**

| HEAVY-DUTY RIGID PAVEMENT* | | |
|---|---|---|
| **Pavement Materials** | **Minimum Thickness (Inches)** | |
| | **Option #1** | **Option #2** |
| Adequately Reinforced Portland Cement Concrete (4,000 psi) | 7 | 7 |
| Compacted Crushed Limestone or Crushed Portland Cement Concrete Base | 8 | -- |
| Geotextile Fabric Separator | YES | NO |
| Cement Stabilized Subbase (treated with 8 to 9% cement by volume) | -- | 10 |
| Adequately Stripped & Proofrolled Subgrade or Compacted Structural Fill | -- | -- |

*Thicker sections than noted above may be required where forklifts will utilize the pavement system. A structural engineer should be consulted regarding forklift pavement sections.

Soils to be cement treated should have a plasticity index (PI) of 15 or less. If the pavement base soils have a PI greater than 15, then lime treatment will be necessary to lower the PI prior to cement stabilization. The thickness of lime treatment, if necessary, should be at least 12 inches. The amount of lime necessary to lower the PI of the fill soils will depend on the plasticity index of the soils to be treated and should be determined at the time of construction. If grading plans require at least 12 inches of structural fill to reach final grade in the pavement areas, lime stabilization will not be required if the imported fill has a PI of 15 or less. <u>Existing surficial soils which may contain sugar should not be treated with cement as sugar has been shown to reduce or completely mitigate the hydration process of the cement.</u>

It should be noted that soil cement base has a tendency to shrink similar to concrete causing tension cracks that can reflect up through the surface of asphaltic concrete pavements. The surface cracks will require additional maintenance and sealing to maintain the design life of the pavement. Higher percentages of cement than recommended above will further increase the frequency and severity of the hydration/shrinkage cracks.

Pavements and fill materials should meet the requirements of the Louisiana Standard Specifications for Roads and Bridges (LSSRB), latest edition. Structural fill utilized in the pavement areas should be compacted to 95 percent of the maximum dry density as determined by ASTM D698 (standard Proctor) at a moisture content within 2 percent of the optimum value.

Proper finishing of concrete pavement requires the use of appropriate construction joints to reduce the potential for cracking. Construction joints should be designed in accordance with current Portland Cement Association and the American Concrete Institute guidelines. Joints should be sealed to reduce the potential for water infiltration into pavement joints and subsequent infiltration into the supporting soils.

Load transfer devices at the pavement joints should be designed in accordance with accepted codes. The concrete should have a minimum compressive strength of 3,500 psi at 28 days (unless otherwise noted in the above tables). The concrete should also be designed with 5±1 percent entrained air to improve workability and durability. Asphaltic concrete pavement materials should meet the requirements of the LSSRB Section 501 (2016 Edition) and should be compacted to a minimum of 95 percent of the density of the laboratory molded specimen.

In addition, water should not be allowed to pond behind curbs and saturate the pavement base. In down grade areas, granular base should extend through the slope to allow any water entering the base a path to exit. The subgrade or fill soils beneath the pavement base course should be sloped to facilitate drainage. Landscape areas within the pavement system or next to the building should not be allowed to drain under the pavement system or into the pavement base.

The recommended crushed limestone or crushed recycled portland cement concrete base for heavy-duty rigid pavements should meet the material requirements of LSSRB Section 1003.03.1 or 1003.03.2, respectively, and be compacted to at least 95 percent of the maximum dry density as determined by ASTM D-1557 (modified Proctor) at moisture contents within 2 percent of optimum. It is also recommended that a geotextile fabric separator meeting the requirements of LSSRB Section 1019 be placed on the compacted fill prior to placement of crushed stone base. The purpose of the separator is to limit migration of the crushed aggregate into the fine-grained soils below during periods of wet weather.

If the pavement subbase soils are cement treated, the fabric separator may be omitted. In addition, if a sand base is utilized under the light-duty rigid pavements, the geotextile fabric may be omitted; however, placement of a strip of fabric separator approximately 18 to 24 inches in width under each pavement joint is recommended to minimize migration of the sand into the pavement joints. Again, the existing surficial soils should not be cement stabilized due to the potential for these soils to contain sugar concentrations that will inhibit cement hydration.

If unstable soils are encountered during proofrolling of the pavement subgrade, a geogrid soil reinforcement product may be utilized to minimize undercutting or stabilization of soft soils. If desirable, SITE Engineering should be contacted to provide alternative pavement sections which include the placement of geogrid reinforcement.

It is recommended that all utility pipe excavations and subsequent backfilling operations undertaken within the proposed pavement areas and for a distance of 2 feet within the perimeter of the pavement system be accomplished in accordance with LSSRB and/or governing municipality requirements. Where utility excavations traverse the pavement system, the upper 12 inches of utility trench backfill should consist of structural fill soils and/or the required pavement base materials meeting the classification requirements provided within this report.

In addition, water should not be allowed to pond behind curbs and saturate the pavement base. In down grade areas, granular base should extend through the slope to allow any water entering the base a path to exit. The subgrade or fill soils beneath the pavement base course should be sloped to facilitate drainage. Landscape areas within the pavement system or next to the buildings should not be allowed to drain under the pavement system or into the pavement base. It is further recommended that weep holes be constructed or installed in catch basins at the bottom of the aggregate base layer to allow a drainage path for any water that enters the base materials.

# 6.0 CONSTRUCTION CONSIDERATIONS

## 6.1 Construction Testing and Inspection

Many problems can be avoided or solved in the field if proper inspection and testing services are provided. It is recommended that the site preparation, foundation and floor slab construction, and pavement area construction be monitored by the geotechnical engineer or his representative.

Density tests should be performed to verify compaction and moisture content in the fill and base material. Each lift of fill material should be tested and approved by the soils engineer prior to placement of subsequent lifts. As a guideline, it is recommended that field density tests be performed at a frequency of not less than one test per 2,500 and 5,000 square feet of surface area per lift in the building and pavement areas, respectively, with a minimum of three tests per lift.

Inspection should be performed prior to and during concrete placement. Foundation excavations should be observed by the soils engineer or his representative to verify that the exposed materials are suitable for support of the foundations.

It is recommended that SITE Engineering, Inc. be retained to provide observation and testing of construction activities involved in the foundations and pavements, earthwork, and related activities of this project. SITE Engineering, Inc. cannot accept any responsibility for any conditions which deviated 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.

## 6.2 Moisture Sensitive Soils/Weather Related Concerns

The surficial soils encountered at this site are expected to be sensitive to changes in moisture content and may lose strength if allowed to become wet. During wet weather periods, increases 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. If the upper soils are allowed to become saturated and the construction schedule does not allow for drying of the soils naturally, removal and replacement or chemical stabilization will likely be required.

## 6.3 Drainage and Groundwater Concerns

Water should not be allowed to collect in the foundation excavations or floor slab areas, or on prepared subgrades of 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 perimeter of the buildings and beneath the floor slabs.

Groundwater was not encountered during the drilling operations within the upper 25 feet of the borings performed at this site. It should be noted, that it is possible for a groundwater table to be present at a later time depending upon climatic and rainfall conditions. It is recommended that the Contractor determine the actual groundwater levels at the site at the time of the construction activities.

It is recommended that the site be graded in anticipation of wet weather periods to help prevent water from "ponding" within the construction areas and/or flowing into excavations. Filtered sump pumps placed in the bottoms of excavations, or other conventional dewatering techniques, such as drainage swales or other methods approved by the geotechnical engineer, are expected to be suitable for control of surface or runoff water. However, if uncontrollable groundwater infiltration into the excavations is experienced during construction, SITE Engineering should be contacted.

## 6.4 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 excavations, 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.

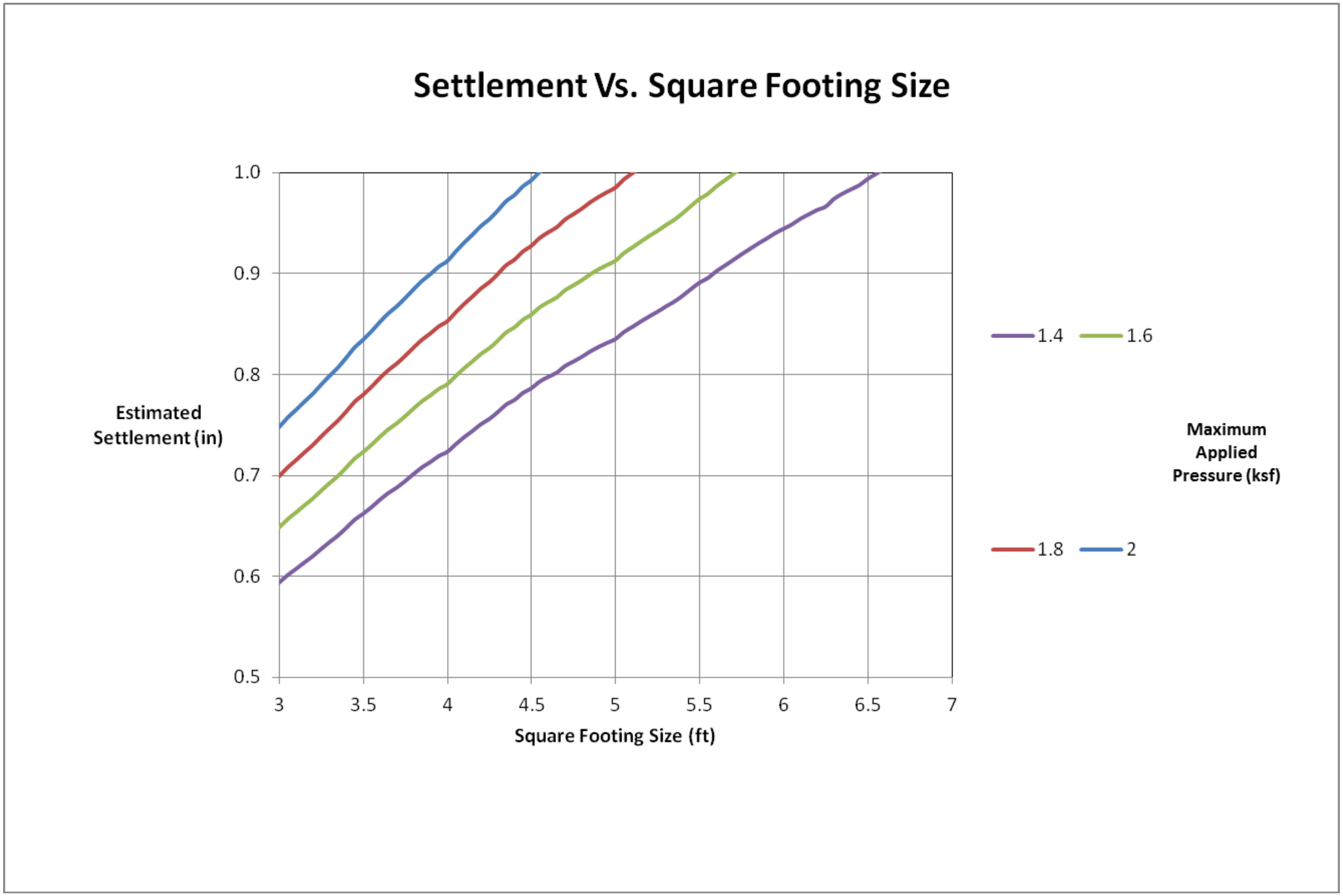
We are providing this information solely as a service to our client. SITE Engineering, Inc. does not assume responsibility for construction site safety or the contractor's or other parties' compliance with local, state, and federal safety or other regulations.

# 7.0 REPORT LIMITATIONS

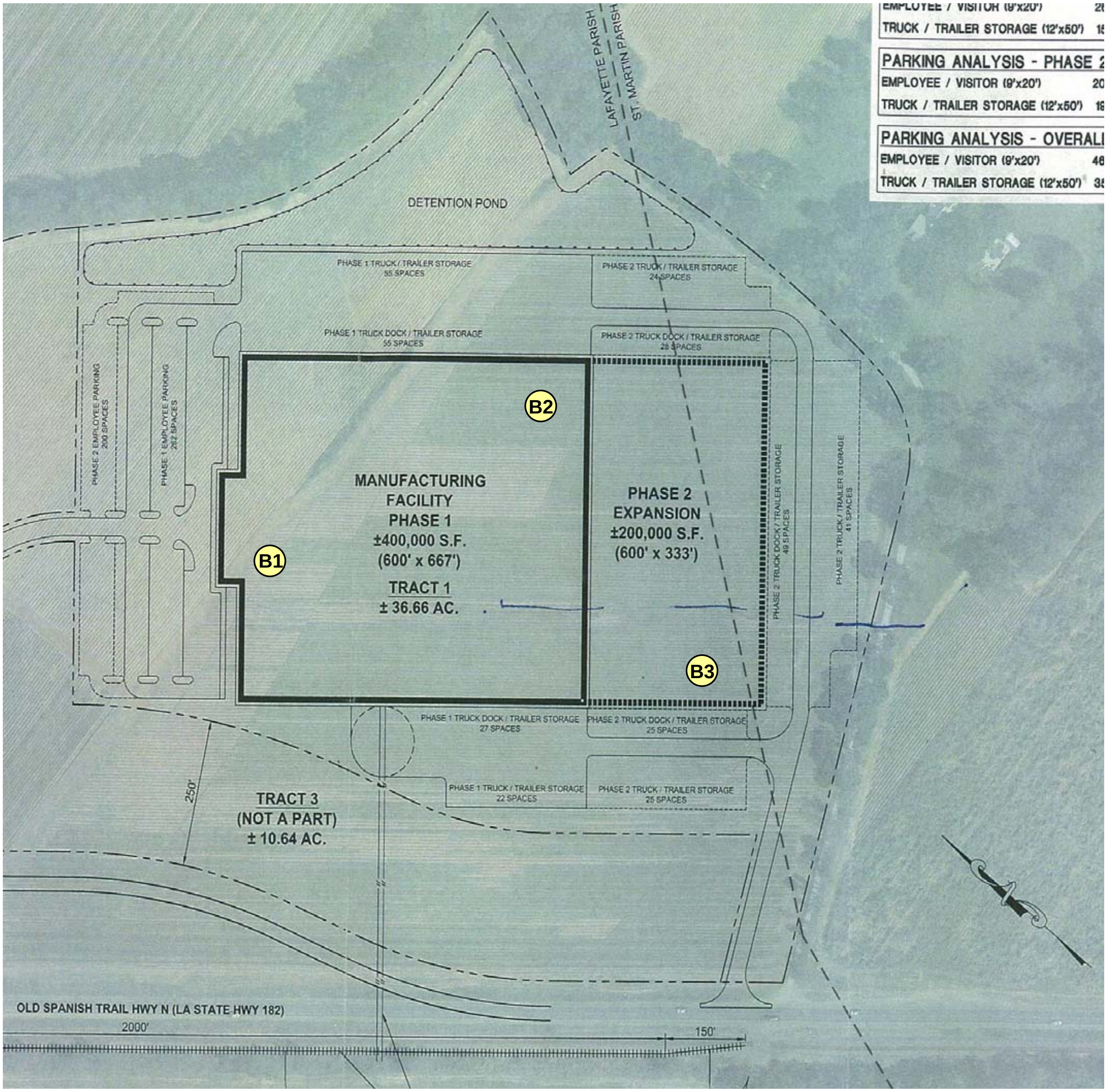
The recommendations submitted in this report are based on the available subsurface information obtained by SITE Engineering and are considered extremely preliminary in nature. Once further development details and project information is established, additional borings should be performed to provide specific recommendations.

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. This report has been prepared for the exclusive use of Domingue, Szabo & Associates, Inc. or their assigns for the proposed “Billeaud Site” industrial development to be constructed at the referenced location in Lafayette Parish, Louisiana.

# APPENDIX


Settlement Vs. Square Footing Size
Estimated Settlement (in)
1.0
0.9
0.8
0.7
0.6
0.5
3
3.5
4
4.5
5
5.5
6
6.5
7
Square Footing Size (ft)
1.4
1.6
1.8
2
Maximum Applied Pressure (ksf)

# Boring Location Diagram




SITE ENGINEERING, INC.

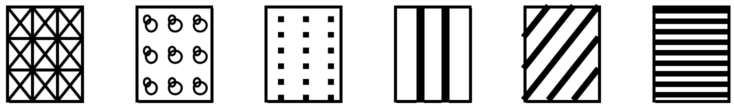
**Proposed Billeaud Site**
**Old Spanish Trail Highway**
**Lafayette & St. Martin Parishes, Louisiana**

**Project #20-G098-01**
**Date: January 5, 2021**

\# = Approximate Boring Location

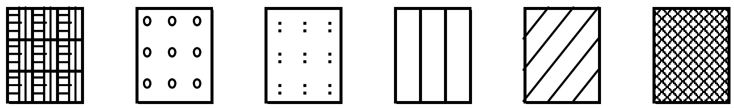
# KEY TO TERMS AND SYMBOLS USED ON LOGS

## SOIL TYPE



ROCK | GRAVEL | SAND | SILT | CLAY | PEAT

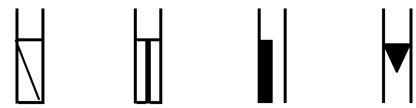
### MODIFIERS



STONE or CONCRETE | GRAVELY | SANDY | SILTY | CLAYEY | FILL or TOPSOIL

## SAMPLE TYPE

NO SAMPLE | AUGER SAMPLE | SHELBY TUBE | SPLIT SPOON



NO RECOVERY | ROCK CORE | 2" SHELBY TUBE | TXDOT CONE

### UNIFIED SOIL CLASSIFICATION SYSTEM - ASTM D 2487-98

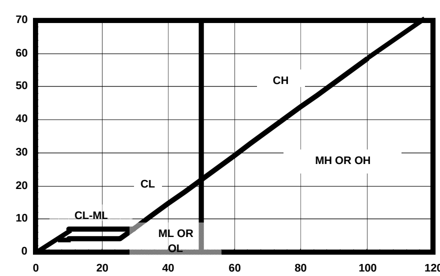
| MAJOR DIVISIONS | | | LETTER SYMBOL | TYPICAL DESCRIPTIONS |
|---|---|---|---|---|
| COARSE GRAINED SOILS (LESS THAN 50% PASSING NO. 200 SIEVE) | GRAVEL & GRAVELY SOILS LESS THAN 50% PASSING NO. 4 SIEVE | CLEAN GRAVEL (LITTLE OR NO FINES | GW | WELL GRADED GRAVEL, GRAVEL-SAND MIXTURES WITH LITTLE OR NO FINES |
| | | | GP | POORLY GRADED GRAVEL, GRAVEL-SAND MIXTURES WITH LITTLE OR NO FINES |
| | | W/ APPRECIABLE FINES | GM | SILTY GRAVEL, GRAVEL-SAND-SILT MIXTURES |
| | | | GC | CLAYEY GRAVELS, GRAVEL-SAND-CLAY MIXTURES |
| | SANDS MORE THAN 50% PASSING NO. 4 SIEVE | CLEAN SANDS LITTLE FINES | SW | WELL GRADED SAND, GRAVELY SAND (LITTLE FINES) |
| | | | SP | POORLY GRADED SANDS, GRAVELY SAND (L.FINES) |
| | | SANDS WITH APPREA. FINES | SM | SILTY SANDS, SAND-SILT MIXTURES |
| | | | SC | CLAYEY SANDS,SAND-CLAY MIXTURES |
| FINE GRAINED SOILS (MORE THAN 50% PASSING NO. 200 SIEVE) | SILTS AND CLAYS LIQUID LIMIT LESS THAN 50 | | ML | INORGANIC SILTS & VERY FINE SANDS,ROCK FLOUR SILTY OR CLAYEY FINE SANDS OR CLAYEY SILT W/ LOW PI |
| | | | CL | INORGANIC CLAY OF LOW TO MEDIUM PI LEAN CLAY GRAVELY CLAYS, SANDY CLAYS, SILTY CLAYS |
| | | | OL | ORGANIC SILTS & ORGANIC SILTY CLAYS OF LOW PI |
| | SILTS AND CLAYS LIQUID LIMIT GREATER THAN 50 | | MH | INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SANDY OR SILTY SOILS, ELASTIC SILTS |
| | | | CH | INORGANIC CLAYS OF HIGH PLASTICITY FAT CLAYS |
| | | | OH | ORGANIC CLAYS OF MED TO HIGH PI, ORGANIC SILT |
| 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 | UNCONFINED COMPRESSIVE STRENGTH IN TONS/FT$^2$ |
|---|---|
| VERY SOFT | 0.0 TO 0.25 |
| SOFT | 0.25 TO 0.50 |
| FIRM | 0.50 TO 1.0 |
| STIFF | 1.0 TO 2.0 |
| VERY STIFF | 2.0 TO 4.0 |
| HARD | > 4.0 OR 4.0+ |

### 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

Qp - HAND PENETROMETER
Qt - TORVANE
MV - MINIATURE VANE
Qu - UNCONFINED COMPRESSION TEST
UU - UNCONSOLIDATED UNDRAINED TRAIXIAL
CU - CONSOLIDATED UNDRAINED

▼ GROUNDWATER FIRST ENCOUNTERED

∇ (? HRS) DELAYED GROUNDWATER READING W/ ELAPSED TIME

### CLASSIFICATION OF GRANULAR SOILS

U.S. STANDARD SIEVE SIZE(S)

6" 3" 3/4" 4 10 40 200

| BOUL--DERS | COBBLES | GRAVEL | | SAND | | | SILT OR CLAY | CLAY |
|---|---|---|---|---|---|---|---|---|
| | | COARSE | FINE | COARSE | MEDIUM | FINE | | |

152 76.2 19.1 4.76 2.0 0.42 0.074 0.002

GRAIN SIZE IN MM

# LOG OF BORING B-1

## Proposed Billeaud Site

## Old Spanish Trail Highway

## Lafayette Parish, Louisiana

TYPE OF BORING: Solid Flight Auger to 25' then Wet Rotary | SITE Project #: 20-G098

| DEPTH, FT. | SOIL TYPE | SAMPLE TYPE | SOIL DESCRIPTION<br>**SURFACE ELEVATION:** Existing Grade | N-VALUE, blows per foot | UNCONFINED COMPRESSIVE STRENGTH (Qu), tsf | HAND PENETROMETER (Qp), tsf | TORVANE (Qt), tsf | UNIT DRY WEIGHT pcf | MOISTURE CONTENT, % | LIQUID LIMIT | PLASTICITY INDEX | % PASSING #200 SIEVE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Very stiff brown lean CLAY (CL) with silt and trace organics | | 3.72 | 4.5+ | | 101 | 23 | | | |
| | | | Very stiff to stiff brown lean CLAY (CL) with silt | | 2.65 | 4.0 | | 97 | 24 | | | |
| | | | | | 2.44 | 4.0 | | 99 | 24 | 49 | 25 | |
| 5 | | | - becoming stiff at 4 feet | | | | | | | | | |
| | | | | | 1.84 | 2.5 | | 97 | 25 | | | |
| | | | | | 1.45 | 2.0 | | 95 | 25 | 38 | 13 | |
| | | | Firm brown lean CLAY (CL) with silt | | | | | | | | | |
| 10 | | | | | 0.93 | 1.5 | | 92 | 26 | | | |
| 15 | | | | | 0.64 | | 0.30 | 89 | 31 | | | |
| | | | Hard reddish brown and gray fat CLAY (CH) with ferrous nodules | | | | | | | | | |
| 20 | | | | | 4.08 | 4.5+ | | 106 | 21 | | | |
| | | | Stiff to firm gray and reddish brown sandy lean CLAY (CL) with silt | | | | | | | | | |
| 25 | | | | | 1.16 | 1.5 | | 97 | 25 | | | 69 |
| | | | - becoming firm at 27 feet | | | | | | | | | |
| 30 | | | | | | | 0.30 | | 27 | | | 67 |
| | | | Dense brown clayey SAND (SC) | | | | | | | | | |
| 35 | | | | | | | | | 28 | | | 23 |
| 40 | | | | 24 | | | | | 27 | | | 24 |
| | | | Medium dense to dense brown SAND (SP-SC) with silty clay | | | | | | | | | |
| 45 | | | | 26 | | | | | 28 | | | 8 |
| | | | - becoming dense at 47 feet | | | | | | | | | |
| 50 | | | | 48 | | | | | 25 | | | 8 |
| | | | Boring terminated at 50 feet below grade | | | | | | | | | |

**DEPTH OF BORING:** 50 Feet Below Existing Grade

**DEPTH TO GROUNDWATER:** Not Encountered Within Upper 25 Feet

**DATE OF BORING:** December 7, 2020

# LOG OF BORING B-2
## Proposed Billeaud Site
## Old Spanish Trail Highway
## Lafayette Parish, Louisiana

TYPE OF BORING: Solid Flight Auger

SITE Project #: 20-G098

**SURFACE ELEVATION:** Existing Grade

| DEPTH, FT. | SOIL DESCRIPTION | N-VALUE, blows per foot | UNCONFINED COMPRESSIVE STRENGTH (Qu), tsf | HAND PENETROMETER (Qp), tsf | TORVANE (Qt), tsf | UNIT DRY WEIGHT pcf | MOISTURE CONTENT, % | LIQUID LIMIT | PLASTICITY INDEX | % PASSING #200 SIEVE |
|---|---|---|---|---|---|---|---|---|---|---|
| | Very stiff brown and gray SILTY CLAY (CL-ML) with trace organics | | | 4.5+ | | | 24 | | | |
| | | | | 4.5+ | | | 18 | 30 | 7 | |
| | Very stiff brown lean CLAY (CL) with silt | | 3.31 | 4.5 | | 99 | 25 | | | |
| 5 | | | 3.09 | 4.0 | | 96 | 26 | 48 | 22 | |
| | | | 2.67 | 3.5 | | 97 | 26 | | | |
| 10 | | | 2.50 | 3.5 | | 98 | 25 | | | |
| | Firm brown lean CLAY (CL) with silt | | | | | | | | | |
| 15 | | | 0.84 | | 0.45 | 92 | 26 | | | |
| 20 | | | 0.88 | | 0.45 | 88 | 31 | | | |
| | Very stiff reddish brown and gray sandy lean CLAY (CL) with silt | | | | | | | | | |
| 25 | | | 1.36 | 2.0 | | 99 | 25 | | | 59 |
| | Boring terminated at 25 feet below grade | | | | | | | | | |
| 30 | | | | | | | | | | |
| 35 | | | | | | | | | | |
| 40 | | | | | | | | | | |
| 45 | | | | | | | | | | |
| 50 | | | | | | | | | | |

**DEPTH OF BORING:** 25 Feet Below Existing Grade

**DEPTH TO GROUNDWATER:** Not Encountered During Drilling

**DATE OF BORING:** December 7, 2020

# LOG OF BORING B-3

## Proposed Billeaud Site

## Old Spanish Trail Highway

## Lafayette Parish, Louisiana

TYPE OF BORING: Solid Flight Auger — SITE Project #: 20-G098

| DEPTH, FT. | SOIL TYPE | SAMPLE TYPE | SOIL DESCRIPTION | N-VALUE, blows per foot | UNCONFINED COMPRESSIVE STRENGTH (Qu), tsf | HAND PENETROMETER (Qp), tsf | TORVANE (Qt), tsf | UNIT DRY WEIGHT pcf | MOISTURE CONTENT, % | LIQUID LIMIT | PLASTICITY INDEX | % PASSING #200 SIEVE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | **SURFACE ELEVATION:** Existing Grade | | | | | | | | | |
| | | | 18" Lean Clay topsoil | | | | 0.25 | | 30 | | | |
| | | | Very stiff to stiff brown lean CLAY (CL) with silt | | 2.66 | 3.5 | | 99 | 20 | | | |
| | | | | | 3.95 | 4.5+ | | 104 | 18 | 39 | 20 | |
| 5 | | | | | 3.18 | 4.5 | | 102 | 21 | | | |
| | | | - becoming stiff at 6 feet | | 1.87 | 2.5 | | 99 | 23 | | | |
| 10 | | | Firm to soft brown and gray lean CLAY (CL) with silt | | 0.92 | 1.5 | | 96 | 26 | | | |
| | | | - becoming soft at 12 feet | | | | | | | | | |
| 15 | | | | | 0.30 | | 0.20 | 89 | 31 | | | |
| 20 | | | Very stiff gray and reddish brown fat CLAY (CH) with ferrous nodules | | 2.44 | 3.5 | | 105 | 22 | | | |
| 25 | | | Stiff gray and reddish brown sandy lean CLAY (CL) with silt | | 1.81 | 2.5 | | 104 | 19 | | | 52 |
| | | | Boring terminated at 25 feet below grade | | | | | | | | | |
| 30 | | | | | | | | | | | | |
| 35 | | | | | | | | | | | | |
| 40 | | | | | | | | | | | | |
| 45 | | | | | | | | | | | | |
| 50 | | | | | | | | | | | | |

**DEPTH OF BORING:** 25 Feet Below Existing Grade

**DEPTH TO GROUNDWATER:** Not Encountered During Drilling

**DATE OF BORING:** December 7, 2020

SITE Engineering, Inc.