GEOTECHNICAL SUBSURFACE INVESTIGATION
RECOMMENDATIONS
FOR THE TAMUCC MOMENTUM FIELD LIGHT POLES
NILE DRIVE
CORPUS CHRISTI, TEXAS

RETL REPORT NUMBER: G118442

PREPARED FOR:

DBR ENGINEERING CONSULTANTS
400 MANN STREET, SUITE 602
CORPUS CHRISTI, TEXAS 78401

NOVEMBER 19, 2018

PREPARED BY:

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TBPE FIRM NO. 2101
November 19, 2018

DBR Engineering Consultants
400 Mann Street, Suite 602
Corpus Christi, Texas 78401

Attention:  Mr. Jeffrey D. Tabb, P.E., LEEP AP

SUBJECT: SUBSURFACE INVESTIGATION, LABORATORY TESTING PROGRAM, AND FOUNDATION RECOMMENDATIONS FOR THE PROPOSED TAMUCC MOMENTUM FIELD LIGHT POLES Nile Drive Corpus Christi, Texas RETL Job No. – G118442

Dear Mr. Tabb,

In accordance with our agreement, we have conducted a subsurface investigation, laboratory testing program, and foundation evaluation for the above referenced project. The results of this investigation, together with our recommendations, are to be found in the accompanying report, one electronic copy of which is being transmitted herewith for your records and distribution to the design team.

Often, because of design and construction details that occur on a project, questions arise concerning soil conditions, and Rock Engineering and Testing Laboratory, Inc. (RETL), Texas Professional Engineering Firm No. – 2101, would be pleased to continue its role as Geotechnical Engineer during the project implementation.

RETL also has great interest in providing materials testing and observation services during the construction phase of this project. If you will advise us of the appropriate time to discuss these engineering services, we will be pleased to meet with you at your convenience. If you have any questions, or if we can be of further assistance, please contact us at (361) 883-4555.

Sincerely,

Mark C. Rock, P.E.
Vice President of Operations
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</tbody>
</table>
INTRODUCTION

This report presents the results of a subsurface investigation, laboratory testing program, and provision of foundation recommendations for the proposed Light Poles to be constructed at the Texas A&M University Corpus Christi (TAMUCC) Momentum Field located off of Nile Drive in Corpus Christi, Texas.

Based on information provided to RETL, the project will include the construction of 12 new monopole lights. The proposed lights will be approximately 70-feet in height.

Authorization

The work for this project was performed in accordance with RETL proposal number P070518A dated July 6, 2018. The proposal was approved and signed by Mr. Jeffery D. Tabb, P.E., LEED AP representing DBR Engineering Consultants on October 8, 2018 and returned to RETL.

Purpose and Scope

The purpose of this exploration was to evaluate the soil and groundwater conditions at the site and to provide foundation recommendations suitable for the proposed project.

The scope of the exploration and analysis included the subsurface exploration, field and laboratory testing, engineering analysis and evaluation of the subsurface soils, provision of foundation recommendations, and preparation of this report.

The scope of services did not include an environmental assessment. Any statements in this report, or on the boring logs, regarding odors, colors, unusual or suspicious items or conditions are strictly for the information of the client.

General

The exploration and analysis of the subsurface conditions reported herein are considered sufficient in detail and scope to provide foundation recommendations for the proposed project. The information submitted for the proposed project is based on preliminary project details provided by Muñoz Engineering and DBR Engineering Consultants, and the soil information obtained at the boring locations. If the designers require additional soil parameters to complete the design of the proposed foundation system and this information can be obtained from the soil data and laboratory tests performed within the scope of work included in our proposal for this project, RETL will provide the additional information requested as a supplement to this report.
The Geotechnical Engineer states that the findings, recommendations, specifications or professional advice contained herein have been presented after being prepared in a manner consistent with that level of care and skill ordinarily exercised by reputable members of the Geotechnical Engineer’s profession practicing contemporaneously under similar conditions in the locality of the project. RETL operates in general accordance with “Standard Practice for Minimum Requirements for Agencies Engaged in the Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction”, (ASTM D3740). No other representations are expressed or implied, and no warranty or guarantee is included or intended.

This geotechnical investigation and foundation recommendations have been prepared for the exclusive use of DBR Engineering Consultants for the proposed to be constructed at the Texas A&M University Corpus Christi (TAMUCC) Momentum Field located off of Nile Drive in Corpus Christi, Texas.

DESCRIPTION OF SITE

The site of the proposed project is located on the east side of Nile Drive between Pharaoh Drive and Islander Way in Corpus Christi, Texas. The surface of the site is covered with grass utilized as sports playing fields. Owner coordination was required to avoid private underground utilities at the site. The ground surface was relatively firm at the time of our field investigation and did not pose any significant difficulties to the drill crew moving their equipment around the site.

FIELD EXPLORATION

Scope

The field exploration, to evaluate the engineering characteristics of the subsurface materials, included reconnaissance of the project site, performing the boring operations and obtaining disturbed split spoon samples and relatively undisturbed Shelby tube samples. During the sample recovery operations, the soils encountered were classified and recorded on the boring logs in accordance with “Standard Guide for Field Logging of Subsurface Exploration of Soil and Rock, (ASTM D5434).”

Six borings were performed at this site for the purpose of providing geotechnical information. The table below provides the boring identifications, boring depths, and GPS coordinates at the boring locations:
SUMMARY OF BORING INFORMATION

<table>
<thead>
<tr>
<th>Boring</th>
<th>Depth (ft)</th>
<th>GPS Coordinates</th>
</tr>
</thead>
<tbody>
<tr>
<td>B-1</td>
<td>50’</td>
<td>N 27.70558° W 97.34071°</td>
</tr>
<tr>
<td>B-2</td>
<td>50’</td>
<td>N 27.70518° W 97.33992°</td>
</tr>
<tr>
<td>B-3</td>
<td>50’</td>
<td>N 27.70479° W 97.33913°</td>
</tr>
<tr>
<td>B-4</td>
<td>50’</td>
<td>N 27.70472° W 97.34125°</td>
</tr>
<tr>
<td>B-5</td>
<td>50’</td>
<td>N 27.70433° W 97.34046°</td>
</tr>
<tr>
<td>B-6</td>
<td>50’</td>
<td>N 27.70394° W 97.33966°</td>
</tr>
</tbody>
</table>

The GPS coordinates were obtained at the boring locations using a commercially available GPS and are provided in this report and on the boring logs. RETL determined the scope of the field work and staked the boring locations. EnviroCore Drilling, Inc., a geotechnical drilling sub-contractor, performed the drilling operations. Upon completion of the drilling operations and obtaining the groundwater observations, the drill holes were backfilled with excavated soil and the site cleaned as required. A Boring Location Plan is provided in the Appendix.

The borings performed for this project were used to determine the classification and strengths of the subgrade soils. This information is provided on the boring logs and includes boring locations, boring depths, soil classifications, soil strengths, and laboratory test results. The boring logs are included in the Appendix.

Drilling and Sampling Procedures

The test borings were performed using a drilling rig equipped with a rotary head turning hollow stem augers to advance the boreholes. Disturbed soil samples were obtained using split-barrel sampling procedures in general accordance with the procedures for, “Penetration Test and Split-Barrel Sampling of Soils, (ASTM D1586).” Relatively undisturbed Shelby tube soil samples were obtained using thin-wall tube sampling procedures in accordance with, “Thin Walled Tube Sampling of Soils, (ASTM D1587).” The samples obtained by this procedure were extruded by a hydraulic ram and classified in the field.

The samples were placed in plastic bags, marked according to boring number, depth and any other pertinent field data, stored in special containers and delivered to the laboratory for testing.
Field Tests and Observations

Standard Penetration Tests (SPT) – During the sampling procedures, SPT were performed to obtain the standard penetration value of the soil at selected intervals. The standard penetration value (N) 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. 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 6-inch penetrations. The “N” value is obtained by adding the second and third 6-inch increment number of blows. The results of standard penetration tests indicate the relative density of cohesionless soils and comparative consistency of cohesive soils, thereby providing a basis for estimating the relative strength and compressibility of the soil profile components.

Water Level Observations - Water level observations were obtained during the test boring operations and are noted on the boring logs provided in the Appendix. In relatively pervious soils, such as sandy soils, the indicated depths are usually reliable groundwater levels. In relatively impervious soils, a suitable estimate of the groundwater depth may not be possible, even after several days of observation. Seasonal variations, temperature, land-use, proximity to a creek, river or lake and recent rainfall conditions may influence the depth to the groundwater. The amount of water in open boreholes largely depends on the permeability of the soils encountered at the boring locations.

Ground Surface Elevations - The ground surface elevations were not provided at the boring locations. Therefore, the depths referred to in this report are from the actual ground surface at the boring locations during the time of our field investigation.

LABORATORY TESTING PROGRAM

In addition to the field investigation, a laboratory testing program was conducted to determine additional pertinent engineering characteristics of the subsurface materials necessary in analyzing the behavior of the foundation system for the proposed project.

The laboratory testing program included supplementary visual classification (ASTM D2487) and water content tests (ASTM D2216) on the samples. In addition, selected samples were subjected to Atterberg limits tests (ASTM D4318) and percent material finer than the #200 sieve tests (ASTM D1140).

The shear strength of a selected cohesive soil sample was evaluated from unconfined compressive strength tests (ASTM D2166). Estimated soil strengths were obtained using a hand penetrometer.

The laboratory testing program was conducted in general accordance with applicable ASTM Specifications. The results of these tests are to be found on the accompanying boring logs provided in the Appendix.
SUBSURFACE CONDITIONS

General

The types of foundation bearing materials encountered in the test borings have been visually classified and are described in detail on the boring logs. The results of the standard penetration tests, strength tests, water level observations and other laboratory tests are presented on the boring logs in numerical form. Representative samples of the soils were placed in polyethylene bags and are now stored in the laboratory for further analysis, if desired. Unless notified to the contrary, all samples will be disposed of three months after issuance of this report.

The stratification of the soil, as shown on the boring logs, represents the soil conditions at the actual boring locations. Variations may occur between, or beyond, the boring locations. Lines of demarcation represent the approximate boundary between different soil types, but the transition may be gradual, or not clearly defined.

It should be noted that, whereas the test borings were drilled and sampled by experienced drillers, it is sometimes difficult to record changes in stratification within narrow limits. In the absence of foreign substances, it is also difficult to distinguish between discolored soils and clean soil fill.

Soil Conditions

The soil conditions encountered in the test borings performed for this project have been summarized and soil properties including soil classification, plasticity, strength, effective unit weight, percent passing the No. 200 sieve, range of SPT results, and range of pocket penetrometer results are provided in the following table:

Soil Profile Table: Borings B-1 & B-2

<table>
<thead>
<tr>
<th>D</th>
<th>Generalized Soil Description</th>
<th>C</th>
<th>( \phi )</th>
<th>( \gamma_e )</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-17</td>
<td>Fat CLAY</td>
<td>1,500</td>
<td>0</td>
<td>120</td>
</tr>
<tr>
<td>17-23</td>
<td>Fat CLAY</td>
<td>2,700</td>
<td>0</td>
<td>120</td>
</tr>
<tr>
<td>23-50</td>
<td>Fat CLAY</td>
<td>2,600</td>
<td>0</td>
<td>60</td>
</tr>
</tbody>
</table>

Soil Profile Table: Borings B-3 through B-6

<table>
<thead>
<tr>
<th>D</th>
<th>Generalized Soil Description</th>
<th>C</th>
<th>( \phi )</th>
<th>( \gamma_e )</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-23</td>
<td>Fat CLAY</td>
<td>2,500</td>
<td>0</td>
<td>120</td>
</tr>
<tr>
<td>23-50</td>
<td>Fat CLAY</td>
<td>2,900</td>
<td>0</td>
<td>60</td>
</tr>
</tbody>
</table>
Where:

- \( D \) = Depth in feet below existing grade
- \( C \) = Soil Cohesion, psf (undrained)
- \( \phi \) = Angle of Internal Friction, deg. (undrained)
- \( \gamma_e \) = Effective soil unit weight, pcf

Detailed descriptions of the soils encountered at the boring locations are provided on the boring logs included in the Appendix.

**Seismic Site Classification**

The site soil shall be classified based on the upper 100 feet of the site profile. Where site-specific data are not available to a depth of 100 ft. appropriate soils properties are permitted to be estimated by the registered design professional preparing the soil investigation report based on known geologic conditions. Where the soils properties are not known in sufficient detail to determine the site class, Site Class D shall be used unless the authority having jurisdiction or geotechnical data determined Site Class E or F soils are present at the site. Site Classes A and B shall not be assigned to a site if there is more than 10 ft. of soil between the rock surface and the bottom of the spread footing or mat foundation. It is RETL’s opinion that given the limits of the site investigation and the guidelines dictated above, that the Seismic Site Class D should be utilized for structural design at this site.

**Groundwater Observations**

Groundwater (GW) observations and the depths the borings caved are provided in the following table:

<table>
<thead>
<tr>
<th>BORING NO.</th>
<th>DURING DRILLING</th>
<th>UPON COMPLETION</th>
<th>DELAYED READING</th>
</tr>
</thead>
<tbody>
<tr>
<td>B-1</td>
<td>23’</td>
<td>GW @ 38’ &amp; Caved @ 46’</td>
<td>GW @ 7’</td>
</tr>
<tr>
<td>B-2</td>
<td>23’</td>
<td>GW @ 35’ and Caved @ 38’</td>
<td>GW @ 7’</td>
</tr>
<tr>
<td>B-3</td>
<td>23’</td>
<td>GW @ 36’ and Caved @ 48’</td>
<td>---</td>
</tr>
<tr>
<td>B-4</td>
<td>25’</td>
<td>GW @ 38’ and Caved @ 46’</td>
<td>GW @ 7’</td>
</tr>
<tr>
<td>B-5</td>
<td>25’</td>
<td>GW @ 40’ and Caved @ 46’</td>
<td>---</td>
</tr>
<tr>
<td>B-6</td>
<td>23’</td>
<td>GW @ 28’ and Caved @ 48’</td>
<td>---</td>
</tr>
</tbody>
</table>

Based on observations made in the field and moisture contents obtained in the laboratory, it appears that groundwater at the time of our field investigation was encountered near the 23-foot depth. It should be noted that the water levels in open boreholes may require several hours to several days to stabilize depending on the permeability of the soils and that groundwater levels at this site may be subject to seasonal conditions, recent rainfall, drought or temperature effects.
FOUNDATION DISCUSSION

Project Description

The project includes the construction of the proposed Light Poles to be constructed at the Texas A&M University Corpus Christi (TAMUCC) Momentum Field located off of Nile Drive in Corpus Christi, Texas. Based on information provided to RETL, the project will include the construction of 12 new monopole lights. The proposed lights will be approximately 70-feet in height. Generally for these types of structures, wind loads will govern the design of the foundations in order to resist the lateral loads.

PVR Discussion

The laboratory test results indicate that the subsoils in the active zone at this site are moderate to high in plasticity. **The maximum calculated total potential vertical rise (PVR) at this site is on the order of 4¼ to 4½-inches.** The PVR was calculated using the Texas Department of Transportation Method TEX-124E and took into account the depth of the active zone, estimated to extend to a depth of approximately 15-feet, and the Atterberg limits test results of the soils encountered within the active zone.

The estimated PVR values provided are based on the floor system applying a sustained surcharge load of approximately 1.0 pound per square inch on the subgrade soils. The value represents the vertical rise that can be experienced by dry subsoils if they are subjected to conditions that allow them to become saturated, such as poor drainage. The actual movement of the subsoils is dependent upon their change in moisture content.

Differential vertical movements can potentially be equal to the expected total movements. Differential vertical movements at this site equal to the calculated PVR over a distance equal to the depth of the active zone, within the footprint of a slab-on-grade if dry soil conditions exist and a localized water source such as ponding water or a plumbing leak occurs resulting in non-uniform moisture conditions.

FOUNDATION TYPES CONSIDERED

Various foundation types have been considered for the support of the proposed light pole structures. The governing design criteria is likely lateral wind loads, therefore overturning would be the primary concern. The foundation types considered most appropriate for this type of loading condition is either spread footings or deep straight shaft drilled piers. In addition to overturning, the moderate plastic clay soils at this site will likely shrink and swell with changes in moisture content that could either result in light poles utilizing spread footings being out of plumb or the clay soils can impart uplift loads on the pier and could attempt to pull the piers out of the ground. Therefore, the foundations will not only need to resist the lateral wind loads but also be designed to be founded on stable soils to resist the negative impact of the moderately plastic clay soils at this site.

Recommendations for spread footings and drilled piers will be provided in this report.
FOUNDATION RECOMMENDATIONS

Conventional Spread Footings

Conventional spread footings are suitable to support the lightly loaded light poles subject to lateral loads. The foundation should be founded at a minimum depth of 5-feet below the existing grade and can be designed for an allowable unit bearing pressure of 2,500 psf for dead load and sustained live loads with a safety factor of 3.0.

Footings designed using the net allowable unit soil pressures provided could expect total settlements to be approximately 1-inch and differential settlements to be approximately ½-inch. The allowable unit soil pressures may be increased by one-third for maximum transient loads, such as wind loads.

The footing geometry and the weight of the footing and the soil above the footing will resist the lateral loads. For stability calculations the weight of concrete can be taken as 150 pounds per cubic feet and the weight of soil can be taken as 120 pounds per cubic feet, if storm conditions resulting in high water tables is to be considered than the buoyant force will result in 90 pounds per cubic feet and 60 pounds per cubic feet, respectively.

In order to minimize the effects of any slight differential movement that may occur due to variations in the character of the supporting soils, it is recommended that all footings be suitably reinforced to make them as rigid as possible.

In areas where a spread footing will be constructed, soil and all loose or excessively organic materials shall be removed to the depth required to achieve the desired bearing pressure. Foundation excavations may be neat cut with conventional excavation equipment, preferably with a smooth-mouthed bucket. If a toothed bucket is used, excavation with this equipment should be stopped 12-inches above the final grade and the foundation excavation completed with a smooth-mouthed bucket or by hand labor. The exposed subgrade soils at the footing bearing depth shall be compacted to a minimum density of 95-percent of the maximum dry density as determined by the standard Proctor test (ASTM D698) and the moisture content shall be maintained at, or above, the optimum moisture content. The smooth firm properly compacted footing bearing surface shall be protected to prevent excessive wetting and desiccation of the subgrade soils and to provide a stable subgrade during placement of reinforcing steel.

Backfill around the footing shall be properly compacted “Select Fill”.

Footing construction should be constructed, including the placement of concrete in one day, if the concrete cannot be placed in one-day then a lean concrete seal slab shall be placed to protect the footing bearing surface from desiccation of excessive wetting.

Drilled Piers

Straight shaft drilled piers can be utilized at this site to support the proposed light poles.
The structural designer can utilize the allowable unit skin friction values for the range in elevation included in the following table for straight shaft drilled piers to resist the axial loads given the strengths of the subsurface soils encountered:

<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>Allowable Unit Skin Friction (psf)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-5</td>
<td>Neglect</td>
</tr>
<tr>
<td>5-17</td>
<td>400</td>
</tr>
<tr>
<td>17-23</td>
<td>650</td>
</tr>
<tr>
<td>23-45</td>
<td>700</td>
</tr>
</tbody>
</table>

The allowable unit skin friction values provided above are based on the strengths of the in-situ soils and utilize a safety factor of 2 to prevent shear failure. The minimum depth below the ground surface for deep foundations at this site required to resist uplift forces, assuming a minimum load of 15 kips, is 20-feet and the maximum termination elevation for straight shaft drilled piers is 45-feet. If the minimum load on any pier is less than 15-kips, RETL should be given the opportunity to revisit the minimum depth recommendations for straight shaft drilled piers at this site. Resistance to uplift can be calculated by taking 60-percent of the axial capacity of a straight shaft drilled pier.

A properly designed and constructed straight shaft drilled pier can be expected to experience settlement on the order of 1-percent of the shaft diameter of the pier. Equally loaded same size drilled shafts should experience differential settlements on the order of 0.5-percent of the pier shaft diameters.

Straight shaft drilled piers should be spaced no closer than three pier diameters apart measured center to center. Drilled piers at this site should be adequately reinforced with a minimum of 1 percent of the cross-sectional area of the pier shaft throughout the depth of the pier to withstand uplift forces.

**Lateral Pier Analysis**

Lateral pier analysis programs such as L-pile will require the following soil design parameters based on the generalized soil conditions for this site:

### Lateral Analysis Parameters; Borings B-1 & B-2

<table>
<thead>
<tr>
<th>D</th>
<th>GENERALIZED SOIL DESCRIPTION</th>
<th>C</th>
<th>0</th>
<th>K</th>
<th>E&lt;sub&gt;50&lt;/sub&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-5</td>
<td>Neglect</td>
<td>---</td>
<td>120</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>5-17</td>
<td>CLAY</td>
<td>1,500</td>
<td>0</td>
<td>120</td>
<td>500</td>
</tr>
<tr>
<td>17-23</td>
<td>CLAY</td>
<td>2,700</td>
<td>0</td>
<td>120</td>
<td>1000</td>
</tr>
<tr>
<td>23-45</td>
<td>CLAY</td>
<td>2,600</td>
<td>0</td>
<td>60</td>
<td>1000</td>
</tr>
</tbody>
</table>
Lateral Analysis Parameters; Borings B-3 through B-6

<table>
<thead>
<tr>
<th>D</th>
<th>GENERALIZED SOIL DESCRIPTION</th>
<th>C</th>
<th>$\phi$</th>
<th>$\gamma_e$</th>
<th>K</th>
<th>$E_{50}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-5</td>
<td>Neglect</td>
<td>---</td>
<td>---</td>
<td>120</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>5-23</td>
<td>CLAY</td>
<td>2,500</td>
<td>0</td>
<td>120</td>
<td>1000</td>
<td>0.005</td>
</tr>
<tr>
<td>23-45</td>
<td>CLAY</td>
<td>2,900</td>
<td>0</td>
<td>60</td>
<td>1000</td>
<td>0.005</td>
</tr>
</tbody>
</table>

Where:
- $D$ = depth (ft)
- $\gamma_e$ = effective unit weight, pcf
- $C$ = shear strength, psf
- $\phi$ = angle of internal friction, deg.
- $K$ = modulus of subgrade reaction (pci)
- $E_{50}$ = 50% strain value

$E_{50}$ values were estimated from known correlations. The upper 5-feet of soil below the pile head shall be neglected depending on the depth of the pile head below the ground surface.

CONSTRUCTION CONSIDERATIONS

Select Fill

Imported select fill material used at this site should be homogenous, free from organics and other deleterious materials and should have a maximum liquid limit of 40-percent and a plasticity index (PI) between 7 and 18. The select fill soils shall have a minimum of 35-percent passing the #200 sieve and no soil particles exceeding 1½-inches will be permitted. The fill should be placed in no greater than 8-inch thick loose lifts and then compacted to a minimum density of 95-percent of the maximum dry density, as determined by the standard Proctor test (ASTM D698), and at, or above, the optimum moisture content.

Drilled Pier Installation Considerations

For deep drilled pier construction at this site, based on observations made in the field, temporary steel casing or the slurry displaced method of excavating drilled piers will be necessary to prevent groundwater and soils from infiltrating into the pier excavation for pier excavations greater than approximately 23-feet.

Temporary Steel Casing - Temporary steel casing is used to prevent groundwater infiltration and soil sloughing into the pier excavation prior to placing reinforcing steel and pier concrete. The casing will require a competent clay stratum to seal the casing. A competent clay stratum was encountered throughout the depth of the borings performed at this site for this project. Overdriving of casing should be avoided but may be warranted.
When installing straight shaft drilled piers with temporary steel casing the concrete should be placed as soon as possible after all loose material has been removed, the pier excavation inspected and reinforcing steel installed. A relatively high slump concrete mix (6 to 7-inches) is suggested to minimize aggregate segregation caused by the reinforcing steel. Free fall of concrete into the pier excavation is permitted provided the concrete can be placed into the pier excavation without striking the sides of the excavation or hitting the rebar.

It should be noted that research has shown that free fall concrete guided at the top of the excavation to avoid contact with the sides of the pier excavation and reinforcing steel can drop more than 80-feet without any measurable segregation. In addition, the research has shown that as long as the concrete drop is in air the strength of the concrete was not adversely affected. In situations where it is impossible for the concrete to fall freely without striking the rebar cage or sides of the pier excavation the free fall should be limited to 10-feet, or placed with a tremie. Pier excavations should not be allowed to stay open overnight.

The successful placement of a drilled pier foundation system is dependent on the expertise of the drilled pier foundation contractor. A test pier excavation should be performed at the site to verify the contractor’s construction methods and to identify any potential groundwater infiltration and soil sloughing problems. The Geotechnical Engineer, or his designated representative, should be present to witness the installation of all the drilled piers, including the test pier excavation.

Slurry Displacement Method - The slurry displacement method of performing the pier excavation is applicable for any situation requiring casing. It is required if it is not possible to get an adequate water seal with the casing to keep groundwater out of the shaft cavity. Note that it is essential in this method that there is a sufficient slurry head available (or that the slurry density can be increased as needed) so the inside pressure is greater than that from the groundwater table or the tendency of the soil to cave.

Bentonite is most commonly used with water to produce the slurry (“bentonite slurry”). Some experimentation may be required to obtain optimum percentage for a site but amounts in the range of 4 to 6 percent by weight are usually adequate.

The bentonite should be well mixed with water so that the mixture is not lumpy. The slurry should be capable of forming a filter cake on the shaft wall and to carry the smaller (say, under 6mm) excavated particles in suspension.

With the slurry method it is generally desirable to:

- Prevent having the slurry in the shaft too long to prevent an excessively thick filter cake is difficult to displace with concrete during shaft filling.
- Pump the slurry and screen out the larger soil particles in suspension then the “conditioned” slurry can be returned to the shaft prior to concreting.
- Care should be exercised in excavating clay through the slurry so that pulling a large fragment does not cause sufficient negative pore pressure, or suction, to develop and collapse a part of the shaft.
When the shaft is complete the rebar cage is set in place and a tremie installed (this sequence is usually necessary so that the tremie does not have to be pulled to set the cage and then reinserted—almost certain to produce a slurry film discontinuity in the shaft). Concrete is pumped with great care taken that the tremie is always well submerged in the concrete so a minimum surface area is exposed and contaminated with slurry. Studies have shown that the concrete will adequately displace slurry particles from the rebar cage so a good bond can be obtained, and as previously noted, if the shaft is not open too long the filter cake on the pier wall is reasonably displaced as well.

Care must be taken during concrete placement and casing removal to ensure that sufficient concrete head is maintained inside the casing to prevent soil intrusions in the pier concrete. Concrete should be placed as soon as possible after all loose material has been removed, the pier excavation inspected and reinforcing steel installed. A relatively high slump concrete mix (6 to 7 inches) is suggested to minimize problems related to the concrete adhering to the casing as the casing is removed and to minimize aggregate segregation caused by the reinforcing steel. The soils engineer should be present to witness the test pier excavation. The pier excavation should not be allowed to stay open overnight.

The successful placement of a pier foundation is dependent on the expertise of the drilled pier foundation contractor. The Geotechnical Engineer, or his designated representative, should be present to witness the pier excavation.

**Earthwork and Foundation Acceptance**

Exposure to the environment may weaken the soils at the foundation bearing level if the excavations remain open for long periods of time. Therefore, it is recommended that the foundation excavations be extended to final grade and that the foundation be constructed as soon as possible to minimize potential damage to the bearing soils. The foundation bearing levels should be free of loose soil, ponded water or debris and should be observed prior to concreting by the Geotechnical Engineer, or his designated representative.

Foundation concrete should not be placed on soils that have been disturbed by rainfall or seepage. If the bearing soils are softened by surface water intrusion, or by desiccation, the unsuitable soils must be removed from the foundation excavations and be replaced with properly compacted “**Select Fill**” prior to placement of concrete.

The Geotechnical Engineer, or his designated representative, should monitor subgrade preparation and placement of select fill. As a guideline, a minimum of one, in-place density test shall be performed on the subgrade soils and each subsequent lift of fill for each 2,000 square feet of slab or pavement area, or a minimum of three in-place density tests per testing interval, whichever is greater. Any areas not meeting the required compaction should be recompacted and retested until compliance is met.

**Utilities**

Utilities supported on multiple foundations and utilities that project through footings or walls should be designed with either some degree of flexibility, or with sleeves, in order to prevent damage to these lines should vertical movement occur.
GENERAL COMMENTS

If significant changes are made in the character or location of the proposed project, a consultation should be arranged to review any changes with respect to the prevailing soil conditions. At that time, it may be necessary to submit supplementary recommendations.

It is recommended that the services of RETL be engaged to test and evaluate the soils in the foundation excavations prior to concreting in order to verify that the bearing soils are consistent with those encountered in the borings. RETL cannot accept any responsibility for any conditions that deviate from those described in this report, nor for the performance of the foundations if not engaged to also provide construction observation and testing for this project. If it is required for RETL to accept any liability, then RETL must agree with the plans and perform such observation during construction as we recommend.

All sheeting, shoring and bracing of trenches, pits and excavations should be made the responsibility of the contractor and should comply with all current and applicable local, state and federal safety codes, regulations and practices, including the Occupational Safety and Health Administration.
BORING LOCATION PLAN

November 19, 2018
Attn.: Mr. Jeffrey D. Tabb, P.E., LEED AP
RETL Job No.: G118442

TAMUCC MOMENTUM FIELD LIGHT POLES
Nile Drive
Corpus Christi, Texas
### Field Data

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### Laboratory Data

- **SOIL SYMBOL**: FAT CLAY with SAND
- **MOISTURE CONTENT (%)**: moist, dark brown and gray, stiff.
- **ATTERBERG LIMITS**: LL: 23, PL: 19, PI: 48
- **DRY DENSITY POUNDS/CU.FT**: 83
- **MINUS NO. 200 SIEVE (%)**: 26

### Remarks

Boring was terminated at a depth of 50-feet.
**LOG OF BORING B-2**

**CLIENT:** DBR Engineering Consultants  
**PROJECT:** TAMUCC Momentum Field Light Poles  
**LOCATION:** Nile Drive; Corpus Christi, Texas  
**NUMBER:** G118442  
**DATE(S) DRILLED:** 10/30/18 - 10/30/18

**GROUNDWATER INFORMATION:**  
Groundwater (GW) was encountered at a depth of 23-feet during drilling. GW at 35-feet and Caved at 38-feet upon completion.  
24-Hour Delayed Readings: GW at 7-feet.

**SURFACE ELEVATION:** N/A

**DESCRIPTION OF STRATUM**

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**FAT CLAY**, moist, dark brown, firm.

Same as above, very stiff.

**FAT CLAY with SAND**, moist, brown, very stiff. (CH)

Same as above.

**LEAN CLAY**, moist, brown, with shell, stiff.

**SANDY LEAN CLAY**, moist, brown, stiff. (CL)

**LEAN CLAY**, moist, brown, very stiff.

Same as above.

**LEAN CLAY**, moist, brown, very stiff.

Same as above.

**LEAN CLAY**, moist, brown, very stiff.

Same as above.

**FAT CLAY**, moist, brown, stiff, slickensided.

Same as above, very stiff.

Boring was terminated at a depth of 50-feet.

**REMARKS:**

Boring depth was determined by RETL and boring location was determined by Munoz Engineering. Drilling operations were performed by EnviroCore Drilling, Inc., a subcontractor to RETL, at GPS Coordinates N 27.70518° W 97.33992°.
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**DESCRIPTION OF STRATUM**

- **FAT CLAY**, moist, dark brown, very stiff.
  - Same as above.
  - Same as above. (CH)

- **FAT CLAY**, moist, brown and dark brown, stiff.
  - Same as above, very stiff. (CH)
  - Same as above, stiff, slickensided.

- **FAT CLAY**, moist, brown, very stiff.
  - Same as above.
  - Same as above.

- **FAT CLAY**, moist, brown, very stiff.
  - Same as above, firm, slickensided.
  - Same as above.

**GROUNDWATER INFORMATION:**

Groundwater (GW) was encountered at a depth of 23-feet during drilling. GW at 26-feet and Caved at 48-feet upon completion.

**SURFACE ELEVATION:** N/A

**REMARKS:**

Boring was terminated at a depth of 50-feet.
**LOG OF BORING B-4**

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<td>18</td>
<td>56</td>
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<td>26</td>
<td>99</td>
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</table>

**DRILLING METHOD(S):**

Hollow Stem Auger

**GROUNDWATER INFORMATION:**

Groundwater (GW) was encountered at a depth of 25-feet during drilling. GW at 38-feet and Caved at 46-feet upon completion. 24-Hour Delayed Readings: GW at 7-feet.

**SURFACE ELEVATION:** N/A

**DESCRIPTION OF STRATUM**

- **FAT CLAY with SAND**, moist, dark brown, very stiff.
  - Same as above, very stiff. (CH)
- **FAT CLAY**, moist, brown, very stiff, slickensided.
  - Same as above. (CH)
- **FAT CLAY with SAND**, moist, brown, stiff.
  - **SANDY LEAN CLAY**, moist, brown, very stiff. (CL)
  - **FAT CLAY**, moist, brown, very stiff.
  - Same as above.
  - Same as above.
  - **FAT CLAY**, moist, brown, very stiff.
  - Same as above.
  - Same as above.
  - **FAT CLAY**, moist, brown, very stiff.
  - Boring was terminated at a depth of 50-feet.

**N - STANDARD PENETRATION TEST RESISTANCE**

**P - POCKET PENETROMETER RESISTANCE**

**UU - UNCONSOLIDATED-UND SHEAR STRENGTH**

**REMARKS:**

Boring depth was determined by RETL and boring location was determined by Munoz Engineering. Drilling operations were performed by EnviroCore Drilling, Inc., a subcontractor to RETL, at GPS Coordinates N 27.70472° W 97.34125°.
<table>
<thead>
<tr>
<th>SAMPLE NUMBER</th>
<th>PI</th>
<th>LL</th>
<th>PL</th>
<th>PI</th>
<th>MOISTURE CONTENT (%)</th>
<th>ATTERBERG LIMITS</th>
<th>DRY DENSITY (POUNDS/CU.FT)</th>
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<tbody>
<tr>
<td>SH S-1</td>
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<td>SH S-13</td>
<td></td>
<td>28</td>
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</tr>
</tbody>
</table>

**DESCRIPTION OF STRATUM**

- **SANDY FAT CLAY**, moist, dark brown and gray, very stiff. (CH)
  - Same as above.

- **FAT CLAY**, moist, brown, very stiff.
  - Same as above, stiff.

- **FAT CLAY**, moist, brown, very stiff. (CH)
  - Same as above, very stiff.

- **FAT CLAY**, moist, brown, very stiff.
  - Same as above, stiff, slickensided.

- **FAT CLAY**, moist, brown, very stiff.
  - Same as above, very stiff.

- **FAT CLAY**, moist, brown, very stiff.
  - Same as above.

- **FAT CLAY**, moist, brown, very stiff.
  - Same as above.

- **FAT CLAY**, moist, brown, very stiff.
  - Same as above, stiff.

Boring was terminated at a depth of 50-feet.

**GROUNDWATER INFORMATION:**

Groundwater (GW) was encountered at a depth of 25-feet during drilling. GW at 40-feet and Caved at 46-feet upon completion.
**LOG OF BORING B-6**

**FIELD DATA**

<table>
<thead>
<tr>
<th>Sample Number</th>
<th>Depth (ft)</th>
<th>Soil Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>SH S-1</td>
<td>25</td>
<td>FAT CLAY with SAND, moist, dark brown and gray, very stiff.</td>
</tr>
<tr>
<td>SH S-2</td>
<td>20</td>
<td>Same as above. (CH)</td>
</tr>
<tr>
<td>SH S-3</td>
<td>25</td>
<td>Same as above, stiff, slickensided.</td>
</tr>
<tr>
<td>SH S-4</td>
<td>25</td>
<td>Same as above, very stiff.</td>
</tr>
<tr>
<td>SH S-5</td>
<td>24</td>
<td>FAT CLAY, moist, brown, stiff.</td>
</tr>
<tr>
<td>SH S-6</td>
<td>35</td>
<td>SANDY LEAN CLAY, moist, brown, stiff.</td>
</tr>
<tr>
<td>SH S-7</td>
<td>40</td>
<td>Same as above, very stiff. (CH)</td>
</tr>
<tr>
<td>SH S-8</td>
<td>40</td>
<td>Same as above, stiff, slickensided.</td>
</tr>
<tr>
<td>SH S-9</td>
<td>40</td>
<td>Same as above, very stiff.</td>
</tr>
<tr>
<td>SH S-10</td>
<td>40</td>
<td>FAT CLAY with SAND, moist, brown, very stiff.</td>
</tr>
<tr>
<td>SH S-11</td>
<td>40</td>
<td>Same as above, very stiff.</td>
</tr>
<tr>
<td>SH S-12</td>
<td>40</td>
<td>Same as above, stiff, slickensided.</td>
</tr>
<tr>
<td>SH S-13</td>
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<td>Same as above, very stiff.</td>
</tr>
<tr>
<td></td>
<td>50</td>
<td>Boring was terminated at a depth of 50-feet.</td>
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**LABORATORY DATA**

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<th>Sample Number</th>
<th>Depth (ft)</th>
<th>Moisture Content (%)</th>
<th>LIQUID LIMIT</th>
<th>PLASTIC LIMIT</th>
<th>ATTERBERG LIMITS</th>
<th>PHASE LIMITS</th>
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<td>SH S-5</td>
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<td>SH S-7</td>
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<td>SH S-13</td>
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<td>24</td>
<td>105</td>
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<td>1.8</td>
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**GROUNDWATER INFORMATION:**
Groundwater (GW) was encountered at a depth of 23-feet during drilling. GW at 28-feet and Caved at 48-feet upon completion.

**SURFACE ELEVATION:** N/A

**DESCRIPTION OF STRATUM**

**REMARKS:**
Boring depth was determined by RETL and boring location was determined by Munoz Engineering. Drilling operations were performed by EnviroCore Drilling, Inc., a subcontractor to RETL, at GPS Coordinates N 27.70394° W 97.33966°.
### Key to Soil Classification and Symbols

#### Unified Soil Classification System

<table>
<thead>
<tr>
<th>Major Divisions</th>
<th>Symbol</th>
<th>Name</th>
<th>Terms Characterizing Soil Structure</th>
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</thead>
<tbody>
<tr>
<td>Coarse Grained Soils</td>
<td>GW</td>
<td>Well Graded Gravels or Gravel-Sand mixtures, little or no fines</td>
<td>SLICKEN SIDED - having inclined planes of weakness that are slick and glossy in appearance</td>
</tr>
<tr>
<td></td>
<td>GP</td>
<td>Poorly Graded Gravels or Gravel-Sand mixtures, little or no fines</td>
<td>FISSLURED - containing shrinkage cracks, frequently filled with fine sand or silt; usually more or less vertical</td>
</tr>
<tr>
<td></td>
<td>GM</td>
<td>Silty Gravels, Gravel-Sand-Silt mixtures</td>
<td>LAMINATED (VARVED) - composed of thin layers of varying color and texture, usually grading from sand or silt at the bottom to clay at the top</td>
</tr>
<tr>
<td></td>
<td>GC</td>
<td>Clayey Gravels, Gravel-Sand-Clay Mixtures</td>
<td>CRUMBLY - cohesive soils which break into small blocks or crumbs on drying</td>
</tr>
<tr>
<td></td>
<td>SW</td>
<td>Well Graded Sands or Gravelly Sands, little or no fines</td>
<td>CALCAREOUS - containing appreciable quantities of calcium carbonate, generally nodular</td>
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<tr>
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<td>SP</td>
<td>Poorly Graded Sands or Gravelly Sands, little or no fines</td>
<td>WELL GRADED - having wide range in grain sizes and substantial amounts of all intermediate particle sizes</td>
</tr>
<tr>
<td></td>
<td>SM</td>
<td>Silty Sands, Sand-Silt Mixtures</td>
<td>POORLY GRADED - predominantly of one grain size uniformly graded or having a range of sizes with some intermediate size missing (gap or skip graded)</td>
</tr>
<tr>
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<td>SC</td>
<td>Clayey Sands, Sand-Clay mixtures</td>
<td></td>
</tr>
<tr>
<td>Fine Grained Soils</td>
<td>ML</td>
<td>Inorganic Silts and very fine Sands, Rock Flour, Silty or Clayey fine Sands or Clayey Silts</td>
<td>SYMBOLS FOR TEST DATA</td>
</tr>
<tr>
<td></td>
<td>CL</td>
<td>Inorganic Clays of low to medium plasticity, Gravelly Clays, Sandy Clays, Silty Clays, Lean Clays</td>
<td>Groundwater Level (Initial Reading)</td>
</tr>
<tr>
<td></td>
<td>OL</td>
<td>Organic Silts and Organic Silt-Clays of low plasticity</td>
<td>Groundwater Level (Final Reading)</td>
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<tr>
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<td>MH</td>
<td>Inorganic Silts, Micaceous or Diatomaceous fine Sandy or Silty soils, Elastic Silts</td>
<td>Shelby Tube Sample</td>
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<td>CH</td>
<td>Inorganic Clays of high plasticity, Fat Clays</td>
<td>SPT Samples</td>
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<td>OH</td>
<td>Organic Clays of medium to high plasticity, Organic Silts</td>
<td>Auger Sample</td>
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<td>PT</td>
<td>Peat and other Highly Organic soils</td>
<td>Rock Core</td>
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</table>

#### Terms Describing Consistency of Soil

<table>
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<tr>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>Very Loose</td>
<td>0 - 4</td>
<td>Very Soft</td>
<td>&lt; 2</td>
<td>&lt; 0.25</td>
</tr>
<tr>
<td>Loose</td>
<td>4 - 10</td>
<td>Soft</td>
<td>2 - 4</td>
<td>0.25 - 0.50</td>
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<tr>
<td>Medium</td>
<td>10 - 30</td>
<td>Firm</td>
<td>4 - 8</td>
<td>0.50 - 1.00</td>
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<tr>
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<td>30 - 50</td>
<td>Stiff</td>
<td>8 - 15</td>
<td>1.00 - 2.00</td>
</tr>
<tr>
<td>Very Dense</td>
<td>over 50</td>
<td>Very Stiff</td>
<td>15 - 30</td>
<td>2.00 - 4.00</td>
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<tr>
<td></td>
<td></td>
<td>Hard</td>
<td>over 30</td>
<td>over 4.00</td>
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Field Classification for "Consistency" is determined with a 0.25" diameter penetrometer.