Geotechnical Engineering Report

AMBUC Baseball Complex
7240 Sallie Mood Drive
Savannah, Chatham County, Georgia

July 30, 2020
Terracon Project No. ES205128

Prepared for:

CHA Consulting Inc.
Savannah, Georgia

Prepared by:

Terracon Consultants, Inc.
Savannah, Georgia

July 30, 2020

CHA Consulting Inc.
200 East Julian Street, Suite 510
Savannah, Georgia 31401

Attn: Patrick Graham – Vice President
E: Pgraham@chacompanies.com

Re: Geotechnical Engineering Report
AMBUC Baseball Complex
7240 Sallie Mood Drive
Savannah, Chatham County, Georgia
Terracon Project No. ES205128

Dear Mr. Graham:

We have completed the Geotechnical Engineering services for the above referenced project. This study was performed in general accordance with Terracon Proposal No. PES205128 dated June 1, 2020. This report presents the findings of the subsurface exploration and provides geotechnical recommendations concerning earthwork and the design and construction of foundations and floor slabs for the proposed project.

We appreciate the opportunity to be of service to you on this project. If you have any questions concerning this report, please contact us at your earliest convenience.

Sincerely,
Terracon Consultants, Inc.

GEORGIA Registered No. 21378 PROFESSIONAL Engineer GUOMING LIN

Daniel Laitano, M.S., E.I.T.
Staff Geotechnical Engineer

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Senior Principal

REPORT TOPICS

Note: This report was originally delivered in a web-based format. **Orange Bold** text in the report indicates a referenced section heading. The PDF version also includes hyperlinks which direct the reader to that section, and clicking on the Terracon GeoReport logo will bring you back to this page. For more interactive features, please view your project online at client.terracon.com.

EXHIBITS

Note: Refer to each individual Attachment for a listing of contents.

REPORT SUMMARY

<table>
<tr><th>Topic [1]</th><th>Overview Statement [2]</th></tr>
<tr><td>Project Description</td><td>Construction of a new, one-story concession building, expansion of concrete walkways, and parking improvements. We understand the existing concession building will be demolished, and the southeastern baseball field will be converted into a miracle field.
■ Maximum column loads: 20 kips (provided)
■ Maximum building slab load: 100 psf (provided)
■ Maximum wall load: 2 klf (provided)
Expected traffic for pavement areas (values provided by CHA Consulting):
■ Autos/light trucks: 150 vehicles per day
■ Light delivery vehicles: 5 delivery vehicles per week
■ Trash collection trucks: 5 trucks per week
■ Semi-trucks: <1 truck per week
■ Design period: 20 years
NOTE: If the loading/grading/traffic information stated above differs from final design values, Terracon should be informed and retained for further analyses.</td></tr>
<tr><td>Geotechnical Characterization</td><td>■ Approximately 6 inches of topsoil.
■ Penetration refusal was encountered in CPT sounding at approximately 24 feet below existing grade surface (BGS).
■ In summary, the subsurface conditions are relatively consistent throughout the project area. Silty sands to sands with silt were encountered to approximately 24 feet BGS. Interbedded dense to very dense sandy layers were encountered at various depths to the termination of the CPT sounding.
■ Depth to groundwater was estimated at 3.5 to 5 feet BGS.</td></tr>
<tr><td>Earthwork</td><td>■ Removal of soils with organics (tree/grass roots) on the upper 12 inches in parking lots areas.
■ Install a site drainage system.
■ Strip/grub topsoil when encountered (note: rutting of subgrade can cause mixing of topsoil with underlying soils, which may require additional topsoil stripping)
■ Level, densify, proofroll subgrade during subgrade preparation. If any soft/weak areas are detected during proofroll testing, repair subgrade by undercut and backfill.
■ Site has mostly sandy soils within the upper 24 feet BGS, which are generally considered suitable for re-use as structural fill. NOTE: Terracon should be onsite during construction to test specific samples for structural fill suitability.</td></tr>
</table>

Topic [1]	Overview Statement [2]
Foundations	▪ **Shallow Foundations:** the building can be supported on a monolithic slab with thickened and turndown edges. The monolithic slab can be reinforced using post-tensioned tendons or conventional reinforcing **designed by the structural engineer.** ▪ In-situ soils in the **upper 24 feet** BGS are suitable for shallow foundation systems (such as slab-on-grade or spread footings) for the concession building after soil densification and proofrolling.
Pavements	With **subgrade prepared** as noted in **Earthwork** **Asphalt:** ▪ **2" ACC** over **6" graded aggregate base (GAB)** in **Light Duty** areas **Concrete:** ▪ **5" PCC** over **4"** of **GAB** in **Light Duty** areas **Please note,** if access, concentrated, and repetitive loading areas or increased tractor-trailer truck traffic are proposed for this site, the light-duty sections will not be sufficient for support, and Terracon should be retained for further evaluation.
General Comments	This section contains important information about the limitations of this geotechnical engineering report.

Geotechnical Engineering Report

AMBUC Baseball Complex
7240 Sallie Mood Drive
Savannah, Chatham County, Georgia

Terracon Project No. ES205128
July 30, 2020

INTRODUCTION

This report presents the results of our subsurface exploration and geotechnical engineering services performed for the proposed concession building and parking improvements to be located at 7240 Sallie Mood Drive in Savannah, Chatham County, Georgia. The purpose of these services is to provide information and geotechnical engineering recommendations relative to:

- Subsurface soil conditions
- Groundwater conditions
- Site preparation and earthwork
- Pavement design and construction
- Foundation design and construction
- Floor slab design and construction
- Seismic site classification per IBC

The geotechnical engineering scope of services for this project included the advancement of one CPT sounding a to depth of approximately 24 feet below existing site grade and four hand auger borings to depths of approximately 5 feet below existing site grades. Maps showing the site and boring locations are shown in **Exhibit A**.

SITE CONDITIONS

The following description of site conditions is derived from our site visit in association with the field exploration and our review of publicly available geologic and topographic maps.

Item	Description
Parcel Information	The project is located north of 7240 Sallie Mood Drive in Savannah, Chatham County, Georgia. Latitude: 32.1792°, Longitude -81.4625° See **Exhibit A-1**
Existing Improvements	4-field baseball complex with one concession/restroom building.

Item	Description
Current Ground Cover	Grassed and paved areas.
Existing Topography	Relatively level.

PROJECT DESCRIPTION

Our initial understanding of the project was provided in our proposal and was discussed in the project planning stage. A period of collaboration has transpired since the project was initiated, and our final understanding of the project conditions is as follows:

Item	Description
Information Provided	Conceptual site plan provided by CHA Consulting on April 29, 2020. We understand the existing concession building located at the center of the baseball complex will be replaced by a new single-story, slab-on-grade building immediately adjacent to the southeast side.
Proposed Structures	▪ A single-story concession building (+/- 1,600 S.F.) ▪ Re-orientation of north parking lot ▪ Expansion of south parking lot (30 additional parking spaces) ▪ Expansion of existing concrete walkways to 10 feet wide
Finished Floor Elevation	Not provided at this time but estimated to be close to the existing grade elevation.
Maximum Loads (provided)	The following loading information was included in our settlement analyses: ▪ Columns: **20** kips ▪ Walls: **2** kips per linear foot (klf) ▪ Slabs: **100** pounds per square foot (psf) **Please note:** should the above structural loading information differ from final design values, **Terracon should be notified** and retained for further analysis.
Pavements	We assume both **rigid (concrete)** and **flexible (asphalt)** pavement sections should be considered. Please confirm this assumption. Anticipated **(please confirm)** traffic is as follows: ▪ Autos/light trucks: **150** vehicles per day ▪ Light delivery vehicles: **5** light delivery vehicles per week ▪ Trash removal trucks: **5** per week ▪ Tractor-trailer trucks: **<1** per week ▪ Pavement design period: **20** years

GEOTECHNICAL CHARACTERIZATION

Subsurface Profile

We have developed a general characterization of the subsurface soil and groundwater conditions based upon our review of the data and our understanding of the geologic setting and planned construction. The following table provides our geotechnical characterization. The geotechnical characterization forms the basis of our geotechnical calculations and evaluation of site preparation, foundation options and pavement options. As noted in **General Comments**, the characterization is based upon widely spaced exploration points across the site, and variations are likely.

Soil Profile near proposed Concession Building Area (Based on CPT Sounding C1)

Stratum	Approximate Depth to Bottom of Stratum (feet)	Material Description	Consistency/ Relative Density
Surface [1]	0.5	Topsoil: silty sands with roots	Loose
1	4	Sand mixtures including silty and clayey sands to poorly graded sands	Loose to medium dense
2	17	Silty sands	Medium dense
3	24 (termination of CPT sounding – penetration refusal)	Silty sands to sands with silt	Dense to very dense

1. **Roots encountered 0 to 30 inches BGS** on hand auger borings HA1 and HA2.

Conditions encountered at each exploration location are indicated on the individual exploration logs shown in **Exhibit B-2** attached to this report. Stratification boundaries on the logs represent the approximate location of changes in native soil types; in situ, **the transition between materials may be gradual.**

Groundwater Conditions

The soundings and hand auger borings were observed while drilling and after completion for the presence and level of groundwater. **Groundwater was encountered in all hand auger boring locations at the time of our field exploration.** We used a Slope Indicator® water level meter upon the completion of the CPT sounding test to obtain the groundwater depths. The water levels observed in the soundings/borings can be found on the boring logs in **Exhibit B-2**, and are summarized in the following table:

CPT Sounding / Hand Auger Boring	Approximate Depth to Groundwater Below Ground Surface (feet)	Remark
C1	3.5	Recorded at completion of sounding
HA1	5.0	Recorded at completion of boring
HA2	4.6	Recorded at completion of boring
HA3	5.0	Recorded at completion of boring
HA4	5.0	Recorded at completion of boring

Groundwater level fluctuations occur due to seasonal variations in the amount of rainfall, runoff and other factors not evident at the time the borings were performed. Therefore, groundwater levels during construction or at other times in the life of the structure may be higher or lower than the levels indicated on the boring logs. **The possibility of shallow groundwater / groundwater level fluctuations should be considered** when developing the design and construction plans for the project.

Laboratory Testing

Laboratory testing procedures were performed on soil samples collected at proposed detention pond areas on the southern side of the project site. Bag samples were obtained at multiple depths ranging from 1.5 to 5 feet below existing grade surface and shipped to Terracon's laboratory for the following testing procedures:

- **Grain Size Analysis:** Standard Test Method for Particle-Size Analysis of Soils (ASTM D422)
- **Atterberg Limits:** Standard Test Methods for Liquid Limits, Plastic Limit, and Plasticity Index of Soils
- **Moisture Content:** Standard Test Methods for Laboratory Determination of Water Content of Soil and Rock by Mass (ASTM D2216)

Our laboratory testing results are represented in individual graphs and tables in detail in **Exhibits B-4** and **B-5.**

RECOMMENDATIONS FOR DESIGN AND CONSTRUCTION

The following evaluation and recommendations are based upon our understanding of the proposed construction and the results from our field exploration. **If the above-described project conditions are incorrect or changed after this report, or subsurface conditions encountered during construction are significantly different from those reported, Terracon should be notified** so we can re-evaluate our recommendations and make appropriate revisions.

Geotechnical Considerations

The subsurface conditions at this site are adaptable for the proposed construction. The generalized soil profile is presented in **Geotechnical Characterization** section.

In summary, the subsurface conditions are relatively consistent throughout the project area. Silty sands were encountered to approximately 24 feet BGS. On hand auger locations at proposed pavement areas, silty sands, and sand with silt were encountered in the upper 5 feet BGS. Interbedded sandy clays and clayey sands were encountered on proposed parking area improvements and baseball field at between 1.5 and 4.5 feet BGS.

Based on the findings from the field exploration and our settlement analyses using the structural loads and grading information mentioned in **Project Description**, the proposed structures can be supported on a shallow foundation system after the guidelines specified in the **Earthwork** section have been followed. Based on the findings from the field exploration and our knowledge of the local geological formation in the project area, **Terracon classifies the subject site as Site Class D** in accordance with the International Building Code (IBC) 2018, Section 1613.

This summary should be used in conjunction with the entire report for design purposes. It should be recognized that details were not included or fully developed in this section, and **the report must be read in its entirety** for a comprehensive understanding of the items and recommendations contained herein.

The **General Comments** section provides an understanding of the report limitations.

DEMOLITION OF EXISTING STRUCTURES

A one-story concession building, and pavement areas were present during our time of field exploration. We understand the old structure foundations and utilities should be completely removed from the pavement areas. Any voids from the removal should be repaired by backfilling with compacted fill. Inert materials such as the aggregate base and concrete and asphalt grindings may be stock-piled for reuse as engineered fill if desired. **The crushed material should be tested for gradation and impurity contents before its use.**

EARTHWORK

In general, soils in the **upper 23 feet are suitable** for reuse as fill material **after proper earthwork and onsite observation by Terracon**. There is a possibility of encountering sandy clays and clayey sands between 1.5 and 3.5 feet throughout the site. These soils should not be used as fill material. Furthermore, on hand auger borings HA1 and HA2, organics including grass roots were encountered to approximately 12 to 30 inches BGS, respectively. If encountered, soils including organics should be removed on building and pavement areas. A subgrade layer of a minimum depth of 2 feet composed of improved insitu soils (silty sands or sands with silt) or imported fill should be placed for support of the proposed concession building and parking lot expansion. **Underground utility lines were also observed** during the private utility scan.

Site preparation should include installation of a site drainage system, topsoil stripping and grubbing, subgrade preparation, densification, and proofrolling. Rutting of the subgrade can also cause mixing of topsoil/organics with underlying soils **which could result in additional required topsoil/organics stripping**. Deeper undercut may be needed in some localized areas to remove unsuitable materials.

Site Drainage

An effective drainage system should be installed prior to site preparation and grading activities to intercept surface water and to improve overall shallow drainage. The drainage system may consist of perimeter ditches supplemented with parallel ditches and swales. Pumping equipment should be prepared if the above ditch system cannot effectively drain water away from the site, especially during the rainy season. The site should be graded to shed water and avoid ponding over the subgrade.

Densification and Proofrolling

Prior to fill placement on the subgrade, the building, fueling canopies, and pavement areas should be densified with a heavy-duty static roller to achieve a uniform subgrade. The subgrade underneath the building, fueling canopies, and the pavement should be thoroughly proofrolled after the completion of densification. Proofrolling will help detect any isolated soft or loose areas that "pump", deflect or rut excessively, and densify the near-surface soils for floor slab support.

A loaded tandem axle dump truck, capable of transferring a load in excess of 20 tons, should be utilized for this operation. Proofrolling should be performed under the Geotechnical Engineer's observation. Areas where pumping, excessive deflection or rutting is observed after successive passes of the proofrolling equipment should be undercut, backfilled and then properly compacted. **It is anticipated that some amount of subgrade undercutting may be required** under the footings during subgrade preparation.

Fill Material Consideration

Structural fill should be placed over a stable or stabilized subgrade. The properties of the fill will affect the performance of the footings and the floor slabs. The soils to be used as structural fill should be free of organics, roots, or other deleterious materials. It should be a non-plastic granular material containing **less than 25 percent fines** passing the No. 200 sieve. Based on the findings from our hand auger borings and CPT soundings, the subject site consists of silty sands and sands with silt in the upper 24 feet BGS. Interbedded clayey soils were encountered in the upper 5 feet on baseball field and parking lot areas

The silty sands and sands with silt are generally considered suitable for structural fill, provided that the soils are free of roots, organics or other foreign materials. Clayey sands may be considered ***marginally suitable***; and the **sandy clays are deemed unsuitable** for structural fill. We define marginally suitable as the soils that may require extra effort to adjust moisture before they can be compacted. The amount of effort required will be highly dependent on the season and the weather conditions during construction. We recommend Terracon be retained during construction to determine the suitability of the onsite soil as fill material.

Areas to receive structural fill should be placed in thin (8 to 10 inches loose) lifts and compacted to a minimum of **95 percent** of the soil's **Modified** Proctor maximum dry density (ASTM D-1557). If import fill is required, the fill should be within 3 percent (wet or dry) of the optimum moisture content and should meet the properties as described above. Some manipulation of the moisture content (such as wetting, drying) will be required during the filling operation to obtain the required degree of compaction. The manipulation of the moisture content is highly dependent on weather conditions and site drainage conditions. Therefore, the contractor should prepare both dry and wet fill materials to obtain the specified compaction during grading. A sufficient number of density tests should be performed to confirm the required compaction of the fill material.

Earthwork Construction Considerations

Shallow excavations, for the proposed structure, are anticipated to be accomplished with conventional construction equipment. Upon completion of filling and grading, care should be taken to maintain the subgrade water content prior to construction of floor slabs. Construction traffic over the completed subgrades should be avoided. The site should also be graded to prevent ponding of surface water on the prepared subgrades or in excavations. Water collecting over, or adjacent to, construction areas should be removed.

If the subgrade becomes saturated or is disturbed, the affected material should be removed, or be scarified, moisture conditioned, and recompacted, prior to floor slab construction. **The groundwater table could affect some excavation efforts,** particularly over-excavation and replacement of lower strength soils. **A temporary dewatering system consisting of sumps with pumps could be necessary** to achieve the recommended depth of over-excavation.

As a minimum, excavations should be performed in accordance with OSHA 29 CFR, Part 1926, Subpart P, "Excavations" and its appendices, and in accordance with any applicable local, and/or state regulations. Construction site safety is the sole responsibility of the contractor who controls the means, methods, and sequencing of construction operations. Under no circumstances shall the information provided herein be interpreted to mean Terracon is assuming responsibility for construction site safety, or the contractor's activities; such responsibility shall neither be implied nor inferred.

FLOOR SLABS

Floor Slab Design Parameters

Item	Description
Floor slab support	Compacted structural fill / inspected and tested natural ground [1]
Modulus of subgrade reaction	120 pounds per square inch per in (psi/in) for point loading conditions
Base course/capillary break [2]	4 inches of free draining granular material
Vapor barrier	Project Specific [3]
Structural considerations	Floor slabs should be structurally separated from columns and walls to allow relative movements [4]

1. **As the existing ground may have been filled or previously disturbed**, we recommend the subgrade be inspected and tested with proofrolling after the topsoil is stripped as outlined in **Earthwork** section of this report.
2. The floor slab design should include a base course comprised of free-draining, compacted, granular material, at least 4 inches thick. The granular subbase may be graded aggregate base (GAB) or sands containing less than 5 percent fines (material passing the #200 sieve). GAB subbase can also help improve workability of the subgrade especially during rain periods.
3. The use of a vapor retarder should be considered beneath concrete slabs on grade that will be covered with wood, tile, carpet or other moisture sensitive or impervious coverings, or when the slab will support equipment sensitive to moisture. When conditions warrant the use of a vapor retarder, the slab designer should refer to ACI 302 and / or ACI 360 for procedures and cautions regarding the use and placement of a vapor retarder.
4. Floor slabs should be structurally independent of any footings or walls to reduce the possibility of floor slab cracking caused by differential movements between the slab and foundation. Where floor slabs are tied to perimeter walls or turn-down slabs to meet structural or other construction objectives, our experience indicates that any differential movement between the walls and slabs will likely be observed in adjacent slab expansion joints or floor slab cracks that occur beyond the length of the **structural dowels**. The structural engineer should account for this potential differential settlement through use of sufficient control joints, appropriate reinforcing or other means.

Floor Slab Construction Considerations

Prior to construction of grade supported slabs, varying levels of remediation may be required to reestablish stable subgrades within slab areas due to construction traffic, rainfall, disturbance, desiccation, etc. As a minimum, the following measures are recommended:

- The interior trench backfill placed beneath slabs should be compacted in accordance with recommendations outlined in **Earthwork** section of this report.
- All floor slab subgrade areas should be moisture conditioned and properly compacted to the recommendations in this report immediately prior to placement of the stone base and concrete.

PAVEMENTS

General Pavement Comments

We understand the proposed development will include the expansion of the existing parking lot area. This section presents thickness recommendations for asphalt concrete and Portland cement concrete pavements and general considerations for the pavement construction. Pavement thickness design is dependent upon:

- Traffic volumes, loads, traffic pattern, and desired service life of the pavement;
- Subgrade conditions including soil strength and drainage characteristics;
- Paving material characteristics;
- Climatic conditions of the region.

Based on our experience with similar projects, we understand the proposed asphalt and concrete pavement sections will experience the following traffic loading for the **pavement design of 20 years.**

- Autos/light trucks: **150** vehicles per day
- Delivery and fuel tanker vehicles: **5** delivery vehicles per week
- Trash collection trucks: **5** trash collection trucks per week
- Tractor-trailer trucks: **<1** trucks per day

If heavier /higher volume traffic loading is expected, we should be provided with the information and allowed to review these pavement sections. As typical for pavement, maintenance repairs are typically **required** after a period of 7 to 10 years to keep the pavement in acceptable condition.

The following tables provide options for AC ("asphalt") and PCC ("concrete") sections. In general, **concrete pavement performs better** in areas with heavier loads and frequent turning. Concrete pavements are also more commonly used for trailer truck parking.

Asphalt Pavement Design Recommendations

Material	Minimum Section Thickness (inches)
	Light Duty Section
	Cars / Light Trucks / Delivery and Trash Collection Vehicles
Asphalt Surface Course [1]	2
Asphalt Intermediate Course [1]	0
Aggregate Base Course [1]	6
Total Pavement Section	**8**
Structural fill [2] /improved subgrade [3]	24

1. Asphalt concrete and base course materials should conform to the following GDOT material specifications:
   - Section 815 for Graded Aggregate
   - Section 828 for Hot Mix Asphalt Concrete Mixture. Surface course may use 9.5 mm Superpave for smooth surface in the light-duty section or 12.5 mm Superpave for the heavy-duty section. 19 mm and/or 25 mm Superpave is recommended for the intermediate course.
2. The select fill should be sands with percent **fines less than 25%.** The fill material should be compacted to a minimum of **95%** of the soil's **Modified** Proctor maximum dry density (ASTM D-1557).
3. If SP or SP-SM or SM soils exist at the proposed subgrade elevation extending to a depth at least 24 inches below the proposed subgrade level, the in-situ soils can replace the select fill and the **subgrade should be improved using densification** as discussed in **Earthwork.**

Notes:

- Proper **surface and subgrade drainage system should be installed** to avoid saturation of subgrade soils underneath the asphalt pavements. The site drainage should be designed to maintain the groundwater **at least 2 feet below** the top of the subgrade.
- Some subgrade soil undercutting and backfilling with suitable structural fill **will be required** if unstable subgrade soils are encountered during subgrade preparation. **The use of geogrid** (Tensar BX1100 or equivalent) **may be necessary to help reduce the depth of undercut** to achieve stability if the unstable subgrade soils extend to greater depths. The need for geogrid and/or the need for undercutting and backfilling should be determined in the field during subgrade preparation.

For the pavement support, the subgrade conditions can often be the overriding factor in pavement performance. The subgrade conditions will depend on the in-situ soils at the subgrade level, characteristics of fill material for the subgrade, as well as site preparation procedures.

The silty sands should have good drainage characteristics and are deemed suitable for the pavement subgrade support. **If encountered, clayey sands/sandy clays should not be used for the subgrade support due to poor drainage.** If, during construction, clayey sands or sandy clays are encountered at the subgrade level, **the upper two (2) feet** of the subgrade should be replaced with sands with less than 25 percent fines. Based on the onsite in-situ soils and typical available imported fills, **a California Bearing Ratio (CBR) value of 8** has been estimated.

For the proposed site, a concrete section 5 inches thick is adequate for the light duty purpose such as auto parking and delivery/trash collection trucks. **Please note, if access, concentrated, and repetitive loading areas or increased tractor-trailer truck traffic are proposed for this site, the following light duty section will not be sufficient for support and Terracon should be retained for further evaluation**. We recommend the following light duty concrete pavement sections for the proposed site.

Concrete Pavement Design Recommendations

Material	Minimum Section Thickness (inches)
	Light Duty Section
	Cars / Light Trucks / Delivery and Trash Collection Vehicles
Concrete [1]	5
Graded aggregate base [2]	4
Structural fill [3] /improved subgrade [4]	24

1. The concrete should be **air entrained** and have a **minimum** compressive strength of **4,000** psi after 28 days of lab curing per ASTM C-31.
2. Graded aggregate base should conform to the GDOT material specification Section 815.
3. The select fill should be sands with percent fines **less than 25%.** The fill material should be compacted to a minimum of **95%** of the soil's **Modified** Proctor maximum dry density (ASTM D-1557).
4. If SP or SP-SM or SM soils exist at the proposed subgrade elevation extending to a depth at least 24 inches below the proposed subgrade level, the in-situ soils can replace the select fill and **the subgrade should be improved** using densification as discussed in Earthwork.

Notes:

- Concrete joints should be **properly sealed** to avoid ingress of surface water into the subgrade soils. Proper surface and **subgrade drainage system** should be installed to avoid saturation of subgrade soils underneath the concrete pavements. The site drainage should be designed to maintain the groundwater **at least 2 feet below** the **top of** the **subgrade**.
- Some subgrade soil **undercutting** and backfilling with suitable structural fill will be required if unstable subgrade soils are encountered during subgrade preparation. **The use of geogrid** (Tensar BX1100 or equivalent) **may be necessary to help reduce the depth of undercut** to achieve stability if the unstable subgrade soils extend to greater depths. The need for geogrid and/or the need for undercutting and backfilling should be determined in the field during subgrade preparation.

The above rigid and flexible pavement sections **represent the minimum design thicknesses** and, as such, periodic maintenance should be anticipated. Prior to the placement of the subbase (compacted structural fill), the pavement areas should be thoroughly proofrolled. **For dumpster pads (if proposed), the concrete pavement area should be large enough to support the container and the tipping axle of the refuse truck.**

Pavement Construction Considerations

Pavement subgrades prepared early in the project should be carefully evaluated as the time for pavement construction approaches. We recommend the pavement areas be rough graded and then thoroughly proofrolled with a loaded tandem-axle dump truck. Particular attention should be paid to high traffic areas that were rutted and disturbed and to the areas where backfilled trenches are located.

Areas where unsuitable conditions are located should be repaired by removing and replacing the materials with properly compacted fill. After proofrolling and repairing subgrade deficiencies, the entire subgrade should be scarified to a depth of 12 inches, and uniformly compacted to **at least 95%** of the materials' **Modified** Proctor maximum dry density.

Pavement and Subgrade Drainage

Poor subgrade drainage is the most common cause of pavement failure. Pavement should be sloped to provide rapid drainage of surface water. **Water should not be allowed to pond on or adjacent to the pavement which would saturate the subgrade soils** and weaken the subgrade support.

Based on our CPT sounding and hand auger logs, the groundwater depth was found to be approximately 3.5 to 5 feet below the existing grade surface. **We recommend the site drainage be designed to maintain the groundwater at least two (2) feet below the top of the subgrade.** Pavement subgrade drainage should be installed surrounding the areas anticipated for frequent wetting or having poor natural drainage, such as landscaped islands, along curbs and gutters and around drainage structures.

All landscaped areas in or adjacent to pavements should be sealed to reduce moisture migration to subgrade soils. **Subgrade drains should be installed with the pipe bottom at least two (2) feet below the top of the structural fill.** The civil engineer should decide the placement of the subgrade drains to avoid the saturation of pavement subgrade. **In order to avoid soil erosion, water from landscaping sprinkler heads should not be directed toward curb and gutter areas.**

Pavement Maintenance

The performance of pavements will require regular maintenance. **One key consideration of such maintenance is to minimize infiltration of water into the pavement base and subgrade.** Preventive maintenance should include crack and joint sealing and patching as well as overall surface sealing and overlay. **Additional engineering observation and evaluation is recommended prior to any major maintenance.**

SEISMIC CONSIDERATIONS

According to the International Building Code (IBC) 2018 and ASCE 7-16, structures should be designed and constructed to withstand the effects of earthquakes and avoid failure during a maximum considered earthquake. The maximum considered earthquake (MCE) is a seismic event that has a 50-year exposure period with a 2% probability of exceedance. The 2,500-year earthquake has a Moment Magnitude (Mw) of 7.3 and a Site Class Adjusted Peak Ground Acceleration (PGA_M) of **0.239g**, as determined by data provided by the IBC 2018 and ASCE 7-16 Standards.

Based on our findings from the field exploration and our knowledge of the local geological formation in the project area, the site can be classified as **Site Class D** in accordance with International Building Code (IBC) 2018 and ASCE 7-16. The seismic design parameters obtained based on IBC2018 and ASCE 7-16 are summarized in table below.

The design response spectrum curve, as presented in **Exhibit C-1**, was developed based on the S_{DS} and S_{D1} values according to IBC2018 and ASCE 7-16.

Summary of Seismic Design Parameters

Site Location (Latitude, Longitude)	Site Classification	S_s	S_1	F_a	F_v	S_{DS}	S_{D1}
32.9982°, -81.0895°	D	0.298g	0.110g	1.562	2.380	0.310g	0.175g

- In general accordance with the 2018 International Building Code and ASCE 7-16.
- The 2018 IBC and ASCE 7-16 require a site soil profile determination extending a depth of 100 feet for seismic site classification. The current scope does not include 100-foot soil profile determination. Explorations for this project extended to a maximum depth of 23.8 feet BGS and this seismic site class definition was provided in consideration of the overall soil conditions as well as the general geology of the area.

LIQUEFACTION

We performed a liquefaction potential analysis for the site to evaluate the stability of the soils. Ground shaking at the foundation of structures and liquefaction of the soil under the foundation are the principal seismic hazards identified for the design of earthquake-resistant structures. **Our estimates of liquefaction induced settlements** from the geometric mean maximum considered earthquake (MCE_G) **are less than 1 inch**.

However, actual liquefaction settlements at the site would be highly dependent on magnitude and distance from the source during the design earthquake event. In general, **the estimated liquefaction induced settlement is not considered significant,** and should not cause the structure to collapse. **If the owner is willing to accept the risk of a potential earthquake event,** the building can be supported on shallow foundations without special ground improvements. However, if the owner is **not willing** to accept this risk, **ground improvements such as aggregate columns** can be used with shallow foundations to help mitigate the risk of liquefaction settlement.

GENERAL COMMENTS

As the project progresses, we address assumptions by incorporating information provided by the design team, if any. Revised project information that reflects actual conditions important to our services is reflected in the final report. The design team should collaborate with Terracon to confirm these assumptions and to prepare the final design plans and specifications. This facilitates the incorporation of our opinions related to implementation of our geotechnical recommendations.

Any information conveyed prior to the final report is for informational purposes only and should not be considered or used for decision-making purposes.

Our analysis and opinions are based upon our understanding of the project, the geotechnical conditions in the area, and the data obtained from our site exploration. Natural variations will occur between exploration point locations or due to the modifying effects of construction or weather. The nature and extent of such variations may not become evident until during or after construction.

Terracon should be retained as the Geotechnical Engineer, where noted in the final report, to provide observation and testing services during pertinent construction phases. If variations appear, we can provide further evaluation and supplemental recommendations. If variations are noted in the absence of our observation and testing services on-site, we should be immediately notified so that we can provide evaluation and supplemental recommendations.

Our scope of services does not include either specifically or by implication any environmental or biological (e.g., mold, fungi, bacteria) assessment of the site or identification or prevention of pollutants, hazardous materials or conditions. If the owner is concerned about the potential for such contamination or pollution, other studies should be undertaken.

Our services and any correspondence or collaboration through this system are intended for the sole benefit and exclusive use of our client for specific application to the project discussed and are accomplished in accordance with generally accepted geotechnical engineering practices with no third party beneficiaries intended.

Any third party access to services or correspondence is solely for information purposes to support the services provided by Terracon to our client. Reliance upon the services and any work product is limited to our client, and is not intended for third parties. Any use or reliance of the provided information by third parties is done solely at their own risk. No warranties, either express or implied, are intended or made.

Site characteristics as provided are for design purposes and not to estimate excavation cost. Any use of our report in that regard is done at the sole risk of the excavating cost estimator as there may be variations on the site that are not apparent in the data that could significantly impact excavation cost.

Any parties charged with estimating excavation / earthwork costs should seek their own site characterization for specific purposes to obtain the specific level of detail necessary for costing. Site safety, and cost estimating including, excavation support, and dewatering requirements/design are the responsibility of others.

If changes in the nature, design, or location of the project are planned, our conclusions and recommendations shall not be considered valid unless we review the changes and either verify or modify our conclusions in writing.

EXHIBITS

EXHIBIT A

EXPLORATION PLAN AND PROCEDURES

- **Exhibit A-1** Site Location Plan
- **Exhibit A-2** Exploration Plan
- **Exhibit A-3** Exploration and Testing Procedures

EXHIBIT A-1 - SITE LOCATION PLAN

AMBUC Baseball Complex ■ Savannah, Georgia
July 30, 2020 ■ Terracon Project No. ES205128

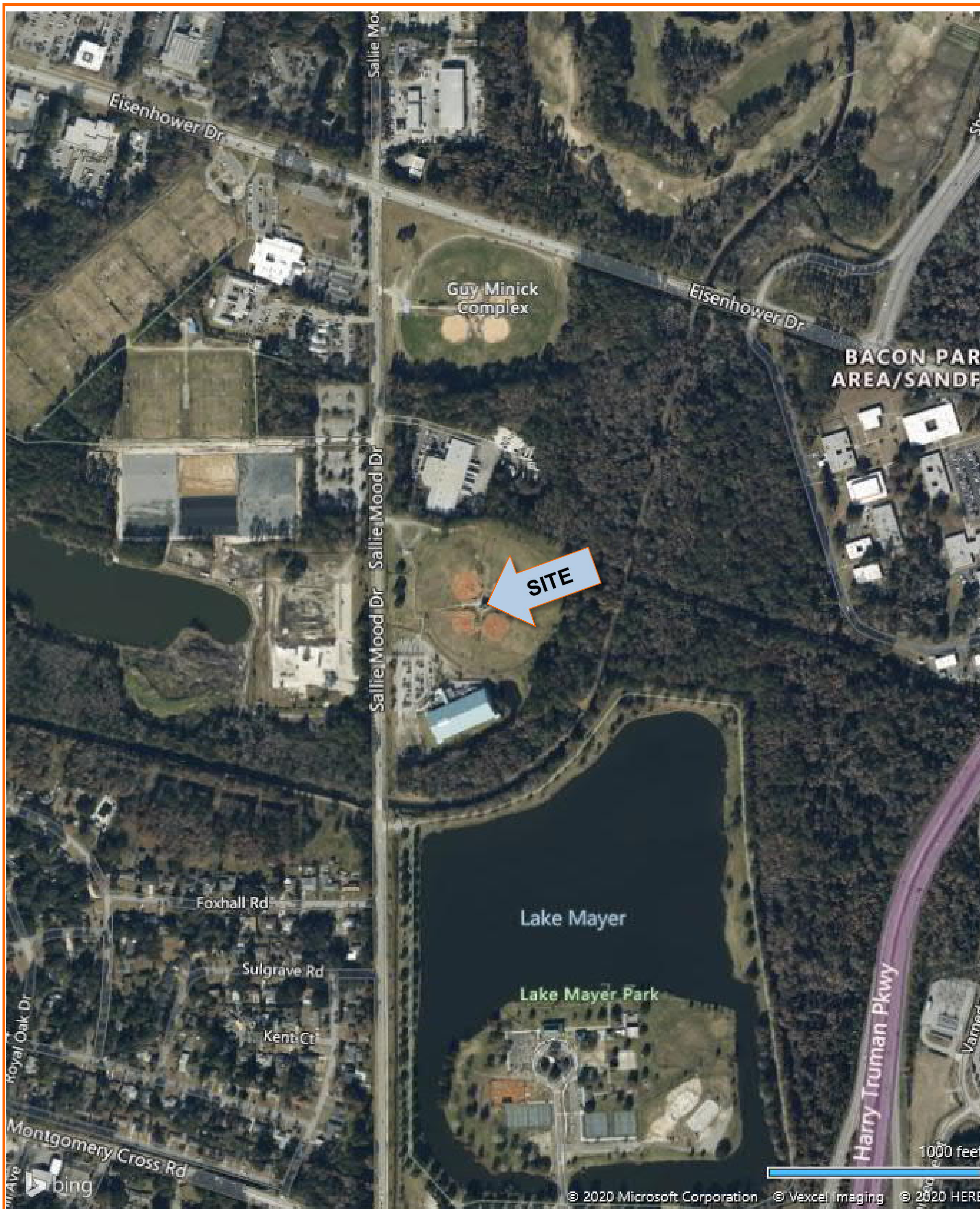


DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

MAP PROVIDED BY MICROSOFT BING MAPS

EXHIBIT A-2 - EXPLORATION PLAN

AMBUC Baseball Complex ■ Savannah, Georgia
July 30, 2020 ■ Terracon Project No. ES205128

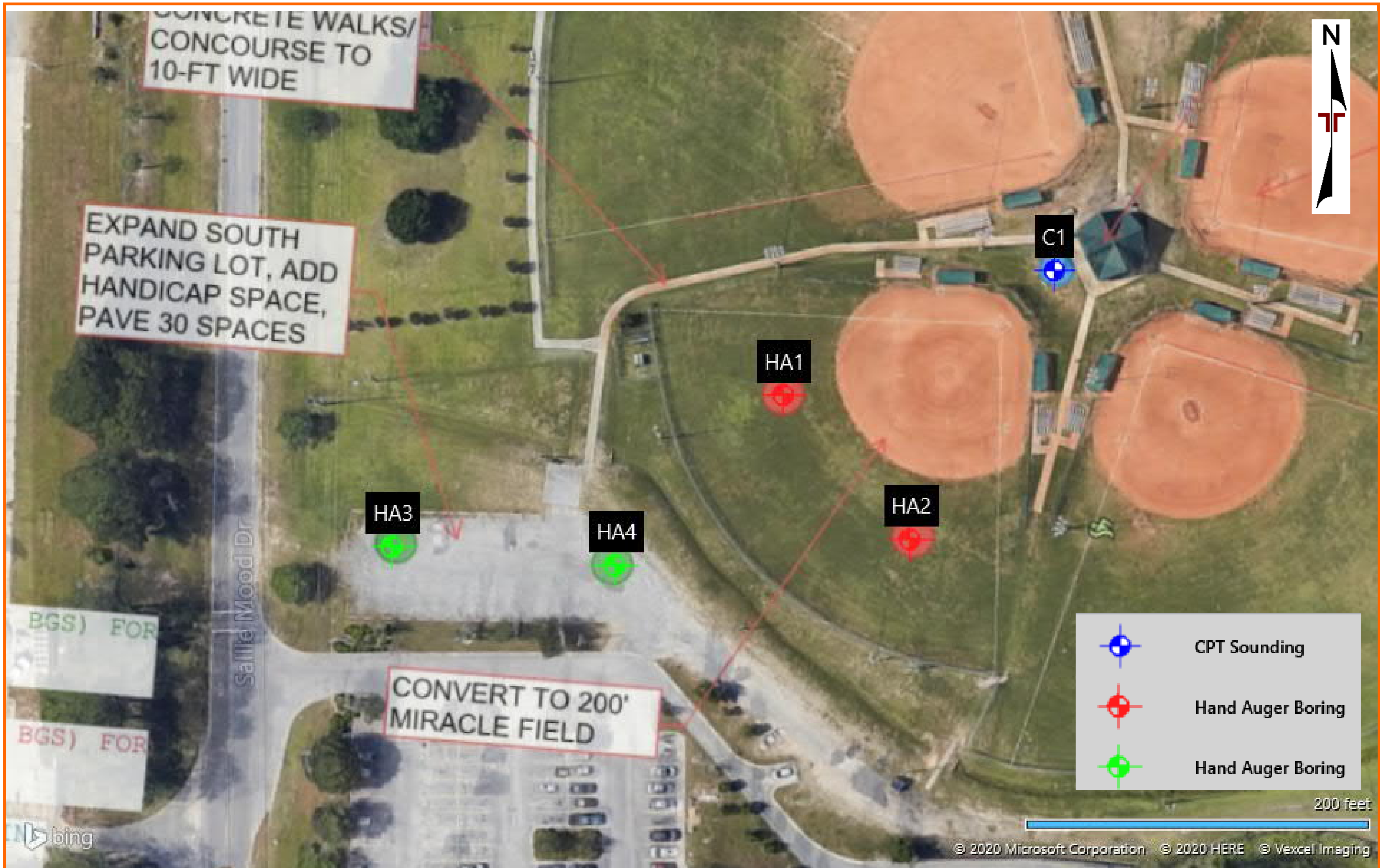


DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

MAP PROVIDED BY MICROSOFT BING MAPS

Field Exploration

No. of Test	Type of Test	Location	Maximum Depth (feet, below ground surface)
1	Cone Penetration Test (CPT) Sounding	Building area	23.8
4	Hand Auger Boring	Baseball field and parking areas	5

Boring Layout and Elevations: Unless otherwise noted, Terracon personnel provided the boring layout. Coordinates were obtained with a handheld GPS unit (estimated horizontal accuracy of about ±10 feet). The elevations on the borings were interpreted from the topographic survey plan provided the client and should be considered approximate.

Subsurface Exploration Procedures:

CPT soundings were performed in accordance with ASTM D-5778. In the CPT soundings, an electronically instrumented cone penetrometer is hydraulically pushed through the soil to measure tip stress, sleeve friction and pore water pressure. The CPT data can be used to determine soil stratigraphy and to estimate soil parameters such as undrained shear strength and modulus of compression.

Hand auger borings were conducted in general accordance with ASTM D 1452-80 to determine the subsurface conditions at shallow depths. In this test, the hand auger boring is drilled by rotating and advancing a bucket auger to the desired depths while periodically removing the auger from the hole to clear and examine the auger cuttings. The soils will be visually classified by a geotechnical engineer or geologist in accordance with ASTM D-2488.

The sampling depths, penetration distances, and other sampling information was recorded on the field boring logs. Our exploration team prepared field boring logs as part of the drilling operations. These field logs included visual classifications of the materials encountered during drilling and our interpretation of the subsurface conditions between samples. Final boring logs were prepared from the field logs. The final boring logs represent the Geotechnical Engineer's interpretation of the field logs and include modifications based on observations and tests of the samples.

Laboratory Testing

The project engineer reviewed the field data and assigned laboratory tests to understand the engineering properties of the various soil strata, as necessary, for this project. Procedural standards noted below are for reference to methodology in general. Standards noted below include reference to other, related standards. Such references are not necessarily applicable to describe the specific test performed.

- **ASTM D2216**: Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass
- **ASTM D4318:** Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils
- **ASTM D422:** Standard Test Method for Particle-Size Analysis of Soils

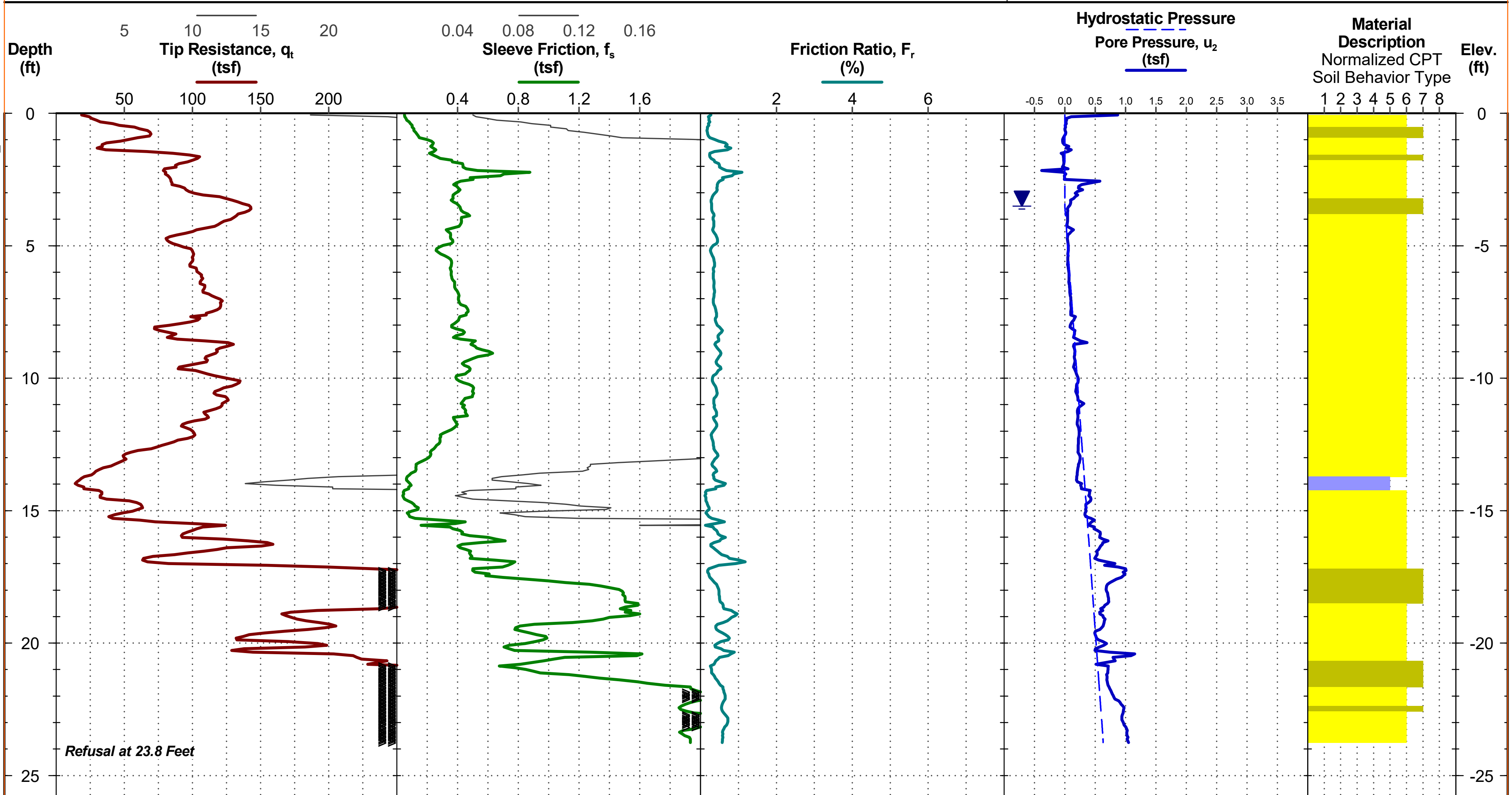
APPENDIX B

EXPLORATION AND TESTING RESULTS

- **Exhibit B-1** CPT Sounding Log
- **Exhibit B-2** Hand Auger Boring Logs
- **Exhibit B-3** Summary of Laboratory Results
- **Exhibit B-4** Grain Size Distribution
- **Exhibit B-5** Atterberg Limits

CPT LOG NO. C1

PROJECT: AMBUC Baseball Complex	**CLIENT:** CHA Consulting Inc Savannah, GA	**TEST LOCATION:** See Exploration Plan
SITE: Sallie Mood Drive Savannah, GA		LL: 31.9984°,-81.0891°



See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).
Elevations not obtained

CPT sensor calibration reports available upon request.

1. Sensitive, fine grained
2. Organic soils - clay
3. Clay - silty clay to clay
4. Silt mixtures - clayey silt to silty clay
5. Sand mixtures - silty sand to sandy silt
6. Sands - clean sand to silty sand
7. Gravelly sand to dense sand
8. Very stiff sand to clayey sand
9. Very stiff fine grained

WATER LEVEL OBSERVATION 3.5 ft measured water depth (used in normalizations and correlations; See Supporting Information)	Probe no. 5207 with net area ratio of .88 U2 pore pressure transducer location Manufactured by Geotech A.B.; calibrated 3/4/202 Tip and sleeve areas of 10 cm² and 150 cm² Ring friction reducer with O.D. of 1.875 in	Terracon 2201 Rowland Ave Savannah, GA	CPT Started: 6/24/2020 Rig: Geoprobe Project No.: ES205128	CPT Completed: 6/24/2020 Operator: RF

Hand Auger Boring Log

Terracon

Project Name: AMBUC Baseball Complex
Project No.: ES205128
Project Location: Savannah, Chatham County, Georgia

Test Date: 6/18/2020
Completed by: CRR

HA1			
Depth (in., BGS)	Material Description	Moisture	USCS Classification
0 to 12	Dark brown fine silty SAND with grass and roots	Moist	SM
12 to 18	Dark brown fine clayey SAND	Moist	SC
18 to 48	Dark brown sandy CLAY	Moist	CL
48 to 60	Light gray fine silty SAND	Moist	SM
Groundwater @ 60" BGS		No mottling	

HA2			
Depth (in., BGS)	Material Description	Moisture	USCS Classification
0 to 30	Dark brown fine silty SAND with grass and roots	Moist	SM
30 to 42	Brown fine clayey SAND	Moist	SC
42 to 55	Dark brown sandy CLAY	Moist	CL
55 to 60	Light gray fine SAND with silt	Wet	SP-SM
Groundwater @ 55" BGS		No mottling	

HA3			
Depth (in., BGS)	Material Description	Moisture	USCS Classification
0 to 6	Graded aggregate base at surface	Moist	--
6 to 36	Dark brown fine silty SAND	Moist	SM
36 to 58	Dark brown fine clayey SAND	Moist	SC
58 to 60	Brown fine silty SAND	Wet	SM
Groundwater @ 60" BGS		No mottling	

HA4			
Depth (in., BGS)	Material Description	Moisture	USCS Classification
0 to 3	Brown fine SAND	Moist	SP
3 to 36	Brown fine silty SAND	Moist	SM
36 to 42	Brown/orange sandy CLAY	Moist	CL
42 to 58	Light brown SAND with silt	Moist	SP-SM
58 to 60	Brown fine clayey SAND	Moist	SC
Groundwater @ 60" BGS		No mottling	

Note: BGS = Below Ground Surface

APPENDIX C

SUPPORTING DOCUMENTS

- **Exhibit C-1** Seismic Design Parameters
- **Exhibit C-2** Liquefaction Analysis
- **Exhibit C-3** CPT General Notes
- **Exhibit C-4** General Notes
- **Exhibit C-5** Unified Soil Classification System

Seismic Design Parameters Based on IBC2018 Code and ASCE 7-16 Standard

Terracon Project Name: AMBUC Baseball Complex

Terracon Project No: ES205128

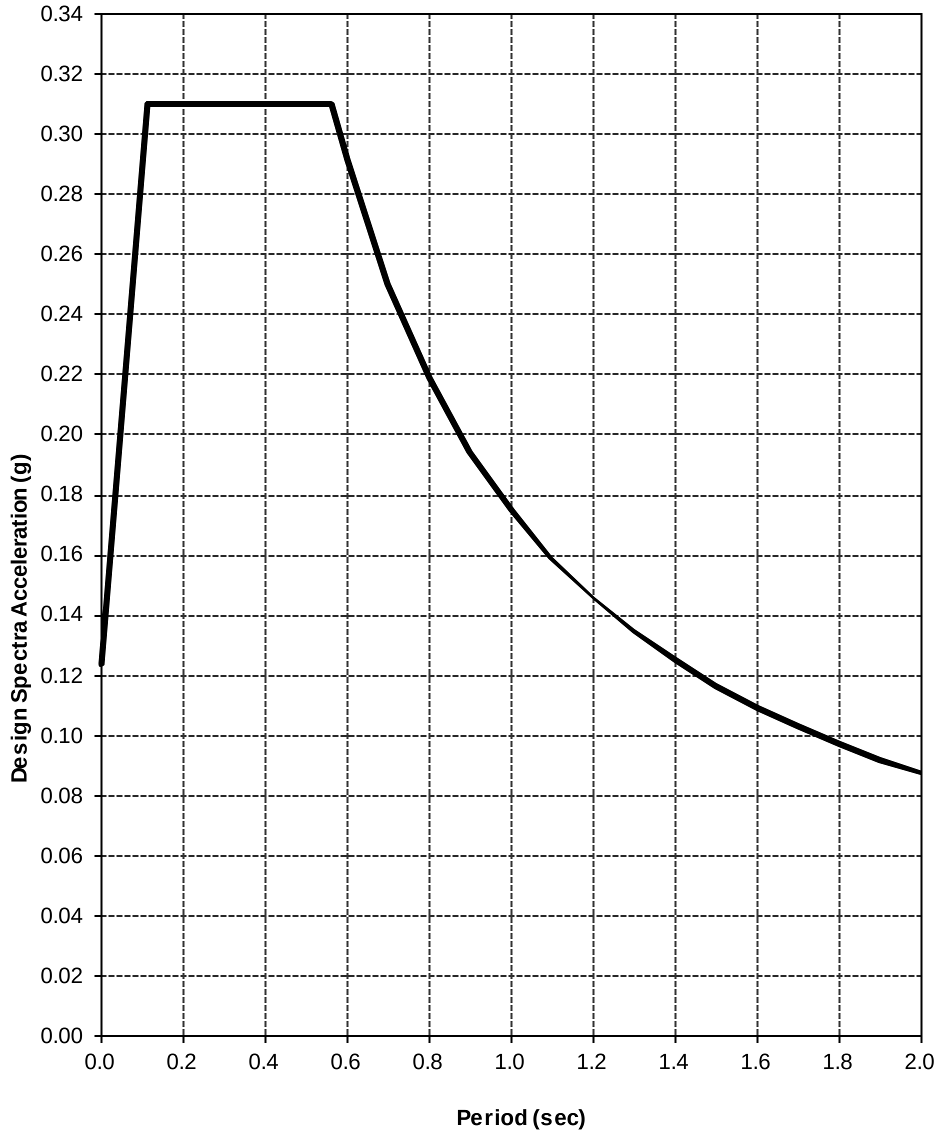
Site Location: Savannah, Georgia
Latitude : 31.9982°
Longitude -81.0895°

Site Class: **D**

Design Response Spectrum for the Site Class

S_s	0.298	S_1	0.110
F_a	1.562	F_v	2.380
S_{MS}	0.466	S_{M1}	0.262
S_{DS}	0.310	S_{D1}	0.175

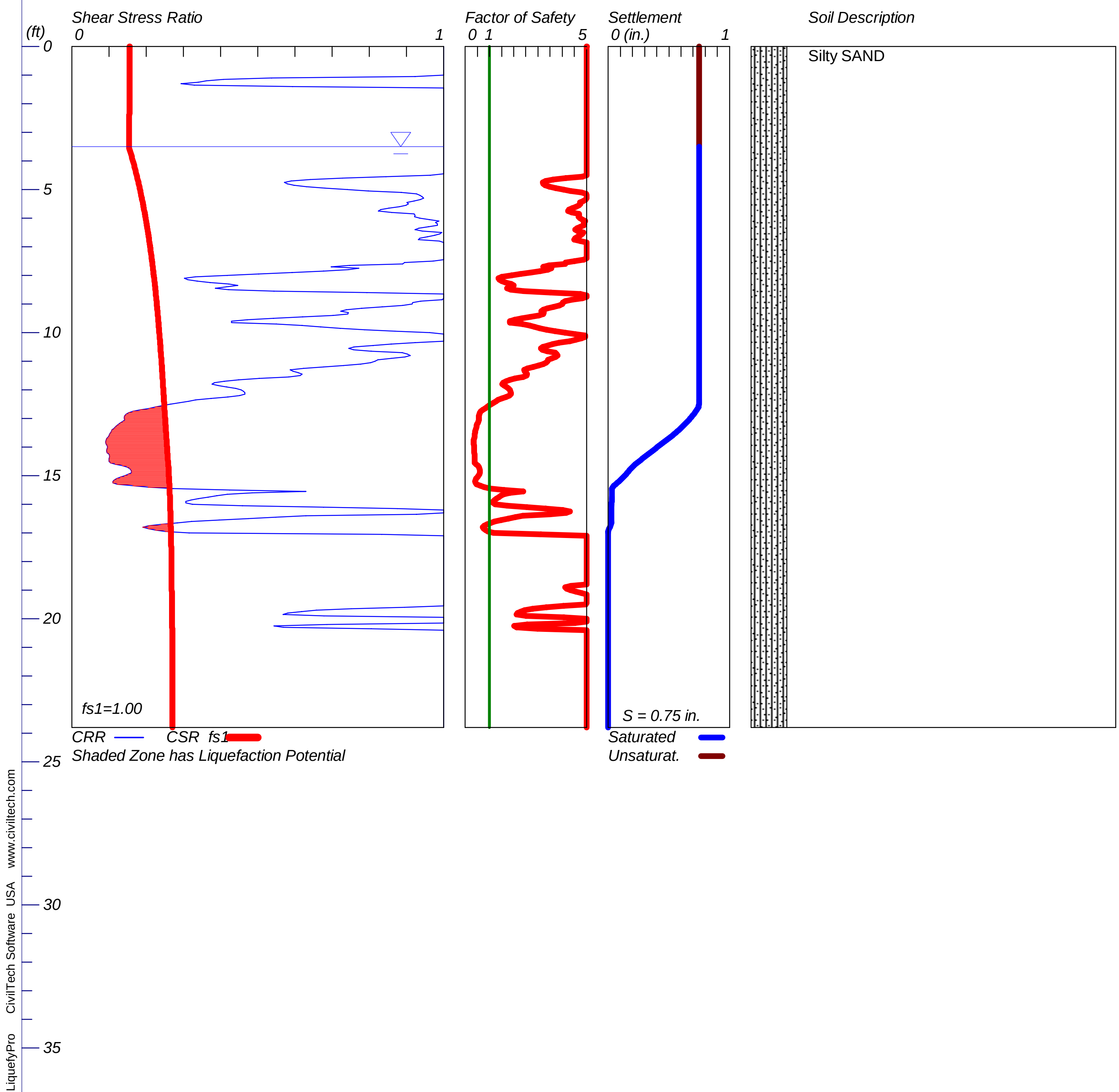
	Period (sec)	Sa (g)
	0.000	0.124
T_0	0.113	0.310
	0.200	0.310
T_S	0.565	0.310
T	0.600	0.292
	0.700	0.250
	0.800	0.219
	0.900	0.194
	1.000	0.175
	1.100	0.159
	1.200	0.146
	1.300	0.135
	1.400	0.125
	1.500	0.117
	1.600	0.109
	1.700	0.103
	1.800	0.097
	1.900	0.092
	2.000	0.088



LIQUEFACTION ANALYSIS

AMBUC Baseball Complex

Hole No.=C1 Water Depth=3.5 ft Surface Elev.=0 ***Magnitude=7.3 Acceleration=0.239g***



ES205128 **Exhibit C2**

CPT GENERAL NOTES

DESCRIPTION OF MEASUREMENTS AND CALIBRATIONS

To be reported per ASTM D5778:

Uncorrected Tip Resistance, q_c
Measured force acting on the cone divided by the cone's projected area

Corrected Tip Resistance, q_t
Cone resistance corrected for porewater and net area ratio effects
$q_t = q_c + U2(1 - a)$
Where a is the net area ratio, a lab calibration of the cone typically between 0.70 and 0.85

Pore Pressure, U1/U2
Pore pressure generated during penetration
U1 - sensor on the face of the cone
U2 - sensor on the shoulder (more common)

Sleeve Friction, fs
Frictional force acting on the sleeve divided by its surface area

Normalized Friction Ratio, FR
The ratio as a percentage of fs to q_t, accounting for overburden pressure

To be reported per ASTM D7400, if collected:

Shear Wave Velocity, Vs
Measured in a Seismic CPT and provides direct measure of soil stiffness

DESCRIPTION OF GEOTECHNICAL CORRELATIONS

Normalized Tip Resistance, Q_t
$Q_t = (q_t - \sigma_{v0})/\sigma'_{v0}$

Over Consolidation Ratio, OCR
OCR (1) $= 0.25(Q_t)^{1.25}$
OCR (2) $= 0.33(Q_t)$

Undrained Shear Strength, Su
$Su = Q_t \times \sigma'_{v0}/N_{kt}$
N_{kt} is a geographical factor (shown on Su plot)

Sensitivy, St
$St = (q_t - \sigma_{v0}/N_{kt}) \times (1/fs)$

Effective Friction Angle, ϕ'
ϕ' (1) $= \tan^{-1}(0.373[\log(q_t/\sigma'_{v0}) + 0.29])$
ϕ' (2) $= 17.6 + 11[\log(Q_t)]$

Unit Weight
$UW = (0.27[\log(FR)]+0.36[\log(q_t/atm)]+1.236) \times UW_{water}$
σ_{v0} is taken as the incremental sum of the unit weights

SPT N_{60}
$N_{60} = (q_t/atm) / 10^{(1.1268 - 0.2817Ic)}$

Soil Behavior Type Index, Ic
$Ic = [(3.47 - \log(Q_t))^2 + (\log(FR) + 1.22)^2]^{0.5}$

Small Strain Modulus, G_0
$G_0 = \rho Vs^2$

Elastic Modulus, Es (assumes $q/q_{ultimate}$ ~ 0.3, i.e. FS = 3)
Es (1) $= 2.6\Psi G_0$
where $\Psi = 0.56 - 0.33\log Q_{t,clean\ sand}$
Es (2) $= G_0$
Es (3) $= 0.015 \times 10^{(0.55Ic + 1.68)}(q_t - \sigma_{v0})$
Es (4) $= 2.5q_t$

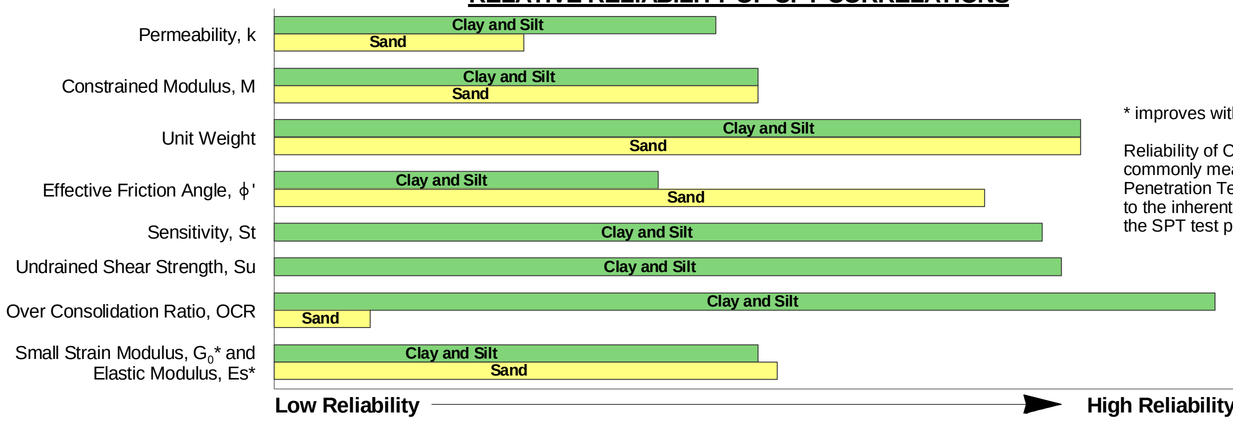
Constrained Modulus, M
$M = \alpha_M(q_t - \sigma_{v0})$
For Ic > 2.2 (fine-grained soils)
$\alpha_M = Q_t$ with maximum of 14
For Ic < 2.2 (coarse-grained soils)
$\alpha_M = 0.0188 \times 10^{(0.55Ic + 1.68)}$

Hydraulic Conductivity, k
For 1.0 < Ic < 3.27 $k = 10^{(0.952 - 3.04Ic)}$
For 3.27 < Ic < 4.0 $k = 10^{(-4.52 - 1.37Ic)}$

REPORTED PARAMETERS

CPT logs as provided, at a minimum, report the data as required by ASTM D5778 and ASTM D7400 (if applicable). This minimum data include tip resistance, sleeve resistance, and porewater pressure. Other correlated parameters may also be provided. These other correlated parameters are interpretations of the measured data based upon published and reliable references, but they do not necessarily represent the actual values that would be derived from direct testing to determine the various parameters. The following chart illustrates estimates of reliability associated with correlated parameters based upon the literature referenced below.

RELATIVE RELIABILITY OF CPT CORRELATIONS



* improves with seismic Vs measurements

Reliability of CPT-predicted N_{60} values as commonly measured by the Standard Penetration Test (SPT) is not provided due to the inherent inaccuracy associated with the SPT test procedure.

WATER LEVEL

The groundwater level at the CPT location is used to normalize the measurements for vertical overburden pressures and as a result influences the normalized soil behavior type classification and correlated soil parameters. The water level may either be "measured" or "estimated:"

Measured - Depth to water directly measured in the field

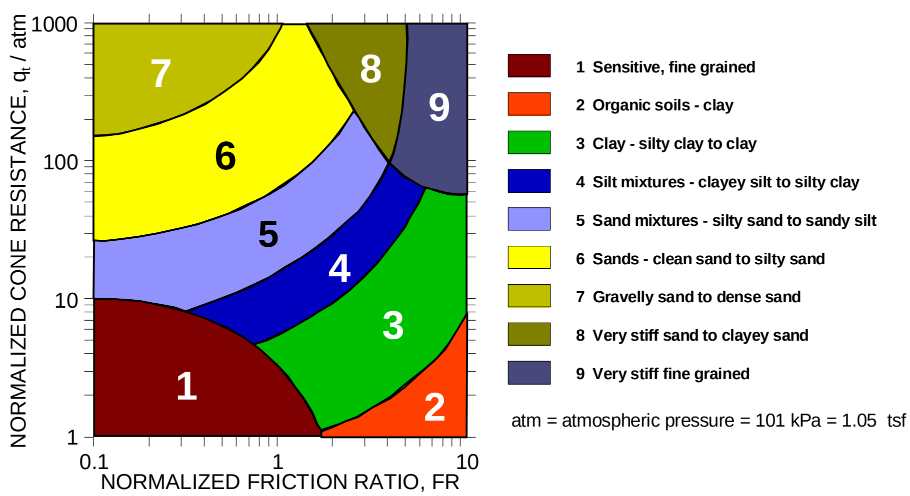
Estimated - Depth to water interpolated by the practitioner using pore pressure measurements in coarse grained soils and known site conditions

While groundwater levels displayed as "measured" more accurately represent site conditions at the time of testing than those "estimated," in either case the groundwater should be further defined prior to construction as groundwater level variations will occur over time.

CONE PENETRATION SOIL BEHAVIOR TYPE

The estimated stratigraphic profiles included in the CPT logs are based on relationships between corrected tip resistance (q_t), friction resistance (fs), and porewater pressure (U2). The normalized friction ratio (FR) is used to classify the soil behavior type.

Typically, silts and clays have high FR values and generate large excess penetration porewater pressures; sands have lower FRs and do not generate excess penetration porewater pressures. Negative pore pressure measurements are indicative of fissured fine-grained material. The adjacent graph (Robertson et al.) presents the soil behavior type correlation used for the logs. This normalized SBT chart, generally considered the most reliable, does not use pore pressure to determine SBT due to its lack of repeatability in onshore CPTs.



REFERENCES

Kulhawy, F.H., Mayne, P.W., (1997). "Manual on Estimating Soil Properties for Foundation Design," Electric Power Research Institute, Palo Alto, CA.
Mayne, P.W., (2013). "Geotechnical Site Exploration in the Year 2013," Georgia Institue of Technology, Atlanta, GA.
Robertson, P.K., Cabal, K.L. (2012). "Guide to Cone Penetration Testing for Geotechnical Engineering," Signal Hill, CA.
Schmertmann, J.H., (1970). "Static Cone to Compute Static Settlement over Sand," *Journal of the Soil Mechanics and Foundations Division*, 96(SM3), 1011-1043.

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Exhibit C-3

GENERAL NOTES

DESCRIPTION OF SYMBOLS AND ABBREVIATIONS

SAMPLING

- Auger
- Split Spoon
- Shelby Tube
- Macro Core
- No Recovery
- Rock Core
- Ring Sampler

GROUNDWATER

- Groundwater Initially Encountered
- Groundwater Level After a Specified Period of Time
- Static Groundwater Level After a Specified Period of Time
- No Groundwater Observed

Water levels indicated on the soil boring logs are the levels measured in the borehole at the times indicated. Groundwater level variations will occur over time. In low permeability soils, accurate determination of groundwater levels is not possible with short term water level observations.

FIELD TESTS

(HP)	Hand Penetrometer
(T)	Torvane
(b/f)	Standard Penetration Test (blows per foot)
(PID)	Photo-Ionization Detector
(OVA)	Organic Vapor Analyzer

DESCRIPTIVE SOIL CLASSIFICATION

Soil classification is based on the Unified Soil Classification System. Coarse Grained Soils have more than 50% of their dry weight retained on a #200 sieve; their principal descriptors are: boulders, cobbles, gravel or sand. Fine Grained Soils have less than 50% of their dry weight retained on a #200 sieve; they are principally described as clays if they are plastic, and silts if they are slightly plastic or non-plastic. Major constituents may be added as modifiers and minor constituents may be added according to the relative proportions based on grain size. In addition to gradation, coarse-grained soils are defined on the basis of their in-place relative density and fine-grained soils on the basis of their consistency.

LOCATION AND ELEVATION NOTES

Unless otherwise noted, Latitude and Longitude are approximately determined using a hand-held GPS device. The accuracy of such devices is variable. Surface elevation data annotated with +/- indicates that no actual topographical survey was conducted to confirm the surface elevation. Instead, the surface elevation was approximately determined from topographic maps of the area.

STRENGTH TERMS

RELATIVE DENSITY OF COARSE-GRAINED SOILS (More than 50% retained on No. 200 sieve.) Density determined by Standard Penetration Resistance Includes gravels, sands and silts.		CONSISTENCY OF FINE-GRAINED SOILS (50% or more passing the No. 200 sieve.) Consistency determined by laboratory shear strength testing, field visual-manual procedures or standard penetration resistance		
Descriptive Term (Density)	Std. Penetration Resistance (blows per foot)	Descriptive Term (Consistency)	Undrained Shear Strength (kips per square foot)	Std. Penetration Resistance (blows per foot)
Very Loose	0 - 3	Very Soft	less than 0.25	0 - 1
Loose	4 - 9	Soft	0.25 to 0.50	2 - 4
Medium Dense	10 - 29	Medium-Stiff	0.50 to 1.00	5 - 7
Dense	30 - 50	Stiff	1.00 to 2.00	8 - 14
Very Dense	> 50	Very Stiff	2.00 to 4.00	15 - 30
		Hard	above 4.00	> 30

RELATIVE PROPORTIONS OF SAND AND GRAVEL

Descriptive Term(s) of other constituents	Percent of Dry Weight
Trace	< 15
With	15 - 29
Modifier	> 30

GRAIN SIZE TERMINOLOGY

Descriptive Term(s) of other constituents	Percent of Dry Weight
Boulders	Over 12 in. (300 mm)
Cobbles	12 in. to 3 in. (300mm to 75mm)
Gravel	3 in. to #4 sieve (75mm to 4.75 mm)
Sand	#4 to #200 sieve (4.75mm to 0.075mm
Silt or Clay	Passing #200 sieve (0.075mm)

RELATIVE PROPORTIONS OF FINES

Descriptive Term(s) of other constituents	Percent of Dry Weight
Trace	< 5
With	5 - 12
Modifier	> 12

PLASTICITY DESCRIPTION

Term	Plasticity Index
Non-plastic	0
Low	1 - 10
Medium	11 - 30
High	> 30

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests [A]				Soil Classification	
				Group Symbol	Group Name [B]
Coarse-Grained Soils: More than 50% retained on No. 200 sieve	**Gravels:** More than 50% of coarse fraction retained on No. 4 sieve	**Clean Gravels:** Less than 5% fines [C]	$Cu \geq 4$ and $1 \leq Cc \leq 3$ [E]	GW	Well-graded gravel [F]
			$Cu < 4$ and/or [$Cc<1$ or $Cc>3.0$] [E]	GP	Poorly graded gravel [F]
		Gravels with Fines: More than 12% fines [C]	Fines classify as ML or MH	GM	Silty gravel [F, G, H]
			Fines classify as CL or CH	GC	Clayey gravel [F, G, H]
	Sands: 50% or more of coarse fraction passes No. 4 sieve	**Clean Sands:** Less than 5% fines [D]	$Cu \geq 6$ and $1 \leq Cc \leq 3$ [E]	SW	Well-graded sand [I]
			$Cu < 6$ and/or [$Cc<1$ or $Cc>3.0$] [E]	SP	Poorly graded sand [I]
		Sands with Fines: More than 12% fines [D]	Fines classify as ML or MH	SM	Silty sand [G, H, I]
			Fines classify as CL or CH	SC	Clayey sand [G, H, I]
Fine-Grained Soils: 50% or more passes the No. 200 sieve	**Silts and Clays:** Liquid limit less than 50	**Inorganic:**	PI > 7 and plots on or above “A”	CL	Lean clay [K, L, M]
			PI < 4 or plots below “A” line [J]	ML	Silt [K, L, M]
		Organic:	Liquid limit - oven dried / Liquid limit - not dried < 0.75	OL	Organic clay [K, L, M, N]
					Organic silt [K, L, M, O]
	Silts and Clays: Liquid limit 50 or more	**Inorganic:**	PI plots on or above “A” line	CH	Fat clay [K, L, M]
			PI plots below “A” line	MH	Elastic Silt [K, L, M]
		Organic:	Liquid limit - oven dried / Liquid limit - not dried < 0.75	OH	Organic clay [K, L, M, P]
					Organic silt [K, L, M, Q]
Highly organic soils:	Primarily organic matter, dark in color, and organic odor			PT	Peat

[A] Based on the material passing the 3-inch (75-mm) sieve.

[B] If field sample contained cobbles or boulders, or both, add “with cobbles or boulders, or both” to group name.

[C] Gravels with 5 to 12% fines require dual symbols: GW-GM well-graded gravel with silt, GW-GC well-graded gravel with clay, GP-GM poorly graded gravel with silt, GP-GC poorly graded gravel with clay.

[D] Sands with 5 to 12% fines require dual symbols: SW-SM well-graded sand with silt, SW-SC well-graded sand with clay, SP-SM poorly graded sand with silt, SP-SC poorly graded sand with clay.

[E] $Cu = D_{60}/D_{10}$ $\quad Cc = \frac{(D_{30})^2}{D_{10} \times D_{60}}$

[F] If soil contains ≥ 15% sand, add “with sand” to group name.

[G] If fines classify as CL-ML, use dual symbol GC-GM, or SC-SM.

[H] If fines are organic, add “with organic fines” to group name.

[I] If soil contains ≥ 15% gravel, add “with gravel” to group name.

[J] If Atterberg limits plot in shaded area, soil is a CL-ML, silty clay.

[K] If soil contains 15 to 29% plus No. 200, add “with sand” or “with gravel,” whichever is predominant.

[L] If soil contains ≥ 30% plus No. 200 predominantly sand, add “sandy” to group name.

[M] If soil contains ≥ 30% plus No. 200, predominantly gravel, add “gravelly” to group name.

[N] PI ≥ 4 and plots on or above “A” line.

[O] PI < 4 or plots below “A” line.

[P] PI plots on or above “A” line.

[Q] PI plots below “A” line.