Geotechnical Engineering Report

Subdivision Infrastructure Improvements
Celery Cove
Sanford, Seminole County, Florida
January 7, 2015
Terracon Project No. H1145213

Prepared for:
GoldChem, LLC
Winter Springs, Florida

Prepared by:
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Winter Park, Florida
January 7, 2014

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Attn: Mr. Nash Hooda
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Re: Geotechnical Engineering Report
Subdivision Infrastructure Improvements
Celery Cove
Sanford, Seminole County, Florida
Terracon Project Number: H1145213

Dear Mr. Hooda:

Terracon Consultants, Inc. (Terracon) has completed the geotechnical engineering services for the above-referenced project. This study was performed in general accordance with our proposal number PH1140645 dated August 21, 2014.

This report presents the findings of the subsurface exploration and provides geotechnical recommendations concerning earthwork, pavements, and stormwater management design parameters 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, or if we may be of further service, please contact us.

Sincerely,

Terracon Consultants, Inc.
Certificate of Authorization Number 8830

Eric J. Lavoie
Staff Engineer

Enclosures

Terracon Consultants, Inc. 1675 Lee Road Winter Park, Florida 32789

Environmental  Facilities  Geotechnical  Materials
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EXECUTIVE SUMMARY

Geotechnical exploration has been performed for the proposed Celery Cover infrastructure improvements planned to be constructed on the east side of Brisson adjacent to Tusca Place and south of Celery Avenue in Sanford, Seminole County, Florida. Five (5) borings, designated as PB-1, PB-2 and B-1 through B-3, have been performed to depths of between 10 and 20 feet below the existing ground surface in the proposed ponds and pavement areas.

Based on the information obtained from our geotechnical exploration, it appears that the site can be developed for the proposed project. The following geotechnical considerations were identified:

- The site appears to be nearly level. Therefore Terracon anticipates 2 feet or less of fine grading fill may be necessary.
- The in-place sands appear suitable for re-use as general engineered fill.
- It should be noted that the site is in an area which commonly used buried drain tiles and artesian wells for irrigation and drainage. Some remnants of the underground drainage systems may remain and should be removed and/or filled if detected.
- The provided plan information indicates two wet retention ponds.

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 contained herein. The section titled GENERAL COMMENTS should be read for an understanding of the report limitations.
1.0 INTRODUCTION

This geotechnical engineering report has been prepared for the proposed Celery Cove infrastructure improvements planned to be constructed on the east side of Brisson adjacent to Tusca Place and south of Celery Avenue, in Sanford, Seminole County, Florida as shown on the Topographic Vicinity Map included as Exhibit A-1 in Appendix A. Five (5) borings, designated as PB-1, PB-2 and B-1 through B-3, have been performed to depths of between 10 and 20 feet below the existing ground surface in the proposed ponds and pavement areas. Logs of the borings along with a Boring Location Diagram (Exhibit A-2) are included in Appendix A of this report. Laboratory testing procedures are included in Exhibit B-1 in Appendix B.

The purpose of these services is to provide information and geotechnical engineering recommendations relative to:

- subsurface soil conditions
- groundwater conditions
- earthwork
- pavement design and construction
- stormwater management design

2.0 PROJECT INFORMATION

2.1 Project Description

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Site Layout</td>
<td>See Exhibit A-3.</td>
</tr>
<tr>
<td>Structures</td>
<td>Single family homes.</td>
</tr>
<tr>
<td>Building Construction</td>
<td>Masonry with standard wood trusses.</td>
</tr>
<tr>
<td>Grading</td>
<td>Fill – fine grading, estimated at up to approximately 2 foot.</td>
</tr>
<tr>
<td>Design Traffic</td>
<td>Standard duty: 30,000 E_{18} SALs (given¹)</td>
</tr>
<tr>
<td></td>
<td>Heavy duty: 50,000 E_{18} SALs (given¹)</td>
</tr>
<tr>
<td>Stormwater Management</td>
<td>Two drainage areas have been identified one the northeast side of the site and one near the center of the site. We anticipate these facilities will be a wet retention/detention pond.</td>
</tr>
</tbody>
</table>

¹ Pavement design to be based on the indicated total number of 18-kip equivalent single axle load repetitions (E_{18}SALs) over a 20-year design life.
2.2 Site Location and Description

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Location</td>
<td>This project will be located east of Brisson adjacent to Tusca Place and south of Celery Avenue in Sanford, Florida.</td>
</tr>
<tr>
<td>Current Ground Cover</td>
<td>Open pasture, formerly vegetable crops. The farming operations in this area typically made use of underground drain tiles and artesian wells for irrigation and drainage. Some remnants of such systems may remain.</td>
</tr>
<tr>
<td>Existing Topography</td>
<td>The site currently appears nearly level. The USGS topographic quadrangle map “Osteen, Florida” depicts ground surface elevations ranging from +15 to +20 feet referencing the National Geodetic Vertical Datum of 1929 (NGVD29).</td>
</tr>
<tr>
<td>Surface Water</td>
<td>The USGS topographic quadrangle map “Osteen, Florida” depicts multiple wetland areas north of the site. The St. Johns River is located within 1 mile north of the site.</td>
</tr>
</tbody>
</table>

3.0 SUBSURFACE CONDITIONS

3.1 General Potential For Sinkhole Development

Sinkhole development occurs in Florida and varies geographically from areas with almost no potential or a very low potential to areas with a high potential where sinkholes occur frequently. The subject property is located in Area II on the United States Geological Survey map entitled “Sinkhole Type, Development, and Distribution in Florida”. The cover (over limestone bedrock) in Area II is between 30 to 200 feet thick and is predominantly sandy. Sinkholes are few, shallow, and of small diameter and develop gradually in Area II. The risk of sinkhole occurrence at most sites is small even in areas known to have a higher than average risk of sinkhole occurrence.

A review of the Florida Geologic Survey’s sinkhole database (updated March 4, 2014) reveals one reported sinkhole within one mile of the subject site. It should be noted that the number of sinkholes is based on information reported to the FGS and does not necessarily reflect the number of sinkholes confirmed by public or private industry.

During our limited evaluation, we did not encounter traditional signs associated with potential sinkhole development including loss of drilling fluids, obvious raveled zones, surface depressions, etc. However, this evaluation was not planned to specifically address sinkhole potential. The risk of sinkhole occurrence at most sites is small even in areas known to have a higher than average risk of sinkhole occurrence. Furthermore, this site is in an area of artesian flow from the Florida Aquifer and therefore, not geologically prone for sinkhole development.
If the sinkhole potential of the site is to be specifically evaluated, additional site-specific data must be obtained. This might include using geophysical methods such as Electrical Resistivity tests and additional geotechnical tests such as Cone Penetrometer Test (CPT) soundings, dilatometer (DMT) soundings, and/or more/deeper Standard Penetration Test borings. Interpretation of the test data should be done by a Professional Geologist/Engineer familiar with the use of these tests under local conditions. However, it should be noted that even if indicators of sinkhole activity are found, it is impossible to predict if, when or precisely where a sinkhole may occur. If requested, Terracon can assist in assessing the sinkhole potential of the location of the proposed construction.

3.2 Soil Survey

The Soil Survey of Seminole County Area, Florida as prepared by the United States Department of Agriculture (USDA), Soil Conservation Service (SCS; later renamed the Natural Resource Conservation Service - NRCS), dated April 1979, identifies the soil type at the subject site as Pineda fine sand. It should be noted that the Soil Survey is not intended as a substitute for site-specific geotechnical exploration; rather it is a useful tool in planning a project scope in that it provides information on soil types likely to be encountered. Boundaries between adjacent soil types on the Soil Survey maps are approximate (included in Appendix A as Exhibit A-2). Descriptions of the mapped soil units are included in Appendix A as Exhibit A-3.

3.3 Typical Profile

Based on the results of the borings, subsurface conditions on the project site can be generalized as follows:

<table>
<thead>
<tr>
<th>Stratum</th>
<th>Approximate Depth to Bottom of Stratum (feet)</th>
<th>Material Description</th>
<th>Consistency/Density</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.0 to 4.0</td>
<td>Fine sand (SP)</td>
<td>Loose to medium dense</td>
</tr>
<tr>
<td>2</td>
<td>4.0 to boring termination</td>
<td>Fine sand with silt to silty fine sand (SP)(SP-SM)</td>
<td>Loose to medium dense</td>
</tr>
</tbody>
</table>

1. Boring PB-1 encountered silty fine sand from 2 feet below grade to boring termination depth.

Conditions encountered at each boring location and results of laboratory testing are indicated on the individual boring logs. Stratification boundaries on the boring logs represent the approximate location of changes in soil types; in-situ, the transition between materials may be gradual. Details for each of the borings can be found on the boring logs in Appendix A of this report. Descriptions of our field exploration are included as Exhibit A-5 in Appendix A. Descriptions of our laboratory testing procedures are included as Exhibit B-1 in Appendix B.
General notes for SPT borings can be found in Exhibit C-1. A more detailed description of the Unified Soil Classification System (USCS) is included as Exhibit C-2 in Appendix C.

3.4 Groundwater

The boreholes were observed during drilling for the presence and level of groundwater. Groundwater was observed in all of the borings, between depths of 1 to 2 feet below existing grade. Longer term monitoring in cased holes or piezometers, possibly installed to greater depths than explored under this project scope, would be required to better define groundwater conditions at the site.

It should be recognized that fluctuations of the groundwater table will occur due to seasonal variations in the amount of rainfall, runoff and other factors not evident at the time the boring was performed. In addition, perched water can develop within higher permeability soils overlying less permeable soils. Therefore, groundwater levels during construction or at other times in the future may be higher or lower than the levels indicated on the boring logs.

We estimate that during the normal wet season (typically June through October) with rainfall and recharge at a maximum, groundwater levels will be about 0.0 to 1.0 feet below the existing grade. Our estimates of the seasonal groundwater conditions are based on the USDA Soil Survey, available survey data, the encountered soil types, recent weather conditions, and the encountered water levels. The estimated normal seasonal high groundwater tables are included in the following table:

<table>
<thead>
<tr>
<th>Boring No.</th>
<th>Approximate Depth to Encountered Water Table (feet)</th>
<th>Approximate Depth to Estimated Normal Seasonal High Groundwater Table (feet)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PB-1</td>
<td>1.0</td>
<td>0.0</td>
</tr>
<tr>
<td>PB-2</td>
<td>2.0</td>
<td>1.0</td>
</tr>
<tr>
<td>B-1</td>
<td>2.0</td>
<td>1.0</td>
</tr>
<tr>
<td>B-2</td>
<td>2.0</td>
<td>1.0</td>
</tr>
<tr>
<td>B-3</td>
<td>2.0</td>
<td>1.0</td>
</tr>
</tbody>
</table>

These seasonal water table estimates do not represent the temporary rise in water table that occurs immediately following a storm event, including adjacent to other stormwater management facilities. This is different from static groundwater levels in wet ponds and/or drainage canals which can affect the design water levels of new, nearby ponds. The seasonal high water table may vary from normal when affected by extreme weather changes, localized or regional flooding, karst activity, future grading, drainage improvements, or other construction that may occur on or around the site following the date of this report.
4.0 RECOMMENDATIONS FOR DESIGN AND CONSTRUCTION

4.1 Geotechnical Considerations

Borings encountered native sand to sand with silt to silty sand. These materials are generally suitable for construction of the proposed foundations, floor slabs, pavements, and stormwater systems following the recommended Earthwork portions of this report.

Seasonal high groundwater levels should be considered in the civil engineering design for site grading, utility construction, and pavements.

It should be noted that the site is in an area which commonly used buried drain tiles and artesian wells for irrigation and drainage. Some remnants of the underground drainage systems may remain and should be removed and/or filled if detected.

We recommend that the exposed subgrade be thoroughly evaluated after stripping of any topsoil and creation of all cut areas, but prior to the start of structural fill operations (if any). We recommend that Terracon be retained to evaluate the satisfactory preparation of the bearing material for the pavement. Subsurface conditions, as identified by the field and laboratory testing programs, have been reviewed and evaluated with respect site layout plan to the known to us at this time.

Design and construction recommendations for earth connected phases of the project are outlined below.

4.2 Earthwork

4.2.1 Site Preparation
Prior to placing any fill, all vegetation, topsoil, possible fill material and any otherwise unsuitable material should be removed from the construction areas. Wet or dry material should either be removed or moisture conditioned and re-compacted. After stripping and grubbing and achieving cut grades, the exposed surface should be proof-rolled where possible to aid in locating loose or soft areas. Proof-rolling can be performed with appropriate heavy equipment to obtain a minimum compaction as defined in Section 4.2.3. Unstable soil (pumping) should be removed or moisture conditioned and compacted in place prior to placing fill.

Existing agricultural sub drainage systems should be removed when detected or grouted/filled to eliminate void spaces in the subsurface. Artesian wells, if detected, should be properly abandoned by a licensed Water Well Contractor.
Where fill is placed on existing slopes, we recommend that fill slopes be over-filled and then cut back to develop an adequately compacted slope face. Slopes should be provided with appropriate erosion protection.

### 4.2.2 Material Requirements

Compacted structural fill should meet the following material property requirements:

<table>
<thead>
<tr>
<th>Fill Type</th>
<th>USCS Classification</th>
<th>Acceptable Location for Placement</th>
<th>Maximum Lift Thickness (in.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>General</td>
<td>SP (fines content &lt; 5%)</td>
<td>All locations and elevations</td>
<td>12(^3)</td>
</tr>
<tr>
<td></td>
<td>SP-SM (fines content between 5 and 12(^%))(^1)</td>
<td>All locations and elevations, except strict moisture control will be required during placement, particularly during the rainy season.</td>
<td>8 to 12(^3)</td>
</tr>
<tr>
<td>Limited</td>
<td>SM (fines content &gt;12%)</td>
<td>Limited to mass fill greater than 2 feet below final grade; strict moisture control will be required during placement.</td>
<td>6 to 8(^4)</td>
</tr>
</tbody>
</table>

1. Controlled, compacted fill should consist of approved materials that are free of organic matter and debris.
2. If fines contents are greater than 12 percent, special design and construction procedures may be necessary.
3. Loose thickness when heavy compaction equipment is used in vibratory mode. Lift thickness should be decreased if static compaction is being used, typically to no more than 8 inches, and the required compaction must still be achieved. Use 4 to 6 inches in loose thickness when hand-guided equipment (i.e. jumping jack or plate compactor) is required.
4. Static equipment should be used.

### 4.2.3 Compaction Requirements-Mass Fill Areas

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum Compaction Requirements(^1)</td>
<td>95 percent of the material’s maximum modified Proctor dry density (ASTM D 1557).</td>
</tr>
<tr>
<td>Moisture Content(^2)</td>
<td>Within ±2 percent of optimum moisture content as determined by the Modified Proctor test, at the time of placement and compaction.</td>
</tr>
<tr>
<td>Minimum Testing Frequency</td>
<td>One field density test per 20,000 square feet or fraction thereof per 1-foot lift.</td>
</tr>
</tbody>
</table>

1. We recommend that engineered fill be tested for moisture content and compaction during placement. Should the results of the in-place density tests indicate the specified moisture or compaction limits have not been met, the area represented by the test should be reworked and retested as required until the specified moisture and compaction requirements are achieved.
2. Specifically, moisture levels should be maintained low enough to allow for satisfactory compaction to be achieved without the cohesionless fill material pumping when proof-rolled.
4.2.4 Utility Trench Backfill
All trench excavations should be made with sufficient working space to permit construction including backfill placement and compaction. Utility trenches are a common source of water infiltration and migration. All utility trenches that penetrate beneath the building should be backfilled with native soils to avoid creating a preferred flow path through the trenches.

4.2.5 Grading and Drainage
Site grades should be set considering the estimated seasonal high groundwater presented in Section 3.4.

4.2.6 Earthwork Construction Considerations
After initial proof-rolling and compaction, unstable subgrade conditions could develop during general construction operations, particularly if the soils are wetted and/or subjected to repetitive construction traffic. Upon completion of filling and grading, care should be taken to maintain the subgrade moisture content prior to construction of pavements. Construction traffic over the completed subgrade should be avoided to the extent practical. The site should also be graded to prevent ponding of surface water on the prepared subgrades or in excavations. If the subgrade should become desiccated, saturated, or disturbed, the affected material should be removed or these materials should be scarified, moisture conditioned, and re-compacted prior to floor slab and pavement construction.

As a minimum, all temporary excavations should be sloped or braced as required by Occupational Health and Safety Administration (OSHA) regulations to provide stability and safe working conditions. Temporary excavations will probably be required during grading operations. The grading contractor, by his contract, is usually responsible for designing and constructing stable, temporary excavations and should shore, slope or bench the sides of the excavations as required, to maintain stability of both the excavation sides and bottom. All excavations should comply with applicable local, state and federal safety regulations, including the current OSHA Excavation and Trench Safety Standards.

Terracon should be retained during the construction phase of the project to observe earthwork and to perform necessary tests and observations during subgrade preparation; proof-rolling; placement and compaction of controlled compacted fills; backfilling of excavations into the completed subgrade.
4.3 Pavements

4.3.1 Subgrade Preparation

Site grading is typically accomplished relatively early in the construction phase. Fills are placed and compacted in a uniform manner. However, as construction proceeds, excavations are made into these areas, rainfall and surface water saturates some areas, heavy traffic from concrete trucks and other delivery vehicles disturbs the subgrade and many surface irregularities are filled in with loose soils to temporarily improve ride comfort. As a result, the pavement subgrades, initially prepared early in the project, should be carefully evaluated as the time for pavement construction approaches.

We recommend the moisture content and density of the top 12 inches of the subgrade be evaluated and the pavement subgrades be proof-rolled and tested within two days prior to commencement of actual paving operations. Compaction tests should be performed at a frequency of 1 test per 10,000 square feet or fraction thereof. Areas not in compliance with the required ranges of moisture or density should be moisture conditioned and re-compacted. Particular attention should be paid to high traffic areas that were rutted and disturbed earlier and to areas where backfilled trenches are located. Areas where unsuitable conditions are found should be repaired by removing and replacing the materials with properly compacted fills.

After proof-rolling and repairing deep subgrade deficiencies, the entire subgrade should be scarified and prepared as recommended in Section 4.2 of the Earthwork section this report to provide a uniform subgrade for pavement construction. Areas that appear severely desiccated following site stripping may require further undercutting and moisture conditioning. If a significant precipitation event occurs after the evaluation or if the surface becomes disturbed, the subgrade should be reviewed by qualified personnel immediately prior to paving. The subgrade should be in its finished form at the time of the final review.

4.3.2 Design Considerations

Traffic patterns and anticipated loading conditions were not available at the time that this report was prepared. However, we anticipate that traffic loads will be produced primarily by automobile traffic and occasional delivery and trash removal trucks. The thickness of pavements subjected to heavy truck traffic should be determined using expected traffic volumes, vehicle types, and vehicle loads and should be in accordance with local, city or county ordinances.

Pavement thickness can be determined using AASHTO, Asphalt Institute, PCA, and/or other methods if specific wheel loads, axle configurations, frequencies, and desired pavement life are provided. Terracon can provide thickness recommendations for pavements subjected to loads other than personal vehicle and occasional delivery and trash removal truck traffic if this information is provided. However, absent that data, we recommend the following minimum typical sections.
4.3.3 Estimates of Minimum Pavement Thickness

<table>
<thead>
<tr>
<th>Traffic Area</th>
<th>Alternative</th>
<th>Asphalt Concrete Surface Course</th>
<th>Limerock, Soil-Cement or Crushed Concrete Base Course</th>
<th>Stabilized Subbase Course²,³,⁴</th>
<th>Portland Cement Concrete</th>
<th>Free Draining Subgrade</th>
</tr>
</thead>
<tbody>
<tr>
<td>Car Parking</td>
<td>PCC</td>
<td>--</td>
<td>--</td>
<td>5.0</td>
<td>18.0</td>
<td></td>
</tr>
<tr>
<td></td>
<td>AC</td>
<td>1.5</td>
<td>6.0</td>
<td>12.0</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Truck and Drive Areas</td>
<td>PCC</td>
<td>--</td>
<td>--</td>
<td>6.0</td>
<td>18.0</td>
<td></td>
</tr>
<tr>
<td></td>
<td>AC</td>
<td>2.5</td>
<td>8.0</td>
<td>12.0</td>
<td>--</td>
<td>--</td>
</tr>
</tbody>
</table>

1. Often referred to as Stabilized Subgrade.
2. Use coarse granular materials such as recycled crushed concrete, shell, or gravel when seasonal high groundwater is within 4 feet of the profile grade. Clay stabilization is acceptable with deeper seasonal high groundwater.
3. Some municipalities do not require stabilized subbase beneath soil-cement base.

4.3.4 Asphalt Concrete Design Recommendations

The following items are applicable to asphalt concrete pavement sections.

- Terracon recommends a minimum separation of 12 inches for this purpose between the bottom of the base course and the seasonal high water table.
- Natural or fill subgrade soils to a depth of 18 inches below the base should be clean, free-draining sands with a fines content passing a No. 200 sieve of 7 percent or less.
- Stabilized subgrade soils (also identified as stabilized subbase) should be stabilized to a minimum Limerock Bearing Ratio (LBR; Florida Method of Test Designation FM 5-515) value of 40 if they do not already meet this criterion, or modified/replaced with new compacted fill that meets the minimum LBR value. Although LBR testing has not been performed, our experience with similar soils indicates that the near surficial sands encountered in the soil borings are unlikely to meet this requirement.
- The stabilized subgrade course should be compacted to at least 98 percent of the Modified Proctor maximum dry density (AASHTO T-180 or ASTM D-1557). Any underlying, newly-placed subgrade fill need only be compacted to a minimum of 95 percent of the Modified Proctor maximum dry density. Compaction tests should be performed at a frequency of 1 test per 10,000 square feet or fraction thereof.
Limerock base courses from an approved FDOT source should have a minimum LBR value of 100, and be compacted to a minimum of 98 percent of the maximum dry density as determined by the Modified Proctor test. Limerock should be placed in uniform lifts not to exceed 6 inches loose thickness. Recycled limerock is not a suitable substitute for virgin limerock for base courses but may be used as a granular stabilizing admixture.

Soil cement base courses typically experience shrinkage cracking due to hydration curing of the cement. This shrinkage cracking typically propagates through the overlying asphalt course and reflects in the pavement surface. This reflective cracking is not necessarily indicative of a pavement structural failure, though it is sometimes considered to be aesthetically undesirable. Seminole County generally discourages use of soil cement.

Soil cement bases should have 7-day design strength of 300 psi. Soil cement base should be compacted to a minimum of 98 percent of the material’s maximum dry density as determined by the Standard Proctor Test for Soil Cement (AASHTO T-134). Higher design strengths may result in increased cracking.

Crushed (recycled) concrete base should meet the current FDOT specification 204 customized for recycled materials.

Asphalt should be compacted to a minimum of 95 percent of the design mix density. Asphalt surface courses should be Type SP, Type S, or other suitable mix design according to FDOT and local requirements.

To verify thicknesses, after placement and compaction of the pavement courses, core the wearing surface to evaluate material thickness and composition at a minimum frequency of 5,000 square feet or two locations per day’s production.

Underdrains or strip drains should be considered along all landscaped areas in, or adjacent to pavements to reduce moisture migration to subgrade soils. Underdrains will also be required below pavement if the separation between the bottom of the base course and the seasonal high groundwater table is less than 1 foot. Seminole County generally discourages lowering pavement grades to the point that underdrains are needed.

All curbing should be full depth. Use of extruded curb sections which lie on top of asphalt surface courses can allow migration of water between the surface and base courses, leading to rippling and pavement deterioration.
### 4.3.5 Portland Cement Concrete Design Recommendations

The following items are applicable to rigid concrete pavement sections.

- At least 18 inches of free-draining material should be included directly beneath rigid concrete pavement. Fill meeting the requirements presented in Section 4.2 (Earthwork) of this report may be considered free-draining for this purpose. Limerock should not be considered free draining for this purpose.

- The PCC should be a minimum of 4,000 psi at 28 days. PCC pavements are recommended for trash container pads and in any other areas subjected to heavy wheel loads and/or turning traffic.

- The upper 1 foot of rigid pavement subgrade soils should be compacted to at least 98 percent of the Modified Proctor maximum dry density (AASHTO T-180 or ASTM D-1557). Compaction tests should be performed at a frequency of 1 test per 10,000 square feet or fraction thereof.

- Rigid PCC pavements will perform better than ACC in areas where short-radii turning and braking are expected (i.e. entrance/exit aprons) due to better resistance to rutting and shoving. In addition, PCC pavement will perform better in areas subject to large or sustained loads. An adequate number of longitudinal and transverse control joints should be placed in the rigid pavement in accordance with ACI and/or AASHTO requirements. Expansion (isolation) joints must be full depth and should only be used to isolate fixed objects abutting or within the paved area.

- Adequate separation should be provided between the bottom of the concrete and the seasonal high water table. Terracon recommends that in no case should less than 1 foot of separation be provided. Based on the encountered conditions and anticipated development, we anticipate this requirement can be readily met.

- Sawcut patterns should generally be square or rectangular but nearly square, and extend to a depth equal to a quarter of the slab thickness. If the bottom of the concrete pavement is separated from the seasonal high water table by at least 1 foot, filter fabric will not be necessary beneath the expansion joints.

### 4.3.6 Pavement Drainage

Pavements should be sloped to provide rapid drainage of surface water. Water allowed to pond on or adjacent to the pavements could saturate the subgrade and contribute to premature pavement deterioration. In addition, the pavement subgrade should be graded to provide positive drainage within the granular base section. The subgrade and the pavement surface should have a minimum ¼ inch per foot slope to promote drainage. Appropriate sub-drainage or connection to a suitable daylight outlet should be provided to remove water from the base layer.
4.3.7 Pavement Maintenance

The pavement sections provided in this report represent minimum recommended thicknesses and, as such, periodic maintenance should be anticipated. Therefore preventive maintenance should be planned and provided for through an on-going pavement management program. Maintenance activities are intended to slow the rate of pavement deterioration, and to preserve the pavement investment. Maintenance consists of both localized maintenance (e.g., crack and joint sealing and patching) and global maintenance (e.g., surface sealing). Preventive maintenance is usually the first priority when implementing a pavement maintenance program. Additional engineering observation is recommended to determine the type and extent of a cost effective program. Even with periodic maintenance, some movements and related cracking may still occur and repairs may be required.

4.4 Stormwater Management

Design of the stormwater management system has not been completed yet, though we understand two wet detention systems are planned. Based on soil conditions and groundwater conditions, this is appropriate.

Composite sample of stormwater pond area soils (Boring Location PB-1 and PB-2, 0 to 2 and 4 to 6 feet below existing grade) had a measured permeability rate of 17 and 0.03 feet/day being representative of fine sand (SP) and silty sand (SM), respectively. We consider this permeability rate to be indicative of a saturated vertical permeability. Past experience and published references have indicated that unsaturated vertical permeability as used in some locally available groundwater models is typically 2/3 the saturated value. Experience with the observed soil types has shown that horizontal permeability may be on the order of 1.5 to 2 times the saturated vertical permeability in undisturbed materials. Also, it has been our experience that SJRWMD requires use of an appropriate factor of safety, generally reducing measured permeability rates or recovery time by a factor of safety of 2 for design of artificial recovery systems such and exfiltration trenches or underdrains, although this does not presently apply to ponds recovering by infiltration. Therefore, we recommend using an unsaturated vertical infiltration rate, $k_V$, of 20 feet/day for the purpose of designing the proposed underground exfiltration system.

For clean sands as encountered at this site, saturated vertical and horizontal permeabilities are similar. As the fines content of the soil increases (silt and/or clay), the ratio of the horizontal to vertical permeability rate generally increases. Also, similar practical limits apply to horizontal permeability rates as apply to vertical permeability rates. Therefore, we recommend using an unsaturated vertical infiltration rate, $k_V$, of 12 feet/day and a horizontal saturated hydraulic conductivity rate, $k_H$, of 12 feet/day for the purpose of designing the proposed underground exfiltration system.
No confining layer was encountered at the site, within the explored depths. Therefore we conservatively recommend that you consider the maximum explored depth of 20 feet as the confining layer for the purpose stormwater system design. Based upon our visual review of the sands, and our local project experience, we recommend that you consider the surficial aquifer (the site sands) to have a fillable porosity (\( \eta \)) of 30 percent. The table below summarizes our recommended stormwater management system design parameters.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Boring Location</th>
<th>Boring Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Estimated Confining Layer Depth, B</td>
<td>2 feet</td>
<td>4 feet</td>
</tr>
<tr>
<td>Estimated Seasonal High Water Table Elevation, WT</td>
<td>0 feet</td>
<td>1 feet</td>
</tr>
<tr>
<td>Unsaturated Vertical Infiltration Rate, ( k_v )</td>
<td>12 feet/day</td>
<td>12 feet/day</td>
</tr>
<tr>
<td>Horizontal Saturated Hydraulic Conductivity, ( k_H )</td>
<td>20 feet/day</td>
<td>20 feet/day</td>
</tr>
<tr>
<td>Fillable Porosity, ( \eta )</td>
<td>30 percent</td>
<td>30 percent</td>
</tr>
</tbody>
</table>

5.0 GENERAL COMMENTS

Terracon should be retained to review the final design plans and specifications so comments can be made regarding interpretation and implementation of our geotechnical recommendations in the design and specifications. Terracon also should be retained to provide observation and testing services during grading, excavation, foundation construction and other earth-related construction phases of the project.

The analysis and recommendations presented in this report are based upon the data obtained from the borings performed at the indicated locations and from other information discussed in this report. This report does not reflect variations that may occur between borings, across the site, 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. If variations appear, we should be immediately notified so that further evaluation and supplemental recommendations can be provided.

The scope of services for this project 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.
This report has been prepared for the exclusive use of our client for specific application to the project discussed and has been prepared in accordance with generally accepted geotechnical engineering practices. No warranties, either express or implied, are intended or made. Site safety, excavation support, and dewatering requirements are the responsibility of others. In the event that changes in the nature, design, or location of the project as outlined in this report are planned, the conclusions and recommendations contained in this report shall not be considered valid unless Terracon reviews the changes and either verifies or modifies the conclusions of this report in writing.
APPENDIX A
FIELD EXPLORATION
Osteen, Florida
1965; Photorevised 1980
7.5 Minute Series (Quadrangle)
U.S.D.A. SOIL SURVEY FOR SEMINOLE COUNTY, FLORIDA
ISSUED: MARCH 1990

SECTION: 32
TOWNSHIP: 19 SOUTH
RANGE: 31 EAST

SOIL LEGEND
20  MYAKKA AND EAUGALLIE FINE SANDS
25  PINEDA FINE SAND
29  ST. JOHNS AND EAUGALLIE FINE SANDS
Soil Survey Descriptions

20 – Myakka and EauGallie fine sands. This soil type is nearly level and poorly drained. It is typically found in broad plains on the flatwoods areas. During years of normal precipitation, this soil type has a seasonal high water table within 12 inches (1.0 foot) of the surface for 1 to 4 months. Myakka soils are generally predominantly sandy throughout the defined profile of 80 inches (6.7 feet). EauGallie soils are generally predominantly sandy except for between depths of 41 to 60 inches (3.4 to 5.0 feet), where they exist as silty sand to clayey sand (USCS Classification symbol SM to SC).

Typical permeability rates for Myakka fine sand generally range from 6 to 20 inches per hour (12 to 40 feet per day), except between typical depths of 28 and 45 inches (2.3 and 3.8 feet) where permeability rates generally range from 0.6 to 6 inches per hour (1.2 to 12 feet per day).

25 – Pineda fine sand. This soil type is nearly level and poorly drained. It is typically found on low hammocks, in broad, poorly defined drainageways, and in sloughs. In its natural state and during years of normal precipitation, this soil type has a seasonal high water table within 12 inches (1.0 foot) of the surface for 2 to 6 months; water may be standing on the surface for brief periods following heavy rains. Pineda soils are generally predominantly sandy except for between depths of 26 to 68 inches (2.2 to 5.7 feet), where they exist as silty sand to clayey sand (USCS Classification symbol SM to SC).

29 – St. Johns and EauGallie fine sands. This soil type is nearly level and poorly drained. It is typically found on low broad plains on the flatwoods. During years of normal precipitation, this soil type has a seasonal high water table within 12 inches (1.0 foot) of the surface for 1 to 4 months. St. Johns soils are generally predominantly sandy throughout the defined profile of 80 inches (6.7 feet). EauGallie soils are generally predominantly sandy except for between depths of 38 to 72 inches (3.2 to 6.0 feet), where they exist as silty sand to clayey sand (USCS Classification symbol SM to SC).
LEGEND

APPROXIMATE LOCATION OF STANDARD PENETRATION TEST BORING

PB-1

NOT PLATTED SEM CO.
A-1 SE

NOT PLATTED SEM CO.
A-1 SE

EXHIBIT
BORING LOCATION MAP

GEOTECHNICAL ENGINEERING REPORT

CELERY COVE

SANFORD, SEMINOLE COUNTY, FLORIDA

CONSULTING ENGINEERS AND SCIENTISTS
1675 LEE ROAD WINTER PARK, FLORIDA 32789
PH. (407) 740-6110 FAX (407) 740-6122

Project No.: H1145213
Date: 12-31-14

EXHIBIT A-4
Field Exploration Description

The boring locations were laid out at the project site by Terracon personnel. The locations indicated on the attached diagram are approximate and were measured by pacing distances and estimating right angles, across vegetated/wooded terrain. The locations of the borings should be considered accurate only to the degree implied by the means and methods used to define them.

The SPT soil borings were drilled with a track-mounted, rotary drilling rig equipped with a rope and cathead-operated safety hammer. The boreholes were advanced with a cutting head and stabilized with the use of bentonite (drillers' mud). Soil samples were obtained by the split spoon sampling procedure in general accordance with the Standard Penetration Test (SPT) procedure. In the split spoon sampling procedure, the number of blows required to advance the sampling spoon the last 12 inches of an 18-inch penetration or the middle 12 inches of a 24-inch penetration by means of a 140-pound hammer with a free fall of 30 inches, is the standard penetration resistance value (N). This value is used to estimate the in-situ relative density of cohesionless soils and the consistency of cohesive soils. The sampling depths and penetration distance, plus the standard penetration resistance values, are shown on the boring logs.

Portions of the samples from the borings were sealed in glass jars to reduce moisture loss, and then the jars were taken to our laboratory for further observation and classification. Upon completion, the boreholes were backfilled with the site soil.

Field logs of each boring were prepared by the drill crew. These logs included visual classifications of the materials encountered during drilling as well as the driller’s interpretation of the subsurface conditions between samples. The boring logs included with this report represent an interpretation of the field logs and include modifications based on laboratory observation of the samples.
**BORING LOG NO. PB-1**

**PROJECT:** Celery Cove  
**SITE:** Sanford, Seminole County, Florida  
**CLIENT:** GoldChem, LLC

### LOCATION

See Exhibit A-4

### GRAPHIC LOG

<table>
<thead>
<tr>
<th>DEPTH (Ft.)</th>
<th>WATER LEVEL OBSERVATIONS</th>
<th>FIELD TEST RESULTS</th>
<th>VERTICAL PERMEABILITY (FT/DAY)</th>
<th>WATER CONTENT (%)</th>
<th>PERCENT FINES</th>
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<td>15.0</td>
<td>3-3-3 N=6</td>
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**SAND (SP), fine grained, dark brown to gray**

**Silty Sand (SM), fine grained, gray**

**Boring Terminated at 15 Feet**

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Rope and Cathead

**Advancement Method:** Mud Rotary

**Abandonment Method:** Borings backfilled with soil cuttings upon completion.

Notes:

See Exhibit A-3 for description of field procedures. See Appendix B for description of laboratory procedures and additional data (if any). See Appendix C for explanation of symbols and abbreviations.

**WATER LEVEL OBSERVATIONS**

- Water Initially Observed at 2.0'

**GEO SMART LOG-NO WELL H1145213-BORING LOGS.GPJ  TERRACON2012.GDT  1/5/15**

**PROJECT:** Celery Cove

**FIELD TEST RESULTS**

**PERCENT FINES**

**WATER CONTENT (%)**

**VERTICAL PERMEABILITY (FT/DAY)**

**Boring Started:** 12/15/2014  
**Boring Completed:** 12/15/2014

**Drill Rig:** BR-2500  
**Driller:** Melvin

**Project No.: H1145213  
Exhibit: A-6**
### BORING LOG NO. PB-2

**PROJECT:** Celery Cove  
**CLIENT:** GoldChem, LLC  
**SITE:** Sanford, Seminole County, Florida

#### GRAPHIC LOG

<table>
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<tr>
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<td>6.0</td>
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<tr>
<td>13.5</td>
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<td>15.0</td>
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#### WATER LEVEL OBSERVATIONS

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<th>FIELD TEST RESULTS</th>
<th>VERTICAL PERMEABILITY (FT/DAY)</th>
<th>WATER CONTENT (%)</th>
<th>PERCENT FINES</th>
</tr>
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<td>15.0</td>
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</tr>
</tbody>
</table>

- **SAND (SP),** fine grained, light brown to gray
- **SILTY SAND (SM),** fine grained, light brown to gray
- **SAND WITH SILT (SP-SM),** fine grained, gray to grayish-brown
- **SILTY SAND (SM),** fine grained, gray

**Boring Terminated at 15 Feet**

Stratification lines are approximate. In-situ, the transition may be gradual.

**Hammer Type:** Rope and Cathead

**Advancement Method:** Mud Rotary

**Abandonment Method:** Borings backfilled with soil cuttings upon completion.

**Notes:**

- See Exhibit A-3 for description of field procedures.
- See Appendix B for description of laboratory procedures and additional data (if any).
- See Appendix C for explanation of symbols and abbreviations.

**WATER LEVEL OBSERVATIONS**

- Water Initially Observed at 2.0'

**Boring Started:** 12/15/2014  
**Boring Completed:** 12/15/2014

**Drill Rig:** BR-2500  
**Driller:** Melvin

**Project No.:** H1145213  
**Exhibit:** A-7
### BORING LOG NO. B-1

**PROJECT:** Celery Cove  
**CLIENT:** GoldChem, LLC  
**SITE:** Sanford, Seminole County, Florida

<table>
<thead>
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<th>LOCATION</th>
<th>GRAPHIC LOG</th>
<th>DEPTH (Ft.)</th>
<th>WATER LEVEL OBSERVATIONS</th>
<th>FIELD TEST RESULTS</th>
<th>VERTICAL PERMEABILITY (FT/DAY)</th>
<th>WATER CONTENT (%)</th>
<th>PERCENT FINES</th>
</tr>
</thead>
<tbody>
<tr>
<td>SAND (SP), fine grained, dark grayish-brown to gray</td>
<td></td>
<td>6.0</td>
<td>4-4-2-6 N=6</td>
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<td>4-5-4-5 N=9</td>
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<tr>
<td>SILTY SAND (SM), fine grained, gray</td>
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<td>3-5-5-4 N=10</td>
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<td>20</td>
<td>19</td>
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</tbody>
</table>

**Boring Terminated at 10 Feet**

Stratification lines are approximate. In-situ, the transition may be gradual.

**Hammer Type:** Rope and Cathead

**Advancement Method:** Mud Rotary  
**Abandonment Method:** Borings backfilled with soil cuttings upon completion.

See Exhibit A-3 for description of field procedures.  
See Appendix B for description of laboratory procedures and additional data (if any).  
See Appendix C for explanation of symbols and abbreviations.

**WATER LEVEL OBSERVATIONS**

- Water Initially Observed at 2.0'  
- Water Level at 10.0'

**Notes:**

- Project No.: H1145213  
- Exhibit: A-8

**Boring Started:** 12/15/2014  
**Boring Completed:** 12/15/2014  
**Drill Rig:** BR-2500  
**Driller:** Melvin
## BORING LOG NO. B-2

**PROJECT:** Celery Cove  
**CLIENT:** GoldChem, LLC  
**SITE:** Sanford, Seminole County, Florida

### GRAPHIC LOG

<table>
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<th>LOCATION</th>
<th>See Exhibit A-4</th>
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<table>
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<th>DEPTH (FT.)</th>
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<th>FIELD TEST RESULTS</th>
<th>VERTICAL PERMEABILITY (FT/DAY)</th>
<th>WATER CONTENT (%)</th>
<th>PERCENT FINES</th>
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</tbody>
</table>

**LOCATION** Sanford, Seminole County, Florida  
**DEPTH**

- SAND (SP), fine grained, brown
- SAND WITH SILT (SP-SM), fine grained, brown

**Boring Terminated at 10 Feet**

Stratification lines are approximate. In-situ, the transition may be gradual.

**Hammer Type:** Rope and Cathead

**Notes:**

Advancement Method: Mud Rotary

Abandonment Method: Borings backfilled with soil cuttings upon completion.

### WATER LEVEL OBSERVATIONS

- Water Initially Observed at 2.0'

**Boring Started:** 12/15/2014  
**Boring Completed:** 12/15/2014  
**Drill Rig:** BR-2500  
**Driller:** Melvin  
**Exhibit:** A-9

**See Exhibit A-3 for description of field procedures.**  
**See Appendix B for description of laboratory procedures and additional data (if any).**  
**See Appendix C for explanation of symbols and abbreviations.**
### BORING LOG NO. B-3

**PROJECT:** Celery Cove  
**CLIENT:** GoldChem, LLC  
**SITE:** Sanford, Seminole County, Florida

**LOCATION**  
See Exhibit A-4

**GRAPHIC LOG**

<table>
<thead>
<tr>
<th>DEPTH (Ft.)</th>
<th>WATER LEVEL OBSERVATIONS</th>
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</table>

**SAND (SP), fine grained, brown to grayish-brown**

**SILTY SAND (SM), fine grained, brown to grayish-brown**

**Boring Terminated at 10 Feet**

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Rope and Cathead

**Notes:**

Advancement Method: Mud Rotary  
Abandonment Method: Borings backfilled with soil cuttings upon completion.

See Exhibit A-3 for description of field procedures.  
See Appendix B for description of laboratory procedures and additional data (if any).  
See Appendix C for explanation of symbols and abbreviations.

**WATER LEVEL OBSERVATIONS**

- Water Initially Observed at 2.0'

**Exhibit:** A-10

**Drill Rig:** BR-2500  
**Driller:** Melvin

**Boring Started:** 12/15/2014  
**Boring Completed:** 12/15/2014

**Project No.:** H1145213
APPENDIX B
LABORATORY TESTING
Laboratory Testing

During the field exploration, a portion of each recovered sample was sealed in a glass jar and transported to our laboratory for further visual observation and laboratory testing. Selected samples retrieved from the borings were tested for moisture (water) content, fines content (soil passing a US standard #200 sieve), and laboratory permeability. Those results are included in this report and on the respective boring logs, except for permeability. The visual-manual classifications were modified as appropriate based upon the laboratory testing results.

The soil samples were classified in general accordance with the appended General Notes and the Unified Soil Classification System based on the material's texture and plasticity. The estimated group symbol for the Unified Soil Classification System is shown on the boring logs and a brief description of the Unified Soil Classification System is included in Appendix B. The results of our laboratory testing are presented in the Laboratory Test Results section of this report and on the corresponding borings logs.

Permeability testing was performed on bulk samples obtained from adjacent to Boring PB-1 and Boring PB-2, from between depths of 0 to 2 feet and 4 to 6 feet below existing grade respectively, the presumed subgrade soils for the proposed stormwater management pond. The bulk samples were remolded in a permeameter to subjectively approximate in-place relative density of the sampled soil. Water was allowed to flow into the soil sample until the sample was apparently saturated. Once saturated, water flow was halted and incremental drops in the supply water level were timed.
**GENERAL NOTES**

**DESCRIPTION OF SYMBOLS AND ABBREVIATIONS**

<table>
<thead>
<tr>
<th>Sampling Method</th>
<th>Water Level Event</th>
<th>Field Tests</th>
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<tbody>
<tr>
<td>Auger Cuttings</td>
<td>Water Initially Encountered</td>
<td>(HP) Hand Penetrometer</td>
</tr>
<tr>
<td>Grab Sample</td>
<td>Water Level After a Specified Period of Time</td>
<td>(T) Torvane</td>
</tr>
<tr>
<td>Shelby Tube</td>
<td>Water Level After a Specified Period of Time</td>
<td>(DCP) Dynamic Cone Penetrometer</td>
</tr>
<tr>
<td></td>
<td>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.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(PID) Photo-Ionization Detector</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(OVA) Organic Vapor Analyzer</td>
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</table>

**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.

---

<table>
<thead>
<tr>
<th>RELATIVE DENSITY OF COARSE-GRAINED SOILS</th>
<th>CONSISTENCY OF FINE-GRAINED SOILS</th>
</tr>
</thead>
<tbody>
<tr>
<td>(More than 50% retained on No. 200 sieve.)</td>
<td>(50% or more passing the No. 200 sieve.)</td>
</tr>
<tr>
<td>Density determined by Standard Penetration Resistance</td>
<td>Consistency determined by laboratory shear strength testing, field visual-manual procedures or standard penetration resistance</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Strength Terms</th>
<th>Standard Penetration or N-Value Blows/Ft.</th>
<th>Descriptive Term (Consistency)</th>
<th>Unconfined Compressive Strength Qu. (psf)</th>
<th>Standard Penetration or N-Value Blows/Ft.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very Loose</td>
<td>0 - 3</td>
<td>Very Soft</td>
<td>less than 500</td>
<td>0 - 1</td>
</tr>
<tr>
<td>Loose</td>
<td>4 - 9</td>
<td>Soft</td>
<td>500 to 1,000</td>
<td>2 - 4</td>
</tr>
<tr>
<td>Medium Dense</td>
<td>10 - 29</td>
<td>Medium Stiff</td>
<td>1,000 to 2,000</td>
<td>4 - 8</td>
</tr>
<tr>
<td>Dense</td>
<td>30 - 50</td>
<td>Stiff</td>
<td>2,000 to 4,000</td>
<td>8 - 15</td>
</tr>
<tr>
<td>Very Dense</td>
<td>&gt; 50</td>
<td>Very Stiff</td>
<td>4,000 to 8,000</td>
<td>15 - 30</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Hard</td>
<td>&gt; 8,000</td>
<td>&gt; 30</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>RELATIVE PROPORTIONS OF SAND AND GRAVEL</th>
<th>GRAIN SIZE TERMINOLOGY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Descriptive Term(s) of other constituents</td>
<td>Percent of Dry Weight</td>
</tr>
<tr>
<td>Trace</td>
<td>&lt; 15</td>
</tr>
<tr>
<td>With</td>
<td>15 - 29</td>
</tr>
<tr>
<td>Modifier</td>
<td>&gt; 30</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>RELATIVE PROPORTIONS OF FINES</th>
<th>PLASTICITY DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Descriptive Term(s) of other constituents</td>
<td>Percent of Dry Weight</td>
</tr>
<tr>
<td>Trace</td>
<td>&lt; 5</td>
</tr>
<tr>
<td>With</td>
<td>5 - 12</td>
</tr>
<tr>
<td>Modifier</td>
<td>&gt; 12</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>
**UNIFIED SOIL CLASSIFICATION SYSTEM**

### Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests

<table>
<thead>
<tr>
<th>Soil Classification Group Symbol</th>
<th>Group Name</th>
<th>Coarse Grained Soils: More than 50% retained on No. 200 sieve</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Gravels:</strong></td>
<td>Clean Gravels: Less than 5% fines</td>
<td>Cu ≥ 4 and 1 ≤ Cc ≤ 3&lt;sup&gt;E&lt;/sup&gt; GW Well-graded gravel&lt;sup&gt;F&lt;/sup&gt;</td>
</tr>
<tr>
<td>More than 50% of coarse fraction retained on No. 4 sieve</td>
<td>Gravels with Fines: More than 12% fines</td>
<td>Cu &lt; 4 and/or 1 &gt; Cc &gt; 3&lt;sup&gt;E&lt;/sup&gt; GP Poorly graded gravel&lt;sup&gt;F&lt;/sup&gt;</td>
</tr>
<tr>
<td><strong>Sands:</strong></td>
<td>Clean Sands: Less than 5% fines</td>
<td>Cu ≥ 6 and 1 ≤ Cc ≤ 3&lt;sup&gt;E&lt;/sup&gt; SW Well-graded sand&lt;sup&gt;I&lt;/sup&gt;</td>
</tr>
<tr>
<td>50% or more of coarse fraction passes No. 4 sieve</td>
<td>Sands with Fines: More than 12% fines</td>
<td>Cu &lt; 6 and/or 1 &gt; Cc &gt; 3&lt;sup&gt;E&lt;/sup&gt; SP Poorly graded sand&lt;sup&gt;I&lt;/sup&gt;</td>
</tr>
<tr>
<td><strong>Silts and Clays:</strong></td>
<td>Inorganic: PI &gt; 7 and plots on or above “A” line</td>
<td>CL Lean clay&lt;sup&gt;K,L,M&lt;/sup&gt;</td>
</tr>
<tr>
<td>Liquid limit less than 50</td>
<td>Organic: Liquid limit - oven dried</td>
<td>ML Silty clay&lt;sup&gt;K,L,M&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>Liquid limit - not dried &lt; 0.75</td>
<td>OL Organic clay&lt;sup&gt;K,L,M,N&lt;/sup&gt;</td>
</tr>
<tr>
<td><strong>Fine-Grained Soils:</strong></td>
<td>Inorganic: PI plots on or above “A” line</td>
<td>CH Fat clay&lt;sup&gt;K,L,M&lt;/sup&gt;</td>
</tr>
<tr>
<td>50% or more passes the No. 200 sieve</td>
<td>Organic: Liquid limit - oven dried</td>
<td>MH Elastic silt&lt;sup&gt;K,L,M&lt;/sup&gt;</td>
</tr>
<tr>
<td>Silts and Clays:</td>
<td>Liquid limit - not dried &lt; 0.75</td>
<td>OH Organic clay&lt;sup&gt;K,L,M,P&lt;/sup&gt;</td>
</tr>
<tr>
<td>Liquid limit 50 or more</td>
<td></td>
<td>Organic silt&lt;sup&gt;K,L,M,G&lt;/sup&gt;</td>
</tr>
<tr>
<td><strong>Highly organic soils:</strong></td>
<td>PI plots on or above “A” line</td>
<td>PT Peat&lt;sup&gt;K,L,M&lt;/sup&gt;</td>
</tr>
<tr>
<td>Primarily organic matter, dark in color, and organic odor</td>
<td>Plots below “A” line</td>
<td></td>
</tr>
</tbody>
</table>

<sup>A</sup> Based on the material passing the 3-inch (75-mm) sieve  
<sup>B</sup> If field sample contained cobbles or boulders, or both, add “with cobbles or boulders, or both” to group name.  
<sup>C</sup> 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.  
<sup>D</sup> 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.  
<sup>E</sup> Cu = D<sub>60</sub>/D<sub>10</sub>  
<sup>F</sup> If soil contains ≥ 15% sand, add “with organic fines” to group name.  
<sup>G</sup> If fines contain ≥ 15% gravel, add “with gravel” to group name.  
<sup>H</sup> If Atterberg limits plot in shaded area, soil is a CL-ML, silt clay.  

#### For classification of fine-grained soils and fine-grained fraction of coarse-grained soils

- **Equation of “A” line**  
  Horizontal at PI=4 to LL=25.5, then PI=0.73 (LL-20)

- **Equation of “U” line**  
  Vertical at LL=16 to PI=7, then PI=0.9 (LL-6)

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**Terracon**

*Exhibit C-2*