May 24, 2016

Mr. Michael Junk  
Construction Manager  
Gate Petroleum Company  
9540 San Jose Boulevard  
P.O. Box 23627  
Jacksonville, Florida   32241-3627

Subject: Report of Geotechnical Exploration  
Gate Convenience Facility  
Park Street and Forest Street  
Jacksonville, Florida  
Amec Foster Wheeler Project No. 6734-16-9861

Dear Mr. Junk:

Amec Foster Wheeler Environment & Infrastructure, Inc. (Amec Foster Wheeler) has performed a geotechnical exploration for the subject project in general accordance with our Proposal No. 16PROPJAXV.022 dated February 24, 2016. You provided authorization for our services on February 26, 2016.

In summary, the subsurface conditions in the area of the proposed Gate facility generally consisted of loose to firm fine sands, firm slightly clayey and slightly silty fine sands, and loose to firm clayey fine sands to the maximum depth explored of 20 feet below the existing ground surface. The groundwater table was not encountered at the boring locations at the time of drilling. The position of the seasonal high groundwater table was estimated to be about 3½ to 5 feet below the existing ground surface.

We consider the subsurface conditions in the explored areas to be acceptable for support of the planned structures on shallow foundation systems, following the recommended site and footing bearing surface preparation. General site preparation will include demolition of the existing structures, stripping of existing pavements, trees, and vegetation, implementation of surface water control, surficial soil compaction by vibratory compaction, and structural fill placement and compaction in controlled lifts.

Detailed recommendations for shallow foundation design and construction and site preparation are presented in the Recommendations section of this report. Recommendations are also provided for pavement subgrade preparation and fuel tank excavation bottom preparation and backfilling.
Gate Petroleum Company
Gate Convenience Facility – Park Street and Forest Street
Report of Geotechnical Exploration

We have enjoyed assisting you and look forward to serving as your geotechnical and construction materials testing consultant on the remainder of this project and on future projects. If you have any questions concerning this report, please contact us.

Sincerely,

Amec Foster Wheeler Environment & Infrastructure, Inc.
Florida Board of Professional Engineers Certificate of Authorization No. 5392

Corey T. Chascin, E.I.
Staff Engineer

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Distribution: Gate Petroleum Company – Mr. Mike Junk (electronic copy and 1 hard copy)
Prosper, Inc. – Mr. Derek Kelsay (electronic copy)
File (1)
Gate Petroleum Company  
Gate Convenience Facility – Park Street and Forest Street  
Report of Geotechnical Exploration

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Soil Test Boring Records
Auger Boring Records
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Project No. 6734-16-9861
May 24, 2016
1.0 PROJECT INFORMATION AND STRUCTURAL CONDITIONS

1.1 General

The purpose of this exploration was to develop information concerning the site and subsurface conditions in order to evaluate site preparation requirements and foundation support alternatives for the planned gas station/convenience store in the Riverside section of Jacksonville, Duval County, Florida. This report briefly describes the field testing activities and presents the findings. The enclosed guideline recommendations for foundation design, foundation preparation, site preparation and foundation construction represent approaches we feel would be appropriate for the planned construction.

1.2 Project Information

Project information was provided by Mr. John Blanchard of Applied Science and Engineering, LLC and Mr. Derek Kelsay of Prosser, Inc. during the period of December 14, 2015, through May 19, 2016. We were furnished with the following pertinent project-related documents:

- Conceptual Site Plan
  Prepared by: Prosser, Inc.
  Dated: September 1, 2015

- Geotechnical Exhibit
  Sheet 2 of 2
  Prepared by: Prosser, Inc.
  Undated (received on February 16, 2016)

As shown on the Site Location Map in the Appendix, the proposed gas station/convenience store will be located the southwest corner of the intersection of Park Street and Forest Street in Jacksonville, Florida. The site is presently occupied by three commercial buildings and a free-standing steel lattice-type telecommunications tower. The existing structures will be demolished in order to construct the proposed convenience store/gas station.
This project will include a 6,401 square foot Gate convenience store, a fueling island with an overhead canopy, a car wash building, buried fuel tanks, buried stormwater vaults, 24 parking spaces, and paved driveways. The convenience store will have overall plan dimensions of approximately 65 by 107 feet and will be located on the northwest side of the subject property. An overhead canopy with plan dimensions of approximately 65 by 168 feet will be constructed southeast of the proposed convenience store building. Five fuel tanks will be buried at a depth of about 15 feet below the existing grade near the southwest end of the proposed canopy. A car wash building with plan dimensions of approximately 27 by 47 feet will be located on the northeast side of the proposed convenience store building.

Based on our experience with similar Gate projects, we assume that relatively high vehicular traffic is expected to travel on the paved surfaces. Detailed vehicular traffic and structural loading information have not been provided. We assume that bearing wall and individual column loads for the structures will not exceed 3 klf and 50 kips, respectively. We also assume that soil-supported ground floor loads (dead load plus live load) in the buildings will not exceed 125 psf. The finished floor elevations for the proposed buildings have not been firmly established; however, we assume that less than 2 feet of earthwork fill (and no significant cut) will be required to bring the site to the required grade.

Pavement areas for automobile and light truck parking are planned around the proposed convenience store building. In addition, stormwater vaults are planned, one between the convenience store building and the canopy, and one southeast of the car wash building.
2.0 FIELD EXPLORATION

In order to explore the subsurface conditions in the areas of the planned construction, the following borings were performed:

Table 2-1: Field Exploration Program

<table>
<thead>
<tr>
<th>Area</th>
<th>Boring Type</th>
<th>Depth* (ft)</th>
<th>Quantity</th>
<th>Boring Nos.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Convenience Store</td>
<td>SPT**</td>
<td>15</td>
<td>2</td>
<td>B-1, B-2</td>
</tr>
<tr>
<td>Canopy</td>
<td>SPT</td>
<td>15</td>
<td>2</td>
<td>B-5, B-6</td>
</tr>
<tr>
<td>Car Wash</td>
<td>SPT</td>
<td>15</td>
<td>1</td>
<td>B-3</td>
</tr>
<tr>
<td>Parking/Driveways</td>
<td>Auger***</td>
<td>6</td>
<td>5</td>
<td>A-1 through A-5</td>
</tr>
<tr>
<td>Stormwater Vaults</td>
<td>Auger</td>
<td>11 to 12</td>
<td>2</td>
<td>P-1, P-2</td>
</tr>
<tr>
<td>Buried Fuel Tanks</td>
<td>SPT</td>
<td>20</td>
<td>1</td>
<td>B-4</td>
</tr>
</tbody>
</table>

* Below existing grade
** SPT – Standard Penetration Test (ASTM D1586)
*** Auger Boring (ASTM D1452)

The depth to the seasonal high water table was estimated in the areas of the stormwater vaults. The field permeability tests that were part of our original scope were not performed at the direction of Mr. Kelsay, but may be performed at a later date. The approximate boring and test locations are shown on the Field Exploration Plan in the Appendix. The borings were drilled on March 16, 2016 by Independent Drilling, Inc. (IDI) working under subcontract to Amec Foster Wheeler. A senior engineering technician from our office observed and documented the drilling operations on a full-time basis. Our technician returned to the site on April 12, 2016 to extend Borings P-1 and P-2 to further explore these areas for the purpose of estimating the seasonal high groundwater level.

The boring layout was accomplished using the geotechnical exhibit prepared by Prosser, Inc. The borings were located in the field by our personnel using a measuring wheel referenced to existing site features. Ground surface elevations at the boring locations were neither furnished to us nor determined by us. All standard penetration tests were performed using an automatic SPT hammer system, with the exception of Boring B-5. Boring B-5 was performed using a manual rope-cathead hammer system due to failure of the automatic hammer.
The Soil Test Boring Records, in the Appendix, graphically show the penetration resistances and present the soil descriptions for each SPT boring. The Auger Boring Records, also in the Appendix, show the seasonal high groundwater levels, and present the soil descriptions for each soil type encountered in the auger borings. The stratification lines and depth designations on the boring records represent the approximate boundaries between soil types. In some instances, the transition between soil types may be gradual. Brief descriptions of the exploratory drilling, testing, and sampling techniques used are presented in the Field Procedures section of the Appendix.
3.0 SITE AND SUBSURFACE CONDITIONS

3.1 Site Conditions

The existing site conditions were observed by a senior engineering technician from our office during the field exploration phase of this project. In general, the site consisted of pavement areas (asphaltic concrete, gravel, and recycled asphalt roofing shingles) and three office/warehouse-type structures with some scattered trees and vegetation. We assume that the existing structures are supported on shallow foundations. A steel self-supported telecommunications tower was located in the central portion of the site. The topography encountered across the subject site was generally flat and level. Standing surface water was not observed on the property at the time of our visit.

3.2 Subsurface Conditions

3.2.1 General

A pictorial representation of the subsurface conditions encountered in the proposed construction area is shown on the Generalized Subsurface Profile presented in the Appendix. The profile and the subsurface conditions outlined below highlight the major subsurface stratification. The Soil Test Boring and Auger Boring Records, in the Appendix, should be consulted for detailed descriptions of the subsurface conditions encountered at each boring location. When reviewing the boring records and the subsurface profile, it should be understood that soil conditions may vary between and away from the boring locations.

3.2.2 Soils

From the existing ground surface to depths of approximate 5 to 18 inches, fill material consisting of loose to firm brown to dark brown fine sand (Unified Soil Classification System symbol: SP) with varying quantities of asphalt fragments, gravel, limerock fragments, pieces of recycled asphalt roofing shingles, red mulch, cemented sand, roots, silt, clay, shell fragments, and hardened clay clods was encountered. Beneath the fill material, sands consisting of loose to firm very light brown to dark brown, gray, and light brownish orange fine sands (SP) were penetrated to depths of about 8 to 12 feet. Loose
to firm orange to orange-gray clayey fine sands (SC) were encountered to depths of about 11 to 15 feet. Firm light orange, light brownish orange, and light orange-gray slightly clayey fine sand (SP-SC) to fine sand (SP) with a trace of clay was then penetrated in Borings B-4 and B-5 to the termination depths of 20 feet and 15 feet, respectively.

3.2.3 Groundwater

The groundwater table was not encountered in any of the borings at the time of drilling. However, based on the relative moisture content of the soil samples, the groundwater table at the time of drilling is estimated to be no shallower than about 8 feet below grade. The depth to the seasonal high groundwater table was estimated at a few boring locations. The estimated depth to the seasonal high water table ranged from about 3¾ to 5 feet below existing grade. Fluctuation in groundwater levels should be expected due to seasonal climatic changes, construction activity, rainfall variations, surface water runoff, and other site-specific factors. Groundwater could temporarily perch on the clayey sand during periods of intense and/or prolonged rainfall. Since groundwater level variations are anticipated, design drawings and specifications should accommodate such possibilities and construction planning should be based on the assumption that variations will occur.
4.0 RECOMMENDATIONS FOR SHALLOW FOUNDATION DESIGN AND SITE PREPARATION

4.1 Basis for Recommendations

The following recommendations are based upon the previously presented project information and the assumed structural loading conditions along with the data obtained in this exploration. The field data have been compared with previous performances of similar structures bearing on soils similar to those encountered at this site. If the assumed structural loading information is incorrect, or if the locations of the structures are changed, please contact us so that our recommendations may be reviewed for continued applicability. The discovery of any site or subsurface condition during construction that deviates from the data obtained in this exploration should also be reported to us for our evaluation. The assessment of site environmental conditions or the presence of pollutants in the soil, rock or groundwater of the site is beyond the proposed scope of this geotechnical exploration.

4.2 Shallow Foundation Design

We consider the subsurface conditions to be acceptable for support of the proposed structures using shallow foundations, following the recommended site and foundation bearing surface preparation. Individual column footings and continuous (strip) footings may bear on compacted acceptable existing soils or compacted structural fill soils. The footings may be designed using an allowable net soil bearing pressure of 3,000 psf. We assume that canopy foundations will be primarily sized for uplift.

The allowable bearing pressure may be increased by about one-third for transient edge stress loading considerations. Long-term edge stresses should not exceed the allowable bearing pressure. Footings should bear at least 12 inches below the finished exterior grade in order to generate the allowable bearing pressure and to provide confinement for the fine sandy bearing soils. Interior footings may bear at shallower depths below the floor slab. It is generally advantageous, however, to design the foundations to bear as high as
possible in order to reduce groundwater control requirements and associated costs during construction. Minimum footing widths of 18 and 24 inches are recommended for continuous and individual column footings, respectively, even though the allowable bearing pressure may not be fully developed in all cases. A density equivalent to at least 95 percent of the Modified Proctor maximum dry density (ASTM D1557) should be achieved in the sandy footing bearing level soils.

4.3 Settlement Potential

We have evaluated the field data obtained in this exploration along with our experience with similar structures and empirical relationships for bearing and settlement. Assuming the footings are designed using an allowable bearing pressure of 3,000 psf (which includes a safety factor of at least 2.5), and the recommended site and footing bearing surface preparation are performed, we have estimated that the total settlement of the structures will be on the order of ½ inch, or less. Differential settlements (between adjacent columns or along the length of a continuous wall footing) should not exceed ¼ inch. We anticipate that the majority of the footing settlements will occur as the structural dead loads are applied.

We have also estimated the fill-induced settlement potential. Settlements due to fill placement and the slab dead load (maximum of 2 feet of fill assumed plus 6-inch thick concrete slab) should be ¼ inch or less. We anticipate that the fill-induced settlement will occur during fill placement.

4.4 Ground Floor Slab Support

We recommend that the ground floor slabs for the proposed buildings be soil-supported, and constructed on a compacted sand subgrade. A gravel frost barrier protection layer is not considered necessary. The natural sandy soils or the recommended structural fill/backfill soils located directly beneath the convenience store floor slab should be compacted to a minimum dry density equal to 95 percent of the Modified Proctor maximum dry density (ASTM D1557) to a depth of at least 12 inches. The compaction criterion should be increased to 98 percent of the Modified Proctor maximum dry density for the
upper 12 inches of subgrade soils located directly beneath the canopy and car wash areas since they will be subject to transient vehicular loads. A modulus of subgrade reaction (k) value of 250 pci may be used in concrete slab design for properly compacted sandy subgrade conditions.

A vapor retarder is recommended for use in situations where the floor slab will include moisture-sensitive floor coverings or will be located in a humidity controlled area, or where the use of a vapor retarder is required by the building code. As defined by the American Concrete Institute (ACI), a vapor retarder is a material that is intended to effectively minimize the transmission of moisture upward through the slab from sources below. A minimum vapor retarder thickness of 10 mils is recommended. A thicker material (15 mils or greater) may be required if concrete will be placed directly on the vapor retarder, or if the vapor retarder will be subjected to heavy construction traffic, such as from ready-mixed concrete trucks. The decision on whether to use a dry, relatively thin granular fill (blotter) layer over the vapor retarder is controversial, and should consider the potential effects on slab performance due to slab curling, increased slab curing time, and uneven slab thickness.

The floor slabs should be appropriately jointed to reduce the potential for uncontrolled cracking, and to allow for some differential movement between different sections of the slabs. We further recommend that slabs be jointed around columns and walls to permit soil-supported slabs and shallow foundations to move differentially.

### 4.5 Site Preparation Recommendations

#### 4.5.1 Surface Stripping

Following demolition of the existing structures, we recommend that the existing pavements, all vegetation, topsoils, root concentrations, and surficial fill zones be stripped and removed from the construction areas for a distance of at least 5 feet beyond the exterior structure limits, and from all areas to be paved. The depth to which stripping will be required will vary to some degree. Some areas may require more than 18 inches of stripping to remove building foundations and surficial roots as well as other unacceptable materials, whereas other areas may require less than 6 inches. The
existing asphaltic concrete, limerock base course material, and gravel may be re-used as structural fill, if desired, as long as it is mixed with the recommended sandy structural fill soils, and no piece is larger than 3 inches. The recycled asphalt roofing shingles should not be re-used.

Any excavations created during the building demolition process should be backfilled with acceptable structural backfill material placed in controlled lifts and compacted to a minimum dry density equal to 95 percent of the Modified Proctor maximum dry density. Existing buried pipelines should either be removed or filled with grout or soil to prevent future ravelling problems.

4.5.2 Shallow Groundwater Control

Significant groundwater control is not anticipated to be necessary for general site preparation, but should be anticipated for buried tank installation. If required due to wet climatic conditions at the time of construction, groundwater can generally be lowered 1 to 3 feet for short periods by pumping from barrel sumps located in perimeter ditches or pits if gravity drainage cannot be established. All sump inlets should be located outside of the bearing areas to avoid loosening of the fine sandy bearing soils due to upward seepage pressures. Groundwater should be maintained at least 1 foot below the bottom of any excavations made during construction, and 2 feet below the surface of any vibratory compaction operations. In areas where deeper groundwater drawdown or control is required, or where more positive groundwater control is desired for prolonged periods (such as in the area of the proposed buried fuel tanks), a fully sanded vacuum wellpoint system or a buried sock-type horizontal underdrain system will likely be required.

4.5.3 Surface Water Control

The need for surface water runoff control should be anticipated during the site preparation and shallow foundation construction process. Construction areas should be graded to drain stormwater runoff away from the immediate area of preparation. This is particularly important during wetter climatic seasons. Lack of proper controls could result
in ponding of surface water in foundation bearing areas and on compaction surfaces. The ponded water, combined with machine or foot traffic during construction operations or other activities, could disturb otherwise acceptable soils or previously compacted existing soils, causing instability, pumping, and generally unacceptable conditions. The ponded water will also impede or prevent necessary soil compaction operations and make construction trafficability difficult.

4.5.4 Temporary Excavation Support

Generally, for excavations less than 4 feet deep in sandy soils, the sides of the excavation can temporarily stand with vertical cut slopes as a result of the apparent cohesion from soil moisture. For excavations greater than 4 feet deep, however, temporary side slopes in the sandy soils of 1½:1 (H:V) or flatter should be maintained, or the excavation should be properly braced and shored. The required flatness of the slope will depend upon the type of groundwater control employed. Where groundwater is permitted to seep through the sides of the excavation, temporary side slopes of 2:1 (H:V), or flatter, should be maintained for excavations deeper than about 4 feet. In areas where groundwater will be more effectively controlled through the use of a buried horizontal underdrain or a vacuum wellpoint dewatering system, temporary excavation side slopes should be cut no steeper than 1½:1 (H:V).

4.5.5 Surficial Soil Compaction

Following demolition of existing structures and surface stripping, the exposed sandy soils in the building and pavement areas should be compacted with overlapping passes of a lightweight vibratory drum roller having a total operating static weight (including fuel and water) of 2 to 4 tons and a drum diameter of 2 to 3 feet. A density equivalent to at least 95 percent of the Modified Proctor maximum dry density should be uniformly obtained to a depth of at least 12 inches below the compacted surface. Regardless of the degree of compaction achieved, a minimum of eight complete coverages should be made in the building and pavement areas with the roller in order to increase the density and improve
the uniformity of the underlying very loose to loose sandy soils. The roller coverages should be divided evenly into two perpendicular directions, where possible.

4.5.6 Structural Filling and Backfilling

Structural fill, as required, may then be placed in lifts not exceeding 12 inches in loose thickness when using the vibratory roller described previously. If the overlapping tracks of a bulldozer or lightweight vibratory compaction equipment are utilized, then the fill loose lift thickness should be reduced to 6 inches. Each lift should be thoroughly compacted with the compaction equipment until densities equivalent to at least 95 percent of the Modified Proctor maximum dry density are uniformly obtained.

Ideally, structural fill or backfill should consist of an inorganic, non-plastic, granular soil containing no more than 10 percent material passing the No. 200 mesh sieve (relatively clean sand with a Unified Soil Classification of SP, SP-SM, or SP-SC). The soils encountered in the upper approximately 8 feet of the subsurface profile are considered acceptable for re-use as structural fill or backfill, with the exception of the surficial fill materials. Soils excavated from below the water table will require drying to facilitate compaction.

4.5.7 Pavement Subgrade Preparation and Other Considerations

Sandy pavement subgrades should be compacted to a density of at least 98 percent of the Modified Proctor maximum dry density to a depth at least 12 inches below the bottom of the pavement base course. The vibratory compaction equipment discussed previously should be used to densify the sandy subgrade soils.

It is generally desirable to maintain the highest normal annual groundwater level at least 18 to 24 inches below the bottom of the pavement base or subbase course depending upon the wheel loads anticipated. Pavement grading design should maintain this minimum separation whenever possible; otherwise, underdrains may be required. At this site, we do not anticipate the need for underdrains.
4.6 Buried Fuel Tank Installation Recommendations

4.6.1 General

The subsurface conditions encountered are considered to be acceptable for support of the planned fuel tanks following the recommended bearing surface preparation. Assuming a bearing depth of about 15 feet, we anticipate that the exposed soils at the excavation bottom will consist of loose to firm slightly clayey fine sands. The sections that follow outline our recommendations for the following:

- Temporary excavation support (please refer to Section 4.5.4)
- Surface water control (please refer to Section 4.5.3)
- Deep dewatering
- Tank bearing surface preparation
- Backfill placement and compaction

4.6.2 Deep Dewatering

Dewatering is expected to be required to permit buried tank installation 15 feet below grade. Dewatering of excavations in sandy soils can best be performed using a single-stage vacuum wellpoint system. Some supplemental sump pumping may be required. Dewatering of excavations by pumping from sumps alone should be avoided due to potential side slope stability problems and the disturbance and loosening of the typical fine sand bearing soils at the sump inlets. The wellpoints should be installed by jetting or drilling. Coarse sand or fine gravel should be placed around each wellpoint and the riser pipe to act as a filter to provide a positive drainage connection between all soil layers being dewatered. All sump inlets should be located outside bearing areas to avoid loosening of the fine sandy bearing soils. The groundwater level should be maintained at least one foot below the bottom of any excavations made during construction and two feet below the surface of any vibratory compaction operations.

4.6.3 Bearing Surface Preparation

Based on the results of Boring B-4 and the assumed tank bearing level of 15 feet below existing grade, firm light orange slightly clayey fine sand (SP-SC) is anticipated at the
planned tank bearing level. The upper 12 inches of the sandy soils at the tank bearing level should be compacted to a density of at least 95 percent of the Modified Proctor maximum dry density (ASTM D1557). Since the sand may be saturated at a depth of about 15 feet, as an alternative to compaction, we recommend that the bearing soils be over-excavated to a depth of 12 inches and backfilled with No. 57 gradation crushed stone or gravel, or Controlled Low-Strength Material (CLSM), also known as flowable fill. Crushed stone or gravel does not need to meet a compaction criterion; however, each 12-inch thickness of gravel should be densified by making at least three passes with a lightweight vibratory compactor over the stone surface.

CLSM is a self-levelling, self-compacting cementitious material that is used as a backfill material in place of conventional sands (refer to ACI Committee Report 229R-94). CLSM is a high-slump, flowable mixture which, by definition, possesses a 28-day compressive strength of less than 1,200 psi. Compaction of CLSM is not required. Because CLSM can be placed by chute, it can be placed without workers entering the excavation, which increases safety.

If CLSM is used, we recommend that the mixture have a specified unconfined compressive strength not exceeding 200 psi at 28 days. Strengths higher than 200 psi cannot be readily excavated using a conventional backhoe at a later date, if necessary. Although CLSM has a higher unit cost than sand backfill, the use of CLSM may provide significant cost savings in labor and placement time on this project. Since weather can have a negative impact on construction, any procedures that result in savings in time should be considered. Test cylinders should be made and cured cylinders tested in unconfined compression in the laboratory to confirm acceptable strength. We recommend that load not be placed on CLSM until the day following its placement (at the earliest).

4.6.4 Backfill Placement and Compaction

After preparation of the tank bearing surface, the fuel tanks may be placed. Clean sand backfill should be placed simultaneously on each side of the tanks and compacted to a density of at least 92 percent of the Modified Proctor maximum dry density. Acceptable excavated material may be reused for the backfilling operation, in accordance with the
Structural Filling and Backfilling section (Section 4.5.6). The clayey sand soils encountered in the borings are not suitable for structural fill or backfill material due to their moisture sensitivity, which would make them difficult to compact. Soils excavated from below the water table will be above optimum moisture content and may be difficult to compact. As such, wet (sandy) soils will require stockpiling and drying prior to placement and compaction.

The 92-percent compaction criterion should be followed until a level 5 feet below the bottom of the pavement subgrade is reached, above which depth compaction to at least 95 percent of the Modified Proctor maximum dry density should be achieved to the level of the bottom of the pavement subgrade, above which depth the 98-percent compaction criterion should be utilized. Compaction may be performed using lightweight, walk-behind vibratory sleds, mechanical tampers, or hand equipment. Most types of power tampers, which can work in confined areas, are satisfactory. If desired, CLSM could be considered for backfill around and above the tanks.

4.7 General Construction Monitoring and Testing Guidelines

Prior to initiating compaction operations, we recommend that representative samples of the structural fill/backfill material to be used and acceptable exposed in-place soils be collected and tested to determine their compaction and classification characteristics. The maximum dry density, optimum moisture content, gradation and plasticity characteristics should be determined. These tests are needed for compaction quality control of the structural fill/backfill material and existing soils and to determine if the fill/backfill material is acceptable.

A representative number of in-place field density tests should be performed in the compacted existing soils and in each lift of structural fill or backfill to confirm that the required degree of compaction has been obtained. In-place density tests should also be performed at representative locations in the bearing level soils in the shallow foundation excavation bottoms. Our recommend minimum density testing frequencies are presented in Table 2.
### Table 4-1: Recommended Field Density Test Frequencies

<table>
<thead>
<tr>
<th>Area</th>
<th>Recommended Minimum Density Test Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subgrade Soils in Structure Areas</td>
<td>1 test per 2,500 ft² in compacted existing soils and in each lift of structural fill or backfill, with a minimum of 2 tests in each structure area.</td>
</tr>
<tr>
<td>Foundation Bearing Level Soils</td>
<td>1 test per 50 ft² of footing bearing surface</td>
</tr>
<tr>
<td>-- Spread (Column) Footings</td>
<td>1 test per 50 lineal feet of wall footing bearing surface</td>
</tr>
<tr>
<td>-- Continuous (Wall) Footings</td>
<td></td>
</tr>
<tr>
<td>Tank Excavation</td>
<td>1 test in compacted existing soils at excavation bottom and 1 test in each 12-inch lift of soil backfill</td>
</tr>
<tr>
<td>Pavement Subgrade Soils</td>
<td>1 test per 5,000 ft² in compacted existing soils and in each lift of structural fill or backfill</td>
</tr>
</tbody>
</table>

#### 4.8 Construction Plans and Specifications Review

We recommend that this office be provided the opportunity to make a general review of the foundation and earthwork plans and specifications prepared from the recommendations presented in this report. We would then suggest any modifications such that our recommendations are properly interpreted and implemented. Our report has been written in a guideline recommendation format and is not appropriate for use as a specification without in-part being reworded into a specification-type format. We recommend that this report not be made a part of the contract documents; however, it should be made available to prospective contractors for information purposes.

The evaluation of conditions which may be encountered in construction requires engineering judgment and interpretation. For this reason, we recommend that Amec Foster Wheeler remain involved with this project during the construction process, particularly during foundation construction and general earthwork operations. If we are not retained during construction, we cannot assume responsibility for misinterpretation of our recommendations, or for unfavorable foundation, floor slab, and pavement performance as a result of judgments rendered by others.
**PROPOSED CONVENIENCE STORE**

- **B-1**
  - Depth: 20.0' A.H.
  - 19' (Asphalt Over Limerock Base)
  - 18' (Fill: Fine SAND (SP); Slightly Silty Fine SAND (SP-SM); With Clay Clods, Roots, Gravel and Limerock Fragments)
  - 17' (Fine SAND (SP); Slightly Silty Fine SAND (SP-SM); Slightly Clayey Fine SAND (SP-SC))
  - 16' (Clayey Fine SAND (SC))

- **B-2**
  - Depth: 20.0' A.H.
  - 19' (Asphalt Over Limerock Base)
  - 18' (Fill: Fine SAND (SP); Slightly Silty Fine SAND (SP-SM); With Clay Clods, Roots, Gravel and Limerock Fragments)
  - 17' (Fine SAND (SP); Slightly Silty Fine SAND (SP-SM); Slightly Clayey Fine SAND (SP-SC))
  - 16' (Clayey Fine SAND (SC))

**PROPOSED CAR WASH**

- **B-3**
  - Depth: 20.0' A.H.
  - 19' (Asphalt Over Limerock Base)
  - 18' (Fill: Fine SAND (SP); Slightly Silty Fine SAND (SP-SM); With Clay Clods, Roots, Gravel and Limerock Fragments)
  - 17' (Fine SAND (SP); Slightly Silty Fine SAND (SP-SM); Slightly Clayey Fine SAND (SP-SC))
  - 16' (Clayey Fine SAND (SC))

**PROPOSED FUEL TANKS**

- **B-4**
  - Depth: 20.0' M.H.
  - 19' (Asphalt Over Limerock Base)
  - 18' (Fill: Fine SAND (SP); Slightly Silty Fine SAND (SP-SM); With Clay Clods, Roots, Gravel and Limerock Fragments)
  - 17' (Fine SAND (SP); Slightly Silty Fine SAND (SP-SM); Slightly Clayey Fine SAND (SP-SC))
  - 16' (Clayey Fine SAND (SC))

**PROPOSED FUEL ISLANDS AND CANOPY**

- **B-5**
  - Depth: 20.0' A.H.
  - 19' (Asphalt Over Limerock Base)
  - 18' (Fill: Fine SAND (SP); Slightly Silty Fine SAND (SP-SM); With Clay Clods, Roots, Gravel and Limerock Fragments)
  - 17' (Fine SAND (SP); Slightly Silty Fine SAND (SP-SM); Slightly Clayey Fine SAND (SP-SC))
  - 16' (Clayey Fine SAND (SC))

- **B-6**
  - Depth: 20.0' A.H.
  - 19' (Asphalt Over Limerock Base)
  - 18' (Fill: Fine SAND (SP); Slightly Silty Fine SAND (SP-SM); With Clay Clods, Roots, Gravel and Limerock Fragments)
  - 17' (Fine SAND (SP); Slightly Silty Fine SAND (SP-SM); Slightly Clayey Fine SAND (SP-SC))
  - 16' (Clayey Fine SAND (SC))

**LEGEND**

- **Black**: Asphalt Over Limerock Base
- **Fill**: Fine SAND (SP); Slightly Silty Fine SAND (SP-SM); With Clay Clods, Roots, Gravel and Limerock Fragments
- **Fine SAND (SP)**: Slightly Silty Fine SAND (SP-SM); Slightly Clayey Fine SAND (SP-SC)
- **Clayey Fine SAND (SC)**

**NOTE**: Please refer to text of report and Soil Test Borings Records for additional information relative to groundwater conditions and potential fluctuations which could occur.
**SOIL TEST BORING RECORD**

**Project:** Gate Convenience Facility - Park St. and Forest St.  
**Boring No.:** B-1  
**Checked By:** CTC  
**Drilled:** March 16, 2016  
**Proj. No.:** 6734-16-9861

**CONTRACTOR:** Independent Drilling, Inc.  
**DRILLER:** Brian (AmecFW field rep.: C. Ignacio)  
**EQUIPMENT:** CME 45B (DR-8, Eff. 87%) - Auto. Hammer  
**METHOD:** Auger/Mud Rotary  
**HOLE DIA.:** 4"  
**REMARKS:** Groundwater not encountered at time of drilling.

---

**SOIL CLASSIFICATION AND REMARKS**

SEE KEY SYMBOL SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS BELOW.

<table>
<thead>
<tr>
<th>DEPTH (ft)</th>
<th>TYPE</th>
<th>ELEV (ft)</th>
<th>SAMPLES</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>FIRM brown fine SAND (SP) with some limerock fragments and cemented sand, and a trace of silt (Fill)</td>
<td>SPT-1</td>
<td>3-10-9</td>
</tr>
<tr>
<td>3</td>
<td>FIRM reddish brown cemented fine SAND (SP)</td>
<td>SPT-2</td>
<td>4-4-3</td>
</tr>
<tr>
<td>3</td>
<td>LOOSE light brown fine SAND (SP)</td>
<td>SPT-3</td>
<td>3-3-4</td>
</tr>
<tr>
<td>4</td>
<td>LOOSE light brownish orange fine SAND (SP) with a trace of clay</td>
<td>SPT-4</td>
<td>4-4-5</td>
</tr>
<tr>
<td>6</td>
<td>FIRM light brownish orange slightly clayey fine SAND (SP-SC)</td>
<td>SPT-5</td>
<td>4-6-5</td>
</tr>
<tr>
<td>10</td>
<td>FIRM orange clayey fine SAND (SC)</td>
<td>SPT-6</td>
<td>6-7-8</td>
</tr>
<tr>
<td>15</td>
<td>BORING TERMINATED</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**DEPTH (ft) | PL (%) | NM (%) | LL (%) | FINES (%) | SPT (bpf) |**
<table>
<thead>
<tr>
<th></th>
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</tbody>
</table>

**THIS RECORD IS A REASONABLE INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BETWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.**
SPT-1
SPT-2
SPT-3
SPT-4
SPT-5
SPT-6

LOOSE brown fine SAND (SP) with traces of clay and limerock fragments (Fill)
LOOSE light brown fine SAND (SP)

LOOSE light brown, orange, and gray clayey fine SAND (SC)

BORING TERMINATED

SOIL CLASSIFICATION AND REMARKS

SEE KEY SYMBOL SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS BELOW.

COLOR

SAMPLES

<table>
<thead>
<tr>
<th>DEPTH (ft)</th>
<th>TYPE</th>
<th>1st 6”</th>
<th>2nd 6”</th>
<th>3rd 6”</th>
<th>N-COUNT</th>
<th>PL (%)</th>
<th>NM (%)</th>
<th>LL (%)</th>
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<tr>
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</tr>
<tr>
<td>5</td>
<td>SPT-2</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>SPT-3</td>
<td>3-2-4</td>
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</tr>
<tr>
<td>15</td>
<td>SPT-4</td>
<td>3-5-5</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>SPT-5</td>
<td>4-5-5</td>
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<tr>
<td>25</td>
<td>SPT-6</td>
<td>1-3-2</td>
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<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

PL (%) NM (%) LL (%)

FINES (%)

SPT (bpf)

CONTRACTOR: Independent Drilling, Inc.
DRILLER: Brian (AmecFW field rep.: C. Ignacio)
EQUIPMENT: CME 45B (DR-8, Eff. 87%) - Auto. Hammer
METHOD: Auger/Mud Rotary
HOLE DIA.: 4"
REMARKS: Groundwater not encountered at time of drilling.

THIS RECORD IS A REASONABLE INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BETWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

SOIL TEST BORING RECORD

Project: Gate Convenience Facility - Park St. and Forest St.
Coord N: Boring No.: B-2
Coord E: Checked By: CTC
Drilled: March 16, 2016
Proj. No.: 6734-16-9861
Soil Classification and Remarks

See key symbol sheet for explanation of symbols and abbreviations below.

- Loose dark brown fine sand (SP) with traces of silt and roots
- Loose light brown fine sand (SP)
- Loose light brown fine sand (SP) with a trace of roots
- Loose light brown fine sand (SP)
- Loose light brown fine sand (SP) with a trace of clay
- Loose orange-gray clayey fine sand (SC)

Boring Terminated

---

Soil Test Boring Record

Project: Gate Convenience Facility - Park St. and Forest St.
Coord N: B-3
Coord E: Checked By: CTC
Drilled: March 16, 2016
Proj. No.: 6734-16-9861

THIS RECORD IS A REASONABLE INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BETWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.
Asphalt over Limerock Base

- **FIRM dark brown fine SAND (SP) with some limerock fragments (Fill)**
  - **FIRM to LOOSE brown to light brown fine SAND (SP)**

- **FIRM light brownish orange fine SAND (SP) with a trace of clay**

- **LOOSE orange-gray clayey fine SAND (SC)**

- **FIRM light orange slightly clayey fine SAND (SP-SC)**

- **FIRM light brownish orange fine SAND (SP) with a trace of clay**

Boring Terminated

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**SOIL TEST BORING RECORD**

**Project:** Gate Convenience Facility - Park St. and Forest St.

**Boring No.:** B-4

**Coord N:**

**Coord E:**

**Drilled:** March 16, 2016

**Checked By:** CTC

**Proj. No.:** 6734-16-9861

**CONTRACTOR:** Independent Drilling, Inc.

**DRILLER:** Brian (AmecFW field rep.: C. Ignacio)

**EQUIPMENT:** CME 45B (DR-8, Eff. 87%) - Auto. Hammer

**METHOD:** Auger/Mud Rotary

**HOLE DIA.:** 4"

**REMARKS:** Groundwater not encountered at time of drilling.

---

THIS RECORD IS A REASONABLE INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BETWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.
See key symbol sheet for explanation of symbols and abbreviations below.

### Soil Classification and Remarks

<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>Type</th>
<th>Sample</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>LOOSE dark brown fine SAND (SP) with some gravel and traces of silt and limberock fragments</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>LOOSE light brown fine SAND (SP) with a trace of gravel</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>FIRM light brown fine SAND (SP) with a trace of clay</td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>FIRM orange-gray clayey fine SAND (SC)</td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>FIRM light orange-gray slightly clayey fine SAND (SP-SC)</td>
<td></td>
</tr>
<tr>
<td>25</td>
<td>BORING TERMINATED</td>
<td></td>
</tr>
</tbody>
</table>

### Soil Test Boring Record

- **Project:** Gate Convenience Facility - Park St. and Forest St.
- **Boring No.:** B-5
- **Coord N:**
- **Coord E:**
- **Drilled:** March 16, 2016
- **Prox. No.:** 6734-16-9861

**Remarks:** Groundwater not encountered at time of drilling.
SOIL TEST BORING RECORD

Project: Gate Convenience Facility - Park St. and Forest St.
Coord N: Boring No.: B-6
Coord E:
Drilled: March 16, 2016
Proj. No.: 6734-16-9861

CONTRACTOR: Independent Drilling, Inc.
DRILLER: Brian (AmecFW field rep.: C. Ignacio)
EQUIPMENT: CME 45B (DR-8, Eff. 87%) - Auto. Hammer
METHOD: Auger/Mud Rotary
HOLE DIA.: 4"
REMARKS: Groundwater not encountered at time of drilling.

THIS RECORD IS A REASONABLE INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BETWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.
# AUGER BORING RECORDS

Gate Convenience Facility  
Park Street and Forest Street  
Amec Foster Wheeler Project No. 6734-16-9861  
Date Performed: March 16 to April 12, 2016

<table>
<thead>
<tr>
<th>Auger Boring No.</th>
<th>Depth (feet)</th>
<th>Material Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A-1</td>
<td>0.0 - 1.0</td>
<td>Brown fine SAND (SP) with a few limerock fragments and traces of hardened clay clods and roots (Fill)</td>
</tr>
<tr>
<td></td>
<td>1.0 - 6.0</td>
<td>Light brown fine SAND (SP)</td>
</tr>
<tr>
<td></td>
<td>A.B.T.¹</td>
<td>GWL²: Not Encountered @ TOD³</td>
</tr>
<tr>
<td>A-2</td>
<td>0.0 - 1.5</td>
<td>Brown fine SAND (SP) with a few limerock fragments and a trace of roots (Fill)</td>
</tr>
<tr>
<td></td>
<td>1.5 - 5.0</td>
<td>Light brown fine SAND (SP)</td>
</tr>
<tr>
<td></td>
<td>5.0 - 6.0</td>
<td>Light brownish orange fine SAND (SP) with a few sandy clay clods</td>
</tr>
<tr>
<td></td>
<td>A.B.T.</td>
<td>GWL: Not Encountered @ TOD</td>
</tr>
<tr>
<td>A-3</td>
<td>0.0 - 1.0</td>
<td>Dark brown fine SAND (SP) with traces of roots, silt, and rock (Fill)</td>
</tr>
<tr>
<td></td>
<td>1.0 - 1.5</td>
<td>Dark gray fine SAND (SP) with a trace of hardened clay clods (Fill)</td>
</tr>
<tr>
<td></td>
<td>1.5 - 5.5</td>
<td>Light brown fine SAND (SP) with traces of roots and rock</td>
</tr>
<tr>
<td></td>
<td>5.5 - 6.0</td>
<td>Very light brown fine SAND (SP)</td>
</tr>
<tr>
<td></td>
<td>A.B.T.</td>
<td>GWL: Not Encountered @ TOD</td>
</tr>
<tr>
<td>A-4</td>
<td>0.0 - 0.5</td>
<td>Dark brown fine SAND (SP) with some limerock fragments and traces of silt and roots (Fill)</td>
</tr>
<tr>
<td></td>
<td>0.5 - 1.5</td>
<td>Dark brown fine SAND (SP) with a trace of silt</td>
</tr>
<tr>
<td></td>
<td>1.5 - 6.0</td>
<td>Light brown fine SAND (SP)</td>
</tr>
<tr>
<td></td>
<td>A.B.T.</td>
<td>GWL: Not Encountered @ TOD</td>
</tr>
<tr>
<td>A-5</td>
<td>0.0 - 0.2</td>
<td>Asphalt</td>
</tr>
<tr>
<td></td>
<td>0.2 - 0.5</td>
<td>Brown fine SAND (SP) with some limerock fragments and pieces of recycled asphalt roofing shingles</td>
</tr>
<tr>
<td></td>
<td>0.5 - 6.0</td>
<td>Very light brown to light brown fine SAND (SP)</td>
</tr>
<tr>
<td></td>
<td>A.B.T.</td>
<td>GWL: Not Encountered @ TOD</td>
</tr>
<tr>
<td>P-1</td>
<td>0.0 - 0.7</td>
<td>Dark brown fine SAND (SP) with some red mulch, a few pieces of recycled asphalt roofing shingles and traces of roots and limerock fragments (Fill)</td>
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<tr>
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<td>0.7 - 4.2</td>
<td>Light brown fine SAND (SP)</td>
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<tr>
<td></td>
<td>4.2 - 8.3</td>
<td>Light brownish orange fine SAND (SP) with a trace of clay</td>
</tr>
<tr>
<td></td>
<td>8.3 - 11.0</td>
<td>Orange-gray clayey fine SAND (SC)</td>
</tr>
<tr>
<td></td>
<td>A.B.T.</td>
<td>GWL: Not Encountered @ TOD</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ESHGWL⁴: 5.0 feet</td>
</tr>
<tr>
<td>P-2</td>
<td>0.0 - 0.4</td>
<td>Dark brown fine SAND (SP) with some limerock fragments and limerock fragments (Fill)</td>
</tr>
<tr>
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<td>0.4 - 1.1</td>
<td>Brown fine SAND (SP) with some limerock fragments and a trace of shell fragments (Fill)</td>
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<td></td>
<td>1.1 - 9.7</td>
<td>Very light brown to light brown fine SAND (SP)</td>
</tr>
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<td></td>
<td>9.7 - 12.0</td>
<td>Orange-gray clayey fine SAND (SC)</td>
</tr>
<tr>
<td></td>
<td>A.B.T.</td>
<td>GWL: Not Encountered @ TOD</td>
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<tr>
<td></td>
<td></td>
<td>ESHGWL: 3.8 feet</td>
</tr>
</tbody>
</table>

Reviewed by: CTC  
Date: 5/24/2016

Notes:  
¹A.B.T. - Auger Boring Terminated  
²GWL - Groundwater Level (depth below existing ground surface)  
³TOD - Time of Drilling  
⁴ESHGWL: Estimated Seasonal High Groundwater Level (depth below existing ground surface)
FIELD PROCEDURES

Soil Test Borings
The soil test borings were performed in general accordance with ASTM D1586, "Standard Test Method for Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils." The borings were initially advanced by augering. A rotary drilling process was subsequently used and bentonite drilling fluid was circulated in the boreholes to stabilize the sides and flush the cuttings. At regular intervals, the drilling tools were removed and soil samples were obtained with a standard 1.4-inch I.D., 2.0-inch O.D., split-tube sampler. An internal liner was not utilized in the sampler. The sampler was first seated 6 inches and then driven an additional foot with blows of a 140-pound automatically or manually tripped hammer falling 30 inches. The number of hammer blows required to drive the sampler the final foot is designated the "Penetration Resistance." The penetration resistance, when properly interpreted, is an index to the soil strength and density.

Representative portions of the soil samples, obtained from the sampler, were placed in plastic jars and transported to our laboratory. The samples were then examined by a geotechnical engineer in order to confirm the field classifications.

Auger Borings (Manual)
The auger borings were advanced manually by the use of a bucket-type auger. The soils encountered were identified, in the field, from cuttings brought to the surface by the augering process. Representative soil samples were placed in glass jars and transported to our laboratory where they were examined by an engineer in order to confirm the field classifications. These borings were performed in accordance with ASTM D1452.

Seasonal High Groundwater Level Estimation
The depth to the seasonal high groundwater level was estimated at selected locations. The position of the seasonal high groundwater level was estimated by closely observing the soil cuttings for changes in root and organic content, soil stratification and subtle changes in soil coloration or mottling or the presence of a polychromatic matrix (two or more colors arranged in a splotchy pattern) which are indicative of the seasonal high water table. The method used to estimate the seasonal high groundwater level is similar to that prescribed by the United States Department of Agriculture Soil Conservation Service. It should be noted that this methodology does not consider recent or future site drainage improvements or man-induced activities which may impact the groundwater level at the site.
# MAJOR DIVISIONS

**COARSE GRAINED SOILS**

(More than 50% of material is larger than No. 200 sieve size)

**GRAVELS**

(More than 50% of coarse fraction is larger than the No. 4 sieve size)

- **CLEAN GRAVELS**
  - (Little or no fines)
  - **GW** Well graded gravels, gravel - sand mixtures, little or no fines.

- **GRAVELS WITH FINES**
  - (Appreciable amount of fines)
  - **GM** Silty gravels, gravel - sand - silt mixtures.
  - **GC** Clayey gravels, gravel - sand - clay mixtures.
  - **WOH - Weight of Hammer**
  - **WOR - Weight of Drill Rods**
  - **SCP - Static Cone Penetrometer Tip Resistance (kg/sq. cm)**
  - **Su - undrained shear strength estimated from pocket penetrometer**
  - **qu - unconfined compressive strength estimated from pocket penetrometer**

**SANDS**

(More than 50% of coarse fraction is smaller than the No. 4 sieve size)

- **CLEAN SANDS**
  - (Little or no fines)
  - **SW** Well graded sands, gravelly sands, little or no fines.

- **SANDS WITH FINES**
  - (Appreciable amount of fines)
  - **SM** Silty sands, sand - silt mixtures.
  - **SC** Clayey sands, sand - clay mixtures.

**FINE GRAINED SOILS**

(Liquid limit LESS than 50)

**SILTS AND CLAYS**

- **ML** Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts and with slight plasticity.

- **CL** Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays.

- **OL** Organic silts and organic silty clays of low plasticity.

**SILTS AND CLAYS**

(Liquid limit GREATER than 50)

- **MH** Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts.

- **CH** Inorganic clays of high plasticity, fat clays

- **OH** Organic clays of medium to high plasticity, organic silt.

**HIGHLY ORGANIC SOILS**

- **PT** Peat and other highly organic soils.

---

**BOUNDARY CLASSIFICATIONS:** Soils possessing characteristics of two groups are designated by combinations of group symbols.

**SILT OR CLAY**

<table>
<thead>
<tr>
<th>SAND</th>
<th>GRAVEL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fine</td>
<td>Medium</td>
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<tr>
<td>No.200</td>
<td>No.40</td>
</tr>
</tbody>
</table>

**U.S. STANDARD SIEVE SIZE**


**KEY TO SYMBOLS AND DESCRIPTIONS**

**Undisturbed Sample (UD)**

**Auger Cuttings**

- **Split Spoon Sample (SS)**
- **Bulk Sample**

- **Rock Core (RC)**

- **Water Table at time of drilling**

- **Water Table after 24 hours**

- **100% - Percent Loss of Drilling Fluid**

- **Su - undrained shear strength estimated from pocket penetrometer**

- **qu - unconfined compressive strength estimated from pocket penetrometer**

**Correlation of Penetration Resistance (N) with Relative Density and Consistency**

**SAND & GRAVEL**

<table>
<thead>
<tr>
<th>No. of Blows</th>
<th>Relative Density</th>
<th>No. of Blows</th>
<th>Consistency</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 - 4</td>
<td>Very Loose</td>
<td>0 - 2</td>
<td>Very Soft</td>
</tr>
<tr>
<td>5 - 10</td>
<td>Loose</td>
<td>3 - 4</td>
<td>Soft</td>
</tr>
<tr>
<td>11 - 20</td>
<td>Firm</td>
<td>5 - 8</td>
<td>Firm</td>
</tr>
<tr>
<td>21 - 30</td>
<td>Very Firm</td>
<td>9 - 15</td>
<td>Stiff</td>
</tr>
<tr>
<td>31 - 50</td>
<td>Dense</td>
<td>16 - 30</td>
<td>Very Stiff</td>
</tr>
<tr>
<td>Over 50</td>
<td>Very Dense</td>
<td>31 - 50</td>
<td>Hard</td>
</tr>
<tr>
<td></td>
<td>Over 50</td>
<td></td>
<td>Very Hard</td>
</tr>
</tbody>
</table>

**SILT & CLAY**

**Modifiers**

These Modifiers Provide Our Estimate of The Amount of Fines (Silt or Clay Size Particles) in The Soil Sample

**APPROX. FINES CONTENT**

<table>
<thead>
<tr>
<th>MODIFIERS</th>
<th>UNIFIED SOIL CLASSIFICATION SYMBOL</th>
</tr>
</thead>
<tbody>
<tr>
<td>5% TO 12%</td>
<td>SLIGHTLY SILTY / SLIGHTLY CLAYEY</td>
</tr>
<tr>
<td>12% TO 30%</td>
<td>SILTY / CLAYEY</td>
</tr>
<tr>
<td>30% TO 50%</td>
<td>VERY SILTY / VERY CLAYEY</td>
</tr>
</tbody>
</table>

These Modifiers Provide Our Estimate of Shell, Rock Fragments, or Roots in The Soil Sample

**APPROXIMATE CONTENT, BY WEIGHT**

<table>
<thead>
<tr>
<th>MODIFIERS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1% to 5%</td>
</tr>
<tr>
<td>5% to 12%</td>
</tr>
<tr>
<td>12% to 30%</td>
</tr>
<tr>
<td>30% to 50%</td>
</tr>
</tbody>
</table>

These Modifiers Provide Our Estimate of Organic Content in The Soil Sample

**ORGANIC CONTENT**

<table>
<thead>
<tr>
<th>MODIFIERS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1% TO 3%</td>
</tr>
<tr>
<td>3% TO 5%</td>
</tr>
<tr>
<td>5% TO 30%</td>
</tr>
<tr>
<td>&gt; 30%</td>
</tr>
</tbody>
</table>