- GEOTECHNICAL ENGINEERING
- CONSTRUCTION MATERIALS ENGINEERING & TESTING
- SOILS • ASPHALT • CONCRETE

July 30, 2019

Trihydro Corporation
1011 West County Line Road
New Braunfels, Texas 78130

Attention: David Weikel, P.E.

SUBJECT: **SUBSURFACE EXPLORATION, LABORATORY TESTING PROGRAM, AND FOUNDATION RECOMMENDATIONS**
FOR THE PROPOSED COMPOSITE ELEVATED STORAGE TANK
JOB NO.: 609-618-800, C200
GREEN VALLEY SUD - PLANT 3
5167 STAGECOACH ROAD
SEGUIN, TEXAS
RETL Project No.: 219100

Dear Mr. Weikel,

In accordance with our agreement, Rock Engineering and Testing Laboratory, Inc. (RETL) has conducted a subsurface exploration, laboratory testing program, and foundation evaluation for the above referenced project. The results of this exploration, together with our recommendations, are presented in this electronic copy. RETL will provide up to two (2) versions of this report in hard copy at the request of the client.

Often, because of design and construction details that occur on a project, questions arise concerning soil conditions. RETL would be pleased to continue its role as the Geotechnical Engineer during project implementation.

RETL also has great interest in providing materials testing and observation services during the construction of the project. If you will advise us of the appropriate time to discuss these engineering services, we will be pleased to meet with you at your convenience.

Sincerely,

Kyle D. Hammock, P.E.
Vice President - San Antonio

**SUBSURFACE EXPLORATION, LABORATORY TESTING PROGRAM,
AND FOUNDATION RECOMMENDATIONS
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JOB NO.: 609-618-800, C200
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RETL PROJECT NUMBER: 219100

PREPARED FOR:

**TRIHYDRO CORPORATION
1011 WEST COUNTY LINE ROAD
NEW BRAUNFELS, TEXAS 78130**

JULY 30, 2019

PREPARED BY:

**ROCK ENGINEERING AND TESTING LABORATORY, INC.
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**TEXAS BOARD OF PROFESSIONAL ENGINEERS
FIRM REGISTRATION NUMBER 2101**

**Kyle D. Hammock, P.E.
Vice President - San Antonio**

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INTRODUCTION

This report presents the results of a soils exploration and foundation evaluation for the proposed Composite Elevated Storage Tank to be located at 5167 Stagecoach Road in Seguin, Texas. This study was conducted for Trihydro Corporation.

Authorization

The work for this project was performed in accordance with RETL Proposal No. P021919B dated February 19, 2019. The proposal contained a scope of work, fee, and limitations. A Trihydro Corporation Professional Services Subcontractor Agreement Work Order No. 19-164WO-M was issued to RETL on May 1, 2019.

Purpose and Scope

The purpose of this exploration was to evaluate the soil and groundwater conditions at the subject site and to provide foundation recommendations suitable for the proposed tank. The scope of the exploration and evaluation included the subsurface exploration, field and laboratory testing, engineering analysis and evaluation of the subsurface soils, provision of foundation recommendations and preparation of this report.

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

General

The exploration and analysis of the subsurface conditions reported herein are considered sufficient in detail and scope to form a reasonable basis for the foundation design. The recommendations submitted for the proposed project are based on the available soil information and the preliminary design details provided by David Weikel, P.E. If the structural engineer requires additional soil parameters to complete the foundation design, and the requested information can be obtained from the agreed upon scope of work, RETL will provide the requested information as a supplement to this report.

The Geotechnical Engineer states that the findings, recommendations, specifications or professional advice contained herein, have been presented after being prepared in a manner consistent with the level of care and skill ordinarily exercised by reputable members of the Geotechnical Engineer's profession practicing contemporaneously under similar conditions in the locality of the project.

RETL operates in general accordance with "*Standard Practice for Minimum Requirements for Agencies Engaged in the Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction*", (ASTM D3740). No other representations are expressed or implied, and no warranty or guarantee is included or intended.

This report has been prepared for the exclusive use of the Trihydro Corporation for the specific application towards the proposed Composite Elevated Storage Tank to be located at 5167 Stagecoach Road in Seguin, Texas.

FIELD EXPLORATION

Scope

The field exploration, completed in order to evaluate the engineering characteristics of the foundation materials, included a reconnaissance of the project site, drilling the test borings, and recovering relatively undisturbed and disturbed samples of the subsurface soils encountered at the test boring locations. RETL performed three (3) borings at the subject site to depths of 80-feet.

During the sample recovery operations, the soils encountered were classified and recorded on Logs of Boring in accordance with "*Standard Guide for Field Logging of Subsurface Exploration of Soil and Rock*", (ASTM D5434). Upon completion of the drilling operations and obtaining the groundwater observations, the drill holes were backfilled with excavated soil.

RETL personnel located the borings in the field utilizing the site plan provided. RETL determined the depth of the borings and performed the boring operations. A Boring Location Plan is provided in the Appendix of this report.

Drilling and Sampling Procedures

The borings were performed using a drilling rig equipped with a rotary head, and solid flight auger drilling methods were used to advance the boreholes to the desired termination depth. Disturbed samples were obtained employing split-barrel sampling procedures in general accordance with the procedures for "*Penetration Test and Split-Barrel Sampling of Soils*" (ASTM D1586). Relatively undisturbed soil samples were obtained using thin-wall tube sampling procedures in accordance with the procedures for "*Thin Walled Tube Sampling of Soils*" (ASTM D1587). The samples obtained by this procedure were extruded by a hydraulic ram and classified in the field.

The samples were placed in plastic bags, marked according to boring number, depth and any other pertinent field data, and stored in special containers. At the completion of each days drilling operations, the samples were delivered to RETL's laboratory for testing.

Field Tests and Measurements

Penetration Tests - During the sampling procedures, standard penetration tests (SPT) were performed to obtain the standard penetration value of the soil. The standard penetration value (N) is defined as the number of blows of a 140-pound hammer, falling 30-inches, required to advance the split-barrel sampler 1-foot into the soil. The sampler is lowered to the bottom of the previously cleaned drill hole and advanced by blows from the hammer.

The number of blows is recorded for each of three successive 6-inch penetrations. The "N" value is obtained by adding the second and third 6-inch increment number of blows. The results of standard penetration tests indicate the relative density of cohesionless soils and comparative consistency of cohesive soils, thereby providing a basis for estimating the relative strength and compressibility of the soil profile components.

Water Level Observations - Water level observations were obtained during the test boring operations and are noted on the Logs of Boring provided in the Appendix. The amount of water in open boreholes largely depends on the permeability of the soils encountered at the boring location.

In relatively pervious soils, such as sandy soils, the indicated depths are usually reliable groundwater levels. In relatively impervious soils, a suitable estimate of the groundwater depth may not be possible, even after several days of observation. Seasonal variations, temperature, land-use, proximity to a body of water, and recent rainfall conditions may influence the depth to the groundwater.

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

LABORATORY TESTING PROGRAM

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

The laboratory-testing program included performing supplementary visual classification (ASTM D2487) on samples obtained. In addition, selected samples were subjected to water content tests (ASTM D2216), Atterberg limits tests (ASTM D4318), and percent material finer than the #200 sieve tests (ASTM D1140) and one-dimensional swell tests (ASTM D4546). The shear strengths of selected cohesive soil samples were evaluated from unconfined compressive strength tests (ASTM D2166). Estimated soil strengths were obtained using a hand penetrometer.

The laboratory-testing program was conducted in general accordance with applicable ASTM Specifications. The results of the testing are presented on the accompanying Logs of Boring provided in the Appendix.

SUBSURFACE CONDITIONS

General

The types of foundation bearing materials encountered in the test borings have been visually classified and are described in detail on the Logs of Boring. The results of the strength tests, standard penetration tests, water level observations and laboratory tests are presented on the Logs of Boring in numerical form. Representative samples of the soils were placed in polyethylene bags and are now stored in the laboratory for further analysis, if desired. Unless notified to the contrary, the samples will be disposed of three (3) months after issuance of this report.

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

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

Soil Conditions

The generalized subsurface conditions encountered at the borings have been summarized and soil properties including classification, strength, plasticity, and grain size are provided in the following table:

D	Description	LL	PI	C	θ	γ_e	-#200	P or N
0-6	Fat **CLAY**	66-73	48-54	1,500	0	120	87-96	P= 2.5-4.5+ N= 4-26
6-30	Fat **CLAY**	54-67	41-46	3,000	0	120	100	P= 2.5-4.5+ N= 20-37
30-70	Fat **CLAY**	61-75	45-54	4,500	0	120	99-100	P= 4.5-4.5+ N= 25-53
70-80	Fat **CLAY**	---	---	5,000	0	120	---	P= 4.5+ N= 39-49

Where:
D = Depth in feet below existing grade
LL = Liquid Limit (%)
PI = Plasticity Index
C = Average Soil Cohesion, psf (undrained)
θ = Angle of Internal Friction, deg. (undrained)
γ_e = Effective Soil Unit Weight, pcf
-#200= Percent Material Finer than a #200 Sieve
N = Standard Penetration Value range, blows per foot
P = Pocket Penetrometer Value range, tsf

Detailed descriptions of the soils and shale encountered at the boring locations are provided on the Logs of Boring included in the Appendix.

Seismic Site Class

The field investigation did not include a 100-foot deep soil boring, therefore, the soil properties are not known in sufficient detail to determine the Site Class per IBC. In general, this site has firm to hard clay soils which extend to the 80-foot depth. In accordance with IBC Section 1613.3.2-Site Class Definitions and Chapter 20 of ASCE 7, Site Class D materials should have soil undrained shear strengths between 1,000 and 2,000 psf and standard penetration resistances between 15 and 50 blows per foot. The clay soils extending to an approximate depth of 80-feet have strengths similar to Site Class D materials; therefore, RETL recommends that Site Class D, “stiff profile” be assumed. The table below provides recommended seismic parameters for the site:

Recommended Design Seismic Parameters	
0.2 sec (Ss)	0.079g
1.0 sec (S1)	0.031g
Site Coefficient 0.2 sec, Fa	1.6
Site Coefficient 1.0 sec, Fv	2.4
0.2 sec (SDS)	0.085g
1.0 sec (SD1)	0.050g

Groundwater Observations

Groundwater seepage at this site was not encountered during the drilling operations. It should be noted that water levels in an open borehole may require several hours to several days to stabilize depending on the permeability of the soils and that groundwater levels at this site may be subject to seasonal conditions, recent rainfall, drought, tidal or temperature effects.

FOUNDATION DISCUSSION AND RECOMMENDATIONS

Project Description

Based on the information provided to RETL, the proposed project will consist of the construction of a 1 MG composite elevated water storage tank with a pedestal diameter of 38-feet and a total load of 11,170 kips. Typical foundations for support of composite elevated water storage tanks include drilled piers, mats and ring beam footings.

PVR Discussion

The fat clay soils at this site are high to very high in plasticity. **The maximum calculated total potential vertical rise (PVR) for slab on grade type construction is approximately 4-inches**. The PVR was calculated using the Texas Department of Transportation Method TEX-124E and into account the depth of active zone, estimated to extend to a depth of approximately 15-feet, and the Atterberg limits test results of the soils encountered within the active zone.

The estimated PVR value provided is based on a slab on grade system applying a sustained surcharge load of approximately 1.0 pound per square inch on the subgrade soils. The value represents the vertical rise that can be experienced by dry subsoils if they are subjected to conditions that allow them to become saturated, such as poor drainage. Using dry soil conditions to calculate the PVR is generally considered the worst-case scenario. The actual movement of the subsoils is dependent upon their change in moisture content. Differential vertical movements can potentially be equal to the expected total movements. Differential vertical movements associated with the soils at this site may occur over a distance of 15-feet, or approximately the depth of the active zone.

To reduce the PVR to approximately 1-inch for slab on grade or flatwork construction, it will be necessary to remove the expansive clay soils to a minimum depth of 8-feet, moisture condition and compact the exposed subgrade soils, and place a minimum of 8-feet of properly compacted, non-expansive select fill soils into the excavation.

Straight Shaft Drilled Pier Recommendations

A composite elevated water storage tank supported on a shallow mat or ring beam foundation at this site would be subject to undesirable total and differential settlement due to the presence of compressible fat clay soils. Therefore, deep straight shaft drilled piers are recommended for support the tank planned for construction at this site.

The drilled piers supporting the tank shall be founded at a minimum depth of 50-feet below the existing ground surface elevation. The structural designer can utilize the allowable design values for the range in depths included in the following table for straight shaft drilled piers to resist axial compression loads given the strengths of the subsurface materials encountered:

Depth Below Existing Grade (ft)	Allowable Unit Skin Friction (psf) (SF= 2.0)	Allowable End Bearing (ksf) (SF= 3.0)
0-6	Neglect	---
6-30	825	---
30-70	1,250	---
70-80	1,375	15

All depths are referenced from the existing ground surface elevation at the boring locations during the time of our field investigation. The allowable unit skin friction values provided above are based on the average strengths of the in-situ soils and utilize a safety factor of 2.0 to prevent shear failure. The allowable end bearing value utilizes a safety factor of 3.0. **The end bearing should be limited to 20-percent of the pier capacity. Resistance to uplift can be calculated by taking 70-percent of the axial capacity of a straight shaft drilled pier calculated using friction only**.

Deep foundations designed as friction elements using the design parameters provided should undergo very little permanent settlement but may experience elastic settlement. Down-drag or negative skin friction is not a design consideration at this site. The settlement that may be observed in a properly designed and constructed straight shaft drilled pier foundation at this site is on the order of ½-inch.

The piers will be subject to tension loading as a result of the upper clay soils swelling with an increase in the soil moisture content. The uplift force acting on the piers is a function of the soil shear strength, soil-pier adhesion factor, pier circumference and the length of the pier that is subjected to swelling soils. **An uplift force in kips equal to 50-times the diameter of the pier shaft (in feet) can be used to estimate the uplift force on the pier created by the expansive clay soils. The uplift forces created due to the expansive soils and any live loads can be resisted by using 70-percent of the allowable friction below a depth of 15-feet and the dead load on the pier**.

The manual *Drilled Shafts: Construction Procedures and Design Methods* suggests that piers be reinforced throughout their length with a minimum of 1-percent longitudinal reinforcing steel by cross sectional area of the pier. The referenced document states that some reduction in the percentage of longitudinal reinforcing steel may be acceptable if the cross-sectional area of the pier is larger than required due to loading conditions. However, a minimum ¾-percent reinforcing steel by cross sectional area is suggested in the manual even if the cross-sectional area of the pier is more than twice that required due to loading conditions.

A minimum 12-inch void space should be constructed beneath pier caps and tie beams. Pier caps and tie beams should be structurally connected to the piers.

L-Pile Design Criteria

The following LPILE parameters may be used to evaluate the lateral capacity of the piers:

D	Description	C	θ	γ_e	K	E_{50}
0-6	**CLAY**	Neglect				
6-30	**CLAY**	3,000	0	120	1,000	0.005
30-70	**CLAY**	4,500	0	120	2,000	0.004
70-80	**CLAY**	5,000	0	120	2,000	0.004

Where: D = Depth in feet below existing grade
C = Average Soil Cohesion, psf (undrained)
θ = Angle of Internal Friction, deg. (undrained)
γ_e = Effective Soil Unit Weight, pcf
K = Percent Material Finer than a #200 Sieve
E_{50} = Strain at 50% stress level of clay

Drilled Pier Construction Considerations

Free fall of concrete into the pier excavation is permitted provided the concrete can be placed into the pier excavation without striking the sides of the excavation or hitting the rebar. In situations where it is impossible for the concrete to fall freely without striking the rebar cage or sides of the pier excavation, the free fall should be limited to 10-feet or placed with a tremie.

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

Detailed inspection of pier construction should be made by the Geotechnical Engineer or his designated representative to verify that the piers are vertical and founded in the proper bearing stratum and at the proper depth, and to verify that all loose materials have been removed prior to concrete placement. Piers installed at the site may require temporary steel casing to seal any groundwater or sloughing soils.

If the pier hole has been cased, sufficient concrete should remain in the casing as the casing is withdrawn to prevent any discontinuities from forming within the concrete section. Furthermore, concrete placed in drilled piers should not be placed at slumps less than 6-inches unless it is consolidated with a vibrator or by other means. Concrete placed in piers at a slump less than 6-inches increases the potential for honeycombing. Concrete used in piers should be designed to achieve the required strength at the higher slump as referenced above.

For any given pier excavation, placement of steel and concreting should be completed within the same workday. Where water inflow or caving soils are encountered, excavation of piers and placement of concrete within a very short time frame will frequently aid in proper pier construction.

SITE IMPROVEMENT METHODS

General Considerations

A majority of foundation related problems are attributable, at least in part, to poor drainage. Cohesive soils can expand or shrink by absorbing or losing water. Reducing the variation in moisture content can reduce the variation in volume. A number of measures may be used to attain a reduction in subsoil moisture content variations, thus reducing the soil's volume change potential. During construction, a positive drainage scheme should be implemented to prevent ponding of water on the subgrade in the foundation area. Positive grades sloping away from the foundation should be designed and implemented for the area extending at least 20-feet away from the foundation.

Project features beyond the scope of those discussed above should be planned and designed similarly to attain a region of relatively uniform moisture content within the foundation area. Poor drainage schemes resulting in soil moisture and volume changes in clay soils are generally the primary cause of foundation problems.

Concrete Flatwork Construction Considerations

Concrete site flatwork such as driveways and sidewalks will be subject to PVR movements when constructed over the highly plastic soils encountered at this site. Changes in the moisture content of the supporting highly plastic soils causes volumetric changes, resulting in differential movements of the flatwork. PVR movements were discussed in the **"PVR Discussion"** section of this report. Traditional methods to minimize movements within a structure where performance criteria are dictated by the owner or the owner's design professional include undercutting the highly plastic soils and replacing them with properly compacted, non-expansive select fill soils to achieve tolerable movements, usually on the order of 1-inch or less.

Or, where a higher level of performance is required, the structure is supported on drilled piers in conjunction with a structural slab. The cost/benefit ratio of these methods to minimize PVR and differential movements may not be considered cost effective for use on flatwork, but some reduction in PVR is warranted.

RETL recommends that the Design Team in conjunction with the Owner, determine the acceptable PVR condition for slab-on-grade flatwork construction at this site. Undercutting and replacement with select fill soils as discussed in the "**PVR Discussion**" section of this report should then be performed where it is determined that PVR reduction is required.

CONSTRUCTION CONSIDERATIONS

Site Preparation

Within the areas of the subject site where engineered improvements are planned, vegetation, roots, objectionable materials, topsoil and fill materials should be stripped from the surface. A stripping depth of at least 6-inches is recommended unless the competent natural soil materials are encountered at depths shallower than 6-inches. The stripped material should either be stockpiled for use in non-structural/ landscaped areas or removed from the site.

Upon completion of the stripping and undercutting operations and prior to compaction, the exposed subgrade soils should be proof-rolled with a minimum 20-ton rubber tire dump truck or loader under the supervision of RETL to detect any soft areas prior to engineered fill placement. If any soft pockets or pumping areas are identified, the soft materials should be removed to expose firm materials and the excavation replaced with properly compacted engineered fill. The RETL Geotechnical Engineer must approve the subgrade condition prior to the placement of engineered fill materials.

Subgrade Preparation

After proofrolling operations are completed, the exposed subgrade soils should be scarified to a depth of 6-inches, moisture conditioned if necessary, and compacted. The subgrade soils should be compacted to at least 95-percent of the maximum dry density as determined by the standard Proctor test (ASTM D698). The moisture content of the subgrade soils should be maintained at or above the optimum moisture content.

Engineered Fill Materials

After subgrade preparation is complete, properly compacted engineered fill soils should be used to the raise the site areas to the design subgrade elevations. Fill soils placed to raise the site to the design subgrade elevations may consist of on-site excavated materials, imported general fill, or imported select fill soils depending on the area to be filled.

Engineered fill materials, except for select fill, should be placed in no greater than 8-inch thick loose lifts and shall be compacted to at least 95-percent of the maximum dry density as determined by the standard Proctor test (ASTM D698). The moisture content of the general fill soils should be maintained within 1-percent below to 3-percent above the optimum moisture content.

On-site Excavated Fill - Soils generated from on-site excavations, free of organics and deleterious materials, can be used as properly compacted engineered fill soils in all areas except for under the foundation.

Imported General Fill - Imported soils free of organics and deleterious materials and with low to medium plasticity can be used as properly compacted engineered general fill soils beneath a structural foundation to raise the grade to a level condition. General fill soils should have a maximum liquid limit (LL) of 45, a plasticity index (PI) between 10 and 25 and a maximum particle size of 2-inches. General fill should also be used if required to raise the site grades to the design elevations when on-site soils are not available.

Select Fill - Imported select fill material used at this site should have a maximum liquid limit of 40 percent and a plasticity index (PI) between 7 and 18 and contain at least 30-percent sand and gravel size particles. The select fill should be placed in no greater than 8-inch thick loose lifts and shall be compacted to a minimum density of 95-percent of the maximum dry density as determined by the modified Proctor test (ASTM D1557) and within 2-percent of the optimum moisture content.

Imported select fill material used at this site may also be a crushed limestone base material. To create a relatively stable working platform, RETL recommends that the upper 12-inches of fill placed in foundation areas consist of crushed limestone. The crushed limestone select fill material should meet the gradation and plasticity requirements set forth in the 2014 Texas Department of Transportation (TxDOT) 2014 Standard Specifications for Construction of Highways, Streets and Bridges; Item 247, Type A, Grade 1-2.

Earthwork and Foundation Acceptance

Exposure to the environment may weaken the soils if excavations remain open for long periods of time. Therefore, it is recommended that the foundation excavation be extended to the required grade and the foundation be constructed as soon as possible to minimize potential damage to the bearing soils. The foundation bearing level should be free of loose or soft soil, ponded water or debris and should be observed prior to concreting by the Geotechnical Engineer, or his designated representative. Foundation concrete should not be placed on soils that have been disturbed by seepage. If the bearing soils are softened by water intrusion, the unsuitable soils must be removed from the foundation excavations prior to placement of concrete.

The Geotechnical Engineer, or his designated representative, should approve the condition of the exposed subgrade and monitor the placement of engineered fill. As a guideline, field density tests should be performed on the subgrade and each lift of engineered fill as follows:

- Structural areas - minimum of one in-place density test for each 3,000 SF or a minimum of three in-place densities per testing interval.
- Improved areas - minimum of one in-placed density test for each 10,000 SF of minimum of three in-place densities per testing interval

Any areas not meeting the required compaction should be recompacted and retested until compliance is met.

Excavations and Slopes

The geotechnical parameters provided in the tables below may be used for the design of braced excavations. The trench protection should be designed to provide the most conservative design.

D	Description	C	Φ	C'	Φ'	Ka	Kp
0-6	**CLAY**	1,500	0	400	20	0.5	2.0
6-15	**CLAY**	3,000	0	520	27	0.38	2.66

Where: D = Depth below existing grade (ft)
C= Undrained Shear Strength (psf)
Φ = Undrained Angle of Internal Friction (degrees)
C'= Drained Shear Strength (psf)
Φ'= Drained Angle of Internal Friction (degrees)
K_a= Active Earth Pressure Coefficient
Kp= Passive Earth Pressure Coefficient

It should be noted that the values provided in the table above are based on the soil strengths and soil densities encountered in the field. Empirical formulas were used to correlate undrained shear strengths to drained shear strengths and the corresponding angle of internal friction for clay soils.

The active and passive earth pressure coefficients for the soils encountered were calculated using the drained angle of internal friction as recommended in "***FOUNDATION ANALYSIS AND DESIGN***", written by Mr. Joseph Bowles where he states, "Drained soil parameters for stiff clays and Φ-C soils in general may be appropriate for lateral pressures behind braced walls where the excavation is open for a considerable length of time".

The contractor is solely responsible for designing and constructing stable, temporary excavations and should shore, slope or bench the sides of the excavations as required to maintain stability of both the excavation sides and bottom. All excavations should comply with applicable local, state and federal safety regulations including the current OSHA Excavation and Trench Safety Standards. We are providing this information solely as a service to our client. Under no circumstances should the information provided herein be interpreted to mean that RETL is assuming responsibility for construction site safety or the contractor's activities; such responsibility is not being implied and should not be inferred.

In no case should slope height, slope inclination or excavation depth, including utility trench excavation depth, exceed those specified in local, state, and federal safety regulations. Specifically, the current OSHA Health and Safety Standards for Excavations, 29 CFR Part 1926 should be followed. It is our understanding that these regulations are being strictly enforced and if they are not closely followed, the owner and the contractor could be liable for substantial penalties.

The contractor's "competent person", as defined in 29 CFR Part 1926, should evaluate the soil exposed in the excavations as part of the contractor's safety procedures. For excavations, including a trench, extending to a depth of more than 20-feet, it will be necessary to have the side slopes designed by a professional engineer licensed in the State of Texas. The contractor's "competent person" should establish a minimum lateral distance from the crest of the slope for all vehicles and spoil piles. Likewise, the contractor's "responsible person" should establish protective measures for exposed slope faces.

Based on the field and laboratory strength test results, the upper natural clays soils have an OSHA soil classification of Type B. OSHA requires temporary slopes of 1H:1V for Type B soils. Long term excavations will require flatter slopes.

GENERAL COMMENTS

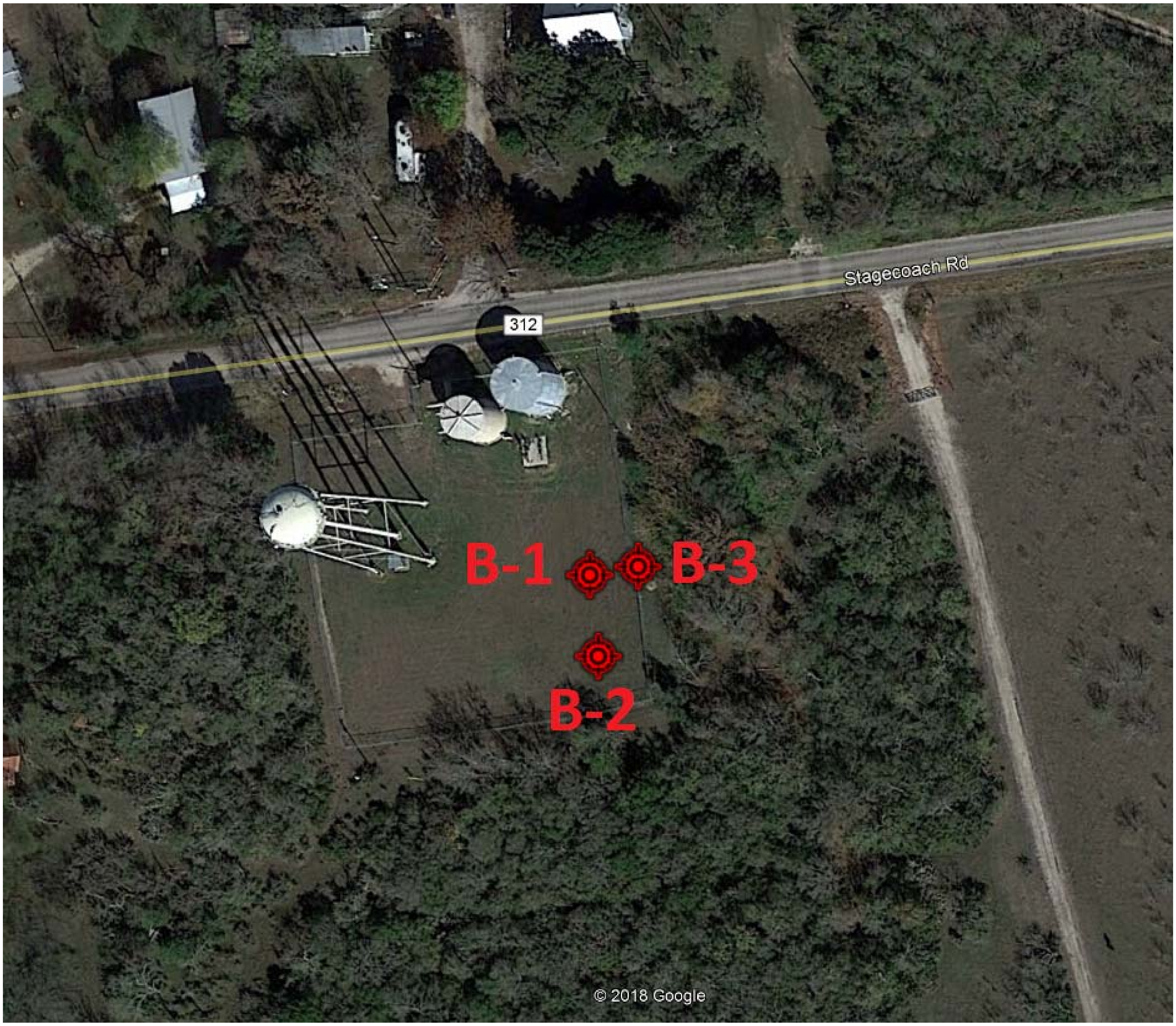
It is recommended that the services of RETL be engaged to test and evaluate the soils in the foundation excavations prior to concreting in order to verify that the bearing soils are consistent with those encountered in the test borings. RETL cannot accept any responsibility for any conditions that deviate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

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

APPENDIX

BORING LOCATION PLAN

NO SCALE
BORING LOCATIONS ARE APPROXIMATE



July 30, 2019
Trihydro Corporation
RETL Project No.: 219100

COMPOSITE ELEVATED STORAGE TANK
Green Valley SUD Plant 3
5167 Stagecoach Rd - Seguin, Texas

ROCK ENGINEERING AND TESTING LABORATORY, INC.
10856 VANDALE STREET
SAN ANTONIO, TEXAS 78216
(210) 495-8000

LOG OF BORING B-1

Rock Engineering & Testing Laboratory, Inc.
10856 Vandale Street
San Antonio, Texas 78216
Telephone: 210-495-8000
Fax: 210-495-8015

CLIENT: Trihydro Corporation
PROJECT: Elevated Storage Tank - Plant 3
LOCATION: 5167 Stagecoach Rd - Seguin, Texas
NUMBER: 219100

DATE(S) DRILLED: 07/09/19

DRILLING METHOD(S):
Solid Flight Auger

GROUNDWATER INFORMATION:
Groundwater was not encountered during drilling, nor measured upon the completion of the drilling.

SURFACE ELEVATION: N/A

FIELD DATA					LABORATORY DATA							
SOIL SYMBOL	DEPTH (FT)	SAMPLE NUMBER	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: TONS/SQ FT PERCENT RECOVERY/ ROCK QUALITY DESIGNATION	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ FT)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
		SH S-1		P= 2.5	31							**FAT CLAY**, dark brown, very moist, very stiff.
		SH S-2		P= 4.5+	18	66	16	50			87	**FAT CLAY**, brown, moist, very stiff. (CH)
	5	SH S-3		P= 4.5+	15							**FAT CLAY**, with calcareous material, light brown and gray, moist, very stiff.
		SH S-4		P= 4.0	18							Same as above. (swell= 0.5%, final moisture= 22%)
		SH S-5		P= 2.5	19							Same as above.
	10											
	15	SH S-6		P= 4.5	24	58	17	41			100	**FAT CLAY**, light brown and gray, moist, very stiff. (CH)
	20	SH S-7		P= 4.0	23							Same as above.
	25	SH S-8		P= 4.5	29							Same as above.
	30	SH S-9		P= 4.5	28				98	1.8		**FAT CLAY**, slickensided, light brown and gray, moist, very stiff.
	35	SH S-10		P= 4.5+	23	61	16	45			99	Same as above, hard. (CH)
	40	SH S-11		P= 4.5+	23							Same as above, light brown & pale brown.
	45	SH S-12		P= 4.5+	25				100	3.2		**FAT CLAY**, slightly slickensided, light brown and pale brown, moist, hard.
	50	SH S-13		P= 4.5+	25							Same as above.

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
T - POCKET TORVANE SHEAR STRENGTH

REMARKS:
Boring location determined by RETL. Drilling operations performed by RETL.
GPS Coordinates: N 29.548137°, W -98.113287°

LOG OF BORING B-1

Rock Engineering & Testing Laboratory, Inc.
10856 Vandale Street
San Antonio, Texas 78216
Telephone: 210-495-8000
Fax: 210-495-8015

CLIENT: Trihydro Corporation
PROJECT: Elevated Storage Tank - Plant 3
LOCATION: 5167 Stagecoach Rd - Seguin, Texas
NUMBER: 219100

DATE(S) DRILLED: 07/09/19

DRILLING METHOD(S):
Solid Flight Auger

GROUNDWATER INFORMATION:
Groundwater was not encountered during drilling, nor measured upon the completion of the drilling.

FIELD DATA				LABORATORY DATA							
DEPTH (FT)	SAMPLE NUMBER	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: TONS/SQ FT PERCENT RECOVERY/ ROCK QUALITY DESIGNATION	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ FT)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
55	SH S-14		P= 4.5+	26	75	21	54			100	Same as above. (CH)
60	SH S-15		P= 4.5+	25							**FAT CLAY**, light brown and pale brown, moist, hard.
65	SH S-16		P= 4.5+	27				99	2.6		Same as above, slickensided.
70	SH S-17		P= 4.5+	24							Same as above.
75	SPT S-18		N= 47	25							**FAT CLAY**, light brown and pale brown, moist, hard.
80	SPT S-19		N= 47	25							Same as above.
											Boring terminated at a depth of 80-feet.

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
T - POCKET TORVANE SHEAR STRENGTH

REMARKS:
Boring location determined by RETL. Drilling operations performed by RETL.
GPS Coordinates: N 29.548137°, W -98.113287°

LOG OF BORING B-2

Rock Engineering & Testing Laboratory, Inc.
10856 Vandale Street
San Antonio, Texas 78216
Telephone: 210-495-8000
Fax: 210-495-8015

CLIENT: Trihydro Corporation
PROJECT: Elevated Storage Tank - Plant 3
LOCATION: 5167 Stagecoach Rd - Seguin, Texas
NUMBER: 219100

DATE(S) DRILLED: 07/09/19

DRILLING METHOD(S):
Solid Flight Auger

GROUNDWATER INFORMATION:
Groundwater was not encountered during drilling, nor measured upon the completion of the drilling.

SURFACE ELEVATION: N/A

DEPTH (FT)	SAMPLE NUMBER	N: BLOWS/FT P: TONS/SQ FT T: TONS/SQ FT PERCENT RECOVERY/ ROCK QUALITY DESIGNATION	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ FT)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
	SH S-1	P= 3.0	32	72	24	48			96	**FAT CLAY**, dark brown, very moist, very stiff. (CH)
	SH S-2	P= 4.5+	22							Same as above, moist. (swell= 5.7%, final moisture= 31%)
5	SPT S-3	N= 50	5							**SILTY GRAVEL**, light brown, dry, very dense.
	SPT S-4	N= 20	17	55	15	40			98	**FAT CLAY**, light brown and gray, moist, very stiff. (CH)
10	SPT S-5	N= 24	18							Same as above, with calcareous material.
15	SH S-6	P= 4.5+	23							Same as above.
20	SH S-7	P= 4.5+	20							**FAT CLAY**, light brown and pale brown, moist, very stiff.
25	SH S-8	P= 4.5+	22	54	12	42			100	Same as above. (CH)
30	SPT S-9	N= 37	23							Same as above, hard.
35	SPT S-10	N= 46	25							**FAT CLAY**, pale brown and dark gray, moist, hard.
40	SH S-11	P= 4.5+	23				101	5.4		Same as above.
45	SH S-12	P= 4.5+	24							Same as above.
50	SPT S-13	N= 40	24							**FAT CLAY**, pale brown and dark gray, moist, hard.

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
T - POCKET TORVANE SHEAR STRENGTH

REMARKS:
Boring location determined by RETL. Drilling operations performed by RETL.
GPS Coordinates: N 29.548009°, W -98.113272°

LOG OF BORING B-2

Rock Engineering & Testing Laboratory, Inc.
10856 Vandale Street
San Antonio, Texas 78216
Telephone: 210-495-8000
Fax: 210-495-8015

CLIENT: Trihydro Corporation
PROJECT: Elevated Storage Tank - Plant 3
LOCATION: 5167 Stagecoach Rd - Seguin, Texas
NUMBER: 219100

DATE(S) DRILLED: 07/09/19

DRILLING METHOD(S):
Solid Flight Auger

GROUNDWATER INFORMATION:
Groundwater was not encountered during drilling, nor measured upon the completion of the drilling.

SOIL SYMBOL	DEPTH (FT)	SAMPLE NUMBER	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: TONS/SQ FT PERCENT RECOVERY/ ROCK QUALITY DESIGNATION	MOISTURE CONTENT (%)	LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ FT)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
	55	SPT S-14		N= 53	26	74	23	51			100	Same as above, light brown and dark gray. (CH)
	60	SPT S-15		N= 46	25							Same as above, pale brown and dark gray.
	65	SH S-16		P= 4.5+	27							**FAT CLAY**, dark gray, moist, hard.
	70	SH S-17		P= 4.5+	25				97	3.5		Same as above, slightly slickensided.
	75	SPT S-18		N= 47	24							Same as above.
	80	SPT S-19		N= 49	25							**FAT CLAY**, dark gray, moist, hard. Boring terminated at a depth of 80-feet.

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
T - POCKET TORVANE SHEAR STRENGTH

REMARKS:
Boring location determined by RETL. Drilling operations performed by RETL.
GPS Coordinates: N 29.548009°, W -98.113272°

LOG OF BORING B-3

Rock Engineering & Testing Laboratory, Inc.
10856 Vandale Street
San Antonio, Texas 78216
Telephone: 210-495-8000
Fax: 210-495-8015

CLIENT: Trihydro Corporation
PROJECT: Elevated Storage Tank - Plant 3
LOCATION: 5167 Stagecoach Rd - Seguin, Texas
NUMBER: 219100

DATE(S) DRILLED: 07/08/19

DRILLING METHOD(S):
Solid Flight Auger / Air Rotary

GROUNDWATER INFORMATION:
Groundwater was not encountered during drilling, nor measured upon the completion of the drilling.

SURFACE ELEVATION: N/A

SOIL SYMBOL	DEPTH (FT)	SAMPLE NUMBER	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: TONS/SQ FT PERCENT RECOVERY/ ROCK QUALITY DESIGNATION	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ FT)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
		SPT S-1		N= 4	31							**FAT CLAY**, dark brown, very moist, firm.
		SPT S-2		N= 26	20							Same as above, moist, very stiff.
	5	SH S-3		P= 4.5+	18	73	19	54			89	**FAT CLAY**, brown, moist, very stiff. (CH) (swell= 8.6%, final moisture= 25%)
		SPT S-4		N= 33	13							Same as above, slightly moist.
	10	SPT S-5		N= 28	18							**FAT CLAY**, light brown, moist, very stiff.
	15	SPT S-6		N= 21	19							Same as above, light brown and gray.
	20	SH S-7		P= 4.5+	20	67	21	46			100	Same as above. (CH)
	25	SH S-8		P= 4.5+	24							**FAT CLAY**, light brown and gray, moist, very stiff.
	30	SH S-9		P= 4.5+	23							Same as above.
	35	SH S-10		P= 4.5+	22	63	19	44			99	Same as above. (CH)
	40	SPT S-11		N= 25	23							**FAT CLAY**, light brown and gray, moist, very stiff.
	45	SH S-12		P= 4.5+	25				101	6.0		Same as above, hard.
	50	SPT S-13		N= 39	24	73	21	52			99	Same as above. (CH)

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
T - POCKET TORVANE SHEAR STRENGTH

REMARKS:
Boring location determined by RETL. Drilling operations performed by RETL.
GPS Coordinates: N 29.548150°, W -98.113200°

LOG OF BORING B-3

Rock Engineering & Testing Laboratory, Inc.
10856 Vandale Street
San Antonio, Texas 78216
Telephone: 210-495-8000
Fax: 210-495-8015

CLIENT: Trihydro Corporation
PROJECT: Elevated Storage Tank - Plant 3
LOCATION: 5167 Stagecoach Rd - Seguin, Texas
NUMBER: 219100

DATE(S) DRILLED: 07/08/19

DRILLING METHOD(S):
Solid Flight Auger / Air Rotary

GROUNDWATER INFORMATION:
Groundwater was not encountered during drilling, nor measured upon the completion of the drilling.

FIELD DATA				LABORATORY DATA							
SOIL SYMBOL	DEPTH (FT)	SAMPLE NUMBER	N: BLOWS/FT P: TONS/SQ FT T: TONS/SQ FT PERCENT RECOVERY/ ROCK QUALITY DESIGNATION	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ FT)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
	55	SH S-14	P= 4.5+	23							**FAT CLAY**, light brown and pale brown, moist, hard.
	60	SH S-15	P= 4.5+	25				96	2.8		Same as above, slightly slickensided.
	65	SPT S-16	N= 56	25							Same as above.
	70	SH S-17	P= 4.5+	27							**FAT CLAY**, light brown and pale brown, moist, hard.
	75	SH S-18	P= 4.5+	27				88	2.1		Same as above, slickensided.
	80	SPT S-19	N= 39	25							Same as above.
											Boring terminated at a depth of 80-feet.

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
T - POCKET TORVANE SHEAR STRENGTH

REMARKS:
Boring location determined by RETL. Drilling operations performed by RETL.
GPS Coordinates: N 29.548150°, W -98.113200°

Engineering & Testing
Laboratory, Inc.

Rock Engineering & Testing Laboratory
10856 Vandale
San Antonio, TX 78216
Telephone: 210-495-8000
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KEY TO SOIL CLASSIFICATION AND SYMBOLS

UNIFIED SOIL CLASSIFICATION SYSTEM

MAJOR DIVISIONS		SYMBOL	NAME
COARSE GRAINED SOILS	GRAVEL AND GRAVELLY SOILS	GW	Well Graded Gravels or Gravel-Sand mixtures, little or no fines
		GP	Poorly Graded Gravels or Gravel-Sand mixtures, little or no fines
		GM	Silty Gravels, Gravel-Sand-Silt mixtures
		GC	Clayey Gravels, Gravel-Sand-Clay Mixtures
	SAND AND SANDY SOILS	SW	Well Graded Sands or Gravelly Sands, little or no fines
		SP	Poorly Graded Sands or Gravelly Sands, little or no fines
		SM	Silty Sands, Sand-Silt Mixtures
		SC	Clayey Sands, Sand-Clay mixtures
FINE GRAINED SOILS	SILTS AND CLAYS LL < 50	ML	Inorganic Silts and very fine Sands, Rock Flour, Silty or Clayey fine Sands or Clayey Silts
		CL	Inorganic Clays of low to medium plasticity, Gravelly Clays, Sandy Clays, Silty Clays, Lean Clays
		OL	Organic Silts and Organic Silt-Clays of low plasticity
	SILTS AND CLAYS LL > 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 Silts
HIGHLY ORGANIC SOILS		PT	Peat and other Highly Organic soils

TERMS CHARACTERIZING SOIL STRUCTURE

SLICKENSIDED - having inclined planes of weakness that are slick and glossy in appearance

FISSURED - containing shrinkage cracks, frequently filled with fine sand or silt; usually more or less vertical

LAMINATED (VARVED) - composed of thin layers of varying color and texture, usually grading from sand or silt at the bottom to clay at the top

CRUMBLY - cohesive soils which break into small blocks or crumbs on drying

CALCAREOUS - containing appreciable quantities of calcium carbonate, generally nodular

WELL GRADED - having wide range in grain sizes and substantial amounts of all intermediate particle sizes

POORLY GRADED - predominantly of one grain size uniformly graded) or having a range of sizes with some intermediate size missing (gap or skip graded)

SYMBOLS FOR TEST DATA

- ▽ — Groundwater Level (Initial Reading)
- ▼ — Groundwater Level (Final Reading)
- — Shelby Tube Sample
- — SPT Samples
- — Auger Sample
- — Rock Core

TERMS DESCRIBING CONSISTENCY OF SOIL

COARSE GRAINED SOILS		FINE GRAINED SOILS		
DESCRIPTIVE TERM	NO. BLOWS/FT. STANDARD PEN. TEST	DESCRIPTIVE TERM	NO. BLOWS/FT. STANDARD PEN. TEST	UNCONFINED COMPRESSION TONS PER SQ. FT.
Very Loose	0 - 4	Very Soft	< 2	< 0.25
Loose	4 - 10	Soft	2 - 4	0.25 - 0.50
Medium	10 - 30	Firm	4 - 8	0.50 - 1.00
Dense	30 - 50	Stiff	8 - 15	1.00 - 2.00
Very Dense	over 50	Very Stiff	15 - 30	2.00 - 4.00
		Hard	over 30	over 4.00

Field Classification for "Consistency" is determined with a 0.25" diameter penetrometer