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May 27, 2009

Mr. Joe Aillet
Black & Veatch
14100 San Pedro Avenue, Suite 410
San Antonio, Texas 78232

RE: Geotechnical Engineering Study
Proposed Anderson Ground
Storage Tank
Loop 1604 and Highway 151
San Antonio, Texas
PSI Project No.: 312-95016

Dear Mr. Aillet:

Professional Service Industries, Inc. (PSI) is pleased to submit our Geotechnical Engineering Study for the referenced project. This report includes the results of field and laboratory testing along with recommendations for use in preparation of the appropriate design and construction documents for this project.

We appreciate the opportunity to perform this Geotechnical Engineering Study and look forward to continuing participation during the design and construction phases of this project. If you have any questions pertaining to this report, or if we may be of further service, please contact our office.

Respectfully submitted,
Professional Service Industries, Inc.

J.R. Eichelberger, III, P.E.
Department Manager
Geotechnical Services

Copies submitted: (10) Black & Veatch; Mr. Joe Aillet

GEOTECHNICAL ENGINEERING STUDY

Proposed Anderson Ground
Storage Tank
Loop 1604 and Highway 151
San Antonio, Texas

PSI Project No.: 312-95016

PREPARED FOR

Black & Veatch
14100 San Pedro Avenue
San Antonio, Texas 78232

May 27, 2009

BY

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5/27/09

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PROJECT INFORMATION

Project Authorization

Professional Service Industries, Inc. (PSI) has completed a geotechnical engineering study for the proposed Anderson Ground Storage Tank to be located at Loop 1604 and Highway 151 in San Antonio, Texas. This project was authorized under a Professional Services Consultant Agreement between Black & Veatch and PSI dated February 16, 2009 for San Antonio Water Systems Job No. 07-6007 and Black & Veatch PN 161472. Our scope of services for this project was outlined in that contract and PSI Proposal No. 312-7-206 dated August 30, 2007. This study was accomplished in general accordance with that contract and proposal. A draft of this report was submitted for review and comment on April 24, 2009.

Project Description

Based on project information provided to PSI by Black & Veatch, we understand the Anderson Pump Station is located near the intersection of Loop 1604 and Highway 151 in northwest San Antonio. The Anderson Pump Station Improvement project includes a 7.5 million gallon ground storage reservoir, two (2) above-grade buildings to house electrical and chlorine equipment, yard piping, and other miscellaneous work.

The ground storage reservoir will have a sidewater depth (floor to overflow) of approximately 47 feet (El. 1028.9 feet) and a diameter of 165 feet. The tank will be constructed of either prestressed concrete or steel and will have a floor elevation of approximately El. 982 feet to match the floor elevation of an adjacent steel ground storage reservoir, which was constructed in 1988. Based on the topography of the site, suitable fill materials will be required below the footprint of the reservoir to provide a flat reservoir footprint to transition from the floor elevation to existing grade. We understand the preferred foundation for this structure will consist of a ring-wall footing supporting the tank walls and a mat foundation in the center of the ring-wall footing. Maximum bearing pressures under the ring-wall footing are expected to be about 3,800 psf based on a five (5) foot wide footing. Maximum bearing pressures under the tank membrane are expected to be about 3,000 psf.

The electrical and chlorine buildings will have concrete block walls with the operating floor at grade. A below-grade vault (approximately eight (8) feet deep as measured from existing grade) will be constructed under the electrical building. Foundations for these facilities may consist of either monolithic slab and grade beam foundations or footings with flat floor slabs.

The geotechnical recommendations presented in this report are based on the available project information, the proposed tank and building locations, and the subsurface materials described in this report. If any of the noted information is incorrect, please inform PSI in writing so that we may amend the recommendations presented in this report as appropriate. PSI will not be responsible for the implementation of our recommendations when we are not notified of changes in the project.

Purpose and Scope of Services

The purposes of this study are to evaluate the subsurface conditions at the site and develop geotechnical engineering recommendations and guidelines for use in preparing appropriate design and other related construction documents for the proposed project. Our scope of services included drilling a total of nine (9) soil borings, performing selected laboratory tests and preparing this geotechnical engineering report. This report briefly outlines the available project information, describes the site and subsurface conditions, and presents our recommendations regarding the following:

- General site development and subgrade preparation.
- Selection and placement of fill and backfill within construction limits.
- Soil parameters for use in the design of appropriate foundation systems.
- General comments regarding factors that may impact construction and performance of the proposed construction.

The scope of services for this project did not include an environmental assessment for determining the presence or absence of wetlands, or hazardous or toxic materials in the soil, bedrock, surface water, groundwater, or air on or below, or around this site. Any statements in this report or on the boring logs regarding odors, colors, and unusual or suspicious items or conditions are strictly for informational purposes.

PSI did not provide any service to investigate or detect the presence of moisture, mold or other biological contaminates in or around any structure, or any service that was designed or intended to prevent or lower the risk of the occurrence of the amplification of the same. Mold is ubiquitous to the environment with mold amplification occurring when building materials are impacted by moisture.

SITE AND SUBSURFACE CONDITIONS

Site Description

The site for the proposed Anderson Ground Storage Tank is located in the southwest quadrant of the intersection of Loop 1604 and Highway 151 in San Antonio, Texas. Within the project site, an existing water tank is located to the north and a private access road borders the east side of the project site. During our drilling operations, our field personnel noted that the topography of the site slopes downward toward the southeast. Vegetation at the site generally consists of grass, weeds, and trees. The ground surface at the site was hard at the time of our drilling operations.

Ground surface elevations ranged from a maximum of approximately El. 966 feet to approximately El. 982 feet in the area of the proposed tank. In the footprint of the proposed tank, the ground surface elevations ranged from about El. 969 feet to about El. 981 feet. The ground surface elevations were estimated from topographic information provided to us by Black & Veatch.

Site Geology

We reviewed the **San Antonio Sheet of the Geologic Atlas of Texas**[1] in an effort to determine the geologic setting of the project site and surrounding areas. The Geologic Atlas of Texas was developed by the Bureau of Economic Geology at The University of Texas using aerial photography, data from various oil and gas exploration companies, and very limited ground reconnaissance. Our review indicates that the project site is located over the Austin Chalk Formation (Kau) of Cretaceous geologic age. The Austin Chalk Formation generally consists of grayish white to white chalk and marl that averages about 85 percent calcium carbonate, contains bentonite and marl seams, and is 350 to 580 feet thick. This formation is known to contain expansive clays at some locations in the San Antonio area.

Subsurface Conditions

The site subsurface conditions were evaluated by drilling a total of nine (9) soil borings, as presented in the Appendix of this report. The number of borings, boring locations and boring depths were selected by Black & Veatch. The borings were located in the field by Black & Veatch. The borings were advanced utilizing solid flight auger drilling methods and both soil and rock samples were routinely obtained during the drilling process. Drilling and sampling techniques were accomplished in general accordance with ASTM procedures.

Selected soil and rock samples obtained during our field exploration were transported to our laboratory where they were reviewed by geotechnical engineering personnel. Representative samples were selected and tested to determine pertinent engineering properties and characteristics for use in our evaluation of the project site. Laboratory testing and soil classification was accomplished in general accordance with ASTM procedures.

Based on the field and laboratory data, we have determined that the stratigraphy of the site is generally as follows:

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[1] **Geologic Atlas of Texas – San Antonio Sheet,** Bureau of Economic Geology, University of Texas at Austin, 1982.

Stratum	Range of Depth, ft.	Stratum Description and Classification
I	0 – 1	FAT CLAY (CH); dark brown; hard.
II	0 – 60	MARL and WEATHERED LIMESTONE; tan; hard.
III	20 – 33	SILTY CLAY (CL); tan, very stiff to hard. *Encountered in boring B-3 only.*
IV	33 – 40	MARL and WEATHERED LIMESTONE; tan; hard. *Encountered in boring B-3 only.*

The above subsurface descriptions are of a generalized nature to highlight the major subsurface stratification features and material characteristics. Boring logs included in the Appendix should be reviewed for specific information such as soil and rock descriptions, stratifications, penetration resistances, locations of the samples and laboratory test data. The stratifications shown on each boring log only represent the conditions at that actual boring location and represent the approximate boundaries between subsurface materials. The actual transitions between strata may be gradual. Variations will occur and should be expected at locations away from the boring locations. Water level observations made during field operations are also shown on the boring logs. The indicated stratum depths and any water levels are measured from the ground surface and are estimated to the nearest one-half (½) foot. Portions of any samples that are not altered or consumed by laboratory testing will be retained by PSI until the award of the contract. At the award of the contract, any remaining samples will be transferred to the designated Owner's facility.

Groundwater Information

The borings were advanced using dry drilling techniques to their full depths, to allow for the detection of the presence of groundwater during drilling operations. Groundwater was not detected either during or upon completion of drilling operations. Upon completion of groundwater observations, the boreholes were backfilled with soil cuttings produced by the drilling operations.

Groundwater levels are influenced by seasonal and climatic conditions which generally result in fluctuations in the elevation of the groundwater level over time. **Transient groundwater could potentially be encountered at any soil/marl and soil/limestone interfaces, as well as in fissures or fractures in the MARL and WEATHERED LIMESTONE materials, especially after periods of extended or heavy rainfall.** Therefore, the foundation contractor should check groundwater conditions just prior to foundation excavation activities. Specific information concerning groundwater is noted on each boring log presented in the Appendix of this report.

EVALUATION AND RECOMMENDATIONS

Geotechnical Discussion

The foundations being considered to provide support for any structure must satisfy three completely independent engineering criteria with respect to the stratigraphy at the site. One criterion is that the foundation system must be designed with an appropriate factor of safety to reduce the possibility of a bearing capacity failure of the soils underlying the foundation. The second criterion is that movement beneath the foundation system due to compression (consolidation), expansion (swell) or shrinkage of the underlying soils must be within tolerable limits for the structure. The third criterion is that differential movements should be within tolerable limits for the structure. The information presented in this report has been developed for use by the project design team for the purpose of accomplishing these criteria.

Potential Vertical Rise

The soil and rock profile at this site consists primarily of MARL and WEATHERED LIMESTONE and exhibits a very low potential to experience volumetric changes as a result of fluctuations in soil moisture content. Based on our laboratory testing results, the estimated Potential Vertical Rise (PVR) of this site is less than one (1) inch in its present condition. This PVR value was calculated in general accordance with Texas Department of Transportation (TxDOT) Method TEX-124-E. This estimate assumes a sustained surcharge load of approximately one (1) pound per square inch on the subgrade materials.

Any grade supported foundation constructed at this site should be expected to undergo some differential vertical movements. In this general area, most structural and geotechnical engineers consider a PVR of one (1) inch or less to be within acceptable tolerances. However, this movement does not take into consideration the movement criteria required or perceived by the facility owner or occupants. These "operational" performance criteria may be, and often are, more restrictive than the structural criteria or tolerances.

Grade supported foundation or floor slab movements that approach one (1) inch may cause doors to stick, cracks in sheetrock or brittle floor covering, cracks in exterior finishes and other forms of cosmetic distress. Measures can and should be taken during the design and construction of the facility to help limit the extent and severity of these types of distress. However, these magnitudes of movement typically do not cause "structural distress" in the foundation.

Tank Pad Preparation

The preparation of the tank pad at this site must be accomplished in such a way that it:

- Maintains or reduces the estimated site PVR of less than one (1) inch;
- Both elastic and long-term settlements are maintained below the settlement limits prescribed by the American Concrete Institute (ACI) in ACI 372 Appendix A;
- The fill body provides allowable bearing capacities that allow for the design of economically feasible ring-wall footings and center mat foundations; and
- The fill body is integrated into the natural materials in such a way as to minimize the potential for the sliding of the fill body along the slope of the existing ground surface.

As discussed previously, the soil and rock profile at this site exhibits a very low potential to experience volumetric changes with fluctuations in soil moisture content as quantified by an estimated site PVR of less than one (1) inch in its current condition. This is below the value considered acceptable by most structural and geotechnical engineers in this area and special steps will not be required to reduce the estimated PVR. Based on the recommendations presented below, the estimated PVR for the tank pad will be negligible. However, the remaining issues discussed above must be addressed. We have prepared the following recommendations for the purpose of addressing those remaining issues for the tank pad. The recommendations presented below are based on a tank Finished Floor Elevation (FFE) of El. 982 feet and the topographic information provided to us by Black & Veatch as a part of this project.

- Strip the tank pad area of all topsoil, vegetation, roots, loose or soft soils and any other deleterious materials to completely expose the Stratum II MARL and WEATHERED LIMESTONE. Given the thickness of the Stratum I FAT CLAY materials encountered in our borings, we anticipate the site stripping operation will generally require the removal of no more than six (6) to nine (9) inches of soil to reach the Stratum II materials. In some locations, the removal depths could be deeper. The stripped materials may be removed from the site and properly disposed or may be stockpiled and used for grade adjustments in areas <u>outside</u> of the tank pad.
- Upon completion of site stripping, the tank pad area should be benched. Each bench should be at least 12 inches, but no more than 30 inches, in depth and the bench surfaces should consist of the Stratum II materials. The benching should result in relatively vertical cut faces and relatively horizontal bench surfaces that are wide enough to safely accommodate construction equipment. The benching should also be accomplished in such a way that allows for the placement of at least 12 inches of crushed limestone base below all tank foundation elements.

- Upon completion of benching, the exposed Stratum II materials should be visually inspected by qualified personnel. The purpose of this visual inspection is to verify that the Stratum II materials have been completely exposed and that no clay seams, layers, or pockets are present at the exposed Stratum II surface.

- After visual inspection of the bench surfaces, crushed limestone base materials conforming to all of the requirements of TxDOT Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges Item 247, Type A, Grades 1 or 2 should be placed in the tank pad to achieve the tank design FFE of 982 feet. The crushed limestone base materials should be placed in uniform horizontal lifts with a maximum loose lift thickness of eight (8) inches and a maximum compacted lift thickness of six (6) inches. The crushed limestone base should be moisture conditioned to between minus three (-3) and plus three (+3) percentage points of the optimum moisture content and compacted to at least 95 percent of the maximum dry density as determined by ASTM D 1557. This should result in at least 12 inches of crushed limestone base beneath all tank foundation elements.

- The subgrade should be prepared so that the completed tank pad extends at least three (3) feet beyond the tank foundation perimeter then slopes downward to the Stratum II materials at a 1H:1V slope. The upper one (1) foot of fill **outside** of the tank foundation should consist of properly compacted cohesive clay (CL) soil to reduce infiltration of moisture into the fill materials comprising the tank pad. This clay layer may be replaced with asphalt or concrete pavement that extends to the edge of the tank foundation.

- To observe and document the construction of the tank pad as recommended above, we recommend that PSI personnel working under the direction of the Geotechnical Engineer be present during earthwork activities for tank pad construction.

Tank Foundation Recommendations

We understand the foundations for this tank will consist of a ring-wall footing (shaped like an inverted T) that supports the walls of the tank and a mat type membrane foundation inside of the ring-wall. The ring-wall footing should bear on at least 12 inches of crushed limestone base placed over the Stratum II materials as recommended in this report. The ring-wall footing should be, at a minimum, at least 18 inches in width. The ring-wall footing may be designed using a net allowable bearing pressure of **6,400 psf** based on operating loads with transient loads or **4,800 psf** based on normal operating loads, whichever results in a larger bearing surface. These allowable bearing pressures include design factors of safety of 2.25 and 3, respectively. We have recommended the ring-wall footing bear completely on at least one (1) foot of properly compacted crushed limestone base to prevent the development of "stress points" at locations where the footings would have otherwise transitioned from crushed limestone base fill to the native MARL and WEATHERED LIMESTONE material. These "stress points" generally develop as a result of differential settlement characteristics between the crushed limestone base materials and the MARL and WEATHERED LIMESTONE materials.

The mat foundation that will be constructed inside the ring-wall footing may be designed using a net allowable bearing pressure of **6,400 psf** based on operating loads with transient loads or **4,800 psf** based on normal operating loads. These net allowable bearing pressures include design factors of safety of 2.25 and 3, respectively. The design of a mat foundation also typically involves the use of a Winkler foundation type model. The Winkler foundation model assumes that the soil can be modeled using an infinite number of elastic springs. The spring constant in this model is known as the modulus of subgrade reaction. The modulus of subgrade reaction for the tank pad prepared as recommended herein may be taken as **325 pci** based on a 30 inch diameter plate.

Tank Foundation Construction Considerations

The Stratum II materials within the tank foundation footprint area should be excavated such that smooth surfaces are obtained that are suitable for the placement and proper compaction of crushed limestone base materials. The excavations should be sloped sufficiently to create internal sumps for the collection and removal of water. Debris or loose material in the bottom of the excavations should be removed prior to steel placement. After excavation, the steel and concrete should be placed as quickly as possible to avoid exposure of the excavation bottom to wetting and drying or other disturbances. Surface runoff should be drained away from the excavations and not allowed to pond. Accumulations of water in the foundation excavations deeper than one (1) inch should be collected and removed. The foundation concrete should be placed during the same day the excavations are made if possible. If it is required that the foundation excavations be left open for extended periods, measures should be taken as necessary to protect the exposed Stratum II surfaces prior to concrete placement to minimize the amount of work necessary to provide surfaces free of loose soil or other debris at the time of concrete placement.

Tank Foundation Settlement Estimates

The tank planned for this project will experience both elastic and long-term settlements of the fill material necessary to construct the pad and various clay layers contained within the MARL and WEATHERED LIMESTONE. Based on the tank FFE and existing topographic information, the recommendations presented in the section of this report entitled **Tank Pad Preparation**, the information developed as a part of this study, and anticipated bearing pressures of 3,800 psf for the ringwall footing and 3,000 psf for tank membrane, we have developed the following settlement estimates:

- Elastic settlements of the tank pad are estimated to be approximately two (2) inches at the center and one and one-half (1½) inches at the edges.

- Long-term consolidation of the tank pad fill body are estimated to be negligible where the fill pad is approximately one (1) to two (2) feet thick and approximately one-half (½) of an inch where the fill pad is approximately 12½ feet thick. Settlement values for intermediate fill thicknesses may be interpolated linearly using these values.

- Long-term settlement of the Stratum II and IV materials are expected to be insignificant. However, some long-term settlement of the Stratum III SILTY CLAY materials can be expected. We estimate this Stratum could potentially experience up to one (1) inch of settlement in the footprint of the tank represented by borings B-1, B-3, B-5 and B-6. We anticipate that long-term consolidation at borings B-2, B-4 and B-7 will be negligible.

- As was discussed previously, the estimated PVR of the tank pad prepared as recommend in this report will be negligible.

Applying these estimates to the tank footprint, the following settlement calculations may be used in the design of the foundations for this tank:

- At the high side of the tank (the area of thinnest fill), the total settlement is expected to be approximately one and one-half (1½) inches.

- At the tank center, the total settlement is expected to be approximately three and one-quarter (3¼) inches.

- At the low side of the tank (the area of thickest fill), the total settlement is expected to be approximately three (3) inches.

As was stated above, these estimates are based on bearing pressures of 3,800 psf applied to a five (5) foot wide ring-wall footings and 3,000 psf for the tank membrane. If the final design bearing pressures exceed those provided to us and/or the ring-wall footing widths are changed, we should be contacted to revise our settlement estimates accordingly.

Chlorine/Electrical Building Pad Preparation

The foundations for the chlorine and electrical buildings are expected to consist of either monolithic slab and grade beam foundations or footing foundations with flat floor slabs. The chlorine building is expected to be constructed with a Finished Floor Elevation (FFE) at or near the existing ground surface. The electrical building will be constructed with a below-grade vault that will be located approximately eight (8) feet below existing grade. As discussed previously, the soil and rock profile at this site exhibits a very low potential to experience volumetric changes with fluctuations in soil moisture content and an estimated site PVR of less than one (1) inch. This is below the value considered acceptable by most structural and geotechnical engineers in this area and will not require special steps to prepare the building pads. We have developed the following recommendations to ensure the pads are properly designed and constructed so that they provide adequate support to the building foundations.

- Strip the building pad areas of all topsoil, vegetation, roots, loose or soft soils and any other deleterious materials to completely expose the Stratum II MARL and WEATHERED LIMESTONE. Given the thickness of the Stratum I FAT CLAY materials encountered in our borings, we anticipate the site stripping operation will generally require the removal of no more than six (6) to nine (9) inches of soil to reach the Stratum II materials. In some locations, the removal depths could be deeper. Clean onsite soils may be stockpiled and used for grade adjustments in areas outside of the building pads.

- Upon completion of stripping operations, the site may be excavated as necessary to reach a sufficient depth to provide a minimum of six (6) inches of select fill beneath the floor slabs. If so desired, the foundation areas may be overexcavated as necessary to allow for grade beam or footing construction in properly placed and compacted select fill material. We recommend that, at a minimum, at least six (6) inches of select fill be placed below any overexcavated grade beams or footings.

- Prior to the placement of any select fill in the building pad, the exposed Stratum II materials should be visually inspected by qualified personnel. The purpose of this visual inspection is to verify that the Stratum II materials have been completely exposed and that no clay seams, layers or pockets are present at the exposed Stratum II surface.

- Select fill materials should be placed in each building pad to achieve each design FFE. Select fill materials should be placed in uniform horizontal lifts with a maximum loose lift thickness of eight (8) inches and a maximum compacted lift thickness of six (6) inches. The select fill should be moisture conditioned to between minus three (-3) and plus three (+3) percentage points of the optimum moisture content and compacted to at least 95 percent of the maximum dry density as determined by ASTM D 1557.

  Consideration should be given to creating an "all weather" working surface with the final six (6) inches of the building pad. Such a working surface should consist of an Item 247 Type A, Grade 1 or 2 base material. The use of an "all weather" working surface can significantly improve the accessibility of the site to construction traffic during periods of wet weather.

- Subgrade preparation and fill placement should extend at least three (3) feet beyond the perimeter of the structure and should include covered walkways and other improvements adjacent to the structure. The upper one (1) foot of fill **outside** of the structure should consist of properly compacted cohesive clay (CL) soil to reduce infiltration of moisture into the fill materials comprising the building pad. This clay layer may be replaced with asphalt or concrete pavement that extends to the edge of the structure foundation.

- To observe and document the construction of the building pads as recommended above, we recommend that PSI personnel working under the direction of the Geotechnical Engineer be present during earthwork activities for building pad construction.

Slab-on-Grade Foundation Recommendations

Monolithic slab and grade beam foundations may be used to support the planned chlorine and electrical buildings provided that the foundations are properly designed and constructed. The foundations should be constructed on building pads prepared as recommended in the section of this report entitled **Chlorine/Electrical Building Pad Preparation**. Grade beams may bear on either properly placed and compacted select fill materials or the Stratum II MARL and WEATHERED LIMESTONE. Grade beams bearing on select fill material may be designed for a net allowable bearing pressure of **3,000 psf** based on total loads or **2,000 psf** based on dead plus long-term live loads. Grade beams bearing on the Stratum II materials or on TxDOT Item 247, Type A, Grade 1 or 2 materials may be designed for a net allowable bearing pressure of **6,400 psf** based on total loads or **4,800 psf** based on dead plus long-term live loads. In areas where the bearing materials transition from fill to the Stratum II materials, we recommend that the lower bearing capacities be used for several feet into the Stratum II materials to prevent the development of excess stresses in grade beams at the transition point that can arise from the differential settlement characteristics between select fill materials and the Stratum II materials. This issue may be passed by overexcavating the grade beams and placing at least six (6) inches of select fill beneath the beams.

Exterior grade beams should be at least 12 inches wide and extend at least 12 inches below final exterior construction grade. If necessary, the grade beams or slab portions of the foundation may be thickened and widened to serve as spread footings in areas with concentrated loads. The net allowable bearing pressure values shown above include design safety factors of approximately two (2) and three (3), respectively. These recommendations are intended for proper development of bearing capacity for continuous beam sections, to assure proper concrete cover is achieved between reinforcing steel and soil, and to reduce potential water migration beneath the foundation. These recommendations are **not** based on structural considerations. Therefore, the required grade beam widths and depths may be greater than recommended herein for structural considerations and should be properly evaluated and designed by the structural engineer.

The design approach described in the Post-Tensioning Institute (PTI) "Design of Post-Tensioned Slabs-on-Ground" manual, Third Edition, 2004, may be used to design slab and grade beam foundations for this project. We have developed soil parameters for use in the PTI design method as shown in the following table. These parameters were calculated using VOLFLO 1.5 published by Geostructural Tool Kit, Inc. It should be understood that the PTI design method is empirical in nature. Furthermore, the recommended design parameters shown below are based on our understanding of the proposed project, our interpretation of the information and data collected as a part of this study, our experience in the project area and the criteria published in the above referenced publication.

Edge Moisture Variation Distance (center lift) (ft):	8.5
Edge Moisture Variation Distance (edge lift) (ft):	4.4
Differential Swell (center lift) (in):	-1.0
Differential Swell (edge lift) (in):	1.5

Monolithic slab and grade beam foundations should be excavated such that smooth, undisturbed surfaces are obtained that are suitable for either the placement and compaction of select fill or for bearing foundation elements. The foundation excavations should be sloped sufficiently to create internal sumps for the collection and removal of water. Debris or loose material in the bottom of the excavations should be removed prior to steel placement. After excavation, the steel and concrete should be placed as quickly as possible to avoid exposure of the excavation bottom to wetting and drying or other disturbances. Surface runoff should be drained away from the excavations and not allowed to pond. Accumulations of water in the foundation excavations deeper than one (1) inch should be collected and removed. The foundation concrete should be placed during the same day the excavations are made. If it is required that the foundation excavations be left open for extended periods, measures should be taken as necessary to protect the exposed Stratum II surfaces prior to concrete placement to minimize the amount of work necessary to provide surfaces free of loose soil or other debris at the time of concrete placement.

The post construction settlements of monolithic, slab and grade beam foundations constructed as recommended in this report should be less than one (1) inch. The settlement response of a fill supported slab is influenced more by the quality of construction than by soil-structure interaction.

Chlorine/Electrical Building Footing Recommendations

Spread and strip footing foundations may be used to support the chlorine and electrical buildings. Based on the results of our field and laboratory results, the building subgrade must be prepared as discussed in the section of this report entitled **Chlorine/Electrical Building Pad Preparation.** Spread and strip footing foundations should be designed to bear at a minimum depth of one and one-half (1½) feet below the Finished Floor Elevation. All footings should bear completely in either properly compacted select fill materials or the Stratum II MARL and WEATHERED LIMESTONE materials. Footings that bear on select fill may be designed using a net allowable bearing pressure of **3,000 psf** based on total load or **2,000 psf** based on dead plus long-term live load, whichever results in a larger bearing surface. Footings that bear completely on the Stratum II materials or on TxDOT Item 247, Type A, Grade 1 or 2 materials may be designed using a net allowable bearing pressure of **6,400 psf** based on total load or **4,800 psf** based on dead plus long-term live load, whichever results in a larger bearing surface. These bearing capacities include design factors of safety of two (2) and three (3), respectively.

If necessary, the footing foundations may be used to resist uplift loadings induced by the structure. Uplift resistance for a footing generally consists of the dead load from the structure and the weight of the footing. If more resistance is necessary, the footing can be geometrically shaped so the weight of soil overlying the footing can also be considered. In such a case, a unit weight of 100 pcf may be used for the backfill provided it is placed in compacted lifts not to exceed six (6) inches. Selection, placement and compaction of the backfill should meet the guidelines noted in the section of this report entitled **Chlorine/Electrical Building Pad Preparation**.

Properly constructed footings should experience total settlements of about one (1) inch or less based on the indicated bearing pressures. The settlement between footings will generally be elastic in nature with most of the observed settlement occurring during construction. Differential settlement approaching one-half (½) to three-quarters (¾) of the total footing settlement should be expected to occur between adjacent footings. The settlement response of footings is impacted more by the quality of construction than by soil-structure interaction. The improper installation of footings can result in differential settlements that are greater than we have estimated.

Footing foundations should be excavated such that smooth, undisturbed surfaces are obtained that are suitable for either the placement and compaction of select fill or for bearing foundation elements. The foundation excavations should be sloped sufficiently to create internal sumps for the collection and removal of water. Debris or loose material in the bottom of the excavations should be removed prior to steel placement. After excavation, the steel and concrete should be placed as quickly as possible to avoid exposure of the excavation bottom to wetting and drying or other disturbances. Surface runoff should be drained away from the excavations and not allowed to pond. Accumulations of water in the foundation excavations deeper than one (1) inch should be collected and removed. The foundation concrete should be placed during the same day the excavations are made. If it is required that the foundation excavations be left open for extended periods, measures should be taken as necessary to protect the exposed Stratum II surfaces prior to concrete placement to minimize the amount of work necessary to provide surfaces free of loose soil or other debris at the time of concrete placement.

Floor Recommendations

If spread or strip footing foundations are utilized, a flat floor slab may be used and supported by a building pad constructed as recommended in the section of this report entitled **Chlorine/Electrical Building Pad Preparation**. The floor slab may be cast independent of the footings, grade beams, walls, or columns to allow the floor to move freely vertically without causing distress to the foundation and structure. Consideration should be given to dowelling the floor slab into fixed structural members at doorways, general pathways and other features where differential movements can create trip hazards or other problems. However, by dowelling the floor slab into fixed structural members, it is likely that the floor slab will develop plastic hinge cracks that are generally about three (3) to six (6) feet away and parallel to the structural member to which the slab is dowelled.

Flat floor slabs used in conjunction with footing foundations may utilize the bearing capacities discussed in the section of this report entitled **Slab-on-Grade Foundation Recommendations** as the net allowable bearing pressures. The design of any grade-supported floor slab should take into consideration the interaction between the slab and the supporting soils in resisting moments and shears induced by applied loads. Several design methods use the modulus of subgrade reaction, k, to account for soil properties in design. The modulus of subgrade reaction is a spring constant that depends on the kind of soil, the degree of compaction and the moisture content. The k values presented in the following table can be used for the design of flat, grade-supported floor slabs for this project and are based on a 30 inch plate diameter.

Select Fill Type	k value, pci
Select Fill over Stratum II	125
TxDOT Item 247, Ty. A, Gr. 1 or 2 over Stratum II	325

“At-Rest” Earth Pressures

The electrical building will include the construction of a below-grade vault that is expected to extend to a depth of approximately eight (8) feet below existing grade. Below-grade walls such as those to be used with this vault are generally designed and constructed so that little or no outward movement of the structural member occurs. Because this wall system will not be allowed to experience significant movements or rotations, an “at-rest” earth pressure scenario will develop behind the walls.

The magnitude of the “at-rest” earth pressure is highly dependent upon the type of material used to backfill the “active zone” behind the wall and whether the active zone is allowed to drain water freely. The “active zone” consists of the area behind the below-grade wall within a boundary created by a 45 degree angle drawn from the top edge of the wall foundation and extending upward to the ground surface. The 45 degree angle of the “active zone” arises out of where failure surfaces generally develop in soil masses with slope faces steeper than 45 degrees. When the soil mass is composed primarily of materials such as the Stratum II MARL and WEATHERED LIMESTONE, the definition of the “active zone” becomes somewhat irrelevant since these materials possess internal strength characteristics that make it possible for them to maintain stable long-term vertical cuts. Based on this information, we have developed the following “at-rest” earth pressures for use in the design and construction of the below-grade vault for the electrical building. It should be noted that the equivalent fluid densities shown in the following table **do not include** any safety factors and do not account for any surcharges.

"At-Rest" Condition Equivalent Fluid Density

Backfill Material Type	Total Unit Weight, pcf	Earth Pressure Coefficient	Drained Active Zone, pcf	Undrained Active Zone, pcf
General Fill	120	0.96	118	118
Imported, Granular, Clean Sand	115	0.47	54	87
Crushed Limestone Base Material	135	0.48	65	98

Backfill Material Recommendations

Sand used for backfill should be free draining material with 100 percent passing the Nº 16 sieve and no more than eight (8) percent passing the Nº 200 sieve. Crushed limestone base materials should conform to the gradation and Atterberg limit requirements of the Texas Department of Transportation 2004 Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges Item 247, Type A, Grades 1 or 2.

Fill materials should be placed behind the wall in horizontal lifts. These lifts should be no more than eight (8) inches thick, loose measure, and six (6) inches thick, compacted measure. Fill materials placed behind the wall should be moisture conditioned to between minus three (-3) to plus four (+4) percentage points of the optimum moisture content and compacted to at least 95 percent of the maximum dry density as determined by ASTM D 698. **The use of clean sand as backfill will not require any significant compactive efforts to properly consolidate.**

Wall Drainage Systems

Consideration should be given to the construction of a drainage system as a part of the below-grade wall system to facilitate the rapid drainage of water out of free draining backfills placed behind the wall. We recommend that free draining materials used behind the wall be protected from clogging by wrapping the fill body with geotextile filter fabric. The filter fabric will prevent fine-grained materials from infiltrating the interstitial spaces between the grains of the free draining backfill. A perforated drainpipe should also be installed behind and parallel to the walls to collect and discharge water from behind the wall as quickly as possible. The water should be directed to a collection point so that it may be removed from behind the walls as quickly as possible. The use of a drainage system will likely require the use of a sump and pump to remove the water from the vault excavation as the use of a gravity system will not likely be economical. Finally, we recommend that the below-grade walls be waterproofed to reduce the risks that water collecting in the materials behind the wall will not infiltrate the below-grade portion of the structure. **The installation of a drainage system that rapidly discharges water from behind the walls can substantially reduce the lateral earth pressures acting on the walls. The magnitude of pressure reduction can be seen in the differences in the equivalent fluid densities for "Drained" and "Undrained" active zones in the above table. It should be noted that clay soils are not free draining materials and the installation of a drain will not reduce the pressure exerted by these materials on the walls. If drainage is not provided behind below-grade walls, then undrained equivalent fluid densities should be used in the design of the walls.**

Site Seismic Activity

For the purposes of seismic design, a Site Class B as defined on Table 1613.5.2 in the 2006 International Building Code (IBC) is recommended for use at this site. The site class is based on the subsurface conditions encountered at our soil borings, the results of field and laboratory testing, our experience with similar projects in this area, and consider the site prepared as recommended herein. It should be noted that our deepest boring at this site extends to 60 feet whereas IBC site classifications are based on the upper 100 feet of the soil profile.

General Site Preparation

Construction areas outside of the tank, chlorine, and electrical buildings (for example, areas where fill will be used to raise grade around the tank) should be stripped of topsoil, vegetation, roots, loose or soft soils, pavements, foundations, and any other deleterious materials. The stripped materials should be removed from the site and properly disposed. Upon completion of stripping operations, the site may be either excavated or filled as necessary to achieve the desired site elevation. After site stripping and any necessary excavation, or prior to placement of any fill materials, the exposed subgrade should be proofrolled with appropriate construction equipment weighing at least 20 tons. Weak or soft areas should be removed to expose non-yielding soils and may be replaced with properly compacted select fill materials or clean onsite soils. The exposed subgrade should be scarified and moisture conditioned to between optimum and plus four (+4) percent of the optimum moisture content after proofrolling. The subgrade should then be compacted to at least 95 percent of the maximum dry density as determined by ASTM D 698. **Exposed Stratum II and IV materials will not require scarification and moisture conditioning.**

We recognize the uncertainty of knowing what will be encountered during site excavation as a result of the construction of any previous facilities at the site. Any debris, foundations or utilities that are encountered during construction may be removed (or rerouted in the case of active utilities) as necessary. Such elements may remain in place provided they do not interfere with the planned foundation systems. Any granular bedding and/or backfill materials encountered around existing utilities may be collared or plugged such that they do not transmit water beneath the new facilities. We recommend that any abandoned or to-be-abandoned sewer or large diameter water pipes be filled with a cementitious grout material. If any existing foundations or utilities are removed, general fill material may be used to fill these excavated areas provided that there is sufficient space to prepare, place, and compact the fill material. If the void or excavated area is too confined, we recommend the use of flowable fill material or lean concrete to fill these areas.

Grade adjustments at the project site can be made using select or general fill material. The fill materials should be placed on prepared surfaces in lifts not to exceed eight (8) inches loose measure or six (6) inches compacted measure. Fill materials may be moisture conditioned as necessary to achieve a compaction of at least 95 percent of the maximum dry density as determined by ASTM D 698.

General Fill Recommendations

General fill materials may consist of onsite soils, select fill materials or clean imported fill soils. The purpose of a general fill is to provide a soil material with good compaction characteristics that will provide suitable, uniform support for pavements and other non-habitable facilities that are not extremely sensitive to movements. Such materials may also be used in open areas where such facilities will not be constructed or in building pad areas where the structure is completely suspended. As a result, there are not specific requirements with regard to a given soil type for use as general fill, although we suggest that the use of CH, CL, SC, GC, SW, or GW materials as defined by ASTM D 2487 will likely produce the best results. Other non-organic soil types may be used but will likely require extensive preparation to produce adequate compaction and strength characteristics. General fill material should be clean and free of any vegetation, roots, organic materials, trash or garbage, construction debris, or other deleterious materials and should contain stones no larger than three (3) inches in maximum dimension. If the use of oversized aggregate in the fill body is desired, PSI may be contacted to provide recommendations for these materials on a case-by-case basis as determined by the Geotechnical Engineer of Record. The Plasticity Index of general fill material should be limited to 35. **It should be understood that it is not the intent of this recommendation to control differential soil movements due to expansive soils through the use of general fill.** If differential soil movements arising from the use of general fill cannot be tolerated, select fill material should be used and should conform to the recommendations made in the section of this report entitled **Select Fill Recommendations.**

Select Fill Recommendations

Select fill materials should be free of organic material and debris and should consist of low-expansive (inert) soil materials such as silty or sandy (lean) clay, clayey sand, or clayey gravel. Select fill materials should possess a plasticity index (PI) of between seven (7) and 17. Clayey gravel materials should conform to the gradation requirements of the 2004 TxDOT

Standard Specifications Manual Item 247, Type B, Grade 2 or better. Crushed limestone materials should conform to the gradation requirements of the TxDOT Standard Specifications Manual Item 247, Type A, Grade 2 or better. The select fill materials should not possess stones with dimensions larger than two and one-half (2½) inches. Onsite soils meeting these requirements may be used as select fill.

CONSTRUCTION CONSIDERATIONS

Moisture Sensitive Soils/Weather Related Concerns

Soils are sensitive to disturbances caused by construction traffic and changes in moisture content. During wet weather periods, increases in the moisture content of the soil can cause significant reduction in the soil strength and support capabilities. In addition, soils which become wet may be slow to dry and thus significantly retard the progress of grading and compaction activities. It will, therefore, be advantageous to perform earthwork and foundation construction activities during dry weather.

Drainage Concerns

Water should not be allowed to collect in the foundation excavations, on foundation surfaces, or on prepared subgrades within the construction area either during or after construction. Undercut or excavated areas should be sloped as necessary to facilitate removal of any collected rainwater, groundwater, or surface runoff. Positive surface drainage at the site should be provided to reduce infiltration of surface water around the perimeter of the structure and beneath the structure foundations. The grades should be sloped away from the structure and the surface and roof drainage should be collected and discharged such that water is not permitted to infiltrate the soils underlying the structure foundations.

Excavations

As was discussed previously, FAT CLAY, MARL and WEATHERED LIMESTONE materials were encountered at very shallow depths at this site. SILTY CLAY materials were encountered in seams and layers within the MARL and WEATHERED LIMESTONE stratigraphic units. While the FAT CLAY and SILTY CLAY soils are not expected to present significant excavation difficulties, the MARL and WEATHERED LIMESTONE materials are "rock" or "rock-like" and are very hard. The excavation of these materials will require the use of heavy duty rock excavation equipment and techniques.

It should be noted that excavation equipment varies and field conditions may vary. Generally, geologic processes (such as faulting, weathering, etc.) are erratic and large variations can occur in small lateral distances. Details regarding "means and methods" to accomplish the work (such as excavation equipment and technique selection) are the sole responsibility of the project contractor. The comments contained in this report are based on the observations of small diameter boreholes. The performance of other excavations may differ significantly as a result of the differences between borehole and large scale excavation sizes.

In Federal Register, Volume 54, No. 209 (October 1989), the United States Department of Labor, Occupational Safety and Health Administration (OSHA) amended its "Construction Standards for Excavations, 29 CFR, part 1926, Subpart P". This document was issued to better insure the safety of workmen entering trenches or excavations. This Federal regulation mandates that excavations be constructed in accordance with the current OSHA guidelines. We understand 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 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. The contractor's "responsible person", as defined in 29 CFR Part 1926, should evaluate the soil exposed in the excavations as part of the contractor's safety procedures. 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.

We are providing this information solely as a service to our client. PSI does not assume responsibility for construction site safety or the contractor's or other parties' compliance with local, state, and Federal safety or other regulations.

Slope Stability Analysis

Based on the topographic information provided to us, we understand that the construction of the ground storage tank at a Finished Floor Elevation of El. 982 feet will require the placement of fill material along the eastern perimeter of the tank. The purpose of this fill placement is to adjust the grade around the tank such that it provides an acceptable ground surface slope that integrates into the existing topography around the tank. Furthermore, it is desired that the slope of the fill body be such that it does not require the construction of retaining structures at the electrical and chlorine building locations to allow for the construction of those facilities. Based on the anticipated geometry of the Stratum II surfaces, the geometry of the crushed limestone base fill in the tank pad, the expected use of general fill material in grading operations outside of the tank pad, and the recommendations presented in this report, we have performed slope stability analyses of both a 3H:1V and a 4H:1V ground surface on the eastern perimeter of the tank. Our analyses of these slopes indicate a factor of safety against slope failure of approximately 1.4 or better in both cases. Based on our experience with similar projects, it is our opinion that this estimated factor of safety is acceptable for this project.

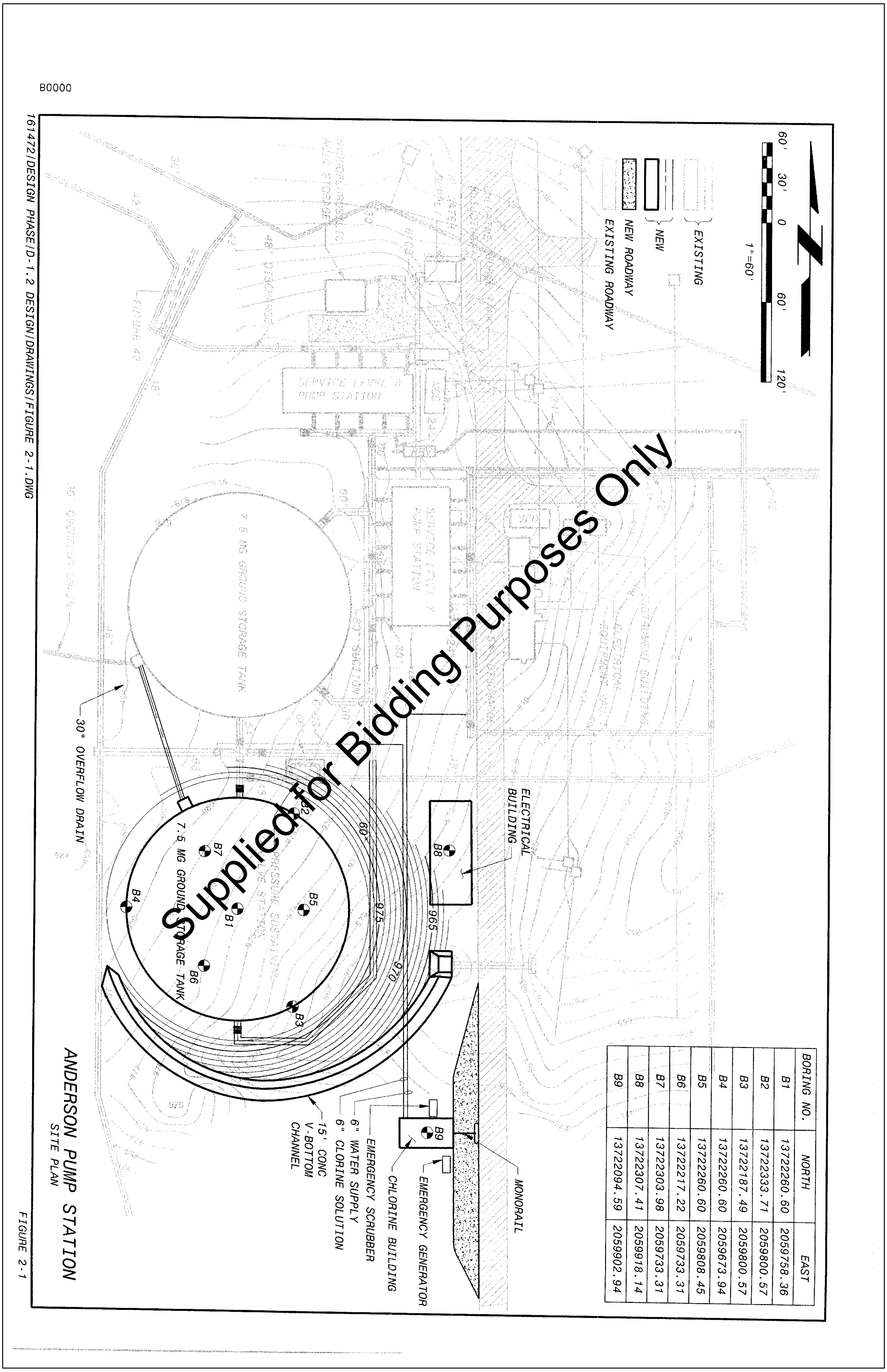
REPORT LIMITATIONS

The recommendations submitted in this report are based on the available subsurface information obtained by PSI and design details furnished by the client for the proposed project. If there are any revisions to the plans for this project, or if deviations from the subsurface conditions noted in this report are encountered during construction, PSI should be notified immediately to determine if changes in the recommendations presented in this report are required. If PSI is not notified of such changes, PSI will not be responsible for the impact of those changes on the project.

The Geotechnical Engineer warrants that the findings, recommendations, specifications, or professional advice contained herein have been made in accordance with generally accepted professional Geotechnical Engineering practices in the local area. No other warranties are implied or expressed. This report should not be copied, except in its entirety, without the written consent of PSI.

After the plans and specifications are more complete, the Geotechnical Engineer should be retained and provided the opportunity to review the final design plans and specifications to check that our engineering recommendations have been properly incorporated into the design documents. At that time, it may be necessary to submit supplemental recommendations. If PSI is not retained to perform these functions, PSI will not be responsible for the impact of those conditions on the project. This report has been prepared for the exclusive use of Black & Veatch and the Design Team for the specific application to the proposed Anderson Ground Storage Tank located at the intersection of Loop 1604 and Highway 151 in San Antonio, Texas.

APPENDIX



BORING NO.	NORTH	EAST
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B2	13722333.71	2059800.57
B3	13722187.49	2059800.57
B4	13722260.60	2059673.94
B5	13722260.60	2059808.45
B6	13722217.22	2059733.31
B7	13722303.98	2059733.31
B8	13722307.41	2059918.14
B9	13722094.59	2059902.94

LEGEND

● Approximate Boring Location

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3 BURWOOD LANE
SAN ANTONIO, TEXAS 78216

BORING LOCATION PLAN

DRAWING NOT TO SCALE

PROPOSED ANDERSON
GROUND STORAGE TANK
LOOP 1604 AND HIGHWAY 151
SAN ANTONIO, TEXAS

DATE:	04/27/08
PROJECT #:	312-95016
DWG. NAME:	2009-036

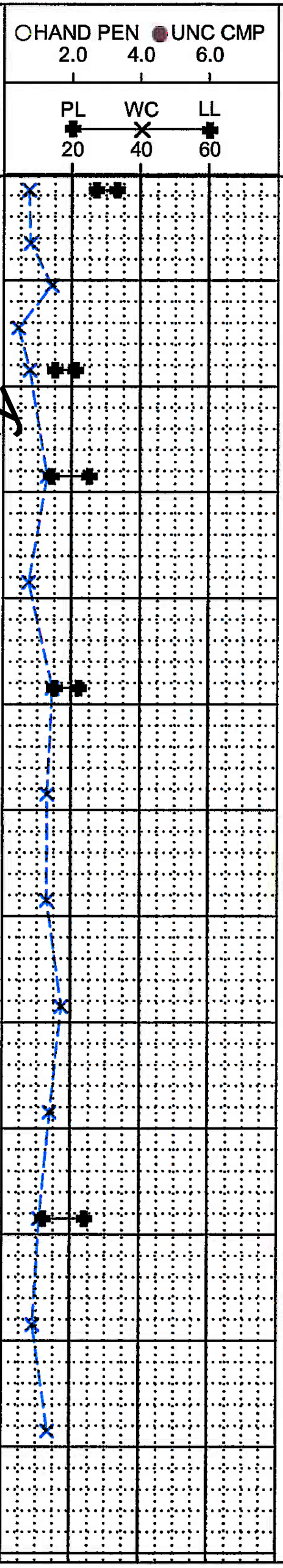
Anderson Ground Storage Tank
Loop 1604 & Hwy 151
Project No. 312-95016

BORING B-1

LOCATION: See Boring Location Plan

Elevation: El. 976.5 Feet

DEPTH, FT.	SOIL DESCRIPTION	MOISTURE CONTENT	% RETAINED #4	% PASSING #200	SPT (N) & TCP (T) VALUES	% REC	%RQD	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	UNCONF. COMP. (TSF)	UNIT DRY WT. (LB/CU FT)
	Stratum II HARD, tan, MARL and WEATHERED LIMESTONE; with interbedded clay seams and layers	7.4			50/5"			33	27	6		
		7.8			50/5"							
5		14.1			50/2"							
		4.4			50/2"							
10		7.7			41 50/2"			21	15	6		
15	- with a LEAN CLAY (CL) layer at 13 feet	12.8			55			25	14	11		
20		7.5			50/5"							
25	- with a LEAN CLAY (CL) layer at 23 feet	14.4			33			22	15	7		
30		13.0			50/4"							
35		12.9			50/6"							
40		17.2			50/1"							
45		13.9			50/2"							
50		10.9			50/1"			24	12	12		
55		9.0			50/1"							
60		13.4			50/2"							
	Boring Terminated at a depth of 60 feet											
65												



COMPLETION DEPTH: 60.0 Feet
DATE: 4/13/09

psi Information To Build On
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DEPTH TO GROUND WATER
SEEPAGE (ft.): NONE ENCOUNTERED
END OF DRILLING (ft.): NONE ENCOUNTERED
DELAYED WATER LEVEL (FT): N/A

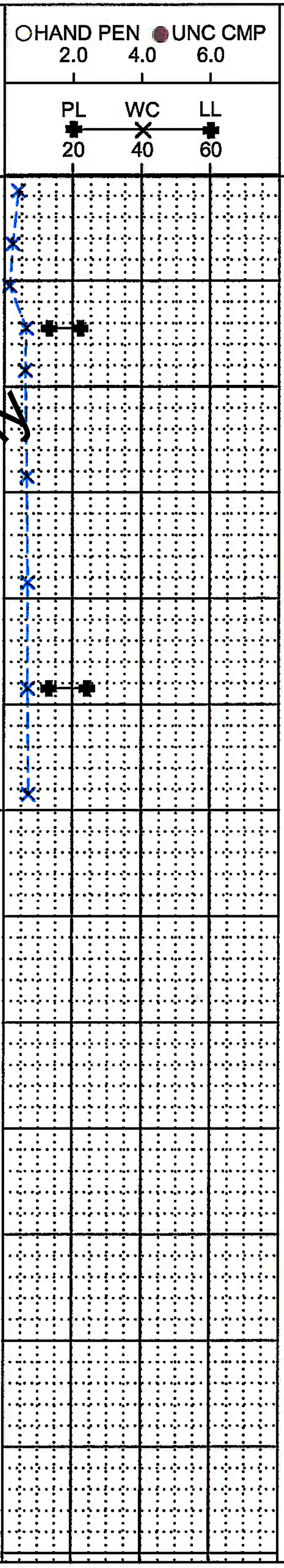
Anderson Ground Storage Tank
Loop 1604 & Hwy 151
Project No. 312-95016

BORING B-2

LOCATION: See Boring Location Plan

Elevation: El. 977 Feet

DEPTH, FT.	SYMBOL	SAMPLES	WATER	SOIL DESCRIPTION	MOISTURE CONTENT	% RETAINED #4	% PASSING #200	SPT (N) & TCP (T) VALUES	% REC	%RQD	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	UNCONF. COMP. (TSF)	UNIT DRY WT. (LB/CU FT)
		☒		**Stratum II** HARD, tan, MARL and WEATHERED LIMESTONE; with interbedded clay seams and layers	4.0			50/3"							
		☒			2.4			50/3"							
5		☒			1.5			50/3"							
		☒			6.3			50/3"			22	13	9		
		☒			6.1			50/2"							
10															
15		☒			6.6			50/2"							
20		☒			6.9			50/3"							
25		☒			6.9			50/3"			24	13	11		
30		☒			7.1			50/3"							
				Boring Terminated at a depth of 30 feet											
35															
40															
45															
50															
55															
60															
65															



COMPLETION DEPTH: 30.0 Feet
DATE: 3/2/09

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DEPTH TO GROUND WATER
SEEPAGE (ft.): NONE ENCOUNTERED
END OF DRILLING (ft.): NONE ENCOUNTERED
DELAYED WATER LEVEL (FT): N/A

Anderson Ground Storage Tank
Loop 1604 & Hwy 151
Project No. 312-95016

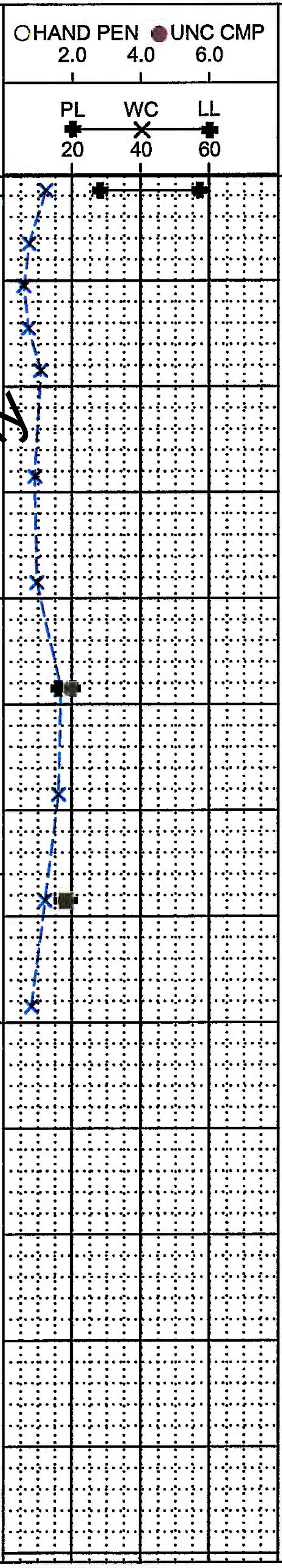
BORING B-3

LOCATION: See Boring Location Plan

Elevation: El. 971 Feet

SOIL DESCRIPTION	MOISTURE CONTENT	% RETAINED #4	% PASSING #200	SPT (N) & TCP (T) VALUES	% REC	%RQD	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	UNCONF. COMP. (TSF)	UNIT DRY WT. (LB/CU FT)
Stratum I HARD, brown, FAT CLAY (CH)	12.3			50/3"			57	28	29		
Stratum II HARD, tan, MARL and WEATHERED LIMESTONE; with interbedded clay seams and layers	7.4			50/1"							
	5.9			50/2"							
	7.2			50/2"							
	10.8			50/1"							
	9.1			50/1"							
	9.7			50/1"							
Stratum III VERY STIFF to HARD, tan, SILTY CLAY	16.7			33			20	16	4		
	16.0			34							
Stratum IV HARD, tan, MARL and WEATHERED LIMESTONE; with interbedded clay seams and layers	12.1			38 50/5"			19	17	2		
	8.1			50/2"							
Boring Terminated at a depth of 40 feet											

DEPTH, FT.: 5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 55, 60, 65



COMPLETION DEPTH: 40.0 Feet
DATE: 4/10/09

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DEPTH TO GROUND WATER
SEEPAGE (ft.): NONE ENCOUNTERED
END OF DRILLING (ft.): NONE ENCOUNTERED
DELAYED WATER LEVEL (FT): N/A

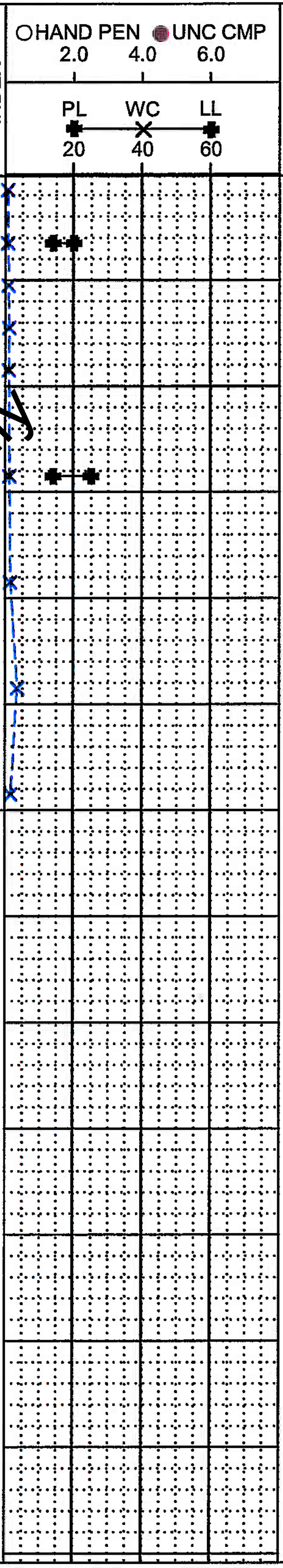
Anderson Ground Storage Tank
Loop 1604 & Hwy 151
Project No. 312-95016

BORING B-4

LOCATION: See Boring Location Plan

Elevation: El. 980.5 Feet

SOIL DESCRIPTION	MOISTURE CONTENT	% RETAINED #4	% PASSING #200	SPT (N) & TCP (T) VALUES	% REC	%RQD	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	UNCONF. COMP. (TSF)	UNIT DRY WT. (LB/CU FT)
Stratum II HARD, tan, MARL and WEATHERED LIMESTONE; with interbedded clay seams and layers	0.8			50/5"							
	0.8			50/4"			20	14	6		
	1.0			50/4"							
	1.2			50/3"							
	1.1			50/3"							
	1.3			50/2"			25	14	11		
	1.5			50/2"							
	3.6			50/4"							
	1.7			50/2"							
Boring Terminated at a depth of 30 feet											



COMPLETION DEPTH: 30.0 Feet
DATE: 2/26/09

DEPTH TO GROUND WATER
SEEPAGE (ft.): NONE ENCOUNTERED
END OF DRILLING (ft.): NONE ENCOUNTERED
DELAYED WATER LEVEL (FT): N/A

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Anderson Ground Storage Tank
Loop 1604 & Hwy 151
Project No. 312-95016

BORING B-5

LOCATION: See Boring Location Plan

DEPTH, FT.	SYMBOL	SAMPLES	WATER	SOIL DESCRIPTION Elevation: El. 973.5 Feet	MOISTURE CONTENT	% RETAINED #4	% PASSING #200	SPT (N) & TCP (T) VALUES	% REC	%RQD	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	○HAND PEN ●UNC CMP 2.0 4.0 6.0 PL WC LL 20 40 60	UNCONF. COMP. (TSF)	UNIT DRY WT. (LB/CU FT)
				Stratum II HARD, tan, MARL and WEATHERED LIMESTONE; with interbedded clay seams and layers												
20				Boring Terminated at a depth of 20 feet												

5 10 15 20 25 30 35 40 45 50 55 60 65

COMPLETION DEPTH: 20.0 Feet
DATE: 4/15/09

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DEPTH TO GROUND WATER
SEEPAGE (ft.): NONE ENCOUNTERED
END OF DRILLING (ft.): NONE ENCOUNTERED
DELAYED WATER LEVEL (FT): N/A

Anderson Ground Storage Tank
Loop 1604 & Hwy 151
Project No. 312-95016

BORING B-6

LOCATION: See Boring Location Plan

DEPTH, FT.	SYMBOL	SAMPLES	WATER	SOIL DESCRIPTION Elevation: El. 977 Feet	MOISTURE CONTENT	% RETAINED #4	% PASSING #200	SPT (N) & TCP (T) VALUES	% REC	%RQD	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	○HAND PEN ●UNC CMP 2.0 4.0 6.0 PL WC LL 20 40 60	UNCONF. COMP. (TSF)	UNIT DRY WT. (LB/CU FT)
0 – 20 5 10 15				**Stratum II** HARD, tan, MARL and WEATHERED LIMESTONE; with interbedded clay seams and layers												
20 25 30 35 40 45 50 55 60 65				Boring Terminated at a depth of 20 feet												

COMPLETION DEPTH: 20.0 Feet
DATE: 4/15/09

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DEPTH TO GROUND WATER
SEEPAGE (ft.): NONE ENCOUNTERED
END OF DRILLING (ft.): NONE ENCOUNTERED
DELAYED WATER LEVEL (FT): N/A

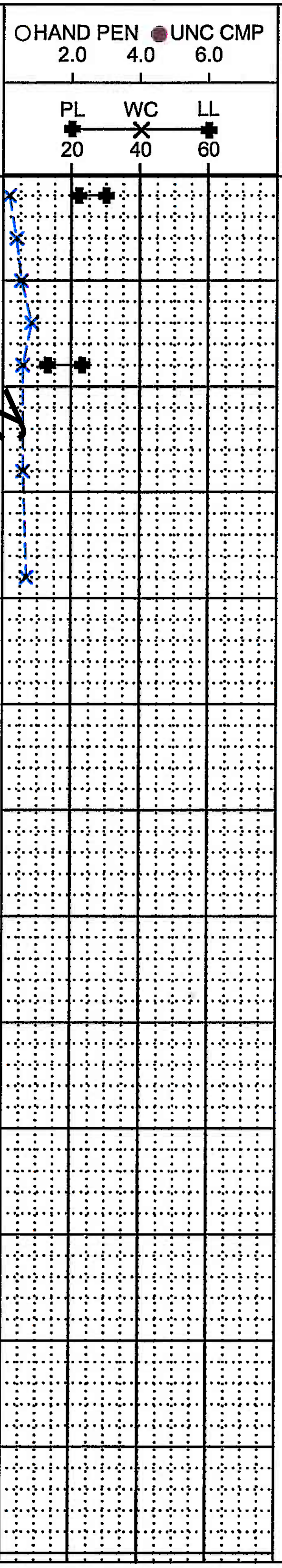
GEO TESTS 95016.GPJ DATA FORM.GDT 5/27/09

Anderson Ground Storage Tank
Loop 1604 & Hwy 151
Project No. 312-95016

BORING B-7

LOCATION: See Boring Location Plan

DEPTH, FT.	SYMBOL	SAMPLES	WATER	SOIL DESCRIPTION Elevation: El. 979 Feet	MOISTURE CONTENT	% RETAINED #4	% PASSING #200	SPT (N) & TCP (T) VALUES	% REC	%RQD	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	UNCONF. COMP. (TSF)	UNIT DRY WT. (LB/CU FT)
				Stratum II HARD, tan, MARL and WEATHERED LIMESTONE; with interbedded clay seams and layers	1.7		34				30	22	8		
					3.8										
5					5.3										
					8.3										
					5.7						23	13	10		
					5.8										
					6.9										
20				Boring Terminated at a depth of 20 feet											



COMPLETION DEPTH: 20.0 Feet
DATE: 3/2/09

psi Information To Build On
Engineering • Consulting • Testing

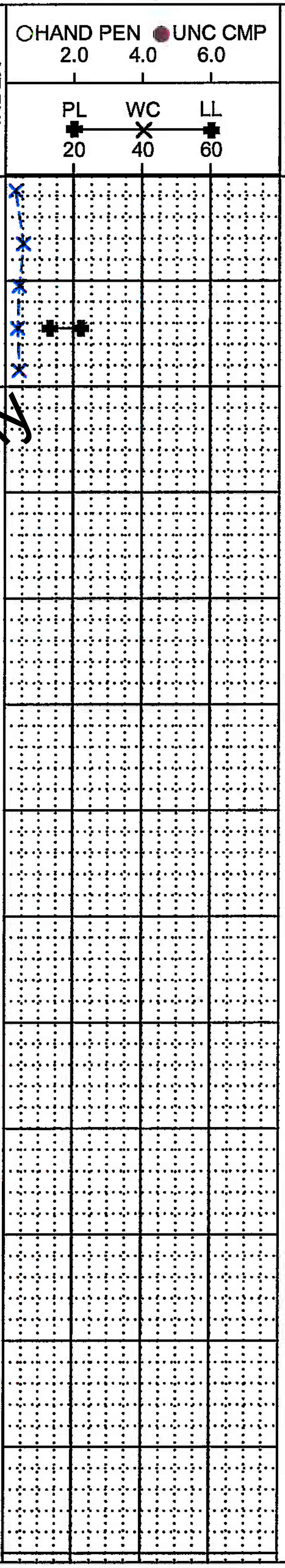
DEPTH TO GROUND WATER
SEEPAGE (ft.): NONE ENCOUNTERED
END OF DRILLING (ft.): NONE ENCOUNTERED
DELAYED WATER LEVEL (FT): N/A

Anderson Ground Storage Tank
Loop 1604 & Hwy 151
Project No. 312-95016

BORING B-8

LOCATION: See Boring Location Plan

DEPTH, FT.	SYMBOL	SAMPLES	WATER	SOIL DESCRIPTION Elevation: El. 969 Feet	MOISTURE CONTENT	% RETAINED #4	% PASSING #200	SPT (N) & TCP (T) VALUES	% REC	%RQD	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	○HAND PEN ●UNC CMP 2.0 4.0 6.0 PL WC LL 20 40 60	UNCONF. COMP. (TSF)	UNIT DRY WT. (LB/CU FT)
		☒		**Stratum II** HARD, tan, MARL and WEATHERED LIMESTONE; with interbedded clay seams and layers	3.0			50/4"								
		☒			5.3			50/2"								
5		☒			4.1			50/2"								
		☒			3.7			50/2"			22	13	9			
		☒			4.1			50/2"								
10				Boring Terminated at a depth of 10 feet												
15																
20																
25																
30																
35																
40																
45																
50																
55																
60																
65																



COMPLETION DEPTH: 10.0 Feet
DATE: 3/2/09

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DEPTH TO GROUND WATER
SEEPAGE (ft.): NONE ENCOUNTERED
END OF DRILLING (ft.): NONE ENCOUNTERED
DELAYED WATER LEVEL (FT): N/A

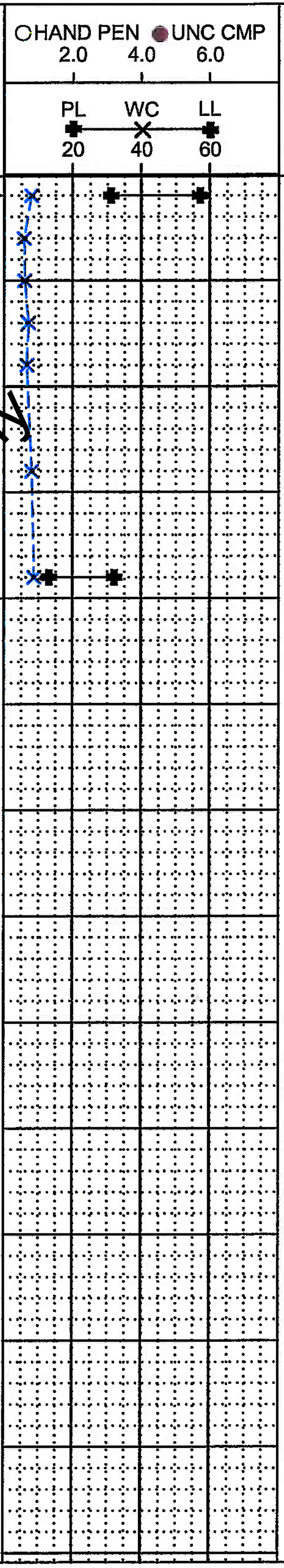
Anderson Ground Storage Tank
Loop 1604 & Hwy 151
Project No. 312-95016

BORING B-9

LOCATION: See Boring Location Plan

Elevation: El. 971 Feet

DEPTH, FT.	SYMBOL	SAMPLES	WATER	SOIL DESCRIPTION	MOISTURE CONTENT	% RETAINED #4	% PASSING #200	SPT (N) & TCP (T) VALUES	% REC	%RQD	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	UNCONF. COMP. (TSF)	UNIT DRY WT. (LB/CU FT)
				Stratum I dark brown, FAT CLAY (CH)	7.9						57	31	26		
				Stratum II HARD, tan, MARL and WEATHERED LIMESTONE; with interbedded clay seams and layers	5.8										
5					6.0										
					7.1										
					6.6										
10															
					8.0										
15															
					8.7						32	13	19		
20				Boring Terminated at a depth of 20 feet											
25															
30															
35															
40															
45															
50															
55															
60															
65															



COMPLETION DEPTH: 20.0 Feet
DATE: 3/2/09

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DEPTH TO GROUND WATER
SEEPAGE (ft.): NONE ENCOUNTERED
END OF DRILLING (ft.): NONE ENCOUNTERED
DELAYED WATER LEVEL (FT): N/A