GEOTECHNICAL INVESTIGATION
Foundation Recommendations

Proposed Single Family Residence
815 County Road 106
Purmela, Texas

Report For:

Chris Itin
323 W. 32 Street
Houston, Texas 77018

May 8, 2013

Project No.: 213127.001

Kohutek Engineering & Testing, Inc.
Geotechnical, Construction Materials
and Forensics
TBPE Registration No. F-778

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TABLE OF CONTENTS

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Purmela, Texas

BACKGROUND

This report presents the results of a geotechnical investigation for a proposed single family residence. The residence is to be located at 815 County Road 106 in Purmela, Coryell County, Texas. Authorization to perform this analysis was given by Mr. Chris Itin, Owner of property from Houston, Texas. Authorization was given on April 4, 2013 and in accordance with proposal no. 213P084.

The purpose of this investigation was to determine the soil profile, the engineering characteristics of the foundation soil and to provide criteria for use by the design engineers in preparing a foundation design for the residence. The scope included a review of geologic literature, a reconnaissance of the immediate site, the subsurface exploration, field and laboratory testing, and an engineering analysis and evaluation of the foundation materials.

The exploration and analysis of the foundation conditions reported herein is considered in sufficient detail and scope to form a reasonable basis for the foundation design. The recommendations submitted are based on the available soil information and the assumed preliminary design for the proposed structure. Any revision in the plans for the proposed structure from those stated in this report should be brought to the attention of the Geotechnical Engineer so that he may determine if changes in the foundation recommendations are required. If deviations from the noted subsurface conditions are encountered during construction, these should also be brought to the attention of the Geotechnical Engineer. This investigation was completed in general conformance with American Society for Testing and Materials (ASTM) D 420 and the guidelines of the Texas Section of the American Society of Civil Engineers.

This report has been prepared for the exclusive use of Chris Itin and his design professionals for specific application to the proposed project in accordance with generally accepted soils and foundation engineering practice. This report is not intended to be used as a specification or construction contract document, but as a guide and information source to those qualified professionals who prepare such documents. It is not to be relied upon by any other entities without the written authorization of Kohutek Engineering & Testing, Inc. The use of this report is not transferable to a third party. By acceptance and use of this report, the Client agrees to the terms and conditions of the referenced proposal, services agreement and the limitations of report as contained in this report.

ARCHITECTURAL AND STRUCTURAL ASSUMPTIONS

The subject residence is to be constructed on a large acreage, rural tract. The street address is 815 County Road 106, Purmela, Texas. This tract is approximately 3.6 miles northeast of the downtown district of Purmela, Texas. According to a hand-held Magellan GPS unit, the latitude and longitude of this lot is approximately 31^0 30' 12" North and 97^0 54' 18" West. At the time of this investigation the tract was vacant, see photographs.

The proposed residence is planned to have a foundation area of approximately 3,000 sq. ft. The foundation is assumed to be a concrete slab on ground with partial stone veneer on the exterior. The structure is assumed to be 1 story. The framing is to be wood with a composition shingle roof. Maximum column loads are to be less than 50 kips and perimeter loads are assumed to be less than 1.5 to 2.0 kips per lf.

If the assumptions concerning the structural loads for the proposed building are not valid, this office should be notified to review the effects it may have on the design recommendations submitted herein.

FIELD INVESTIGATION

Subsurface soil conditions at the project site were investigated by 2 exploratory borings that was drilled on April 16, 2013. The exploratory boring was completed to the depth as shown on the respective log of boring and completed in the vicinity of the proposed residence as located on the site by the Client. A Mobile B-53 drilling rig was used to complete the boring. The drilling and sampling was completed by use of continuous flight augers for advancing the borehole dry and recovering disturbed samples. Procedures completed during the field investigation are more fully discussed in Appendix 'B' to this report.

All soil samples were removed from the samplers in the field, visually classified by a technician, and placed in appropriate containers to reduce disturbance and loss of moisture during transfer to the laboratory. Observations of ground water made during drilling are presented on the boring log.

An estimate of the compressive strength, in tons per square foot (tsf), of the soil was determined in the field by use of a pocket penetrometer. The pocket penetrometer value is equivalent to the undrained shear strength and tabulated on the boring log.

The approximate location of this boring is shown on the enclosed figure entitled ***Plan of Boring*** in Appendix 'A' to this report. A description of the various strata encountered in the boring is presented on the individual Log of Boring, likewise enclosed in Appendix 'A'.

LABORATORY TESTING

Engineering characteristics of the subsurface materials that were encountered and sampled were studied by performing the following tests:

- Visual and laboratory classifications, ASTM D 2487 and D 2488,
- Natural moisture contents, ASTM D 2216, and
- Liquid Limit, Plastic Limit, and Plasticity Index of Soils, ASTM D 4318.

Descriptions of each stratum as made in the field at the time of completing the borings were modified in accordance with the results of laboratory tests and visual examination in the laboratory by a licensed geotechnical engineer. All recovered soil and rock samples were examined and classified in general accordance with ASTM D 2487. Classifications of soils and finalized descriptions of both soils and rock strata are shown on the boring logs. See Appendix 'B' for a brief discussion of each applicable test that was completed.

SITE TOPOGRAPHY, DRAINAGE AND VEGETATION

In near proximity of the foundation area the ground surface gently slopes. Concluding from visual field observations, it appears that the lot slopes at approximately 1.0 to 4.0 percent. There are no abrupt changes in grade in near proximity of the proposed foundation.

At the time of the field investigation, surface drainage appeared to be satisfactory within the immediate area of the residence. There were no apparent signs of any ditches, gullies, or ground water seeps in the immediate vicinity of the proposed foundation area.

The general area of the proposed residence supports a landscape of native vegetation characteristic of the Grand Prairie Land Resource Area. The ground cover consisted of a sparse to moderate stand of native range grasses and weeds with no improved landscaping in vicinity of the foundation area. The subject tract in proximity of the foundations supports scattered stands of mature live oaks intermixed with a few cedar trees, see photographs.

SUBSURFACE CONDITIONS AND LOCAL GEOLOGY

The subject tract is situated on an outcrop of the Glen Rose Formation, *Kgr*. (1, 2) The Glen Rose is the youngest formation of the Trinity Group of Lower Cretaceous Age strata, and its outcrop forms a narrow prairie in the Austin area from Mt. Bonnell northwest to Burnet. Its outcrop is characterized by steep canyons and terraced or "staircase" topography on hillsides.

The Glen Rose is predominantly a limestone formation, typically consisting of thin to massive bedded, hard limestone strata alternating with clay, argillaceous limestone and thin sandstone strata. The formation was deposited under neritic or near shore conditions and the various strata represent different depositional environments such as mud flats, lagoons, beaches and shallow water reefs. The alternations of hard and soft layers causes the characteristic staircase topography of the Glen Rose.

At the subject site, a typical Glen Rose sequence of hard continuous limestone strata alternating with softer limestone and clay strata was encountered. The several flat terraces are supported by hard limestone strata with individual layers ranging from one to four feet in thickness. The slopes separating the terraces are predominantly medium hard to hard argillaceous limestone interbedded with silty clay.

According to the USDA/Soils Conservation Service, the solum soils are classified as belonging to the Real-Rock outcrop Complex, *ReF*. (3) The Real soils consists of shallow, well drained, soils on uplands. These soils formed in weakly and strongly cemented limestone interbedded with loamy, calcareous materials. At the near surface, the soils matrix typically contains limestone rubble, in the size of sand to gravel intermixed with pieces of marl. About 20 percent of the surface is covered with this limestone rubble. In typical sequence, it is expected that limestone will be encountered within 4 to 8 feet or less of the surface.

During the field investigation, ground water was not encountered in either of the exploratory borings. However, the determination of ground water gradients and flow quantities was beyond the scope of this investigation. Based upon the stratigraphy encountered, it is believed that the extent of the possibility of ground water will be dependent upon the antecedent rainfall. Thus, it may be possible to encounter ground water during the construction process.

At this particular site, the soils can basically be categorized into one of several groupings. These groupings are based on the soil's physical and engineering properties; such as, grain size, Atterberg limits and shear strength.

Table 1.
Subsurface Stratigraphy

Stratum	Description	Depth Encountered	Approximate Thickness Encountered, ft.
I	sandy lean CLAY with gravel, limestone particles, damp, stiff, dark brown to light grayish brown, CL.	at the surface	0.75 to 1.5
II	LIMESTONE, weathered to unweathered, soft to medium hard, dark tan to light blue-gray, Kgr.	0.75 to 1.5	13.5 to 14.25

Detailed descriptions of the various strata encountered are noted on the individual ***Logs of Borings***, which may be seen in Appendix 'A'.

CONCLUSIONS

Excavation and site work: Excavation may be carried on by ordinary power equipment to at least the depths of encountering the medium hard limestone. Within the medium hard limestone, an increase in excavation effort may be necessary. This might require the use of heavy duty excavators, rock saws or heavy duty trenchers.

Stability of vertical excavation walls will be generally good to depths of approximately 4 feet, for short periods of time while using common precautionary measures. If personnel are to enter excavations, these excavations should be braced and shored in accordance with applicable regulations.

Ground water is possible in excavations or pier holes depending on antecedent rainfall. The amount of ground water actually encountered will be dependent upon the preceding rainfall.

Settlement Potential: According to published literature (4, 5), if the in-situ moisture content is in close proximity to the plastic limit, the soil is over-consolidated. By examining the laboratory data it is apparent that this condition prevails for the soils sampled during this investigation. Thus, it is concluded that the natural soils encountered at this site are considered to be over-consolidated. For over-consolidated soils of the characteristics of that which were encountered, **settlement potential of the <u>natural soils</u> delineated in this report for light structures may be categorized as minimal**.

Settlement of the footings under the anticipated magnitudes of sustained loading are expected to be in the order of 0.5 to 0.75 inches for footings founded within the stratum and not exceeding the allowable bearing pressures as recommended in this report. Differential settlements are expected to be approximately 75 percent of the total settlement, or approximately 0.6 inches.

However, heavy structures or structures more than three stories in height will require analysis beyond the scope of this report.

Expansive Soil Potential: The soils encountered at this project site exhibited plasticity indices less than 17. One method of determining a soils potential for expansive movements is by examination of its liquidity index, LI. The LI for these soils is estimated to be -0.353. It can be concluded that soils possessing a LI in this range will most probably be in a "non-swelled" state and will have a high potential for swell. (6)

The potential vertical rise (PVR) (7) of this soil profile, for both in-situ conditions and under the anticipated loads, was calculated by the Texas Department of Transportation test method TEX-124-E. Summarizing, the expected PVR for these soils when subjected to the anticipated building loads will vary from 0.6 to 0.8 inches. Thus, the potential for disruptive foundation movements due to the soils may be categorized as **<u>slight</u>.**

Seismic Considerations: According to the 2006 International Building Code (IBC), the site classification for seismic considerations is based upon a soil profile in the upper 100-foot depth. The soils encountered during this investigation were extrapolated from the boring depth of 20 feet to the 100-foot depth. Based upon experience in this geologic formation, it is my opinion that this is a conservation extrapolation.

On the basis of the site class definitions as presented in Table 1613.5.2 and 1613.5.5 of the IBC and the encountered stratigraphy, it is determined that this site can be classified in the Site Class C, a very dense soil and soft rock.

Hazards associated with slope stability, soil liquefaction, surface rupture, and lateral spreading are not considered an issue with this project site due to the study area being in a seismically inactive area and the site being underlain by a very dense soil and soft rock profile.

RECOMMENDATIONS - FOUNDATIONS

A stiffened, soil supported slab-on-ground will perform to acceptable industry standards on this site for the size of structure proposed. This type of slab will be both economical and sufficiently stable for a lightly loaded structure. However it should be noted that there are some levels of risks associated with all types of foundations and there is no such thing as a zero risk foundation. Stiffened, soil supported slab-on-ground foundations are not designed to resist soil and foundation movements resulting from climate anomalies, sewer/plumbing leaks, excessive lawn irrigation, poor drainage, lack of proper maintenance, and/or water ponding near the foundation.

For a clayey site, such as the subject site, where there are several large trunk diameter trees in near proximity of the proposed foundation, care should be exercised in designing a foundation. The types of building materials, the Owner's performance expectations combined with past experiences will greatly influence the selected foundation system. Thus, the final selection of the foundation system will require the Owner to evaluate his performance expectations with the economics of construction.

Discussed in the subsequent sections of this report are specific foundation recommendations for a foundation system. The Owner along with his consultants should evaluate this foundation system and ensure that this foundation system best compliments his construction and utilization plans for this residence and addition.

I. Stiffened Slab-on-Ground Foundation with Select Fill Pad.

A. Slab-on-Ground.

For design of a soil supported stiffened slab bearing on a foundation pad prepared as recommended in the following sections of this report, the following design parameters are recommended for use in sizing the foundation elements. These procedures should be used only as a guide by the structural engineer and should be modified to consider the geometrics and loadings of the proposed structures. Typically, it is recommended that any soil movements (or potential vertical rise) beneath the slab be limited to less than 1.0 inch **or** as an alternative, the slab should be designed sufficiently rigid to withstand the anticipated vertical soil movements.

In order to develop soil support design parameters for a foundation, several assumptions were made. These assumptions are based upon published literature and personal knowledge of the soils in the Central Texas region.

modulus of elasticity = 5,000 psi

Concluding from the correlation to similar soils, it was assumed that the percent clay fraction is 40 percent. As with most soils in the Central Texas region, the predominant clay mineral is montmorillonite. Due to the expansiveness of the underlying strata, a high value of edge moisture variation distance, em, was selected.

Discussed in the subsequent sections of this report are specific foundation recommendations for stiffened slab-on-grade type of foundation systems, see Table 2 and Figure 1. These procedures should be used only as a guide by the structural engineer and should be modified to consider the geometrics and loadings of the proposed structure.

It is essential that water not be allowed to pond beneath the foundation. One of several methods might be used in order to accomplish this. One method is to construct an impervious moisture barrier around the perimeter of the foundation. This impervious moisture barrier might consist of the clay cap as detailed in Figure 1. Another acceptable method would be to construct a sump at the low end of the excavation in order to collect any water. A positive method of discharging water from the sump must be included with the sump. Other methods might work equally well. If you have specific questions concerning this, please contact me.

It is recommended that caution be exercised by the design engineers when bearing the foundation partially in natural clay and partially in select fill. It is recommended that all of the various foundation elements bear within identical material, see Figure 1.

Table 2.
Slab on Ground Foundation Recommendations

Option	Underslab Fill Condition	Potential Vertical Rise, inches	P.T.I. Criteria (8)				Effective
			e_m, ft		y_m, in.		
			Ctr	Edge	Ctr	Edge	P.I. (9)
3rd Edition							
1	remove 6" vegetation and natural CLAY & replace with a minimum of 12" select fill.	0.9	9.0	5.0	0.5	0.7	22

B. Shallow Foundations.

Structural loads may be transmitted within the natural soils by means of continuous footings. An allowable bearing capacity value of **3,500 pounds per square foot, PSF**, may be used to proportion the footings. (4, 5, 6) The footings should be founded a minimum of 12 inches within the Stratum I as described in Table 1. This allowable bearing capacity value considers a factor of safety of 3 against a bearing capacity failure. Stratum I material approved by the geotechnical engineer may be used to support foundations.

Safe bearing pressures as given above are for ensuring against shear failure of the foundation soil immediately below the footings and do not account for possible long term volumetric changes, such as swelling or settlement which could contribute to foundation movements. Such phenomena must be considered in the design approach.

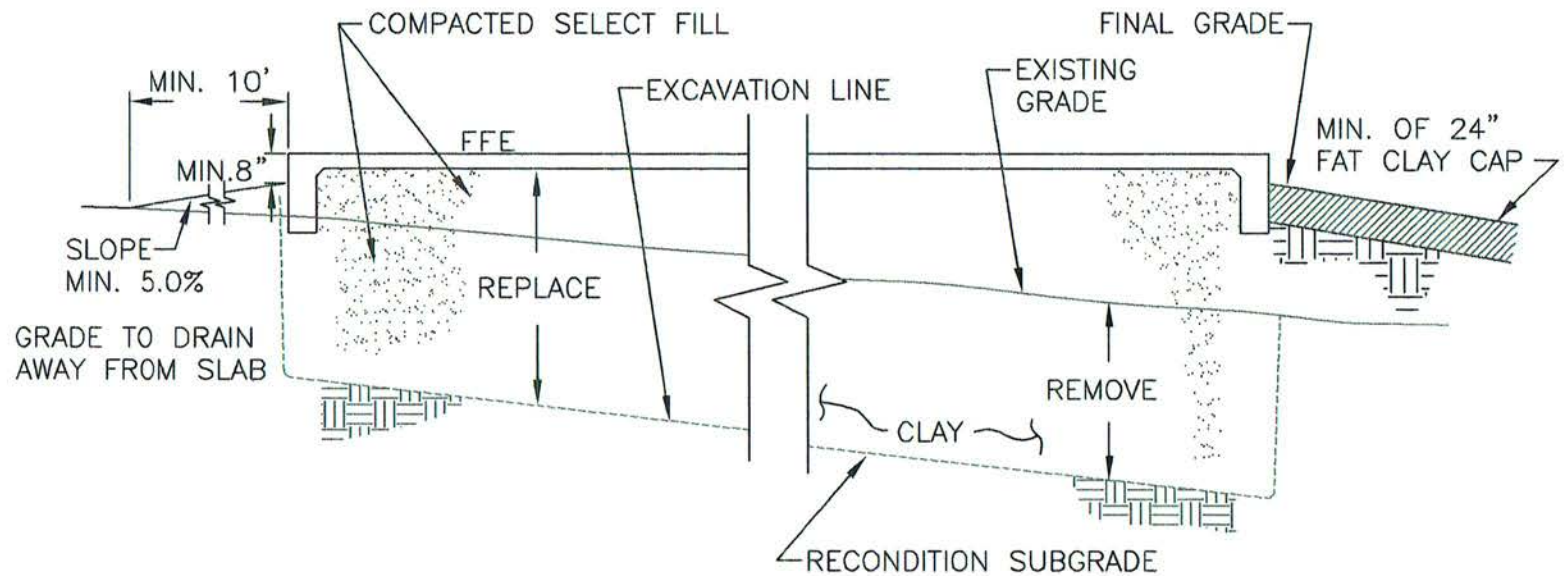

FIGURE 1
BUILDING PAD CROSS-SECTION
NTS

Kohutek Engineering & Testing, Inc.

RECOMMENDATIONS - CONSTRUCTION PROCEDURES

The following information has been assimilated after examination of numerous problems dealing with similar subsurface conditions throughout the area. It is presented here for inclusion into the foundation design. If these features are incorporated into the overall design of the project, the performance of the proposed structure will be improved. However, due to the characteristics of the underlying soils, some cosmetics cracking of sheetrock, bricks, mortar and concrete may still be experienced.

In the course of preparing the foundation pad, the surface vegetative layer should be **removed to a minimum depth of 6 inches or as recommended in this report, whichever is greater**. The exposed subgrade should be compacted to a minimum dry density of 95 percent and no more than 100 percent of the maximum dry density as determined by test method ASTM D 698, Standard Proctor. At time of testing the subgrade compaction, the moisture content should be no less than the optimum moisture content and no greater than plus 4 percentage points of the optimum moisture content. This moisture in the subgrade should be maintained at this content until the first lift of select fill is placed. It is the intent of the subgrade preparation to meet the requirements of HUD/FHA Data Sheet 79G, Paragraph 10, Controlled Earthwork and the International Residential Code (IRC) R403.1. If there appears to be any conflicts between the recommendations given in this report, the 79G, and IRC R403.1, the geotechnical engineer should be further consulted in providing clarification. Additional excavation must be carried to whatever depth is required to allow a minimum of the required thickness of selected and compacted fill beneath the slab as recommended in the respective specifications item as enclosed with this report.

Subsequent to this preparation of the subgrade, **a minimum thickness of inert fill shall be placed as recommended in this report**. This should be replaced in accordance with the enclosed specifications for ***Residential Underslab Fill***. Any imported underslab fill should meet the enclosed specifications for ***Residential Underslab Fill***, if this imported fill is to be relied upon for footing and slab support. If footing beams penetrate fill and rest in natural soil or approved **FILL**, the compaction of the imported fill may be nominal and the ***Residential Underslab Fill*** will be considered forming fill only. This construction technique should be approved by the foundation designer prior to construction. Underslab fills utilizing existing on-site material shall conform to the enclosed specification for ***Residential Underslab Fill***.

Grade beams in excess of 48 inches in height should be designed as a retaining wall. If this condition prevails on this site, the geotechnical engineer should be notified so that additional recommendations can be developed specifically for the condition. Also, within grade beams greater than 48 inches in height, consideration of hydrostatic pressure should be incorporated into the design.

The underlying clayey soils may result in some amount of unacceptable deflection of the utility pipes that will be placed beneath the foundation slab on grade. In particular, the water and wastewater lines. Thus, it is recommended that some flexibility be incorporated in the design and construction of all utility lines placed beneath the foundation slab. It is also recommended that any utility lines placed beneath the foundation slab be buried a minimum of 8 inches or more if required by local building code, beneath the bottom of the slab. Prior to the placement of the foundation concrete it is recommended that all utility lines placed beneath the foundation slab be pressure tested in order to ensure tightness of the respective line.

A 6 mil vapor barrier should be placed under the entire concrete slab area that will be in contact with the earth.

The concrete should contain a minimum of 4.5 sacks per cubic yard of cementitious materials and develop a minimum 28 day compressive strength of 3,000 PSI. Slump should be 6 inches or less. Fly ash may be substituted for up to a maximum of 25 percent, weight basis, of the cement content. All concrete placed in the foundation should contain sufficient air entraining agent such that a minimum of 4.5 percent entrained air will be achieved. Other provisions of ACI Practices 211, 302, 304, 318, 360 and other applicable practice codes should be followed.

For the slab-on-ground, the slab concrete is to be placed monolithically with any stiffening beams. All joints are to be approved by the structural engineer prior to commencement of the concrete pour.

The design of the superstructure shall consider the foundation conditions and some flexibility should be built into the system. All permanent, non-flexible or load-bearing partitions should be designed per structural analysis. Control joints at not over 20 feet spacing should be used in masonry walls, with a wall control joint located at each foundation slab control joint, if walls are slab supported, see American Concrete Institute 530. If prefab roof trusses are to be used in this structure then it is recommended that the foundation designer consider the deflection criteria as presented in Table 6.2 of the PTI design procedure (8). Due to the underlying soils, it is recommended that if the construction materials are to consist of concrete, masonry, and/or sheetrock, the Owner should expect some degree of cracking in these building materials. This is due to the underlying clay soils. If some degree of cracking is not acceptable to the Owner, it is recommended that these building materials not be incorporated into the construction of this structure. However, if designed and constructed in accordance with all recommendations contained in this report, these anticipated movements are not expected to result in a structure that will functionally fail. (10)

The sidewalks or driveways should be doweled to the proposed foundation to avoid differential displacements. They should be sloped away from the structure so that water will drain away from the foundation.

Drainage should be maintained away from the foundation, both during and after construction, see IRC R401.3 and R801.3, see Figure 1. Downspouts or a collector system for roof drains must have provisions for removing storm water runoff as per the IRC. Likewise, the condensate drain from the HVAC should also be conveyed a minimum of 10 feet from the structure. Provisions of the current edition of the International Plumbing Code concerning downspouts, roof drains, and HVAC condensate drains shall be complied with. Care must be maintained at all times to ensure that surface watering or storm water runoff not be allowed to accumulate next to or below the proposed structure.

Trees and large shrubs can, by transpiration, remove significant quantities of water from the upper clays resulting in shrinkage of these upper clays and settlement of the floor slabs. Therefore, any shrubs or trees planted for landscaping should be located at least one and one-half their anticipated mature height away from the foundation. Additionally, if any existing tree within this delineated area around the foundation is to remain, then special consideration should be given to preventing the roots from encroaching beneath the foundation area. Existing trees that are within the limits of the foundation and will require to be removed will necessitate special consideration for the backfill. All backfill required to level the "root hole" shall consist of the ***Residential Underslab Fill*** as specified in this report. Placement, moisture conditioning, and testing shall likewise meet these requirements.

It is <u>not</u> recommended that flowers or other plants requiring a high amount of water be planted any closer than 5 feet to the foundation. It is recommended that <u>if</u> flower beds are to be placed adjacent to the foundation, then native plants or other plants that have low water requirements be planted in landscaped areas around the entire perimeter of the foundation. These native plants and other plants that have low water requirements will assist in sheltering the soil from moisture evaporation; thus, reducing moisture fluctuations. It is essential for the successful performance of this foundation for the Owner not to allow extreme moisture fluctuations within 5 feet of the foundation. Additionally, sprinkler systems shall not spray water any closer than 5 feet of the foundation and shall extend around the entire perimeter of the foundation. Sprinkler systems are notorious for water leaks that result in isolated wet spots. If these isolated wet spots occur, it is recommended that the Owner take immediate steps to stop the leaks. It is recommended that if a sprinkler system is installed, it should be placed around the entire perimeter of the foundation. This will provide a more uniform moisture condition at the edge of the foundation. A non-uniform moisture condition will result in differential movement of the slab that was not considered in this geotechnical report.

It is recommended that the Owner secure a copy of the booklet entitled "*So Your Home is Built on Expansive Soils*" edited by Warren K. Wray. This booklet is published by the American Society of Civil Engineers. For additional information on care and maintenance of a foundation on medium to highly expansive soils, a booklet has been prepared by the Post-Tensioning Institute entitled "*Construction and Maintenance Procedures Manual For Post-Tensioned Slabs-on-Ground*", see chapters 12 and 13. Although the final design of the foundation may not be post-tensioned, the PTI manual contains many items of care and maintenance that are applicable for a conventional reinforced foundation. Ordering information for the ASCE booklet and the PTI manual can be found on their respective web sites.

Prior to construction, the Geotechnical Engineer should be given the opportunity to review the plans in order to ensure that all recommendations have been properly implemented. With the final grading/elevations having not been established as of this report, it is essential that this review be completed prior to commencement of construction. It is recommended that the foundation construction be inspected by the Geotechnical Engineer to ensure that the bearing soils, pads and various foundation elements are properly constructed. A recommended schedule of quality assurance considerations is enclosed in a following section of this report. **Kohutek Engineering & Testing, Inc. cannot be responsible for misinterpretations of our recommendations if we have not had an opportunity to review the construction plans, specifications and complete the quality assurance testing and inspection as recommended for this project. Failure to comply with all recommendations contained in this report may result in the recommendations to be void.**

RESIDENTIAL UNDERSLAB FILL SPECIFICATIONS

A. Selection of fill material should be guided by the following criteria:

1. Maximum plasticity index: 15
   Minimum plasticity index: 3
2. Minimum and maximum passing #200 sieve: 10% to 70%.
3. No stones larger than 2".

B. Compaction should be 95 percent of maximum laboratory density determined in accordance with American Society of Testing Materials, method ASTM D 698, using a compactive effort of 7.16 ft.lbs./cu.in.

C. Placement should be in lifts not exceeding eight inches before compaction. Top of finished fill shall be within ten inches of underslab grade (but not above) and be bladed flat. Material excavated from beam trenches may be used for fine grading. Each compacted lift should be inspected and tested for density compliance by the Geotechnical Engineer prior to placing the next lift. Fill should extend at least 24 inches (36 inches on fills over six feet) beyond neat slab lines before sloping downward at not more than one on two slope to natural soil, unless grade changes are accomplished by properly designed deep foundation beams. Fill shall be within 3 percentage points of optimum moisture content during compaction. Backslopes shall be well compacted.

D. Testing and certification of raw fill material, placement, and compaction shall be performed by the Geotechnical Engineer. A 50 lb. sample of proposed fill material should be submitted to Geotechnical Engineer for approval and for determination of Moisture-Density Relationship, a minimum of 7 days in advance of filling and compaction operations to permit inspection and testing as fill is placed. Not less than one field density test per 2,000 sq. ft. or minimum of 3 per lift is required. (Call 512-930-5832 for inspection coordination.)

E. Beam trenches shall be cut directly into compacted fill to plan dimensions and sacking of trenches will be permitted for inside of perimeter beams. In case sacking is used, density testing will not be performed closer than 4 feet from inside of perimeter beam face. The Geotechnical Engineer may require deepened exterior beams in lieu of excessively high fills.

F. Deviations from the above criteria may be permitted upon approval of the Geotechnical Engineer on an individual basis.

G. Compliance with these specifications as stated above or as modified by the Geotechnical Engineer for specific conditions shall be the basis for certification of compliance with FHA Data Sheet 79G and VA requirements.

H. Structural support of slab foundations may be carried through underslab fill to natural soil by the designer's option. In this case, paragraphs "B" through "G" of this specification are void and the underslab fill will be considered "forming fill" only.

RECOMMENDATIONS - QUALITY ASSURANCE

TYPE OF WORK	ITEM	SAMPLE FREQUENCY	SAMPLE SIZE	MINIMUM TESTING
General Earthwork, Subgrade, and Fill	Soil Material	1 per soil Type	50 lbs.	-sieve -P.I. -Moisture-Density
	Compaction	1 per 2000 sq.ft. per lift (min. of 3 per lift)		Field Density Test
Concrete	Mix Design	1 per concrete class		-review & approval with confirmatory cylinders -Plant & materials approval, testing if questionable
	Aggregates (coarse & fine)	1 per 500 cu.yd., min. 1 per job	50 lbs.	Sieve, organic, impurities, specific gravity
	Cement	1 per 100 cu. yds. 10 lbs. min. 1 per job		-fineness -chemical compound -see mill reports
	Concrete Placement	1 per 50 cu. yds. or each days pour if less		-slump -air test -5 compressive cylinder test, test 2 at 7 days, 2 at 28 day, 1 hold

TYPE OF WORK	ITEM	SAMPLE FREQUENCY	SAMPLE SIZE	MINIMUM TESTING
All Steel Including reinforcing	Material	Per Lot		See Mill Report
Foundation	Reinforcing, beams and concrete.	Each Pour		Qualified inspector
	Drilled Piers	Each		Qualified inspector

REFERENCES

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9. "*Design of Slab-on-Ground Foundations, An Update*", Wire Reinforcement Institute, Walter L. Snowden, P.E., Austin, Texas, March 1996.

10. Meyer, Kirby T. "*Defining Foundation Failure*", Presented to the Texas Section of the American Society of Civil Engineers, October 4, 1991.

LIMITATIONS OF REPORT

Conditions of the site at locations other than the specific location of each exploratory boring are not expressed or implied, and conditions may be different at different times from the time of this investigation. Subsurface conditions have been extrapolated based upon the samples actually recovered and actual field conditions may differ from those described in this report. Kohutek Engineering & Testing, Inc. simply cannot guarantee that conditions elsewhere on the subject site will be the same as encountered at the specific exploratory boring locations. Additionally, the findings, conclusions and recommendations contained within this report are subject to revision based on site conditions as exposed during construction activities. Thus, Kohutek Engineering & Testing, Inc. recommends that the Client retains our consulting services through the construction stage to identify variations in the site conditions and to confirm that the recommendations contained in this report are applicable to the conditions encountered elsewhere on the subject site. Contractors or others desiring more information are advised to secure their own supplemental borings. The analysis and recommendations contained herein are based on the available data as submitted by the Client and the writer's professional expertise, experience and training, and no other warranty is expressed or implied concerning the satisfactory use of these recommendations or data. The scope of services for this investigation does not include environmental evaluations of the surface or subsurface conditions, and the lack of that information in this report does not indicate an absence of potential environmental problems.

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APPENDIX A

GEOTECHNICAL DATA

Summary of Laboratory Investigation

Proposed Single Family Residence
815 County Road 106
Purmela, Texas

Project No.: 213127.001

Boring	Depth (Ft.)	LL	PL	PI	MC %	USCS
B-1	1	37	20	17	14	CL

Notes:

LL	=	Liquid Limit
PL	=	Plastic Limit
PI	=	Plasticity Index
MC	=	Moisture Content in Place (%)
USCS	=	Unified Soil Classification System

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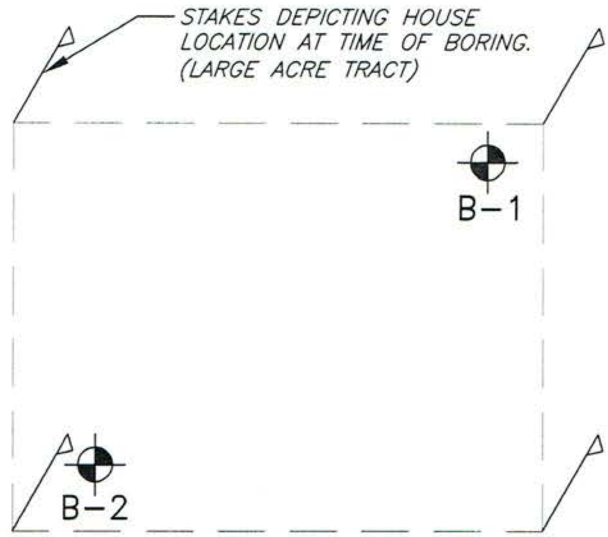
Site Location Map
Proposed Single Family Residence
815 County Road 106
Purmela, Texas
Project No. 213127.001



SCALE: NOT TO SCALE

PLAN OF BORINGS
PROPOSED SINGLE FAMILY RESIDENCE
815 COUNTY ROAD 106
PURMELA, TEXAS
PROJECT NO. 213127.001

Kohutek Engineering & Testing, Inc.

LOG OF BORING

Project: Proposed Single Family Residence
815 County Road 106
Purmela, Texas

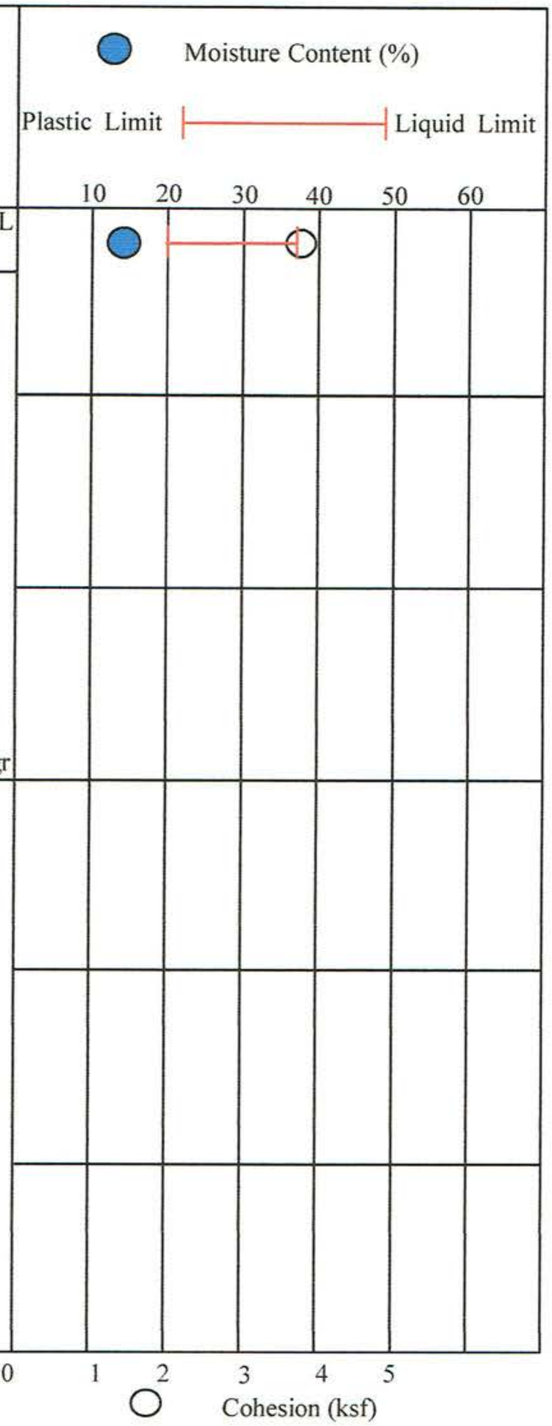
Project No.: 213127.001

Date: April 16, 2013   Elevation:

Boring No.: B-1

DEPTH (FEET)	SYMBOL	MATERIAL DESCRIPTION	
0–1.5		sandy lean CLAY with gravel, limestone particles, damp, stiff, dark brown	CL
1.5–15		LIMESTONE, weathered, slightly marly, soft to medium hard, light tan ...unweathered, medium hard, light tan ...light blue-gray	Kgr
15		DISCONTINUED AT 15.0 FEET	

Depth scale: 5, 10, 15, 20, 25



Note: Boring advanced without the use of drilling fluid.
Cohesion from hand Penetrometer.

Kohutek Engineering & Testing, Inc.

LOG OF BORING

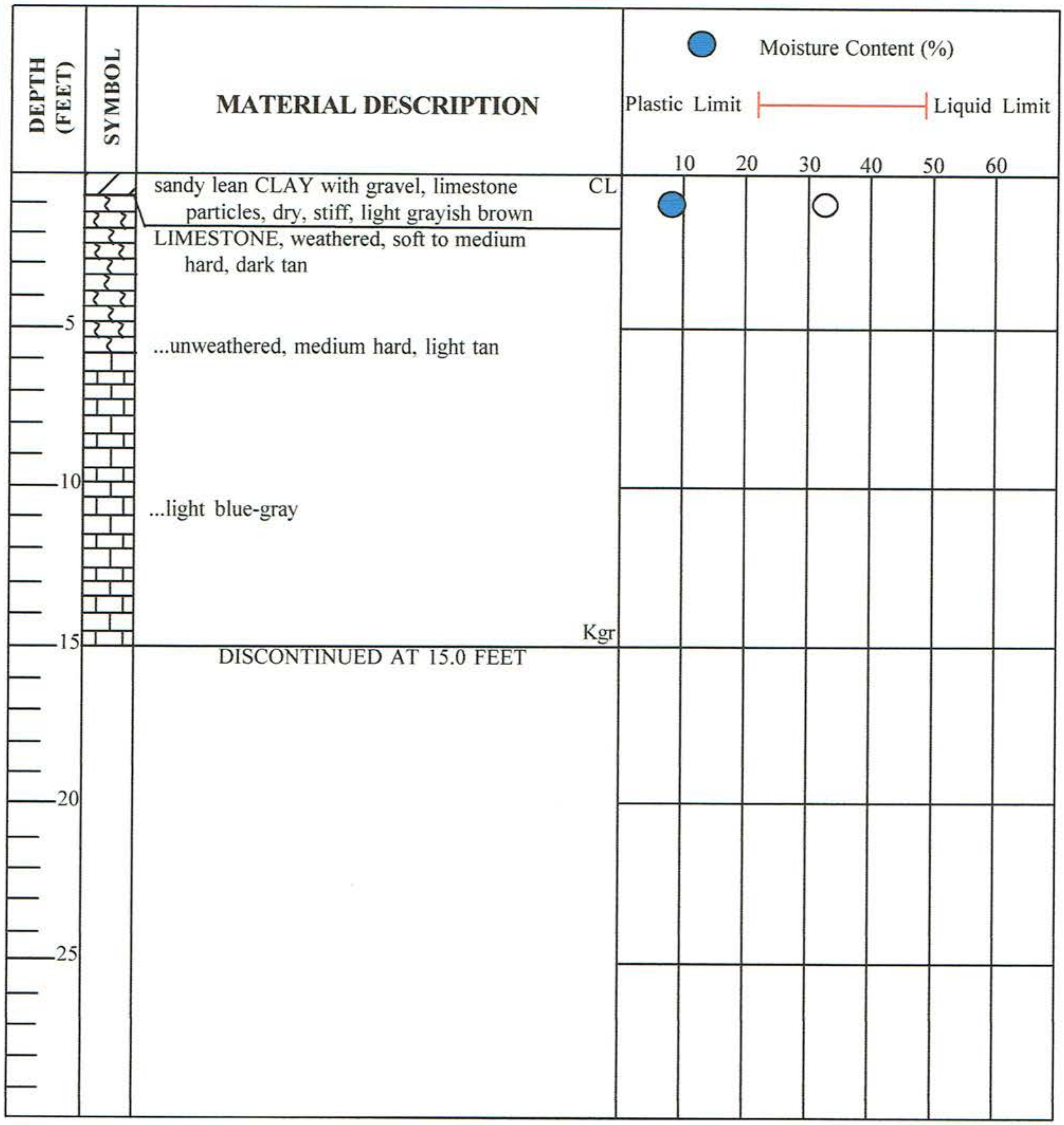
Project: Proposed Single Family Residence
815 County Road 106
Purmela, Texas

Project No.: 213127.001

Date: April 16, 2013

Elevation:

Boring No.: B-2



Note: Boring advanced without the use of drilling fluid.
Cohesion from hand Penetrometer.

Cohesion (ksf)

Kohutek Engineering & Testing, Inc.

Site Photographs

A KEY TO SOIL CLASSIFICATIONS & SYMBOLS

UNIFIED SOILS CLASSIFICATION SYSTEM(1)

Major Divisions	Letter	Symbol	Name
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
SILTS AND CLAYS L <50	ML		Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity
	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 L > 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

LIMESTONE			WEATHERED LIMESTONE
CLAYSTONE OR SILTSTONE			SANDSTONE
SHALE			IGNEOUS ROCK

TERMS CHARACTERIZING SOILS(2)

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

STANDARD ABBREVIATIONS

Med.	MEDIUM	Brn.	BROWN
Sev.	SEVERELY	Dk.	DARK
Wx.	WEATHERED	Lt.	LIGHT
Fer.	FERRUGINOUS	Yel.	YELLOW
Frac.	FRACTURED	Blk.	BLACK
V.	VERY	Or.	ORANGE
Ls.	LIMESTONE	Calcs.	CALCAREOUS
Moi.	MOIST	Frag.	FRAGMENTS
Ang.	ANGULAR	Nod.	NODULES
Cemd.	CEMENTED	w/	WITH
Chlky.	CHALKY		
Chty.	CHERTY		

TERMS DESCRIBING CONSISTENCY OF SOILS(2)

COARSE GRAINED SOILS

DESCRIPTIVE TERM	NO. BLOWS/FT. – S.P.T
VERY LOOSE	0 – 4
LOOSE	4 – 10
FIRM (medium)	10 – 30
DENSE	30 – 50
VERY DENSE	over 50

SHALE, LIMESTONE, CLAYSTONE, or SILTSTONE

DESCRIPTIVE TERM	STRENGTH – TONS/SQ.FT.
SOFT	4 – 8
MED HARD	8 – 15
HARD	15 – 50
VERY HARD	over 50

FINE GRAINED SOILS

DESCRIPTIVE TERM	NO. BLOWS/FT. S. P. T.	UNCONFINED COMPRESSION TONS/SQ.FT.
VERY SOFT	< 2	< 0.25
SOFT	2 – 4	0.25 – 0.50
PLASTIC (med. stiff)	4 – 8	0.50 – 1.00
STIFF	8 – 15	1.00 – 2.00
VERY STIFF	15 – 30	2.00 – 4.00
HARD	over 30	over 4.00

SYMBOLS FOR TEST DATA

L_w = Liquid Limit P_w = Plastic Limit

δ = 95 – Dry unit weight in lbs./cu ft.

SCR - Standard Core Recover

RQI - Rock Quality Index

30% Finer – Percent finer than No. 200 mesh sieve

N = 30 – Number of blows per foot, standard penetration test (SPT)

THD = 30 – Number of blows per foot, Texas Highway Department Cone Penetrometer Test

▼ – Ground Water Table

APPENDIX B

STANDARD FIELD AND LABORATORY PROCEDURES

STANDARD FIELD AND LABORATORY PROCEDURES

STANDARD FIELD PROCEDURES

Drilling and Sampling

Borings are typically staked in the field by the drillers, using simple taping procedures and locations are assumed to be accurate to within several feet. Unless noted otherwise, ground surface elevations (GSE) when shown on logs are estimated from topographic maps and are assumed to be accurate to within a foot. A plan of Borings, showing the boring locations and the proposed structures is provided in the Appendix.

A log of each boring was prepared as drilling and sampling progressed. In the laboratory, the driller's classification and description is reviewed by a Geotechnical Engineer. Individual logs of each boring are provided in the Appendix. Descriptive terms and symbols used on the logs are in accordance with the Unified Soil Classification System (ASTM D 2487). A reference key is also provided. The stratification of the subsurface material represents the soil conditions at the actual boring locations, and variations may occur between borings. Lines of demarcation represent the approximate boundary between the different material types, but the transition may be gradual.

A truck-mounted rotary drill rig utilizing rotary wash drilling or continuous flight hollow or solid stem auger procedures is used to advance the borings, unless otherwise noted. Samples of soil are obtained from the borings for subsequent laboratory study. Samples are sealed in plastic bags and marked as to depth and hole locations in the field. Cores are wrapped in a polyethylene wrap to preserve field moisture conditions, placed in core boxes and marked as to depth and core runs. Unless notified to the contrary, samples and cores will be stored for 90 days, then discarded.

Standard Penetration Test and Split-Barrel Sampling of Soils (ASTM D 1586) (SPT)

This sampling method consists of driving a 2 inch outside diameter split barrel sampler using a 140 pound hammer free falling through a distance of 30 inches. The sampler is first seated 6 inches into the material to be sampled and then driven an additional 12 inches. The number of blows required to drive the sampler the final 12 inches is known as the Standard Penetration Resistance. The results of the SPT is recorded on the boring logs as "N" values.

Thin-Walled Tube Sampling of Soils (ASTM D 1587) (Shelby Tube Sampling)

This method consists of pushing thin walled steel tubes, usually 3 inches in diameter, into the soils to be sampled using hydraulic pressure or other means. Cohesive soils are usually sampled in this manner and relatively undisturbed samples are recovered.

Soil Investigation and Sampling by Auger Borings (ASTM D 1452)

This method consists of auguring a hole and removing representative soil samples from the auger flight or bit at intervals or with each change in the substrata. Disturbed samples are obtained and this method is, therefore, limited to situations where it is satisfactory to determine the approximate subsurface profile and obtain samples suitable for index property testing.

Diamond Core Drilling for Site Investigation (ASTM D 2113)

This method consists of advancing a hole into hard strata by rotating a single or double tube core barrel equipped with a cutting bit. Diamond, tungsten carbide, or other cutting agents may be used for the bit. Wash water or air is used to remove the cuttings and to cool the bit. Normally, a 3 inch outside diameter by 2-1/8 inch inside diameter coring bit is used unless otherwise noted. The rock or hard material recovered within the core barrel is examined in the field and in the laboratory and the cores are stored in partitioned boxes. The intactness of all rock core specimens is evaluated in two ways. The first method is the Standard Core Recovery expressed as the length of the total core recovered divided by the length of the core run, expressed as a percentage:

$$SCR = \frac{\text{total core length recovered}}{\text{length of core run}} \times 100\%$$

This value is exhibited on the boring logs as the Standard Core Recovery (SCR).

The second procedure for evaluating the intactness of the rock cores is by Rock Quality Index (RQI). The RQI provides an additional qualitative measure of soundness of the rock. This index is determined by measuring the intact recovered core unit which exceed four inches in length divided by the total length of the core run:

$$RQI = \frac{\text{all core lengths greater than 4"}}{\text{length of core run}} \times 100\%$$

The RQI is also expressed as a percentage and is shown on the boring logs.

Vane Shear Tests

In-situ vane shear tests may be utilized to determine the shear strength of soft to medium cohesive soil. This test consists of placing a four-bladed vane in the undisturbed soil and determining the torsional force applied at the ground surface required to cause the cylindrical perimeter surface of the vane to be sheared. The torsional force sufficient to cause shearing is converted to a unit of shearing resistance or cohesion of the soil surrounding the cylindrical surface.

THD Cone Penetrometer Test

The THD Cone Penetrometer Test is a standard field test to determine the relative density or consistency and load carrying capacity of foundation soils. This test is performed in much the same manner as the Standard Penetration Test described above. In this test, a 3 inch diameter penetrometer cone is used in place of a split-spoon sampler. This test calls for a 170-pound weight falling 24 inches. The actual test in hard materials consists of driving the penetrometer cone and accurately recording the inches of penetration for the first and second 50 blows for a total of 100 blows. These results are then correlated using a table of load capacity vs. number of inches penetrated per 100 blows.

Ground Water Observation

Ground water observations are made during the boring operations and are reported on the boring logs. Moisture condition of cuttings are noted, however, the use of water for circulation precludes direct observation of wet conditions. Water levels after completing the borings are noted. Seasonal variations, temperatures and recent rainfall conditions may influence the levels of the ground water table and water may be present in excavations, even though not indicated on the logs.

STANDARD LABORATORY PROCEDURES

In order to adequately characterize the subsurface material at this site, some or all of the following laboratory tests were completed. Results of the actual tests performed are shown on the Summary of the Laboratory Test Results, and some are also shown graphically on the Logs of Borings.

Moisture Content - ASTM D 2216

Natural moisture contents of the samples (based on dry weight of soil) have been determined for selected samples at depths shown on the respective boring logs. These moisture contents are useful in delineating the depth of the zone of moisture change and as a gauge of correlation between the various index properties and the engineering properties of the soil. For example, the relationship between the plasticity index and moisture content is a source of information for the correlation of shear strength data.

Atterberg Limits - ASTM D 4318

The Atterberg Limits are the moisture contents at the time the soil meets certain arbitrarily defined tests. At the moisture content defined as the plastic limit, Pw, the soil is assumed to change from a semisolid state to a plastic state. By the addition of more moisture, the soil may be brought up to the moisture content defined as the liquid limit, Lw, or that point where the soil changes from a plastic state to a liquid state. A soil existing at a moisture content between these two previously described states is said to be in a plastic state. The difference between the liquid limit, Lw, and the plastic limit, Pw , is termed the plasticity index, Iw. As the plasticity index increases, the ability of a soil to attract water and remain in a plastic state increases. The Atterberg limits that were determined are plotted on the appropriate Log of Boring.

The Atterberg limits are quite useful in soil exploration as an indexing parameter. Using the Atterberg limits and grain size analysis, A. Casagrande developed the Unified Soils Classification System (USCS) which is widely used in the geotechnical engineering field. This system related the liquid limit to the plasticity index by dividing a classification chart into various zones according to degrees of plasticity of clays and silts. Although the Atterberg limits are an indexing parameter, K. Terzaghi has related these limits to various engineering properties of a soil. Some of these relationships are as follows:

1. As the grain size of the soil decreases, the Atterberg limits increase.

2. As the percent clay in the soil increases, the Atterberg limits increase.

3. As the shear strength increases, the Atterberg limits decrease.

4. As the compressibility of a soil increases, the Atterberg limits increase.

Triaxial Shear Test - ASTM D 2850-70

Triaxial tests may be performed on samples that are approximately 2.83 inches in diameter, unless a smaller diameter sample was necessary to achieve a more favorable length:diameter (L:D) ratio. In order to reduce end effects, the L:D ratio should be a minimum of 2.0.

The triaxial tests are typically unconsolidated-undrained using nitrogen gas for chamber confining pressure. Confining pressures are selected to conform to in-situ hydrostatic pressure considering the earth to be a fluid of 120 PCF. In this test, undisturbed Shelby tube samples are trimmed so that their ends are square and then pressed in a triaxial compression machine. The load at which failure occurs is the compressive strength. The results of the triaxial tests and the correlated hand penetrometer strengths can be utilized to develop soil shear strength values.

Unconfined Compressive Strength of Rock Cores - ASTM D 2938

The unconfined compressive strength is a valuable parameter useful in the design of foundation footings. This value, qu , is related to the shearing resistance of the rock and thus to the capacity of the rock to support a load. In completing this test it is imperative that the length:diameter ratio of the core specimens are maintained at a minimum of 2:1. This ratio is set so that the shear plane will not extend through either of the end caps. If the ratio is less than 2.0

a correction is applied to the result. The results of these tests are compiled in Appendix A if the tests were performed.

Grain Size Analysis - ASTM D 421 and D 422

Grain size analysis tests are performed to determine the particle size and distribution of the samples tested. The grain size distribution of the soils coarser than the Standard Number 200 sieve is determined by passing the sample through a standard set of nested sieves, and the distribution of sizes smaller than the No. 200 sieve is determined by a sedimentation process, using a hydrometer. The results are given on the "Summary of Laboratory Test Results" or on Grain Size Distribution semi-log graphs within the report.