



SCI ENGINEERING, INC.

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Geotechnical Report

**REED TRACT
WARRENTON, MISSOURI**

August 2004

**MR. JOHN KNECHT
Developer**

SCI No. 2004-0779.10



8-13-04



August 13, 2004

SCI ENGINEERING, INC.

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Mr. John Knecht
#7 Lost Dutchman Drive
St. Peters, Missouri 63376

RE: Geotechnical Report
Reed Tract
Warrenton, Missouri
SCI No. 2004-0779.10

CONSULTANTS IN DEVELOPMENT, DESIGN, AND CONSTRUCTION

GEOTECHNICAL
ENVIRONMENTAL
ARCHAEOLOGY
WETLANDS
CONSTRUCTION SERVICES

Dear Mr. Knecht:

Attached is our *Geotechnical Report*, dated August 2004. It should be read in its entirety, and our recommendations applied to the design and construction of the project. Selected excerpts are highlighted below:


- Shallow foundations bearing in remediated high plastic clay, or newly placed low plastic structural fill are appropriate for support of the proposed structure.
- High plastic clay was encountered in the borings, and remediation will be necessary.

We look forward to working with you during the construction phase of the project. We should be included as participants in a formal preconstruction meeting with the Owner's Representative, Civil Engineer, and Contractor, prior to construction at the site. Such meetings are valuable in reviewing and clarifying project requirements and responsibilities.

If you have any questions or comments, please call.

Respectfully,

SCI ENGINEERING, INC.


Shawanna Erter, E.I.T.
Staff Engineer


Allen G. Minks, P.E.
Senior Engineer

SLE/AGM/eak

Enclosure: Geotechnical Report

Two additional copies submitted.

\\sciestl\gcfp01\shared\1\soils\1\NEW\PROJECT FILES\2004 PROJECTS\2004-0235 lot 6 mid rivers\GS\2004-0235 rpt.doc

ST. CHARLES, MISSOURI
FAIRVIEW HEIGHTS, ILLINOIS
ARNOLD, MISSOURI
ST. CLAIR, MISSOURI

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Figure 1 - Vicinity Map

Figure 2 - Site Plan

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Appendix A - Boring Log Legend and Nomenclature, Boring Logs

Geotechnical Report
REED TRACT
WARRENTON, MISSOURI

1.0 INTRODUCTION

At the request of Mr. John Knecht, SCI Engineering, Inc. (SCI) performed a geotechnical study for the proposed building. The purpose of our study was to characterize and evaluate the subsurface conditions, provide recommendations for foundations, and address other geotechnical aspects. Our services were provided in general accordance with our proposal dated March 4, 2004, and authorized by Mr. Knecht.

2.0 SITE AND PROJECT DESCRIPTION

SCI understands that a new office building is currently being planned for a 5-acre site located along Highway 47, just south of Interstate 70 in Warrenton, Missouri. The location of the site is shown on a USGS topographic Vicinity Map, Figure 1. We understand that the building will be a single-story, slab-on-grade structure, approximately 6,000 square feet in footprint, with associated parking. At the time of this proposal, no existing or proposed grades were available. We have assumed that cuts and fills across the site will be minimal (less than 5 feet). The proposed construction is show on the Site Plan, Figure 2.

Structural loadings are not available, but we anticipate that the building will be moderately loaded, with column loads less than 200 kips and wall loads less than 4 kips per lineal foot. If these loads will be exceeded, then SCI should be contacted to review our recommendations. No retaining walls are anticipated.

We have not reviewed, nor are we aware of, any previous studies on this specific site, by SCI or others, that would affect the preparation of this report. However, SCI is currently completing a Phase One Environmental Site Assessment for the subject site.

3.0 SUBSURFACE CONDITIONS

A total of seven borings, designated B-1 through B-7, were drilled at the approximate locations shown on the Site Plan. Detailed information regarding the nature and thickness of the soils encountered, and the results of the field sampling and laboratory testing are shown on the appended Borings Logs.

A Boring Log Legend and Nomenclature Sheet, to aid with interpretation of the boring logs, is also appended.

The boring locations were staked in the field by SCI personnel measuring from existing site features. Approximate ground surface elevations at the boring locations were not available at the time of this report.

Beneath the topsoil, high plastic clay (CH in accordance with the Unified Soil Classification System and ASTM D 2487) was encountered to the termination depths of the borings. However in B-2, B-3, B-5, and B-6, sand was encountered at depths of 12, 12, 8.5, and 8.5 feet, respectively.

A liquid limit of 78 with a plasticity index of 54 was measured for the sample from Boring B-4 at a depth of 1 to 2.5 feet. These results classify the sample as high plastic clay (CH in accordance with the Unified Soil Classification System).

Groundwater was not observed during drilling. The groundwater level depends on seasonal and climatic variations, and may be present at different depths in the future. In addition, without extended periods of observation, accurate groundwater level measurements may not be possible, particularly in low permeability soils. We do not anticipate that groundwater will influence the construction of building foundations.

4.0 DESIGN RECOMMENDATIONS

4.1 Shallow Foundations

Spread footing foundations bearing in remediated high plastic clay or newly placed low plastic structural fill are appropriate for support of the proposed structure. Based on the natural soils encountered during our exploration, shallow foundations can be sized for maximum net allowable bearing pressures of 2,200 pounds per square foot (psf) for continuous wall footings and 2,700 psf for isolated, square, column footings. Some localized areas of inadequate bearing materials may be encountered during construction; therefore, we recommend that an allowance be made in the construction budget for selected footing overexcavations.

Continuous wall footings should be at least 24 inches wide and isolated column footings should have a minimum dimension of 30 inches. Exterior footings and foundations in unheated areas of the building

should be provided with at least 30 inches of soil cover for frost protection. Interior footings in heated areas can be located at nominal depths below the finished floor. For footings designed and constructed in accordance with our recommendations, total settlement should be less than 1 inch, and differential settlement between adjacent footings should be less than $\frac{3}{4}$ inch.

4.2 Seismic Considerations

The 2003 International Building Code (IBC) requires the design of buildings and their structural components to withstand seismic forces. Site coefficients, which are a function of the soil or rock type and consistency, are required for the calculation of minimum earthquake design forces. Based on the soils encountered and the depth to bedrock, Site Class C should be used for shallow foundation design. The site coefficient F_a , as a function of Site Class C and mapped spectral response acceleration at short periods (S_s), is 1.2; and at 1-second periods (S_1), is 1.7. Some vertical and horizontal movement should be expected during a major earthquake event, particularly if the earthquake occurs during a period of elevated groundwater.

4.3 Floor Slabs

We recommend that the floor slab be designed using a modulus of subgrade reaction (k) of 150 pounds per square inch per inch of deflection (pci) after remediation of the high plastic clay. Floor slabs should be supported on a minimum 4-inch-thick layer of free-draining crushed stone. This will help distribute concentrated loads and equalize moisture conditions beneath the slab.

It is generally preferable to maintain structural separation between the floor slab and the foundation walls and column pads, using isolation joints. We also suggest that joints be placed in the floor slab on no more than 15-foot intervals in any direction. Such joints permit slight movements of the independent elements and help reduce random cracking that might otherwise be caused by restraint of shrinkage, slight rotations, heave, or settlement.

We recommend 6-mil-thick, polyethylene sheeting be placed immediately beneath the floor slab and above the crushed rock or gravel to reduce the transfer of capillary moisture to the slab. However, without careful attention to curing of the floor slab, the polyethylene sheet can cause excessive shrinkage cracking and "curling." We suggest the applicable recommendations provided in the American Concrete Institute (ACI) Standards 305R, 306R, and 308 be followed for curing the concrete floor slab.

4.4 High Plastic Clay Remediation

High plastic clay has the potential for volume change with variations in the soil's moisture content, which is normally evidenced by the heaving and cracking of floor slabs and, in severe cases, by the movement and cracking of footings and foundation walls. It appears that the entire floor slab and foundation will require treatment. The actual extent of remediation should be evaluated during construction.

Where the subgrade consists of high plastic clay, we recommend that these soils be removed to minimum depths of 2 feet beneath the bearing level of the footings and 3 feet beneath the floor slab subgrade. The overexcavation should extend at least 2 feet beyond the outside edge of the footings and building footprint to facilitate uniform compaction of the replacement materials, and may require additional widening at the building corners to allow equipment access for proper compaction. The overexcavation should be backfilled with properly compacted low plastic soil, 1-inch minus crushed limestone, or lean concrete. Low plastic soils are preferred. If lean concrete is used as backfill, the overexcavation need not extend beyond the edges of the footing. If 1-inch clean crushed limestone is substituted as fill, a sump or gravity drain must be included to remove water that might otherwise collect in the clean crushed limestone. The footings and floor slab would then be constructed on the newly placed fill.

As an alternative to overexcavation and replacement, the high plastic clay may be remediated by the addition of lime in combination with a recompaction operation. If lime stabilization is performed, we recommend thoroughly mixing in "Code L" (a locally available calcium oxide by-product also known as lime kiln dust) at a rate of 7 percent, or approximately 8 pounds of Code L per cubic foot of soil, to the depths and lateral limits described in the preceding paragraph. Pulverizing and tilling equipment, such as "gators," are preferred for mixing the lime into the soil.

The methods of treatment described above are based on generally accepted standards in the local engineering community; however, swell pressures and volume change potential greater than can be mitigated by these methods may exist. Consequently, the developer should recognize that there is an inherent, but reduced risk that foundation and floor slab damage may occur, even after remedial treatment of the subgrade soil.

4.5 Site Drainage and Grading

Positive site drainage should be provided to reduce surface water infiltration around the perimeter of the building and beneath the floor slab. All grades should be sloped away from the building, and roof and

surface drainage should be collected and discharged such that water is not permitted to infiltrate the backfill of the building.

Large trees and shrubs should be planted away from exterior footings as they may cause drying and shrinkage of the foundation soils and, with the passage of time, potentially detrimental settlement of the building floor slab and foundations. A minimum distance of 20 feet or the mature tree's dripline, whichever is greater, is suggested.

We recommend that all final slopes have a maximum inclination of 3 horizontal to 1 vertical (3H:1V), and that a crest of at least 10 feet in width or a distance equivalent to the height of the slope, whichever is less, be provided around the building before the surface slopes down and away. Cut slopes of less than 15 feet in height and properly compacted fill slopes up to about 30 feet in height should perform satisfactorily at this inclination, or flatter. We do not anticipate that steeper or taller slopes will be required. However, if they are proposed, the slopes should be brought to our attention and individually addressed and evaluated by SCI on a case-by-case basis.

Natural slopes to receive fill which are steeper than 5H:1V should be benched prior to the placement of fill. Benching will provide level surfaces for compaction and reduce the potential for development of inclined planes of weakness between the natural soil and compacted fill. The benches should be spaced such that the maximum height of cut at the up-slope end of the bench is 5 feet.

4.6 Underground Utilities

Underground utilities can provide a pathway for water to migrate below the floor slab. Therefore, we recommend the careful placement of utility line trench backfill immediately adjacent to the footing. Soil backfill should be hand tamped in an area that extends at least 1 foot beyond either edge of the footing. As an alternate, lean concrete may be used to backfill the trench below the footing. We recommend the concrete "plug" be at least 1 foot in length. Soil may be used for the balance of the backfill. Drain and utility pipes beneath floors should have tight joints to prevent leakage.

With the exception of individual service lines to the building that intersect foundations perpendicularly, below-grade utilities should not be located within the stress influence zone of the building foundations. Accordingly, below-grade utilities should be located outside a zone extending 45 degrees downward and outward from the edge of the footings.

4.7 Pavements

Selection of the pavement section is dependent on the design life, traffic loads, subgrade strength, drainage characteristics, and the desired level of maintenance. Neither CBR testing nor formal pavement design was a part of our scope for this project. However, for planning purposes, the following recommendations typically result in pavements that perform satisfactorily on similar subgrades under automobile and pickup truck loads. They are intended to roughly provide a pavement requiring routine maintenance for a 5-year period, minor repair and maintenance during the 5- to 10-year life of the pavement, and possibly major repairs and restoration after a 10-year service life.

A flexible pavement section may be used for the parking lot and driveways. Parking areas for automobiles and light trucks should consist of a minimum 6-inch thick crushed stone base with a minimum 3-inch thick asphaltic concrete wearing surface. The crushed stone base should be thickened to at least 8 inches in drive areas. Care should be taken to provide drains or drainable transition at locations where pavement sections of varying thickness abut, so as not to trap water within the crushed stone base, which could saturate and soften the subgrade.

Alternately, a rigid concrete pavement section may be used, with less anticipated long-term maintenance. Parking areas for automobiles and light trucks should consist of a minimum 6-inch thick, non-reinforced concrete pavement. Crushed stone base is not required under this light-duty pavement section. For more heavily trafficked areas, we recommend that the section consist of an 8-inch thick, non-reinforced concrete pavement, over 4 inches of compacted base rock. This concrete pavement section should also be used to support concentrated wheel loads for trash dumpster pads, approaches, and other areas where trucks will maneuver. To provide resistance against salt and freeze-thaw cycles, we recommend the concrete have a minimum 28-day compressive strength of 4,000 pounds per square inch (psi) and air entrainment of 5 to 7 percent by volume. We also recommend that the maximum joint spacing be approximately 15 feet.

5.0 SITE DEVELOPMENT AND CONSTRUCTION CONSIDERATIONS

5.1 Site Preparation

Areas to be cut or to receive fill should be stripped of any surface vegetation or organic topsoil. The strippings should be removed and stockpiled for later placement in landscaped or common ground areas, as appropriate. Topsoil can be reused as fill, if thoroughly mixed with other, acceptable, non-organic, fill materials, as approved by SCI.

After stripping, the site should be proofrolled by systematically passing over the subgrade to achieve complete coverage with proper compaction or loaded construction equipment, and observing the subgrade for pockets of excessively soft, wet, or disturbed soil, or otherwise unacceptable materials. Soft areas or otherwise unacceptable materials, if encountered, should be removed and replaced with structural fill or stabilized prior to placing additional fill. If removal of soft soils is impractical due to their excessive depth, they should be stabilized or "bridged over" in a manner approved by SCI.

Soft soils are likely to be encountered in the lower-lying areas of the site. If organic or soft areas are encountered, they should be removed and replaced with properly compacted fill or otherwise stabilized as approved by SCI. "Bridging" of the soft soils can often be accomplished by working 2- to 4-inch clean crushed rock into the softer soils and then placing a geofabric, such as Mirafi 600X or equivalent, prior to placing additional fill.

5.2 Fill Materials and Compaction

Structural fill should be placed in maximum 8-inch thick loose lifts and mechanically compacted to at least 90 percent of its modified Proctor maximum dry density (ASTM D 1557). Aggregate base course should be compacted to at least 95 percent modified Proctor. We recommend that any fill placed in building areas have a liquid limit less than 45 and a plasticity index less than 25. Acceptable non-organic fill soils include materials designated CL, ML, CL-ML, SP, SW, GP, and GW by ASTM D 2487.

Prior to compaction, the soil may require moisture adjustment. During warm weather, moisture reduction can generally be accomplished by disking or otherwise aerating the soil. When air drying is not feasible, a moisture reducing chemical additive, such as hydrated lime, could be incorporated into the soil. During dry weather, some addition of moisture may be required to facilitate compaction. This should also be done in a controlled manner using a tank truck with a spray bar. The moistened soil should be thoroughly blended with a disk or pulverizer to produce a uniform moisture content. If construction is performed during the winter season, fill materials should be carefully observed to see that no frozen soil is placed as fill or remains in the base materials upon which fill is placed.

Backfill for foundation walls may consist of low plastic silty clay or 1-inch minus crushed limestone. We advise performing field density tests on at least every other lift to monitor compliance with this standard. As an alternate, we suggest using 1-inch clean crushed limestone to provide improved drainage and to reduce lateral pressures on the walls. Due to a risk of migration of soil fines into the clean rock, a

synthetic filter fabric, such as Mirafi 140N or equivalent, should be placed between the soil face of the excavation and the crushed limestone. If clean rock is used, it may be placed in 2-foot thick lifts and tamped or tracked to achieve adequate densification.

Backfill placed next to walls should be compacted with hand operated equipment and not large self-propelled or machine operated equipment, which could result in potential overcompaction and higher lateral pressures. Compaction should be reduced within approximately 1 foot of the walls, and the walls should be observed periodically for signs of movement. If movement is detected, it may be necessary to provide bracing and/or change backfill procedures.

In addition to the minimum density requirements listed above, the soil must be stable, i.e., not “pumping” or rutting excessively under construction traffic, prior to placing additional fill or constructing foundations, floor slabs, or pavements. Field density tests should be performed on each lift of fill to document that proper compaction is achieved.

Significant problems may be incurred if construction takes place in wet or cold weather. Special measures may be required to facilitate construction during these periods. These measures may include, but are not limited to, the addition of lime to the subgrade soils for drying purposes, or the removal of soft spongy soils and their replacement with 1-inch minus crushed limestone.

Unstable subgrade conditions can develop easily in areas of high moisture content or poor drainage. Cohesive soils, particularly those which are more silty, can exhibit a significant loss of strength when they become saturated and disturbed. Disturbance may occur from trafficking of construction equipment, or other sources. If there is any indication that disturbance has occurred, SCI should be retained to observe these conditions and provide recommendations regarding corrective measures.

5.3 Shallow Foundation Excavations

SCI should observe all footing and floor slab excavations for problem areas, such as soft zones or areas of untreated high plastic clay, prior to placing concrete. Excessive disturbance of siltier soils in footing excavations should be avoided and could complicate construction. The potential for such disturbance will increase during wetter times of the year. Footing excavations that have been excessively disturbed should be overdeepened to approved undisturbed soils. Overexcavation and replacement with structural fill should be performed where inadequate bearing materials are present in footing excavations.

The base of all excavations should be clean, relatively dry, and free of loose soil or uncompacted fill. Excavations should be protected from extreme temperatures, precipitation, and construction disturbances. To reduce the possibility of desiccation or saturation of the foundation soils, we recommend that the concrete be placed as soon as possible after excavations are made.

Groundwater is not anticipated to be encountered in the footing excavations. However, in most situations, small amounts of groundwater seepage into the excavations can be handled by means of gravity ditching and a sump pump. If greater flows are experienced, SCI should be retained to provide additional consultation.

5.4 Floor Slab and Pavement Subgrades

Floor slab and pavement subgrades may be subjected to construction traffic and exposure to weather for an extended period. It may be necessary, therefore, to proofroll the subgrade, in both cut and fill areas, and recompact the subgrade immediately prior to placing base rock for the floor slab or pavement. Soft areas should be selectively undercut and backfilled with properly compacted cohesive soil. Proofroll passes should be limited, particularly on silty subgrades, to reduce the potential for pumping of moisture from deeper within the soil profile. A geotechnical stabilization fabric, such as Mirafi 600X or equivalent, may be used to help stabilize particularly soft areas. Where possible, the subgrade should be sloped to provide drainage.

Subgrade covered with base rock may be very slow to dry if precipitation occurs after placing the base rock. Therefore, we recommend that proofrolling and placement of the base rock be done as close to the time of pouring the floor slab or paving as is practical.

5.5 Excavation Bracing Requirements

In the *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 provide for the safety of workers entering excavations, including utility trenches, basements, footings, and others. All operations should be performed under the supervision of qualified site personnel in accordance with OSHA regulations.

5.6 Erosion Control

Appropriate erosion control measures, such as proper contouring during site grading activities, the installation of siltation fences, or the placement of staked straw bales, should be used during construction to keep eroded materials from being carried onto adjacent properties. Depending on the length of time the subgrade is exposed and the amount of siltation that occurs, it may be necessary to periodically remove materials collected by the silt fence. Timely sodding and/or seeding of sloped surfaces will reduce this potential problem.

6.0 CONSTRUCTION MONITORING PROGRAM

The following list summarizes SCI's recommendations for a construction monitoring program. These services are recommended to provide quality assurance in assessing design assumptions and to document earth-related construction procedures for compliance with plans, specifications, and good engineering practice. SCI should be retained to:

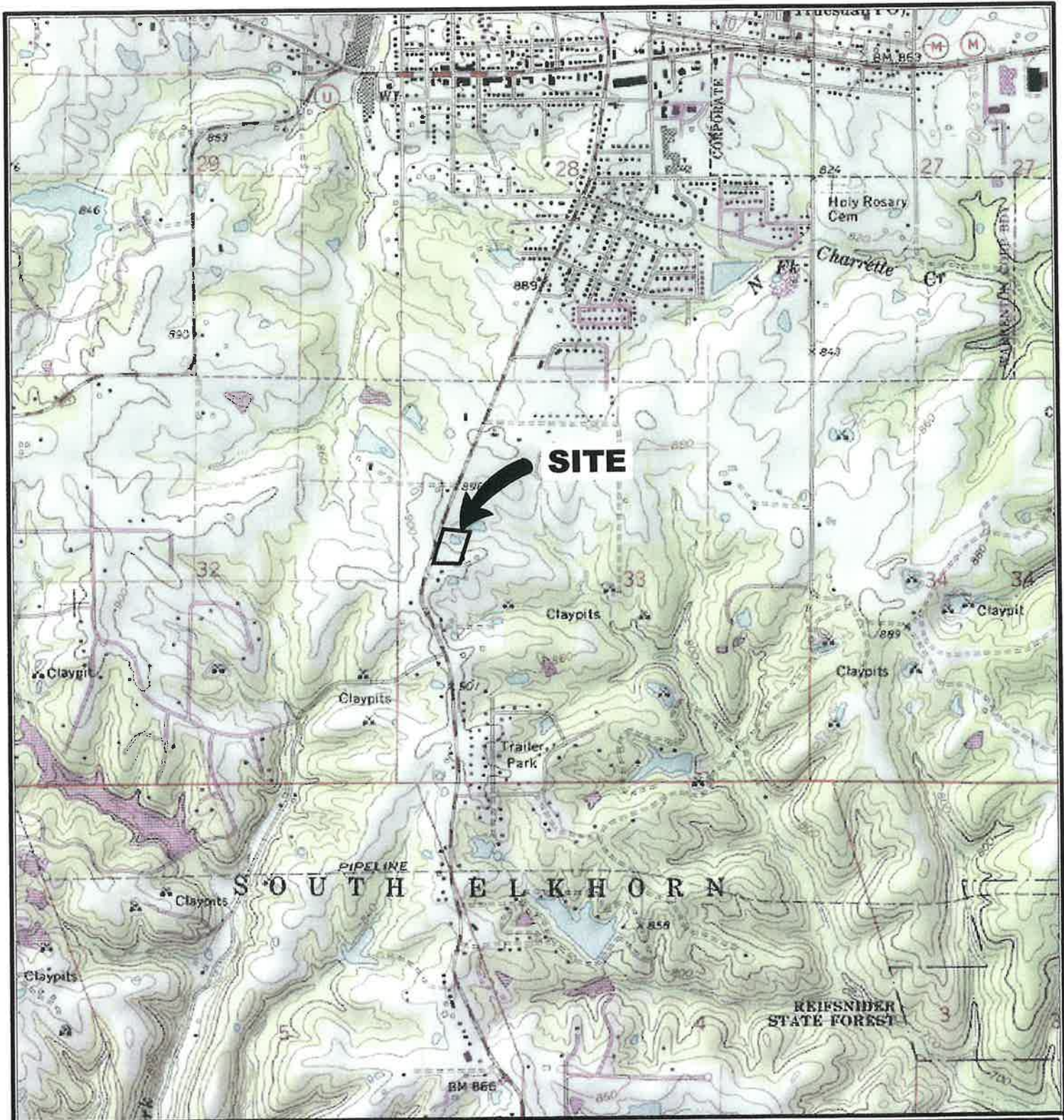
- Participate in a formal preconstruction meeting with the Owner's Representative, Civil Engineer, and Contractor, prior to construction at the site.
- Observe site preparation activities prior to construction, including proofrolling.
- Assess the suitability of potential fill materials, including both on-site and off-site sources.
- Monitor placement and compaction of structural fill and backfill.
- Observe foundation excavations and the floor slab subgrade to assess the impact of high plastic clay soil and to recommend the extent of remedial measures.
- Observe footing excavations for adequacy of bearing materials.
- Observe the floor slab subgrade prior to placing base rock.
- Observe backfilling of below-grade utility excavations.
- Observe pavement subgrade preparation and provide observation and testing services for the base course and pavement section.
- Check the thickness of pavement sections and, for asphaltic concrete, its density.
- Provide quality assurance testing of foundation and floor slab concrete and pavement materials.

7.0 LIMITATIONS

The recommendations provided herein are for the exclusive use of our client. They are specific only to the project described, and are not meant to supercede more stringent requirements of local ordinances. They are based on subsurface information obtained at seven, specific, boring locations within the project area; our understanding of the project as presented in Section 2.0, *Site and Project Description*; and geotechnical engineering practice consistent with the standard of care. No other warranty is expressed or implied. SCI should be contacted if conditions encountered are not consistent with those described.

We should also be provided with a set of construction plans and specifications, once they are available, to review whether our recommendations have been understood and applied correctly. Failure to provide these documents to SCI may nullify some or all of the recommendations provided herein. In addition, any changes in the planned project or changed site conditions may require revised or additional recommendations on our part.

The final part of our geotechnical service should consist of direct observation during construction, to observe that conditions actually encountered are consistent with those described in this report, and to assess the appropriateness of the analyses and recommendations contained herein. SCI cannot assume responsibility or liability for the adequacy of its recommendations without being retained to observe construction.



	PROJECT NAME REED TRACT WARRENTON, MISSOURI		General Notes/Legend USGS TOPOGRAPHIC MAP WARRENTON, MISSOURI QUADRANGLE DATED 1982 REVISED 1985 20' CONTOURS		 SCI ENGINEERING, INC. WWW.SCIENGINEERING.COM
	VICINITY MAP		DRAWN BY DKM	FIGURE 1	
SCALE 1" = 2000'	JOB NUMBER 2004-0779.10	DATE AUGUST 2004	CHECKED BY SLE		



PROJECT NAME
 REED TRACT
 WARRENTON, MISSOURI

SITE PLAN

DRAWN BY
 DKM
CHECKED BY
 SLE

FIGURE
 2

SCALE
 1" = 100'
 APPROXIMATE

JOB NUMBER
 2004-0779.10

DATE
 AUGUST 2004

General Notes/Legend

DENOTES APPROXIMATE BORING LOCATIONS

AERIAL PHOTOGRAPH OBTAINED FROM
 www.teraserver.com
 DATED 04/03/95
 DRAWING BASED ON OBSERVATIONS MADE BY SCI
 PERSONNEL. DIMENSIONS AND LOCATIONS ARE
 APPROXIMATE. ACTUAL MAY VARY. DRAWING SHALL
 NOT BE USED OUTSIDE THE CONTEXT OF THE REPORT
 FOR WHICH IT WAS GENERATED.





BORING LOG LEGEND AND NOMENCLATURE

Items shown on Boring Logs refer to the following:

Depth in feet below ground surface.

Sample Type

- SS** Split-spoon sample, disturbed, obtained by driving 2-inch O.D. split-spoon sampler (ASTM D 1586).
- NX** Diamond core bit, nominal 2-inch diameter rock sample (ASTM D 2113).
- ST** Thin-walled (Shelby) tube sample, relatively undisturbed, obtained by penetration of a 3-inch-diameter tube (ASTM D 1587).
- CS** Continuous sample tube system, relatively undisturbed, obtained by split-barrel sampler in conjunction with auger advancement.
- SV** Shear vane, field test to determine strength of cohesive soil by pushing or driving a 2-inch diameter vane, and then shearing by torquing soil in existing and remolded states (ASTM D 2573).
- BS** Bag sample, disturbed, obtained from cuttings

Recovery is expressed as a ratio of the length recovered to the total length pushed, driven, cored.

Blows Numbers indicate blows per 6 inches of split-spoon sampler penetration when driven with a 140-pound hammer falling freely 30 inches. The number of total blows obtained for the second and third 6-inch increments is the N value (Standard Penetration Test) in blows per foot (ASTM D 1586). Practical refusal is considered to be 50 or more blows without achieving 6 inches of penetration, and is expressed as a ratio of 50 to actual penetration, e.g., 50/2 (blows/inches).

For analysis, the N value is used when obtained by a cathead and rope system. When an automatic hammer is used, the N value is increased by a factor of 1.33.

Vane Shear Strength is expressed as the peak strength (existing state) / residual strength (remolded state).

Description indicates soil constituents and other classification characteristics (ASTM D 2488) and the Unified Soil Classification (ASTM D 2487). Secondary soil constituents are described as follows: "trace" for 0 to < 10 percent, "some" for 10 to 35 percent, or by modifier to the main soil type for > 35 percent.

Stratigraphic Break is indicated by a solid line where changes are observed in retained samples, or a dashed line where changes occur between observed samples. Transition between described materials may be gradual.

Laboratory Test Results

- Natural moisture content (ASTM D 2216) in percent.
- Dry density in pounds per cubic foot (pcf).
- Hand penetrometer value of apparently intact cohesive sample in kips per square foot (ksf).
- Unconfined compressive strength (ASTM D 2166) in kips per square foot (ksf).
- Liquid and Plastic Limits (ASTM D 4318) in percent.

Remarks are keyed by number to the "SEE REMARK NO." column. See notation at bottom of log for description of data entries.

RQD (Rock Quality Designation) is the ratio between the total length of core segments greater than 4 inches in length and the total length of core drilled (expressed as percentage). RQD indicates insitu rock quality as follows: "excellent" for 90 to 100%, "good" for 75 to 90%, "fair" for 50 to 75%, "poor" for 25 to 50%, and "very poor" for 0 to 25 percent.



BORING LOG

PROJECT Reed Tract
LOCATION Warrenton, Missouri
DRILLER Midwest Drilling, Inc. **HAMMER** Automatic
EQUIPMENT CME-550 w/CFA **ELEVATION** N/A

BORING NO. B-1
SHEET 1 **OF** 1
PROJECT NO. 2004-0779.10
DATE DRILLED 7/28/2004

DEPTH (FT)	SAMPLE				DESCRIPTION (UNIFIED SOIL CLASSIFICATION)	GRAPHIC	SEE REMARK NO.	LABORATORY TEST RESULTS						ELEVATION (FT)	
	NUMBER	TYPE	RECOVERY (IN/IN)	BLOWS (PER 6 IN)				MOISTURE CONTENT (%)	DRY DENSITY (PCF)	HAND PENETROMETER (KSF)	UNCONFINED COMPRESSIVE STRENGTH (KSF)	LIQUID LIMIT	PLASTIC LIMIT		
0					1" TOPSOIL CLAY (CH): Brown and gray, high plastic		1								
1	1	SS		2 2 3			31		5						
3					Trace sand										
2	2	SS		2 3 6			17		8						
6	3	SS		3 3 4			25		3.5						
9	4	SS		3 4 6			17		8.5						
12															
15	5	SS		6 7 9	Becomes brown in color, some sand		16		9+						
18															
	6	SS		8 10 13			15		9						
Drilling terminated at 20 feet.															

WATER LEVEL: <input checked="" type="checkbox"/> NONE OBSERVED WHILE DRILLING <input type="checkbox"/> FT WHILE DRILLING <input type="checkbox"/> FT _____ HRS AFTER DRILLING <input type="checkbox"/> FT _____ HRS AFTER DRILLING	REMARKS: 1) Driller's observation
---	---



BORING LOG

PROJECT Reed Tract
LOCATION Warrenton, Missouri
DRILLER Midwest Drilling, Inc. **HAMMER** Automatic
EQUIPMENT CME-550 w/CFA **ELEVATION** N/A

BORING NO. B-2
SHEET 1 **OF** 1
PROJECT NO. 2004-0779.10
DATE DRILLED 7/29/2004

DEPTH (FT)	SAMPLE				DESCRIPTION (UNIFIED SOIL CLASSIFICATION)	GRAPHIC	SEE REMARK NO.	LABORATORY TEST RESULTS									
	NUMBER	TYPE	RECOVERY (IN/IN)	BLOWS (PER 6 IN)				MOISTURE CONTENT (%)	DRY DENSITY (PCF)	HAND PENETROMETER (KSF)	UNCONFINED COMPRESSIVE STRENGTH (KSF)	LIQUID LIMIT	PLASTIC LIMIT	ELEVATION (FT)			
0					2" TOPSOIL		1										
1	1	SS	21/24		CLAY (CH): Brown and gray, high plastic, trace sand			24	90	5	0.9						
3											6						
	2	SS		2 3 4						19		6.5					
6																	
	3	SS		3 4 5								5.5					
9					Becomes brown in color												
	4	SS		3 6 9					15		7.5						
12					SILTY SAND (SM): Brown, fine												
15																	
	5	SS		7 9 11						3							
15					Drilling terminated at 15 feet.												
18																	

WATER LEVEL: <input checked="" type="checkbox"/> NONE OBSERVED WHILE DRILLING <input type="checkbox"/> FT WHILE DRILLING <input type="checkbox"/> FT _____ HRS AFTER DRILLING <input type="checkbox"/> FT _____ HRS AFTER DRILLING	REMARKS: 1) Driller's observation
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BORING LOG

PROJECT Reed Tract
LOCATION Warrenton, Missouri
DRILLER Midwest Drilling, Inc. **HAMMER** Automatic
EQUIPMENT CME-550 w/CFA **ELEVATION** N/A

BORING NO. B-3
SHEET 1 **OF** 1
PROJECT NO. 2004-0779.10
DATE DRILLED 7/29/2004

DEPTH (FT)	SAMPLE				DESCRIPTION (UNIFIED SOIL CLASSIFICATION)	GRAPHIC	SEE REMARK NO.	LABORATORY TEST RESULTS						ELEVATION (FT)
	NUMBER	TYPE	RECOVERY (IN/IN)	BLOWS (PER 6 IN)				MOISTURE CONTENT (%)	DRY DENSITY (PCF)	HAND PENETROMETER (KSF)	UNCONFINED COMPRESSIVE STRENGTH (KSF)	LIQUID LIMIT	PLASTIC LIMIT	
0					1" TOPSOIL		1							
1	1	SS		2 3 4	CLAY (CH): Brown and gray, high plastic			30		3.5				
3	2	ST	20/24		Some sand			20	102	1.5	3.2			
6	3	SS		3 4 5	Trace sand			20		3.5				
9	4	SS		3 5 7				19		7.5				
12														
15	5	SS		4 10 11	CLAYEY SAND (SC): Brown, fine to coarse			14						
15					Drilling terminated at 15 feet.									
18														

WATER LEVEL: <input checked="" type="checkbox"/> NONE OBSERVED WHILE DRILLING <input type="checkbox"/> _____ FT WHILE DRILLING <input type="checkbox"/> _____ FT _____ HRS AFTER DRILLING <input type="checkbox"/> _____ FT _____ HRS AFTER DRILLING	REMARKS: 1) Driller's observation
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BORING LOG

PROJECT Reed Tract
LOCATION Warrenton, Missouri
DRILLER Midwest Drilling, Inc. **HAMMER** Automatic
EQUIPMENT CME-550 w/CFA **ELEVATION** N/A

BORING NO. B-4
SHEET 1 **OF** 1
PROJECT NO. 2004-0779.10
DATE DRILLED 7/29/2004

DEPTH (FT)	SAMPLE				DESCRIPTION (UNIFIED SOIL CLASSIFICATION)	GRAPHIC	SEE REMARK NO.	LABORATORY TEST RESULTS						ELEVATION (FT)	
	NUMBER	TYPE	RECOVERY (IN/IN)	BLOWS (PER 6 IN)				MOISTURE CONTENT (%)	DRY DENSITY (PCF)	HAND PENETROMETER (KSF)	UNCONFINED COMPRESSIVE STRENGTH (KSF)	LIQUID LIMIT	PLASTIC LIMIT		
0					1" TOPSOIL CLAY (CH): Brown and gray, high plastic		1								
1	1	SS		2 3 4			29		6		78	24			
3					Trace sand										
2	2	SS		3 3 5			18		5						
6															
3	3	SS		2 3 5		23		6							
9															
4	4	SS		5 6 9		17		9+							
12															
15	5	SS		4 10 14	Some sand and gravel	12		4.5							
15					Drilling terminated at 15 feet.										
18															

WATER LEVEL:

NONE OBSERVED WHILE DRILLING
 FT WHILE DRILLING
 FT _____ HRS AFTER DRILLING
 FT _____ HRS AFTER DRILLING

REMARKS:

1) Driller's observation



BORING LOG

PROJECT Reed Tract
LOCATION Warrenton, Missouri
DRILLER Midwest Drilling, Inc. **HAMMER** Automatic
EQUIPMENT CME-550 w/CFA **ELEVATION** N/A

BORING NO. B-5
SHEET 1 **OF** 1
PROJECT NO. 2004-0779.10
DATE DRILLED 7/28/2004

DEPTH (FT)	SAMPLE				DESCRIPTION (UNIFIED SOIL CLASSIFICATION)	GRAPHIC	SEE REMARK NO.	LABORATORY TEST RESULTS						ELEVATION (FT)	
	NUMBER	TYPE	RECOVERY (IN/IN)	BLOWS (PER 6 IN)				MOISTURE CONTENT (%)	DRY DENSITY (PCF)	HAND PENETROMETER (KSF)	UNCONFINED COMPRESSIVE STRENGTH (KSF)	LIQUID LIMIT	PLASTIC LIMIT		
0					1" TOPSOIL		1								
	1	SS		2 3	CLAY (CH): Reddish brown and gray, high plastic, trace sand			30		7.5					
3					-Some sand and gravel										
	2	SS		2 4				23		2.5					
6					Becomes brown in color										
	3	SS		4 5 7				17		9+					
9															
	4	SS		5 7 9	CLAYEY SAND (SC): Brown, fine to medium			19							
					Drilling terminated at 10 feet.										
12															
15															
18															

WATER LEVEL: <input checked="" type="checkbox"/> NONE OBSERVED WHILE DRILLING <input type="checkbox"/> FT WHILE DRILLING <input type="checkbox"/> FT _____ HRS AFTER DRILLING <input type="checkbox"/> FT _____ HRS AFTER DRILLING	REMARKS: 1) Driller's observation
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BORING LOG

PROJECT Reed Tract
LOCATION Warrenton, Missouri
DRILLER Midwest Drilling, Inc. **HAMMER** Automatic
EQUIPMENT CME-550 w/CFA **ELEVATION** N/A

BORING NO. B-6
SHEET 1 **OF** 1
PROJECT NO. 2004-0779.10
DATE DRILLED 7/28/2004

DEPTH (FT)	SAMPLE				DESCRIPTION (UNIFIED SOIL CLASSIFICATION)	GRAPHIC	SEE REMARK NO.	LABORATORY TEST RESULTS						ELEVATION (FT)
	NUMBER	TYPE	RECOVERY (IN/IN)	BLOWS (PER 6 IN)				MOISTURE CONTENT (%)	DRY DENSITY (PCF)	HAND PENETROMETER (KSF)	UNCONFINED COMPRESSIVE STRENGTH (KSF)	LIQUID LIMIT	PLASTIC LIMIT	
0					1" TOPSOIL		1							
1	1	SS		2	CLAY (CH): Reddish brown, high plastic, trace sand			22		4				
3					Trace gravel									
2	2	SS		3					23		4			
6														
3	3	SS		4				17		8				
9					SILTY SAND (SM): Brown, fine									
4	4	SS		3			23							
12					Drilling terminated at 10 feet.									
15														
18														

WATER LEVEL: <input checked="" type="checkbox"/> NONE OBSERVED WHILE DRILLING _____ FT WHILE DRILLING _____ FT _____ HRS AFTER DRILLING _____ FT _____ HRS AFTER DRILLING	REMARKS: 1) Driller's observation
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BORING LOG

PROJECT Reed Tract
 LOCATION Warrenton, Missouri
 DRILLER Midwest Drilling, Inc. HAMMER Automatic
 EQUIPMENT CME-550 w/CFA ELEVATION N/A

BORING NO. B-7
 SHEET 1 OF 1
 PROJECT NO. 2004-0779.10
 DATE DRILLED 7/28/2004

DEPTH (FT)	SAMPLE				DESCRIPTION (UNIFIED SOIL CLASSIFICATION)	GRAPHIC	SEE REMARK NO.	LABORATORY TEST RESULTS						ELEVATION (FT)
	NUMBER	TYPE	RECOVERY (IN/IN)	BLOWS (PER 6 IN)				MOISTURE CONTENT (%)	DRY DENSITY (PCF)	HAND PENETROMETER (KSF)	UNCONFINED COMPRESSIVE STRENGTH (KSF)	LIQUID LIMIT	PLASTIC LIMIT	
0					1" TOPSOIL		1							
1	1	SS		2 3	CLAY (CH): Reddish brown and gray, high plastic, trace sand			31		4.5				
3					Becomes brown and gray in color									
2	2	SS		2 3 6				18		8.5				
6					Some sand and gravel									
3	3	SS		4 5 7			16		9+					
9					Becomes brown in color									
4	4	SS		4 6 10			15		8					
					Drilling terminated at 10 feet.									
12														
15														
18														

WATER LEVEL: <input checked="" type="checkbox"/> NONE OBSERVED WHILE DRILLING <input type="checkbox"/> FT WHILE DRILLING <input type="checkbox"/> FT _____ HRS AFTER DRILLING <input type="checkbox"/> FT _____ HRS AFTER DRILLING	REMARKS: 1) Driller's observation
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IMPORTANT INFORMATION ABOUT YOUR GEOTECHNICAL REPORT

Subsurface problems are a principal cause of construction delays, cost overruns, claims, and disputes. While you cannot eliminate all such risks, you can manage them. The following suggestions and observations are offered to help.

Geotechnical Services Are Performed for Specific Purposes, Persons, and Projects

Geotechnical engineers structure their services to meet the specific needs of their clients. A geotechnical study conducted for a civil engineer may not fulfill the needs of a construction contractor or even another civil engineer. Because each geotechnical study is unique, each geotechnical report is unique, prepared *solely* for the client. *No one except you* should rely on your geotechnical report without first conferring with the geotechnical engineer who prepared it. *And no one—not even you*—should apply the report for any purpose or project except the one originally contemplated.

Read the Full Report

Serious problems have occurred because those relying on a geotechnical report did not read it all. Do not rely on an executive summary. Do not read selected elements only.

A Geotechnical Report Is Based on a Unique Set of Project-specific Factors

Geotechnical engineers consider a number of unique project-specific factors when establishing the scope of a study. Typical factors include the client's goals, objectives, and risk management preferences; the general nature of the structure involved, its size, and its configuration; the location of the structure on the site; and other planned or existing site improvements, such as access roads, parking lots, and underground utilities. Unless the geotechnical engineer who conducted the study specifically indicates otherwise, do not rely on a geotechnical report that was:

- not prepared for you,
- not prepared for your project,
- not prepared for the specific site explored, or
- completed before important project changes were made.

Typical changes that can erode the reliability of an existing geotechnical report include those that affect the:

- function and character of the proposed structure,
- elevation, configuration, location, orientation, or loading of the proposed structure,
- composition of the design team, or
- project ownership.

As a general rule, *always* inform your geotechnical engineer of project changes—even minor ones—and request an assessment of their impact. *Geotechnical engineers cannot accept responsibility or liability for problems that occur because their reports do not consider developments of which they were not informed.*

Subsurface Conditions Can Change

A geotechnical report is based on conditions that existed at the time the study was performed. Do not rely on a geotechnical report whose adequacy may have been affected by the passage of time; by man-made events, such as construction on or adjacent to the site; or by natural events, such as floods, earthquakes, or groundwater fluctuations. *Always* contact the geotechnical engineer before applying the report to determine if it is still reliable. A minor amount of additional testing or analysis could prevent major problems.

Most Geotechnical Findings Are Professional Opinions

Site exploration identifies subsurface conditions *only* at those points where subsurface tests are conducted or samples are taken. Geotechnical engineers review field and laboratory data and then apply their professional judgment to render an *opinion* about subsurface conditions throughout the site. Actual subsurface conditions may differ—sometimes significantly—from those indicated in your report. Retaining the geotechnical engineer who developed your report to provide construction observation is the most effective way of managing the risks associated with unanticipated conditions.

A Report's Recommendations Are *Not* Final

Do not overrely on the construction recommendations included in your report. *Those recommendations are not final*, because geotechnical engineers develop them principally from judgment and opinion. Geotechnical engineers can finalize their recommendations only by observing actual subsurface conditions revealed during construction. *The geotechnical engineer who developed your report cannot assume responsibility or liability for the report's recommendations if that engineer does not perform construction observation.*