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Geotechnical Report

SCENIC REGIONAL LIBRARY
SULLIVAN, MISSOURI

February 2016

SCENIC REGIONAL LIBRARY
Owner

WASHINGTON ENGINEERING & ARCHTECTURE, P.C.
Civil Engineer/Architect

SCI No. 2015-5182.10 Task 100

STATE OF MISSOURI
SHAWNNA L. ERTER
NUMBER
PE-2005000979
PROFESSIONAL ENGINEER
2/18/16

SCI ENGINEERING, INC.
CONSULTANTS IN DEVELOPMENT, DESIGN AND CONSTRUCTION
GEOTECHNICAL
ENVIRONMENTAL
NATURAL RESOURCES
CULTURAL RESOURCES
CONSTRUCTION SERVICES

February 18, 2016

Mr. Steven W. Campbell
Scenic Regional Library
304 Hawthorne Drive
Union, Missouri 63084

RE: Geotechnical Report
Scenic Regional Library
Sullivan, Missouri
SCI No. 2015-5182.10 Task 100

Dear Mr. Campbell:

Attached is our *Geotechnical Report*, dated February 2016. It should be read in its entirety, and our recommendations applied to the design and construction of the project. Selected excerpts from the report are highlighted below:

- Existing fill was encountered to a depth of 3 feet (approximate El. 967) in B-4 through B-7. There is some risk of settlement or other performance problems if the foundations, floor slabs or pavements are supported on the fill material. In order to totally eliminate this risk, all of the existing fill would have to be excavated and either recompacted or replaced. Based on a proposed finish floor elevation of 967.75, we anticipate that the majority of existing fill within the building area will be excavated during construction and during remediation of expansive clay soils.

- Expansive fat clay soils were encountered at or near the surface across the site. Where the bearing and/or subgrade soils consist of expansive clay soils, we recommend that they be remediated to a minimum depth of 3 feet beneath the floor slab; and to a depth of 2 feet below shallow foundations, as further discussed in this report.

- Weathered chert and sandstone was encountered at depths of 5½ to 17 feet (approximate El. 961 to El. 953) in eight of nine borings. Auger refusal was encountered at depths of 12½ to 17 feet (approximate El. 955 to El. 949.5) in seven of nine borings. Based on a proposed finish floor elevation of 967.75, we do not anticipate that rock excavation will be required during foundation construction. However, rock excavation may be required for deeper utilities.

- Shallow spread footing foundations may be designed for maximum net allowable soil bearing pressures of 2,500 and 3,000 pounds per square foot (psf) for continuous strip footings and isolated column footings respectively.

- Based on the soils encountered and the anticipated depth to rock, Site Class C should be used for foundation design, with seismic design parameters for the site as follows: $F_A = 1.20$, $F_V = 1.66$, $S_{DS} = 0.34$, and $S_{D1} = 0.16$. The Seismic Design Category (SDC) for the site is C.

We appreciate the opportunity to be of service, and look forward to working with you during the construction phase of the project. SCI should participate in a meeting prior to clearing/grading of 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.

James P. Bauer, E.I.
Staff Engineer

Shawnna L. Erter, P.E.
Vice President

JPB/SLE/krm

C: Mr. Ron Unnerstall, AIA; Washington Engineering & Architecture, P.S.

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SCENIC REGIONAL LIBRARY
SULLIVAN, MISSOURI

1.0 INTRODUCTION

At the request of Mr. Ron Unnerstall of Washington Engineering & Architecture, P.S. (WEA), SCI Engineering conducted a geotechnical exploration for the proposed library. The purpose of our exploration 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 December 31, 2015 and authorized by Mr. Steven Campbell of Scenic Regional Library on January 5, 2016.

2.0 SITE AND PROJECT DESCRIPTION

A library is currently being planned for a site located on the northeast side of Cumberland Way, approximately 600 feet north of the intersection of East Springfield Road and Cumberland Way, in Sullivan, Missouri. The location of the site is shown on the *Vicinity and Topographic Map*, Figure 1. The property is currently an undeveloped agricultural field with no structures. The existing site conditions are shown on the *Aerial Photograph*, Figure 2.

Based on information provided by WEA, the proposed library will be a single-story, slab-on-grade structure, approximately 10,415 square feet in footprint, with associated parking located to the southwest. In addition, a detention basin is planned northwest of the library. As indicated on the plans the proposed library will have a finish floor elevation of 967.75, which will require cuts on the order of 2 to 3 feet within the building pad. Maximum cuts and fills of 4 feet are anticipated for the parking and future expansion areas located west and north of the library, respectively. The proposed construction is shown on the *Site Plan*, Figure 3.

Structural loads were unavailable at the time of this report. Based on similar buildings, SCI anticipates that the building will be lightly loaded, with column loads of less than 150 kips and wall loads of less than 4 kips per lineal foot. If these loads will be exceeded, then SCI should be contacted to review our recommendations.

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 recently completed a Phase One Environmental Site Assessment for the subject site.

3.0 SUBSURFACE CONDITIONS

A total of nine borings, designated B-1 through B-9, were drilled at the approximate locations shown on the *Aerial Photograph* and the *Site Plan*. The boring locations were staked in the field by SCI personnel utilizing global positioning equipment (gps). Ground surface elevations at the boring locations were surveyed by WEA upon completion of drilling. Detailed information regarding the nature and thickness of the soils and rock encountered, and the results of the field sampling and laboratory testing are shown on the Boring Logs in Appendix A.

3.1 Existing Fill

Existing fill was encountered to a depth of 3 feet in B-4 through B-7. The fill material encountered in B-4 and B-7 generally consisted of fat clay, while lean clay fill was encountered in B-5 and B-6. Standard Penetration Tests (SPTs) within the existing fill resulted in N-Values ranging from 12 to 34 blows per foot (bpf) with moisture contents in the range of 15 to 28 percent. Based on the results of the field and laboratory testing, the existing fill appears to have been placed with some level of compactive effort. However, documentation in regards to the placement of the fill was not available at the time of this report.

3.2 Natural Soil Profile

The natural soils generally consist of lean clay (CL in accordance with the Unified Soil Classification System and ASTM D 2488-06), containing varying amounts of chert gravel, overlying fat clay (CH), containing varying amounts of sand and chert gravel, which was encountered at depths of 3 to 5½ feet (approximate El. 957.5 to El. 967) in B-1, B-2, B-3, B-8, and B-9. Standard Penetration Tests (SPTs) within the natural soils resulted in N-Values ranging from 11 to 46 blows per foot (bpf), classifying the soils as stiff to hard in consistency. As an exception, very soft lean clay soil was encountered at a depth of 2 feet in B-8.

3.3 Bedrock Profile

During drilling weathered chert and sandstone was encountered underlying the clay soils at depths of 5½ to 17 feet (approximate El. 961 to El. 953) in eight of nine borings. Auger refusal was encountered at depths of 12½ to 17 feet (approximate El. 955 to El. 949.5) in seven of nine borings. The depths at which weathered chert and sandstone was encountered, as well as auger refusal, are provide below in Table 3.1.

Table 3.1 – Bedrock Summary

Boring	Boring Elevation	Weathered Rock Depth (ft)	Approximate Weathered Rock Elevation	Auger Refusal Depth (ft)	Approximate Refusal Elevation
B-1	965.23	12	953	15	950
B-2	966.33	5.5	961	12.5	954
B-3	970.25	17	953	NR*	--
B-4	970.08	17	953	NR*	--
B-5	969.67	8	961.5	16	954
B-6	970.13	13.5	956.5	15.5	955
B-7	970.88	14	957	17	954
B-8	963.03	--	--	13.5	949.5
B-9	966.52	8.5	958	13	953.5

* No refusal encountered, boring terminated at a depth of 20 feet.

Documented geology, including the *Geologic Map of Missouri 2003,* published by the Missouri Department of Natural Resources (MoDNR), indicates that bedrock at the site consists of the Roubidoux Formation which is typically sandstone and chert with interbedded layers of dolomite.

3.4 Groundwater

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 the building foundations.

4.0 DESIGN RECOMMENDATIONS

4.1 Existing Fill

Existing fill was encountered to a depth of 3 feet (approximate El. 967) in B-4 through B-7. Based on the results of the field and laboratory testing, the existing fill appears to have been placed with some level of compactive effort. However, documentation in regards to the placement of the fill was not available at the time of this report. As a result, there is some risk of settlement or other performance problems if the foundations, floor slabs or pavements are supported on the fill material. In order to totally eliminate this risk, all of the existing fill would have to be excavated and either recompacted or replaced.

Based on a proposed finish floor elevation of 967.75, we anticipate that the majority of existing fill within the building area will be excavated during construction and during remediation of expansive clay soils. However, existing fill may extend to greater depths between our widely spaced boring. If additional remediation of existing fill is required, it is recommended that the foundations be extended downwards through the fill to bear on natural soils.

The disposition of the existing fill beneath the building floor slab should also be considered. In order to eliminate potential settlement and cracking of the new floor slab that would overlie the existing fill, the fill should be removed. However, the cost of entirely removing and replacing the fill beneath the floor slab and pavements may not justify the potential benefit gained. Considering the probable length of time that the fill has been in place, and the anticipated light load on the building floor slab and pavements, the risk of supporting the floor slab and pavements on the existing fill is judged to be low, with proper proofrolling and treatment as described later in this report.

4.2 Expansive Clay Remediation

Expansive clay soils were encountered at or near the surface across the site. These soils are susceptible to excessive volume changes with variations in moisture contents. Where the bearing and/or subgrade soils consist of expansive clay soils, we recommend that they be removed to a minimum depth of 3 feet beneath the bottom of the floor slab, and to a depth of 2 feet below the shallow building foundations. The overexcavation should extend at least 2 feet beyond the building and/or foundation footprints to facilitate uniform compaction of replacement materials, and may require additional widening at the corners to allow equipment access for proper compaction. The overexcavation should be backfilled with properly compacted low plastic soil or 1-inch minus crushed limestone. As an alternative, the overexcavation for shallow foundations may be backfilled with lean concrete, which would not require widening of the footing overexcavations.

As an alternative to overexcavation and replacement, the expansive fat 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. Water may need to be added during mixing to allow for proper hydration of the lime. Pulverizing and tilling equipment, such as “gators”, are preferred for mixing the lime into the soil. The treated soil should be placed in compacted lifts as discussed in the “Fill Materials and Compaction” section.

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 owner should recognize that there is an inherent, but reduced risk that damage may occur, even after remedial treatment of the subgrade soil.

4.3 Shallow Rock

During drilling weathered chert and sandstone was encountered underlying the clay soils at depths of 5½ to 17 feet (approximate El. 961 to El. 953) in eight of nine borings. Auger refusal was encountered at depths of 12½ to 17 feet (approximate El. 955 to El. 949.5) in seven of nine borings. Based on a proposed finish floor elevation of 967.75, we do not anticipate that rock excavation will be required during foundation construction. However, rock excavation may be required for deeper utilities. It should be noted that the depth to weathered rock and bedrock may vary significantly between the widely spaced boring locations. If bedrock is encountered within the footing excavations, the foundations should be extended through the natural soil so that they all bear on bedrock. Or, an alternative would be to maintain at least 1 foot of soil beneath all foundations, even if this requires excavating rock from below the bearing elevation and replacing it with compacted earth fill. This will allow the foundations for any single structure to bear on material of similar subgrade characteristics, and reduce the possibility of the foundation cracking due to differential movement.

4.4 Shallow Foundations

Shallow spread footing foundations bearing on natural lean clay, remediated existing fill, or remediated expansive clay soils are appropriate for support of the foundations. Based on the soils encountered during our exploration, shallow foundations can be sized for maximum net allowable bearing pressures of 2,500 and 3,000 pounds per square foot (psf) for continuous strip footings and isolated column footings, respectively. Foundations bearing on competent bedrock may be sized for a maximum net allowable bearing capacity of 5,000 psf. We anticipate that some localized areas of inadequate bearing materials, such as present at depth of 2 feet in B-8, may be encountered during construction; therefore, we recommend that an allowance be made in the construction budget for selected footing overexcavations. A one-third increase in the net allowable bearing pressures may be used for transient loads, such as wind and earthquake.

Exterior footings and foundations in unheated areas of the buildings 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 ¾ inch.

4.5 Seismic Considerations

Ground shaking at the foundation of structures and liquefaction of the soil under the foundation are the principle seismic hazards to be considered in design of earthquake-resistant structures. Liquefaction occurs when a rapid buildup in water pressure, caused by the ground motion, pushes sand particles apart, resulting in a loss of strength and later densification as the water pressure dissipates. This loss of strength can cause bearing capacity failure while the densification can cause excessive settlement. Potential earthquake damage can be mitigated by structural and/or geotechnical measures or procedures common to earthquake resistant design.

4.5.1 Design Earthquake

According to International Building Code (2009 edition) (IBC 2009), structures such as the one proposed for this project are required to be designed to a design earthquake with a 2 percent Probability of Exceedance (PE) over a 50-year exposure period (i.e. a 2,475-year design earthquake). The design earthquake has a Moment Magnitude (Mw) of 7.7 and a Peak Ground Acceleration (PGA) of 0.14g, as determined from data provided by the IBC 2009 and the United States Geological Survey (USGS) National Seismic Hazard Mapping Project.

4.5.2 International Building Code Site Classification

Based on procedures outlined in the IBC 2009 and our geotechnical explorations for the subject site, including the borings through predominantly stiff to hard near surface cohesive soil and the depth to bedrock, the site can be classified as Site Class C. Using the procedures outlined in Section 1613 of the IBC 2009, the calculated weighted average undrained shear strength (s_u) is in excess of the 2,000 psf required to be classified as Site Class C. Seismic design parameters for the site are as follows: F_A = 1.20, F_V = 1.66, S_{DS} = 0.34, and S_{D1} = 0.16. The Seismic Design Category (SDC) is C for this site with an Occupancy Category of I, II, or III.

4.5.3 Liquefaction Potential Analysis

The liquefaction potential analysis for the site was conducted using data from the field exploration and laboratory test results and the techniques outlined in the National Center for Earthquake Engineering (NCEER) Technical Report NCEER-97-0022. Based on our analyses, the soils at the project site have sufficient strength values to resist liquefaction and/or a plasticity index that makes the threat of liquefaction minimal during the design earthquake. While the amount of the seismically induced settlement is dependent on the magnitude and distance from the seismic event, we estimate that the settlements from the design earthquake will be negligible and relatively uniform in nature so liquefaction mitigation techniques are not required.

4.6 Floor Slab

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) if bearing on newly placed, low plastic structural fill, natural lean clay soils, remediated existing fill or remediated expansive clay soils. The floor slab should be supported on a minimum 4-inch-thick layer of crushed stone. This will help to 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 that 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 interior slab. However, without careful attention to curing of the floor slab, the polyethylene sheeting can cause excessive shrinkage cracking and "curling".

4.7 Below-Grade Walls

Below-grade walls at this site may include minor retaining walls designed to accommodate surface grade changes around the proposed building. The maximum toe pressure for below-grade walls should not exceed the bearing pressure previously given for continuous strip footings. Retaining walls may be designed with an allowable coefficient of friction between the base of the concrete footing and the soil subgrade of 0.3, or 0.5 if bearing on rock.

Below-grade walls should also be designed to withstand lateral earth pressures caused by the weight of the backfill, including slopes behind the walls; and any surcharge, such as adjacent floor loads. We recommend the equivalent fluid unit weights tabulated in Table 4.1 below for lateral earth pressures, in pounds per cubic foot (pcf), be used in the design of below-grade walls. The indicated values assume that positive drainage is provided to prevent buildup of hydrostatic pressure. Expansive clay soils should not be used to backfill the wall excavations. Values for granular material should only be used if the granular backfill extends upwards and outwards the full height of the wall at a slope of 45 degrees or flatter from its base. In this case, exterior granular backfill should be capped with approximately 2 feet of cohesive soil to reduce the potential for surface water infiltration into the granular backfill. With clean granular backfill, filter fabric, such as Mirafi 140N, should be placed along the interface between the soil and granular backfill to reduce the potential for infiltration of the soil into the granular material.

Table 4.1 - Recommended Lateral Earth Pressures

Backfill Type	Equivalent Fluid Unit Weights	
	At-Rest Earth Pressures (pcf)	Active Earth Pressures (pcf)
Cohesive Soil	70	50
Granular Material (1-inch minus)	60	40
Free-Draining Granular Material (1-inch clean)	50	30

At-rest earth pressures should be used for restrained or fixed-headed walls that are restricted from rotation, such as loading dock or basement walls connected to floor joists or beams, or a wing wall attached to a basement wall. Active earth pressures should be used for free-headed walls where the base remains fixed and deflection at the top of the wall of approximately 1 inch for each 10 feet of wall height is allowed, such as a retaining wall.

The above values are applicable when the surface of the backfill behind the wall is horizontal. Upward sloped or loaded backfill will result in increased values. In addition to lateral earth pressures, below-grade walls should be designed to resist any surcharge loads, including shallow building foundations and traffic. These surface loads can be modeled as uniform lateral loads, equivalent to one-half of the surface load, acting at the halfway point on the wall.

A passive soil resistance modeled by an equivalent fluid unit weight of 250 pcf may be used for natural soil against the face of the exterior base or a key below the base of the wall. The upper 2 feet of soil backfilled against the exterior face of the walls and uncontrolled backfill soils should be ignored when calculating the lateral resistance. Lower passive pressure should be used if the ground surface slopes downward away from the face of the wall.

We recommend that all below-grade walls be provided with a drainage system. A minimum 4-inch diameter, perforated drainpipe should be used, and placed at foundation level. Granular drainage material, consisting of 1-inch clean crushed rock, classified as GP by ASTM D 2487, with less than 5 percent of the rock passing the No. 200 sieve, should be placed a minimum of 6 inches in all directions around the drainage pipe. Synthetic filter fabric, such as Mirafi 140N or equivalent, should encapsulate the drainpipe and granular drainage material. The pipe should be sloped to drain by gravity or through weepholes located on approximately 10-foot centers for above-grade retaining walls, or to a sump with a pump for below-grade walls where positive drainage by gravity cannot be achieved. Alternately, drainage can be provided directly through the weepholes without a drain pipe, provided that filter fabric is used or other measures are taken to prevent the granular backfill from migrating out through the weepholes. Any interior sumps must be isolated “watertight” from the interior subgrade to prevent the movement of moisture from the sump into the underlying soils.

4.8 Site Grading and Drainage

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. 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 slabs 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 total height of the slope, whichever is less, be provided around the structures before the surface slopes down and away. We do not anticipate that slopes steeper or taller than 15 feet in total height 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.

4.9 Underground Utilities

Underground utilities can provide a pathway for water to migrate below the floor slab. Drain and utility pipes beneath the slab should have tight joints to prevent leakage. If utility excavations are backfilled with free-draining granular materials, then cutoffs should be provided at the exterior walls to reduce the potential for water to migrate beneath the structures. Impermeable cutoffs may consist of a 3-foot-long “plug” of cohesive soil or bentonite soil mix, or a 1-foot-long plug of lean concrete. Soil may be used for the balance of the backfill.

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.

4.10 Stormwater Detention Basin

As shown on the *Site Plan*, a stormwater detention basin is planned northwest of the library. The upstream and downstream slopes of the storm water detention basin embankments should be no steeper than 3 horizontal to 1 vertical (3H:1V). We recommend that the crest be at least 8 feet wide to provide access for maintenance. The entire embankment should consist of cohesive soils with a plasticity index (PI) of at least 20. The expansive fat clay encountered on site is suitable for construction of the detention basin embankments. Rocky or organic soils or high silt-content soils are not suitable for the construction of stormwater detention basin embankments because of their potential for erosion and piping.

Rock bedding should not be used for the outlet piping of the stormwater detention basin. Instead, the outlet pipe should be placed on a cohesive soil subgrade, shaped to fit the pipe barrel, and the trench backfilled with properly compacted cohesive soil. Alternately, the trench can be backfilled to the springline of the pipe with lean concrete or flowable fill. Concrete anti-seepage collars should also be used to reduce seepage around the pipe.

4.11 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.

The existing fill and expansive fat clay could cause some distress in the pavement. To reduce long-term maintenance, consideration could be given to remediating the upper 12 inches of subgrade. Alternatives include removal and replacement with crushed stone or low plastic soil, or lime treatment. However, proper construction, along with periodic patching and overlaying, are likely more economical than remediation of the existing fill and fat clay.

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. 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. "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

Prior to fill placement and compaction, the upper 8 inches of the exposed subgrade should be scarified, moisture conditioned, and recompacted. Structural fill, including aggregate base course, 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). We recommend that any fill placed in building areas have a liquid limit less than 45 and a plasticity index less than 25. If higher plasticity soils are placed within 2 feet of shallow building foundations or within 3 feet of the floor slab subgrades, then remediation will be required. Acceptable non-organic fill soils include materials designated CL, ML, CL-ML, 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 and retaining walls may consist of low plastic lean clay or 1-inch minus crushed limestone. We advise performing field density tests on at least every other lift to monitor compaction. 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 slight 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. Exterior clean rock backfill should be capped with cohesive soil to reduce the potential for surface water infiltration.

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, and pavements. Field density tests should be performed on each lift of fill to document that proper compaction is achieved.

5.3 Shallow Excavations

SCI should observe all footing and floor slab excavations and pavement subgrades for problem areas, such as soft zones, areas of existing fill, or areas of untreated expansive clay soils, 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. 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, free of loose soil or uncompacted fill, relatively dry and maintained near their optimum moisture content. 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 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 Subgrade Considerations

Floor slab and pavement subgrades may be subjected to construction traffic and exposure to weather for an extended period and significant problems may be incurred. It may be necessary 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 pavements. In addition, subgrades 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 slab or paving as is practical. Proofroll passes should be limited, particularly on silty subgrades, to reduce the potential for pumping of moisture from deeper within the soil profile.

Special measures may be required to facilitate construction during wet or cold weather, or where excessive areas of soft soils are identified. 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 crushed limestone. Soft areas should be selectively undercut and backfilled with properly compacted cohesive soil. A geotextile, such as Mirafi 600X, or geogrid, such as Tensar TX140, or equivalent, may be used to help stabilize particularly soft areas. Where possible, the subgrade should be sloped to provide drainage.

5.5 Rock Excavation

Although not characterized by rock coring, we anticipate that most, if not all, of the bedrock encountered below our auger refusal depths will require blasting or other rock removal methods such as chipping. The chert and weathered sandstone zones will likely require ripping rock buckets mounted on heavy duty equipment, chipping, or perhaps blasting. If blasting is required at the site, it should be controlled to keep peak velocities at the existing structures and property lines to less than 2 inches per second, unless local ordinances require more stringent criteria. Velocities greater than this could cause damage. A pre-blast survey of adjacent structures is recommended; and vibration monitoring during blasting operations is advisable, particularly until the amount of explosives to be used is determined. Blasts using small amounts of explosives or a number of delays should be considered to reduce blasting damage.

5.6 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.

5.7 Erosion Control and Land Disturbance Monitoring Program

Appropriate erosion and sediment control measures, such as proper contouring during site grading activities, the installation of siltation fences, and/or inlet protection, should be used during construction to keep eroded materials from being carried onto adjacent properties or waterbodies. 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 sediment control systems. Timely sodding and/or seeding of sloped surfaces will help reduce this potential problem.

SCI recommends following the procedures detailed in the Stormwater Pollution Prevention Plan (SWPPP). Any site disturbing more than one acre of ground must obtain a Land Disturbance Permit from the Missouri Department of Natural Resources (MDNR). As part of the permit compliance procedures, weekly and rain-event site observations must be performed to document the changing site conditions and maintenance of control measures.

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:

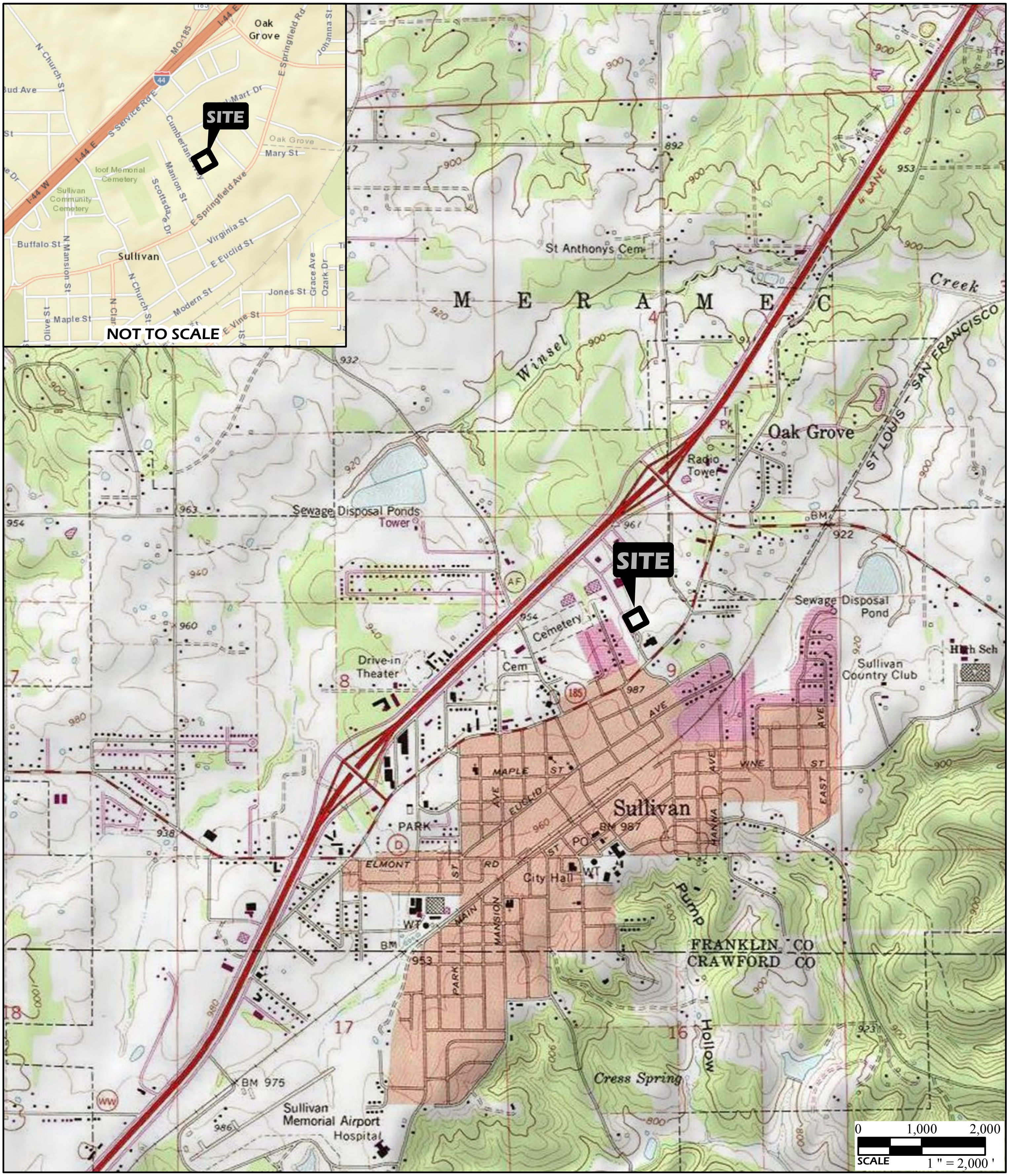
- Review final development plans.
- Participate in a formal preconstruction meeting with the Owner's Representative, Civil Engineer, and Contractor, prior to construction at the site.
- Conduct and document weekly and rain-event observations at the site, maintain and update on-site paperwork, and provide submittals required by the SWPPP and Land Disturbance Permit.
- 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, floor slab and pavement subgrades to assess the impact of existing fill and expansive clay soils, and to recommend the extent of remedial measures.
- Observe footing excavations for adequacy of bearing materials.
- Observe the floor slab and pavement subgrades prior to placing base rock.
- Observe backfilling of below-grade utility excavations.
- Provide quality assurance testing of structural concrete materials.

7.0 LIMITATIONS

The recommendations provided herein are for the exclusive use of our client. It is imperative that SCI be contacted by any third-party interests to evaluate the applicability of this report relative to use by anyone other than our client. Our recommendations are specific only to the project described, and are not meant to supersede more stringent requirements of local ordinances. They are based on subsurface information obtained at seven specific, widely spaced, 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 final development plans, once they are available, to review whether our recommendations have been understood and applied correctly, and to assess the need for additional exploration or analysis. 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.



SCI	**PROJECT NAME** SCENIC REGIONAL LIBRARY SULLIVAN, MISSOURI	**GENERAL NOTES/LEGEND** USGS TOPOGRAPHIC MAP SULLIVAN, MISSOURI QUADRANGLE DATED 1969 PHOTO REVISED 1982 10' CONTOURS	N W E S
	VICINITY MAP		
	DRAWN BY LAP / **CHECKED BY** JPB — **DATE** 02/2016 — **JOB NUMBER** 2015-5182.10	STREET MAP http://goto.arcgisonline.com/maps/World_Street_Map	**FIGURE** 1

SCI

PROJECT NAME

SCENIC REGIONAL LIBRARY
SULLIVAN, MISSOURI

AERIAL PHOTOGRAPH

DRAWN BY	LAP	DATE	JOB NUMBER
CHECKED BY	JPB	02/2016	2015-5182.10

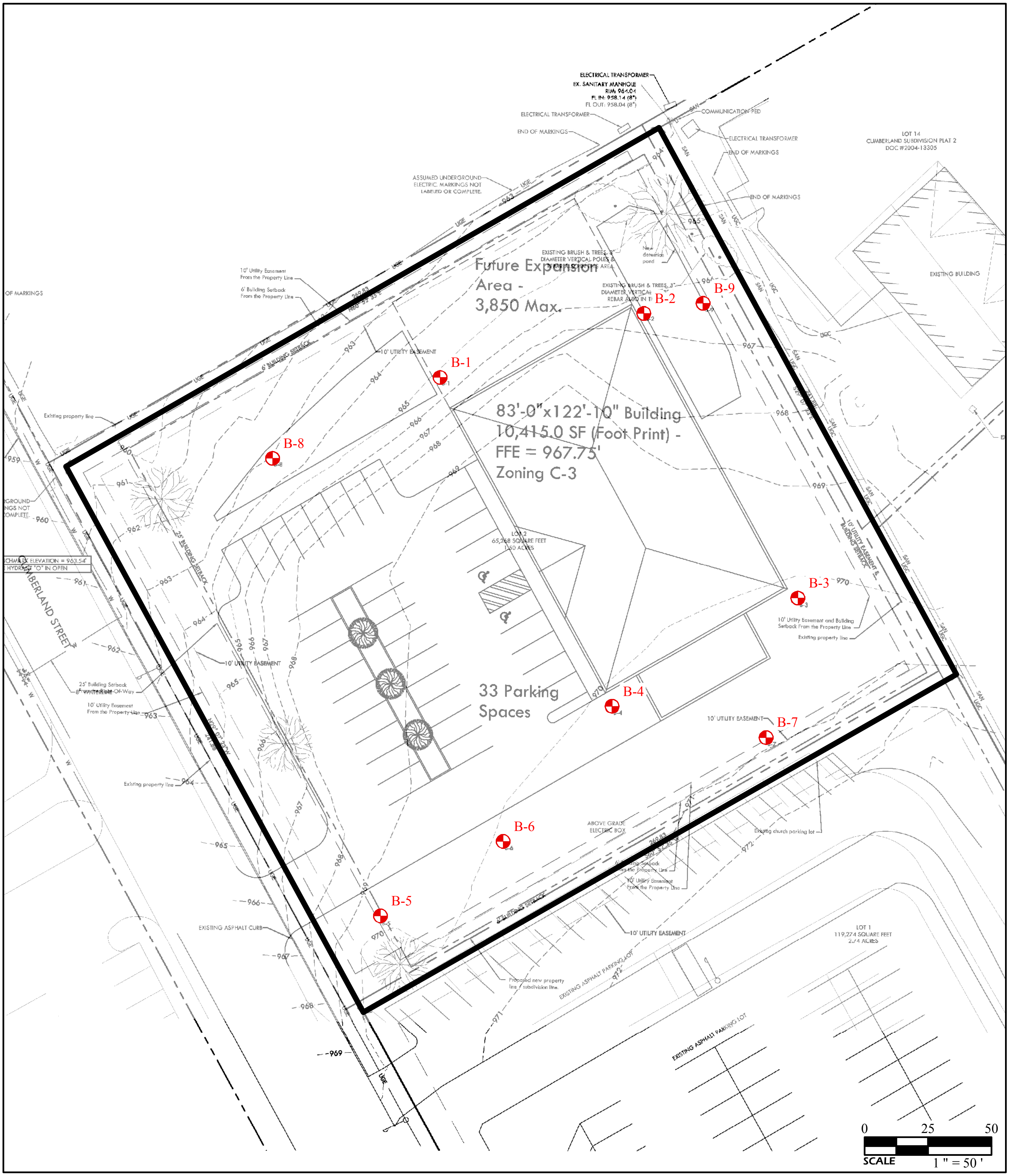
GENERAL NOTES/LEGEND

INDICATES APPROXIMATE SOIL BORING LOCATIONS

AERIAL PHOTOGRAPH OBTAINED FROM BING MAPS

N W E S

FIGURE
2



PROJECT NAME	SCENIC REGIONAL LIBRARY SULLIVAN, MISSOURI	**GENERAL NOTES/LEGEND**	
	SITE PLAN	INDICATES APPROXIMATE SOIL BORING LOCATIONS	N / W / E / S
DRAWN BY LAP	**DATE** 02/2016	**JOB NUMBER** 2015-5182.10	**FIGURE**
CHECKED BY JPB		DIMENSIONS AND LOCATIONS ARE APPROXIMATE; ACTUAL MAY VARY. DRAWING SHALL NOT BE USED OUTSIDE THE CONTEXT OF THE REPORT FOR WHICH IT WAS GENERATED.	3

Appendix A

SCI ENGINEERING, INC.

47 St. Andrews Drive
Union, Missouri 63084
636-584-7991 Fax 636-584-7966
www.sciengineering.com

BORING LOG LEGEND AND NOMENCLATURE

Depth is in feet below ground surface. **Elevation** is in feet mean sea level, site datum, or as otherwise noted.

Sample Type

- **SS** Split-spoon sample, disturbed, obtained by driving a 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 pushing 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 or SPT) 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 (50 blows for 2 inches).

For analysis, the N value is used when obtained by a cathead and rope system. When obtained by an automatic hammer, the N value may be increased by a factor of 1.3.

Vane Shear Strength is expressed as the peak strength (existing state) / the 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 (expressed as a percentage) are described as follows:

Trace	<5
Few	5-15
With	>15-30

Stratigraphic Breaks may be observed or interpreted, and are indicated by a dashed line. 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.

RQD (Rock Quality Designation) is the ratio between the total length of core segments 4 inches or more in length and the total length of core drilled. RQD (expressed as a percentage) indicates insitu rock quality as follows:

Excellent	90 to 100
Good	75 to 90
Fair	50 to 75
Poor	25 to 50
Very Poor	0 to 25

BORING LOG

PROJECT Scenic Regional Library
LOCATION Sullivan, Missouri
DRILLER Midwest Drilling, Inc. **HAMMER** Auto
EQUIPMENT CME-750 w/CFA **ELEVATION** 965.23
BORING NUMBER B-1
SHEET 1 **of** 1
PROJECT NO. 2015-5182.10
DATE DRILLED 01/16/16

DEPTH (ft)	SAMPLE NUMBER	TYPE	RECOVERY (in/in)	BLOWS (per 6 in)	DESCRIPTION (UNIFIED SOIL CLASSIFICATION)	GRAPHIC	SEE REMARK NO.	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	HAND PENETROMETER (ksf)	UNCONFINED COMPRESSIVE STRENGTH (ksf)	LIQUID LIMIT	PLASTICITY INDEX	ELEVATION (ft)
					LEAN CLAY (CL): Gray, with brown, trace coarse gravel									
	1	SS	18/18	14 16 9				18		>9.0		31	13	963
3					FAT CLAY (CH): Red and light gray, with coarse gravel									
	2	SS	15/18	12 16 14				27		7.5				960
6					SANDY FAT CLAY (CH): Red and white, with fine to coarse chert and sandstone									
	3	SS	15/18	8 14 10				9		--				957
9					SHALEY FAT CLAY (CH): Light green, trace red, trace fine sand									
	4	SS	18/18	21 7 12				25		6.5				954
12					WEATHERED SANDSTONE									
	5	SS	7/8	8 50/2"				12		6.0				951
15					Auger refusal at 15 feet.									948
18														

WATER LEVEL:
X NONE OBSERVED WHILE DRILLING
___ ft WHILE DRILLING
___ ft ___ HRS AFTER DRILLING
___ ft ___ DAYS AFTER DRILLING

REMARKS:

BORING LOG

PROJECT Scenic Regional Library
LOCATION Sullivan, Missouri
DRILLER Midwest Drilling, Inc. **HAMMER** Auto
EQUIPMENT CME-750 w/CFA **ELEVATION** 966.33
BORING NUMBER B-2
SHEET 1 **of** 1
PROJECT NO. 2015-5182.10
DATE DRILLED 01/16/16

DEPTH (ft)	SAMPLE NUMBER	TYPE	RECOVERY (in/in)	BLOWS (per 6 in)	DESCRIPTION (UNIFIED SOIL CLASSIFICATION)	GRAPHIC	SEE REMARK NO.	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	HAND PENETROMETER (ksf)	UNCONFINED COMPRESSIVE STRENGTH (ksf)	LIQUID LIMIT	PLASTICITY INDEX	ELEVATION (ft)
					GRAVELLY LEAN CLAY (CL): Red and brown, gravel is coarse chert									966
	1	SS	18/18	2 15 31				10		--				
3														963
	2	SS	4/18	5 18 22				12		--				
					WEATHERED CHERT: With lean clay									
6	3	SS	1/1	50/1"										960
9	4	SS	1/2	50/2"	With shaley fat clay									957
12														954
					Auger refusal at 12.5 feet.									
15														951
18														948

WATER LEVEL:

X NONE OBSERVED WHILE DRILLING
ft WHILE DRILLING
ft HRS AFTER DRILLING
ft DAYS AFTER DRILLING

REMARKS:

BORING LOG

PROJECT Scenic Regional Library
LOCATION Sullivan, Missouri
DRILLER Midwest Drilling, Inc. **HAMMER** Auto
EQUIPMENT CME-750 w/CFA **ELEVATION** 970.25

BORING NUMBER B-3
SHEET 1 **of** 1
PROJECT NO. 2015-5182.10
DATE DRILLED 01/16/16

DEPTH (ft)	SAMPLE NUMBER	TYPE	RECOVERY (in/in)	BLOWS (per 6 in)	DESCRIPTION (UNIFIED SOIL CLASSIFICATION)	GRAPHIC	SEE REMARK NO.	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	HAND PENETROMETER (ksf)	UNCONFINED COMPRESSIVE STRENGTH (ksf)	LIQUID LIMIT	PLASTICITY INDEX	ELEVATION (ft)
					LEAN CLAY (CL): Gray, with brown									969
	1	SS	15/18	5 7 16				24		5.0				
3					FAT CLAY (CH): Red, trace fine chert gravel									
	2	SS	15/18	8 7 4				31		>9.0		106	73	966
6	3	SS	1/1	50/1"	CLAYEY GRAVEL (GC): Coarse chert, clay is fat, trace fine sand									
														963
9	4	SS	3/5	50/5"				12		--				
					SANDY FAT CLAY (CH): Red and tan, with sandstone gravel									960
12														
	5	SS	15/18	7 12 14				15		--				957
15														954
					WEATHERED SANDSTONE: With fat clay									
18	6	SS		50/1"										951

Boring terminated at 20 feet.

WATER LEVEL:
X NONE OBSERVED WHILE DRILLING
____ ft WHILE DRILLING
____ ft ____ HRS AFTER DRILLING
____ ft ____ DAYS AFTER DRILLING

REMARKS:

BORING LOG

PROJECT Scenic Regional Library
LOCATION Sullivan, Missouri
DRILLER Midwest Drilling, Inc. **HAMMER** Auto
EQUIPMENT CME-750 w/CFA **ELEVATION** 970.08
BORING NUMBER B-4
SHEET 1 **of** 1
PROJECT NO. 2015-5182.10
DATE DRILLED 01/15/16

DEPTH (ft)	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE RECOVERY (in/in)	SAMPLE BLOWS (per 6 in)	DESCRIPTION (UNIFIED SOIL CLASSIFICATION)	GRAPHIC	SEE REMARK NO.	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	HAND PENETROMETER (ksf)	UNCONFINED COMPRESSIVE STRENGTH (ksf)	LIQUID LIMIT	PLASTICITY INDEX	ELEVATION (ft)
					FILL: Red, fat clay, trace coarse gravel									969
	1	SS	10/18	5 6 8				24		>9.0				
3					FAT CLAY (CH): Red and light gray, with chert and sandstone gravel									
	2	SS	12/18	13 6 5				24		6.0				966
6	3	SS	15/18	6 5 13	Becomes red and tan			35		2.0				963
					SHALEY FAT CLAY (CH): Orange, trace chert gravel									
9	4	SS	15/18	5 7 14				75		>9.0				960
12														957
	5	SS	18/18	8 10 13	Becomes red and orange			53		8.5				
15														954
					WEATHERED SANDSTONE: With fat clay									
18	6	SS	3/3	50/3"				20		--				951

Boring terminated at 20 feet.

WATER LEVEL:

X NONE OBSERVED WHILE DRILLING
ft WHILE DRILLING
ft HRS AFTER DRILLING
ft DAYS AFTER DRILLING

REMARKS:

BORING LOG

PROJECT Scenic Regional Library
LOCATION Sullivan, Missouri
DRILLER Midwest Drilling, Inc. **HAMMER** Auto
EQUIPMENT CME-750 w/CFA **ELEVATION** 969.67
BORING NUMBER B-5
SHEET 1 **of** 1
PROJECT NO. 2015-5182.10
DATE DRILLED 01/15/16

DEPTH (ft)	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE RECOVERY (in/in)	SAMPLE BLOWS (per 6 in)	DESCRIPTION (UNIFIED SOIL CLASSIFICATION)	GRAPHIC	SEE REMARK NO.	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	HAND PENETROMETER (ksf)	UNCONFINED COMPRESSIVE STRENGTH (ksf)	LIQUID LIMIT	PLASTICITY INDEX	ELEVATION (ft)
					FILL: Brown, lean clay									969
	1	SS	18/18	4 8 28				15		7.0				
3					FAT CLAY (CH): Red, with coarse chert gravel									966
	2	SS	12/18	7 6 9				25		>9.0				
6					Becomes red and tan									
	3	SS	18/18	5 6 9				26		7.5				963
					WEATHERED SANDSTONE: With fat clay									
9	4	SS	18/18	3 6 15				14		--				960
12														957
	5	SS	5/5	50/5"	Trace fat clay			14		--				
15														954
					Auger refusal at 16 feet.									
18														951

WATER LEVEL:
X NONE OBSERVED WHILE DRILLING
___ ft WHILE DRILLING
___ ft ___ HRS AFTER DRILLING
___ ft ___ DAYS AFTER DRILLING

REMARKS:

BORING LOG

PROJECT Scenic Regional Library		**BORING NUMBER**	B-6
LOCATION Sullivan, Missouri		**SHEET** 1 **of** 1	
DRILLER Midwest Drilling, Inc.	**HAMMER** Auto	**PROJECT NO.**	2015-5182.10
EQUIPMENT CME-750 w/CFA	**ELEVATION** 970.13	**DATE DRILLED**	01/15/16

DEPTH (ft)	SAMPLE NUMBER	SAMPLE TYPE	RECOVERY (in/in)	BLOWS (per 6 in)	DESCRIPTION (UNIFIED SOIL CLASSIFICATION)	GRAPHIC	SEE REMARK NO.	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	HAND PENETROMETER (ksf)	UNCONFINED COMPRESSIVE STRENGTH (ksf)	LIQUID LIMIT	PLASTICITY INDEX	ELEVATION (ft)
					FILL: Brown and gray, lean clay, trace gravel									
	1	SS	8/18	8 15 19				17		--		45	26	969
3					FAT CLAY (CH): Red and tan									
	2	SS	15/18	4 5 7				31		7.5				966
6	3	SS	12/18	5 7 7	With fine sand, chert and weathered sandstone			25		--				963
9	4	SS	18/18	4 8 15				11		--				960
12														957
	5	SS	6/10	8 50/4"	WEATHERED SANDSTONE: With fat clay			10		--				
15					Auger refusal at 15.5 feet.									954
18														951

WATER LEVEL:

X NONE OBSERVED WHILE DRILLING
____ ft WHILE DRILLING
____ ft ____ HRS AFTER DRILLING
____ ft ____ DAYS AFTER DRILLING

REMARKS:

BORING LOG

PROJECT	Scenic Regional Library	**BORING NUMBER**	B-7
LOCATION	Sullivan, Missouri	**SHEET**	1 **of** 1
DRILLER	Midwest Drilling, Inc. **HAMMER** Auto	**PROJECT NO.**	2015-5182.10
EQUIPMENT	CME-750 w/CFA **ELEVATION** 970.88	**DATE DRILLED**	01/15/16

DEPTH (ft)	SAMPLE NUMBER	SAMPLE TYPE	RECOVERY (in/in)	BLOWS (per 6 in)	DESCRIPTION (UNIFIED SOIL CLASSIFICATION)	SEE REMARK NO.	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	HAND PENETROMETER (ksf)	UNCONFINED COMPRESSIVE STRENGTH (ksf)	LIQUID LIMIT	PLASTICITY INDEX	ELEVATION (ft)
					FILL: Red and brown fat clay, trace coarse chert								
	1	SS	10/18	4 5 7			28		>9.0				969
3					FAT CLAY (CH): Red and light gray								
	2	SS	18/18	4 6 7			32		8.5				966
6	3	SS	18/18	5 11 8	Becomes light gray, trace red		31		7.0				963
9	4	SS	10/11	8 50/5"	Trace coarse chert gravel		39		--				
12													960
	5	SS	12/15	15 19 50/3"	WEATHERED SANDSTONE: With fat clay		13		--				957
15													
					Auger refusal at 17 feet.								954
18													951

WATER LEVEL:

X NONE OBSERVED WHILE DRILLING
____ ft WHILE DRILLING
____ ft ____ HRS AFTER DRILLING
____ ft ____ DAYS AFTER DRILLING

REMARKS:

BORING LOG

PROJECT Scenic Regional Library
LOCATION Sullivan, Missouri
DRILLER Midwest Drilling, Inc. **HAMMER** Auto
EQUIPMENT CME-750 w/CFA **ELEVATION** 963.03
BORING NUMBER B-8
SHEET 1 **of** 1
PROJECT NO. 2015-5182.10
DATE DRILLED 01/16/16

DEPTH (ft)	SAMPLE NUMBER	TYPE	RECOVERY (in/in)	BLOWS (per 6 in)	DESCRIPTION (UNIFIED SOIL CLASSIFICATION)	GRAPHIC	SEE REMARK NO.	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	HAND PENETROMETER (ksf)	UNCONFINED COMPRESSIVE STRENGTH (ksf)	LIQUID LIMIT	PLASTICITY INDEX	ELEVATION (ft)
					LEAN CLAY (CL): Brown									
	1	SS	18/18	1 1 2				30		<1.0				
3					GRAVELLY LEAN CLAY (CL): Red and brown, gravel is chert									960
	2	SS	8/11	12 50/5"				9		--				
6					FAT CLAY (CH): Red, with fine sand, chert and weathered sandstone									957
	3	SS	15/18	6 7 9				28		2.5				
9	4	SS	10/18	7 12 14				11		4.5				954
12														951
					Auger refusal at 13.5 feet.									
15														948
18														945

WATER LEVEL:

X NONE OBSERVED WHILE DRILLING
___ ft WHILE DRILLING
___ ft ___ HRS AFTER DRILLING
___ ft ___ DAYS AFTER DRILLING

REMARKS:

BORING LOG

PROJECT Scenic Regional Library
LOCATION Sullivan, Missouri
DRILLER Midwest Drilling, Inc. **HAMMER** Auto
EQUIPMENT CME-750 w/CFA **ELEVATION** 966.52

BORING NUMBER B-9
SHEET 1 **of** 1
PROJECT NO. 2015-5182.10
DATE DRILLED 01/16/16

DEPTH (ft)	SAMPLE NUMBER	TYPE	RECOVERY (in/in)	BLOWS (per 6 in)	DESCRIPTION (UNIFIED SOIL CLASSIFICATION)	GRAPHIC	SEE REMARK NO.	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	HAND PENETROMETER (ksf)	UNCONFINED COMPRESSIVE STRENGTH (ksf)	LIQUID LIMIT	PLASTICITY INDEX	ELEVATION (ft)
					LEAN CLAY (CL): Brown and gray									966
	1	SS	15/18	2 3 9				32		2.0				
3					FAT CLAY (CH): Red, with fine chert gravel									963
	2	SS	15/18	5 16 29				20		--				
6	3	SS	2/3	50/3"	GRAVELLY FAT CLAY (CH): Red, gravel is fine to coarse chert and sandstone			7		>9.0				960
	4	SS	1/1	50/1"	WEATHERED SANDSTONE: Trace fat clay									
9														957
12														954
					Auger refusal at 13 feet.									
15														951
18														948

WATER LEVEL:

X NONE OBSERVED WHILE DRILLING
___ ft WHILE DRILLING
___ ft ___ HRS AFTER DRILLING
___ ft ___ DAYS AFTER DRILLING

REMARKS:

Important Information about Your

Geotechnical Engineering 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 information is provided 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 engineering study conducted for a civil engineer may not fulfill the needs of a construction contractor or even another civil engineer. Because each geotechnical engineering study is unique, each geotechnical engineering report is unique, prepared *solely* for the client. No one except you should rely on your geotechnical engineering 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 engineering report did not read it all. Do not rely on an executive summary. Do not read selected elements only.

A Geotechnical Engineering 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 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 engineering 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 engineering report include those that affect:

- the function of the proposed structure, as when it's changed from a parking garage to an office building, or from a light industrial plant to a refrigerated warehouse,
- elevation, configuration, location, orientation, or weight 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 engineering report is based on conditions that existed at the time the study was performed. *Do not rely on a geotechnical engineering 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 method 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.*

A Geotechnical Engineering Report Is Subject to Misinterpretation

Other design team members' misinterpretation of geotechnical engineering reports has resulted in costly problems. Lower that risk by having your geotechnical engineer confer with appropriate members of the design team after submitting the report. Also retain your geotechnical engineer to review pertinent elements of the design team's plans and specifications. Contractors can also misinterpret a geotechnical engineering report. Reduce that risk by having your geotechnical engineer participate in prebid and preconstruction conferences, and by providing construction observation.

Do Not Redraw the Engineer's Logs

Geotechnical engineers prepare final boring and testing logs based upon their interpretation of field logs and laboratory data. To prevent errors or omissions, the logs included in a geotechnical engineering report should *never* be redrawn for inclusion in architectural or other design drawings. Only photographic or electronic reproduction is acceptable, *but recognize that separating logs from the report can elevate risk.*

Give Contractors a Complete Report and Guidance

Some owners and design professionals mistakenly believe they can make contractors liable for unanticipated subsurface conditions by limiting what they provide for bid preparation. To help prevent costly problems, give contractors the complete geotechnical engineering report, *but* preface it with a clearly written letter of transmittal. In that letter, advise contractors that the report was not prepared for purposes of bid development and that the report's accuracy is limited; encourage them to confer with the geotechnical engineer who prepared the report (a modest fee may be required) and/or to conduct additional study to obtain the specific types of information they need or prefer. A prebid conference can also be valuable. *Be sure contractors have sufficient time* to perform additional study. Only then might you be in a position to give contractors the best information available to you, while requiring them to at least share some of the financial responsibilities stemming from unanticipated conditions.

Read Responsibility Provisions Closely

Some clients, design professionals, and contractors do not recognize that geotechnical engineering is far less exact than other engineering disciplines. This lack of understanding has created unrealistic expectations that have led to disappointments, claims, and disputes. To help reduce the risk of such outcomes, geotechnical engineers commonly include a variety of explanatory provisions in their reports. Sometimes labeled "limitations" many of these provisions indicate where geotechnical engineers' responsibilities begin and end, to help others recognize their own responsibilities and risks. *Read these provisions closely.* Ask questions. Your geotechnical engineer should respond fully and frankly.

Geoenvironmental Concerns Are Not Covered

The equipment, techniques, and personnel used to perform a *geoenvironmental* study differ significantly from those used to perform a *geotechnical* study. For that reason, a geotechnical engineering report does not usually relate any geoenvironmental findings, conclusions, or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. *Unanticipated environmental problems have led to numerous project failures.* If you have not yet obtained your own geoenvironmental information, ask your geotechnical consultant for risk management guidance. *Do not rely on an environmental report prepared for someone else.*

Obtain Professional Assistance To Deal with Mold

Diverse strategies can be applied during building design, construction, operation, and maintenance to prevent significant amounts of mold from growing on indoor surfaces. To be effective, all such strategies should be devised for the *express purpose* of mold prevention, integrated into a comprehensive plan, and executed with diligent oversight by a professional mold prevention consultant. Because just a small amount of water or moisture can lead to the development of severe mold infestations, a number of mold prevention strategies focus on keeping building surfaces dry. While groundwater, water infiltration, and similar issues may have been addressed as part of the geotechnical engineering study whose findings are conveyed in this report, the geotechnical engineer in charge of this project is not a mold prevention consultant; ***none of the services performed in connection with the geotechnical engineer's study were designed or conducted for the purpose of mold prevention. Proper implementation of the recommendations conveyed in this report will not of itself be sufficient to prevent mold from growing in or on the structure involved.***

Rely, on Your ASFE-Member Geotechncial Engineer for Additional Assistance

Membership in ASFE/The Best People on Earth exposes geotechnical engineers to a wide array of risk management techniques that can be of genuine benefit for everyone involved with a construction project. Confer with your ASFE-member geotechnical engineer for more information.

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