GEOTECHNICAL ENGINEERING REPORT

MCPL EAST LEE'S SUMMIT
SE BLUE PARKWAY AND SE BATTERY DRIVE
LEE'S SUMMIT, MISSOURI

PREPARED FOR
MID-CONTINENT PUBLIC LIBRARY

PREPARED BY
OLSSON, INC.
OLATHE, KANSAS

JANUARY 7, 2019

OLSSON PROJECT NO. 018-0330.182

1700 East 123rd Street • Olathe, KS 66061 • (913) 829-0078 • FAX (913) 829-0258

olsson

olsson

January 7, 2019

Mid-Continent Public Library
Attn: Jake Wimmer
15616 East 24 Highway
Independence, MOP 64050

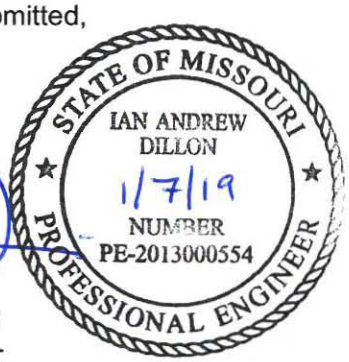
Re: Geotechnical Engineering Report
"New Branch" East Lee's Summit
Lee's Summit, MO
Olsson Project No. 018-0330.182

Dear Mr. Wimmer,

Olsson, Inc. has completed the authorized Geotechnical Engineering Report for the above referenced project. This report describes our understanding of the project, presents the results of the borings and laboratory tests, discusses the observed subsurface conditions, and, based on these conditions, provides our opinions and geotechnical engineering recommendations for this project.

We appreciate the opportunity to provide our geotechnical engineering services for this project. If you have any questions or need further assistance, please contact us.

Respectfully submitted,
Olsson, Inc.



Ian A. Dillon, PE
Project Engineer

James M. Landrum, PE
Vice President

1700 E. 123rd Street / Olathe, KS 66061
O 913.829.0078 / olsson.com

TABLE OF CONTENTS

PAGE

A. PROJECT UNDERSTANDING

A.1. GEOTECHNICAL SCOPE

This Geotechnical Engineering Report presents the results of the subsurface exploration completed for the new Mid-Continent Public Library (MCPL) branch in Lee's Summit, Missouri. We drilled nine borings at the site for the proposed structure and associated parking and drive areas. The locations of the borings are shown on the Boring Location Plan in Appendix A. Borehole Reports are provided in Appendix B. The purpose of this exploration was to evaluate the existing subsurface conditions encountered at the borings and, based on these conditions, provide geotechnical design recommendations for the support of foundations, floor slabs, and pavements for the proposed project.

A.2. SITE DESCRIPTION

The project site is located northeast of the intersection of SE Blue Parkway and SE Battery Drive in Lee's Summit, Missouri (Figure 1). At the time of this report, the site was grass covered. The site slopes down from the south to the north with elevations ranging from a high of about 1024 feet to a low of about 1011 feet.

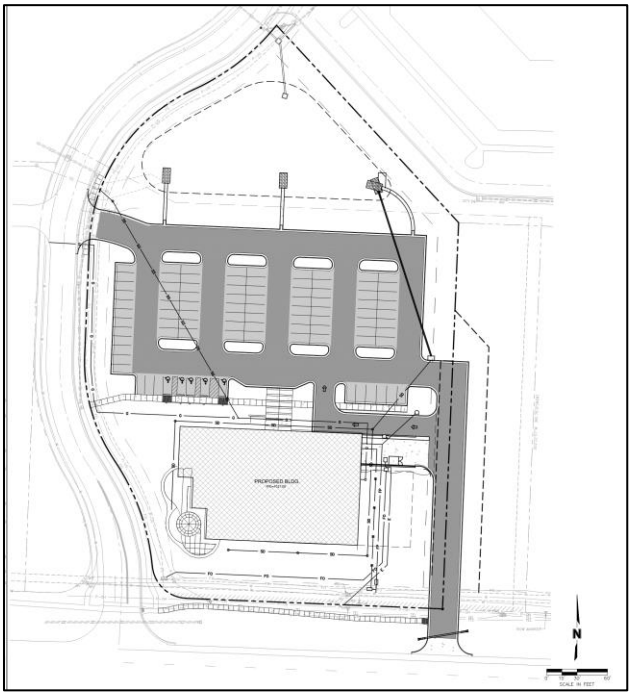
Figure 1: Site Location

As part of this exploration, we reviewed historical aerial images dating back to 1991 obtained from Google Earth. The images indicate the area has been used for agricultural purposes until around 2016. The aerial image for 2016 indicates that the north corner of the property was rough graded during the construction of the structure to the north.

A.3. PROJECT DESCRIPTION

We understand the project will consist of a single-story, slab-on-grade structure with a footprint area of around 18,000 square feet. Associated parking and drive areas will be located to the north and east of the structure. The finished floor elevation (FFE) is planned to be at 1021 feet. The planned building location is shown in Figure 2.

Figure 2: Site Layout



Planned cut and/or fill amounts of ± 2 feet are expected in the building area. Up to 5 feet of fill is planned in the parking lot area just north of the building, while 5 to 7 feet of cut is planned in the detention basin in the north corner of the property. We anticipate structural loads to be less than 5 kips per lineal foot for walls and less than 60 kips for columns for the slab-on-grade structure. If loads are significantly greater than those presented above, Olsson, Inc. (***Olsson***) should be contacted to confirm the recommendations provided in this report. New parking will be subjected primarily to personal vehicles (cars, light trucks and SUVs) with occasional moving, delivery, and trash trucks.

B. Exploratory and Test Procedures

B.1. Field Exploration

The drill crew used a truck mounted drill rig to advance nine borings at the site. The drill crew located the borings in the field by using GPS coordinates. The drill crew measured surface elevations at each boring using a surveyor's level and rod. The manhole atop the curb inlet along SE Battery Drive in the northwest corner of the property was used as a benchmark with an elevation of 1014.8 feet. Boring elevations are shown on the Borehole Reports and are reported to the nearest tenth of a foot. The approximate locations of the borings are shown on the Boring Location Plan in Appendix A.

Each boring was drilled to practical auger refusal on bedrock. Soil samples designated 'U' on the boring logs were obtained with thin-walled tubes hydraulically pushed into the soil. Soil samples designated as 'SS' on the boring logs were obtained with a split spoon sampler during performance of the Standard Penetration Test (SPT). Prior to backfilling the borings, the drill crew measured water levels in the boreholes during and immediately after drilling activities.

B.2. Laboratory Testing

At our laboratory, we visually classified the soil samples in accordance with the Unified Soil Classification System (USCS). We performed moisture content, density and unconfined compressive strength tests on selected samples. Three Atterberg limits test was performed on a selected sample to aid in the classification of the soils under the USCS. Based on the laboratory test results and our observations of the samples, we modified the field logs that were prepared by the drill crew. Results of the laboratory tests are shown on the appended Borehole Reports.

C. SUBSURFACE CONDITIONS

C.1. SOIL AND BEDROCK STRATIGRAPHY

The appended Borehole Reports show soil and bedrock conditions at the boring locations. The stratification boundaries shown on the Borehole Reports represent the approximate location of changes in the soil and rock types. In-situ, this transition is usually gradual. Based on the borings, the subsurface conditions at this project site can be generalized as follows.

Native fat clay soils were encountered below the rootzone at each boring. The fat clay soils continued to depths ranging from 10 to 13.5 feet below the base of the borings. The clay soils can be generalized as being firm to stiff, brown to reddish brown and gray, very moist and shaley near the base of the stratum. A thin seam of light brown to red brown weathered shale was observed in several of the borings below the native fat clay and above the limestone bedrock. At each boring, practical auger refusal on limestone bedrock was encountered. Refusal depths varied from 11.5 to 15.3 feet below the ground surface. The upper 6 inches to a foot of the limestone bedrock was slightly weathered.

C.2. GROUNDWATER SUMMARY

The borings were monitored while drilling and immediately after completion for the presence and level of water. Water was observed in borings B-1, B-2 and B-7 while drilling at depths 8.2 feet, 8.5 feet and 8 feet, respectively. Water was not encountered in the remaining borings. The presence or lack of groundwater in each boring should not be construed to represent a permanent or stable condition. Variations and uncertainties exist with relatively short-term water level observations in boreholes. Water levels can and should be anticipated to vary between boring locations, as well as with time within specific borings. Water typically collects near the interface between different materials, such as bedrock and soil. Groundwater levels fluctuate with variations in precipitation, site grading, drainage and adjacent land use. Long term monitoring with piezometers generally provides a more representative reflection of the potential range of groundwater conditions.

D. GEOTECHNICAL CONSIDERATIONS

The fat clay soils encountered in the borings are high in plasticity and prone to volume change with variations in moisture content. For this reason, we recommend a 24-inch thick Low Volume Change (LVC) zone be constructed beneath grade-supported floor slabs. Additional recommendations are provided in a subsequent section of this report.

Some relatively high moisture content soils were encountered in some of the borings and could be exposed in excavations and cuts, including foundation excavations. These soils may become unstable when disturbed and could become relatively soft and unstable under construction traffic. Depending upon site conditions during construction, over-excavation or stabilization of the subgrade and/or base of over-excavations may be needed to achieve a suitable working surface. Accordingly, we recommend that the owner budget for the possibility that over-excavation and/or subgrade stabilization may be required, and contractors be prepared to handle potentially unstable and/or soft conditions.

E. SITE PREPARATION

E.1. BUILDING AND PAVEMENT AREAS

Site preparation should commence with the stripping of any existing organic topsoil, root systems, frozen soil, and/or any other deleterious or unsuitable materials from the construction areas. Stripping depths will likely vary and should be adjusted as necessary.

Firm soils with very high moisture contents were encountered in some of the borings near the planned bearing elevation. These soils could be susceptible to rutting and pumping and may need to be removed and replaced with structural fill and/or stabilized in place. Foundation over-excavation recommendations are provided in the foundation section of this report.

Prior to the placement of new fill, exposed soil subgrades should be proofrolled with a loaded tandem-axle dump truck with a minimum gross weight of 20 tons or similar equipment. Proofrolling operations should be observed by a representative of ***Olsson***. In areas where soils are more susceptible to rutting and pumping, proofrolling may reduce the stability of the subgrade. If this condition occurs, the subgrade should be thoroughly observed by ***Olsson***. Unstable and unsuitable soils revealed by this evaluation and/or proofrolling that cannot be adequately densified in place should be removed and replaced or stabilized.

Upon completion of the subgrade evaluation, the upper 8 inches of exposed soil subgrade should be scarified, moisture conditioned and compacted to a minimum of 95 percent of the materials standard Proctor maximum dry density (ASTM Specification D-698) at a moisture content between optimum and 4 percent above optimum. Once the subgrade has been compacted, structural fill should be placed in accordance with the recommendations presented in this report.

E.2. STRUCTURAL FILL

All structural fill and backfill should consist of approved materials, free of organic matter (organic content less than 5 percent), and debris. Also, the soils should not contain particle sizes larger than three inches. Imported fill soils should generally exhibit a liquid limit less than 60 and a plasticity index less than 30. Samples of all proposed fill materials should be submitted to the geotechnical engineer of record prior to use on the site. Laboratory Proctor compaction tests and classification tests should be performed on any fill material placed during mass grading operations. The native on-site soils appear to be suitable for use as structural fill but would not be acceptable for use as LVC fill directly below the floor slabs.

We recommend that structural fill and backfill be compacted in accordance with the criteria provided in Table 1. An ***Olsson*** representative should observe fill placement operations and perform field density tests, as required.

Table 1: Fill Placement Guidelines

Area of Fill Placement	Material	Compaction Recommendation*	Moisture Content (Percent of Optimum)
Granular Layer – 6" beneath floor slabs	ASTM C-33, # 57 Stone	65% of Relative Density	As necessary to obtain density
Low Volume Change (LVC) – 18" below base of building granular layer	LL < 50 PI < 25	95%	0 to +4 percent
	MoDOT Type 5 Baserock	95%	As necessary to obtain density
Structural Fill – on-site	On-site Cohesive Soil	95%	0 to +4 percent
Structural Fill – imported	LL < 60 PI < 30	95%	0 to +4 percent
At Grade Pavement Subgrade – 8" chemically stabilized soil	15% Class "C" Fly ASH 5% CKD or LKD	95%	-1 to +3 percent

*According to ASTM D-698 – Standard Proctor

Suitable fill materials should be placed in thin loose lifts of 8 inches or less. Within small excavations, such as in utility trenches, around manholes, or behind retaining walls, the use of vibrating plate compactors, jumping jack compactors or walk behind sheepsfoot compactors may be used to facilitate compaction in these areas. Loose lift thicknesses of 4 inches or less are recommended where small compaction equipment is used.

The moisture content for suitable borrow soils at the time of compaction should generally be maintained between the ranges specified above. More stringent moisture limits may be necessary with certain soils and some adjustments to moisture contents may be necessary to achieve compaction in accordance with project specifications.

E.3. Drainage and Groundwater Considerations

Water should not be allowed to collect at the ground surfaces near foundations, floor slabs, or areas of new pavement, either during or after construction. Provisions should be made to quickly remove accumulating seepage water or storm water runoff from excavations. Undercut or excavated areas should be sloped toward one corner to allow rainwater or surface runoff to be quickly collected and gravity drained or pumped from construction areas. Subgrade soils that are exposed to precipitation or runoff should be evaluated by ***Olsson*** prior to the placement of new fill, reinforcing steel, or concrete, to determine if corrective action is required.

To minimize concerns related to improper or inadequate drainage away from foundation bearing subgrades or from cohesive backfill materials used in utility or foundation trenches, we recommend the following:

- Site grading should provide for efficient drainage of rainfall or surface runoff away from new structures and pavement.
- Roof run-off should be collected and transferred directly to the storm sewer system or directed to a location with positive and rapid drainage away from new structures and pavements.
- External hose connections in unpaved areas should incorporate splash blocks to prevent accidental flooding of foundation bearing or backfill soils. External hose connections should have cut-off valves inside the building to prevent accidental or unauthorized use.
- Maintenance personnel should be informed of the potential problems associated with watering near the building.

F. STRUCTURES

F.1. FOUNDATIONS

Based on the subsurface conditions observed at the borings, the foundations for the new MCPL branch will bear on firm to stiff native clay soils and/or structural fill. For shallow foundations supported on firm to stiff native clay soils and/or structural fill, a maximum net allowable soil bearing pressure of 2,000 pounds per square foot (psf) can be used for design. The net allowable soil bearing pressure refers to the bearing pressure at foundation level in excess of surrounding overburden pressure.

The foundation subgrades should be observed by an ***Olsson*** representative to determine if unsuitable soils are present. Where foundations encounter soft or otherwise unsuitable materials that cannot support the allowable bearing pressure, the foundations should be deepened to suitable materials. The foundations could be constructed directly on the suitable material or on a lean concrete (2,000 psi) backfill to the original planned bearing elevation. As an alternative, the footings could also bear on properly compacted structural backfill extending down to the suitable soils. Over-excavation for compacted structural fill placement below footings should extend laterally beyond all edges of the footings at least 8 inches per foot of over-excavation depth below footing base elevation.

Exterior footings should bear at a minimum depth of 3 feet below the lowest adjacent final ground surface. Footings should have a minimum foundation width of 18 inches for continuous footings and 30 inches for isolated column footings. Earth formed trench footings should have a minimum width of 12 inches.

Lightly loaded interior partition walls (applying less than 0.75 kips per lineal foot (klf)) may be supported directly on the slab-on-grade floor. Depending on the floor slab design and the specific wall loads, it may be necessary to increase the floor slab reinforcement or provide a thickened slab cross-section below interior walls. For interior walls with loads greater than 0.75 klf, we recommend a footing be installed, independent of the floor slab, to properly distribute the wall loads to the underlying soils and reduce the potential for floor slab damage.

The base of all foundation excavations should be free of all water and loose material prior to placing concrete. After foundation subgrades have been observed and evaluated by an ***Olsson*** representative, concrete should be placed as soon as possible to avoid subjecting the exposed soils to drying, wetting, or freezing conditions. If foundation subgrade soils are subjected to such conditions, ***Olsson*** should be contacted to reevaluate the foundation bearing materials.

In our opinion, foundations supported on clay soils (fill or native) could experience total settlements on the order of 1 inch and differential settlements on the order of ½ inch.

F.2. FLOOR SLAB SUBGRADE PREPARATION

A low volume change (LVC) material should be used to construct at least the top 18 inches of the building floor slab subgrades. Acceptable LVC materials would consist of cohesive soils having a liquid limit less than 50 and a plasticity index less than 25 or approved granular materials. Based on the materials encountered in the borings and the results of the laboratory tests, the on-site soils do not meet the low volume change criteria. Imported low plasticity soils or granular materials having at least 15 percent fines passing the No. 200 sieve (such as MoDOT Type 5 baserock) could be used to complete the low volume change sections.

The low volume change material should be placed and compacted in accordance with the *Structural Fill* section of this report. Upon completion of grading operations in the building areas, care should be taken to maintain the recommended subgrade moisture content and density until the floor slabs are constructed. Areas of the completed subgrade that become desiccated, saturated, frozen or disturbed by construction activity should be reconditioned to meet the recommendations of this report prior to placement of the granular leveling course and construction of the slabs.

A free-draining, compacted granular leveling course (e.g. ASTM C 33 Size No. 57 aggregate) having a minimum thickness of 6 inches should be placed below the floor slabs to provide uniform slab support. The layer of free-draining granular material should be in addition to the minimum 18-inch thick low volume change zone recommended below the building floor slab. If moisture vapor transmission through the concrete slab is a concern (e.g. if moisture sensitive floor coverings will be used), a vapor barrier should be used.

The procedures recommended above may not eliminate all future subgrade volume change and resultant floor slab movement. However, the procedures outlined should significantly reduce the potential for subgrade volume change. Common construction practice is to tie the slab-on-grade into the foundation elements to limit the impact of differential movement at doorways. Depending on the location of construction joints in the slab, the rigidity of the slab and foundation connection, and the magnitude of actual movement that occurs, some minor cracking within the floor slab could occur and should be anticipated.

F.3. SEISMIC SITE CLASSIFICATION

The subsurface profile for the project site consists of clay soils over limestone and shale bedrock. These conditions are consistent with the definition of Site Class "C" according to ASCE 7.

G. PAVEMENTS

G.1. PAVEMENT SUBGRADE PREPARATION

We understand at grade parking and drive lanes are planned north and east of the building along with a trash pickup area. On most project sites, the site grading is accomplished relatively early in the construction phase, and controlled fills are placed and compacted in a uniform manner. However, as construction proceeds, excavations are made into these areas, rainfall and surface water saturates some areas, heavy construction traffic disrupts the subgrade and many surface irregularities are filled in with loose soils to temporarily improve trafficability. A non-uniform subgrade can result in poor pavement performance and local failures relatively soon after pavements are constructed.

All pavements should be supported on a minimum of 8 inches of chemically stabilized soil subgrade that has been moisture conditioned between -1 and +3 percent of optimum and compacted to at least 95 percent of the material's maximum dry density according to ASTM D-698. A minimum of 15 percent Class "C" fly ash or 5 percent CKD or LKD (based on dry weight) should be used to stabilize the on-site soils.

As the time for pavement construction approaches, the pavement subgrades initially prepared early in the project should be carefully evaluated. We recommend that the moisture content and density of the top 8 inches of the subgrade be checked and the pavement subgrades be evaluated by proofrolling within two days prior to commencement of actual paving operations. Particular attention should be paid to high traffic areas that were rutted and disturbed earlier and to areas where backfilled trenches are located. If the material is not in compliance with the required ranges of moisture or density, the subgrade should then be moisture conditioned and recompacted. If any significant event (such as precipitation) occurs after the evaluation, the subgrade should be reviewed by qualified personnel immediately prior to paving. The subgrade should be in its finished form at the time of the final review.

G.2. PAVEMENT DESIGN

Table 2 summarizes typical pavement sections for full-depth Asphaltic Cement (AC) and Portland Cement Concrete (PCC). The sections represent typical minimum thicknesses. Routine maintenance of the pavement will be required, consisting of periodic seal coats and possibly one intermediate mill, in addition to regular crack maintenance.

Table 2: Minimum Recommended Pavement Sections

Parking Areas	Drive Areas	Heavy Vehicle Areas*
Full Depth AC: 2" AC Surface 3" AC Base	Full Depth AC: 2" AC Surface 6" AC Base	Full Depth PCC: 6" PCC *Applies to trash receptacle pads

PCC pavements are recommended for trash receptacle pads and other areas where heavy wheel loads will be concentrated. Concrete pavements in these areas should have a minimum thickness of 8 inches. It is also recommended that a 4-inch leveling and drainage course of clean, crushed rock be placed below all PCC pavements. We further recommend that the length of concrete sections be such that no heavy truck wheels are allowed to rest on asphaltic concrete sections during loading/unloading operations.

The clean rock base for PCC pavements should be uniform and the pavement subgrade should be graded to provide positive drainage of the granular base section. The granular section should be graded to adjacent storm sewer inlets and provisions should be made to provide drainage from the granular section into the storm sewer. Drainage of the granular base is particularly important where two different sections of pavements (such as AC and PCC) abut, so that water does not pond beneath the pavements and saturate the subgrade soils.

The performance of pavements will be dependent upon a number of factors, including subgrade conditions at the time of paving, rainwater runoff, and traffic. Rainwater runoff should not be allowed to seep below pavements from adjacent areas. Pavements should be sloped approximately ¼ inch per foot to provide rapid surface drainage.

Proper drainage below the pavement section helps prevent softening of the subgrade and has a significant impact on pavement performance and pavement lift. Therefore, we recommend that a granular blanket drain be constructed at all storm sewer inlets within the pavement areas. The blanket drain should consist of clean, crushed rock extending a minimum of 6 inches below pavement subgrade level. The blanket drains should extend radially a minimum of 8 feet from each of the storm sewer inlets. The grade within the blanket drain should be sloped toward the storm sewer inlet, and weep holes should be drilled through the inlet to provide drainage of the granular section into the inlet. Placement of geotextile filter fabric across the weep holes could be considered to prevent loss of aggregate through the weep holes.

Construction traffic on the pavements has not been considered in the above noted typical sections. If construction scheduling dictates that the pavements will be subject to traffic by construction equipment/vehicles, increasing the pavement thickness should be considered to include the effects of additional traffic loading. Construction traffic should not be allowed on partially completed pavements as the pavements will not have adequate structural capacity and could be damaged.

H. CONCLUSIONS AND LIMITATIONS

H.1. CONSTRUCTION OBSERVATION AND TESTING

We recommend that all earthwork during construction be monitored by a representative of ***Olsson***, including site preparation, placement of all structural fill and trench backfill, and pavement subgrades. The purpose of these services would be to provide ***Olsson*** the opportunity to observe the soil conditions encountered during construction, evaluate the applicability of the recommendations presented in this report to the soil conditions encountered, and recommend appropriate changes in design or construction procedures if conditions differ from those described herein.

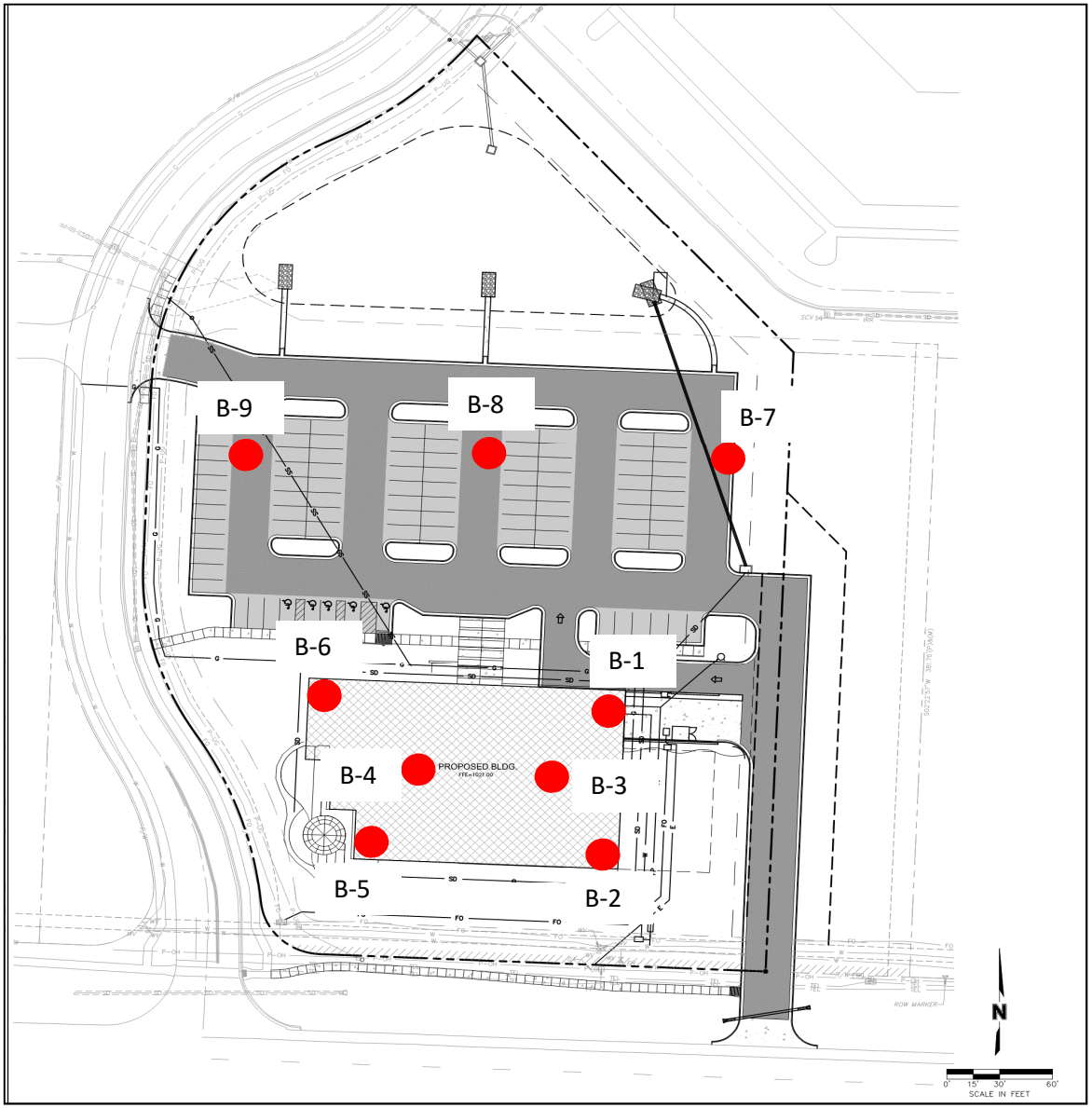
H.2. LIMITATIONS

The conclusions and recommendations presented in this report are based on the information available regarding the proposed construction, the results obtained from our borings, laboratory testing program, and our experience with similar projects. The borings represent a very small statistical sampling of subsurface soils and it is possible that conditions may be encountered during construction that are substantially different from those indicated by the borings. In these instances, adjustments to design and construction may be necessary.

This geotechnical report is based on the site plan and information provided to ***Olsson*** and our understanding of the project as noted in this report. Changes in the location or design of new structures and could significantly affect the conclusions and recommendations presented in this geotechnical report. ***Olsson*** should be contacted in the event of such changes to determine if the recommendations of this report remain appropriate for the revised site design.

This report was prepared under the direction and supervision of a Professional Engineer registered in the State of Missouri with the firm of **Olsson, Inc.** The conclusions and recommendations contained herein are based on generally accepted, professional, geotechnical engineering practices at the time of this report, within this geographic area. No warranty, express or implied, is intended or made. This report has been prepared for the exclusive use of **Mid-Continent Public Library** and their authorized representatives for specific application to the proposed project described herein.

APPENDIX A
Boring Location Plan



olsson

Boring Location Map

MCPL - East Lee's Summit
Lee's Summit, MO

Olsson Project No:	018-0330.182
Client:	MCPL
Last Revision Date:	1/2/2019
Engineer:	I. Dillon, PE

APPENDIX B
Symbols and Nomenclature
Boring Logs

SYMBOLS AND NOMENCLATURE

DRILLING NOTES

DRILLING AND SAMPLING SYMBOLS

SS:	Split-Spoon Sample (1.375" ID, 2.0" OD)	HSA:	Hollow Stem Auger	NE:	Not Encountered
U:	Thin-Walled Tube Sample (3.0" OD)	CFA:	Continuous Flight Auger	NP:	Not Performed
CS:	Continuous Sample	HA:	Hand Auger	NA:	Not Applicable
BS:	Bulk Sample	CPT:	Cone Penetration Test	% Rec:	Percent of Recovery
MC:	Modified California Sampler	WB:	Wash Bore	WD:	While Drilling
GB:	Grab Sample	FT:	Fish Tail Bit	IAD:	Immediately After Drilling
SPT:	Standard Penetration Test Blows per 6.0"	RB:	Rock Bit	AD:	After Drilling
				CI:	Cave-In

DRILLING PROCEDURES

Soil samples designated as "U" samples on the boring logs were obtained in using Thin-Walled Tube Sampling techniques. Soil samples designated as "SS" samples were obtained during Penetration Test using a Split-Spoon Barrel sampler. The standard penetration resistance 'N' value is the number of blows of a 140 pound hammer falling 30 inches to drive the Split-Spoon sampler one foot. Soil samples designated as "MC" were obtained in using Thick-Walled, Ring-Lined, Split-Barrel Drive sampling techniques. Recovered samples were sealed in containers, labeled, and protected for transportation to the laboratory for testing.

WATER LEVEL MEASUREMENTS

Water levels indicated on the boring logs are levels measured in the borings at the times indicated. In relatively high permeable materials, the indicated levels may reflect the location of groundwater. In low permeability soils, the accurate determination of groundwater levels is not possible with only short-term observations.

SOIL PROPERTIES & DESCRIPTIONS

Descriptions of the soils encountered in the soil test borings were prepared using Visual-Manual Procedures for Descriptions and Identification of Soils.

PARTICLE SIZE

Boulders	12 in. +	Coarse Sand	4.75mm-2.0mm	Silt	0.075mm-0.005mm
Cobbles	12 in.-3 in.	Medium Sand	2.0mm-0.425mm	Clay	<0.005mm
Gravel	3 in.-4.75mm	Fine Sand	0.425mm-0.075mm		

COHESIVE SOILS

Consistency	Unconfined Compressive Strength (Qu) (tsf)
Very Soft	<0.25
Soft	0.25 – 0.5
Firm	0.5 – 1.0
Stiff	1.0 – 2.0
Very Stiff	2.0 – 4.0
Hard	> 4.0

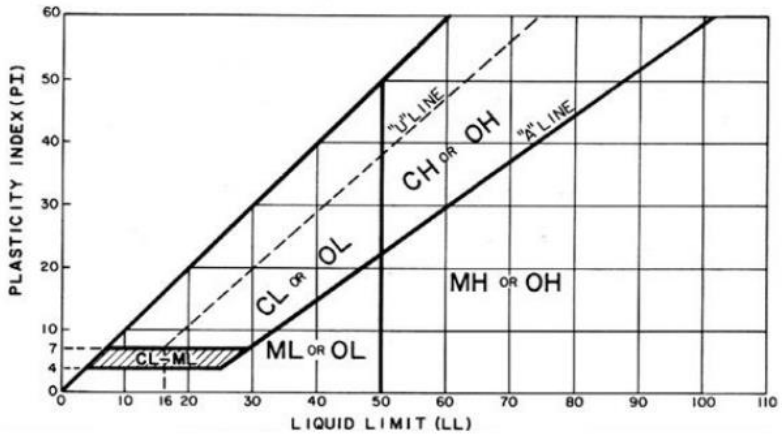
COHESIONLESS SOILS

Relative Density	'N' Value
Very Loose	0 – 3
Loose	4 – 9
Medium Dense	10 – 29
Dense	30 – 49
Very Dense	≥ 50

COMPONENT %

Description	Percent (%)
Trace	<5
Few	5 - 10
Little	15 - 25
Some	30 - 45
Mostly	50 - 100

PLASTICITY CHART



ROCK QUALITY DESIGNATION (RQD)

Description	RQD (%)
Very Poor	0 – 25
Poor	25 – 50
Fair	50 – 75
Good	75 – 90
Excellent	90 – 100

olsson

BOREHOLE REPORT NO. B-1

Sheet 1 of 1

PROJECT NAME	CLIENT
MCPL East Lee's Summit Branch	Mid-Continent Public Library
PROJECT NUMBER	**LOCATION**
018-0330	Lee's Summit, Missouri

Shelby Tube

APPROX. SURFACE ELEV. (ft): 1018.1

ELEVATION (ft)	MATERIAL DESCRIPTION	GRAPHIC LOG	DEPTH (ft)	SAMPLE TYPE NUMBER	CLASSIFICATION (USCS)	BLOWS/6" N-VALUE	UNC. STR. (tsf)	MOISTURE (%)	DRY DENSITY (pcf)	LL/PI (%)	ADDITIONAL DATA/ REMARKS
	ROOT ZONE *0.5'*		0								
	FAT CLAY *1.0'*										
	Brown			U 1	CH		1.0	30.9	90.5	63/41	
1015	*Firm, reddish gray with brown, very moist* *3.0'*										
	Red with gray, trace dark brown, very moist			U 2				31.2	92.8		
	5.0'		5								
	Reddish brown										
1010	*8.0'*										
	8.5'										
	Gray and red brown			U 3							
	Gray		10								
	11.0'										
	WEATHERED LIMESTONE *11.5'*										

REFUSAL AT 11.5 FEET

WATER LEVEL OBSERVATIONS	
WD	▽ 8.2 ft
IAD	▼ Not Encountered
AD	▼ Not Performed

OLSSON ASSOCIATES
1700 E. 123RD STREET
OLATHE, KANSAS 66061

STARTED:	12/7/18	FINISHED:	12/7/18
DRILL CO.: RC DRILLING		DRILL RIG:	RC-550
DRILLER:	LUKE	LOGGED BY:	ALAN
METHOD: CONTINUOUS FLIGHT AUGER			

olsson

BOREHOLE REPORT NO. B-2

Sheet 1 of 1

PROJECT NAME	CLIENT
MCPL East Lee's Summit Branch	Mid-Continent Public Library
PROJECT NUMBER	**LOCATION**
018-0330	Lee's Summit, Missouri

Shelby Tube ▮ Split Spoon ⊠

ELEVATION (ft)	MATERIAL DESCRIPTION	GRAPHIC LOG	DEPTH (ft)	SAMPLE TYPE NUMBER	CLASSIFICATION (USCS)	BLOWS/6" N-VALUE	UNC. STR. (tsf)	MOISTURE (%)	DRY DENSITY (pcf)	LL/PI (%)	ADDITIONAL DATA/ REMARKS
	APPROX. SURFACE ELEV. (ft): 1020.5		0								
1020	***ROOT ZONE*** 0.5'										
	FAT CLAY 1.0'										
	Brown			U 1			1.3	30.1	90.9		
	Stiff, gray and red, with brown, very moist 3.0'										
	Gray and red			U 2							
	5.0'		5								
1015	*Reddish brown*										
	▽ 8.5'										
	Stiff, red with gray, trace dark brown 10.0'		10	SS 3		4-4-6 N=10		26.8			
1010	***WEATHERED SHALE***										
	Light brown, clayey 12.5'										
	WEATHERED LIMESTONE 13.0'										

REFUSAL AT 13.0 FEET

WATER LEVEL OBSERVATIONS	
WD	▽ 8.5 ft
IAD	▼ Not Encountered
AD	▼ Not Performed

OLSSON ASSOCIATES
1700 E. 123RD STREET
OLATHE, KANSAS 66061

STARTED:	12/7/18	FINISHED:	12/7/18
DRILL CO.: RC DRILLING		DRILL RIG:	RC-550
DRILLER:	LUKE	LOGGED BY:	ALAN
METHOD: CONTINUOUS FLIGHT AUGER			

BOREHOLE REPORT NO. B-3

Sheet 1 of 1

PROJECT NAME	CLIENT
MCPL East Lee's Summit Branch	Mid-Continent Public Library
PROJECT NUMBER	**LOCATION**
018-0330	Lee's Summit, Missouri

Shelby Tube

APPROX. SURFACE ELEV. (ft): 1019.9

ELEVATION (ft)	MATERIAL DESCRIPTION	GRAPHIC LOG	DEPTH (ft)	SAMPLE TYPE NUMBER	CLASSIFICATION (USCS)	BLOWS/6" N-VALUE	UNC. STR. (tsf)	MOISTURE (%)	DRY DENSITY (pcf)	LL/PI (%)	ADDITIONAL DATA/ REMARKS
	FAT CLAY		0								
	Brown — ***1.0'***										
	Stiff, reddish gray with reddish brown			U 1	CH		1.7	29.4	92.5	57/34	
				U 2				28.7	93.4		
1015			5								
	8.0'										
	Light brown, shaley — ***8.9'***			U 3			2.4	28.3	95.7		
1010	*Very stiff, reddish brown to light brown*		10								
	12.5'										
	WEATHERED LIMESTONE — ***13.0'***										

REFUSAL AT 13.0 FEET

WATER LEVEL OBSERVATIONS	
WD	▽ Not Encountered
IAD	▼ Not Encountered
AD	▼ Not Performed

OLSSON ASSOCIATES
1700 E. 123RD STREET
OLATHE, KANSAS 66061

STARTED:	12/7/18	FINISHED:	12/7/18
DRILL CO.:	RC DRILLING	DRILL RIG:	RC-550
DRILLER:	LUKE	LOGGED BY:	ALAN
METHOD: CONTINUOUS FLIGHT AUGER			

BOREHOLE REPORT NO. B-4

Sheet 1 of 1

PROJECT NAME	CLIENT
MCPL East Lee's Summit Branch	Mid-Continent Public Library
PROJECT NUMBER	**LOCATION**
018-0330	Lee's Summit, Missouri

Split Spoon

APPROX. SURFACE ELEV. (ft): 1020.2

ELEVATION (ft)	MATERIAL DESCRIPTION	GRAPHIC LOG	DEPTH (ft)	SAMPLE TYPE NUMBER	CLASSIFICATION (USCS)	BLOWS/6" N-VALUE	UNC. STR. (tsf)	MOISTURE (%)	DRY DENSITY (pcf)	LL/PI (%)	ADDITIONAL DATA/ REMARKS
1020	***ROOT ZONE*** *0.5'*		0								
	FAT CLAY *1.0'*										
	Brown			SS 1		4-6-6 N=12		29.2			
	Stiff, reddish brown with gray										
	3.5'										
	Stiff, gray with reddish brown			SS 2		3-6-6 N=12		28.6			
1015	*5.0'*		5								
	Reddish brown										
	8.5'										
	Stiff, reddish brown with dark brown, very moist			SS 3		3-5-5 N=10		30.5			
1010	*10.0'*		10								
	Light brown, shaley										
	13.0'										
	WEATHERED LIMESTONE *13.7'*										

REFUSAL AT 13.7 FEET

WATER LEVEL OBSERVATIONS	
WD	▽ Not Encountered
IAD	▼ Not Encountered
AD	▼ Not Performed

OLSSON ASSOCIATES
1700 E. 123RD STREET
OLATHE, KANSAS 66061

STARTED:	12/7/18	FINISHED:	12/7/18
DRILL CO.:	RC DRILLING	DRILL RIG:	RC-550
DRILLER:	LUKE	LOGGED BY:	ALAN
METHOD: CONTINUOUS FLIGHT AUGER			

BOREHOLE REPORT NO. B-5

Sheet 1 of 1

PROJECT NAME: MCPL East Lee's Summit Branch	CLIENT: Mid-Continent Public Library
PROJECT NUMBER: 018-0330	LOCATION: Lee's Summit, Missouri

Shelby Tube

APPROX. SURFACE ELEV. (ft): 1022.8

ELEVATION (ft)	MATERIAL DESCRIPTION	GRAPHIC LOG	DEPTH (ft)	SAMPLE TYPE NUMBER	CLASSIFICATION (USCS)	BLOWS/6" N-VALUE	UNC. STR. (tsf)	MOISTURE (%)	DRY DENSITY (pcf)	LL/PI (%)	ADDITIONAL DATA/ REMARKS
	FAT CLAY		0								
	Brown — ***1.0'***										
1020	*Firm to stiff, reddish brown with gray, with grayish brown*			U 1			0.9	30.8	91.1		
				U 2			1.6	26.9	96.9		
			5								
1015	***8.0'***										
	Firm, light brown, trace gray, shaley			U 3			0.8	27.6	97.7		
			10								
1010	***13.0'***										
	WEATHERED SHALE			U 4				23.7			
	Gray, with red, sandy — ***14.5'***										
	WEATHERED LIMESTONE — ***15.3'***		15								

REFUSAL AT 15.3 FEET

WATER LEVEL OBSERVATIONS	
WD	▽ Not Encountered
IAD	▼ Not Encountered
AD	▼ Not Performed

OLSSON ASSOCIATES
1700 E. 123RD STREET
OLATHE, KANSAS 66061

STARTED:	12/6/18	FINISHED:	12/6/18
DRILL CO.:	RC DRILLING	DRILL RIG:	RC-550
DRILLER:	LUKE	LOGGED BY:	ALAN
METHOD: CONTINUOUS FLIGHT AUGER			

BOREHOLE REPORT NO. B-6

Sheet 1 of 1

PROJECT NAME	CLIENT
MCPL East Lee's Summit Branch	Mid-Continent Public Library
PROJECT NUMBER	**LOCATION**
018-0330	Lee's Summit, Missouri

Shelby Tube

ELEVATION (ft)	MATERIAL DESCRIPTION	GRAPHIC LOG	DEPTH (ft)	SAMPLE TYPE NUMBER	CLASSIFICATION (USCS)	BLOWS/6" N-VALUE	UNC. STR. (tsf)	MOISTURE (%)	DRY DENSITY (pcf)	LL/PI (%)	ADDITIONAL DATA/ REMARKS
1020	**APPROX. SURFACE ELEV. (ft):** 1020.1		0								
	ROOT ZONE 0.5'										
	FAT CLAY 1.0'										
	Brown			U 1			1.1	30.3	91.7		
	Stiff, reddish brown with gray 3.0'										
	Stiff, red with gray, trace dark brown			U 2			1.4	26.9	96.8		
1015	5.0'		5								
	Reddish gray to light brown										
				U 3			0.7	30.3	95.1		
1010			10								
	12.0'										
	WEATHERED SHALE										
	Light brown with gray, trace red 13.5'										
	WEATHERED LIMESTONE			U 4				21.7	102.5		
	15.0'		15								

REFUSAL AT 15.0 FEET

WATER LEVEL OBSERVATIONS	
WD	▽ Not Encountered
IAD	▼ Not Encountered
AD	▼ Not Performed

OLSSON ASSOCIATES
1700 E. 123RD STREET
OLATHE, KANSAS 66061

STARTED:	12/6/18	FINISHED:	12/6/18
DRILL CO.:	RC DRILLING	DRILL RIG:	RC-550
DRILLER:	LUKE	LOGGED BY:	ALAN
METHOD: CONTINUOUS FLIGHT AUGER			

BOREHOLE REPORT NO. B-7

Sheet 1 of 1

PROJECT NAME	CLIENT
MCPL East Lee's Summit Branch	Mid-Continent Public Library
PROJECT NUMBER	**LOCATION**
018-0330	Lee's Summit, Missouri

Shelby Tube

APPROX. SURFACE ELEV. (ft): 1014.4

ELEVATION (ft)	MATERIAL DESCRIPTION	GRAPHIC LOG	DEPTH (ft)	SAMPLE TYPE NUMBER	CLASSIFICATION (USCS)	BLOWS/6" N-VALUE	UNC. STR. (tsf)	MOISTURE (%)	DRY DENSITY (pcf)	LL/PI (%)	ADDITIONAL DATA/ REMARKS
	ROOT ZONE *0.5'*		0								
	FAT CLAY *1.0'*										
	Brown			U 1	CH		0.6	29.7	91.7	61/39	
	Firm to stiff, gray with reddish brown and brown										
1010				U 2			1.0	31.8	92.5		
			5								
	▽										
1005				U 3			0.6	35.1	87.4		
	10.0'		10								
	Reddish brown to light brown, shaley										
	13.0'										
	WEATHERED LIMESTONE *14.0'*										

REFUSAL AT 14.0 FEET

WATER LEVEL OBSERVATIONS	
WD	▽ 8.0 ft
IAD	▼ Not Encountered
AD	▼ Not Performed

OLSSON ASSOCIATES
1700 E. 123RD STREET
OLATHE, KANSAS 66061

STARTED:	12/6/18	FINISHED:	12/6/18
DRILL CO.: RC DRILLING		DRILL RIG:	RC-550
DRILLER:	LUKE	LOGGED BY:	ALAN
METHOD: CONTINUOUS FLIGHT AUGER			

BOREHOLE REPORT NO. B-8

Sheet 1 of 1

PROJECT NAME	CLIENT
MCPL East Lee's Summit Branch	Mid-Continent Public Library
PROJECT NUMBER	**LOCATION**
018-0330	Lee's Summit, Missouri

Shelby Tube

APPROX. SURFACE ELEV. (ft): 1017.2

ELEVATION (ft)	MATERIAL DESCRIPTION	GRAPHIC LOG	DEPTH (ft)	SAMPLE TYPE NUMBER	CLASSIFICATION (USCS)	BLOWS/6" N-VALUE	UNC. STR. (tsf)	MOISTURE (%)	DRY DENSITY (pcf)	LL/PI (%)	ADDITIONAL DATA/ REMARKS
	ROOT ZONE *0.5'*		0								
	FAT CLAY *1.0'*										
	Brown										
1015	*Stiff, gray with reddish brown, with dark brown, very moist*			U 1			1.0	30.3	91.9		
				U 2			1.7	27.4	95.7		
	5.0'		5								
	Reddish brown										
1010	*8.0'*										
	Stiff, green olive gray, with red, wet			U 3			0.4	31.6	92.8		
	10.0'		10								
	Reddish gray to light brown, shaley										
1005	*12.0'*										
	WEATHERED LIMESTONE *12.5'*										

REFUSAL AT 12.5 FEET

WATER LEVEL OBSERVATIONS	
WD	▽ Not Encountered
IAD	▼ Not Encountered
AD	▼ Not Performed

OLSSON ASSOCIATES
1700 E. 123RD STREET
OLATHE, KANSAS 66061

STARTED:	12/6/18	FINISHED:	12/6/18
DRILL CO.:	RC DRILLING	DRILL RIG:	RC-550
DRILLER:	LUKE	LOGGED BY:	ALAN
METHOD: CONTINUOUS FLIGHT AUGER			

BOREHOLE REPORT NO. B-9

Sheet 1 of 1

PROJECT NAME	CLIENT
MCPL East Lee's Summit Branch	Mid-Continent Public Library
PROJECT NUMBER	**LOCATION**
018-0330	Lee's Summit, Missouri

■ Shelby Tube

APPROX. SURFACE ELEV. (ft): 1017.0

ELEVATION (ft)	MATERIAL DESCRIPTION	GRAPHIC LOG	DEPTH (ft)	SAMPLE TYPE NUMBER	CLASSIFICATION (USCS)	BLOWS/6" N-VALUE	UNC. STR. (tsf)	MOISTURE (%)	DRY DENSITY (pcf)	LL/PI (%)	ADDITIONAL DATA/ REMARKS
	ROOT ZONE *0.5'*		0								
	FAT CLAY *1.0'*										
	Brown to reddish brown										
1015	*Gray and red*			U 1							
	3.0'										
	Stiff, red, trace gray			U 2			1.7	28.9	96.6		
	5.0'		5								
	Reddish brown to light brown, shaley										
1010	*8.0'*										
	Light brown with gray, shaley			U 3			1.2	30.3	96.3		
	11.2'		10								
	WEATHERED LIMESTONE										
1005	*12.0'*										

REFUSAL AT 12.0 FEET

WATER LEVEL OBSERVATIONS	
WD	▽ Not Encountered
IAD	▼ Not Encountered
AD	▼ Not Performed

OLSSON ASSOCIATES
1700 E. 123RD STREET
OLATHE, KANSAS 66061

STARTED:	12/7/18	FINISHED:	12/7/18
DRILL CO.:	RC DRILLING	DRILL RIG:	RC-550
DRILLER:	LUKE	LOGGED BY:	ALAN
METHOD: CONTINUOUS FLIGHT AUGER			