GEOTECHNICAL REPORT

Scenic Regional Library Addition
912 South Highway 47
Warrenton, Missouri

Project No. 16-6413

November 2016

Presented to:

Scenic Regional Library

November 28, 2016
Date

Karen L. Albert, P.E. #2006019581
State of Missouri
Registered Professional Engineer for Cochran

COCHRAN

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November 28, 2016

Mr. Steve Campbell, Director
Scenic Regional Library
304 Hawthorne Drive
Union, Missouri 63084

RE: Geotechnical Investigation
Scenic Regional Library Addition
912 South Highway 47
Warrenton, Missouri
Project No. 16-6413

Dear Mr. Campbell:

Attached is our Geotechnical Report presenting the results of a subsurface exploration conducted for the above-referenced project. This exploration was conducted in general accordance with our proposal. The Geotechnical Report includes our understanding of the project, observed site conditions, conclusions and/or recommendations, and support data as listed in the Table of Contents.

We appreciate the opportunity to be of service to you on this project. We welcome the opportunity to provide other services during the course of the project, should they be necessary. If you have any questions or comments, please feel free to contact us.

Sincerely,

Karen L. Albert, P.E.
Director of Geotechnical Services
Cochran

Copies submitted: 3 Bound Reports, 1 Electronic

TABLE OF CONTENTS

1. EXECUTIVE SUMMARY

The following is a brief summary of the exploration including our findings, conclusions, and recommendations. The summary omits a number of details, any one of which could be crucial to the proper application of this report. Any party who relies on this report must refer to subsequent sections within the report for a more detailed discussion.

A. The project consists of an approximately 3,000 square foot, one-story, slab-on-grade addition with associated parking and driveways. The addition will be constructed on the north side of the existing facility.

B. The soil stratigraphy at the site generally consists of very soft to soft, low plastic silty clay to stiff to very stiff, high plastic clay to boring termination depth within the proposed building footprint. Fill consisting of low to high plastic clay was encountered in Borings B-1 and B-3 to a depth of 3 feet (EL 873). The very soft to soft, low plastic clay was encountered in Borings B-1, B-2, and B-4 to depths of 6 to 8 feet (EL 870.5 to 868) within the proposed building addition. Groundwater was encountered in four of the six borings while drilling at depths of 3 to 7 feet.

C. Uncontrolled fill is present in Borings B-1 and B-3 within the proposed building footprint to a depth of 3 feet (EL 873). The fill is considered to be compressible and should be removed within the footprint of the building and backfilled with compacted engineered fill.

D. Very soft to soft, very moist, low plastic, silty clay was encountered in Borings B-1, B-2, and B-4 to depths of 6 to 8 feet (EL 870.5 to EL 868) within the proposed building addition. The typical approach for near-surface very soft to soft soils beneath load bearing elements would be over excavation to the underlying stiffer soils. In order to reduce the depth of the over excavation under load bearing elements, the existing soil should be removed to a minimum depth of 3 feet beneath the bearing level of all foundations. The overexcavation should extend at least 2 feet beyond the outside edge of the footings to facilitate uniform compaction of the 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 1-inch minus crushed limestone with an interbedded geogrid-reinforcing layer at a depth of approximately 1.5 feet. A geotextile is to be placed at the base of the over-excavation to help provide a stable base/platform for the engineered fill. With this approach the proposed addition may be supported on strip and spread footings proportioned for a net allowable bearing pressure of 1,250 pounds per square foot (psf), provided the footing bear on the engineered fill. In addition, with this approach, other geotechnical considerations to consider are:

    1. Loss of lateral support (leading to possible downward deformation) and the effects of compaction-induced vibration on the soils underlying the existing structure would necessitate underpinning the existing structure to preclude or minimize damage to the existing structure during construction.

    2. Due to the high groundwater table at the site, water pumping into the overexcavation could lead to difficulty in achieving the necessary compaction required for the engineered fill.

    3. Cost of underpinning the existing facility.

    4. Even with this approach, total settlements of up to 1.5 inches could occur below the footings for the proposed addition. Therefore, the system would need to be designed to handle movement between the addition and existing structure if up to 1.5 inches of settlement can be tolerated.

E. Alternatively, the addition may be supported on deep foundations. Deep foundations alternative include drilled piers, geopiers and helical foundation piers.

    1. Geopiers utilized for foundation support may not be acceptable due to the vibration caused during installation which could adversely affect the existing structure. Additional geopiers are not easily constructed below the groundwater table.

    2. Drilled piers may be a more viable deep foundation option than geopiers. However, the presence of shallow groundwater will complicate drilled pier construction.

3. Helical piers such as those designed by Atlas Systems, Helitech or AB Chance would be viable deep foundation option. Helical pier option would avoid the groundwater issues. With the use of helical piers, the helical piers can be used to support the foundations and a structural floor slab. Helical pier systems are proprietary and a designer experienced in such a method should be consulted.

F. Care must be exercised to maintain the integrity of the subgrade during grading, as the soils are susceptible to disturbance.

2. INTRODUCTION

Cochran has completed the requested geotechnical service for the proposed 3,000 square foot addition to the Scenic Regional Library located at 912 South Highway 47 in Warrenton, Missouri. The proposed one-story, slab-on-grade addition will be constructed on the north side of the existing facility. The services documented in this report were provided in accordance with the terms, conditions and scope of services described in Cochran's proposal. This report was prepared for the purpose of describing the subsurface conditions at the site, analyze and evaluate the test data, and develop recommendations for geotechnical aspects of the design and construction of the project. Our services consisted of site reconnaissance, drilling six borings, laboratory testing, engineering analyses, report preparation and submittal of this report.

3. PROJECT AND SITE DESCRIPTION

The project will include the construction of an approximately 3,000-square foot, one-story, slab-on-grade addition with associated driveways and parking. The addition will be constructed on the north side of the existing facility. The site is located at 912 South Highway 47 in Warrenton, Missouri. We understand the finished floor for the proposed addition will match the finished floor elevation (EL 876.79) of the existing structure. Structural loads were not provided.

Currently the site is generally asphalt covered within the footprint of the proposed addition. Based on a topographic survey provided to Cochran by the client, the elevations at the site within the proposed building addition footprint ranges from approximately El 875.5 to EL 876.5. The finished floor elevation for the proposed addition will be El 876.79. Fills up to a foot are anticipated within the building footprint. The site location is shown on the United States Geological Survey (USGS) map included as Plate 1.

4. FIELD EXPLORATION AND LABORATORY TESTING

A. Field Exploration. The subsurface conditions at the site were explored by drilling six borings, four (4) within the building addition footprint (Borings B-1 through B-4) and two (2) within the proposed parking area (Borings B-5 and B-6). The boring locations were located in the field by measuring distances from existing site features. The boring locations are presented on Plate 2. The elevations at the boring locations were interpolated from a topographic survey conducted by Cochran. The locations and elevations should be considered accurate only to the degree implied by the methods employed.

Borings B-1 through B-6 were drilled to predetermined boring depths of 10 and 20 feet without encountering auger refusal. Standard Penetration Tests (SPTs) were generally obtained at 2.5-foot and 5-foot intervals in the overburden soils using an automatic hammer. Undisturbed Shelby tube samples were collected at select locations. The samples were sealed, secured, and transported to our laboratory for observation and testing. The sampling intervals, soil descriptions, standard penetration data and other pertinent field information are indicated on the boring logs, which are presented in Appendix A. An explanation of the terms and symbols used on the boring logs is also provided in Appendix A.

B. Laboratory Testing. In the laboratory, the samples were observed and described by an engineer using manual-visual methods. Moisture contents were determined for cohesive soil samples. Atterburg limits were determined for select soil samples. Unconfined compression tests were conducted on the undisturbed Shelby tube samples. The results of the laboratory tests are presented on the boring logs.

5. SUBSURFACE CONDITIONS

The general description of the soils encountered during the subsurface exploration is presented herein. The stratification lines on the boring logs are approximate and the transition between the materials may be gradual rather than distinct.

A. Stratigraphy. The soil stratigraphy at the site generally consists of very soft to soft, low plastic silty clay to stiff to very stiff, high plastic clay to boring termination depth within the proposed building footprint. The very soft to soft, low plastic clay was encountered in Borings B-1, B-2, and B-4 to depths of 6 to 8 feet (EL 870.5 to 868) within the proposed building addition.

Fill consisting of low to high plastic clay was encountered in Borings B-1 and B-3 to a depth of 3 feet (EL 873). The fill appears to be uncontrolled and is considered compressible.

B. Groundwater. Groundwater was encountered in B-1 , B-2, B-4 and B-5 at depths of 3 to 7 feet during the subsurface exploration. It should be understood that due to the low permeability of the cohesive soils encountered in the borings, groundwater levels (if any) shown on the boring logs may not have stabilized prior to backfilling. Groundwater may fluctuate over time due to seasonal and climatic variations. Therefore the observed or lack of groundwater levels may not represent present or future levels.

6. GEOTECHNICAL CONSIDERATIONS AND RECOMMENDATIONS

As previously indicated, very soft to soft, very moist, low plastic, silty clay was encountered in Borings B-1, B-2, and B-4 to depths of 6 to 8 feet (EL 870.5 to EL 868) within the proposed building addition. The typical approach for near-surface very soft to soft soils beneath load bearing elements would be over excavation to the underlying stiffer soils. If the very soft to soft soils were to be left in place beneath load bearing elements, excessive differential and/or total settlements could occur.

In order to reduce the depth of the over excavation under load bearing elements, the existing soil should be removed to a minimum depth of 3 feet beneath the bearing level of all foundations. The overexcavation should extend at least 2 feet beyond the outside edge of the footings to facilitate uniform compaction of the 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 1-inch minus crushed limestone with an interbedded geogrid-reinforcing layer at a depth of approximately 1.5 feet . A geotextile is to be placed at the base of the over-excavation to help provide a stable base/platform for the engineered fill (Plate 3). With this approach the proposed addition may be supported on strip and spread footings proportioned for a net allowable bearing pressure of 1,250 pounds per square foot (psf), provided the footing bear on the engineered fill. In addition, with this approach other geotechnical considerations to consider are:

- Loss of lateral support (leading to possible downward deformation) and the effects of compaction-induced vibration on the soils underlying the existing structure would necessitate underpinning the existing structure to preclude or minimum damage to the existing structure during construction.
- Due to the high groundwater table at the site, water pumping into the overexcavation could lead to difficulty in achieving the necessary compaction required for the engineered fill.
- Cost of underpinning the existing facility.
- Even with this approach, total settlements of up to 1.5 to 2 inches could occur for in the proposed addition. Therefore, the system would need to be designed to handle movement between the addition and existing structure if up to 1.5 to 2 inches of settlement can be tolerated.

Alternatively, the addition may be supported on deep foundations. Deep foundation alternatives include drilled piers, geopiers and helical foundation piers. Geopiers utilized for foundation support may not be acceptable due to the vibration caused during installation, which could adversely affect nearby structures: additionally geopiers are not easily constructed below the groundwater table.

Drilled piers may be a more viable deep foundation option. However, the presence of shallow groundwater will complicate drilled pier construction. Helical foundation piers such as those designed by Atlas Systems, Helitech or AB Chance can be considered to avoid groundwater issues. With the use of helical piers the helical piers can be used to support the foundations and a structural floor slab. Helical piers systems are proprietary and a designer experienced in such a method should be consulted.

The soils at the site are susceptible to disturbance during grading operations (i.e, pumping and/or rutting). Care must be exercised to maintain the integrity of the subgrade when preparing the site for the placement of fill, making excavations, and other earth-related construction activities. The weak, spongy, and/or wet soils may be present in some areas, and it may be not be possible to perform conventional filling and compacting operations without disturbing the underlying soils. If sensitive soils are present, a special approach to grading may need to be adopted. The special approach to grading includes excavating with a trackhoe or wide-tracked excavator. Care should be exercised to maintain the integrity of the subgrade prior to the placement of fill and building construction.

Uncontrolled fill is present in Borings B-1, B-5 and B-6 to depths of approximately 1 to 2 feet below the existing grade. The fill is considered to be compressible and should be removed within the footprint of the building and backfilled with compacted engineered fill.

A. Site Preparation. All vegetation/organic materials and pavement must be stripped where encountered. The organic material can be stockpiled on-site for later use in landscaped areas or disposed of off-site in a legal manner. In all areas, the resulting exposed subgrade should be proofrolled, and any soft soil or yielding areas should be over excavated and backfilled with new compacted fill or well-graded crushed rock.

   Existing, urban fill materials, where encountered, should be entirely removed from within and to a 5 foot horizontal distance beyond the proposed building addition footprint. In planned pavement areas, urban fill, if encountered, should be removed to a depth of 2 feet below the subgrade elevation. In all areas, the resulting exposed subgrade should be proofrolled, and any soft soil or yielding areas should be over excavated and backfilled with new compacted fill or well-graded crushed rock. Topsoil, if any, may be stockpiled for later use during landscaping or removed from the site.

B. Fill Materials. Prior to placement of the fill, the fill material is to be approved by a representative of Cochran. In general, fill materials should consist of low plasticity, (liquid limit less than 45 percent and a plasticity index less than 20) cohesive soils or granular materials. Acceptable non-organic fill soils include materials designated CL, ML, CL-ML, SP, SW, and GW by ASTM D 2487. Open-graded “clean” granular materials, in general, should not be used, as they tend to hold water, resulting in softening of the underlying cohesive soil subgrade.

C. Compaction. Fill or backfill must be placed in lifts of uniform thickness and compacted. The fill should be placed in 8-inch loose lifts. The engineered fill should be compacted to at least 95 percent of its standard Proctor (ASTM 698) maximum dry density. Soil fill should be placed at a moisture content that is plus or minus 2 percent of optimum moisture content. The soil fill may require aeration or wetting at the time of construction to achieve proper compaction. Deleterious material should not be included in fill, nor should the fill be placed on soft or frozen materials.

   Settlement of loosely backfilled utility trenches can result in unsightly depressions and localized pavement failures. The magnitude of settlement can be significantly reduced by mechanically compacting the trench backfill to the minimum specified compaction levels given in the Compaction Section.

   Observation of the type of soil or granular material to be placed as fill, placement of the compacted fill and field density testing should be performed by a qualified technician on each lift to verify the compaction requirements are met in the field and to insure that high plastic or highly compressible soils are not in the fill within the building pad area.

D. Site Drainage and Grading. During construction, proper drainage should be provided to protect the foundation excavations, floor slab and pavement subgrades from the detrimental effects of weather conditions during construction. Finished subgrades and foundation excavations should be kept free of standing water at all times.

   Positive site drainage should be provided to reduce surface water infiltration around the perimeter of the building and beneath the floor slab. Grades must be sloped away from the structures and roof and surface drainage collected and discharged in such a way that water is not permitted to infiltrate the foundation backfill. Drain and utility pipes beneath the floor should have tight joints to prevent leakage. Utility trenches beneath the floor slab and pavement areas should be carefully backfilled with compacted low plastic soil or minus gradation crushed rock. “Clean” rock backfill can be a possible pathway for moisture to the potentially expansive high plastic clay.

Large trees and shrubs should not be planted next to exterior footings as they may cause drying and shrinkage of the foundation soils and, with the passage of time, potentially detrimental settlement of the building floor slab and foundation may occur. A minimum distance of 20 feet or a distance equal to 1.5 times their expected mature height is suggested.

E. Construction Dewatering. Short–term ground water readings made during the field exploration program indicated ground water was encountered in Borings B-1, B-2, B-4 and B-5 at depths of approximately 3 to 7 feet below the existing ground surface. It is likely water will be encountered in the footing excavations. In addition, it should be realized that an increase in local precipitation will result in a rising ground water level.

If groundwater seepage is experienced in shallow excavations, it is expected that it can be handled by pumping from sumps, or using perimeter trenches to collect and discharge the water away from the work area.

7. SHALLOW FOUNDATIONS

Shallow foundations bearing on an engineered fill pad as previously indicated above are appropriate for support of the proposed building. Strip and spread footings may be proportioned for a net allowable bearing pressure of 1,250 pounds per square foot (psf). Even with this approach, total settlements of up to 1.5 inches could occur below the footings for the proposed addition. Therefore, the system would need to be designed to handle movement between the addition and existing structure if up to 1.5 inches of settlement can be tolerated

The minimum lateral dimensions for strip and spread footings should be 24 and 30 inches, respectively. Exterior footings should be embedded 30 inches below the lowest adjacent exterior grade for frost protection purposes. Due to the periodic severity of winters in this area, footings in poorly heated or unheated areas of the building should also be placed at least 30 inches below the adjacent exterior grade. All footings must be protected from the effects of frost when construction is carried out during winter months.

Special attention must be given to designing the foundations immediately adjacent to the existing structure. Foundations for the proposed addition should bear at the same elevation as those of the existing structure. Construction joints should be provided between the existing structure and the proposed addition to accommodate differential movement.

As previously indicated, loss of lateral support (leading to possible downward deformation) and the effects of compaction-induced vibration on the soils underlying the existing structure during the construction of the engineered pad and depth of overexcavation that would be required for the engineered pad would necessitate underpinning the existing structure to preclude or minimize damage to the existing structure during construction. It is the contractor's responsibility to protect the integrity of the existing footings.

The bearing conditions at the base of the footing excavation should be observed by Cochran personnel. The base of all foundation excavations should be free of water and loose soil prior to placing concrete.

8. DEEP FOUNDATIONS

Alternatively, the addition may be supported on deep foundations such as helical piers. Helical piers systems are proprietary and a designer experienced in such a method should be consulted. Helical foundation piers such as those designed by Atlas Systems, Helitech or AB Chance can be considered to support the addition and the proposed floor slab.

9. FLOOR SLABS

The floor slabs should be underlain by a minimum 4-inch layer of well-graded crushed rock to distribute concentrated loads and reduce potential capillary moisture transfer. The use of a plastic vapor barrier is left to the discretion of the architect. Careful attention to curing of the concrete slabs should be followed if a polyethylene moisture barrier is placed on top of the crushed stone and beneath the floor or excessive shrinkage cracking and "curling" may occur.

The floor slabs should be designed to allow for differential movements, which normally occur between the floor slab, columns and foundation walls. Joints should be placed in the floor slab in accordance with the applicable American Concrete Institute (ACI) standards and be located in such a manner that each floor slab section is

rectangular. Such joints permit slight movements of the independent elements and help prevent random cracking that might otherwise be caused by restraint of shrinkage, slight rotations, heave, or settlement.

10. SEISMICITY

The International Building Code (IBC) requires the structural design of the building to be in accordance with the requirements of Section 1613.1.1 of the code. A site classification is required for seismic design. The classification is a function of the soil profile representing the average properties comprising the top 100 feet of the site. From the results of the test borings from this study and regional geological information, it is our opinion that the soil profile is classified as Site Class D.

11. PAVEMENT CONSIDERATIONS

A pavement analysis and design is beyond the scope of our services. The thickness of the pavement section used is directly related to the service life and the initial costs. The owner's desire may range from a low cost pavement having a short life to a more costly pavement with a longer expected life and less maintenance.

There are certain aspects in the design and construction of pavements that should be considered. The subgrade should be shaped to prevent ponding if pavements are not constructed immediately after grading. Minor ponding, even short durations, can cause softening of a soil subgrade to a significant depth. The pavement subgrades may be subjected to construction traffic and exposure to weather for an extended period. Therefore, 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 pavement. Soft areas should be selectively undercut and backfilled with properly compacted cohesive soil of the same type present in the subgrade, possibly combined with a geotextile or geogrid. Proofroll passes should be limited, particularly on silty subgrades to reduce the potential for pumping of moisture from deeper within the soil profile. The asphaltic concrete surface course should be checked during placement to verify density and total thickness.

12. RECOMMENDED CONSTRUCTION SERVICES

The conclusions and recommendations given in this report are based on interpretation of exploration data and Cochran's experience. The client must recognize variations may occur from conditions observed in the borings, particularly within existing fills or previously developed areas. The design recommendations are based on data from borings, sampling and related procedures. Actual subsurface conditions may vary from those encountered in the 5 borings. Therefore, design recommendations are subject to adjustment in the field, based on subsurface conditions encountered during construction.

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

A. Review grading and foundation plans to observe that recommendations given in this report have been correctly implemented.

B. Assess the suitability of potential fill materials, including both on-site and off-site sources (if applicable)

C. Monitor placement of structural fill and backfill.

D. Observe foundation excavations to verify that suitable bearing materials are present.

E. Observe floor slab subgrades to assess the impact of medium and high plastic clay soils and to recommend the extent of remedial measures.

F. Provide testing services during pavement construction.

Construction observation is intended to enhance compliance with project plans and specifications. It is not insurance, nor does it constitute a warranty or guarantee of any type. In all cases, contractors, etc., are solely responsible for the quality of their work and for adhering to plans and specifications.

13. LIMITATIONS OF REPORT

The recommendations provided herein are for the exclusive use of the client for specific application to the named project as described herein. They are not meant to supersede more stringent requirements of local ordinances. They are based on the subsurface information obtained at six specific borings within the project area, our understanding of the project and geotechnical engineering practice consistent with the standard of care. If this report is provided to prospective contractors, the client should make it clear that the information is provided for factual data only and not as a warranty of subsurface conditions included in this report.

This report does not reflect variations that may occur between borings, across the site, or due to the modifying effects of weather. The nature and extent of such variations may not become evident until, during or after construction. If variations appear, we should be immediately notified so that further evaluation and supplemental recommendations can be provided.

The scope of our services for this phase of the project did not include any environmental assessment or investigation for the presence or absence of wetlands or hazardous or toxic material in the soil, surface water, groundwater or air, on or below or around this site. Any statements in this report or on the soil logs regarding odors noted or unusual or suspicious items or conditions observed are strictly for the information of our client.

Cochran should be provided with a set of final development plans as soon as they are available for review to determine the applicability of our recommendations. Failure to provide these documents 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.

Cochran should be retained to perform construction observation and complete its geotechnical engineering service using the observational methods. Cochran cannot assume responsibility or liability for the adequacy of its recommendations when they are used in the field without Cochran being retained to observe construction.

ILLUSTRATIONS

VICINITY AND TOPOGRAPHIC MAP

SITE VICINITY MAP
NO SCALE

GENERAL NOTES / LEGEND

USGS TOPOGRAPHIC MAP
WARRENTON, MO 2015
20' CONTOURS
GOOGLE MAPS

VICINITY & TOPOGRAPHIC MAP

SCENIC REGIONAL LIBRARY - ADDITION

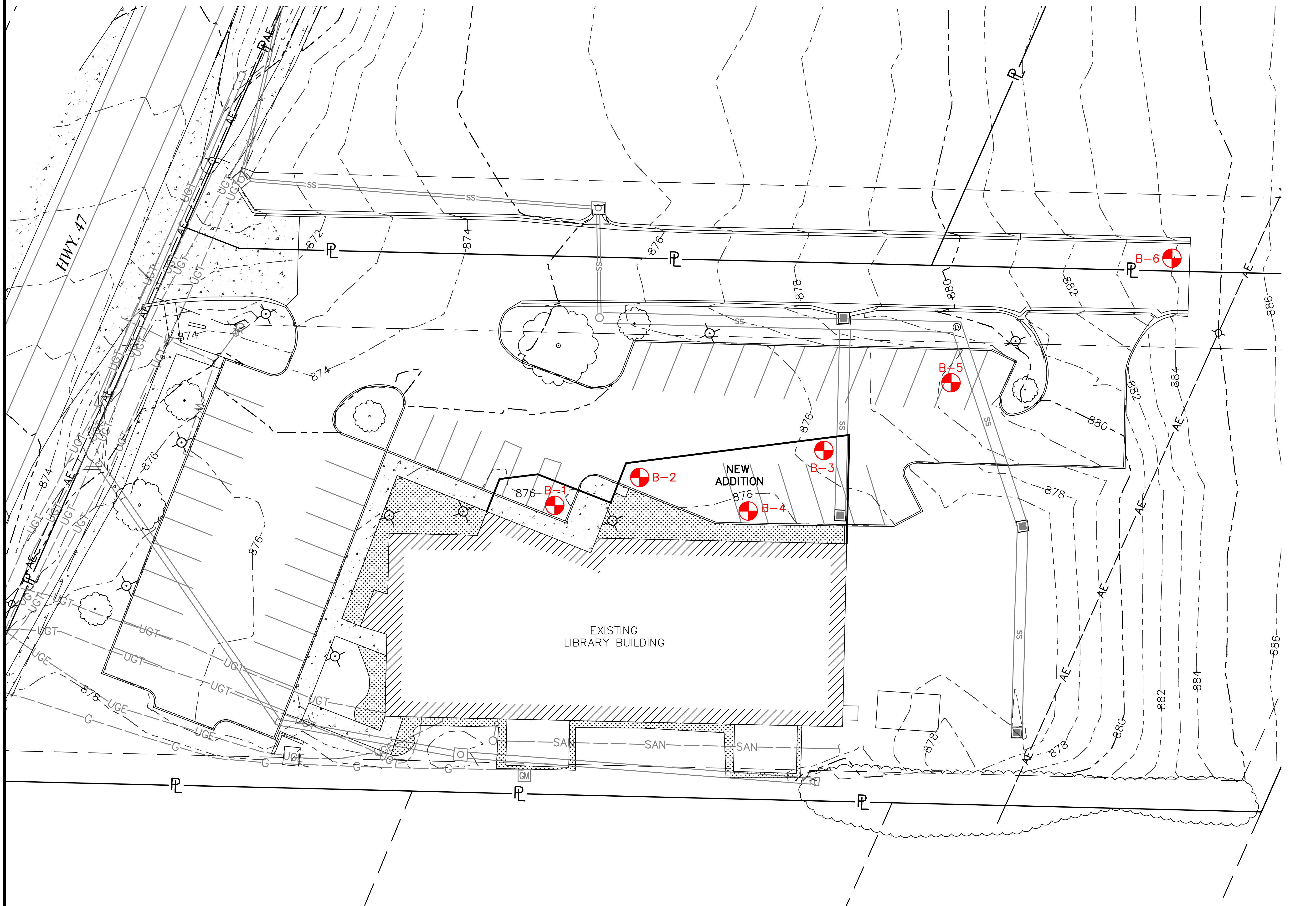
WARRENTON, MO

DWN. BY:	APP'D. BY:
JMM	KLA

DATE: AUG. 10, 2016
SCALE: 1"=2000'
PROJ. NO: 16-6413
PLATE: *1*

ILLUSTRATIONS

SITE AND BORING LOCATIONS



COCHRAN

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SITE PLAN & BORING LOCATIONS
SCENIC REGIONAL LIBRARY - ADDITION
WARRENTON, MO

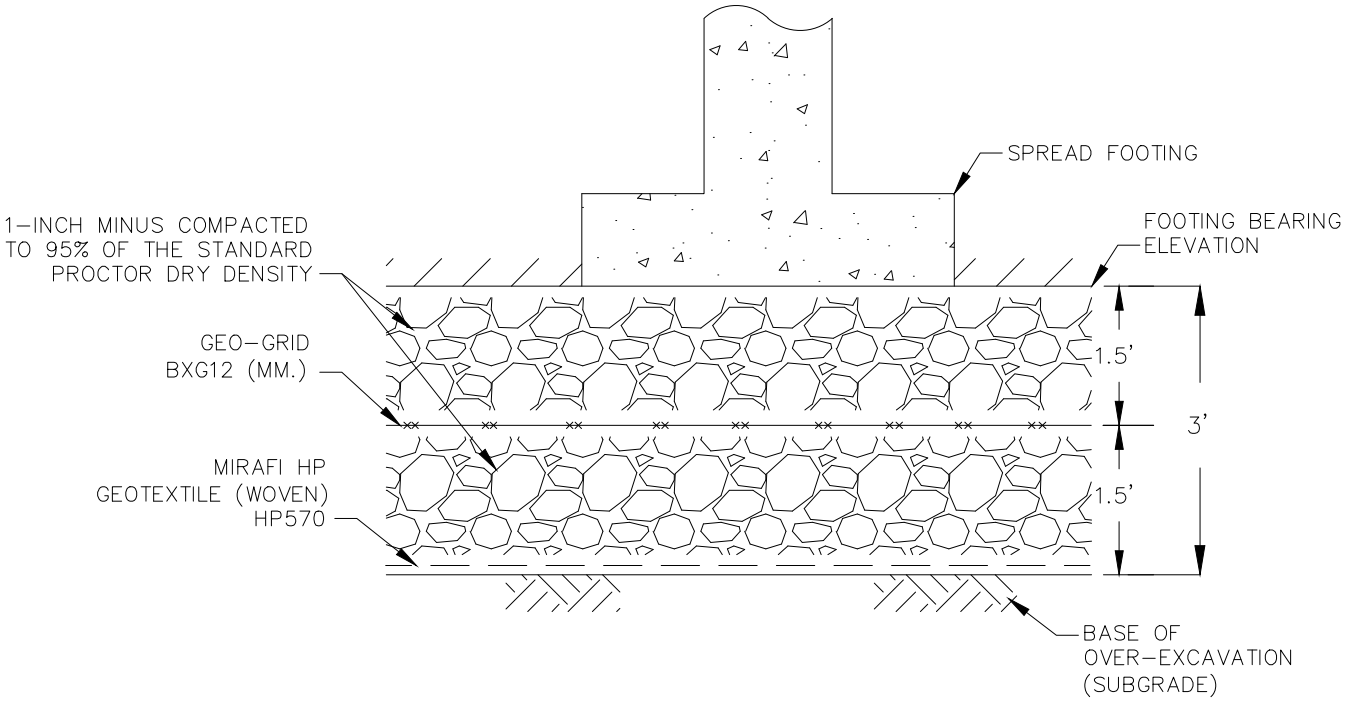
GENERAL NOTES

DWN. BY: JMM	APP'D. BY: KLA
DATE: AUG. 10, 2016	
SCALE: 1"=30'	
PROJ. NO: 16-6413	
PLATE: 2	

Drawing name: F:\16-6413 - Scenic Regional Library - Warrenton\geotech\AutoCAD Drawings\PLATE 2 - SITE & BORING LOCATIONS.dwg Tab: PLATE 1 Plotted on: Aug 10, 2016 - 10:58am Plotted by: jmeyer

ILLUSTRATIONS

FOUNDATIONS – REMEDIATION DETAIL



FOUNDATIONS – REMEDIATION DETAIL

N.T.S.

530A E. Independence Dr.
Union, Missouri 63084
636–584–0540 (tel.)
636–584–0512 (fax)
mail@cochranengineering.com

OCHRAN

: Civil Engineering
: Land Surveying
: Architecture
: Site Development
: General Consulting
: Master Planning

Two working days prior to the start of construction on this site, contractor shall call 1–800–DIG–RITE for utility location information.

All OSHA rules & regulations established for the type of construction involved in these plans shall be strictly followed (ie. Trenching, Blasting, etc.)

FOUNDATIONS - REMEDIATION DETAIL

SCENIC REGIONAL LIBRARY ADDITION

WARRENTON, MO

DATE:	REVISION:	DWN. BY:	APPD. BY:

DWN. BY: LMV
APPD. BY: KLA
DATE: SEPT. 23, 2016
SCALE: NOT TO SCALE
PROJ. NO: 16–6413
DWG. NO: 3

PLATE 3

APPENDIX A

DETAILED LOGS OF BORINGS B-1 THROUGH B-6
BORING LOG: LEGEND AND NOMENCLATURE

LOG OF BORING NO. **B-1**

Cochran
530A East Independence
Union, Missouri 63084

PROJECT: Scenic Regional Library Addition
LOCATION: Warrenton, MO
PROJECT NO.: 16-6413A
DATE: 7-19-16 COMPLETION DEPTH : 20.0 ft

ELEVATION, ft	DEPTH, ft	SYMBOL	DESCRIPTION	SAMPLES	DRY UNIT WEIGHT, PCF	NATURAL MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %	PERCENT PASSING NO. 200 SIEVE	SPT N-VALUE blows per foot
			SURFACE ELEVATION: 876.0ft								
876.0	0		ASPHALT - 4 inches								
875.8			ROCK BASE - 5 inches								
875.1			FILL - brown low plastic silty clay with gravel			13	27	22	5		5
873.0			Soft, brown, low plastic silty CLAY with trace organics - CL		88	30					
870.5	5		Very soft, brown and gray, high plastic CLAY with sand - CH			25					0
868.0			Stiff, brown and gray, high plastic CLAY with sand - CH			20					9
863.0	10		Stiff to very stiff, brown and gray, high plastic CLAY with gravel - CH			17					10
856.0	15		Boring terminated at 20 feet								15
	20										
	25										

UNDRAINED SHEAR STRENGTH, tsf
○ HAND PENETROMETER
△ TORVANE
● UNCONFINED COMPRESSION
▲ UNCONSOLIDATED-UNDRAINED TRIAXIAL
0.5 1.0 1.5 2.0 2.5

WATER OBSERVATIONS:
: FREE WATER ENCOUNTERED AT 7.0 FT. DURING DRILLING.

LOG OF BORING NO. **B-2**

Cochran
530A East Independence
Union, Missouri 63084

PROJECT: Scenic Regional Library Addition
LOCATION: Warrenton, MO
PROJECT NO.: 16-6413A
DATE: 7-19-16 COMPLETION DEPTH : 20.0 ft

ELEVATION, ft	DEPTH, ft	SYMBOL	DESCRIPTION	SAMPLES	DRY UNIT WEIGHT, PCF	NATURAL MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %	PERCENT PASSING NO. 200 SIEVE	SPT N-VALUE blows per foot
			SURFACE ELEVATION: 876.0ft								
876.0	0										
875.8			ASPHALT - 4 inches								
875.1			ROCK BASE - 6 inches								
			Very soft, brown, low plastic silty CLAY to clayey SILT - CL-ML			33	29	21	8		3
						25					0
	5										
						19					3
868.5			Stiff to very stiff, brown and gray, high plastic CLAY with sand- CH								
						17					11
	10										
						16					15
	15										
858.0			Very stiff, brown and gray, high plastic CLAY with gravel - CH			15					15
856.0	20		Boring terminated at 20 feet								
	25										

UNDRAINED SHEAR STRENGTH, tsf
○ HAND PENETROMETER
△ TORVANE
● UNCONFINED COMPRESSION
▲ UNCONSOLIDATED-UNDRAINED TRIAXIAL
0.5 1.0 1.5 2.0 2.5

WATER OBSERVATIONS:
: FREE WATER ENCOUNTERED AT 5.0 FT. DURING DRILLING.

LOG OF BORING NO. **B-3**

Cochran
530A East Independence
Union, Missouri 63084

PROJECT: Scenic Regional Library Addition
LOCATION: Warrenton, MO
PROJECT NO.: 16-6413A
DATE: 7-19-16 COMPLETION DEPTH : 20.0 ft

ELEVATION, ft	DEPTH, ft	SYMBOL	DESCRIPTION	SAMPLES	DRY UNIT WEIGHT, PCF	NATURAL MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %	PERCENT PASSING NO. 200 SIEVE	SPT N-VALUE blows per foot
			SURFACE ELEVATION: 876.5ft								
876.5	0		ASPHALT - 2 inches								
876.4			ROCK BASE - 9 inches								
875.6			FILL - brown low plastic to high plastic clay with gravel			24					3
873.5			Stiff, brown and gray, high plastic CLAY with sand - CH			29	60	27	33		10
	5					25					12
868.5			Medium dense, brown, clayey SAND - SW-SC			11					26
	10										
863.5			Stiff to very stiff, brown and gray, high plastic CLAY with gravel - CH			16					15
	15					15					21
856.5	20		Boring terminated at 20 feet								
	25										

UNDRAINED SHEAR STRENGTH, tsf
○ HAND PENETROMETER
△ TORVANE
● UNCONFINED COMPRESSION
▲ UNCONSOLIDATED-UNDRAINED TRIAXIAL
0.5 1.0 1.5 2.0 2.5

WATER OBSERVATIONS:
NO FREE WATER ENCOUNTERED DURING DRILLING

LOG OF BORING NO. **B-4**

Cochran
530A East Independence
Union, Missouri 63084

PROJECT: Scenic Regional Library Addition
LOCATION: Warrenton, MO
PROJECT NO.: 16-6413A
DATE: 7-19-16 COMPLETION DEPTH : 20.0 ft

ELEVATION, ft	DEPTH, ft	SYMBOL	DESCRIPTION	SAMPLES	DRY UNIT WEIGHT, PCF	NATURAL MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %	PERCENT PASSING NO. 200 SIEVE	SPT N-VALUE blows per foot
			SURFACE ELEVATION: 876.0ft								
876.0	0										
875.8			ASPHALT - 4 inches								
875.1			ROCK BASE - 7 inches								
			Soft, brown and gray, low plastic silty CLAY to clayey SILT - CL-ML			23					4
					93	28					
870.5	5		Medium stiff, high plastic CLAY with sand - CH			20					6
			more sand			15					19
	10										
						23					9
	15										
						20					13
856.0	20		Boring terminated at 20 feet								
	25										

UNDRAINED SHEAR STRENGTH, tsf
○ HAND PENETROMETER
△ TORVANE
● UNCONFINED COMPRESSION
▲ UNCONSOLIDATED-UNDRAINED TRIAXIAL
0.5 1.0 1.5 2.0 2.5

WATER OBSERVATIONS:
: FREE WATER ENCOUNTERED AT 6.0 FT. DURING DRILLING.

LOG OF BORING NO. **B-5**

Cochran
530A East Independence
Union, Missouri 63084

PROJECT: Scenic Regional Library Addition
LOCATION: Warrenton, MO
PROJECT NO.: 16-6413A
DATE: 7-19-16 COMPLETION DEPTH : 10.0 ft

ELEVATION, ft	DEPTH, ft	SYMBOL	DESCRIPTION	SAMPLES	DRY UNIT WEIGHT, PCF	NATURAL MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %	PERCENT PASSING NO. 200 SIEVE	SPT N-VALUE blows per foot
			SURFACE ELEVATION: 879.0ft								
879.0	0		ASPHALT - 4 inches								
878.8			ROCK BASE - 8 inches								
878.0			FILL - crushed rock with clay			21					2
876.0			Stiff, brown and gray shaley CLAY - CH			23					9
	5					24					11
						18					13
869.0	10		Boring terminated at 10 feet								
	15										
	20										
	25										

UNDRAINED SHEAR STRENGTH, tsf
○ HAND PENETROMETER
△ TORVANE
● UNCONFINED COMPRESSION
▲ UNCONSOLIDATED-UNDRAINED TRIAXIAL
0.5 1.0 1.5 2.0 2.5

WATER OBSERVATIONS:
: FREE WATER ENCOUNTERED AT 3.0 FT. DURING DRILLING.

LOG OF BORING NO. **B-6**

Cochran
530A East Independence
Union, Missouri 63084

PROJECT: Scenic Regional Library Addition
LOCATION: Warrenton, MO
PROJECT NO.: 16-6413A
DATE: 7-19-16 COMPLETION DEPTH : 10.0 ft

ELEVATION, ft	DEPTH, ft	SYMBOL	DESCRIPTION	SAMPLES	DRY UNIT WEIGHT, PCF	NATURAL MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %	PERCENT PASSING NO. 200 SIEVE	SPT N-VALUE blows per foot
			SURFACE ELEVATION: 884.0ft								
884.0	0										
883.8			ASPHALT - 4 inches								
883.1			ROCK BASE - 6 inches								
			Medium stiff, brown and gray, high plastic CLAY - CH			19					7
						26					7
	5										
878.0			Stiff, brown and gray shaley CLAY with gravel - CH			16					12
						16					14
874.0	10		Boring terminated at 10 feet								
	15										
	20										
	25										

UNDRAINED SHEAR STRENGTH, tsf
○ HAND PENETROMETER
△ TORVANE
● UNCONFINED COMPRESSION
▲ UNCONSOLIDATED-UNDRAINED TRIAXIAL
0.5 1.0 1.5 2.0 2.5

WATER OBSERVATIONS:
NO FREE WATER ENCOUNTERED DURING DRILLING

BORING LOG: LEGEND & NOMENCLATURE

General Notes:

1. **Information on each boring log** is a compilation of subsurface conditions based on soil and/or rock classifications obtained from the field as well as from laboratory testing of the samples. The strata lines on the logs may be approximate or the transition between the strata may be gradual rather than distinct.
2. **Water level measurements** refer only to those observed at the time indicated and may vary with time, geologic condition or construction activity.

Drilling Method

HSA	Hollow-stem Auger
HA	Hand Auger
MR	Mud Rotary
SF	Solid Flight Auger

Sampling Method

PP	Pocket Penetrometer
GB	Grab Sample Taken From Auger Cuttings
TV	Torvane
CS	Continuous Sampler
ST	Three Inch Diameter Shelby Tube Sample (ASTM D 1587)
SS	Split Spoon Sample (Standard Penetration Test)
NX	NX Rock Core Sample; percent recovery and RQD reported (ASTM D 2113)

Standard Penetration Test – (SPT or N-value) is the standard penetration resistance based on the number of blows, using a 140-lb. Hammer with 30-inch free fall, required to drive a split spoon the last two of three, 6-inch drive increments. Driving is limited to 50 blows within any 6-inch interval. Samples which have not driven the full 6-inch interval upon-completing 50 blows are considered to have reached "split spoon refusal."

General Order of Classification Terms

Relative density or consistency * color * soil constituents * organics * odor * other

Density of Granular Soils

Descriptive Term	N-Value
Very Loose	0-4
Loose	5-10
Medium Dense	11-30
Dense	31-50
Very Dense	>50

Consistency of Fine-Grained Soils

Consistency	Undrained Shear Strength – Tons Per Square Ft.	Field Test	Approximate N-Value Range
Very Soft	less than 0.12	Thumb will penetrate soil more than 1"	0-1
Soft	0.13 to 0.25	Thumb will penetrate soil about 1"	2-4
Medium Stiff	0.26 to 0.50	Thumb will penetrate soil about ¼"	5-8
Stiff	0. 51 to 1.00	Thumb hardly indents soil	9-15
Very Stiff	1.01 to 2.00	Thumb will not indent soil, but readily Indented with thumbnail	16-30
Hard	greater than 2.00	Thumbnail will not indent soil	>30

Relative Composition

Trace	0-10%
With/Some	11-35%
Soil modifier such as Silty, clayey, sandy, etc.	>35%

Soil Grain Size

U.S. Standard Sieve

12"	3"	3/4"	4	10	40	200		
Boulders	Cobbles	Gravel		Sand			Silt	Clay
		Coarse	Fine	Coarse	Medium	Fine		
300	76.2	19.1	4.76	2.00	0.42	0.074	.002	

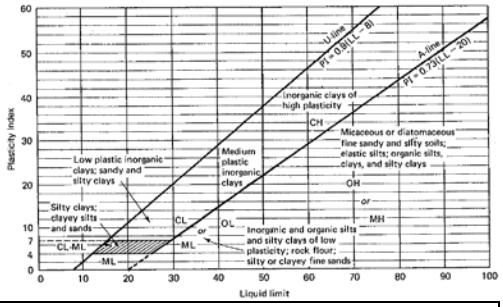
Soil Grain Size in Millimeters

Unified Soil Classification System

Soil Classifications of the samples are made by visual inspection and/or laboratory test results in accordance with the Unified Soil Classification System (ASTM Designations D-2487 and D-2488). Visual estimates are approximate only. If laboratory tests were performed to classify the soil, the unified designation is shown in parenthesis.

MAJOR DIVISIONS			SYMBOL	DESCRIPTION
Coarse-Grained Soils (more than 50% Larger than No. 200 Sieve Size)	Gravel and Gravelly Soils	Clean Gravels Little or No Fines	GW	Well-Graded Gravel, Gravel-Sand Mixture
			GP	Poorly-Graded Gravel, Gravel-Sand Mixture
		Gravels with Appreciable Fines	GM	Silty Gravel, Gravel-Sand-Silt Mixture
			GC	Clayey-Gravel, Gravel-Sand-Clay Mixture
	Sand and Sandy Soils	Clean Sands Little or No Fines	SW	Well-Graded Sand, Gravelly Sand
			SP	Poorly-Graded Sand, Gravelly Sand
		Sands with Appreciable Fines	SM	Silty Sand, Sand-Silt Mixture
			SC	Clayey Sand, Sand-Clay Mixture
Fine-Grained Soils (more than 50% Smaller than No. 200 Sieve Size)	Silts and Clays	Liquid Limit Less Than 50	ML	Silt, Clayey Silt, Silty or Clayey Very Fine Sand, Slight Plasticity
			CL	Clay, Sandy Clay, Silty Clay, Low to Medium Plasticity
			OL	Organic Silts or Silty Clays of Low Plasticity
	Silts and Clays	Liquid Limit More Than 50	MH	Silty, Fine Sandy or Silty Soil with High Plasticity
			CH	Clay, High Plasticity
			OH	Organic Clay or Medium to High Plasticity
	Highly Organic Soils		PT	Peat, Humus, Swamp Soil

PLASTICITY CHART



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