SUBSURFACE EXPLORATION AND FOUNDATION RECOMMENDATIONS PROPOSED EMERGENCY DEPARTMENT REMODEL VA MEDICAL CENTER MARION, ILLINOIS

Prepared for:

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File H-17002

TABLE OF CONTENTS

APPENDIX

SUBSURFACE EXPLORATION AND FOUNDATION RECOMMENDATIONS

PROPOSED VETERANS ADMINISTRATION EMERGENCY DEPARTMENT REMODEL PROJECT NUMBER 657-500

MARION, ILLINOIS

1.0 Introduction

GLMV Architecture, Inc. is designing a remodel of the emergency room at the Veterans Administration Medical Center in Marion, Illinois. This report provides a summary of the subsurface exploration and engineering recommendations for foundation design of the proposed facility. This project was authorized with an AIA Agreement between GLMV and Holcomb Foundation Engineering Company dated December 20, 2016.

2.0 Scope and Purpose of Report

The purpose of this geotechnical exploration is to explore subsurface conditions at the specific locations of four soil borings, conduct field and laboratory tests to gather data necessary to perform an evaluation of the subsurface conditions, and prepare engineering recommendations relative to the following items:

- Subsurface conditions encountered in the soil borings, including material types to be expected at existing grades and their impact on the construction scheme.
- Site preparation considerations relative to the subsurface conditions.
- Foundation support of the proposed addition, including acceptable bearing pressures, anticipated bearing levels, and settlement estimates.
- Floor slab support and construction.
- Anticipation and management of ground water during construction.

- Soil material and compaction requirements for support of the proposed building.

- Seismic design recommendations for the proposed structure.

- Presence of mining activity as indicated on the Illinois State Geological Survey underground mine maps.

3.0 Site Description

This site is located on the east side of Building #42 at the Veterans Administration Medical Center in Marion, Illinois. Earthwork was performed in this area prior to our soil borings, and the site was relatively level, with surface elevations ranging from 95 to 97 in the vicinity of the soil borings, using the existing first floor slab at Building 42 as elevation 100.0.

4.0 Project Description

This project is to consist of construction of a new Emergency Room on the east side of Building 42. The addition will have plan dimensions of about 49 by 80 feet. The structure will have a basement and first floor, with two additional stories in the future. The basement floor slab will be constructed at an approximate elevation of 85.0 (using the first-floor slab at Building 42 as elevation 100.0). Maximum column loadings are approximately 270 kips, with unfactored gravity + seismic loadings of about 425 kips.

5.0 Field Exploration

On February 13, 2017, we drilled four soil borings at this site. Boring locations were staked by Holcomb Foundation Engineering personnel using a boring location plan provided by GMLV Architecture, Inc.

5.1 Drilling and Sampling Procedures

The soil borings were drilled with a CME-550 all-terrain drilling rig. Conventional 3.25 inch inside diameter hollow stem augers were used to advance the boreholes to 15 feet in depth a Borings #1 and #4, with Borings #2 and #3 advanced five to ten feet into sandstone bedrock. Representative soil samples were obtained on 2.5 and 5.0 foot intervals employing split barrel sampling procedures in accordance with ASTM D-1586. Boring #2 was advanced ten feet into bedrock with an NWX Rock Core Barrel. Upon completion of drilling, the boreholes were backfilled with the soil cuttings.

5.2 Field Tests and Measurements

The following field tests and measurements were performed during exploration activities at the site:

- Ground water readings were obtained during and upon completion of drilling at all soil boring locations.
- Standard penetration tests were performed and penetration resistances recorded during the recovery of all split barrel samples.
- Approximate measurements of undrained shear strength were taken on all cohesive soil samples with a calibrated hand penetrometer.
- All samples were visually classified according to the Unified Classification System by the boring technician in preparation of the field boring logs. The samples were then placed into glass jars for transport to our laboratory.

The field test data and measurements are summarized in the Boring Logs located in the appendix to this report.

6.0 Laboratory Tests

In addition to the field exploration, a laboratory-testing program was conducted to determine additional engineering characteristics of the foundation subsoils. All tests were performed in accordance with applicable ASTM specifications. The laboratory-testing program included the following tests:

6.1 Natural Moisture Content

Natural moisture content determinations were performed on all samples. Moisture content determinations aid in estimating the settlement potential of a soil strata. The in-situ moistures also yield information as to the workability of a soil type. Moisture content results are graphically presented on the Boring Logs.

6.2 Visual Classifications

All soil samples were visually classified by the geotechnical engineer in accordance with the Unified Classification System. The visual classifications are noted on the Boring Logs.

6.3 Unconfined Compressive Strengths

Cohesive soil samples were subjected to unconfined compressive strength tests. Unconfined compressive strengths are used to determine the undrained shear strength of a soil. Results of the compressive strength tests are plotted on the Boring Logs.

6.4 Sample Disposal

The soil samples are stored in our laboratory for further analysis, if desired. Unless notified to the contrary, the samples will be disposed of six months after the date of this report.

7.0 Subsurface Conditions

The types of subsurface materials encountered in the soil borings are briefly described on the Boring Logs in the appendix to this report. The general characteristics are described in the following paragraphs. The conditions represented by these test borings should be considered applicable only at the test boring locations on the dates shown. It is possible the conditions encountered may be different at other locations or at other times.

7.1 General Subsurface Profile

The subsurface profile at this site consists of about six feet of brown silty clay fill soil in Borings #1 and #3 (adjacent to Building #42) overlying gray mottled brown to brown mottled gray silty clay (CL classification). The silty clay extends down to weathered sandstone bedrock, encountered at elevation 58.3 in Boring #2, and 62.1 at Boring #3. Borings #2 and #3 were terminated in the sandstone bedrock.

7.2 Silty Clay Fill

The upper silty clay encountered in Borings #1 and #3 is soft to firm, with unconfined compressive strengths of 0.2 to 1.0 tons per square foot, averaging 0.6 tsf. Moisture contents vary from 14 to 25 percent, averaging 21 percent. These soils have a relatively high settlement potential, but appear to be above the proposed bottom of basement elevation.

7.3 Silty Clay Natural Soils

The naturally deposited silty clay soils are firm to stiff, with unconfined compressive strengths of 0.9 to 3.3 tons per square foot, averaging 2.0 tsf. Moisture contents vary from 12 to 26 percent, averaging 19 percent. The silty clay has a moderate to low settlement potential.

7.4 Weathered Sandstone Bedrock

The weathered sandstone bedrock encountered below 34 to 38 feet at this site has standard penetration test values in excess of 60 blows per foot of penetration. Moisture contents vary from 7 to 16 percent. Although the rock cores did not recover any sandstone, it is estimated the sandstone is dense and has a very low settlement potential.

7.5 Ground Water

Ground water was encountered at 13.5 feet in Borings #1 and #4, and at 28.5 feet in Boring #2. Boring #3 was dry during and upon completion of drilling operations. Upon completion of drilling operations, water was measured at depths ranging from 15 to 20 feet below the existing ground line.

7.6 Undermining

Based upon mine maps available from the Illinois State Geological Survey, it does not appear the proposed site is undermined. Therefore, there should be no potential for mine subsidence at this location.

8.0 Grading Considerations

8.1 Site Preparation

Since this structure is to have a basement, the upper soils will be excavated down to about elevation 85. During excavation of the basement, any debris, footings, slabs, or utilities encountered in the basement building pad area should be removed from the site. Boring #1 encountered marginal soils at about 13 to 15 feet in depth, which is near the basement slab elevation. These soils may require undercut and replacement, or processing and recompaction prior to construction of the floor slab.

Due to the high silt content of the subsoils, if possible the site grading should be performed during hot, dry months of the year. If site grading is performed when the soils are wet, the subgrade may pump to such a degree that it may have to be removed and replaced, or require the addition of hydrated lime for drying prior to compaction.

8.2 Basement Excavation

Since the structure is to have a basement, the silty clay subsoils excavated for the basement may be used for structural fill in other areas of this site, and to backfill around the new structure.

The basement sidewalls should be overexcavated for workmen's safety. A minimal overdig may be used to assure the sidewalls do not slough into the excavation. The OSHA 29 CFR Part 1926 publication indicates the subsoils at this site have a type 'B' soil classification.

8.3 Fill Placement

Outside of the basement area, fill may be placed to grade the site. It is recommended the fill soils are placed in maximum eight inch loose lifts, with each lift compacted to a minimum of 95% of the standard Proctor dry density. It is recommended the fill material consist of a low plastic silty clay, sandy clay, or crushed limestone with a liquid limit of less than 40 and a plasticity index of less than 20. The clayey soils encountered on site should provide acceptable fill material for these structures.

A sufficient number of in-place field density tests should be performed by an engineering technician to evaluate the contractor's performance during fill soil placement and compaction. The tests will also aid in determining whether project specifications are being met. A minimum of four compaction tests per every lift are recommended, with at least one per every 5000 square feet.

8.4 Subgrade Preparation for Floor Slabs

Environmental conditions and construction traffic often disturb even a well-prepared soil surface at the final grade elevation. Provisions should be made in the construction specifications for the contractor to restore the subgrade soils to a stable condition prior to placing the granular mat. Backfilling of utility trenches is often accomplished in an uncontrolled manner, leading to cracking of floor slabs and pavements. We recommend the utility trenches are backfilled with acceptable fill in 8 inch lifts and compacted with piston tampers to the project requirements.

The concrete floor slabs may be supported upon a four-inch layer of free draining granular material. Generally, Illinois Department of Transportation Type "A" CA-7 or CA-11 crushed limestone is used in Southern Illinois for this purpose. This is to provide a capillary break and a uniform leveling course beneath the slab.

8.5 Ground Water Control

During basement excavation, ground water is not anticipated. However, if free water is encountered in the basement excavation, it may be sumped out prior to placement of concrete or drained using interceptor ditches.

Perforated drain pipes are recommended around the basement walls and below the floor slab to allow any seepage water to be drained to a sump pump or gravity drain.

9.0 Engineering Recommendations

9.1 Building Foundations

Based upon results of the field and laboratory tests, the proposed building may be supported by shallow foundations consisting of isolated column and continuous wall footings. A maximum net allowable soil bearing pressure of up to 3000 pounds per square foot may be used to dimension the footings. The exterior footings in areas exposed to frost should be founded at a minimum depth of 2.5 feet for frost protection. Interior footings in areas that are protected from frost may be founded at one foot below the final subgrade elevation. It is also recommended all footings have a minimum width of 24 inches to avoid a punching type failure of the foundation.

Total settlements of a 270-kip column load are estimated to range from approximately 0.5 to 1.0 inch, with differential settlements of about 0.5 inch.

Although most of the borings indicate most of the subsoils on this site are adequate for support of the proposed structure, due to marginal soils encountered near elevation 85 in Boring #1, undercut of soft soils may be necessary below the footings. We recommend the foundation excavations are tested for bearing pressure with a calibrated penetrometer to two feet below the bottom of foundation elevation prior to placement of concrete. Should soils with less than the specified bearing pressure be encountered, it is recommended they are excavated and replaced with a properly compacted granular fill soil or lean concrete.

As an alternative foundation, drilled shafts may be used for support of this structure. The drilled shafts should be socketed at least three to five feet into the sandstone bedrock. If properly socketed into the bedrock, the drilled shafts may be dimensioned using 30 kips per square foot bearing pressure on the sandstone. Since these are end-bearing units, skin friction values are not employed for design of these shafts.

The drilled shaft lateral resistance may be estimated using the "Drilled Shaft Geotechnical Parameters" table in the appendix to this report.

The bottom of all drilled shafts must be cleaned properly so that they are free from loose soils and excessive water prior to concrete placement. It is recommended a representative of the geotechnical engineer observe the excavations prior to concrete placement.

The drilled shafts should be designed with reinforcement bar "cages" by a structural engineer for seismic and lateral force resistance.

If founded on the dense sandstone bedrock, the drilled shafts are estimated to have approximately 1/4 inch of settlement. However, the elastic compression of these drilled shaft foundations should be evaluated.

9.2 Seismic Design

Based upon the seismic design criteria provided by the I.B.C., this site has a site classification type "C" profile. Based upon this profile, the spectral response acceleration coefficients have been determined as follows:

0.2 Second Period: S_{Ms} = 0.902 g x 1.039 (Soil Factor F_a) = 0.937

1.0 Second Period: S_{M1} = 0.308 g x 1.490 (Soil Factor F_v) = 0.459

The recommended design spectral response factors are as follows:

S_{DS} = 0.625 g

S_{D1} = 0.306 g

These values were obtained from the IBC Section 1615 and the USGS Earthquake Hazards Program based upon the latitude and longitude of this site.

9.3 Basement Wall Design

Coefficients for active and passive pressures acting upon retaining walls in the upper ten feet of this site are estimated as follows:

Coefficient of Active Pressure:	0.36
Coefficient of Passive Pressure:	2.77
Coefficient of At-Rest Pressure:	0.53

The silty clay subsoils encountered on this site have a wet soil density of approximately 125 pounds per cubic foot. It is recommended the retaining walls be backfilled with a free draining sand or crushed stone up to within one foot of the final ground line, with perforated PVC pipe at the base of the wall sloped to gravity drain or drain to a sump.

The recommended coefficient of friction between the concrete and soils which may be used for design is 0.33.

9.4 Floor Slab Design

The proposed concrete slab on grade may be designed using a modulus of subgrade reaction estimated at approximately 100 psi per inch. The soil subgrade beneath the slab should be properly proofrolled or compacted per the recommendations in Section 8 of this report.

10.0 Pavement Design

The following pavement designs are based upon an estimated Illinois bearing ratio of 2.5 for the soil subgrade, and the subgrade being compacted to a minimum of 95% of the maximum standard laboratory dry density. Recommended pavement designs are as follows:

10.1 Automobile Parking Lot Pavement

Traffic Loadings:	500 Passenger Cars/Day
Design Life:	20 Years
Illinois Bearing Ratio:	2.5

Pavement Design - Automobile Parking Lots

Bituminous Concrete Surface:	2.5"
CA-06 Basecourse:	8.0"

10.2 Heavy Duty Pavement

Traffic Loadings:	500 Passenger Cars/Day 4 Single Unit Delivery Trucks 1 Trash Truck
Design Life:	20 Years
Illinois Bearing Ratio:	2.5

Pavement Design - Heavy Duty Pavement

Bituminous Concrete Surface:	2.0"
Bituminous Concrete Binder:	2.0"
CA-06 Basecourse:	10.0"

Or

Portland Cement Concrete:	7.0"
Granular Subbase, Type A:	4.0"

Due to the heavy point loadings of steel dumpster wheels, the dumpster storage areas should be paved with Portland Cement Concrete.

The Illinois Department of Transportation "Standard Specifications for Road and Bridge Construction" adopted on January 1, 2016 indicates the materials to be used in the following sections:

Bituminous Concrete Surface and Binder
Section 406 (Pages 189-202)

Portland Cement Concrete
Section 420 (Pages 218-233)

Crushed Stone Basecourse
Section 351 (Pages 162-166)

Granular Subbase, Type A
Section 311 (Pages 154-157)

11.0 Summary

This subsurface exploration has been conducted at the site of the proposed Emergency Department Remodel at the Veterans Administration Medical Center in Marion, Illinois. This report has been prepared for the exclusive use of GLMV Architecture, Inc. for the specific application to this project.

Design and construction criteria have been suggested and potential problems have been discussed.

The following information has been discussed in this report:

- Soils encountered on the site consist of about six feet of silty clay fill soil adjacent to the existing building overlying gray to brown naturally deposited silty clay. Below the silty clay at depths ranging from about 34 to 39 feet a brown weathered sandstone was encountered. The deeper borings were terminated in the sandstone bedrock.

- Site grading will include excavation of the basement to about elevation 85 (with the existing first floor slab at Building #42 having an assumed elevation of 100.0.

- The basement excavation should be overexcavated or shored for worker's safety. The OSHA 29 CFR Part 1926 publication indicates the subsoils at this site have a type 'B' soil classification.

- Fill soils placed outside of the basement area may be compacted to a minimum of 95% of the standard Proctor dry density.

- Foundation design criteria have been discussed, and allowable end bearing pressures have been recommended for spread footings and drilled shaft foundations.

- Spread footings may be dimensioned using a maximum net allowable soil bearing pressure of up to 3000 psf if founded at or below elevation 85.

- The drilled shafts may be dimensioned using a maximum allowable soil bearing pressure of up to 30,000 pounds per square foot if socketed about 3 to 5 feet into the sandstone bedrock.

- During construction of the foundations at this site, the spread footings or drilled shafts should be observed and tested by a representative of the geotechnical engineer. Any soft or unsuitable soils encountered below the footings should be undercut and properly replaced.

- The International Building Code indicates this site has a type "C" site classification, based upon the soil borings. The recommended design spectral response factors for this site are S_{DS} = 0.625 g and S_{D1} = 0.306 g.

- Pavement design recommendations have been made for light and heavy duty traffic loadings.

The analyses, conclusions, and recommendations contained in this report are professional opinions based on the site conditions and project scope described herein. It is assumed the conditions observed in the exploratory borings are representative of subsurface conditions throughout the site. If during construction, subsurface conditions differ from those encountered in the exploratory borings are observed or appear to be present beneath excavations, we should be advised at once so that we can review these conditions and reconsider our recommendations where necessary. Unless specifically noted, the scope of our services did not include an assessment of the effects of flooding and natural erosion of creeks or rivers adjacent to the project site.

If there is a substantial lapse in time between the submittal of this report and the start of work at this site, or if site conditions are changed due to natural causes or construction operations, we recommend that this report be reviewed to determine the applicability of conclusions and recommendations considering the changed conditions and time lapse.

For us to provide a complete professional geotechnical engineering service, we should be retained to observe construction, particularly site grading, earthwork and foundation construction.

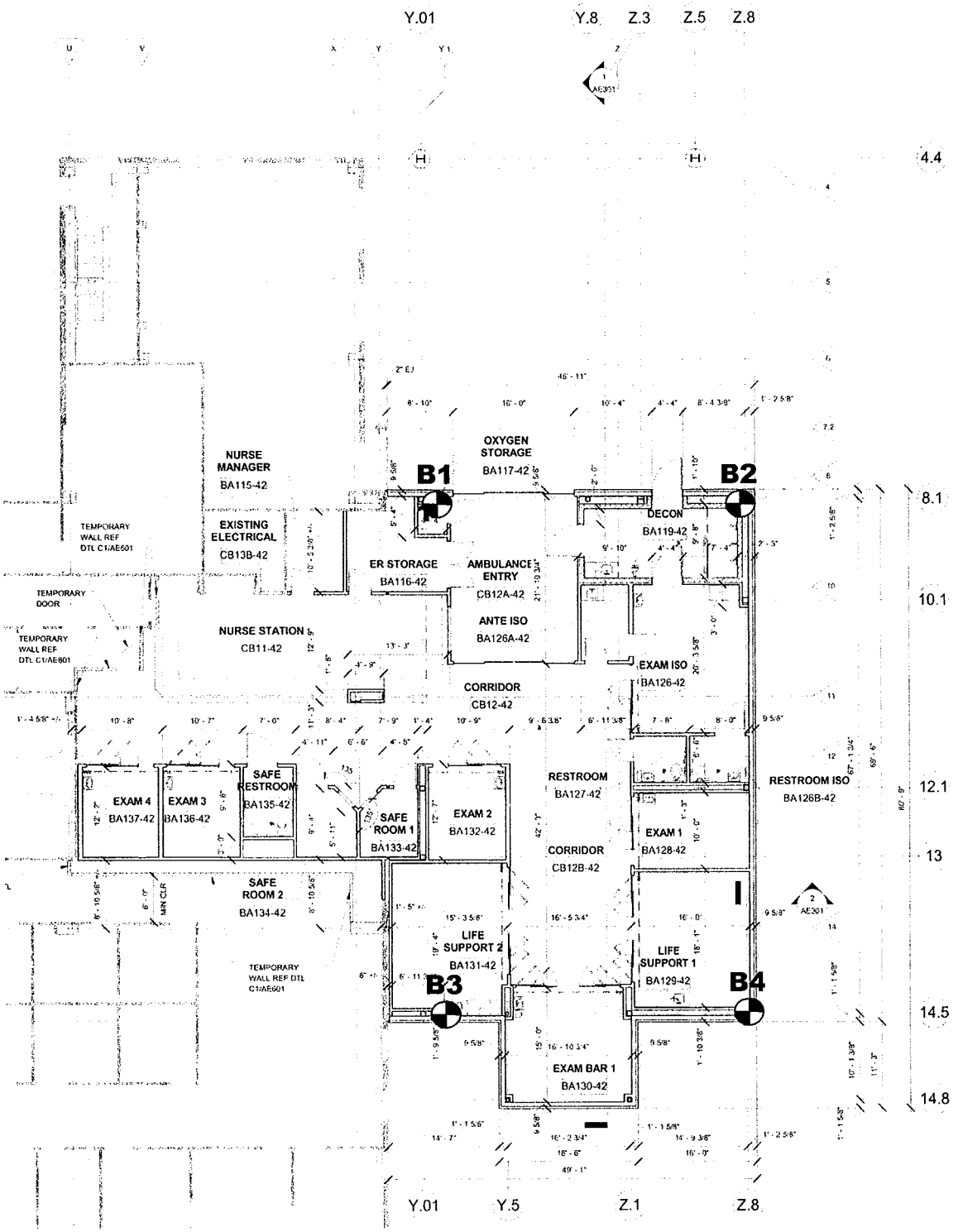
The scope of our services for this phase of the project does not include any environmental assessment or investigation for the presence or absence of wetlands or hazardous or toxic material in the soil, surface or ground water or air, on or below this site. Any statements in this report or on the boring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

This report was prepared for the exclusive use of the owner, architect, or engineer for evaluating the design of the project as it relates to the geotechnical aspects discussed herein. It should be made available to prospective contractors for information on factual data only and not as a warranty of subsurface conditions included in this report. Unanticipated soil conditions or rock may require that additional expense be made to attain a properly constructed project. Therefore, some contingency fund is recommended to accommodate such potential extra costs.

It is recommended that we be retained to review final project layout and those portions of plans and specifications which pertain to foundations and earthwork to determine if they are consistent with our findings and recommendations.

Scott G. Holcomb, E.I.

Timothy J. Holcomb, P.E.



Project:
Emergency Department Remodel
Marion VA Medical Center
Marion, Illinois
Client:
GLMV Architecture
Kansas City, Missouri

Boring Location Diagram

North

Project No. H-17002

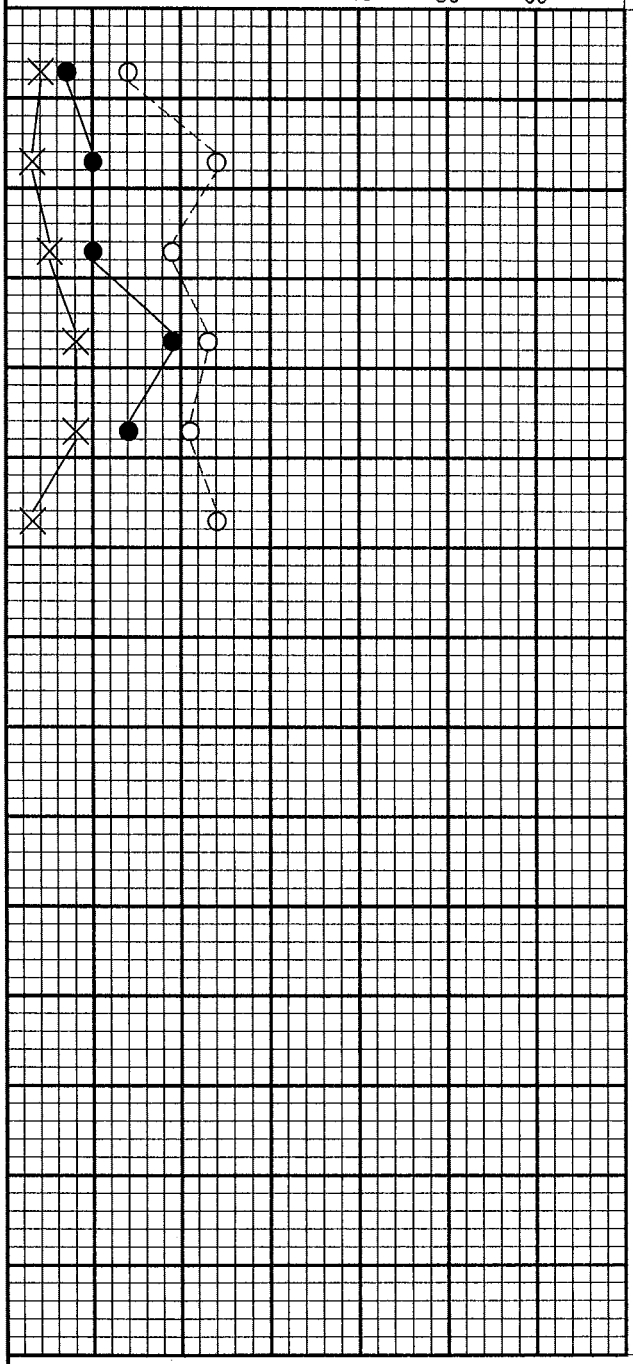
Not to Scale

February 13, 2017

Holcomb Foundation Engineering Co.
PO Box 88 Carbondale, Illinois

LOG of BORING 1

Unconfined Compressive Strength (Tons/Sq. Ft.)
1 2 3 4 5 6
Water Content (%)
Standard N Penetration, Blows/Ft.
10 20 30 40 50 60



Depth in Feet	Sample No.	Type Sample	Sample Distance	Description of Material
				Surface Elevation **97.4**
	1	ss		Brown Silty CLAY (CL) with crushed stone
5	2	ss		
	3	ss		Gray Silty CLAY (CL) with pebbles
	4	ss		Brown Mottled Gray Silty CLAY (CL) with trace sand
10	5	ss		Gray Mottled Brown Silty CLAY (CL) with trace sand
	6	ss		Brown Sandy CLAY (CL)
15				End of Boring @ −15.0'
20				
25				
30				
35				

Ground Water Data
Ground Water Encountered @ −13.5' During Drilling.

Project: **Emergency Department Remodel**
Marion VA Medical Center Marion, Illinois

Date of Boring
February 13, 2017

Client: **GLMV Architecture, Inc.**
Kansas City, Missouri

Project No.
H−17002

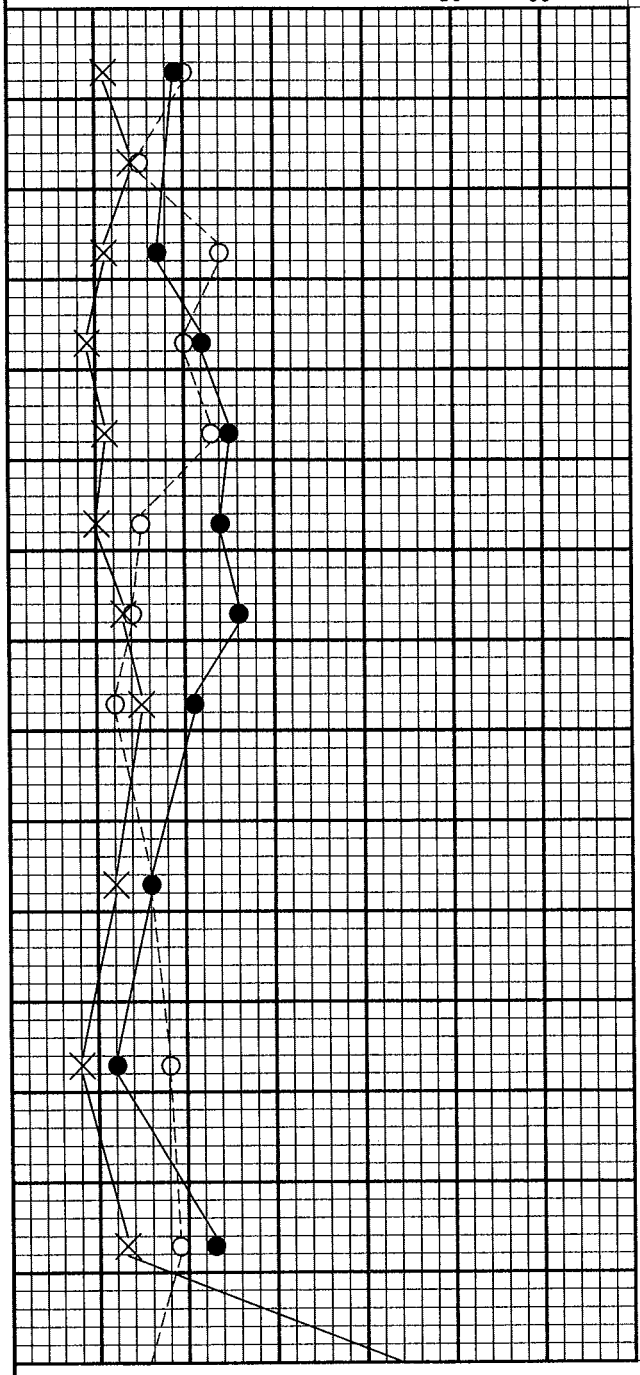
Holcomb Foundation Engineering Co.
PO Box 88 Carbondale, Illinois

LOG of BORING 2

Unconfined Compressive Strength (Tons/Sq. Ft.)
1 2 3 4 5 6

Water Content (%)

Standard N Penetration, Blows/Ft.
10 20 30 40 50 60



Depth in Feet	Sample No.	Type Sample	Sample Distance	Description of Material
				Surface Elevation **97.3**
				Gray Mottled Brown Silty CLAY (CL)
	1	ss		
5	2	ss		
	3	ss		
	4	ss		Brown Mottled Gray Silty CLAY (CL)
10	5	ss		
	6	ss		Brown Mottled Gray Silty CLAY (CL) with pebbles
15	7	ss		
	8	ss		
20				
	9	ss		
25				
	10	ss		Brown Silty CLAY (CL) with pebbles
30				
	11	ss		
35				

Ground Water Data
Ground Water Encountered @ −28.5' During Drilling/ @ −20.0' Upon Completion.

Project: **Emergency Department Remodel**
Marion VA Medical Center Marion, Illinois

Date of Boring
February 10, 2017

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Kansas City, Missouri

Project No.
H−17002

Holcomb Foundation Engineering Co.
PO Box 88 Carbondale, Illinois

LOG of BORING 2

Unconfined Compressive Strength (Tons/Sq. Ft.)
1 2 3 4 5 6
Water Content (%)
Standard N Penetration, Blows/Ft.
10 20 30 40 50 60

Depth in Feet	Sample No.	Type Sample	Sample Distance	Description of Material
				Surface Elevation
				silty clay (continued)
	12	ss	60/2"	Gray Mottled Brown Weathered SANDSTONE
40				
		rc		Rock Core No Recovery
45				
		rc		Rock Core No Recovery
50				End of Borings @ −50.0'
55				
60				
65				
70				

Ground Water Data
Ground Water Encountered @ −28.5' During Drilling/ @ −20.0' Upon Completion.

Project: **Emergency Department Remodel**
Marion VA Medical Center Marion, Illinois

Date of Boring
February 10, 2017

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Kansas City, Missouri

Project No.
H−17002

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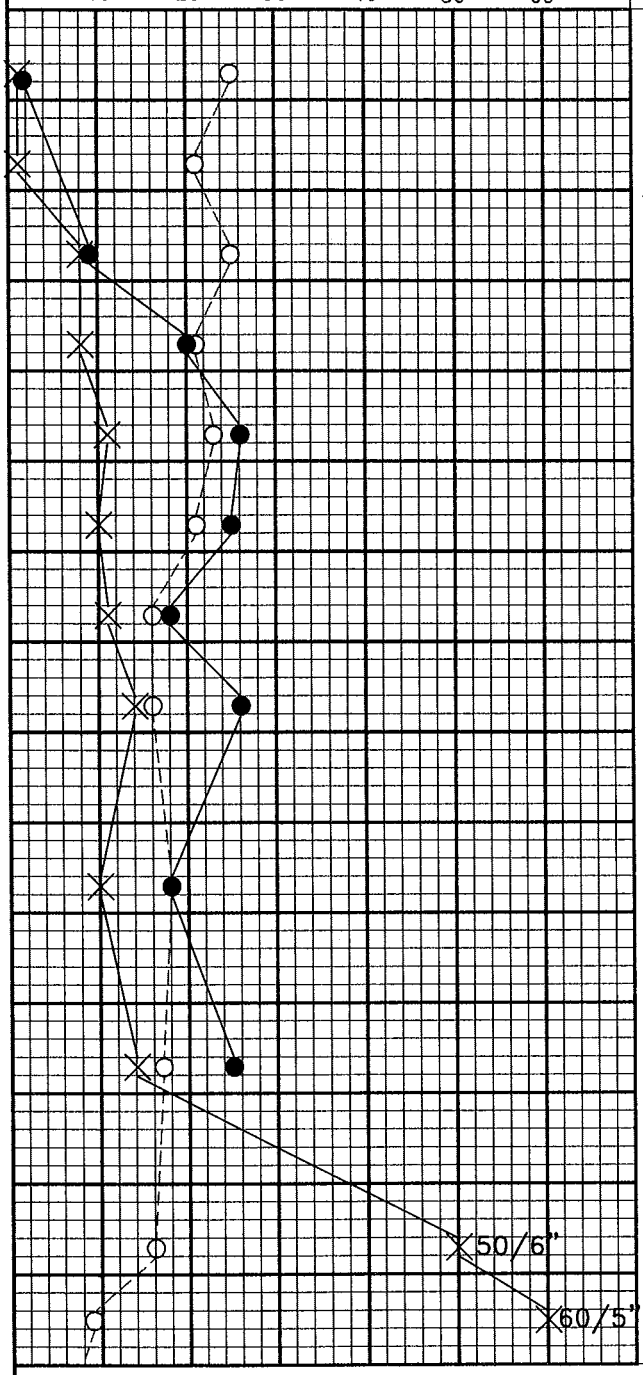
PO Box 88 Carbondale, Illinois

LOG of BORING 3

Unconfined Compressive Strength (Tons/Sq. Ft.)
1 2 3 4 5 6

Water Content (%)

Standard N Penetration, Blows/Ft.
10 20 30 40 50 60



Depth in Feet	Sample No.	Type Sample	Sample Distance	Description of Material
				Surface Elevation **96.6**
				Brown Silty CLAY (CL) Fill
	1	ss		
5	2	ss		
	3	ss		Gray Mottled Brown Silty CLAY (CL)
10	4	ss		
	5	ss		Brown Mottled Gray Silty CLAY (CL)
15	6	ss		
	7	ss		
	8	ss		Brown mottled Gray Silty CLAY (CL) with pebbles
20				
	9	ss		
25				
	10	ss		
30				
	11	ss		
35	12	ss		Brown Weathered SANDSTONE

Ground Water Data
No Ground Water Encountered During Drilling.

Project: **Emergency Department Remodel**
Marion VA Medical Center Marion, Illinois

Date of Boring
February 13, 2017

Client: **GLMV Architecture, Inc.**
Kansas City, Missouri

Project No.
H-17002

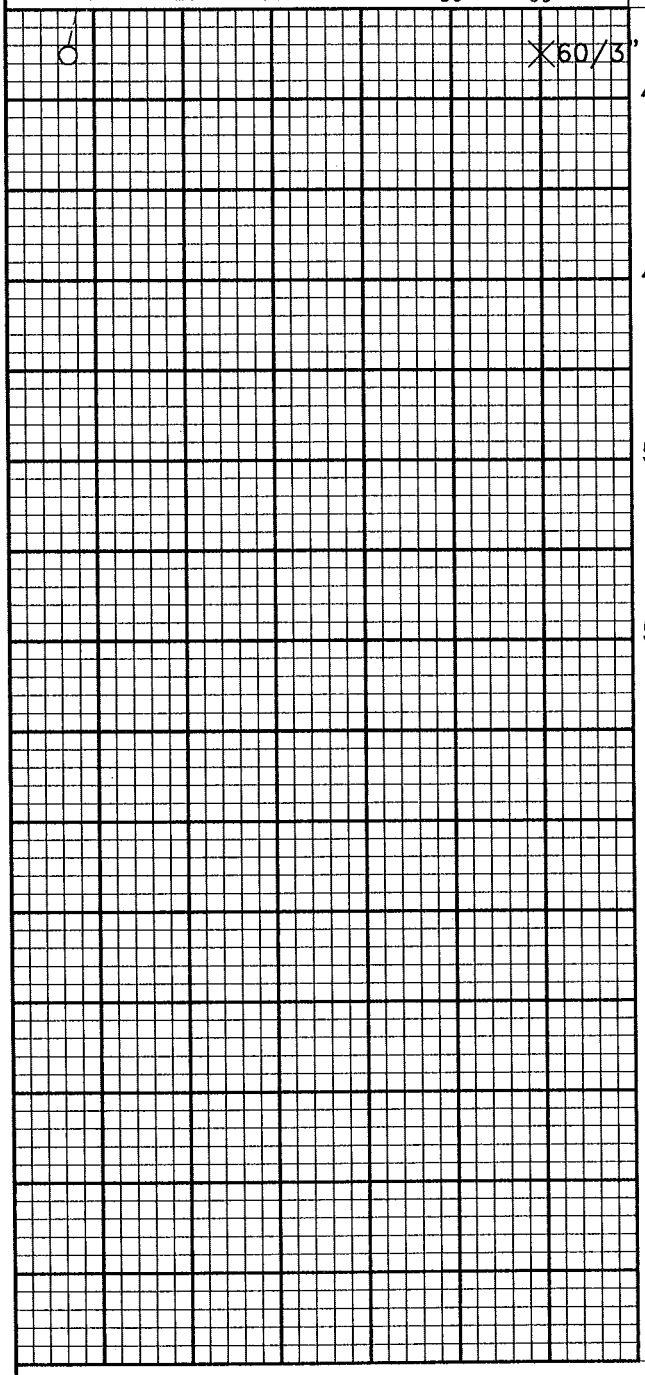
Holcomb Foundation Engineering Co.
PO Box 88 Carbondale, Illinois

LOG of BORING 3

Unconfined Compressive Strength (Tons/Sq. Ft.)
1 2 3 4 5 6

Water Content (%)

Standard N Penetration, Blows/Ft.
10 20 30 40 50 60



Depth in Feet	Sample No.	Type Sample	Sample Distance	Description of Material
				Surface Elevation
				sandstone (continued)
40	13	SS		End of Boring @ −39.0'

Ground Water Data
No Ground Water Encountered During Drilling.

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Marion VA Medical Center Marion, Illinois

Date of Boring
February 13, 2017

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H−17002

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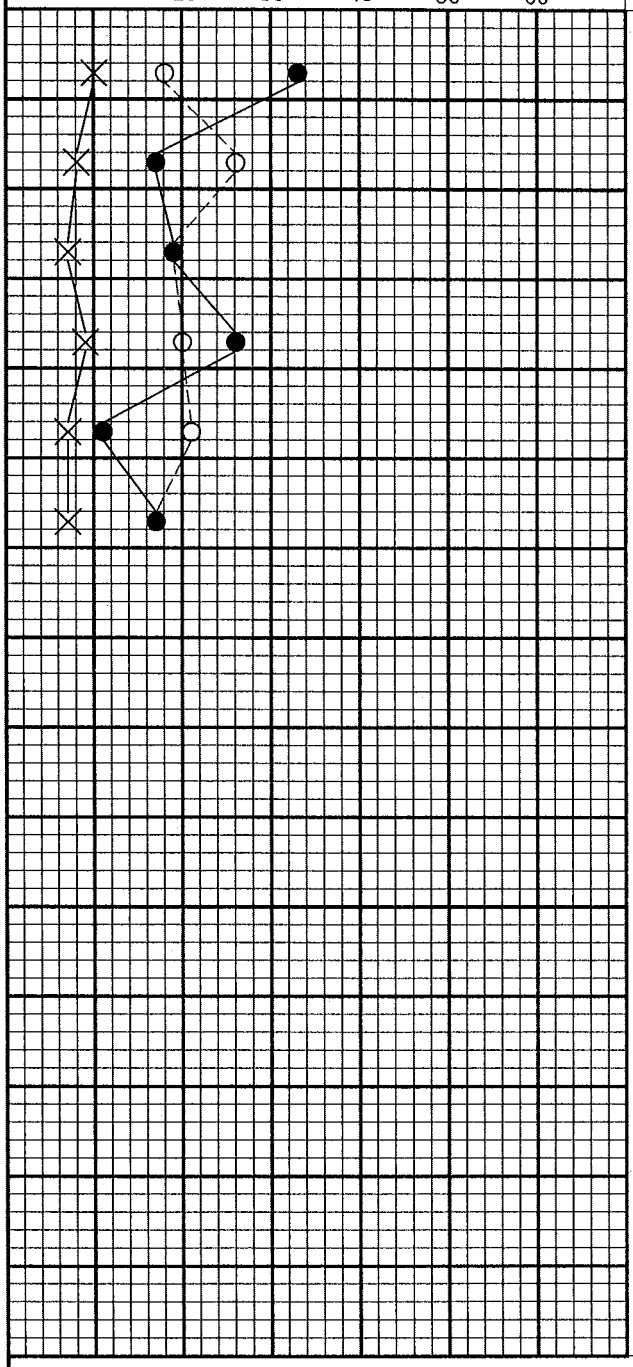
LOG of BORING 4



Depth in Feet	Sample No.	Type Sample	Sample Distance	Description of Material
				Surface Elevation **95.3**
				Gray Mottled Brown Silty CLAY (CL)
	1	ss		
	2	ss		Brown Mottled Gray Silty CLAY (CL)
5	3	ss		
	4	ss		
10	5	ss		
	6	ss		Brown Silty CLAY (CL) with pebbles
15				End of Boring @ −15.0'
20				
25				
30				
35				

Ground Water Data
Ground Water Encountered @ −13.5' During Drilling and @ −15.0' Upon Completion.

Project:	**Emergency Department Remodel** **Marion VA Medical Center Marion, Illinois**	**Date of Boring**	**February 13, 2017**
Client:	**GLMV Architecture, Inc.** **Kansas City, Missouri**	**Project No.**	**H−17002**

Drilled Shaft Geotechnical Parameters
Emergency Department Remodel
Marion Veterans Administration Medical Center
Marion, Illinois
HFE File H-17002

Material Type	Depth (ft.) (Below Elev. 85)	Soil * Classification	Equivalent Skin Friction (PSF)	Phi Angle (Deg)	Undrained Shear Strength (PSF)	Strain @ 50% of Peak Strength (E50)	Soil Unit Weight (PCF)	Static Soil Modulus Parameter k (pci)
2*	0-39	Silty Clay	500	N/A	1500	0.005	120.0	500
9*	Below 39**	Weath. Sandstone	2000	N/A	15000	0.0005	130.0	1000

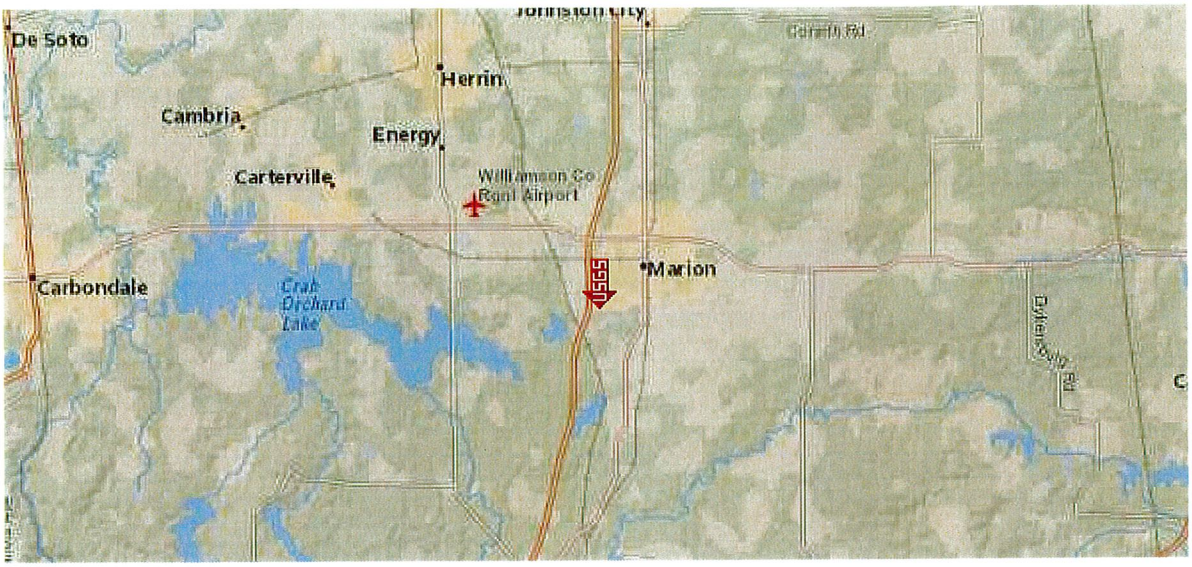
* 1 - Soft Clay, 2- Stiff Clay with free water, 3 - Stiff Clay without free water, 4 - Sand, 5 - Linear Interpolation (p-y curves), 6 - Hard Rock, 7 - Silt, 8 - API Sand, 9 - Weak Rock

**- Depth of weathered sandstone below top of drilled shaft.

USGS Design Maps Summary Report

User–Specified Input

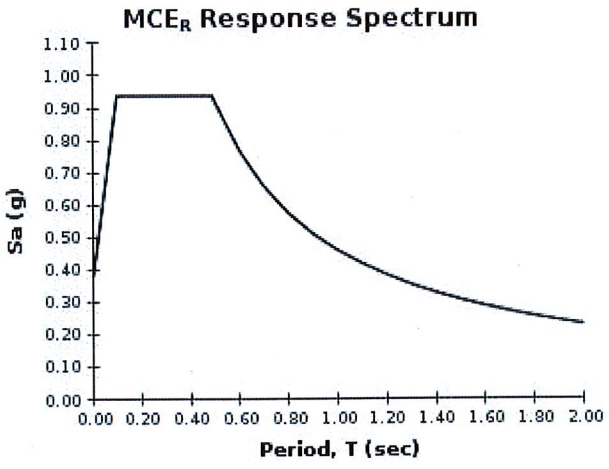
Report Title	Marion VA Emergency Dept. Remodel Thu February 16, 2017 16:56:46 UTC
Building Code Reference Document	2012/2015 International Building Code (which utilizes USGS hazard data available in 2008)
Site Coordinates	37.72444°N, 88.95432°W
Site Soil Classification	Site Class C – "Very Dense Soil and Soft Rock"
Risk Category	IV (e.g. essential facilities)

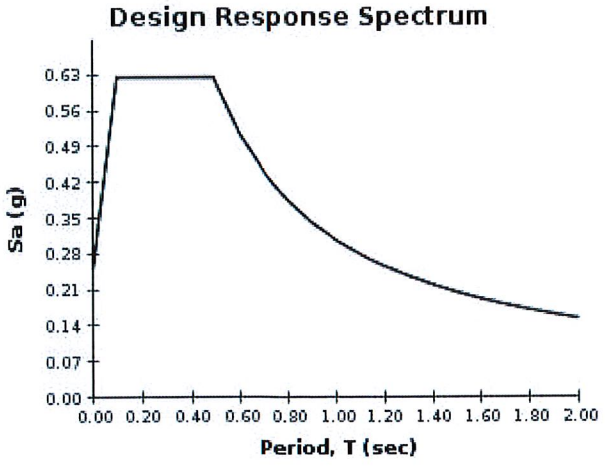


USGS–Provided Output

S_S =	0.902 g	S_{MS} =	0.937 g	S_{DS} =	0.625 g
S_1 =	0.308 g	S_{M1} =	0.459 g	S_{D1} =	0.306 g

For information on how the SS and S1 values above have been calculated from probabilistic (risk-targeted) and deterministic ground motions in the direction of maximum horizontal response, please return to the application and select the "2009 NEHRP" building code reference document.





GENERAL NOTES

SAMPLE INDENTIFICATION

The Unified Classification System is used to indentify the soil unless othwerwise noted.

RELATIVE DENSITY & CONSISTENCY CLASSIFICATION

TERM (NON-COHESIVE SOILS)	BLOWS PER FOOT
Very Loose	0-4
Loose	5-10
Firm	11-30
Dense	31-50
Very Dense	Over 50

TERM (COHESIVE SOILS)	QU (tsf)
Very Soft	0.00- 0.25
Soft	0.25-0.50
Firm	0.50-1.00
Stiff	1.00-2.00
Very Stiff	2.00-4.00
Hard	4.00+

DRILLING & SAMPLING SYMBOLS

ss:	Split Spoon-	1 3/8" I.D., 2" O.D.
st:	Shelby Tube-	2.80" I.D., 3" O.D.
au:	Auger Samples	
cs:	Continuous Sampling	2.0" I.D

SOIL PROPERTY SYMBOLS

●	Unconfined Compressive Strength, Qu (tsf)
+	Penetrometer Value, (tsf)
	Plastic Limit (%)
o	Water Content (%)
	Liquid Limit (%)
x	Standard "N" Penetration: Blows per foot of a 140 pound hammer falling 30 inches on a 2" O.D. Split Spoon

PARTICLE SIZE

Boulders	8in +	Medium Sand	0.6mm to 0.2mm
Cobbles	8in to 3in	Fine Sand	0.2mm to 0.74 mm
Gravel	3in. to 5mm	Silt	0.074mm to 0.0005mm
Coarse Sand	5mm to 0.6mm	Clay	Less Than 0.005mm

UNIFIED SOIL CLASSIFICATIONS

MAJOR DIVISIONS			SYMBOL	TYPICAL DESCRIPTION
COARSE GRAINED SOILS	GRAVEL AND GRAVELLY SOILS	CLEAN GRAVELS	GW	Well graded gravels, gravel-sand mixtures
			GP	Poorly graded gravels, gravel-sand mixtures
		GRAVELS WITH FINES	GM	Silty gravels, gravels-sand silt mixtures
			GC	Clayey gravels, gravel-sand clay mixtures
		CLEAN SANDS	SW	Well-graded sands, gravelly sands
			SP	Poorly graded sands, gravelly sands
		SANDS WITH FINES	SM	Silty sands, sand-silt mixtures
			SC	Clayey sands, clay-sand mixtures
FINE GRAINED SOILS	SILTS AND CLAYS LOW PLASTICITY		ML	Inoganic silts of clayey silts with slight plasticity
			CL	Inorganic clays of low to medium plasticity
	SILTS AND CLAYS HIGH PLASTICITY		OL	Organic silts and organic silty clays of low plasticity
			MH	Inorganic clays of high plasticity
			CH	Organic clays of high plasticity
HIGHLY ORGANIC SOILS			OH	Organic clays of medium to high plasticity
			PT	Peat, humus, swamp soils with high organic contents