

**SUBSURFACE INVESTIGATION, SOIL ANALYSIS
and
FOUNDATION DESIGN RECOMMENDATIONS
for
KC VETERANS MEDICAL CENTER ADDITIONS
KANSAS CITY, MISSOURI**

Prepared for

MR. FRED MOJTAHEDI
AECOM
1101 CONNECTICUT AVENUE
WASHINGTON, D.C. 20036

Prepared by

ENGINEERING SURVEYS & SERVICES
1113 FAY STREET
COLUMBIA, MISSOURI 65201

Missouri Engineering Corporation Number 2004005018

April 7, 2011



Engineering Surveys and Services

Consulting Engineers, Geologists, and Land Surveyors
Analytical and Materials Laboratories

Larry L. Hendren, PE, RG
David A. Bennett, PE
Timothy J. Reed, PLS
Morton L. Ratliff, PLS
Bruce A. Dawson, PE
Richard J. Rolsing, PE
Chris M. Wickern, PLS

Randall A. Lee, PE, RG
Timothy J. O' Connor, PE
Benjamin A. Ross, PE, PTOE
Clifford S. Jarvis, PE
Zachary K. Thomas, PE
Matthew A. Kriete, PE
Fred E. Carroz III, PLS

1113 Fay Street
Columbia, Missouri 65201
Telephone 573-449-2646
Facsimile 573-499-1499
E-Mail ess@ess-inc.com
<http://www.ess-inc.com>

April 7, 2011

Mr. Fred Mojtahedi
AECOM
1101 Connecticut Avenue
Washington, DC 20036

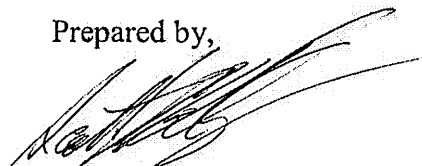
RE: Geotechnical Engineering
KC Veterans Medical Center Additions
Kansas City, Missouri

Dear Mr. Mojtahedi:

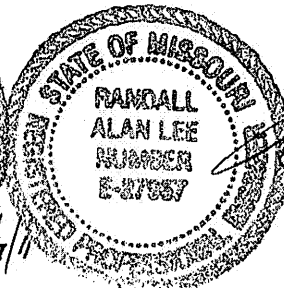
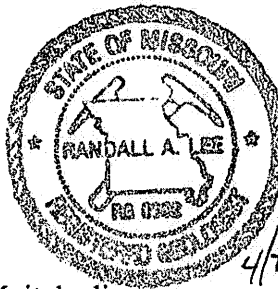
We have conducted a subsurface investigation and evaluated subsurface conditions for the referenced project. The following report includes the results of the investigation, an evaluation of these results and our recommendations regarding foundation design and construction considerations.

We appreciate the opportunity to assist you on this project and anticipate inquiries during the design phase. We stand ready to assist during the design phase and through construction with a full range of construction oriented engineering, surveying, and laboratory services. If we can be of further assistance, please do not hesitate to contact us.

Prepared by,



Scott J. Kelly, E.I.



Reviewed by,



Randall A. Lee, P.E., R.G.

cc: 3- Mojtahedi

TABLE OF CONTENTS

EXECUTIVE SUMMARY.....	1
PROJECT SCOPE	2
DESCRIPTION OF THE SITE AND PROJECT	2
VICINITY MAP	3
GEOLOGY OF THE AREA.....	4
FIELD INVESTIGATION.....	4
LABORATORY INVESTIGATION.....	6
SUBSURFACE CONDITIONS.....	6
ENGINEERING ANALYSIS AND RECOMMENDATIONS.....	7
CONSTRUCTION CONSIDERATIONS	13
APPENDIX.....	17
Symbols and Terms	18
Summary of Laboratory Test Results	19
Plan of Boring Locations.....	20
Boring Logs	21

**SUBSURFACE INVESTIGATION, SOIL ANALYSIS
and
FOUNDATION DESIGN RECOMMENDATIONS
for
KC VETERANS MEDICAL CENTER ADDITIONS
KANSAS CITY, MISSOURI**

EXECUTIVE SUMMARY

An exploration of subsurface conditions has been conducted for the proposed addition to the KC Veterans Medical Center. The project consists of the construction of three additions to the existing building. The method of construction is not known at this time.

Addition 1 will be located at the main entrance to the hospital and include a single story expansion of office and lobby space and a new 5-story elevator and stair tower with restrooms at each level. Maximum column loads are estimated to be 800 kips. The basement floor slab will match existing with a finished floor elevation of approximately 934 feet.

Addition 2 will be located on the west face of the southwest wing of Building 1, facing Building 15 and include construction of an MRI clinic at basement level with additional clinic and access areas for a total of four stories. Maximum column loads are estimated to be 500 kips. The basement floor slab will match existing with a finished floor elevation of approximately 934 feet.

Addition 3 will be located at the southeast corner of the Emergency Room and include a single story expansion of the patient receiving area. Maximum column loads are estimated to be 200 kips. The floor slab will match existing with a finished floor elevation of approximately 946 feet.

The site of the KC Veterans Medical Center is located in Jackson County, Missouri in the east-central part of Kansas City. The site is bordered to the north by the East Linwood Boulevard, to the east by Emanuel Cleaver II Boulevard, to the south by East 35th Street, and to the west by a residential subdivision.

A total of nine soil and rock borings were drilled for this investigation. Boring B6 was not drilled due to a conflict with the existing, basement level kitchen. The information from these borings is included in this report.

The borings indicate that the subsurface profile of this site is slightly variable. A review of the boring logs shows that limestone and shale bedrock underlie the site. The soil/rock interface was encountered at 6.5 to 20 feet below the existing ground surface. Groundwater was not encountered in the borings and is not expected to influence construction of the foundations.

Both deep and shallow foundation systems were evaluated for the proposed structure. However, due to the variability in elevation of the soil/rock interface, a deep foundation system, bearing on limestone capable of supporting a net allowable bearing pressure of 20,000 psf is recommended. The elevation of such limestone varies across the site from 902 to 930 feet. Additional details on a drilled shaft foundation system are included in this document. Slab on grade and pavement recommendations are also provided in this document.

The exploration and analysis of the foundation conditions are considered to be in sufficient detail and scope to form a reasonable basis for design. The recommendations submitted are based on the results of our geotechnical investigation and analysis, and the preliminary design concepts provided by AECOM.

PROJECT SCOPE

The scope of the investigation included a reconnaissance of the site, a review of all available subsurface data in the vicinity, a subsurface investigation consisting of nine soil and rock borings to depths ranging from 6.5 to 35 feet, laboratory soil testing, and an engineering analysis and evaluation of the foundation materials present at the site.

The purpose of the investigation was to determine the types of subsurface materials present at the site likely to be encountered or affected by the proposed construction; to determine the general engineering characteristics of the various materials; to determine the seismic site class according to the 2009 International Building Codes and to provide a basis for recommendations regarding bearing capacity, shear strength, and compressibility of the foundation and subgrade materials. Results are indicated on the Boring Logs.

DESCRIPTION OF THE SITE AND PROJECT

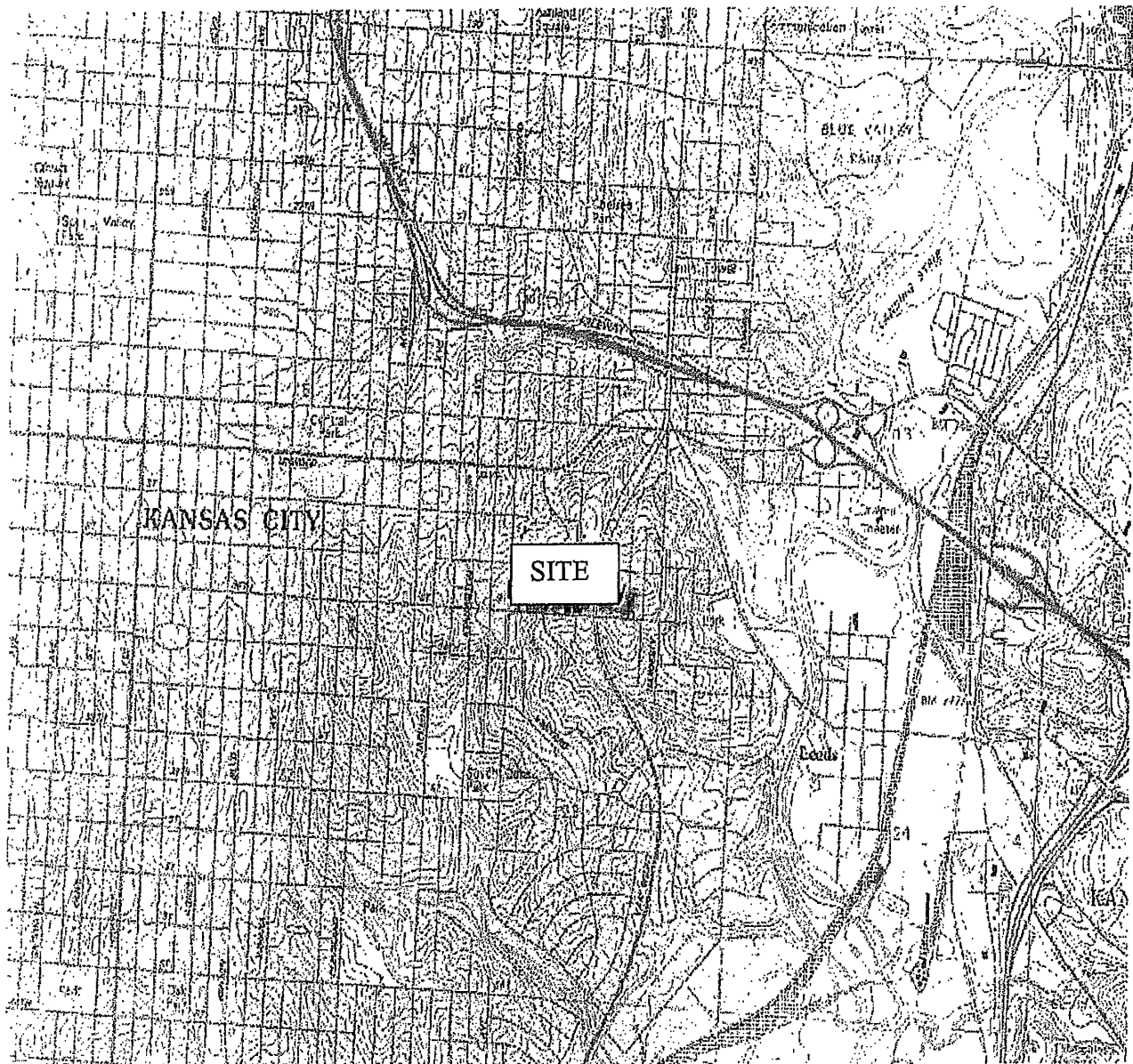
Site Location

The site of the KC Veterans Medical Center is located in Jackson County, Missouri in the east-central part of Kansas City. The site is bordered to the north by the East Linwood Boulevard, to the east by Emanuel Cleaver II Boulevard, to the south by East 35th Street, and to the west by a residential subdivision. Specifically, the project is located in the southwest 1/4 of Section 14, Township 49 North, Range 33 West (See Vicinity Map, page 3).

Project Description

The project consists of the construction of three separate additions to the existing building. Addition 1 will be located at the main entrance to the hospital and include a single story expansion of office and lobby space and a new 5-story elevator and stair tower with restrooms at each level. Addition 2 will be located on the west face of the southwest wing of Building 1, facing Building 15 and include construction of an MRI at basement level with additional clinic and access areas for a total of three stories. Addition 3 will be located at the southeast corner of the Emergency Room and include a single story expansion of the patient receiving area. Finished basement and ground floor elevations will match existing at 934 and 946 feet, respectively. Maximum column loads are estimated to be 800 kips.

VICINITY MAP



Site Description, Topography, and Drainage

The project site has been highly modified by man. A review of available records indicates the original construction took place in 1949. Since then, various additions and parking expansions have taken place. Site drainage for all three additions is handled by a combination of surface runoff and storm sewers.

The building footprint for Addition 1 is currently occupied by sidewalks, patios and landscaped areas. Interviews with onsite personnel indicate the area received up to 15 feet of fill approximately 20 to 25 years ago. There is approximately 3 feet of vertical relief across the proposed addition footprint. The ground surface slopes down to the northwest.

The building footprint for Addition 2 is currently occupied by a sidewalk, patio and landscape areas. There is approximately 13 feet of vertical relief across the proposed addition footprint. The ground surface slopes down to the south.

The building footprint for Addition 3 is currently occupied by parking areas and utility components. There is approximately one foot of vertical relief across the proposed addition footprint. The ground surface slopes down to the east.

GEOLOGY OF AREA

General

Kansas City, Missouri lies near the southern terminus of the Dissected Till Plains and the northern terminus of the Osage Plains Physiographic Provinces. The southern limit of glaciation passes through the Kansas City area. The project site lies south of the glaciation limit and is within the Osage Plains. The geology of the area is characterized by loess that overlays Pennsylvanian aged limestone and shale.

Loess

Clayey silt to silty clay blankets much of Jackson County. This loess is primarily wind-blown deposits of silt size particles. These soils are typically variable in strength and consolidation characteristics. These soils are easily eroded.

Pennsylvanian Deposits – Kansas City Group

Pennsylvanian rock composed of interbedded layers of limestone and shale with some sandstone and minor amounts of coal occurs under most of the Kansas City area, including beneath the project site. Records from previous investigations indicate layer thicknesses range 0.2 to 21 feet or more.

FIELD INVESTIGATION

Drilling

Field investigations, consisting of a site reconnaissance, a review of subsurface information in the vicinity, and the drilling of nine soil and rock borings, were performed on April 2 and 3, 2011. Boring B6 could not be drilled at its planned location due to potential damage to the basement level kitchen and was not drilled. Borings were advanced using 4-inch continuous flight augers equipped with a drag-type drill bit. All drilling was powered with a truck-mounted drill rig. Borings were drilled to depths ranging from 6.5 to 35 feet. Boring locations are shown on the boring plan included in the Appendix of this report.

Borings B1 and B7 were advanced past the point of auger refusal with NQ core barrels and a 4 inch tri-cone roller bit. Boring B1 encountered auger refusal at an elevation of 924 feet. The boring was advanced by coring to a bottom elevation of 903 feet. Boring B7 encountered auger refusal at an elevation of 925.7 feet. The boring was advanced by coring to an elevation of 922.7 feet, at which point the core bit seized in hard shale. The boring was continued to a bottom elevation of 910.7 feet by use of a tri-cone roller bit.

The field investigation and the site reconnaissance were performed in accordance with procedures outlined in ASTM D420. Undisturbed samples were obtained using 3-inch O.D. thin-walled tube sampling procedures in accordance with ASTM D1587. Split barrel samples were obtained following the procedures in ASTM D1586.

Drilling was monitored by an engineer from this firm. The engineer provided technical direction, logged the borings, performed field tests, and prepared and transported the samples to the laboratory for testing.

Previous geotechnical and construction information from previous projects at the site was reviewed as part of this investigation. The Pennsylvanian bedrock in at the site consists of alternating layers of limestone and shale. Previous construction at the site is supported on a drilled pier foundation system with allowable bearing pressures ranging from 20 to 40 ksf.

Building 15 was constructed in the early 1970's and is supported by drilled piers. Bearing elevation of the piers ranges from approximately 903 feet, at the south central portion of the building, to 930 feet, at the northeast corner. Design bearing pressure is listed as 25 ksf. Most of the piers bear at or near the elevation of 920 feet.

Building 26 was constructed in the mid-1970's and is supported by drilled piers. Bearing elevations of the piers range from approximately 915 feet, at the north central portion of the building, to 918.5 feet, near the southwest building corner. Design bearing pressure is listed as 40 ksf.

Field Tests and Measurements

Boring locations were selected based on a topographic survey prepared by this firm and are shown on the enclosed Plan of Boring Locations. Boring elevations are assumed correct to within ± 0.2 feet.

Field measurements made during drilling include shear strength determinations using a hand-held torvane shear device and a hand-held pocket penetrometer. Water level observations were made at the time of drilling in each borehole. The borings were backfilled immediately afterward. Field observations are detailed in the boring logs in the Appendix of this report.

LABORATORY INVESTIGATION

In conjunction with the field investigation, a laboratory investigation was conducted on the sampled materials to determine the engineering properties needed to analyze and predict foundation and subgrade performance. The laboratory investigation included supplementary visual classification, water content tests, unconfined compressive strength tests, dry unit weight measurements and Atterberg limit tests. All tests were performed by this firm in accordance with appropriate ASTM procedures. Results may be found in the Appendix of this report.

Laboratory tests performed on soil samples retrieved during the field investigation provided a range of results. The natural moisture contents of the soils were found to range from 12 to 48 percent. The dry density of the undisturbed samples ranged from 95 to 97 pounds per cubic foot (pcf). The cohesion, as measured in the unconfined compression test, was found to be 0.5 tons per square foot for both samples. The Atterberg liquid limits ranged from 50 to 57 percent while the plastic limits ranged from 16 to 17 percent, giving plasticity indices from 34 to 40. This indicates the tested soils have a moderate to high plasticity. The pH and resistivity ranged from 6.2 to 7.0 and from 695 to 862 ohms per centimeter, respectively. These values indicate a corrosive environment for metal pipes.

SUBSURFACE CONDITIONS

General

The materials encountered during the subsurface investigation were visually classified according to ASTM D2488. These materials were further classified using the results of Atterberg limit testing and the Unified Soil Classification System. The materials encountered during the field investigation are described in detail in Boring Logs included in the Appendix of this report. The stratification lines represent approximate boundaries, and the transition may be gradual.

Description of Subsurface Materials

The subsurface conditions in the vicinity of the proposed additions were slightly variable over the investigation site. In general, underlying a thin mantle of asphalt, concrete pavement or topsoil, silty clay soils were encountered. All borings reached auger refusal on limestone at depths ranging from 6.5 to 20 feet. Borings B1 and B7 were advanced past auger refusal by coring or using a wash boring with a tri-cone roller bit. Boring B1 was cored to a total depth of 31 feet. Coring in B7 was terminated in a layer of shale at a depth of 23 feet. Boring B7 was advanced with a tri-cone roller bit and wash boring to a depth of 28 feet. Coring was resumed and the boring was advanced to a total depth of 35 feet.

With the exception of boring B7, all borings encountered one to 13 feet of man-made fill. This fill consisted of silty and sandy clay soils and appeared to be well compacted.

Underlying the fill, native silty clay soils were encountered in all of the borings. These soils were described as brown and gray, moist and firm to stiff in consistency.

Underlying the clay soils, Pennsylvanian age limestone was encountered at elevations ranging from 925.7 to 937.2 feet. Borings B1 and B7 were advanced past the point of auger refusal to termination at elevations of 905 and 910.7 feet, respectively. Interbedded layers of shale and limestone were encountered in these two borings at these depths. Recovery ranged from 0 to 100 % in the cores. Rock Quality Designations (RQD) ranged from 0.00 to 0.78, increasing with depth.

Utilities

Numerous existing underground utilities and piping are known to exist in the vicinity of the structure. Localized utility trench or piping backfill may contain material that is unsuitable for use under the proposed structure. Unsuitable soils will need to be replaced with engineered fill.

ENGINEERING ANALYSIS AND RECOMMENDATIONS

General

The engineering analysis and recommendations which follow are based upon the results of a geotechnical investigation, analysis, and the preliminary design information provided by AECOM. If the project scope is altered appreciably or differing geotechnical conditions are encountered than those noted in the Boring Logs, a review of the changes or conditions is recommended to determine their impact upon design.

Shallow spread footings and deep foundation options were considered for the proposed structures. A deep foundation system consisting of drilled piers bearing on limestone capable of supporting 20 ksf is recommended. Recommendations for both are presented below. It is recommended that a geotechnical engineer observe all bearing surfaces immediately after excavation and prior to concrete placement to verify the suitability of the bearing surface and bearing material.

Seismic Loading

In the design of the proposed structure the following seismic parameters may be used. These parameters are based on the 2009 International Building Codes and are site specific.

1. Site Class	C
2. Mapped Spectral Response, Short Periods (S_s)	0.13
3. Mapped Spectral Response, Short Periods (S_1)	0.06
4. Site Coefficient as a Function of S_s (F_a)	1.2
5. Site Coefficient as a Function of S_1 (F_v)	1.7

Site Grading

Additions 1 and 2 will have lower level finished floors with elevations matching the existing floor at approximately 934 feet. This will require the excavation of 3 to 13 feet of material from within the addition footprint. Addition 3 will have a finished floor elevation, matching existing, of approximately 946 feet. This will require minor grading following the removal of the existing pavement and utilities within the footprint. It is recommended that any unsuitable material encountered during excavation be removed from the site. Additionally, any cavities created by the removal of underground structures should be brought back to subgrade with engineered fill. Anticipated rock top lies slightly below the finished lower floor elevation in all boring locations. Rock excavation may be anticipated during this portion of excavation.

Laboratory tests indicate that the upper 5 feet of the slab subgrade elevation contains moderate to high plasticity soils. Due to the presence of highly plastic soils at or near the surface of the existing grade, it is recommended that the upper 2 feet of subgrade consist of low volume change material. Low volume change material may consist of imported soils with a liquid limit less than 50 or a granular fill similar to MoDOT 1007 Type 1/5.

Construction should not begin until all cuts have been completed within the plan area of the proposed structure. Prior to the start of construction, it is recommended that all vegetation, debris, and other unsuitable materials be removed from the site. Following completion of excavation and stripping, and prior to slab-on-grade construction, it is recommended that the slab subgrade be proof-rolled with a rubber-tired piece of construction equipment such as a fully loaded, tandem-axle dump truck to help identify any soft or unsuitable areas. Areas identified as unsuitable should be scarified, moisture conditioned and recompacted to engineered fill specifications or overexcavated and reconstructed with engineered fill.

Groundwater

Groundwater was not encountered in any of the borings and is not expected to affect construction. The exact location of the groundwater surface should be expected to fluctuate depending on normal seasonal variations in precipitation and other climatic conditions, surface runoff, permeability of onsite soils, continuity of pervious material, and other factors.

Foundation Recommendations

Due to the differential settlement that may occur between the existing structure and the proposed addition, it is recommended that the proposed additions be designed as free standing structures. Construction joints and flexible connections should be incorporated into each addition's design where it attaches to the existing structure.

Isolated Shallow and Continuous Foundation System

The structure may be supported by a shallow foundation system with allowable bearing pressures of 15,000 psf for continuous and isolated footings. The interior spread footings will be up to 7.5 feet, square. It is recommended for a shallow foundation system, the footings bear at the

soil/rock interface at elevations ranging from 925 to 937 feet. Anticipated settlement will be on the order of one-half inch or less. However, significant excavation volumes should be anticipated at locations where the soil/rock interface is at a lower elevation. In the vicinity of boring B7, up to 8.3 feet below lower level finished floor elevation will be excavated before suitable bearing material is encountered. Any excavation that extends below the perimeter grade beam of an existing structure will require shoring to prevent loss of lateral support of the existing structure. The overexcavation may then be brought back to a higher design bearing elevation with 2,000 psi concrete.

Drilled Shaft Foundation System

The preferred option for supporting the proposed additions is a deep foundation system. Shafts should extend to limestone or hard shale with a minimum allowable net endbearing pressure of 20 ksf. Anticipated settlement of the drilled shaft foundations system is expected to be negligible.

A review of borings B1, B2 and B3 indicates that the soil/rock interface elevation ranges from 925.9 to 933.5 feet within the footprint of Addition 1. A review of borings B4, B5, B7 and B8 indicates the soil/rock interface elevation ranges from 925.7 to 932.2 feet within the footprint of Addition 2. A review of borings B9 and B10 indicates the soil/rock interface elevation ranges from 932.9 to 937.2 feet within the footprint of Addition 3.

Straight shafts are recommended for the piers. Drilled shaft capacities should be adjusted by varying the diameter of the shaft. A minimum shaft diameter of 30 inches is recommended for clean-out and inspection purposes. It is also recommended that each pier penetrate a minimum of one foot past the soil/rock interface to verify suitable bearing material.

Shaft capacities should be adjusted by varying the shaft diameter. The minimum diameter recommended for shafts is 30 inches, for cleanout and inspection purposes. A generous rock allowance should be established to address the variability of the soil/rock interface elevation. No verification holes are recommended.

The drilled shafts may be advanced to the desired bearing material using conventional truck-mounted pier drilling equipment. It is anticipated that rock augers and/or core barrels will be required to penetrate to design depth.

Shallow foundations bearing for small surface structures bearing in the upper 4 feet of the existing soil may be designed for a net allowable bearing capacity of 2,000 psf. Total settlement is estimated to be less than one inch with approximately ½ inch of differential settlement.

To minimize the effect of seasonal moisture variations, provide frost protection, and improve performance, exterior foundations should be constructed such that the bearing surface is a minimum of 36 inches below the adjacent exterior finish grade.

A perimeter foundation drainage system is recommended to discharge accumulated moisture away from the structure. The perimeter drainage system should consist of a perforated pipe bedded and backfilled with free draining aggregate. The free draining aggregate zone should be wrapped in geotextile filter fabric with an apparent opening size (ASTM D 4751) of 70 to 100 and minimum

trapezoid tear strength (ASTM D 4533) of 50 pounds. If the free draining aggregate will not be beneath concrete pavement or sidewalk, it should be covered with at least 2 feet of compacted low permeability clay soil. Downspouts and gutters should not be designed to flow into the foundation drain system.

Trees or other vegetation whose root systems have the ability to remove excessive moisture from the subgrade and foundation soils should not be planted next to the structures. Planted and landscaped areas adjacent to the structure should not be covered with impermeable sheeting commonly used to reduce weed growth.

Retaining Walls

The basement level walls will function as retaining walls. All walls subject to unbalanced earth pressure should be designed for earth pressures equal to or greater than those provided on the following table. For the granular or cohesionless backfill values to be valid the "Structural Backfill" zone must extend 45° from vertical from the heel of the retaining structure's foundation. These load distributions do not include a factor of safety or include the influence of hydrostatic pressures on the wall. Surcharge loads above the top of the wall due to vehicles, equipment, or sloped backfill should be considered in the design as well.

EARTH PRESSURE COEFFICIENTS

Earth Pressure Conditions	Coefficient for Backfill Type	Equivalent Fluid Pressure (psf)	Surcharge Pressure P_1 (psf)	Earth Pressure P_2 (psf)
Active (K_a)	Cohesionless or Granular – 0.30	36	(0.30)S	(36)H
	Low Plasticity Clays ($LL < 50$) – 0.42	50	(0.42)S	(50)H
	High Plasticity Clays ($LL \geq 50$) – 0.52	60	(0.52)S	(60)H
At-Rest (K_o)	Cohesionless or Granular – 0.46	55	(0.46)S	(55)H
	Low Plasticity Clays ($LL < 50$) – 0.59	70	(0.59)S	(70)H
	High Plasticity Clays ($LL \geq 50$) – 0.69	82	(0.69)S	(82)H
Passive (K_p)	Cohesionless or Granular – 3.4	410	---	---
	Low Plasticity Clays ($LL < 50$) – 2.4	285	---	---
	High Plasticity Clays ($LL \geq 50$) – 1.9	230	---	---

The above chart is based on the following conditions.

- Equivalent Fluid Pressures are based on a unit soil weight of 120 pcf.
- No groundwater is acting on the wall.
- For active earth pressure, wall must rotate at base, top lateral movement should be between 0.002 and 0.004 times the height of the wall (H).
- Surcharge pressure (S) acts at H/2 above the base.
- Backfill is compacted to a minimum of 95% of Maximum Dry Density (ASTM D698).
- Ignore passive pressure in the frost zone.

A maximum toe pressure of $2,000 + 120H$ psf may be used for design on the native clay-rich soils. Small walls bearing on the existing soil may use a maximum toe pressure of 2,000 psf. A coefficient of friction 0.4 may be used to calculate sliding resistance. A slightly roughened surface will increase adhesion and friction between the soil and foundation surface.

Shallow temporary below grade excavations should be stable long enough to allow for construction of the foundation and walls of the proposed structure. All excavations should be benched, sloped or shored in accordance with OSHA guidelines. Some sloughing may occur due to weathering and freeze/thaw cycles. Long term excavation slopes and deep excavations should be analyzed prior to construction to insure that adequate stability is achieved.

Floor Slab Design

Soils with moderate to high swelling potential were encountered in some of the near-surface, on-site soils. In consideration of this, if slabs on grade are used, they should be designed using a modulus of subgrade of 100 pounds per cubic inch (pci).

In order to reduce the potential damaging effects of the subgrade volume change, we recommend that the floor slab thickness be a minimum of five inches and that the slab subgrade includes a minimum 6 inch layer of free draining base course. Free draining base course will meet the gradation requirements for a #67 rock as defined by ASTM C33. It is also recommended that construction joints be provided at the foundation walls and column locations to ensure that the new floor slab can move independently of the wall, floor, or support foundations. In addition, we recommend the slab be reinforced with a 6 by 6-inch woven wire mesh.

Prior to placement of the drainage layer of aggregate, the upper 8 inches of the entire slab soil subgrade should be scarified, moisture conditioned to within 0 to +4 percent of optimum moisture content and recompact as engineered fill. The drainage aggregate should be compacted by a minimum of three passes with a vibratory plate or smooth roller when placed.

Construction and saw joints are recommended for all of the slabs-on-grade. Saw and construction joints should be installed such that the panels are nearly square but do not exceed a length to width ratio of 1.4 to 1.0. Maximum panel size depends on several factors including the amount of cement in the mix, the maximum coarse aggregate size, and slab thickness.

Additional precautions are normally used to minimize the potential damaging effects caused by swelling soils located near the design subgrade level. These include the installation of a precipitation removal system involving the use of gutters, downspouts, and landscaping; not allowing water to pond next to the proposed structure during or after construction; and not allowing the subgrade soil to become inundated or desiccated prior to or during the time required for construction of the floor slab.

Utilities

Underground utilities will be installed to service the new additions. Due to the potential for corrosion of metal pipes, some form of corrosion protection is recommended. Metal pipes and conduits can be economically protected by encasing the pipe with 8-mil polyethylene. Alternatively, PVC piping and conduit can be used for utilities, with little potential for corrosion.

Pavement Design and Recommendations

The pavement is expected to include parking areas for cars and light trucks as well as service lanes for ambulances and delivery trucks. Because the service lanes carry a higher traffic volume and heavier vehicles, it is recommended that the pavement in these areas be designed to be more durable than the pavement in the parking areas. Due to the shearing loads created by turning vehicles, it is preferred that the service lanes (heavy duty areas) be constructed with Portland cement concrete. Recommendation for both Portland and Asphaltic cement concrete are provided. Rigid pavements should be reinforced, at a minimum, with 6 by 6-inch welded wire fabric and 1/2-inch epoxy coated dowel bars at transverse joints.

The following pavement design recommendation has taken into account site specific traffic estimates, geotechnical information, and subgrade modification or reinforcement. A California Bearing Ratio (CBR) value of 3 was used to develop the following pavement design recommendations for the parking lot.

HEAVY DUTY

Portland Cement Concrete

6"	Portland Cement Concrete (4,000 psi mix)
6"	MoDOT Type 1 crushed stone base

Asphaltic Cement Concrete

2"	Type 'BP-2' Asphaltic Concrete Surface Course
4"	MoDOT Plant Mix Bituminous Course
7"	MoDOT Type 1 crushed stone base

STANDARD DUTY AREAS

Portland Cement Concrete

4"	Portland Cement Concrete (4,000 psi mix)
6"	MoDOT Type 1 crushed stone base

Asphaltic Cement Concrete

2"	Type 'BP-2' Asphaltic Concrete Surface Course
2"	MoDOT Plant Mix Bituminous Course
6"	MoDOT Type 1 crushed stone base

It is recommended that the upper one foot of material for the paved areas consist of low volume change material. Wastelime is not recommended for use under pavement. In lieu of placing one foot of low volume change material in the parking lot area, if a flexible pavement system is selected for the parking area, a woven geotextile equal to a Mirafi 500X is recommended.

CONSTRUCTION CONSIDERATIONS

Site Preparation

All utility trenches should be backfilled in accordance with appropriate controlled engineered fill specifications. All trench excavations should be made with sufficient working space to permit the placing, inspection, and completion of all work including backfill construction. It is recommended that a representative of the geotechnical engineer be present during fill placement and compaction to assure that adequate compaction is achieved and that proper methods are employed.

Site Excavation

General site excavation may be accomplished using standard earthwork equipment, including dozers and trackhoes. It is recommended that a unit price for rock removal be established in the contract documents, to address any erratic boulders or limestone pinnacles that may be encountered.

In areas where the excavation side wall cannot be sloped to meet OSHA requirements, some form of shoring system will be required. Shoring systems may consist of trench boxes, soldier piles and lagging and sheet piles. The same design parameters presented in the retaining wall section may be used for design of the shoring system.

Slab Subgrade Preparation

The moderate to high shrink-swell potential of the subgrade soils require that they do not dry excessively or become inundated prior to or during construction of the floor slab. If subgrade soils are found to be unsuitable or become disturbed by nature or construction activities, these areas should be excavated to a solid base and then regraded with engineered fill.

Foundation Excavation and Construction

Foundation bearing surfaces should be free of loose soil and standing water, and should be level. Foundation concrete should be placed the same day the foundation is excavated. Deleterious

materials or isolated soft spots within the foundation should be overexcavated to suitable base and filled to design bearing elevation with lean concrete.

Drilled Pier Construction

Difficult drilling conditions including layers of gravel, cobbles and/or boulders are expected on the project. In light of this, it is recommended that a rock allowance be included in unit prices. Groundwater is not expected to influence pier construction, when encountered. A casing and dewatering allowance should also be included in the unit prices.

Pier shafts should be excavated within the following tolerances:

1. The shaft centerline should be within 3 inches or four percent of the shaft diameter, whichever is less.
2. The shaft diameter should not vary by more than plus three or minus one inch.
3. The shaft should be plumb to within $\frac{1}{4}$ inch per foot, 12.5 percent of the shaft diameter, or 15 inches total, whichever is less.

If loose soil, high groundwater levels, or other conditions occur which cause the sides or bottom of the excavation to become unstable, the excavation should be advanced through a temporary or permanent casing, or other approved method. Any water that enters the excavation should be pumped down to a depth of less than 2 inches prior to concrete placement. If any pier excavation cannot be satisfactorily dewatered, concrete should be placed using tremie techniques. Groundwater was encountered during drilling and should be expected during pier excavation. It is recommended that sufficient casing of proper size be on location during drilling. A temporary casing is required for all downhole inspections.

All pier concrete should be placed immediately after excavation due to the deteriorating nature of the sandy clay soils but no later than 1 to 2 hours after excavation. Concrete should be placed in dry pier excavations with the use of tremie and free fall method and should not hit the side of the shaft or the reinforcing steel cage during placement.

All loose material and spoil should be removed from the shaft prior to placing concrete. In no case should the volume of such material exceed that which would be required to cover five percent of the shaft base at the bearing elevation to a depth of more than 2 inches. Shafts bearing on limestone bedrock should be excavated to a level plane. Shafts bearing at soil auger refusal should be as level as possible.

Construction Fill and Backfill

Engineered fill is defined as soil or granular fill containing sufficient fines to establish a moisture/density relationship. Engineered fill should be free of frozen soil, organics, rubbish, large rocks, wood, or other deleterious material. Cohesive soils should be uniformly compacted to at least 95 percent of the "Standard" maximum dry density and be within -2 to +4 percent of optimum

moisture content as described by ASTM D698. Granular fill, such as MoDOT 1007 Type 1/5, should be compacted to at least 95% of the maximum dry density as determined by the Standard Proctor, ASTM D698. The moisture content should be high enough to provide for proper compaction but low enough to prevent undue pumping. Should the results of the in-place density tests indicate that the specified compaction limits have not been achieved, the area represented by the test should be reworked and retested as required until the specified limits are reached. Proposed fill should be analyzed by the geotechnical engineer as soon as borrow sources are identified to determine suitability and conformance with the following recommendations.

Soil classified as MH, OH, OL, or PT (high plasticity soils and organic soils) by the Unified Soil Classification System (ASTM D 2487) should not be imported for use as engineered fill. Soils that classify as CH should be analyzed and approved by a qualified geotechnical engineer prior to use on site. Imported materials for general site fill should be approved by the geotechnical engineer prior to use. Suitable imported materials for wall and trench backfill are those that classify as GW, GM, GC, SM, SW, SP, SC, and CL in accordance to ASTM D 2487.

The fill material should be placed in layers, not to exceed eight inches in loose thickness, and should be wetted or dried as required to secure specified compaction. Effective spreading equipment should be used on each lift to obtain a uniform lift thickness prior to compaction. Each layer should be uniformly compacted by means of suitable equipment of the type required by the materials composing the fill. Material that is too wet to permit proper compaction may be stockpiled or spread and permitted to dry assisted by disking, harrowing, or pulverizing until the moisture content is reduced to a satisfactory value. The fill layers should be placed approximately parallel to the finished grade. Rocks and stones that exceed the thickness of the 8 inch loose lift layer should be removed and disposed of off the immediate construction site.

Fill and subgrade construction should not be started on foundation soil, partially completed fill, or subgrades that contain frost or ice. Fill should not be constructed of frozen soil. Frozen soil should be removed prior to placing fill material.

Warranties and Limitations

This report has been prepared for the exclusive use of AECOM, and their consultants for the specific project discussed, in accordance with generally accepted soils engineering practices common to the western Missouri area. No other warranties, expressed or implied, are made.

This investigation and report do not constitute a guarantee of subsurface conditions, groundwater conditions, excavation characteristics or construction conditions. We recommend that excavation conditions across the site be evaluated during construction relative to this interpretation of subsurface conditions. Variations in subsurface conditions may occur that require evaluation or revision of geotechnical design parameters or recommendations. If the scope of the project is altered or differing geotechnical conditions are encountered, it would be advisable to review and update our recommendations in consideration of those findings or variations.

Recommendations contained in this report are based on subsurface conditions and proposed designs provided as of this date. The above study and recommendations are applicable only for the conditions and locations described, and for the specific project mentioned. Use of the data contained herein by others may require interpretation or analysis that was not contemplated by our investigation and analysis. The use of this data and any interpretations or conclusions developed by others are the sole responsibility of those firms or individuals.

Factors affecting design and construction often become apparent during detailed design or actual construction that were not anticipated in the pre-design or early design phases. Engineering Surveys and Services is available during design and construction to assist in evaluating these factors and their impact on these geotechnical recommendations.

APPENDIX

LAB NO. 2500

PROJECT: *Kansas City Veterans Medical Center*
Kansas City, Missouri

SYMBOLS AND TERMS

SAMPLE TYPES



Auger



Shelby
Tube



Split
Spoon



Giddings
Tube



No
Recovery



NX Core
Boring



Roller Bit
(Tri-Cone)



Concrete
Corer



Down Hole
Hammer

ABBREVIATIONS

- ⊗ Unconfined Compression (1)
- Water Content (2)
- + Plastic (PL) & Liquid (LL) Limit (2)

USCS Unified Soil Classification System

PI Plasticity Index

ATD At Time of Drilling

RQD Rock Quality Designation

SS Split Spoon — 1 3/8" I.D., 2" O.D.

ST Shelby Tube — 3" O.D.

PA Power Auger

HA Hand Auger

AS Auger Sample

S Cuttings Sample

TV Hand-Held Torvane

DEFINITIONS

Blows per ft.— Indicates blows per 12 inches of sampler penetration when driven by a 140-pound hammer falling freely 30 inches. The Standard Penetration Resistance is the number of blows for the last 12 inches of penetration of the split-spoon sampler.

NOTES

- (1) Shear Strength Data plotted on cohesion scale of Boring Logs.
- (2) Classification and Index Properties plotted on Water Content Scale of Boring Logs.

LAB NO. 2500PROJECT: *Kansas City Veterans Medical Center*
Kansas City, Missouri

SUMMARY OF

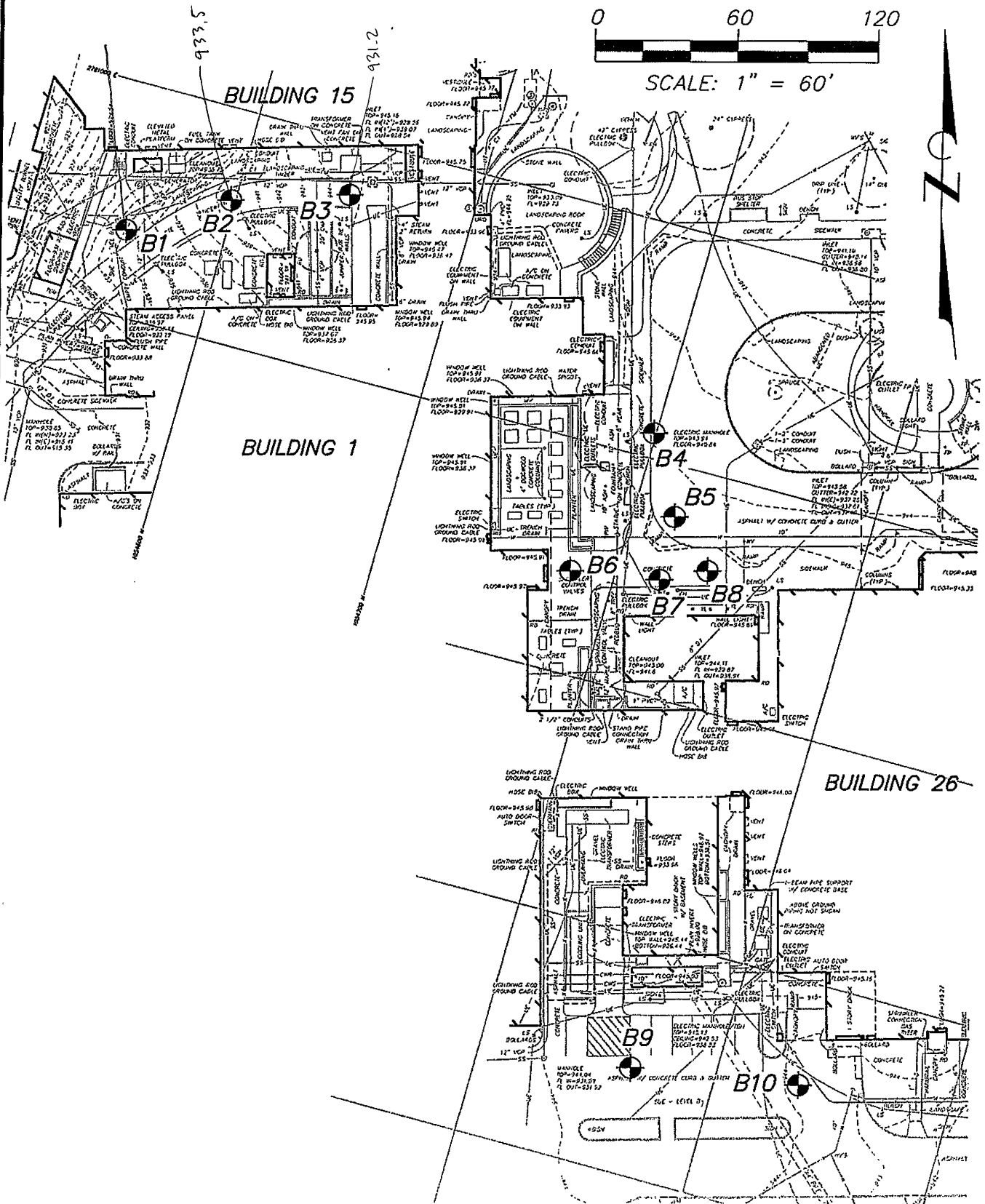
LABORATORY TEST RESULTS

BORING NO.	SAMPLE NO.	DEPTH (FEET)	USCS CLASS	NATURAL MOISTURE CONTENT (%)	NATURAL DRY DENSITY (PCF)	ATTERBERG LIMITS			UNCONFINED COMPRESSION (TSF)	COHESION STRAIN %	REMARKS
						LL	PL	PI			
B1	ST1	2.0-4.0	CL/CH	28.0		50	16	34			pH = 6.2; Resistivity = 695 Ω/cm
	ST2	5.0-7.0		23							
B2	SS1	2.0-3.5		25							
	SS1	2.0-3.5		24							
B3	SS2	5.0-6.5		26							
	ST3	11.0-12.5		30							
B4	ST1	2.5-4.5		26							
	SS2	4.5-6.0		26							
B5	SS1	2.0-3.5	CH	12	95	57	17	40	0.5	5.7	
	ST2	5.5-6.0		27							
	ST3	10.5-12.5		27							
B7	SS1	2.0-3.5		23							
	ST2	6.0-6.5		26							
	SS3	7.0-8.5		21							
	SS4	10.0-11.5		29							
	SS5	13.5-15.0		48							
B8	SS1	2.0-3.5		21	97						
	ST2	5.0-6.5		21							
	SS3	9.0-10.5		25							
B9	ST1	2.0-4.0		28						pH = 7.0; Resistivity = 862 Ω/cm	
	SS2	5.0-6.5		27							
B10	ST1	3.0-5.0		26							

PLAN OF BORING LOCATIONS

PROJECT: KANSAS CITY VETERANS MEDICAL CENTER
LOCATION: KANSAS CITY, MO

LAB NO. 2500



C:\ENGINEERING\KANSAS\AECOM\2500\BORING PLANDWG 4/15/2011



Engineering Surveys & Services
Columbia, Missouri

LAB NO. 2500LOG OF BORING NO. B1PROJECT: *Kansas City Veterans Medical Center
Kansas City, Missouri*TYPE: *4" Solid Stem Auger*

DEPTH, FT.	SAMPLE TYPE	SOIL DESCRIPTION TYPE, COLOR, MOISTURE & OTHER LOCATION: <i>See Plan of Boring Locations</i> SURF. ELEV.: 934.0'	BLOWS PER FT.	UNIFIED CLASSIFICATION	UNIT DRY WT. LB./CU.FT.	COHESION, TON/SQ.FT.						
						0.2 0.4 0.6 0.8 1.0 1.2 1.4						
						PLASTIC LIMIT	WATER CONTENT, %			LIQUID LIMIT		
						+	+			+		
						10	20	30	40	50	60	70
		TOPSOIL										
		FILL: SILTY CLAY; Medium to dark brown, moist, firm		CL/CH								
5		-; some mottled medium gray										
		CLAY: Medium brown, moist, firm										
10												
		LIMESTONE: Buff, dry, hard										
		CORE 1 (10.0' - 16.0'):										
		RECOVERY = 5%, RQD = 0.00										
15												
		CORE 2 (16.0' - 21.0'):										
		RECOVERY = 100%, RQD = 0.67										
20												
		CORE 3 (21.0' - 26.0'):										
		RECOVERY = 78%, RQD = 0.67										
25												
		SHALE: Dark gray, hard										
		CORE 4 (26.0' - 31.0'):										
		RECOVERY = 100%, RQD = 0.78										
30												
35												
40												
45												
50												

Completion Depth: *31.0'*Date: *2 APRIL 2011*Depth to Water: *Not Encountered*Date: *2 APRIL 2011*

LAB NO. 2500LOG OF BORING NO. B2PROJECT: *Kansas City Veterans Medical Center
Kansas City, Missouri*TYPE: *4" Solid Stem Auger*

DEPTH, FT.	SAMPLE TYPE	SOIL DESCRIPTION TYPE, COLOR, MOISTURE & OTHER LOCATION: <i>See Plan of Boring Locations</i> SURF. ELEV.: 939.5'	BLOWS PER FT.	UNIFIED CLASSIFICATION	UNIT DRY WT. LB./CU.FT.	COHESION, TON/SQ.FT.		
						PLASTIC LIMIT	WATER CONTENT, %	LIQUID LIMIT
		CONCRETE						
2	X	FILL: SILTY CLAY; Medium brown to slight dark yellowish brown, moist, firm -; dark brownish gray	10					
4								
6								
8		LIMESTONE: Buff, hard						
10		AUGER REFUSAL ON LIMESTONE						
12								
14								
16								
18								
20								

Completion Depth: *6.5'*
 Date: *2 APRIL 2011*

Depth to Water: *Not Encountered*
 Date: *2 APRIL 2011*

LAB NO. 2500LOG OF BORING NO. B3PROJECT: *Kansas City Veterans Medical Center
Kansas City, Missouri*TYPE: *4" Solid Stem Auger*

DEPTH, FT.	SAMPLE TYPE	SOIL DESCRIPTION TYPE, COLOR, MOISTURE & OTHER LOCATION: <i>See Plan of Boring Locations</i> SURF. ELEV.: 944.7'	BLOWS PER FT.	UNIFIED CLASSIFICATION	UNIT DRY WT. LB./CU.FT.	COHESION, TON/SQ.FT. 0.2 0.4 0.6 0.8 1.0 1.2 1.4						
						PLASTIC LIMIT			WATER CONTENT, %		LIQUID LIMIT	
						+	+	+	+	+	+	+
						10	20	30	40	50	60	70
		CONCRETE										
		FILL: SILTY CLAY; Medium brown with some reddish brown, moist, firm										
2	X	SILTY CLAY: Brown, moist, stiff	8					•				
4												
6	X	SILTY CLAY; Brown, moist, firm to stiff, trace lignite	8					•				
8												
10												
12		-; some gravel						•				
14		931.2 LIMESTONE										
16		929.2 AUGER REFUSAL ON LIMESTONE										
18												
20												

Completion Depth: *15.5'*Date: *2 APRIL 2011*Depth to Water: *Not Encountered*Date: *2 APRIL 2011*

LAB NO. 2500LOG OF BORING NO. B4PROJECT: *Kansas City Veterans Medical Center
Kansas City, Missouri*TYPE: *4" Solid Stem Auger*

DEPTH, FT.	SAMPLE TYPE	SOIL DESCRIPTION TYPE, COLOR, MOISTURE & OTHER LOCATION: <i>See Plan of Boring Locations</i> SURF. ELEV.: 944.4'	BLOWS PER FT.	UNIFIED CLASSIFICATION	UNIT DRY WT. LB./CU.FT.	COHESION, TON/SQ.FT.						
						0.2 0.4 0.6 0.8 1.0 1.2 1.4						
						PLASTIC LIMIT	WATER CONTENT, %				LIQUID LIMIT	
						+	+				+	
						10	20	30	40	50	60	70
		ASPHALT										
		FILL: SILTY CLAY; Medium brown, moist, firm										
2												
		SILTY CLAY; Brown, moist, stiff, friable										
4												
6			12									
8												
10		LIMESTONE: Buff, dry, hard										
		; clay seam										
12		LIMESTONE: Buff, dry, hard										
		AUGER REFUSAL ON LIMESTONE										
14												
16												
18												
20												

Completion Depth: *12.2'*
 Date: *2 APRIL 2011*

Depth to Water: *Not Encountered*
 Date: *2 APRIL 2011*

LAB NO. 2500LOG OF BORING NO. B5PROJECT: *Kansas City Veterans Medical Center
Kansas City, Missouri*TYPE: *4" Solid Stem Auger*

DEPTH, FT.	SAMPLE TYPE	SOIL DESCRIPTION TYPE, COLOR, MOISTURE & OTHER LOCATION: <i>See Plan of Boring Locations</i> SURF. ELEV.: 944.5'	BLOWS PER FT.	UNIFIED CLASSIFICATION	UNIT DRY WT. LB./CU.FT.	COHESION, TON/SQ.FT. 0.2 0.4 0.6 0.8 1.0 1.2 1.4						
						PLASTIC LIMIT +	WATER CONTENT, % +	LIQUID LIMIT +				
						10	20	30	40	50	60	70
		ASPHALT										
2		FILL: SILTY CLAY; Medium brown, moist, firm -; soft, some sand and gravel	40									
4												
6					95							
8		FILL: GRAVELLY CLAY; Medium brown, moist, firm, fine gravel										
10												
12				CH			+					+
14		LIMESTONE: Buff, dry, hard AUGER REFUSAL ON LIMESTONE										
16												
18												
20												

Completion Depth: *14.0'*Date: *2 APRIL 2011*Depth to Water: *Not Encountered*Date: *2 APRIL 2011*

LAB NO. 2500LOG OF BORING NO. B7PROJECT: *Kansas City Veterans Medical Center
Kansas City, Missouri*TYPE: *4" Solid Stem Auger*

DEPTH, FT.	SAMPLE TYPE	SOIL DESCRIPTION TYPE, COLOR, MOISTURE & OTHER LOCATION: <i>See Plan of Boring Locations</i> SURF. ELEV.: 945.7'	BLOWS PER FT.	UNIFIED CLASSIFICATION	UNIT DRY WT. LB./CU.FT.	COHESION, TON/SQ.FT.		
						PLASTIC LIMIT	WATER CONTENT, %	LIQUID LIMIT
						0.2 0.4 0.6 0.8 1.0 1.2 1.4	10 20 30 40 50 60 70	
		CONCRETE						
		GRAVEL: Gray, dry, 1/2" clean						
		CLAY: Reddish brown, moist, firm	8					
5					97			
		-; stiff	7					
10			12					
15		CLAY: Reddish brown, moist, firm, trace lignite	8					
20		Limestone: Buff, dry, hard -; interbedded clay and shale						
		CORE 1 (20.0' - 23.0'): RECOVERY = 0%, RQD = 0.00						
25		SHALE: Dark gray, hard						
		LIMESTONE: Gray						
30		SHALE: Dark gray						
35								
40								
45								
50								

Completion Depth: *35.0'*
Date: *2 APRIL 2011*Depth to Water: *Not Encountered*
Date: *2 APRIL 2011*

LAB NO. 2500LOG OF BORING NO. B8PROJECT: *Kansas City Veterans Medical Center
Kansas City, Missouri*TYPE: *4" Solid Stem Auger*

DEPTH, FT.	SAMPLE TYPE	SOIL DESCRIPTION TYPE, COLOR, MOISTURE & OTHER LOCATION: <i>See Plan of Boring Locations</i> SURF. ELEV.: 945.3'	BLOWS PER FT.	UNIFIED CLASSIFICATION	UNIT DRY WT. LB./CU.FT.	COHESION, TON/SQ.FT. 0.2 0.4 0.6 0.8 1.0 1.2 1.4						
						PLASTIC LIMIT			WATER CONTENT, %		LIQUID LIMIT	
						+	+	+	+	+	+	+
						10	20	30	40	50	60	70
		CONCRETE										
		FILL: SILTY CLAY; Medium brown, moist, firm										
2	X	-; some gray, trace dark brown	10									
4												
6												
8												
10	X	SILTY CLAY: Medium reddish brown, moist, firm, very uniform	11									
12												
14		LIMESTONE: Buff, dry, hard, thin clay seams										
16												
18												
20												
		AUGER REFUSAL ON LIMESTONE										

Completion Depth: *13.5'*
Date: *3 APRIL 2011*Depth to Water: *Not Encountered*
Date: *3 APRIL 2011*

LAB NO. 2500LOG OF BORING NO. B9PROJECT: *Kansas City Veterans Medical Center
Kansas City, Missouri*TYPE: *4" Solid Stem Auger*

DEPTH, FT.	SAMPLE TYPE	SOIL DESCRIPTION TYPE, COLOR, MOISTURE & OTHER LOCATION: <i>See Plan of Boring Locations</i> SURF. ELEV.: 944.4'	BLOWS PER FT.	UNIFIED CLASSIFICATION	UNIT DRY WT. LB./CU.FT.	COHESION, TON/SQ.FT.						
						0.2 0.4 0.6 0.8 1.0 1.2 1.4						
						PLASTIC LIMIT	WATER CONTENT, %			LIQUID LIMIT		
						+	+			+		
						10	20	30	40	50	60	70
		ASPHALT										
		AGGREGATE BASE: 1" top size										
2		FILL: SILTY CLAY; Grayish brown, moist, firm, friable										
		SILTY CLAY: Brown, moist, firm, friable										
4												
6		SILTY CLAY: Brown, moist, firm to stiff	7									
8												
10		-; gravel										
		LIMESTONE: Buff, dry, hard										
12		AUGER REFUSAL ON LIMESTONE										
14												
16												
18												
20												

Completion Depth: *11.5'*
Date: *3 APRIL 2011*Depth to Water: *Not Encountered*
Date: *3 APRIL 2011*

LAB NO. 2500LOG OF BORING NO. B10PROJECT: *Kansas City Veterans Medical Center
Kansas City, Missouri*TYPE: *4" Solid Stem Auger*

DEPTH, FT.	SAMPLE TYPE	SOIL DESCRIPTION TYPE, COLOR, MOISTURE & OTHER LOCATION: <i>See Plan of Boring Locations</i> SURF. ELEV.: 943.8'	BLOWS PER FT.	UNIFIED CLASSIFICATION	UNIT DRY WT. LB./CU.FT.	COHESION, TON/SQ.FT.						
						0.2 0.4 0.6 0.8 1.0 1.2 1.4						
						PLASTIC LIMIT	WATER CONTENT, %			LIQUID LIMIT		
						+	+			+		
						10	20	30	40	50	60	70
		ASPHALT										
		FILL: SILTY CLAY; Grayish brown, moist, firm										
2												
		SILTY CLAY: Reddish brown, moist, firm to stiff, gravel										
4												
		LIMESTONE: Weathered with clay										
6	X	-; buff	44 6"									
		AUGER REFUSAL ON LIMESTONE										
8												
10												
12												
14												
16												
18												
20												

Completion Depth: *7.0'*Date: *3 APRIL 2011*Depth to Water: *Not Encountered*Date: *3 APRIL 2011*

