Geotechnical Exploration
Proposed Joint Operations Facility
NE Tudor Road and NW Sloan
Lee's Summit, Missouri

Prepared for:

City of Lee's Summit, Missouri

Prepared by:

Geotechnology, LLC, dba UES
Overland Park, Kansas

Date:

May 14, 2024

UES Project No.:

J045326.01

SAFETY
TEAMWORK
RESPONSIVENESS
INTEGRITY
VALUE
EXCELLENCE

May 14, 2024

Sharon Bloom, M. Arch
City of Lee's Summit, Missouri
220 SE Green Street
Lee's Summit, Missouri 64063

Re: Geotechnical Exploration
Proposed Joint Operations Facility
NE Tudor Road and NW Sloan
Lee's Summit, Missouri
UES Project No. J045326.01

Dear Ms. Bloom:

Presented in this report are the results of the geotechnical exploration conducted for the referenced project. This report includes our project understanding, observed site conditions, conclusions and/or recommendations, and support data as given in the Table of Contents.

It has been our pleasure to provide geotechnical services to you, and we welcome the opportunity to provide other services during the project. Please contact the undersigned if you need further information about this document.

Sincerely,

UES

Matt McQuality, P.E.
Office Lead

MHM/JAW:mhm/sem

Environmental
Geotechnical Engineering
Materials Testing
Field Inspections & Code Compliance
Geophysical Technology

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NE TUDOR ROAD AND NW SLOAN
LEE'S SUMMIT, MISSOURI
May 14, 2024 | UES Project No. J045326.01

1.0 EXECUTIVE SUMMARY

The executive summary is provided solely for the purpose of overview and several details are omitted, each of which could be crucial to the recommended application of this report. Those who rely on this report should read the entire report.

- The project consists of the design and construction of a facility to house fire administration, an emergency operations center, network infrastructure, co-located fire and police emergency communications, and traffic monitoring/management support. The facility will include a two-level structure with an overall footprint of approximately 140 feet by 210 feet. Planned structures also include a single-story, slab-on-grade vehicle storage building, covered parking canopies and modular block retaining walls.
- Fill was encountered at 18 of the 21 boring locations to depths of 2 feet to 8 feet. The fill sampled included fat clay, lean clay and limestone gravel. Below the fill and/or root zone, the native soil overburden generally consists of medium stiff to very stiff fat clay and lean clay. Shale and limestone bedrock occurs at approximate depths of 2 to 13 feet in 20 of the borings. Groundwater was encountered in three borings.
- Existing fill should be considered uncontrolled and compressible. Full-depth remediation of existing fill in building areas is recommended. Partial remediation of fill in pavement areas may be considered as discussed herein.
- Fat clay occurs at the site. If present at floor slab subgrade, fat clay must be remediated to a depth of 24 inches. Fat clay occurring at pavement subgrade could also be remediated below the pavement section as a measure to improve pavement performance. Discussion of fat clay remediation is presented herein.
- Black shale was encountered in one boring. Black shale occurring at floor slab subgrade and below footings should be completely removed as discussed herein.
- Relatively shallow shale and limestone bedrock occurs at the site. Shale encountered in mass excavations can sometimes be excavated with heavy trackhoes or bulldozers equipped with rippers. However, hard rock removal techniques might be required for shale in confined or trench excavations. Hard rock removal techniques should be anticipated for limestone. Blasting is not recommended due to the urban nature of the project site.
- Strip and spread footings bearing on firm, native soil and compacted fill may be proportioned for net allowable bearing pressures of 2,500 and 3,000 pounds per square foot (psf), respectively.
- Rock-bearing footings may be proportioned for a net allowable bearing pressure of 12,000 psf.

- Based on the results of the borings and the general procedures of the 2018 Edition of the International Building Code (IBC), Site Class B (Rock) may be used.

2.0 PROJECT DATA

2.1 Authorization

The services documented in this report were provided in general accordance with the scope of services described in UES' proposal P045326.01 dated February 19, 2024. The City of Lee's Summit, Missouri authorized our services by issuance of the February 27, 2024 *Memorandum of Authorization for Services for Geotechnical Exploration* and Purchase Order 133398 dated March 6, 2024.

2.2 Purpose and Scope of Services

The purpose of our services was to develop recommendations for geotechnical aspects of the design and construction of the project as defined in the scope of services of the referenced proposal. Briefly, geotechnical services consisted of drilling 21 borings, laboratory testing, engineering analyses and reporting.

A copy of "Important Information about This Geotechnical-Engineering Report" that is published by the Geotechnical Business Council (GBC) of the Geoprofessional Business Association (GBA) is included in Appendix A for your review. The publication discusses some other limitations, as well as ways to manage risk associated with subsurface conditions.

2.3 Project Description and Site Location

***Project Description*.** The project consists of the design and construction of a Joint Operations Facility for the City of Lee's Summit (City). The facility will house fire administration, the City's Emergency Operations Center, network infrastructure, co-located fire and police emergency communications, and traffic monitoring/management support.

Preliminary details of the Joint Operations Facility include a two-story building with an overall footprint of approximately 140 feet by 210 feet. The upper floor will be finished at El 1025.3[1] and the lower level, which is partially below grade, will be finished at El 1009.

Planned structures also include single-story, slab-on-grade vehicle storage building, covered parking canopies and modular block retaining walls. Structural loads are being developed. Based on our experience with similar structures, column and wall loads of up to 200 kips and 8 kips per lineal foot, respectively, are anticipated. Pavements subject to automobiles, fire trucks and ambulances are also planned. Finished site grades are being developed.

***Site Location*.** The project site is located at the northeast corner of the intersection of NE Tudor Road and NW Sloan. The site abuts the west side of the City's Police Headquarters. Currently, the site includes lawn areas, asphalt pavements, an asphalt-paved trail, and occasional moderately-sized trees. A detention pond occurs at the north end of the site. The site slopes from the south down to the north and has an overall relief of approximately 15 feet. The site

[1] Elevations herein are in feet and reference 1988 North American Vertical Datum (NAVD88).

location and general topography of the area as per the 2021 U.S.G.S. maps of the vicinity are shown on Figure 1.

3.0 FIELD EXPLORATION AND LABORATORY TESTING

3.1 Field Exploration

The field exploration consisted of drilling 21 borings, designated as Borings B-1 through -21, at approximately the locations shown on Figure 2. The City provided the boring locations. A representative of UES estimated the boring locations by measuring distances from site features. Elevations at the boring locations, which are listed on the boring logs given in Appendix B, were estimated using a USGS website. The boring locations should be measured by a professional surveyor if accurate location data is required.

The borings were drilled using an all-terrain CME 550X rotary drill rig equipped with 4-inch outside diameter (O.D.) flight augers and 3 3/4-inch inside diameter (I.D.) hollow stem augers. Standard Penetration Tests (SPTs) were performed using an automatic hammer. Split-spoon and Shelby tube samples were obtained at the depths indicated on the boring logs. Borings B-1, -3, -5, -7, -9, -11, -13 and -15 were extended 10 to 15 feet into rock using NQ2 rock coring tools. An explanation of the terms and symbols used on the boring logs is also included in Appendix B. Photographs of the rock core are included as Appendix C.

A field engineer from UES provided direction during field exploration, observed drilling and sampling, prepared logs of the material encountered, and estimated the as-drilled boring locations using a handheld GPS device. The boring logs represent conditions observed at the time of exploration and have been edited by a professional engineer to incorporate results of the laboratory tests.

Unless noted on the boring logs, the lines designating the changes between various strata represent approximate boundaries. The transition between materials might be gradual or might occur between recovered samples. The stratification given on the boring logs, or described herein, is for use by UES in its analyses and should not be used as the basis of design or construction cost estimates without realizing that there can be variation from that shown or described.

The boring logs and related information depict subsurface conditions only at the specific locations and time where sampling was conducted. The passage of time might result in changes in conditions, interpreted to exist, at or between the locations where sampling was conducted.

3.2 Laboratory Testing

Laboratory testing was performed on soil and shale samples to estimate engineering and index properties. Moisture content tests were generally performed on selected fine-grained soil and shale samples. Atterberg limits tests were performed on selected fine-grained soil and shale samples. Dry unit weight determination and unconfined compressive strength tests were performed on the Shelby tube samples. Results of the laboratory tests are presented on the boring logs.

4.0 SUBSURFACE CONDITIONS

Generalized subsurface profiles are given on Figures 3 through 5. These profiles depict general subsurface conditions across the site from north to south. Actual conditions at locations between the borings might differ from the generalized subsurface profiles.

4.1 Stratigraphy

Overburden. In general, the boring locations are surfaced with grass with a 4- to 12-inch-deep root zone. Borings B-19 through -21 were drilled in the City's police department parking lot. The pavement section at these borings consisted of 5.5 to 7 inches of asphalt underlain by 5 to 6.5 inches of well-graded crushed rock.

Below the surface cover, fill occurs at 18 of the 21 boring locations. The fill sampled included fat clay and lean clay of various colors, limestone gravel, shale fragments and organics. The fill occurs to depths ranging from 2 to 8 feet.

Below the fill or the root zone, the natural soil stratigraphy generally consists of medium stiff and stiff, reddish brown and brown, fat clay and medium stiff to hard, tan and brown, lean and fat, shaley clay to the top of shale or limestone bedrock at depths of 2 to 13 feet. In Boring B-21, shale occurs at a depth of approximately 23 feet.

Rock. A summary of the top of rock and auger refusal information is presented in Table 1. The refusal level given in Table 1, however, occurs after penetrating several feet of shale and/or limestone. The boring logs should be reviewed for additional information regarding the shale and limestone above the refusal level. The elevations given in Table 1 should not be considered the competent rock bearing level for foundations.

The underlying bedrock in Borings B-1, -3, -5, -7, -9, -11, -13 and -15 was cored. In Borings B-1 and -3, the 10 feet of recovered rock core consisted of approximately 2 feet of limestone underlain by calcareous shale. In Boring B-5, the 11 feet of recovered rock core consisted of alternating layers of limestone and calcareous shale with layer thicknesses ranging from approximately 4 inches to 2 feet. In Boring B-7, the 10 feet of recovered rock core consisted of approximately 4 feet of limestone underlain by 2 feet of calcareous shale underlain, in turn, by limestone. In Boring B-9, the 11 feet of recovered rock core consisted of approximately 30 inches of limestone underlain by 13 inches of shale underlain, in turn, by 3 feet of limestone underlain by calcareous shale. In Boring B-11, the 10 feet of recovered rock core generally consisted of 5 feet of limestone underlain by 3 feet of shale underlain, in turn, by limestone. In Boring B-13, the 15 feet of recovered rock core consisted of approximately 5 feet of limestone underlain by 5 feet of interbedded calcareous shale and limestone with layer thicknesses ranging from 3 to 24 inches underlain, in turn, by calcareous shale. In Boring B-15, the 10 feet of recovered rock core consisted of alternating layers of limestone and calcareous shale with layer thicknesses ranging from approximately 4 inches to 3 feet.

The recovered shale is generally gray and dark gray, very soft, weathered and slightly weathered. The recovered limestone is gray, moderately hard, weathered and slightly weathered. In general, the rock core recovery values ranged from 92 to 100 percent, and the corresponding rock quality designation (RQD) values ranged from zero to 100 percent.

In Boring B-7, core loss of 9 inches occurred in one rock core run resulting in a recovery value of 85 percent. In Boring B-13, core loss of 18 inches occurred in one rock core run resulting in a recovery value of 68 percent. Rock core recovery values of less than 100 percent indicate that less material was recovered than the cored interval. Less material recovery could be due to the washing away of clay seams and/or portions of the rock that are poorly cemented and/or highly weathered. RQD is the ratio of the sum of the pieces of core measuring 4 inches or longer to the total length of the cored interval, expressed as a percentage. Higher quality rock typically has higher RQD value (i.e. more than 75 percent). Conversely, poor quality rock typically has a low RQD value (i.e., less than 50 percent). Further explanation of RQD values is provided on the *Rock Core Descriptions* explanation sheet at the end of Appendix B.

Table 1. Refusal Information

Boring Location	Surface Elevation	Top of Rock		Approximate Refusal Level	
		Depth, feet/Type	Elevation	Depth, feet	Elevation
B-1	1011	12/Shale	999	16	995
B-2	1008	8/Shale	1008	12.5	995.5
B-3	1006	1.5/Limestone	1004.5	12	994
B-4	1014	8/Shale	1006	12	1002
B-5	1010	3/Shale	1007	10	1000
B-6	1009	5.5/Limestone	103.5	13.5	995.5
B-7	1017	11.5/Limestone	1005.5	14	1003
B-8	1013	5.5/Shale	1007.5	19.5	993.5
B-9	1011	5/Shale	1006	13.5	997.5
B-10	1019	11/Shale	1008	17.5	1001.5
B-11	1017	9/Shale	1008	15.5	1001.5
B-12	1015	8/Shale	1007	15	1000
B-13	1021	11/Shale	1010	19.5	1001.5
B-14	1019	12/Shale	1007	24*	995
B-15	1017	9/Shale	1008	20	997
B-16	1012	9/Shale	1003	14	998
B-17	1017	12/Shale	1005	17.5	999.5
B-18	1008	5/Limestone	1003	6.5	1001.5
B-19	1007	5.5/Limestone	1001.5	7.5	999.5
B-20	1007	None	n/a	13	994
B-21	1006	23/Shale	983	24*	982

*Boring terminated at sampler refusal on shale

4.2 Groundwater

During drilling groundwater was encountered at approximate depths of 17 feet and 23 feet at Borings B-8 and -14. At Boring B-3 groundwater was measured at a depth of 9.9 feet approximately 16 hours after completion of drilling. At Boring B-14 groundwater was measured at a depth of 18.9 feet approximately 3.5 hours after completion of drilling.

Groundwater might not have stabilized before borehole backfilling and/or commencement of rock coring techniques. Rock coring requires the introduction of water into the borehole, which masks the presence of groundwater. The lack of and/or observed groundwater levels might not represent present or future levels. Groundwater levels might vary substantially over time because of seasonal variation in precipitation, recharge, or other factors not evident at the time of exploration. Therefore, groundwater levels during construction or at other times in the life of the structures might be higher than the levels indicated herein. Water might be trapped near the top of rock. Water might also be trapped within permeable fill pockets, in pavement base course, and in utility trenches. Excavations that remain open could collect water.

5.0 DESIGN CONSIDERATIONS AND RECOMMENDATIONS

UES should be allowed to review final grading and foundation plans to check that our recommendations have been properly implemented. If the structure loads, grades/elevations, or building locations vary from those discussed, the recommendations herein might require modifications, and/or additional field exploration and related analysis might be required. Subsurface features that will influence the geotechnical approach to the proposed development include (1) the presence of existing fill, fat clay and black shale and (2) the shallow depth to limestone and shale bedrock. Discussions of each of these features and foundations supported by mixed-bearing materials follows.

Existing Fill. Fill was encountered at 18 of the 21 boring locations to approximate depths of 2 to 8 feet. Fill likely occurs in unexplored areas of the site. Fill might extend to greater depths than those depicted on the boring logs. The composition of the fill could vary in unexplored locations.

The presence of fill complicates the project. The fill should be considered uncontrolled and compressible. The risks associated with supporting foundations, floor slabs and pavements on uncontrolled fill include total and differential settlement in excess of tolerable limits.

The more positive approach for site development is the full depth remediation of the existing fill. The planned lower level finished floor could result in the overexcavation of the existing fill within the footprint of the Joint Operations Facility. Remaining fill within the footprint of the Joint Operations Facility, however, should be fully removed.

Partial removal and replacement of fill can be considered in pavement areas only. In exchange for the cost savings associated with remediating only a portion of the fill, the City must recognize that partial remediation will require acceptance of a greater risk for pavement distress compared to full depth overexcavation and replacement. Discussion of fill remediation is presented herein.

Fat Clay. Fat clay occurs at the site. Fat clay has the potential for volume change due to fluctuations in moisture content throughout the life of the structure. Swelling and consequent heaving of floors and pavements can occur when a fat clay subgrade absorbs moisture. Alternatively, shrinkage and consequent loss of subgrade support can occur when a fat clay subgrade desiccates. If present at floor slab subgrade, fat clay must be remediated as discussed herein. As a measure to improve pavement performance, fat clay at pavement subgrades could also be remediated.

Black Shale. Black shale was encountered at Boring B-15, which is located within the footprint of the Joint Operation Facility. In the Kansas City area black shale is known to be problematic due to its potential for swelling and heaving. Black shale encountered below footings and at floor slab subgrade should be completely removed. Overexcavations in footing areas should be backfilled with concrete or lean concrete. Overexcavations in floor slab areas should be backfilled with lean clay or well-graded crushed limestone placed as discussed in this report.

Shallow Depth to Rock. Limestone and shale occurs at approximate depths of 2 to 13 feet in 20 of the 21 borings. Limestone and shale might occur at shallower depths between the boring locations and at unexplored locations.

Shale encountered in mass excavations can sometimes be excavated with heavy trackhoes or bulldozers equipped with rippers. However, hard rock removal techniques should be anticipated for shale encountered in confined or trench excavations. Hard rock removal techniques should be anticipated for limestone. Hard rock removal techniques should also be anticipated for limestone that is penetrable to augers turned by a drill rig. Blasting is not recommended due to the urban nature of the project site.

Mixed-Bearing Materials. Structures supported by footings with different bearing materials (natural soil/compacted fill, shale and limestone) could experience different magnitudes of settlement. Individual spread footings should bear either entirely on shale/limestone or on soil, and not a combination of both. Considerations for structures underlain by shallow shale/limestone to control and/or reduce the effects of differential settlement include the following:

- Extending each footing to rock (i.e., limestone and/or shale)
- Extending each footing excavation to rock and then backfilling with lean concrete or concrete to the elevation of the planned footing bottom
- Designing wall footings to span unsupported lengths of 10 to 15 feet
- Frequent construction joints, and
- Selection of flexible and/or adjustable materials.

5.1 Site Grading

Site Preparation. In general, the site should be stripped of the root zone, soft soil, and other deleterious materials. Existing fill should be fully removed. Where the removal creates excavations below the final grade, the excavations should be brought to final grade with compacted fill. The exposed subgrade should be proofrolled. Soft soil or yielding areas should be excavated and backfilled with soil or crushed rock compacted to the density specified in the Compaction Summary.

Proofrolling with a tandem axle dump truck loaded to approximately 20,000 pounds per axle (or equivalent proofrolling equipment) can be considered as a means of evaluating the subgrade. Soft areas that develop and areas that exhibit deflection should be overexcavated and backfilled with soil fill or well-graded crushed limestone compacted to the density listed in Table 2.

Remediation of Existing Fill. Remediation alternatives for existing fill occurring below soil-supported structures and pavements are discussed in the following paragraphs.

1. The more positive approach for site development is the complete removal of existing fill beneath new foundations, floor slabs and pavements. Existing fill should be removed

10 feet beyond building lines. The resulting excavations may be backfilled with compacted fill as discussed herein. Foundations, floor slabs and pavements will experience conventional magnitudes of settlement (as discussed later in this report) with this remediation technique.

2. Partial removal and replacement of existing fill may be considered in pavement areas only. In exchange for the cost savings associated with remediating only a portion of these materials, the client must recognize that partial remediation will require acceptance of a greater risk for pavement distress compared to full depth overexcavation and replacement.

   For such an alternative, existing fill could be removed to a depth of 2 feet below planned pavement subgrade. If the pavement section includes a granular base course, the 2-foot overexcavation depth should be measured from the bottom of the base course. As a measure to further reduce the potential for pavement distress, Tensar BX1200 geogrid or similar could be placed at the base of the excavation and the lower 12 inches of overexcavation backfilled with compacted well-graded 2-inch minus crushed rock. If the client is willing to accept an even greater risk of pavement distress, pavement areas could be proofrolled and soft spots remediated as discussed herein.

   Using these partial remediation techniques, pavements have a potential to experience higher magnitudes of settlement if low-density fill remains below the remediation zone and/or the condition of the remaining fill deteriorates. Greater depths of removal and replacement may be required based on observation during proofrolling and/or excavation.

***Remediation of Fat Clay*.** Fat clay present at floor slab subgrade must be removed to a depth of at least 2 feet and these overexcavations backfilled with low volume change (LVC) material. LVC material includes lean clay, well-graded crushed limestone or on-site fat clay which has been stabilized by incorporating hydrated lime (5 percent by dry weight at a minimum), Portland Cement (5 percent dry weight at a minimum), or Type C fly ash (15 percent by dry weight at a minimum). Agricultural lime cannot be substituted for hydrated lime. Cement kiln dust (CKD) and lime kiln dust (LKD) are acceptable alternatives to lime and fly ash; however, the percentage of incorporation should be determined by laboratory testing due to the variability of these materials.

As a measure to improve performance, fat clay could also be remediated below new pavement sections. The City of Lee's Summit prefers the use of geogrid/geotextile-reinforced aggregate base as the remediation technique for fat clay below pavements. The crushed rock shall have a thickness of at least 6 inches. The geogrid/geotextile shall be comprised of polypropylene; the geotextile shall be woven. Approved geogrid products include Tensar BX 1200, Tensar Triax TX140 and Tensar Triax TX160; Tencate/Mirafi BXG12; TerraGrid RX1200, and BOSTD RX1200. Approved woven geotextile products include Tencate/Mirafi HP370, HP570, RS380i, RS580i, and Geotex 3x3UF and 4x4UF.

In lieu of the use of geogrid-reinforced crushed rock as the remediation technique below pavements, fat clay within 9 inches of pavement subgrades could be excavated and replaced with LVC material as previously discussed. If the pavement section includes crushed rock base course, the 9-inch remediation depth is from the bottom of the crushed rock. The backfill should be placed and compacted as specified in Table 2.

For lime stabilization, and after the lime is incorporated into the soil, the supplemented soil should be allowed to cure (i.e., age) prior to final mixing, moisture conditioning and compaction. The supplemented soil should be moisture conditioned and protected from drying throughout the aging process.

If soil stabilization with cement and fly ash is selected, the cement/fly ash and soil should be thoroughly mixed within ½ hour after introduction. Generally, the soil is moisture conditioned prior to amendment and adjusted following introduction of the cement/fly ash. Cement/fly ash mixing should not be performed at ambient or soil temperatures below 40 degrees Fahrenheit. Compaction of the cement/fly ash-supplemented soil should be completed within one hour after incorporation. Additional compaction after two hours could cause degradation of the soil strength.

If lean clay (liquid limit less than 45 percent) or well-graded crushed limestone is selected as the LVC material, the backfill should be placed and compacted as specified in Table 2. Funds should be provided in the construction budget for treatment of fat clay. Additionally, the potential for excess soils where overexcavation is required should be considered in final grading plans if a balanced site is required.

The method of treatment previously suggested is based on generally accepted standards in the local engineering community. Clay properties, including plasticity, moisture content, density, swell pressure, and mineralogy are extremely variable and could, in some instances, be conducive to more severe swell pressures and volume change potential than can be mitigated by nominal treatment. Consequently, when building in an area where fat clay is present, the owner should recognize that there is an inherent risk that damage associated with shrink or swell of the soil could occur, even with remedial treatment of subgrade soil.

Suitable Fill Materials. On-site materials generated from excavations are expected to include lean clay and fat clay. Lean clay and fat clay may be used for fill provided the material is moisture conditioned and free of deleterious materials. However, fat clay should be placed at least 24 inches below floor slab subgrade and at least 9 inches below pavement subgrade unless chemically treated as previously discussed.

Imported fill should consist of lean clay (liquid limit value of 45 percent or less) and well-graded crushed limestone with a 2-inch maximum particle size. Limestone screenings are susceptible to changes in moisture content and are not advised in pavement areas or building areas.

Fill and Backfill Placement. Fill or backfill should be placed in uniform lifts and compacted. The loose lift thickness should not exceed 8 inches. The fill should be systematically compacted to the level given in Table 2. The soil should be placed at moisture contents compatible with the required unit weight. Depending on the soil moisture at the time of construction, drying or wetting might be required to achieve compaction. Deleterious material should not be included in the fill, and the fill should not be placed on soft materials or frozen ground.

Table 2. Compaction Summary

Category	Minimum Compaction[a]
Fine-Grained Soil	95%[b]
Pavement Subgrade	
Well-Graded Crushed Limestone	95%

[a] Measured as a percent of the maximum unit weight as determined by the standard Proctor test (ASTM D 698).
[b] Moisture content within zero to plus 3 percent of the optimum moisture content.

Trench Backfill. Settlement of trench backfill can result in unsightly depressions and localized slab and pavement failures. The magnitude of settlement can be substantially reduced by mechanical compaction of the trench backfill. In floor slab and pavement areas, well-graded crushed limestone compacted to the minimum level specified in Table 2 should be used as trench backfill. Poorly graded (i.e., clean) rock must not be used for trench backfill. Clean rock can collect water which can soften the underlying fine-grained soils or lead to the migration of fines and loss of subgrade support, or in the presence of fat clay, could lead to heaving.

Subgrade Protection. Drainage of the construction areas should be provided to protect foundation, floor slab and pavement subgrades from the detrimental effects of weather during construction. Finished subgrades and foundation excavations should be kept free of standing water. Concrete should be placed in foundation excavations the same day they are completed. Subgrades will be exposed to weather and disturbances from the installation of utilities and normal construction traffic. Disturbance is easier to repair in drier months by reworking the upper soils. During wetter periods of the year, such as spring and winter, considerable difficulty can be experienced. Construction traffic should be routed away from prepared subgrades.

Collection and Disposal of Site Water. Managing site water is important for the successful performance of foundations, pavement systems and retaining walls. Water from surface runoff, downspouts and subsurface drains should be collected and discharged away from structures through a site drainage system. Water should not be allowed to pond next to footings, pavements or retaining walls.

Control of surface runoff should be maintained in compliance with the rules and regulations set forth in the Federal Water Pollution Control Act. Additionally, permits related to site grading activities and control of stormwater during construction activities should be obtained from the applicable governmental jurisdiction(s).

5.2 Temporary Excavations

The opinions provided in the following paragraphs regarding temporary slopes are for use by the design team in estimating construction costs during the design phase of the project and are not intended for use by a contractor for design of construction slopes.

If site geometry permits, it might be possible to lay slopes back to a stable configuration. The soil type encountered during excavations is anticipated to consist of fill, medium stiff to very stiff natural soil, and shale. The existing fill should be considered OSHA Type C soil. The natural soil may generally be considered OSHA Type B soil. Competent shale and limestone may be considered OSHA Stable Rock. Temporary slopes in OSHA Type C soil up to 20 feet deep may be constructed at 1V:1.5H or flatter; however, benched excavations in OSHA Type C soil are not permitted. Temporary slopes in OSHA Type B soil up to 20 feet deep may be constructed at 1V:1H or flatter. Regardless of the soil type, temporary excavations that extend below groundwater should be constructed at 1V:1.5H or flatter; however, benched excavations below groundwater are not permitted. Temporary excavations in OSHA Stable Rock may be constructed near vertical.

The provided soil classification is the professional opinion of UES. Soil classification relative to temporary slope configuration and worker safety is the responsibility of the contractor. The contractor should be aware that excavation depths and inclinations must comply with local, state, or federal safety regulations (e.g., OSHA Health and Safety Standards for Excavations, 29 CFR Part 1926, or successor regulations). Such regulations are strictly enforced and, if not followed, the contractor, or earthwork or utility subcontractors, could be subjected to substantial penalties. Construction site safety is the responsibility of the contractor, who shall also be solely responsible for the means, methods, and sequencing of construction operations.

Materials can vary across the excavation, and even if the OSHA criteria are used, there is a potential for slope failure. Temporary slopes left open could undergo sloughing and result in an unstable situation. The contractor should evaluate stability and failure consequences before open cut slopes are made. Minor sloughing of open face slopes can occur. If the slope is expected to remain open for an extended time an impermeable membrane covering the slopes could be considered as a means to reduce the potential for slope degradation and instability.

5.3 Rock-Supported Footings

Allowable Bearing Pressure. Strip and spread footings bearing on shale and limestone may be proportioned for a net allowable bearing pressure of 12,000 psf. Net allowable bearing pressure is that pressure in excess of the weight of the material; i.e., the increase in pressure that the material below the footing can experience to keep settlements within tolerable limits.

The minimum lateral dimensions for strip and spread footings should be 18 and 24 inches, respectively. Frost heave is generally not a problem for rock-supported foundations; therefore, the minimum depth of embedment is 12 inches below grade or as required for structural considerations.

Construction Considerations. Foundation excavations should be extended through weathered rock to competent rock. Black shale occurring in footing excavations should be completely removed. Foundation overexcavations should be backfilled with lean concrete or concrete. The bottom of footing excavations should generally be level; however, vertical steps may be excavated if required to expose sound bedrock. Vertical, soil-filled seams exposed in the bottom of the excavation should be removed and the overexcavations backfilled with concrete. Loose rock should be removed from foundation excavations.

Settlement. Rock-supported footings, proportioned and constructed as recommended herein, are expected to settle approximately 1/4 inch. Differential settlement between footings could be approximately 1/4 inch. Estimated values of settlement contained in this report are based on our experience with projects of a similar nature.

Lateral Resistance. Lateral loads may be resisted by available frictional resistance between the base of the footing and the underlying bedrock. Resistance to sliding can be computed assuming an ultimate coefficient of friction of 0.5. Ultimate passive resistance, if required, can be computed assuming an equivalent fluid pressure of 450 pounds per cubic foot (pcf). Safety factors should be applied to determine the allowable sliding and passive resistances.

Uplift Resistance. Uplift loads can be resisted with (1) the dead weight of the footing and the structure and (2) frictional resistance between the sides of the footing and the rock. An allowable value of 2,500 psf can be used for frictional resistance between the sides of the footing and the rock, provided the footings are poured neat against the rock.

5.4 Soil-Supported Footings

Allowable Bearing Pressure. Strip and spread footings may be proportioned for net allowable bearing pressures of 2,500 and 3,000 psf, respectively, provided the footings bear on firm, native soil and compacted fill as discussed herein. Provisions for different bearing materials should be incorporated as discussed previously in this report.

The minimum lateral dimensions for strip and spread footings should be 18 and 24 inches, respectively. As a measure to provide protection from seasonal moisture variations and frost penetration, exterior footings and footings in unheated interior areas should bear at least 36 inches below grade.

Construction Considerations. Existing fill should be remediated as previously discussed. If soft native soil is encountered at footing bearing elevations, footing excavations should be extended through these materials to firm, native soil and the overexcavation backfilled with concrete or lean concrete.

Settlement. Footings, proportioned and constructed as recommended herein, could settle approximately 1 inch. Differential settlement between footings could be approximately 3/4 inch. Estimated values of settlement contained in this report are based on our experience with projects of a similar nature.

Lateral Resistance. Lateral loads may be resisted by available frictional resistance between the base of the footing and the bearing material. Resistance to sliding can be computed assuming an ultimate coefficient of friction of 0.35; however, the maximum resistance should be limited to 750 psf. Ultimate passive resistance, if required, can be computed assuming an equivalent fluid pressure of 320 pounds per cubic foot (pcf). Safety factors should be applied to determine the allowable sliding and passive resistances. Passive resistance in the top 36 inches of soil should be neglected due to seasonal variations in moisture and frost penetration.

Uplift Resistance. Uplift loads can be resisted with (1) the dead weight of the footing and the structure, (2) the weight of the soil above the footing and within an angle of 30 degrees extending up and away from the top of the footing to the ground surface, and (3) frictional resistance between the sides of the footing and the soil. A value of 120 pcf may be used for determining the unit weight of soil. An allowable resistance of 750 psf can be used for frictional resistance between the sides of the footings and the soil, provided the footings are earth-formed or compacted backfill is placed around them. Frictional resistance in the top 36 inches of soil should be neglected due to seasonal variations in moisture and frost penetration.

5.5 Floor Slabs

Existing fill and fat clay should be remediated as previously discussed. Floor slabs can be designed using a vertical subgrade modulus of 100 pounds per cubic inch (pci). Floor slabs should be underlain by a 4- to 6-inch layer of compacted well-graded crushed rock. A 15-mil or thicker plastic vapor barrier can be placed below the floor in interior finished areas to reduce the potential for moisture permeation through the slab and for mold growth within the building. Floor slabs should be structurally separated from walls, columns, footings, and penetrations to allow independent movement of the floor. Alternatively, floor slabs that are not structurally independent should be designed to allow for differential movements that normally occur between the floor slabs, columns, and foundation walls.

5.6 Lateral Earth Pressures

Below-grade walls and retaining walls should be designed to withstand lateral earth pressures caused by adjacent soil. Design lateral pressures from surcharge loads should be added to the lateral earth pressure load. Lateral earth pressures can vary with wall restraint conditions, drainage condition, type of backfill, slope of the ground surface behind the wall, and method of backfill compaction. Fat clay should not be used as backfill since considerable lateral loads might develop with these potentially expansive materials.

Design values are provided in Table 3 for lateral earth pressures on retaining walls with horizontal backfill and below-grade walls. If tilting or deflection is not tolerable, at-rest earth pressures should be assumed. Design values for retaining walls with sloping backfill subject to active conditions are provided on Figure 6. Passive resistance should be ignored in the upper 36 inches below proposed grade due to seasonal variations in moisture and frost penetration.

Table 3. Lateral Earth Pressures for Horizontal Ground Surfaces – Drained Condition

Description of Backfill	Design Soil Lateral Load (psf per foot of depth)	
	At-rest	Active
Lean Clay (CL)	65h + 0.55q	45h + 0.38q
Well-Graded Crushed Limestone (GW)	56h + 0.40q	35h + 0.25q

Where:

h = depth below adjacent grade, feet
q = surcharge load, psf

The given values assume that hydrostatic pressures will not develop behind the walls and that the wall backfill will be compacted as previously recommended. Undrained walls might be subjected to additional pressures from groundwater, perched water, or surface water infiltration. A drain system to allow for dissipation of water pressures should be placed behind retaining walls.

For the equations in Table 3 to be valid for crushed stone backfill, the backfill should be placed in a wedge extending upward and away from the edge of the footings at an angle of 45 degrees or flatter. If crushed stone is placed within a wedge at an angle of more than 45 degrees from the edge of the footings, the values for lean clay provided in Table 3 should be used.

If the walls are not designed to resist hydrostatic forces, backfill behind the walls should include a clean, granular material that should be positively drained to prevent buildup of static water level/hydrostatic pressures against walls. "Clean" indicates less than 2 percent finer than the No. 200 sieve. Clean material should be wrapped with a geotextile such as Mirafi 140N and capped with 2 feet of lean clay. The thickness of the backfill zone should be at least 24 inches behind the base of the wall to allow drainage. A drain system should be installed around the perimeter of the walls. The perimeter drain system should consist of a 4-inch PVC or equivalent pipe with 3/8- to 1/2-inch perforations. Drainage should be either to a sump pump or by gravity. The pipe should be placed with the perforations down and enveloped with clean rock (ASTM C 33 Size No. 57). The rock should be surrounded with Mirafi 140N filter cloth or equivalent.

5.7 MSE Wall Considerations

The following geotechnical parameters may be used for design of a mechanically stabilized earth (MSE) wall.

- For soil-supported MSE walls, a friction angle of 27 degrees and cohesion of 100 psf may be used for long-term conditions. An undrained shear strength of 1,200 psf may be used for short-term conditions.
- MSE walls bearing on firm, natural soil or new, compacted fill may be designed using a maximum net allowable bearing pressure of 3,500 psf.
- For rock-supported MSE walls, an undrained shear strength of 5,000 psf may be used for both long-term and short-term conditions.
- MSE walls bearing on rock may be designed using a maximum net allowable bearing pressure of 12 ksf.
- The minimum geogrid length ratio shall be 0.7H, where H is the measurement from the top of the leveling pad.

5.8 Pavement Considerations

Pavement design and analysis were beyond the scope of our services. Standard asphaltic concrete and Portland cement concrete (PCC) pavement design for a given service life requires evaluation of the soil by CBR tests or other methods, estimates of daily traffic volumes and axle weights, drainage requirements, and the desired level of maintenance.

Based on the results of the laboratory tests and our local experience, asphaltic pavement sections may be designed assuming a CBR value of 2, which is typical for clay soils in the Kansas City region. Where heavy wheel loads are concentrated, particularly at approaches to trash dumpsters, concrete pavement should be used. The concrete pavement may be designed assuming a vertical subgrade modulus of 75 pci where concrete is placed on a clay subgrade and 100 pci where 6 inches of a granular subbase is used.

Pavement service life can decrease substantially if the pavement is constructed on a poor subgrade, if it has poor surface or subsurface drainage, and/or if the pavement is not maintained. Therefore, (1) the soil subgrade should be stable and the top 9 inches compacted as specified in Table 2, (2) existing fill, utilities and associated trench backfill, building remnants and fat clay in pavement areas should be remediated as discussed previously, (3) pavements and the underlying subgrade should be sloped to provide drainage, (4) water should not be allowed to pond next to pavements, and (5) periodic maintenance, such as filling cracks, sealing and preservation of surface drainage, is required for a pavement section to achieve its design life.

If pavements are not constructed immediately after grading, the subgrade should be shaped to prevent ponding. Minor ponding, of even short duration, can cause softening of a soil subgrade to a substantial depth. If there is a substantial lapse of time between grading and paving, or if the subgrade is disturbed by construction activities, the subgrade should be proofrolled. Soft spots observed during initial construction or proofrolling should be removed and replaced with compacted soil of the same type present in the subgrade, possibly combined with a geotextile or geogrid. The rock base course, if used, and soil subgrade should be compacted to the levels given in Table 2.

Depending on when the pavement is constructed, the subgrade might not support construction equipment such as rock trucks or asphalt trucks, which have substantially heavier axle loads than those vehicles that the pavement section is expected to support. Such conditions will be more apparent during wetter periods of the year. Overexcavation of soft subgrade and placement of additional base course and/or geogrid could be required to construct pavements during these periods.

Typical Pavement Sections. Traffic is expected to consist of lightly loaded automobiles, SUVs, and pick-up trucks, and occasional garbage trucks and delivery trucks. The pavement sections presented in Tables 4 and 5 are based on City of Lee's Summit Design Criteria Section 5200 Streets.

Table 4. Typical Asphaltic Concrete Pavement Sections

Material	Drive Lanes	Parking Stalls
Asphalt Surface Course	2 inches	2 inches
Asphalt Base Course	5.5 inches	4 inches
MoDOT Type 5	6 inches	6 inches
Compacted Pavement Subgrade	9 inches	

Areas subjected to heavy wheel loads and/or turning traffic should be constructed with thicker asphaltic concrete pavement or PCC pavement. These typical pavement sections are presented in Table 5.

Table 5. Typical Pavement Sections for Areas Subject to Heavy Traffic

Pavement Type	Material	Pavement Section
Rigid	Portland Cement Concrete	7 inches
	MoDOT Type 5	4 inches
	Compacted Pavement Subgrade	9 inches
Flexible	Asphalt Surface Course	2 inches
	Asphalt Base Course	7.5 inches
	MoDOT Type 5	6 inches
	Compacted Pavement Subgrade	9 inches

5.9 Seismicity

Shale and limestone within 10 feet of footing bottoms is anticipated. Per the general procedures of Section 1613 of the 2018 edition of the International Building Code (IBC), the soil profile at the project site can be defined as Class B – Estimated (Rock). Based on the web application *Seismic Design Maps* prepared by the Structural Engineers Association of California (SEAOC) and the California's Office of Statewide Health Planning and Development (OSHPD) using the latitude and longitude coordinates of the project site, the seismic parameters that can be used for this project are given in Table 6.

Table 6. Seismic Parameters

Seismic Site Class	S_s (g)	S_1 (g)	S_{MS}* (g)	S_{M1}* (g)	S_{DS}* (g)	S_{D1}* (g)
B – Estimated (Rock)	0.099	0.068	0.099	0.068	0.066	0.045

*Site coefficients taken as unity since site-specific velocity measurements were not performed.

6.0 RECOMMENDED ADDITIONAL SERVICES

The conclusions and recommendations given in this report are based on: UES' understanding of the proposed design and construction, as outlined in this report, site observations, interpretation of the exploration data, and our experience. Since the intent of the design recommendations is best understood by UES, we recommend that UES be included in the final design and construction process and be retained to review the project plans and specifications to confirm that the recommendations given in this report have been correctly implemented. We recommend that UES be retained to participate in prebid and preconstruction conferences to reduce the risk of misinterpretation of the conclusions and recommendations in this report relative to the proposed construction of the subject project.

Since actual subsurface conditions between boring locations may vary from those encountered in the borings, our design recommendations are subject to adjustment in the field based on the subsurface conditions encountered during construction. Therefore, we recommend that UES be retained to provide construction observation services as a continuation of the design process to confirm the recommendations in this report and to revise them accordingly to accommodate differing subsurface conditions. 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. Regardless of construction observation, contractors, suppliers, and others are solely responsible for the quality of their work and for adhering to plans and specifications.

7.0 LIMITATIONS OF REPORT

This report has been prepared on behalf of, and for the exclusive use of the client for specific application to the named project as described herein. If this report is provided to other parties, it should be provided in its entirety with all supplementary information. In addition, the client should make it clear that the information is provided for factual data only, and not as a warranty of subsurface conditions presented in this report.

UES has attempted to conduct the services reported herein in a manner consistent with that level of care and skill ordinarily exercised by members of the profession currently practicing in the same locality and under similar conditions. The recommendations and conclusions contained in this report are professional opinions. The report is not a bidding document and should not be used for that purpose.

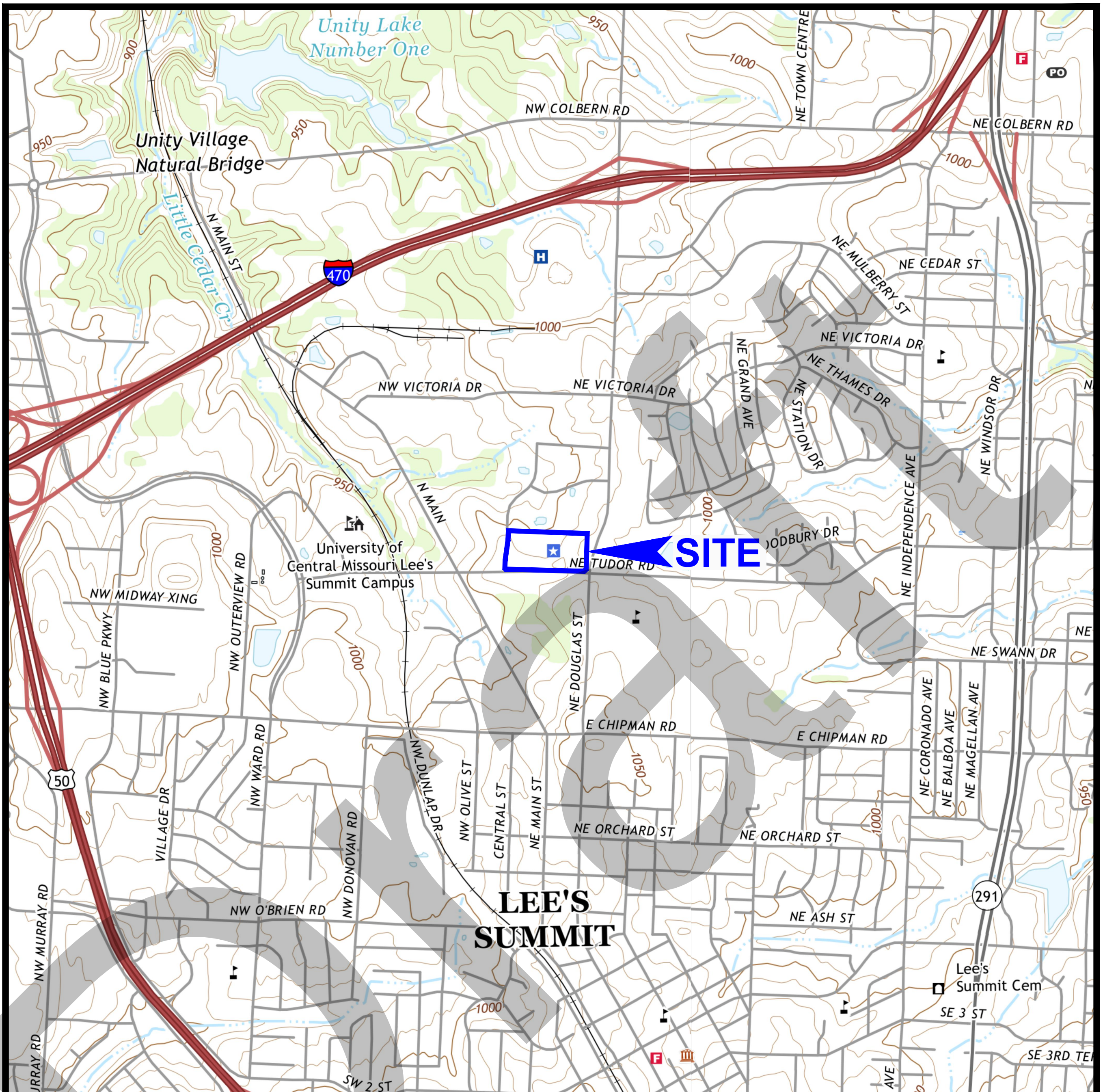
Our scope of service for this phase of the project did not include any environmental assessment or investigation for the presence or absence of wetlands or hazardous or toxic materials in the soil, surface water, groundwater, or air, on or below or around this site. Any statements in this report or on the boring logs regarding odors noted or unusual or suspicious items or conditions observed are strictly for the information of our client. Our scope of service did not include an assessment of the effects of flooding and erosion of creeks or rivers adjacent to or on the project site.

The analyses, conclusions, and recommendations contained in this report are based on the data obtained from the subsurface exploration. The field exploration methods used indicate subsurface conditions only at the specific locations where samples were obtained, only at the time they were obtained, and only to the depths penetrated. Consequently, subsurface conditions may vary gradually, abruptly, and/or nonlinearly between sample locations and/or intervals.

The conclusions or recommendations presented in this report should not be used without UES' review and assessment if the nature, design, or location of the facilities is changed, if there is a substantial lapse in time between the submittal of this report and the start of work at the site, or if there is a substantial interruption or delay during work at the site. If changes are contemplated or delays occur, UES must be allowed to review them to assess their impact on the findings, conclusions, and/or design recommendations given in this report. UES will not be responsible for any claims, damages, or liability associated with any other party's interpretations of the subsurface data or with reuse of the subsurface data or engineering analyses in this report.

The recommendations included in this report have been based in part on assumptions about variations in site stratigraphy that may be evaluated further during earthwork and foundation construction. UES should be retained to perform construction observation and continue its geotechnical engineering service using observational methods. UES cannot assume liability for the adequacy of its recommendations when they are used in the field without UES being retained to observe construction.

FIGURES



NOTES

1. Plan adapted from 7.5 minute U.S.G.S. maps for Lee's Summit and Lake Jacomo, Missouri quadrangles, last revised in 2021.

0 2,000 4,000

SCALE IN FEET

N

Drawn By: WAH	Ck'd By: MHM	App'vd By: JAW
Date: 4-22-24	Date: 4-30-24	Date: 5-13-24

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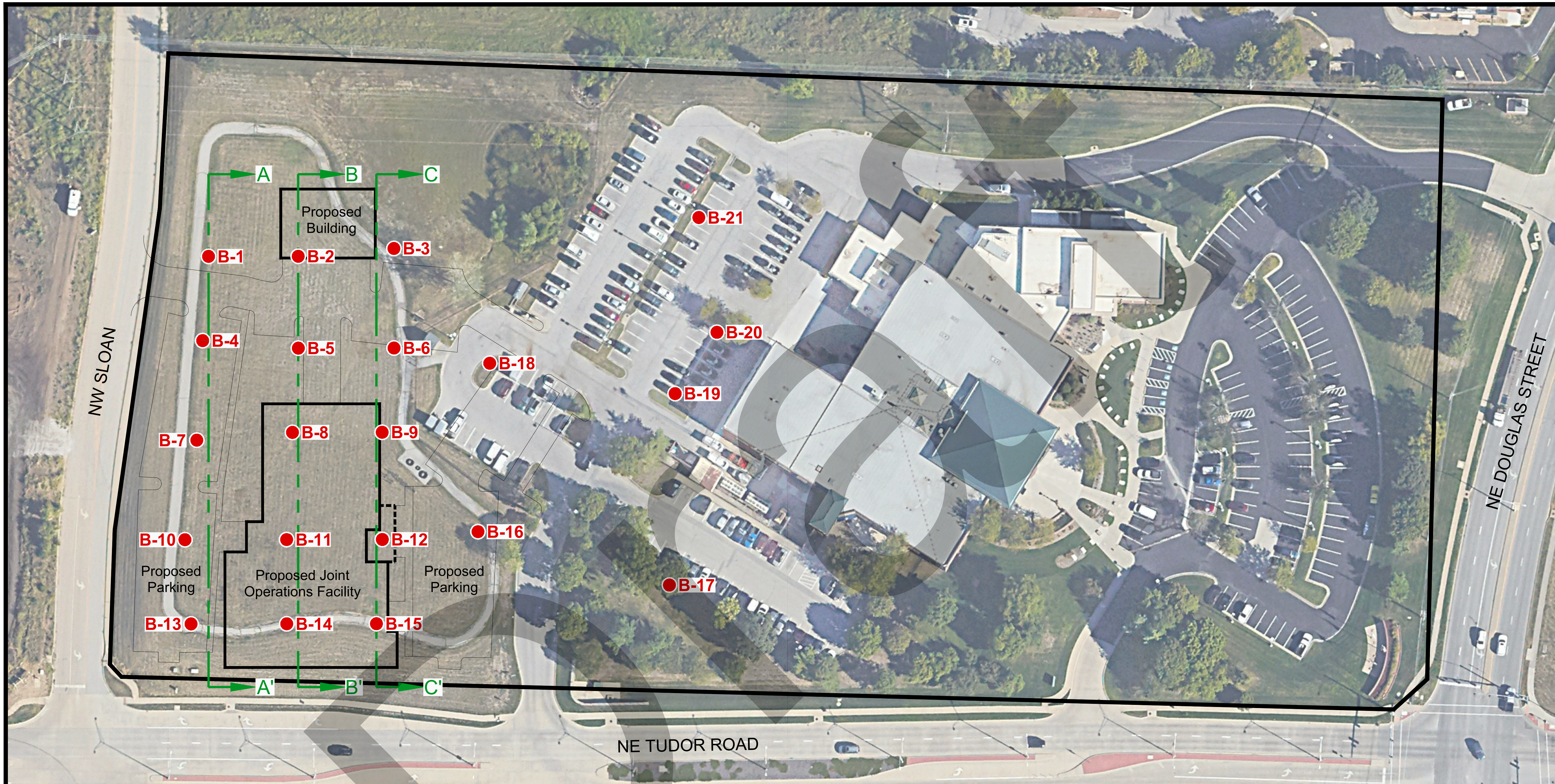
Lee's Summit, Missouri

SITE LOCATION AND TOPOGRAPHY

Project Number J045326.01

FIGURE 1



NOTES

1. Plan adapted from an August 5, 2022 aerial photograph courtesy of Google Earth and a drawing dated April 3, 2024, titled "Site Base", prepared by Hoefer Welker.
2. Borings were located in the field with reference to site features and are shown approximate only.

LEGEND

- ● Boring Location
- Generalized Subsurface Profile (See Figures 3 through 5)

0 40 80 160
SCALE IN FEET

N

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AERIAL PHOTOGRAPH OF SITE AND BORING LOCATIONS

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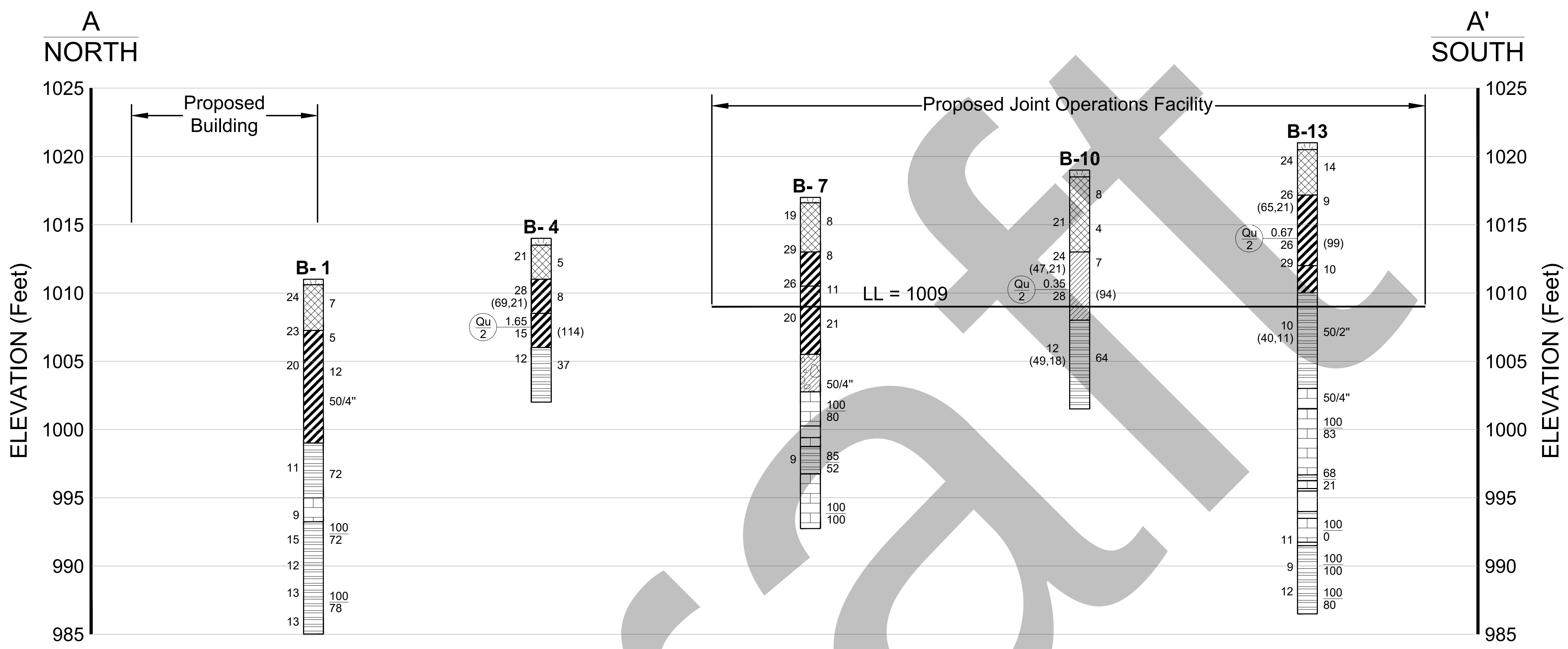
FIGURE 2



KEY TO BOREHOLE SYMBOLS

- Top Soil
- Fill
- Lean Clay
- Fat Clay
- Weathered Limestone and Clay
- Core Loss
- Shale
- Limestone

KEY TO TEST DATA

Natural Water Content in Percent Liquid and Plastic Limits	21 (58,31)	
	9	Standard Penetration Test Resistance (No. of Blows of a 140-lb. Hammer Dropping 30-in. Required to Drive a 2-in. O.D. Split Spoon One Foot or Indicated Depth - "S" Denotes Seating)
Shear Strength in TSF from Unconfined Compression	Qu 2 0.73	
	(97)	Dry Unit Weight in Pounds per Cubic Foot
	▽	Groundwater Elevation Observed at Time of Drilling
	▼	Groundwater Elevation Observed > 24 Hours after Drilling
	100 83	Percent Core Recovery R.Q.D.*

*R.Q.D. Denotes Modified Core Recovery Percentage in Which Only Pieces of Sound Core Over 4 Inches Long are Counted as Recovery

NOTES

1. See Figure 2 for location of Generalized Subsurface Profile A-A'.
2. Data concerning subsurface conditions were obtained at boring locations only. Actual conditions at locations between borings could differ from the generalized profile shown here.

SCALE IN FEET
Horizontal 1" = 40'
Vertical 1" = 10'

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Date: 5-2-24	Date: 5-3-24	Date: 5-13-24

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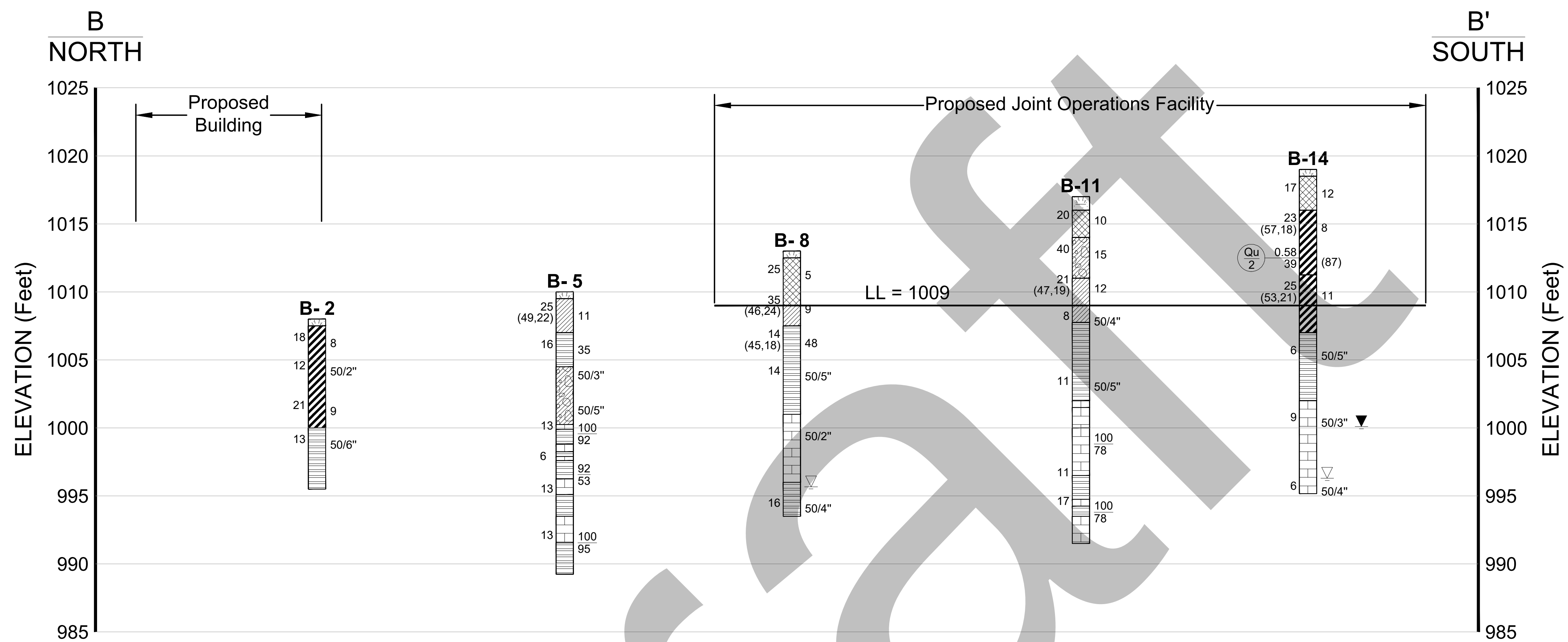
GENERALIZED SUBSURFACE PROFILE A-A'

Project Number J045326.01

FIGURE 3



KEY TO BOREHOLE SYMBOLS

- Top Soil
- Fill
- Lean Clay
- Fat Clay
- Weathered Limestone and Clay
- Core Loss
- Shale
- Limestone

KEY TO TEST DATA

Natural Water Content in Percent Liquid and Plastic Limits	21 (58,31)	
	9	Standard Penetration Test Resistance (No. of Blows of a 140-lb. Hammer Dropping 30-in. Required to Drive a 2-in. O.D. Split Spoon One Foot or Indicated Depth - "S" Denotes Seating)
Shear Strength in TSF from Unconfined Compression	Qu 2 — 0.73	
	(97)	Dry Unit Weight in Pounds per Cubic Foot
	▽	Groundwater Elevation Observed at Time of Drilling
	▼	Groundwater Elevation Observed > 24 Hours after Drilling
	100 83	Percent Core Recovery R.Q.D.*

*R.Q.D. Denotes Modified Core Recovery Percentage in Which Only Pieces of Sound Core Over 4 Inches Long are Counted as Recovery

NOTES

1. See Figure 2 for location of Generalized Subsurface Profile B-B'.
2. Data concerning subsurface conditions were obtained at boring locations only. Actual conditions at locations between borings could differ from the generalized profile shown here.

SCALE IN FEET
Horizontal 1" = 40'
Vertical 1" = 10'

Drawn By: WAH	Ck'd By: MHM	App'vd By: JAW
Date: 5-2-24	Date: 5-3-24	Date: 5-13-24

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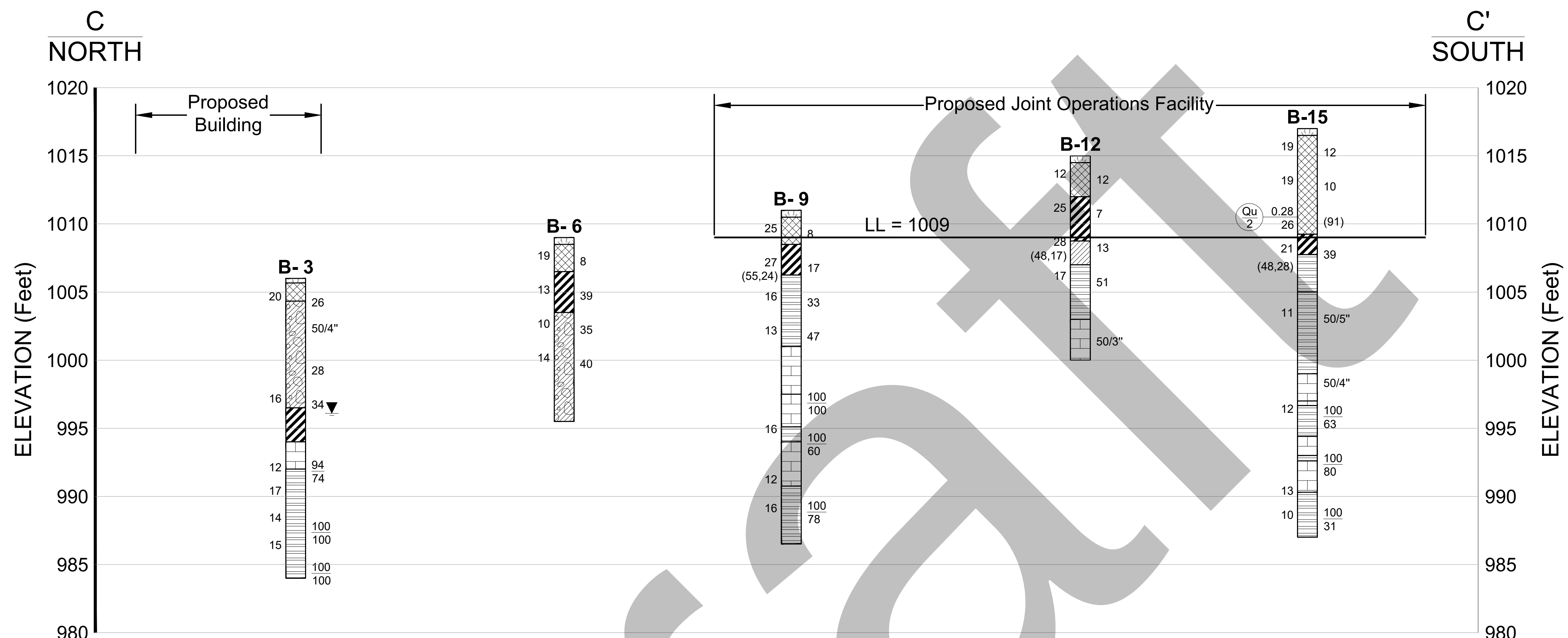
GENERALIZED SUBSURFACE PROFILE B-B'

Project Number J045326.01 — FIGURE 4



KEY TO BOREHOLE SYMBOLS

- Top Soil
- Fill
- Lean Clay
- Fat Clay
- Weathered Limestone and Clay
- Core Loss
- Shale
- Limestone

KEY TO TEST DATA

Natural Water Content in Percent	21	9 Standard Penetration Test Resistance (No. of Blows of a 140-lb. Hammer Dropping 30-in. Required to Drive a 2-in. O.D. Split Spoon One Foot or Indicated Depth - "S" Denotes Seating)
Liquid and Plastic Limits	(58,31)	
Shear Strength in TSF from Unconfined Compression	Qu 2 0.73	
		(97) Dry Unit Weight in Pounds per Cubic Foot
		Groundwater Elevation Observed at Time of Drilling
		Groundwater Elevation Observed > 24 Hours after Drilling
		100/83 Percent Core Recovery / R.Q.D.*

*R.Q.D. Denotes Modified Core Recovery Percentage in Which Only Pieces of Sound Core Over 4 Inches Long are Counted as Recovery

NOTES

1. See Figure 2 for location of Generalized Subsurface Profile C-C'.
2. Data concerning subsurface conditions were obtained at boring locations only. Actual conditions at locations between borings could differ from the generalized profile shown here.

SCALE IN FEET
Horizontal 1" = 40'
Vertical 1" = 10'

Drawn By: WAH	Ck'd By: MHM	App'vd By: JAW
Date: 5-2-24	Date: 5-3-24	Date: 5-13-24

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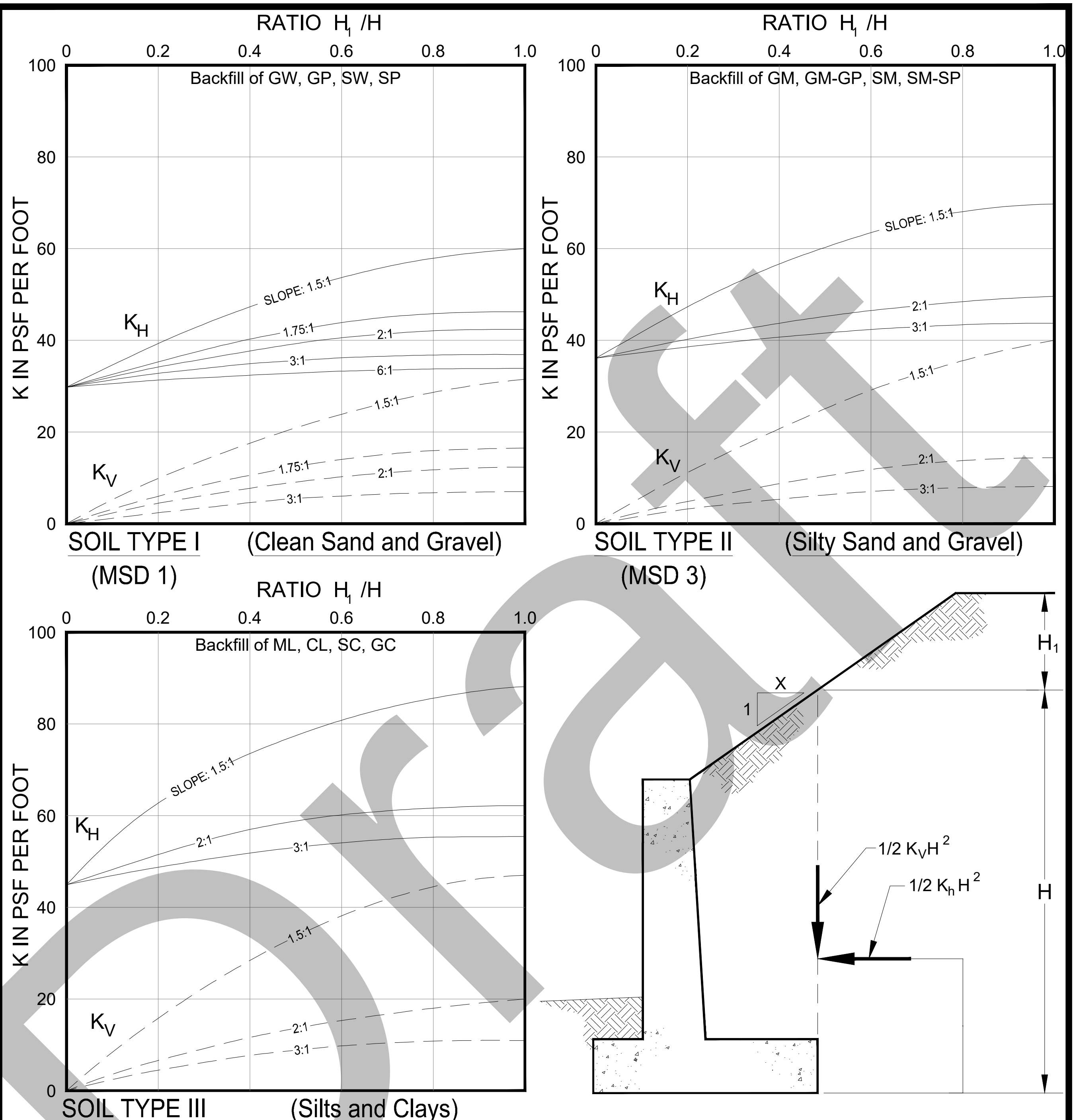
GENERALIZED SUBSURFACE PROFILE C-C'

Project Number J045326.01

FIGURE 5



NOTES

1. The above charts and the diagrams for earth pressures were reconstructed from figures presented by Terzaghi, K. and Peck, R.B., "Soil Mechanics in Engineering Practice", John Wiley and Sons, Inc., 1967, pp. 366.
2. All units for these diagrams and equations are feet and pounds.
3. Assumed unit weight of soil = 120 pcf.
4. Soil types IV (Soft Clay and Organic Silt) and V (High Plastic Clay) should not be used as backfill.
5. Wall is not influenced by any uniformly distributed surcharge load or concentrated point load.
6. The wall is provided with a drain system or properly designed weep holes to allow dissipation of water and hydrostatic pressure will not develop behind the walls.

Drawn By: WAH	Ck'd By: MHM	App'vd By: JAW
Date: 4-22-24	Date: 4-30-24	Date: 5-13-24

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Lee's Summit, Missouri

LATERAL EARTH PRESSURE AGAINST RETAINING WALLS

Project Number J045326.01

FIGURE 6

APPENDIX A

Important Information about This Geotechnical-Engineering Report

Important Information about This

Geotechnical-Engineering Report

Subsurface problems are a principal cause of construction delays, cost overruns, claims, and disputes.

While you cannot eliminate all such risks, you can manage them. The following information is provided to help.

Geotechnical Services Are Performed for Specific Purposes, Persons, and Projects

Geotechnical engineers structure their services to meet the specific needs of their clients. A geotechnical-engineering study conducted for a civil engineer may not fulfill the needs of a constructor — a construction contractor — or even another civil engineer. Because each geotechnical- engineering study is unique, each geotechnical-engineering report is unique, prepared *solely* for the client. No one except you should rely on this geotechnical-engineering report without first conferring with the geotechnical engineer who prepared it. *And no one — not even you* — should apply this report for any purpose or project except the one originally contemplated.

Read the Full Report

Serious problems have occurred because those relying on a geotechnical-engineering report did not read it all. Do not rely on an executive summary. Do not read selected elements only.

Geotechnical Engineers Base Each Report on a Unique Set of Project-Specific Factors

Geotechnical engineers consider many unique, project-specific factors when establishing the scope of a study. Typical factors include: the client's goals, objectives, and risk-management preferences; the general nature of the structure involved, its size, and configuration; the location of the structure on the site; and other planned or existing site improvements, such as access roads, parking lots, and underground utilities. Unless the geotechnical engineer who conducted the study specifically indicates otherwise, do not rely on a geotechnical-engineering report that was:

- not prepared for you;
- not prepared for your project;
- not prepared for the specific site explored; or
- completed before important project changes were made.

Typical changes that can erode the reliability of an existing geotechnical-engineering report include those that affect:

- the function of the proposed structure, as when it's changed from a parking garage to an office building, or from a light-industrial plant to a refrigerated warehouse;
- the elevation, configuration, location, orientation, or weight of the proposed structure;
- the composition of the design team; or
- project ownership.

As a general rule, *always* inform your geotechnical engineer of project changes—even minor ones—and request an assessment of their impact. *Geotechnical engineers cannot accept responsibility or liability for problems that occur because their reports do not consider developments of which they were not informed.*

Subsurface Conditions Can Change

A geotechnical-engineering report is based on conditions that existed at the time the geotechnical engineer performed the study. *Do not rely on a geotechnical-engineering report whose adequacy may have been affected by*: the passage of time; man-made events, such as construction on or adjacent to the site; or natural events, such as floods, droughts, earthquakes, or groundwater fluctuations. *Contact the geotechnical engineer before applying this report to determine if it is still reliable.* A minor amount of additional testing or analysis could prevent major problems.

Most Geotechnical Findings Are Professional Opinions

Site exploration identifies subsurface conditions only at those points where subsurface tests are conducted or samples are taken. Geotechnical engineers review field and laboratory data and then apply their professional judgment to render an opinion about subsurface conditions throughout the site. Actual subsurface conditions may differ — sometimes significantly — from those indicated in your report. Retaining the geotechnical engineer who developed your report to provide geotechnical-construction observation is the most effective method of managing the risks associated with unanticipated conditions.

A Report's Recommendations Are Not Final

Do not overrely on the confirmation-dependent recommendations included in your report. *Confirmation-dependent recommendations are not final,* because geotechnical engineers develop them principally from judgment and opinion. Geotechnical engineers can finalize their recommendations *only* by observing actual subsurface conditions revealed during construction. *The geotechnical engineer who developed your report cannot assume responsibility or liability for the report's confirmation-dependent recommendations if that engineer does not perform the geotechnical-construction observation required to confirm the recommendations' applicability.*

A Geotechnical-Engineering Report Is Subject to Misinterpretation

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

Do Not Redraw the Engineer's Logs

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

Give Constructors a Complete Report and Guidance

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

Read Responsibility Provisions Closely

Some clients, design professionals, and constructors fail to recognize that geotechnical engineering is far less exact than other engineering disciplines. This lack of understanding has created unrealistic expectations that have led to disappointments, claims, and disputes. To help reduce the risk of such outcomes, geotechnical engineers commonly include a variety of explanatory provisions in their reports. Sometimes labeled "limitations," many of these provisions indicate where geotechnical engineers' responsibilities begin and end, to help others recognize their own responsibilities and risks. *Read these provisions closely.* Ask questions. Your geotechnical engineer should respond fully and frankly.

Environmental Concerns Are Not Covered

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

Obtain Professional Assistance To Deal with Mold

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

Rely, on Your GBC-Member Geotechnical Engineer for Additional Assistance

Membership in the Geotechnical Business Council of the Geoprofessional Business Association exposes geotechnical engineers to a wide array of risk-confrontation techniques that can be of genuine benefit for everyone involved with a construction project. Confer with you GBC-Member geotechnical engineer for more information.

GEOTECHNICAL BUSINESS COUNCIL
of the Geoprofessional Business Association

8811 Colesville Road/Suite G106, Silver Spring, MD 20910
Telephone: 301/565-2733 Facsimile: 301/589-2017
e-mail: info@geoprofessional.org www.geoprofessional.org

APPENDIX B

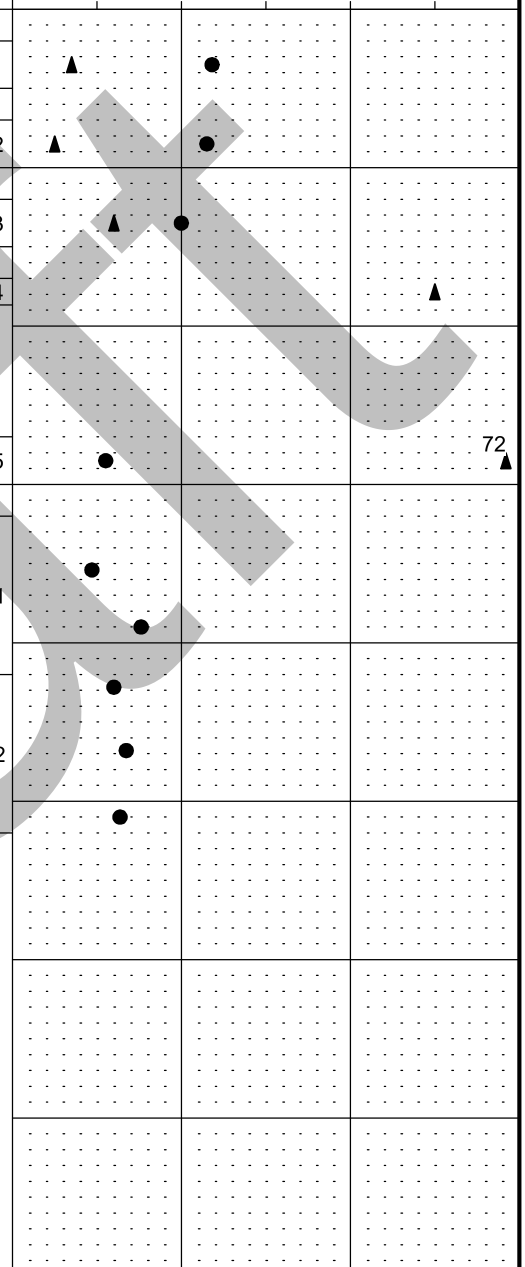
Logs of Borings B-1 through -21
Boring Log: Terms and Symbols
Rock Core Descriptions

Surface Elevation 1011

Datum NAVD88

Completion Date: 3/21/24

DEPTH IN FEET	DESCRIPTION OF MATERIAL	GRAPHIC LOG	DRY UNIT WEIGHT (pcf) SPT BLOW COUNTS CORE RECOVERY/RQD	SAMPLES
	ROOT ZONE - 4 inches			
	Possible FILL - black and dark brown fat clay, trace organics		3-4-3	SS1
5	CLAY - tan and brown, medium stiff to stiff, fat, shaley - CH		3-2-3	SS2
			4-5-7	SS3
10	sampler refusal on weathered limestone		21-50/4"	SS4
15	SHALE - tan-brown, very soft, weathered		11-23-49	SS5
	LIMESTONE - gray, moderately hard, slightly weathered			
20	SHALE - gray to dark gray, very soft, slightly weathered, calcareous		100% / 72%	NQ1
25			100% / 78%	NQ2
	Auger refusal at 16 feet. Boring terminated at 26 feet.			
30				
35				



NOTE: STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARIES BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL. GRAPHIC LOG FOR ILLUSTRATION PURPOSES ONLY.

GROUNDWATER DATA

X FREE WATER NOT ENCOUNTERED DURING DRILLING

DRILLING DATA

__ AUGER 3 3/4" HOLLOW STEM

WASHBORING FROM __ FEET

BCS DRILLER RAW LOGGER

CME 550X DRILL RIG

HAMMER TYPE Auto

REMARKS:

Drawn by: RAW Date: 3/25/24 | Check by: MHM Date: 4/30/24 | App'vd by: JAW Date: 5/13/24

UES

Proposed Joint Operations Facility
NE Tudor Road and NW Sloan
Lee's Summit, Missouri

LOG OF BORING: B- 1

Project No. J045326.01

Surface Elevation 1008

Datum NAVD88

Completion Date: 3/25/24

DEPTH IN FEET	DESCRIPTION OF MATERIAL	GRAPHIC LOG	DRY UNIT WEIGHT (pcf) SPT BLOW COUNTS CORE RECOVERY/RQD	SAMPLES
	ROOT ZONE - 6 inches			
	CLAY - tan and brown, medium stiff to stiff, fat, shaley - CH		3-3-5	SS1
			15-50/2"	SS2
5	sampler refusal on weathered limestone			
			3-5-4	SS3
	SHALE - tan to gray, very soft, weathered		13-26 -50/6"	SS4
10	sampler refusal			
	Auger refusal at 12.5 feet.			
15				
20				
25				
30				
35				

SHEAR STRENGTH, tsf

Δ - UU/2 ○ - QU/2 ▯ - PP/2

0.5 1.0 1.5 2.0 2.5

STANDARD PENETRATION RESISTANCE

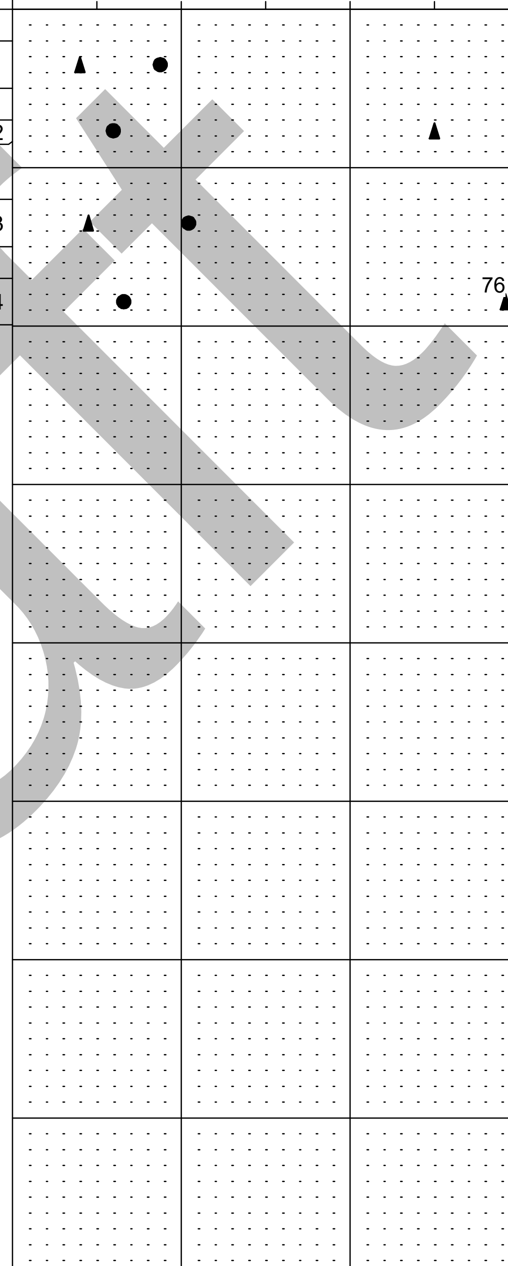
(ASTM D 1586)

▲ N-VALUE (BLOWS PER FOOT)

WATER CONTENT, %

PL ● LL

10 20 30 40 50



NOTE: STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARIES BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL. GRAPHIC LOG FOR ILLUSTRATION PURPOSES ONLY.

GROUNDWATER DATA

X FREE WATER NOT ENCOUNTERED DURING DRILLING

DRILLING DATA

4" AUGER ___ HOLLOW STEM

WASHBORING FROM ___ FEET

BCS DRILLER RAW LOGGER

CME 55TRK DRILL RIG

HAMMER TYPE Auto

REMARKS:

Drawn by: RAW Date: 3/29/24

Check by: MHM Date: 4/30/24

App'vd by: JAW Date: 5/13/24

UES

Proposed Joint Operations Facility
NE Tudor Road and NW Sloan
Lee's Summit, Missouri

LOG OF BORING: B- 2

Project No. J045326.01

Surface Elevation 1006

Datum NAVD88

Completion Date: 3/21/24

DEPTH IN FEET	DESCRIPTION OF MATERIAL	GRAPHIC LOG	DRY UNIT WEIGHT (pcf) / SPT BLOW COUNTS / CORE RECOVERY/RQD	SAMPLES
0	ROOT ZONE - 4 inches			
	FILL - black, dark brown, gray fat clay, some gravel and organics		4-5-21	SS1
	Weathered LIMESTONE and CLAY			
	sampler refusal on weathered limestone		50/4"	SS2
5			5-14-14	SS3
			11-20-14	SS4
10	CLAY - tan and brown, very stiff, fat, shaley - CH			
	LIMESTONE - gray, moderately hard, weathered		94% / 74%	NQ1
15	SHALE - dark gray, very soft, slightly weathered, calcareous			
			100% / 100%	NQ2
20			100%/100%	NQ3
	Auger refusal at 12 feet. Boring terminated at 22 feet.			
25				
30				
35				

SHEAR STRENGTH, tsf

∆ - UU/2 ○ - QU/2 ▯ - PP/2

0.5 1.0 1.5 2.0 2.5

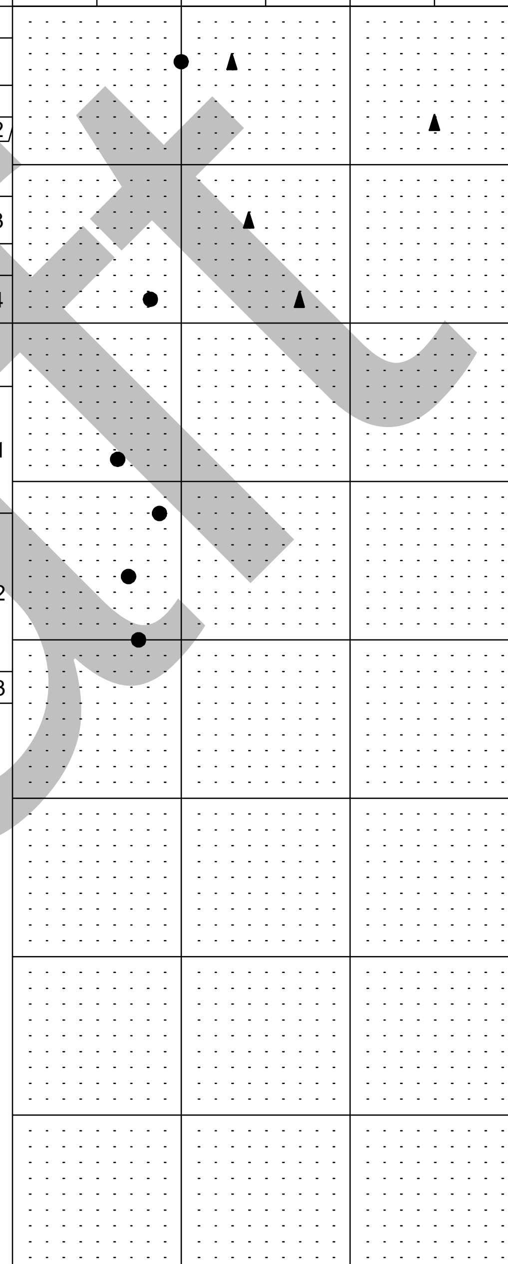
STANDARD PENETRATION RESISTANCE (ASTM D 1586)

▲ N-VALUE (BLOWS PER FOOT)

WATER CONTENT, %

PL ⊢——●——⊣ LL

10 20 30 40 50



NOTE: STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARIES BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL. GRAPHIC LOG FOR ILLUSTRATION PURPOSES ONLY.

GROUNDWATER DATA

X FREE WATER NOT ENCOUNTERED DURING DRILLING

AT 9.9 FEET AFTER 16.25 HOURS

DRILLING DATA

__ AUGER 3 3/4" HOLLOW STEM

WASHBORING FROM __ FEET

BCS DRILLER RAW LOGGER

CME 550X DRILL RIG

HAMMER TYPE Auto

REMARKS:

Drawn by: RAW Date: 3/29/24

Check by: MHM Date: 4/30/24

App'vd by: JAW Date: 5/13/24

UES

Proposed Joint Operations Facility
NE Tudor Road and NW Sloan
Lee's Summit, Missouri

LOG OF BORING: B- 3

Project No. J045326.01

Surface Elevation 1014

Datum NAVD88

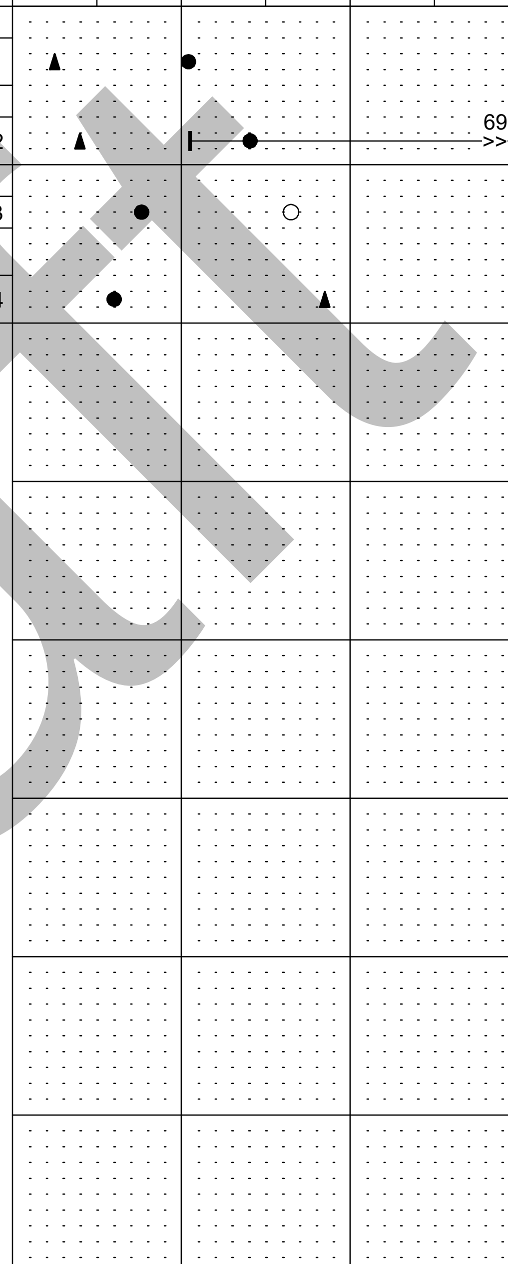
Completion Date: 3/25/24

DEPTH IN FEET	DESCRIPTION OF MATERIAL	GRAPHIC LOG	DRY UNIT WEIGHT (pcf) / SPT BLOW COUNTS / CORE RECOVERY/RQD	SAMPLES
	ROOT ZONE - 6 inches			
	FILL - dark brown and black fat clay, some organics		3-3-2	SS1
	CLAY - tan and brown, medium stiff, fat - (CH)		3-3-5	SS2
5	CLAY - tan and brown, very stiff, fat, shaley - CH		114	ST3
	SHALE - tan, very soft, weathered		2-10-27	SS4
10				
	Auger refusal at 12 feet.			
15				
20				
25				
30				
35				

SHEAR STRENGTH, tsf: Δ - UU/2, ○ - QU/2, □ - PP/2 (0.5, 1.0, 1.5, 2.0, 2.5)

STANDARD PENETRATION RESISTANCE (ASTM D 1586) ▲ N-VALUE (BLOWS PER FOOT)

WATER CONTENT, %: PL, LL (10, 20, 30, 40, 50)



NOTE: STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARIES BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL. GRAPHIC LOG FOR ILLUSTRATION PURPOSES ONLY.

GROUNDWATER DATA

X FREE WATER NOT ENCOUNTERED DURING DRILLING

DRILLING DATA

4" AUGER ___ HOLLOW STEM

WASHBORING FROM ___ FEET

BCS DRILLER RAW LOGGER

CME 55TRK DRILL RIG

HAMMER TYPE Auto

REMARKS:

Drawn by: RAW	Check by: MHM	App'vd by: JAW
Date: 3/29/24	Date: 4/30/24	Date: 5/13/24

UES

Proposed Joint Operations Facility
NE Tudor Road and NW Sloan
Lee's Summit, Missouri

LOG OF BORING: B- 4

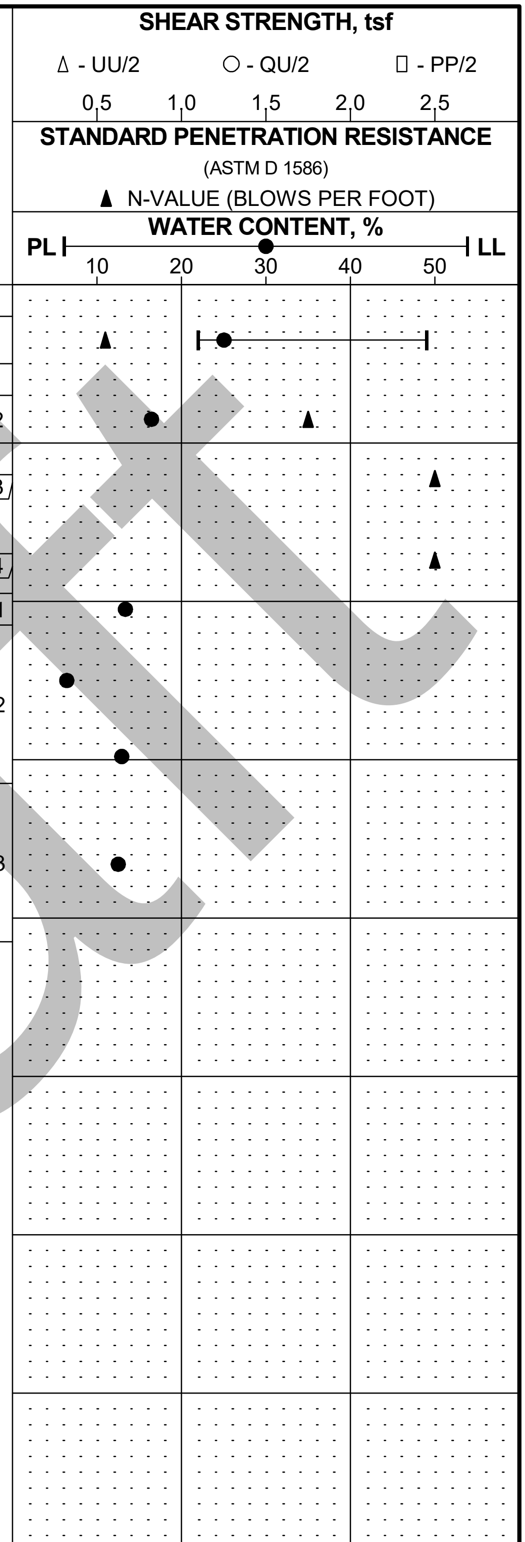
Project No. J045326.01

Surface Elevation 1010

Datum NAVD88

Completion Date: 3/22/24

DEPTH IN FEET	DESCRIPTION OF MATERIAL	GRAPHIC LOG	DRY UNIT WEIGHT (pcf) / SPT BLOW COUNTS / CORE RECOVERY/RQD	SAMPLES
	ROOT ZONE - 6 inches			
	CLAY - tan and brown, stiff, lean, shaley - (CL)		2-3-8	SS1
	SHALE - tan, very soft, weathered		7-12-23	SS2
5	Weathered LIMESTONE and CLAY sampler refusal		50/3"	SS3
	sampler refusal		50/5"	SS4
10	LIMESTONE - gray, moderately hard, weathered		100%/92%	NQ1
	SHALE - grayish blue, very soft, slightly weathered, calcareous			
	LIMESTONE - gray, moderately hard, slightly weathered		92% 53%	NQ2
	SHALE - grayish blue, very soft, weathered, calcareous			
15	LIMESTONE - white, moderately hard, weathered			
	SHALE - gray, very soft, weathered, calcareous			
	LIMESTONE - white, moderately hard, slightly weathered		100% 95%	NQ3
	SHALE - dark gray, very soft, weathered, calcareous			
20	LIMESTONE - gray, moderately hard, slightly weathered dark gray			
	SHALE - dark gray, very soft, slightly weathered, calcareous			
	Auger refusal at 9.75 feet. Boring terminated at 20.75 feet.			
25				
30				
35				



NOTE: STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARIES BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL. GRAPHIC LOG FOR ILLUSTRATION PURPOSES ONLY.

GROUNDWATER DATA

X FREE WATER NOT ENCOUNTERED DURING DRILLING

DRILLING DATA

__ AUGER 3 3/4" HOLLOW STEM

WASHBORING FROM __ FEET

BCS DRILLER RAW LOGGER

CME 550X DRILL RIG

HAMMER TYPE Auto

REMARKS:

Drawn by: RAW	Check by: MHM	App'vd by: JAW
Date: 3/29/24	Date: 4/30/24	Date: 5/13/24

UES™

Proposed Joint Operations Facility
NE Tudor Road and NW Sloan
Lee's Summit, Missouri

LOG OF BORING: B- 5

Project No. J045326.01

Surface Elevation 1009 | Datum NAVD88 | Completion Date: 3/25/24

DEPTH IN FEET	DESCRIPTION OF MATERIAL	GRAPHIC LOG	DRY UNIT WEIGHT (pcf) / SPT BLOW COUNTS / CORE RECOVERY/RQD	SAMPLES
0	ROOT ZONE - 6 inches			
	FILL - black fat clay poor sample recovery		4-4-4	SS1
	CLAY - tan, hard, fat, shaley, some gravel - CH		8-14-25	SS2
5	Weathered LIMESTONE and CLAY		21-18-17	SS3
			12-14-26	SS4
10				
	Auger refusal at 13.5 feet.			
15				
20				
25				
30				
35				

SHEAR STRENGTH, tsf

∆ - UU/2 ○ - QU/2 ▯ - PP/2

0.5 1.0 1.5 2.0 2.5

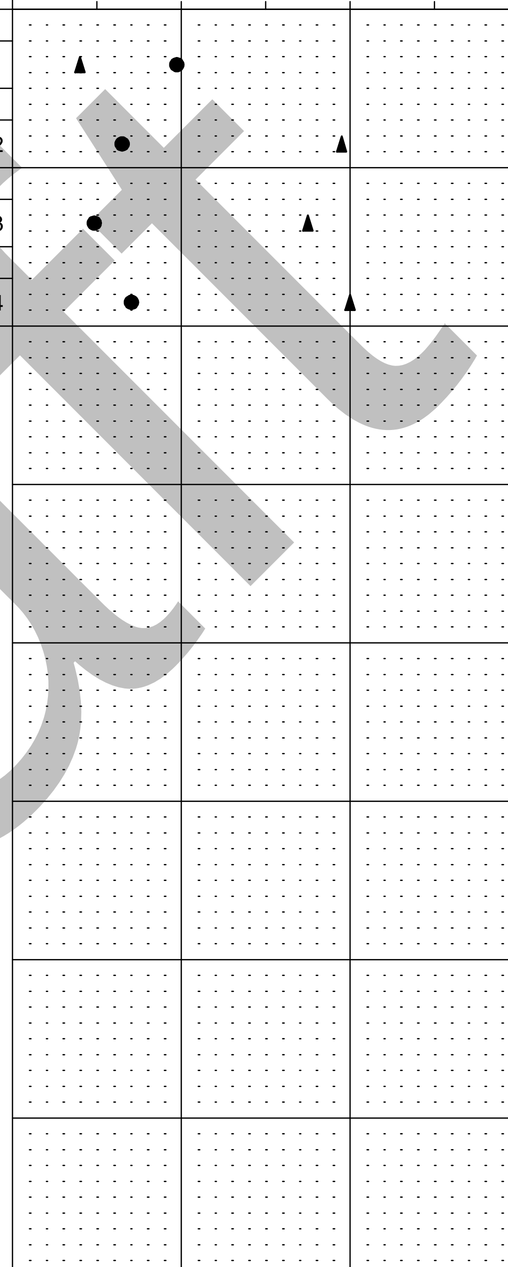
STANDARD PENETRATION RESISTANCE (ASTM D 1586)

▲ N-VALUE (BLOWS PER FOOT)

WATER CONTENT, %

PL ├─●─┤ LL

10 20 30 40 50



NOTE: STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARIES BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL. GRAPHIC LOG FOR ILLUSTRATION PURPOSES ONLY.

GROUNDWATER DATA

X FREE WATER NOT ENCOUNTERED DURING DRILLING

DRILLING DATA

4" AUGER ___ HOLLOW STEM

WASHBORING FROM ___ FEET

BCS DRILLER RAW LOGGER

CME 55TRK DRILL RIG

HAMMER TYPE Auto

REMARKS:

Drawn by: RAW	Check by: MHM	App'vd by: JAW
Date: 3/29/24	Date: 4/30/24	Date: 5/13/24

UES

Proposed Joint Operations Facility
NE Tudor Road and NW Sloan
Lee's Summit, Missouri

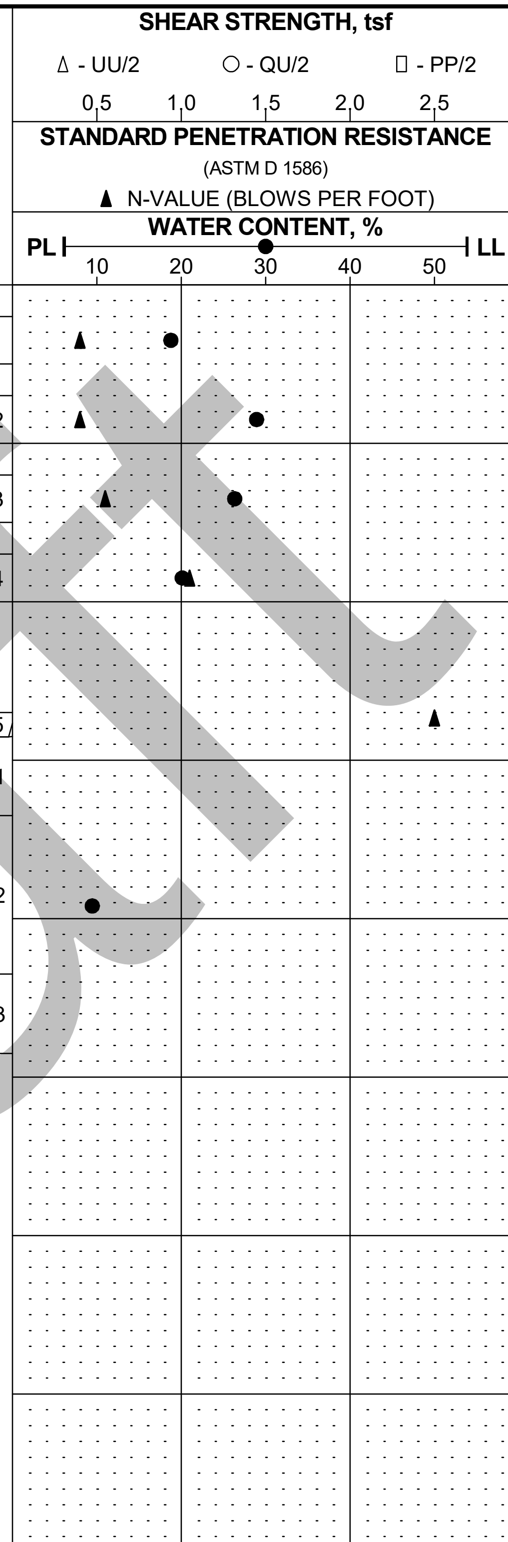
LOG OF BORING: B- 6

Project No. J045326.01

Surface Elevation 1017   Completion Date: 3/26/24

Datum NAVD88

DEPTH IN FEET	DESCRIPTION OF MATERIAL	DRY UNIT WEIGHT (pcf) / SPT BLOW COUNTS / CORE RECOVERY/RQD	SAMPLES
	ROOT ZONE - 5 inches		
	FILL - brown lean clay	4-4-4	SS1
5	CLAY - reddish brown and gray, medium stiff, fat - CH	4-4-4	SS2
	CLAY - tan and brown, stiff to very stiff, fat, some gravel, shaley - CH	4-5-6	SS3
10		6-7-14	SS4
	Weathered LIMESTONE and CLAY		
	sampler refusal	50/4"	SS5
15	LIMESTONE - gray, moderately hard, weathered	100% / 80%	NQ1
	3-inch gray shale band		
	CORE LOSS - 9 inches		
	LIMESTONE - gray, moderately hard, weathered		
	SHALE - gray, very soft, weathered, calcareous	85% / 52%	NQ2
20	LIMESTONE - gray, moderately hard, weathered		
	4-inch gray shale bed	100% / 100%	NQ3
	dark gray		
25	Auger refusal at 14.25 feet. Boring terminated at 24.25 feet.		
30			
35			



NOTE: STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARIES BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL. GRAPHIC LOG FOR ILLUSTRATION PURPOSES ONLY.

GROUNDWATER DATA

X FREE WATER NOT ENCOUNTERED DURING DRILLING

DRILLING DATA

__ AUGER 3 3/4" HOLLOW STEM

WASHBORING FROM __ FEET

BCS DRILLER RAW LOGGER

CME 55TRK DRILL RIG

HAMMER TYPE Auto

REMARKS:

Drawn by: RAW	Check by: MHM	App'vd by: JAW
Date: 3/29/24	Date: 4/30/24	Date: 5/13/24

UES

Proposed Joint Operations Facility
NE Tudor Road and NW Sloan
Lee's Summit, Missouri

LOG OF BORING: B- 7

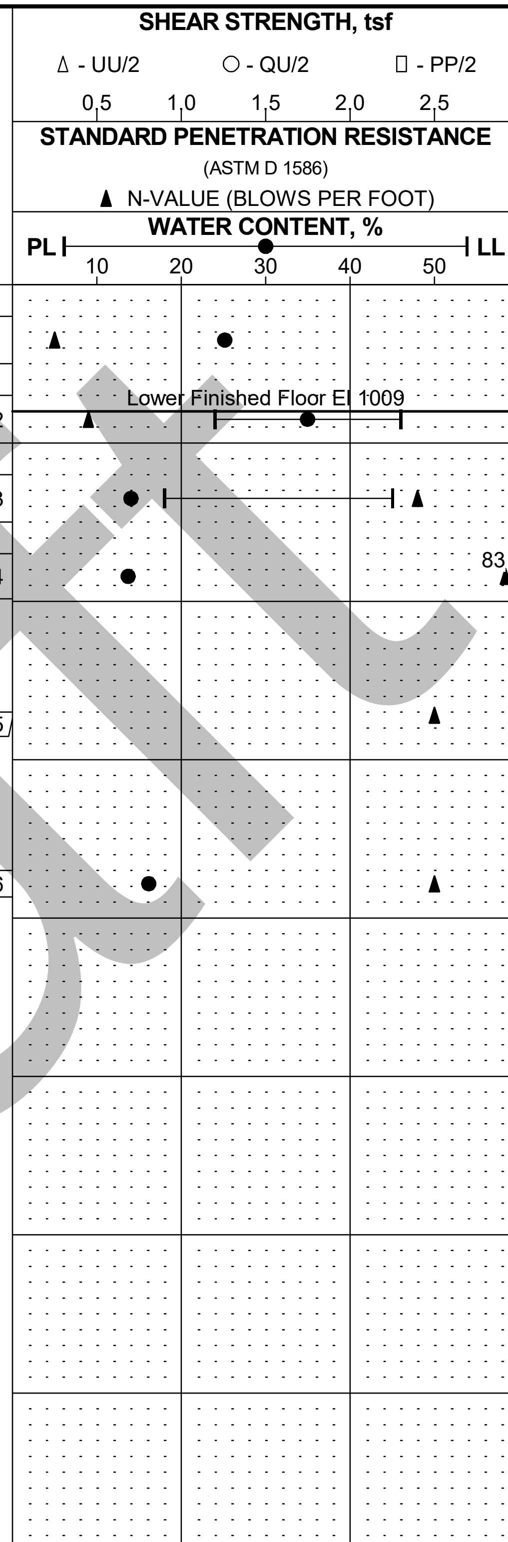
Project No. J045326.01

Surface Elevation 1013

Datum NAVD88

Completion Date: 3/25/24

DEPTH IN FEET	DESCRIPTION OF MATERIAL	GRAPHIC LOG	DRY UNIT WEIGHT (pcf) SPT BLOW COUNTS CORE RECOVERY/RQD	SAMPLES
0	ROOT ZONE - 6 inches			
	Possible FILL - reddish brown and tan fat clay		3-2-3	SS1
4	CLAY - brown, stiff, lean - (CL)		2-3-6	SS2
5.5	SHALE - dark gray, very soft, weathered, calcareous		11-11-37	SS3
			8-33 -50/5"	SS4
10	sampler refusal			
12	Weathered LIMESTONE			
	sampler refusal		50/2"	SS5
17	SHALE - dark gray, very soft, weathered, calcareous		24-50/4"	SS6
	sampler refusal			
19.5	Auger refusal at 19.5 feet.			



NOTE: STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARIES BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL. GRAPHIC LOG FOR ILLUSTRATION PURPOSES ONLY.

GROUNDWATER DATA

ENCOUNTERED AT 17.33 FEET ∇

DRILLING DATA

4" AUGER ___ HOLLOW STEM

WASHBORING FROM ___ FEET

BCS DRILLER RAW LOGGER

CME 55TRK DRILL RIG

HAMMER TYPE Auto

REMARKS:

Drawn by: RAW Date: 3/29/24 | Check by: MHM Date: 4/30/24 | App'vd by: JAW Date: 5/13/24

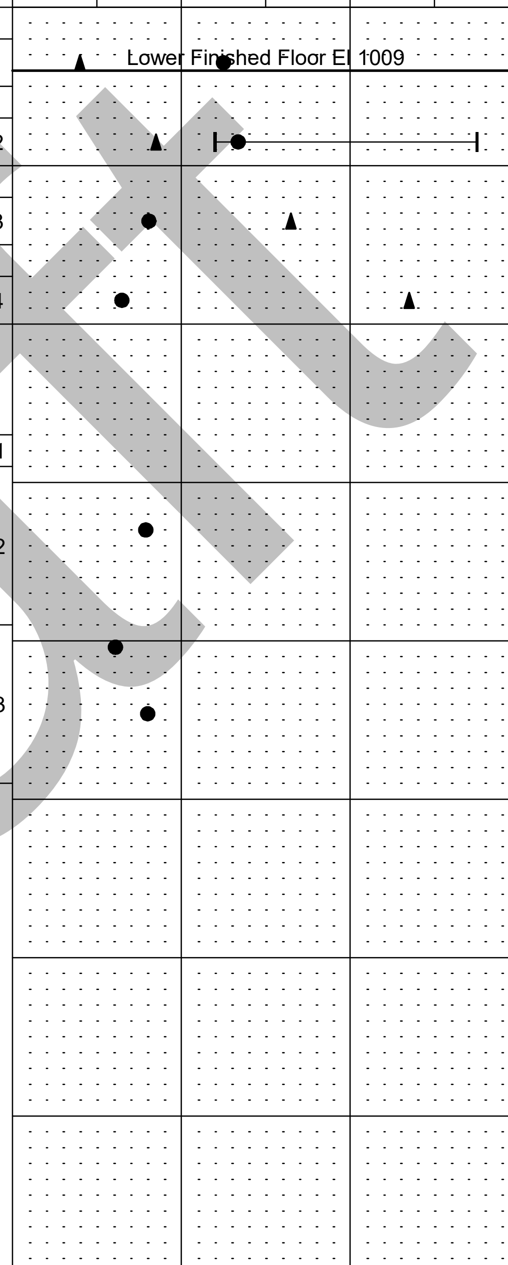
UES

Proposed Joint Operations Facility
NE Tudor Road and NW Sloan
Lee's Summit, Missouri

LOG OF BORING: B- 8

Project No. J045326.01

Surface Elevation 1011 Datum NAVD88	Completion Date: 3/22/24				SHEAR STRENGTH, tsf Δ - UU/2 ○ - QU/2 ▯ - PP/2 0.5 1.0 1.5 2.0 2.5 STANDARD PENETRATION RESISTANCE (ASTM D 1586) ▲ N-VALUE (BLOWS PER FOOT) WATER CONTENT, % PL ⊢ ● ⊣ LL 10 20 30 40 50
DEPTH IN FEET	DESCRIPTION OF MATERIAL	GRAPHIC LOG	DRY UNIT WEIGHT (pcf) SPT BLOW COUNTS CORE RECOVERY/RQD	SAMPLES	
	ROOT ZONE - 6 inches				
	FILL - dark brown fat clay to brown fat clay some shale		3-4-4	SS1	Lower Finished Floor El 1009
	CLAY - tan and brown, very stiff, fat, shaley - (CH)		4-6-11	SS2	
5	SHALE - reddish brown and gray to tan, very soft, weathered		5-13-20	SS3	
			12-20-27	SS4	
10	Weathered LIMESTONE (rough drilling)				
	LIMESTONE - gray, moderately hard, slightly weathered		100%/100%	NQ1	
15	1-inch clay seam				
	SHALE - grayish blue, very soft, weathered, calcareous				
	LIMESTONE - gray to white, moderately hard, slightly weathered 3-inch shale bed		100% 60%	NQ2	
20	dark gray				
	SHALE - dark gray, very soft, weathered, calcareous		100% 78%	NQ3	
25	Auger refusal at 13.5 feet. Boring terminated at 24.5 feet.				
30					
35					



NOTE: STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARIES BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL. GRAPHIC LOG FOR ILLUSTRATION PURPOSES ONLY.

GROUNDWATER DATA

X FREE WATER NOT ENCOUNTERED DURING DRILLING

DRILLING DATA

__ AUGER 3 3/4" HOLLOW STEM

WASHBORING FROM __ FEET

BCS DRILLER RAW LOGGER

CME 550X DRILL RIG

HAMMER TYPE Auto

REMARKS:

Drawn by: RAW Date: 3/29/24	Check by: MHM Date: 4/30/24	App'vd by: JAW Date: 5/13/24

UES

Proposed Joint Operations Facility
NE Tudor Road and NW Sloan
Lee's Summit, Missouri

LOG OF BORING: B- 9

Project No. J045326.01

Surface Elevation 1019

Datum NAVD88

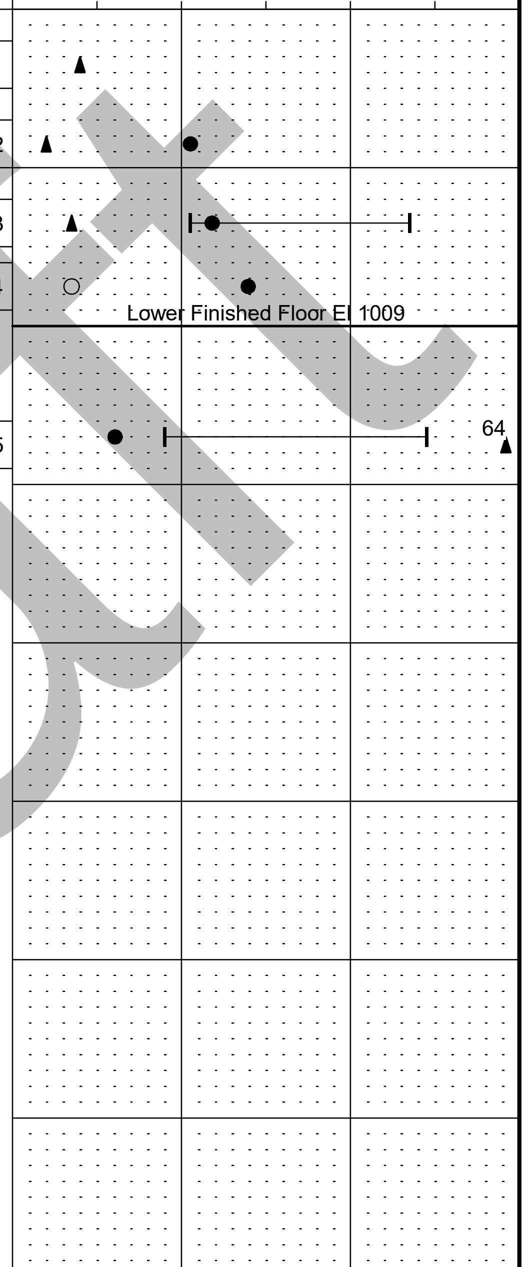
Completion Date: 3/27/24

SHEAR STRENGTH, tsf: Δ - UU/2, ○ - QU/2, ▯ - PP/2 (0.5, 1.0, 1.5, 2.0, 2.5)

STANDARD PENETRATION RESISTANCE (ASTM D 1586): ▲ N-VALUE (BLOWS PER FOOT)

WATER CONTENT, %: PL, LL (10, 20, 30, 40, 50)

DEPTH IN FEET	DESCRIPTION OF MATERIAL	DRY UNIT WEIGHT (pcf) SPT BLOW COUNTS CORE RECOVERY/RQD	SAMPLES
0	ROOT ZONE - 6 inches		
	FILL - dark brown lean clay, trace organics	3-4-4	SS1
	poor sample recovery	3-2-2	SS2
5	rough drilling		
	CLAY - tan and brown, medium stiff, lean, shaley - (CL)	3-3-4	SS3
		94	ST4
10	sampler refusal		
	SHALE - dark gray, very soft, weathered, calcareous	5-25-39	SS5
15			
	Auger refusal at 17.5 feet.		
20			
25			
30			
35			



NOTE: STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARIES BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL. GRAPHIC LOG FOR ILLUSTRATION PURPOSES ONLY.

GROUNDWATER DATA

X FREE WATER NOT ENCOUNTERED DURING DRILLING

DRILLING DATA

4" AUGER ___ HOLLOW STEM

WASHBORING FROM ___ FEET

BCS DRILLER RAW LOGGER

CME 55TRK DRILL RIG

HAMMER TYPE Auto

REMARKS: Auger refusal on coarse fill initially occurs at 3.5 feet. The boring was offset 5 feet to the east and redrilled.

Drawn by: RAW Date: 3/29/24 | Check by: MHM Date: 4/30/24 | App'vd by: JAW Date: 5/13/24

UES

Proposed Joint Operations Facility
NE Tudor Road and NW Sloan
Lee's Summit, Missouri

LOG OF BORING: B-10

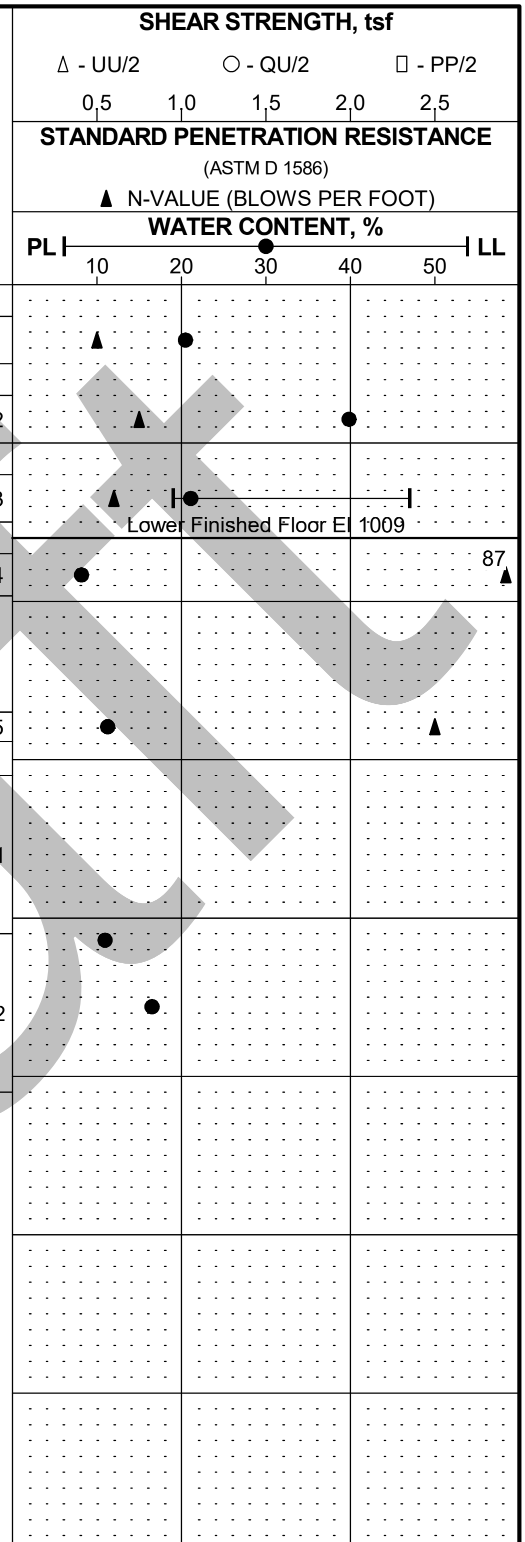
Project No. J045326.01

Surface Elevation 1017

Datum NAVD88

Completion Date: 3/22/24

DEPTH IN FEET	DESCRIPTION OF MATERIAL	DRY UNIT WEIGHT (pcf) / SPT BLOW COUNTS / CORE RECOVERY/RQD	SAMPLES
	ROOT ZONE - 12 inches		
	FILL - brown lean clay, some organics and gravel	4-5-5	SS1
	rough drilling		
	Weathered LIMESTONE and CLAY	17-5-10	SS2
5			
	CLAY - tan, stiff, lean, shaley - (CL)	3-5-7	SS3
		6-37 -50/4"	SS4
10	SHALE - dark gray, very soft, moderately weathered, calcareous		
	sampler refusal		
		18-50/5"	SS5
15	sampler refusal		
	Weathered LIMESTONE (rough drilling)		
	LIMESTONE - grayish blue, soft, weathered, argillaceous		
	4-inch vertical fracture	100% / 78%	NQ1
	LIMESTONE - gray, moderately hard, slightly weathered		
20			
	SHALE - dark gray, very soft, weathered, calcareous		
	LIMESTONE - white, moderately hard, slightly weathered	100% / 78%	NQ2
	SHALE - dark gray, very soft, weathered, calcareous		
25	LIMESTONE - white, moderately hard, slightly weathered		
	dark gray		
	Auger refusal at 15.5 feet.		
	Boring terminated at 25.5 feet.		
30			
35			



NOTE: STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARIES BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL. GRAPHIC LOG FOR ILLUSTRATION PURPOSES ONLY.

GROUNDWATER DATA

X FREE WATER NOT ENCOUNTERED DURING DRILLING

DRILLING DATA

__ AUGER 3 3/4" HOLLOW STEM

WASHBORING FROM __ FEET

BCS DRILLER RAW LOGGER

CME 550X DRILL RIG

HAMMER TYPE Auto

REMARKS:

Drawn by: RAW	Check by: MHM	App'vd by: JAW
Date: 3/29/24	Date: 4/30/24	Date: 5/13/24

UES

Proposed Joint Operations Facility
NE Tudor Road and NW Sloan
Lee's Summit, Missouri

LOG OF BORING: B-11

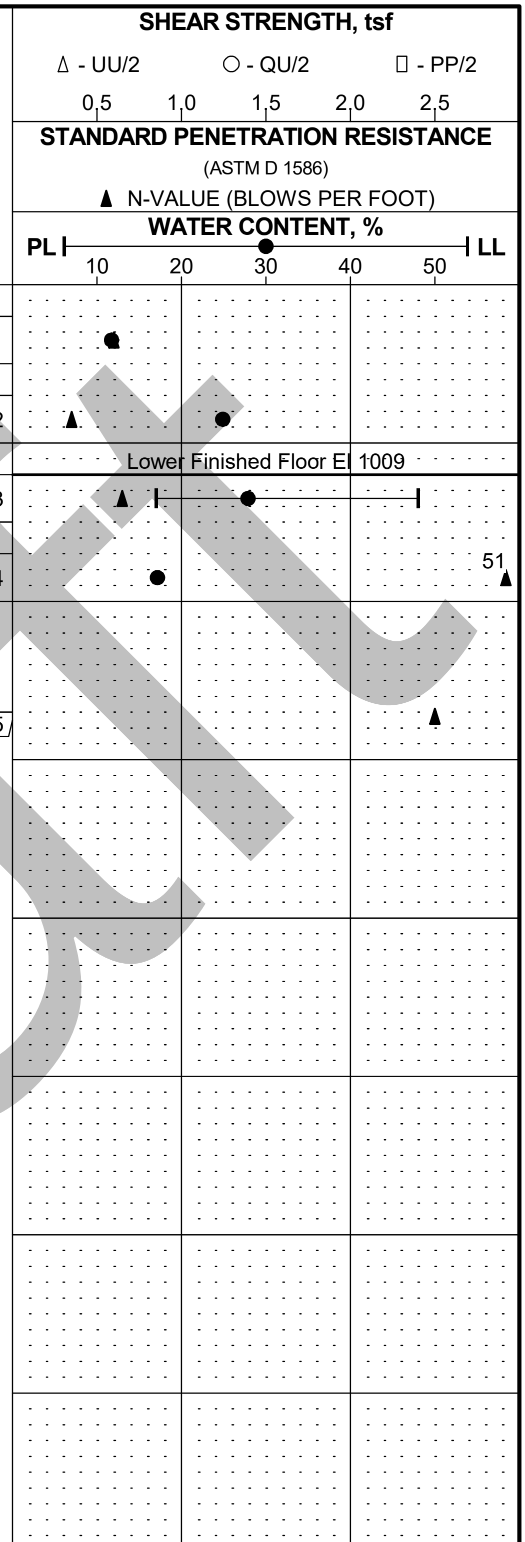
Project No. J045326.01

Surface Elevation 1015

Datum NAVD88

Completion Date: 3/27/24

DEPTH IN FEET	DESCRIPTION OF MATERIAL	GRAPHIC LOG	DRY UNIT WEIGHT (pcf) SPT BLOW COUNTS CORE RECOVERY/RQD	SAMPLES
0	ROOT ZONE - 6 inches			
	FILL - brown lean clay, trace organics		5-7-5	SS1
3	CLAY - reddish brown to tan, medium stiff, fat - CH		2-3-4	SS2
6.5	CLAY - dark brown, stiff, lean, shaley - (CL)		3-7-6	SS3
8	SHALE - dark gray, very soft, weathered, calcareous		13-26-25	SS4
12	Weathered LIMESTONE (rough drilling)			
	sampler refusal		50/3"	SS5
15	Auger refusal at 15 feet.			



NOTE: STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARIES BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL. GRAPHIC LOG FOR ILLUSTRATION PURPOSES ONLY.

GROUNDWATER DATA

X FREE WATER NOT ENCOUNTERED DURING DRILLING

DRILLING DATA

4" AUGER ___ HOLLOW STEM

WASHBORING FROM ___ FEET

BCS DRILLER RAW LOGGER

CME 55TRK DRILL RIG

HAMMER TYPE Auto

REMARKS:

Drawn by: RAW	Check by: MHM	App'vd by: JAW
Date: 3/29/24	Date: 4/30/24	Date: 5/13/24

UES

Proposed Joint Operations Facility
NE Tudor Road and NW Sloan
Lee's Summit, Missouri

LOG OF BORING: B-12

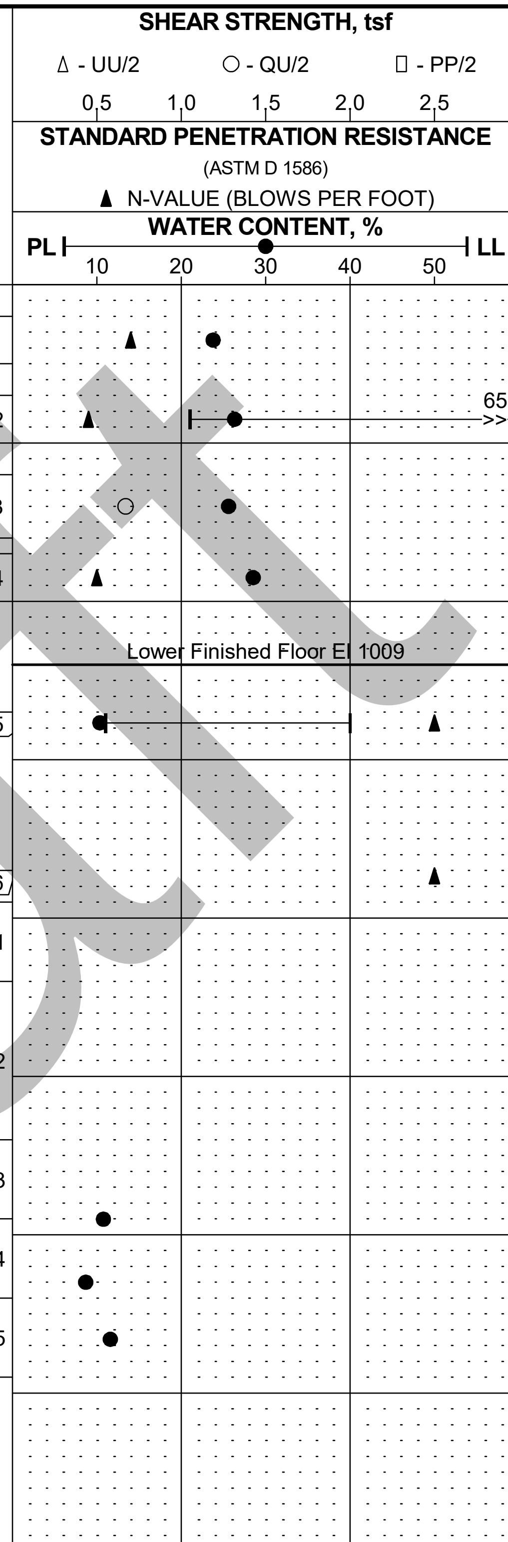
Project No. J045326.01

Surface Elevation 1021

Datum NAVD88

Completion Date: 3/27/24

DEPTH IN FEET	DESCRIPTION OF MATERIAL	GRAPHIC LOG	DRY UNIT WEIGHT (pcf) SPT BLOW COUNTS CORE RECOVERY/RQD	SAMPLES
	ROOT ZONE - 6 inches			
	FILL - brown lean clay, some gravel and organics		5-6-8	SS1
5	CLAY - reddish brown and tan to reddish brown, stiff, fat - (CH)		4-4-5	SS2
			99	ST3
10	CLAY - tan and gray, stiff, fat - CH		9-6-4	SS4
	SHALE - gray, very soft, weathered			
15	sampler refusal		37-50/2"	SS5
	Weathered LIMESTONE			
	sampler refusal		50/4"	SS6
20	LIMESTONE - grayish blue, moderately hard, slightly weathered		100% / 83%	NQ1
	6 inch vertical fracture			
25	SHALE - gray, very soft, weathered, calcareous		68% / 21%	NQ2
	LIMESTONE - gray, moderately hard, weathered			
	SHALE - gray, very soft, weathered, calcareous			
	CORE LOSS - 18 inches		100% / 0%	NQ3
	SHALE - gray, very soft, weathered			
30	LIMESTONE - gray, moderately hard, weathered 1.5-foot vertical fracture		100% / 100%	NQ4
	LIMESTONE - dark gray, moderately hard, weathered			
	SHALE - dark gray, very soft, slightly weathered, calcareous		100% / 80%	NQ5
35	Auger refusal at 19.5 feet. Boring terminated at 34.5 feet.			



NOTE: STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARIES BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL. GRAPHIC LOG FOR ILLUSTRATION PURPOSES ONLY.

GROUNDWATER DATA

X FREE WATER NOT ENCOUNTERED DURING DRILLING

DRILLING DATA

__ AUGER 3 3/4" HOLLOW STEM

WASHBORING FROM __ FEET

BCS DRILLER RAW LOGGER

CME 55TRK DRILL RIG

HAMMER TYPE Auto

REMARKS:

Drawn by: RAW	Check by: MHM	App'vd by: JAW
Date: 3/29/24	Date: 4/30/24	Date: 5/13/24

UES

Proposed Joint Operations Facility
NE Tudor Road and NW Sloan
Lee's Summit, Missouri

LOG OF BORING: B-13

Project No. J045326.01

Surface Elevation **1019**

Datum **NAVD88**

Completion Date: **3/27/24**

DEPTH IN FEET	DESCRIPTION OF MATERIAL	GRAPHIC LOG	DRY UNIT WEIGHT (pcf) / SPT BLOW COUNTS / CORE RECOVERY/RQD	SAMPLES
	ROOT ZONE - 6 inches			
	FILL - dark brown lean clay, trace organics		4-7-5	SS1
	CLAY - reddish brown, medium stiff to stiff, fat - (CH)		3-3-5	SS2
5				
			87	ST3
	sampler refusal			
	CLAY - tan and brown, stiff, fat, shaley - (CH)		3-4-7	SS4
10				
	SHALE - gray, very soft, weathered, calcareous			
	sampler refusal		50/5"	SS5
15				
	Weathered LIMESTONE			
	sampler refusal		50/3"	SS6
20				
			50/4"	SS7
	Boring terminated at split-spoon sampler refusal at 23.8 feet.			
25				
30				
35				

SHEAR STRENGTH, tsf

Δ - UU/2 ○ - QU/2 □ - PP/2

0.5 1.0 1.5 2.0 2.5

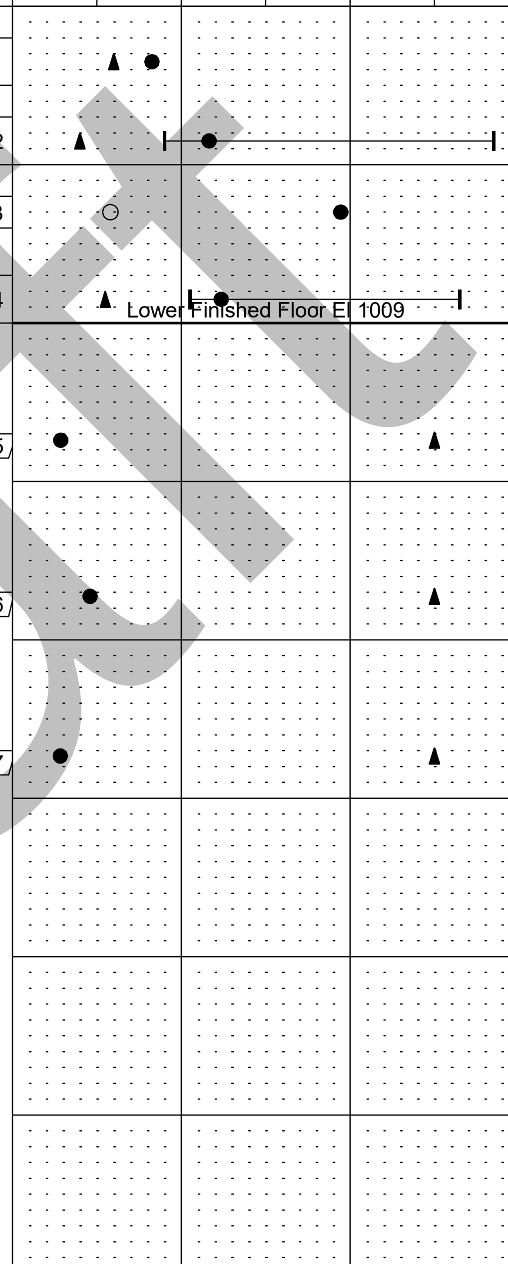
STANDARD PENETRATION RESISTANCE (ASTM D 1586)

▲ N-VALUE (BLOWS PER FOOT)

WATER CONTENT, %

PL ● LL

10 20 30 40 50



NOTE: STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARIES BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL. GRAPHIC LOG FOR ILLUSTRATION PURPOSES ONLY.

GROUNDWATER DATA

ENCOUNTERED AT 22.7 FEET ▽

AT 18.9 FEET AFTER 3.5 HOURS ▼

DRILLING DATA

4" AUGER ___ HOLLOW STEM

WASHBORING FROM ___ FEET

BCS DRILLER RAW LOGGER

CME 55TRK DRILL RIG

HAMMER TYPE Auto

REMARKS:

Drawn by: RAW	Check by: MHM	App'vd by: JAW
Date: 3/29/24	Date: 4/30/24	Date: 5/13/24

UES™

Proposed Joint Operations Facility
NE Tudor Road and NW Sloan
Lee's Summit, Missouri

LOG OF BORING: B-14

Project No. J045326.01

Surface Elevation 1017

Datum NAVD88

Completion Date: 3/27/24

DEPTH IN FEET	DESCRIPTION OF MATERIAL	GRAPHIC LOG	DRY UNIT WEIGHT (pcf) / SPT BLOW COUNTS / CORE RECOVERY/RQD	SAMPLES
	ROOT ZONE - 6 inches			
	FILL - brown and dark brown lean clay, reddish brown fat clay, trace of black shale fragments, some gravel		5-5-7	SS1
5	poor sample recovery		5-4-6	SS2
			91	ST3
	sampler refusal			
	CLAY - tan and brown, hard, fat, shaley - CH		6-13-26	SS4
10	**BLACK SHALE** - extremely soft, weathered			
	SHALE - gray, very soft, weathered, calcareous			
15	sampler refusal		20-50/5"	SS5
	Weathered LIMESTONE			
	sampler refusal		50/4"	SS6
20	LIMESTONE - gray, moderately hard, weathered			
	SHALE - gray, very soft, weathered, calcareous		100% / 63%	NQ1
	LIMESTONE - gray, moderately hard, slightly weathered			
25	SHALE - gray, very soft, weathered, calcareous		100% / 80%	NQ2
	LIMESTONE - gray, moderately hard, slightly weathered			
	dark gray			
	SHALE - dark gray, very soft, weathered, calcareous		100% / 31%	NQ3
30	Auger refusal at 20 feet. Boring terminated at 30 feet.			
35				

SHEAR STRENGTH, tsf

∆ - UU/2 ○ - QU/2 ▯ - PP/2

0.5 1.0 1.5 2.0 2.5

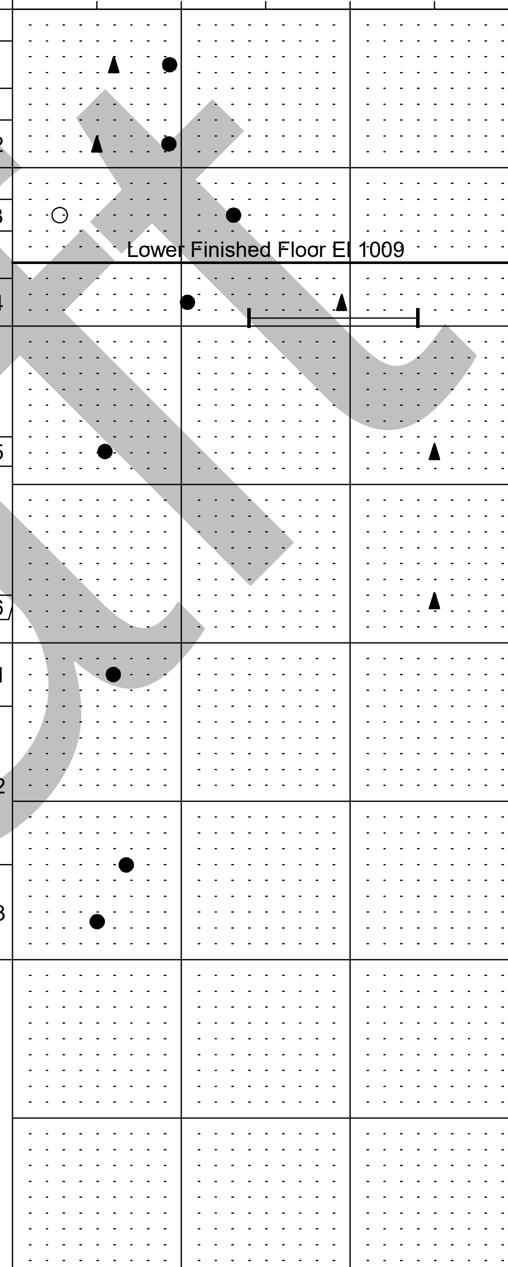
STANDARD PENETRATION RESISTANCE (ASTM D 1586)

▲ N-VALUE (BLOWS PER FOOT)

WATER CONTENT, %

PL ⊢—●—⊣ LL

10 20 30 40 50



NOTE: STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARIES BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL. GRAPHIC LOG FOR ILLUSTRATION PURPOSES ONLY.

GROUNDWATER DATA

X FREE WATER NOT ENCOUNTERED DURING DRILLING

DRILLING DATA

__ AUGER 3 3/4" HOLLOW STEM

WASHBORING FROM __ FEET

BCS DRILLER RAW LOGGER

CME 55TRK DRILL RIG

HAMMER TYPE Auto

REMARKS:

Drawn by: RAW	Check by: MHM	App'vd by: JAW
Date: 3/29/24	Date: 4/30/24	Date: 5/13/24

UES

Proposed Joint Operations Facility
NE Tudor Road and NW Sloan
Lee's Summit, Missouri

LOG OF BORING: B-15

Project No. J045326.01

Surface Elevation **1012**

Datum **NAVD88**

Completion Date: **3/27/24**

DEPTH IN FEET	DESCRIPTION OF MATERIAL	GRAPHIC LOG	DRY UNIT WEIGHT (pcf) SPT BLOW COUNTS CORE RECOVERY/RQD	SAMPLES
	ROOT ZONE - 6 inches			
	FILL - dark gray, black and brown lean clay		3-3-3	SS1
	CLAY - reddish brown and gray, medium stiff, fat - (CH)		3-3-5	SS2
5	CLAY - dark brown to tan, medium stiff to stiff, fat, shaley - CH		3-5-7	SS3
10	SHALE - dark gray, very soft, weathered, calcareous		8-29-50	SS4
15	Weathered LIMESTONE (rough drilling) sampler refusal		50/1"	SS5
	Auger refusal at 14 feet.			
20				
25				
30				
35				

SHEAR STRENGTH, tsf

Δ - UU/2 ○ - QU/2 ▯ - PP/2

0.5 1.0 1.5 2.0 2.5

STANDARD PENETRATION RESISTANCE

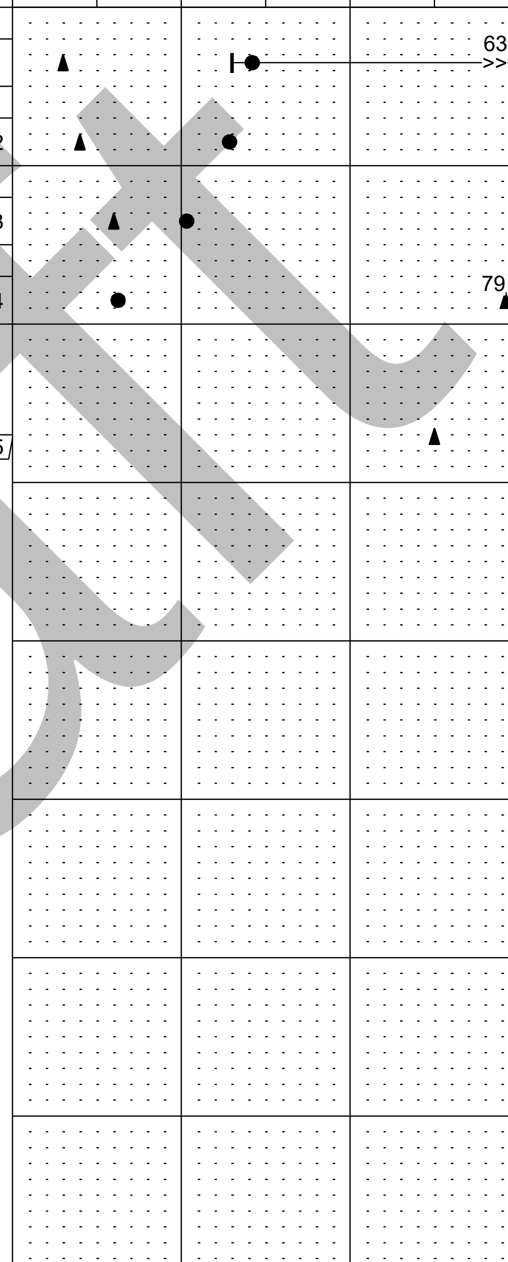
(ASTM D 1586)

▲ N-VALUE (BLOWS PER FOOT)

WATER CONTENT, %

PL ├──●──┤ LL

10 20 30 40 50



NOTE: STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARIES BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL. GRAPHIC LOG FOR ILLUSTRATION PURPOSES ONLY.

GROUNDWATER DATA

X FREE WATER NOT ENCOUNTERED DURING DRILLING

DRILLING DATA

4" AUGER ___ HOLLOW STEM

WASHBORING FROM ___ FEET

BCS DRILLER RAW LOGGER

CME 55TRK DRILL RIG

HAMMER TYPE Auto

REMARKS:

Drawn by: RAW	Check by: MHM	App'vd by: JAW
Date: 3/29/24	Date: 4/30/24	Date: 5/13/24

UES

Proposed Joint Operations Facility
NE Tudor Road and NW Sloan
Lee's Summit, Missouri

LOG OF BORING: B-16

Project No. J045326.01

Surface Elevation 1017

Datum NAVD88

Completion Date: 3/25/24

SHEAR STRENGTH, tsf

∆ - UU/2 ○ - QU/2 ▯ - PP/2

0.5 1.0 1.5 2.0 2.5

STANDARD PENETRATION RESISTANCE (ASTM D 1586)

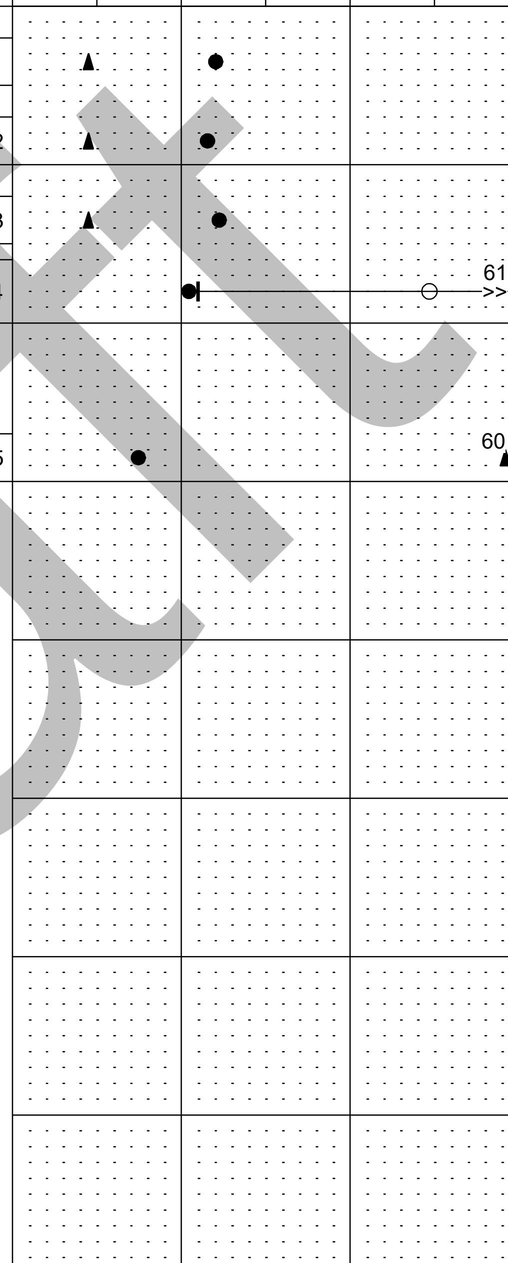
▲ N-VALUE (BLOWS PER FOOT)

WATER CONTENT, %

PL ⊢——●——⊣ LL

10 20 30 40 50

DEPTH IN FEET	DESCRIPTION OF MATERIAL	GRAPHIC LOG	DRY UNIT WEIGHT (pcf) SPT BLOW COUNTS CORE RECOVERY/RQD	SAMPLES
0	ROOT ZONE - 6 inches			
	FILL - black and brown fat clay, some organics and gravel		3-4-5	SS1
5			4-4-5	SS2
	CLAY - dark brown to brown and gray to light brown, stiff to hard, fat, some gravel - (CH)		4-4-5	SS3
10			105	ST4
	SHALE - gray, very soft, weathered, calcareous			
15			10-28-32	SS5
	Auger refusal at 17.5 feet.			
20				
25				
30				
35				



NOTE: STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARIES BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL. GRAPHIC LOG FOR ILLUSTRATION PURPOSES ONLY.

GROUNDWATER DATA

X FREE WATER NOT ENCOUNTERED DURING DRILLING

DRILLING DATA

4" AUGER ___ HOLLOW STEM

WASHBORING FROM ___ FEET

BCS DRILLER RAW LOGGER

CME 55TRK DRILL RIG

HAMMER TYPE Auto

REMARKS:

Drawn by: RAW	Check by: MHM	App'vd by: JAW
Date: 3/29/24	Date: 4/30/24	Date: 5/13/24

UES™

Proposed Joint Operations Facility
NE Tudor Road and NW Sloan
Lee's Summit, Missouri

LOG OF BORING: B-17

Project No. J045326.01

Surface Elevation 1008

Datum NAVD88

Completion Date: 3/25/24

DEPTH IN FEET	DESCRIPTION OF MATERIAL	DRY UNIT WEIGHT (pcf) / SPT BLOW COUNTS / CORE RECOVERY/RQD	SAMPLES
	ROOT ZONE - 6 inches		
	Possible FILL - brown fat clay, some organics and gravel	2-2-2	SS1
	CLAY - tan and gray, very stiff, fat, shaley - CH	112	ST2
	sampler refusal		
5	Weathered LIMESTONE		
	sampler refusal	30/1"	SS3
	Auger refusal at 6.5 feet.		
10			
15			
20			
25			
30			
35			

SHEAR STRENGTH, tsf

Δ - UU/2 ○ - QU/2 ▯ - PP/2

0.5 1.0 1.5 2.0 2.5

STANDARD PENETRATION RESISTANCE (ASTM D 1586)

▲ N-VALUE (BLOWS PER FOOT)

WATER CONTENT, %

PL ├── ● ──┤ LL

10 20 30 40 50

NOTE: STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARIES BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL. GRAPHIC LOG FOR ILLUSTRATION PURPOSES ONLY.

GROUNDWATER DATA

X FREE WATER NOT ENCOUNTERED DURING DRILLING

DRILLING DATA

4" AUGER ___ HOLLOW STEM

WASHBORING FROM ___ FEET

BCS DRILLER RAW LOGGER

CME 55TRK DRILL RIG

HAMMER TYPE Auto

REMARKS:

Drawn by: RAW	Check by: MHM	App'vd by: JAW
Date: 3/29/24	Date: 4/30/24	Date: 5/13/24

UES

Proposed Joint Operations Facility
NE Tudor Road and NW Sloan
Lee's Summit, Missouri

LOG OF BORING: B-18

Project No. J045326.01

Surface Elevation 1007

Datum NAVD88

Completion Date: 3/25/24

DEPTH IN FEET	DESCRIPTION OF MATERIAL	GRAPHIC LOG	DRY UNIT WEIGHT (pcf) / SPT BLOW COUNTS / CORE RECOVERY/RQD	SAMPLES
	ASPHALT - 5.5 inches			
	CRUSHED ROCK - 6.5 inches		3-2-3	SS1
	CLAY - gray and brown, medium stiff, fat, some gravel - (CH)		2-3-5	SS2
5	Weathered LIMESTONE sampler refusal		50/3"	SS3
	Auger refusal at 7.5 feet.			
10				
15				
20				
25				
30				
35				

SHEAR STRENGTH, tsf

Δ - UU/2 ○ - QU/2 ▯ - PP/2

0.5 1.0 1.5 2.0 2.5

STANDARD PENETRATION RESISTANCE

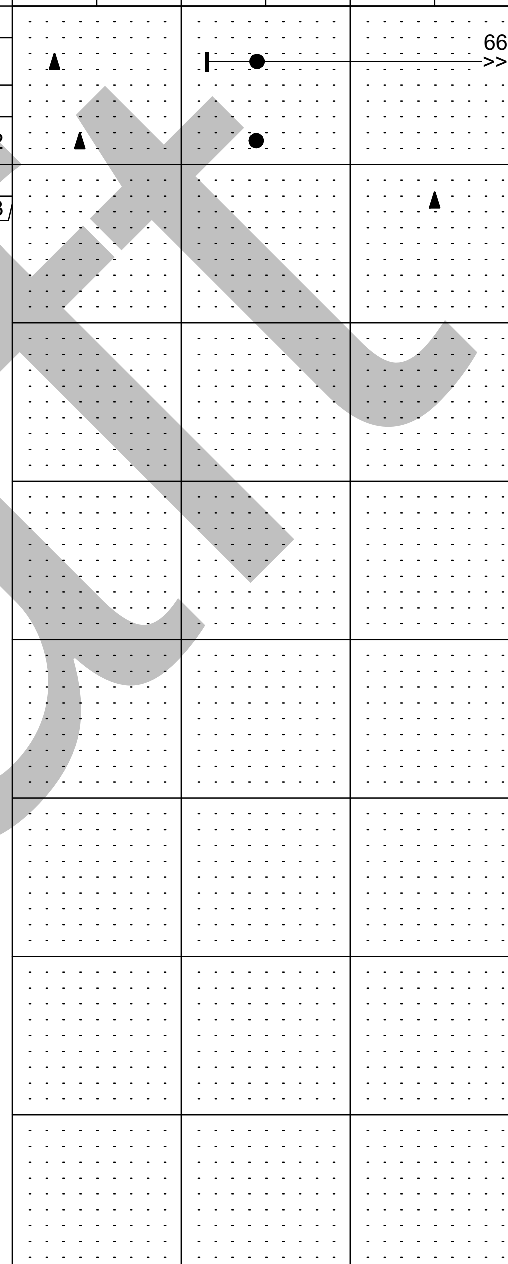
(ASTM D 1586)

▲ N-VALUE (BLOWS PER FOOT)

WATER CONTENT, %

PL ⊢——●——⊣ LL

10 20 30 40 50



NOTE: STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARIES BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL. GRAPHIC LOG FOR ILLUSTRATION PURPOSES ONLY.

GROUNDWATER DATA

X FREE WATER NOT ENCOUNTERED DURING DRILLING

DRILLING DATA

4" AUGER __ HOLLOW STEM

WASHBORING FROM __ FEET

BCS DRILLER RAW LOGGER

CME 55TRK DRILL RIG

HAMMER TYPE Auto

REMARKS:

Drawn by: RAW	Check by: MHM	App'vd by: JAW
Date: 3/29/24	Date: 4/30/24	Date: 5/13/24

UES

Proposed Joint Operations Facility
NE Tudor Road and NW Sloan
Lee's Summit, Missouri

LOG OF BORING: B-19

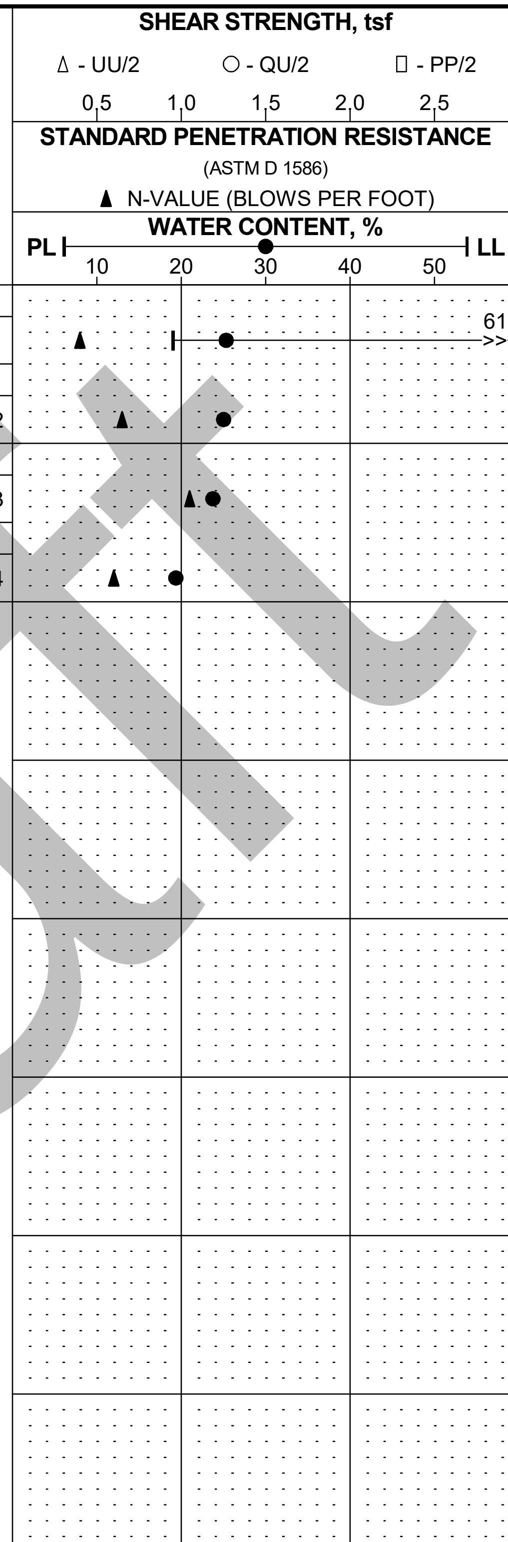
Project No. J045326.01

Surface Elevation **1007**

Datum **NAVD88**

Completion Date: **3/25/24**

DEPTH IN FEET	DESCRIPTION OF MATERIAL	GRAPHIC LOG	DRY UNIT WEIGHT (pcf) / SPT BLOW COUNTS / CORE RECOVERY/RQD	SAMPLES
	ASPHALT - 5.5 inches			
	CRUSHED ROCK - 6.5 inches		3-3-5	SS1
	Possible FILL - black and reddish brown fat clay, some organics and gravel			
5	CLAY - reddish brown to gray and brown, very stiff, fat - CH		6-6-7	SS2
	CLAY - brown and gray, very stiff to stiff, fat, shaley - CH		4-8-13	SS3
10			3-5-7	SS4
	Auger refusal at 13 feet.			
15				
20				
25				
30				
35				



NOTE: STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARIES BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL. GRAPHIC LOG FOR ILLUSTRATION PURPOSES ONLY.

GROUNDWATER DATA

X FREE WATER NOT ENCOUNTERED DURING DRILLING

DRILLING DATA

4" AUGER ___ HOLLOW STEM

WASHBORING FROM ___ FEET

BCS DRILLER RAW LOGGER

CME 55TRK DRILL RIG

HAMMER TYPE Auto

REMARKS:

Drawn by: RAW	Check by: MHM	App'vd by: JAW
Date: 3/29/24	Date: 4/30/24	Date: 5/13/24

UES

Proposed Joint Operations Facility
NE Tudor Road and NW Sloan
Lee's Summit, Missouri

LOG OF BORING: B-20

Project No. J045326.01

Surface Elevation 1006 | Completion Date: 3/25/24

Datum NAVD88

DEPTH IN FEET	DESCRIPTION OF MATERIAL	DRY UNIT WEIGHT (pcf) / SPT BLOW COUNTS / CORE RECOVERY/RQD	SAMPLES
0	ASPHALT - 7 inches		
	CRUSHED ROCK - 5 inches	3-4-5	SS1
	FILL - black, gray and brown fat clay	3-4-6	SS2
5	CLAY - black, medium stiff to stiff, fat - CH	3-4-4	SS3
	CLAY - gray and brown, stiff, fat - CH	3-4-5	SS4
10	CLAY - brown and gray, stiff to hard, fat, shaley - CH		
15		102	ST5
20		3-11-20	SS6
	SHALE - dark gray, very soft, weathered, calcareous	50/5"	SS7
25	Boring terminated at split spoon sampler refusal at 23.9 feet.		
30			
35			

SHEAR STRENGTH, tsf

Δ - UU/2 ○ - QU/2 ▯ - PP/2

0.5 1.0 1.5 2.0 2.5

STANDARD PENETRATION RESISTANCE

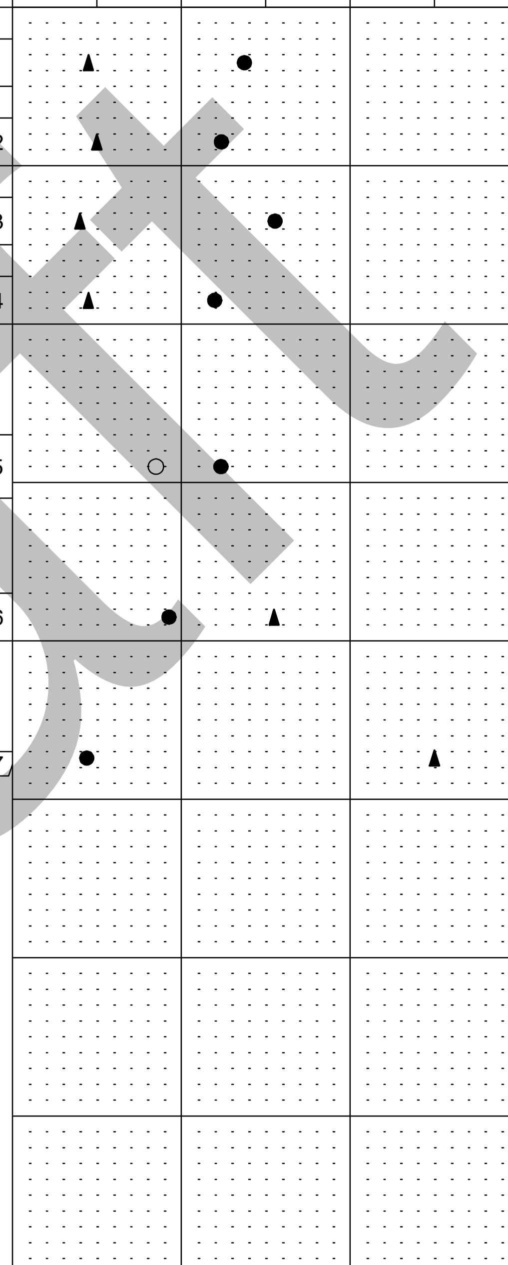
(ASTM D 1586)

▲ N-VALUE (BLOWS PER FOOT)

WATER CONTENT, %

PL ⊢——●——⊣ LL

10 20 30 40 50



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GROUNDWATER DATA

X FREE WATER NOT ENCOUNTERED DURING DRILLING

DRILLING DATA

4" AUGER ___ HOLLOW STEM

WASHBORING FROM ___ FEET

BCS DRILLER RAW LOGGER

CME 55TRK DRILL RIG

HAMMER TYPE Auto

REMARKS:

Drawn by: RAW	Check by: MHM	App'vd by: JAW
Date: 3/29/24	Date: 4/30/24	Date: 5/13/24

UES

Proposed Joint Operations Facility
NE Tudor Road and NW Sloan
Lee's Summit, Missouri

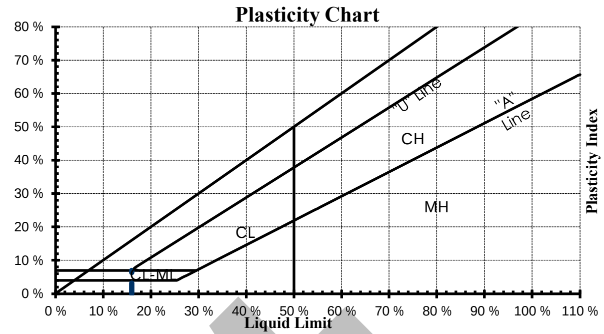
LOG OF BORING: B-21

Project No. J045326.01

BORING LOG: TERMS AND SYMBOLS

LEGEND

CS	Continuous Sampler
GB	Grab Sample
NQ	NQ Rock Core
PST	Three-Inch Diameter Piston Tube Sample
SS	Split-Spoon Sample (Standard Penetration Test)
ST	Three-Inch Diameter Shelby Tube Sample
*	Sample Not Recovered
PL	Plastic Limit (ASTM D4318)
LL	Liquid Limit (ASTM D4318)
SV	Shear Strength from Field Vane (ASTM D2573)
UU	Shear Strength from Unconsolidated-Undrained Triaxial Compression Test (ASTM D2850)
QU	Shear Strength from Unconfined Compression Test (ASTM D2166)



SOIL GRAIN SIZE

US STANDARD SIEVE

Sieve		12"		3"		3/4"		4		10		40		200		

BOULDERS	COBBLES	GRAVEL		SAND			SILT	CLAY
		COARSE	FINE	COARSE	MEDIUM	FINE		

Boundaries (mm)	300	76.2	19.1	4.76	2.00	0.42	0.074	0.005

SOIL GRAIN SIZE IN MILLIMETERS

UNIFIED SOIL CLASSIFICATION SYSTEM

Major Divisions			***Symbol***	***Description***
Coarse-Grained Soils (More than 50% Larger than No. 200 Sieve Size)	Gravel and Gravelly Soil	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, Sandy Silt, Clayey Silt, Slight Plasticity
			CL	Lean Clay, Sandy Clay, Silty Clay, Low to Medium Plasticity
			OL	Organic Silts or Lean Clays, Low Plasticity
	Silts and Clays	Liquid Limit Greater Than 50	MH	Silt, High Plasticity
			CH	Fat Clay, High Plasticity
			OH	Organic Clay, Medium to High Plasticity
	Highly Organic Soils		PT	Peat, Humus, Swamp Soil

STRENGTH OF COHESIVE SOILS

Consistency	***Undrained Shear Strength (tsf)***	***Unconfined Comp. Strength (tsf)***
Very Soft	less than 0.125	less then 0.25
Soft	0.125 to 0.25	0.25 to 0.5
Medium Stiff	0.25 to 0.5	0.5 to 1.0
Stiff	0.5 to 1.0	1.0 to 2.0
Very Stiff	1.0 to 2.0	2.0 to 3.0
Hard	greater than 2.0	greater than 4.0

DENSITY OF GRANULAR SOILS

Descriptive Term	***Approximate N_{60}-Value Range***
Very Loose	0 to 4
Loose	5 to 10
Medium Dense	11 to 30
Dense	31 to 50
Very Dense	>50

N-Value (Blow Count) is the last two, 6-inch drive increments (i.e. 4/7/9, N = 7 + 9 = 16). Values are shown as a summation on the grid plot and shown in the Unit Dry Weight/SPT column.

RELATIVE COMPOSITION

Trace	0 to 10%
Little	10 to 20%
Some	20 to 35%
And	35 to 50%

OTHER TERMS

Layer - Inclusion greater than 3 inches thick.
Seam - Inclusion 1/8-inch to 3 inches thick
Parting - Inclusion less than 1/8-inch thick
Pocket - Inclusion of material that is smaller than sample diameter

UES™

Relative composition and Unified Soil Classification System (USCS) designations are based on visual descriptions and are approximate only. If laboratory tests were performed to classify the soil, the USCS designation is shown in parenthesis.

ROCK CORE DESCRIPTIONS

TERM

Strength
Color
Crystallinity
Grain Size
Mass Bedding
Weathering
Voids
Quality

SEDIMENTARY ROCK TYPE

Sandstone - Predominantly quartz grains cemented by silica, iron, clay or carbonate material. Color depends on cementing agent; porous and pervious; hard and generally thickly bedded.

Siltstone - Composition similar to sandstone but at least 50% grains 0.002 to 0.02 millimeters in size. Rarely forms thick beds, but often hard.

Shale - Predominant particles are less than 0.002 millimeters with a well defined fissile fabric. Commonly interbedded with sandstone or limestone and relatively soft.

Limestone - Contains more than 50% calcium carbonate. The calcite can be precipitated chemically, organically, or it may be detrital in origin. Reacts with dilute HCL.

Dolomite - Harder and heavier than limestone. Forms by alteration of limestone or by direct precipitation from sea water. Reacts with dilute HCL only when powdered.

Coal - Composed of highly altered plant remains and varying amounts of clay, generally black in color.

Chert - Formed by silica deposited from solution in water. May occur as nodules or relatively thick beds.

GEOLOGIC DEFINITIONS

Stylolite - A term applied to parts of certain limestones which have a column like development that is grooved, sutured or striated and irregular in cross-section.

Fissility - A property of splitting along closely spaced parallel planes.

Argillaceous - A term applied to rock or substances having a notable portion, greater then 30%, clay in composition.

Oolitic - A spherical or ellipsoidal texture, 0.25 to 2.0 mm in diameter, with concentric or radial structure.

Brecciated - A rock texture which is composed of angular fragments which correspond in size to gravel and/or pebbles.

Slickenside - A polished or striated surface on or within a rock.

REFERENCE

STRENGTH

Description	***Uniaxial Compressive Strength (ksf)***
Extremely Soft	5 - 20
Very Soft	20 - 100
Soft	100 - 520
Medium Hard	520 - 1,040
Moderately Hard	1,040 - 2,080
Hard	2,080 - 5,620
Very Hard	> 5,620

COLOR

Common colors are gray, brown, black and white. Exotic colors such as green, blue, maroon can be used when necessary.

CRYSTALLINITY

Description	***Criteria***
Aphanitic	Crystals cannot be seen with the naked eye
Very Finely Crystalline	Crystals are barely visible with the naked eye
Finely Crystalline	Crystals are easily visible with the naked eye
Medium Crystalline	Crystals are medium size; up to 1/8-inch diameter
Coarsely Crystalline	Crystals are 1/8- to 1/4-inch in diameter
Very Coarsely Crystalline	Crystals are larger than 1/4-inch in diameter

GRAIN SIZE

Description	***Criteria***
Very Finely Grained	Grains cannot be seen with the naked eye
Fine Grained	Grains are barely visible with the naked eye
Medium Grained	Grains up to 2 mm in diameter
Coarse Grained	Grains are larger than 2 mm in diameter

BEDDING

Description	***Criteria***
Thin	less than 2 inches
Medium	2 to 24 inches
Thick	24 to 48 inches
Massive	greater than 48 inches

WEATHERING

Description	***Criteria***
Slightly Weathered	Rock generally fresh, joints stained and discoloration extends into rock up to 1 inch, open joints may contain clay
Weathered	Rock mass is decomposed 50% or less, significant portions of rock show discoloration and weathering effects, cores cannot be broken by hand
Highly Weathered	Rock mass is more than 50% decomposed, complete discoloration of rock fabric, core may be extremely broken

VOIDS

Description	***Criteria***
Dense	Usually not visible with the naked eye
Pitted	Visible to 1/4-inch
Vuggy	1/4-inch to diameter of the core
Cavity	Larger than 6 inches in diameter

QUALITY

Percent RQD	***Description***
90 to 100	Excellent
75 to 90	Good
50 to 75	Fair
25 to 50	Poor
0 to 25	Very Poor

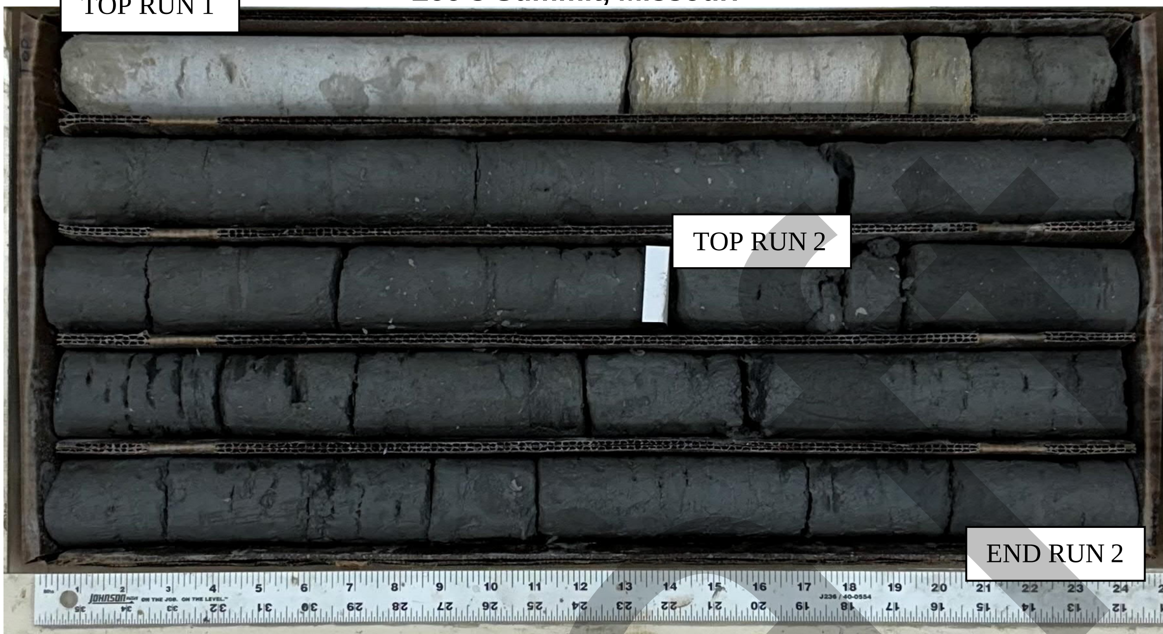
APPENDIX C

Rock Core Photographs

B-1 **Proposed Joint Operations Facility** J045326.01

NE Tudor Road and NW Sloan

Lee's Summit, Missouri

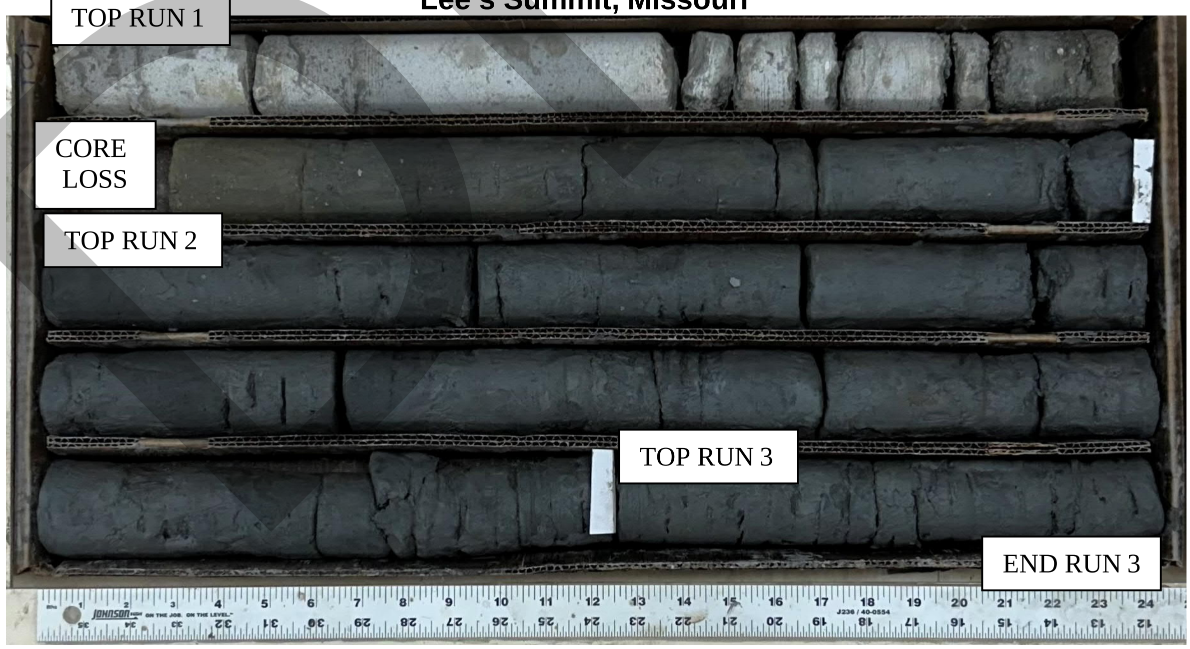


Run No.	Depth (ft)	Recovery (%)	RQD (%)
1	16.0 – 21.0	100	72
2	21.0 – 26.0	100	78

B-3 **Proposed Joint Operations Facility** J045326.01

NE Tudor Road and NW Sloan

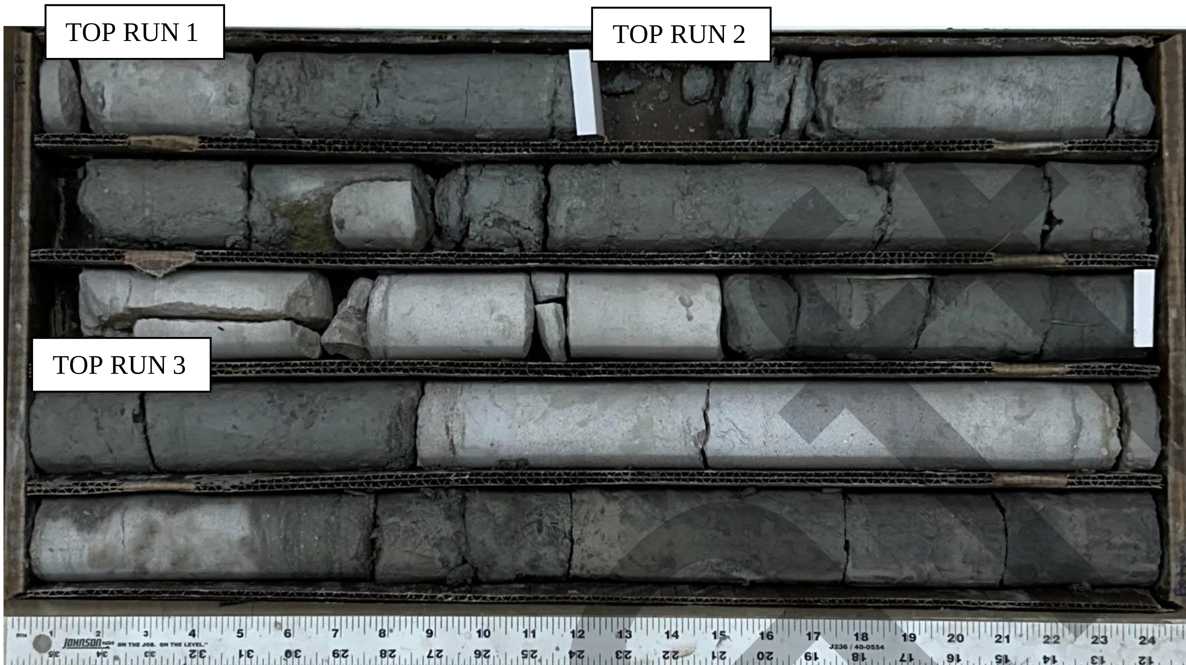
Lee's Summit, Missouri



Run No.	Depth (ft)	Recovery (%)	RQD (%)
1	12.0 – 16.0	94	74
2	16.0 – 21.0	100	100
3	21.0 – 22.0	100	100

B-5 | **Proposed Joint Operations Facility** | J045326.01

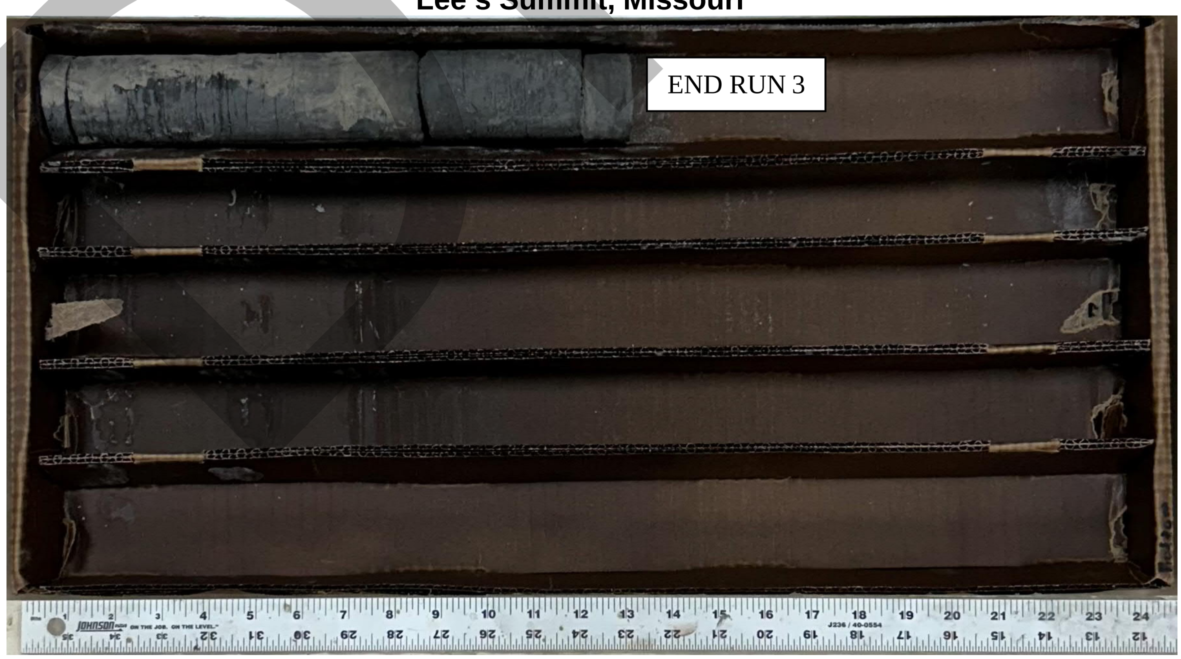
NE Tudor Road and NW Sloan
Lee's Summit, Missouri



Run No.	Depth (ft)	Recovery (%)	RQD (%)
1	9.75 – 10.75	100	92
2	10.75 – 15.75	92	53
3	15.75 – Cont.	100	95

B-5 | **Proposed Joint Operations Facility** | J045326.01

NE Tudor Road and NW Sloan
Lee's Summit, Missouri

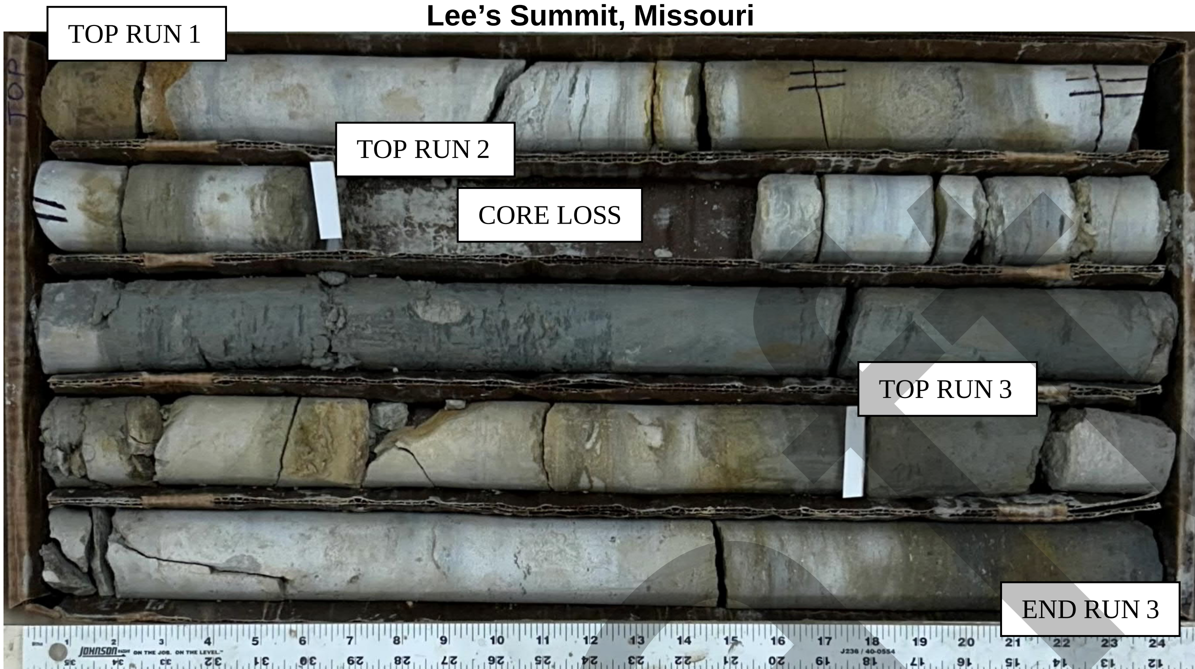


Run No.	Depth (ft)	Recovery (%)	RQD (%)
3	Cont. – 20.75	100	95

B-7

Proposed Joint Operations Facility
NE Tudor Road and NW Sloan
Lee's Summit, Missouri

J045326.01

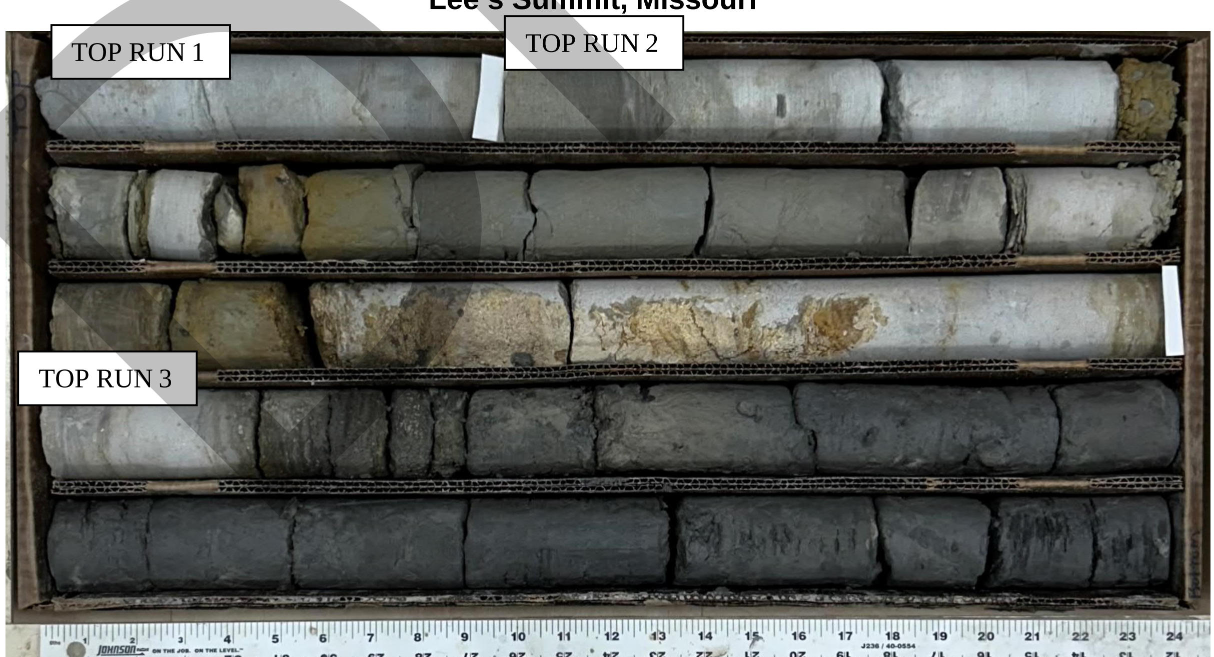


Run No.	**Depth (ft)**	**Recovery (%)**	**RQD (%)**
1	14.25 – 16.75	100	80
2	16.75 – 21.75	85	52
3	21.75 – 24.25	100	100

B-9

Proposed Joint Operations Facility
NE Tudor Road and NW Sloan
Lee's Summit, Missouri

J045326.01



Run No.	**Depth (ft)**	**Recovery (%)**	**RQD (%)**
1	13.5 – 14.5	100	100
2	14.5 – 19.5	100	60
3	19.5 – Cont.	100	78

B-9

Proposed Joint Operations Facility
NE Tudor Road and NW Sloan
Lee's Summit, Missouri

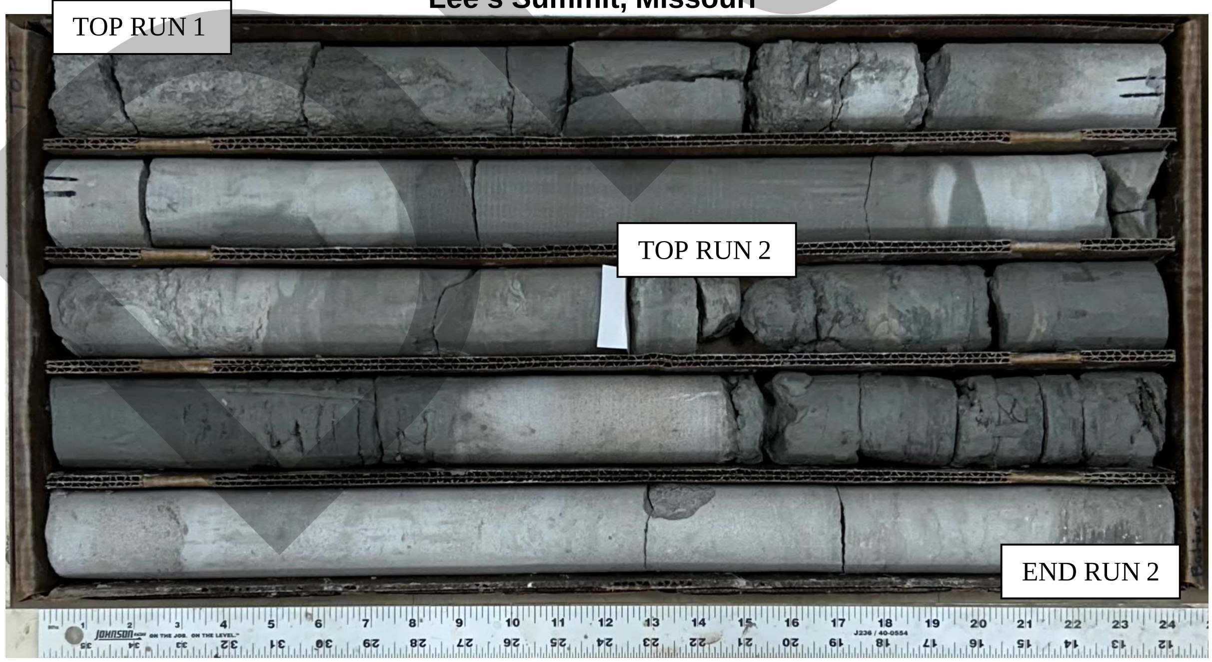
J045326.01

Run No.	**Depth (ft)**	**Recovery (%)**	**RQD (%)**
3	Cont. – 24.5	100	78

B-11

Proposed Joint Operations Facility
NE Tudor Road and NW Sloan
Lee's Summit, Missouri

J045326.01

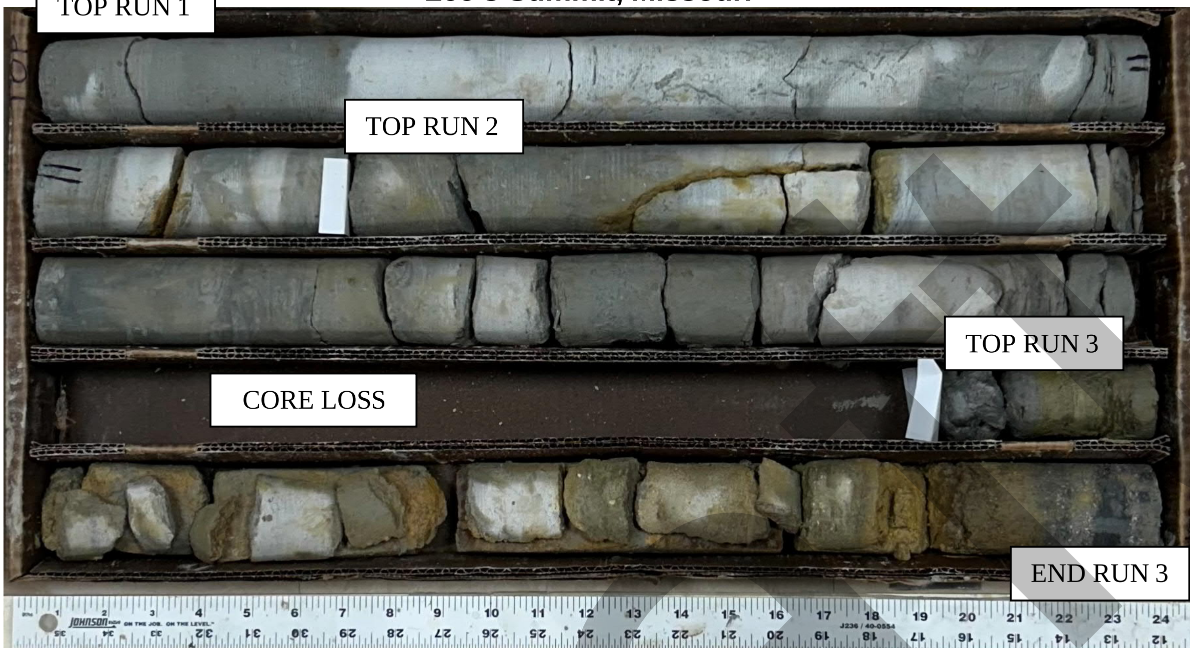


Run No.	**Depth (ft)**	**Recovery (%)**	**RQD (%)**
1	15.5 – 20.5	100	78
2	20.5 – 25.5	100	78

B-13 | **Proposed Joint Operations Facility** | J045326.01

NE Tudor Road and NW Sloan

Lee's Summit, Missouri



Run No.	Depth (ft)	Recovery (%)	RQD (%)
1	19.5 – 22.0	100	83
2	22.0 – 27.0	68	21
3	27.0 – 29.5	100	0

B-13 | **Proposed Joint Operations Facility** | J045326.01

NE Tudor Road and NW Sloan

Lee's Summit, Missouri

Run No.	Depth (ft)	Recovery (%)	RQD (%)
4	29.5 – 32.0	100	100
5	32.0 – 34.5	100	80

B-15

Proposed Joint Operations Facility
NE Tudor Road and NW Sloan
Lee's Summit, Missouri

J045326.01

Run No.	Depth (ft)	Recovery (%)	RQD (%)
1	20.0 – 22.0	100	63
2	22.0 – 27.0	100	80
3	27.0 – 30.0	100	31