VECTOR ENGINEERS, INC
GEOTECHNICAL · MATERIALS · GEOSCIENCES
A SUBSIDIARY OF CTL ENGINEERING, INC

April 10, 2024

Mr. John Meyer
HMB Professional Engineers, Inc.
3 HMB Circle
Frankfort, KY 40601
Email: jmeyer@hmbpe.com

Subject: Compilation of Geotechnical Submittals
Skyview Estates
Hazard, Kentucky
Project Number: 24020013SHE

Dear Mr. Meyer,

VECTOR Engineers, Inc. was requested by the Kentucky Finance Cabinet to review and provide value engineering/opinion report on the initial geotechnical report by L.E. Gregg and Associates entitled "Geotechnical Engineering Exploration, Sky View Estates, Perry County Kentucky." After submission of the review and at the request of KYTC, Vector was contracted by HMB Professional to provide geotechnical engineering consulting during the design and preconstruction phase. As requested, this document provides a compilation of the geotechnical submittal to be provided with the bidding documents.

- *Geotechnical Engineering Exploration for Sky View Estates in Perry County, Kentucky, Project Number 20230004*, prepared by LE Gregg and Associates and dated March 1, 2023.
- *Review of Sky View Estates Geotechnical Report in Perry County, Kentucky, Project Number 22050159SHE*, prepared by Vector Engineers and dated March 30, 2023.
- *Follow up of Geotechnical Items from Meeting on March 13, 2024 for Skyview Estates, Project Number 24020013SHE*, prepared by Vector Engineers and dated March 20, 2024.
- *MASW Geophysical Survey for Proposed Skyview Neighborhood in Hazard, Kentucky*, prepared by NSG Innovations, LLC and dated March 7, 2024.
- *Follow up on Geotechnical Items from Meeting on March 27, 2024 for Skyview Estates, Project Number 24020013SHE*, prepared by Vector Engineers and dated April 5, 2024.

Vector will continue to consult on geotechnical related matters as the project continues into construction.

Respectfully Submitted,
VECTOR ENGINEERS, INC.

John Conway, PE
Construction Services Manager – KY

Wayne A. Karem, PE
Principal

Geotechnical Engineers and Geologists

Geotechnical Engineering Exploration

Project:

Sky View Estates
Perry County, Kentucky

Prepared for:

Frieda Myers
Division of Engineering and Contract Administration

March 1, 2023

March 1, 2023

Frieda Myers
Statewide Projects Branch Manager
Div. of Engineering and Contract Administration (DECA)
Bush Building 403 Wapping St.
Frankfort, KY 40601

RE: Report of Geotechnical Exploration
Sy View Estates
Perry County, Kentucky
L.E. Gregg Project Number: 2023004

Ms. Myers,

L.E. Gregg Associates is pleased to present our report for the geotechnical exploration performed at the above referenced site. The attached report presents a review of the project information provided to us, a description of the site and subsurface conditions encountered, as well as any foundation and earthwork recommendations for the proposed project.

Unless prior arrangements are made, any remaining soil samples will be discarded shortly after the issue date of this report. Rock cores will be retained for a period of 12 months and then discarded.

We appreciate the opportunity to assist you on this project. If we can be of further service on this or other projects, please contact us.

Respectfully,

L.E. GREGG ASSOCIATES

Steven Mortimer, P.E.
Senior Engineer

Jason Ainslie, P.E.
President

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1.0 INTRODUCTION

1.1 PURPOSE OF EXPLORATION

The general purpose of this exploration was to determine if the proposed site will be suitable for the construction of a new athletic complex. This was completed by determining the general subsurface conditions existing at the project site through a program of controlled drilling, sampling, and testing; and to evaluate these findings with respect to the foundation concept, design, and currently accepted engineering practices. The purpose and scope of services were discussed with Frieda Myers with the Division of Engineering and Contract Administration (DECA) for the Commonwealth of Kentucky, and outlined in L.E. Gregg proposal P23-016, dated February 6, 2022. More specifically, the objectives are:

1. Determine the textures, thicknesses, consistencies and general physical properties of the soil strata encountered at the boring locations, along with the depths to and elevations of the underlying bedrock surface beneath the proposed structure.

2. Determine the general geologic conditions existing at the site.

3. Determine the detailed characteristics of the underlying bedrock if rock is encountered at a depth where it may be considered an economical choice as the bearing medium.

4. Determine the existing surface and subsurface water conditions at the site and their relation to design, construction, and service of the proposed project.

2.0 PROJECT INFORMATION

2.1 BACKGROUND INFORMATION

Project information was provided in a request for proposal to L.E. Gregg Associates from Frieda Myers with DECA. The proposed project is in support of the design and layout of a new residential development and supporting infrastructure in Hazard, Kentucky. The development will consist of approximately 204 lots with new roadways and utilities. The proposed site location consists of vacant land which has been used for coal mining since the early 1900's. The mining has consisted of both deep underground mining (room and pillar), area mining, mountain top removal, and contour strip mining. Once the mountaintop has been removed down to a coal seam, contour mining is performed around the mountain to obtain coal from a lower seam. The spoils consisting of soil and bedrock from above the coal seam are then placed back as fill in valleys, side benches, and over the area of mountaintop removal. These various mining practices are shown in Figure 1 below. Based on observations during the field exploration, the site contains from 40 to 110 ft. of mine spoil fill, these depths could be shallower or deeper in areas not explored.

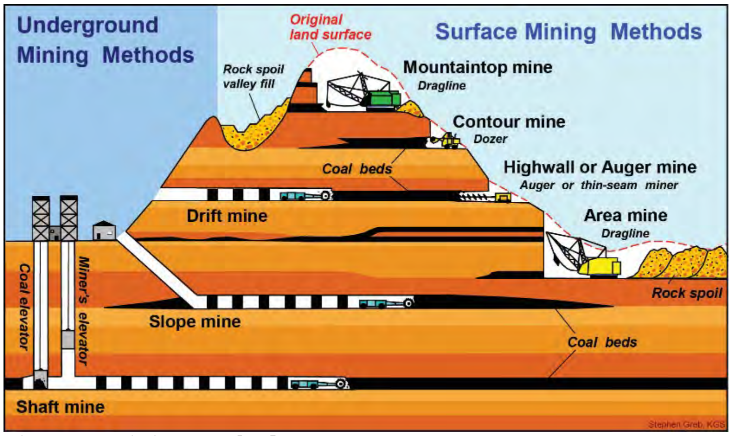
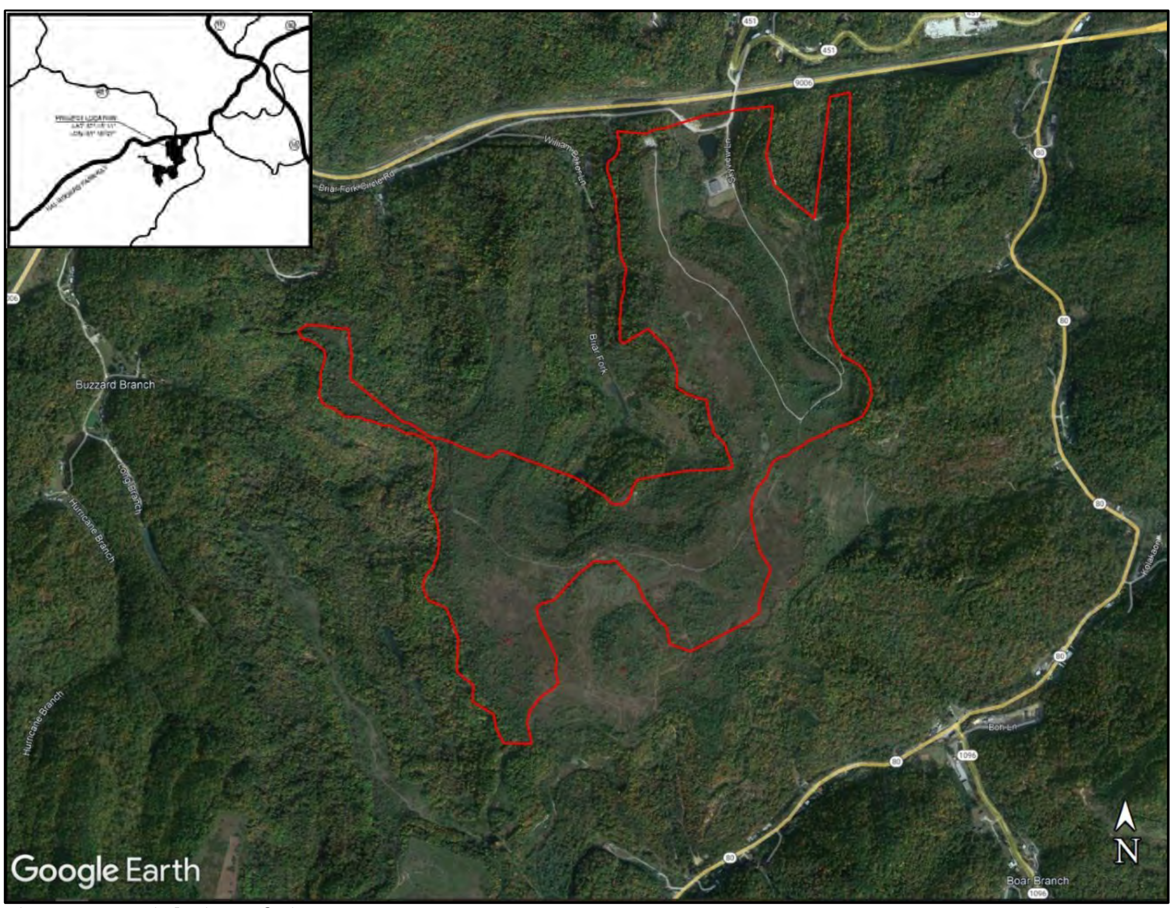


Figure 1: Mining Methods

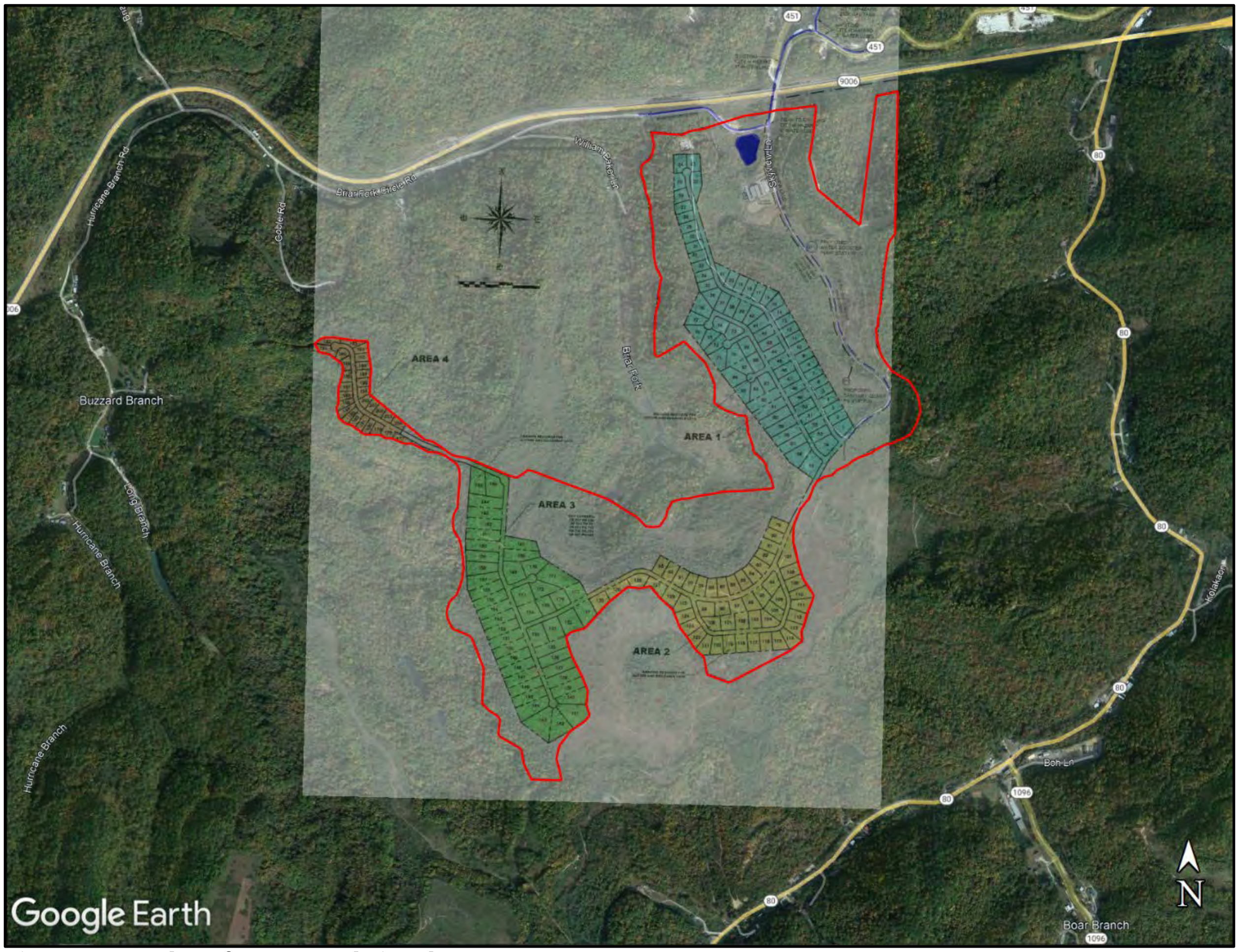
2.2 SITE SURFACE CONDITIONS

The proposed project site is located off of Skyview Lane just west of Hazard, Kentucky. As mentioned above, it has been used for various mining operations since the early 1960's and has never been developed. The ground surface currently consists of grasses, underbrush, and tree cover. The property consists of ridges and valleys along with several relatively flat areas created from the previous mountaintop removal mining operations. Below is an aerial view of the proposed site with the approximate limits outlined in red.



Picture 1: Aerial View of Site

An overlay of the preliminary conceptual plan completed by R.M. Johnson Engineering, Inc. is shown in Picture 2 below.



Picture 2: Overlay of Conceptual Site Plan

2.3 SITE GEOLOGY

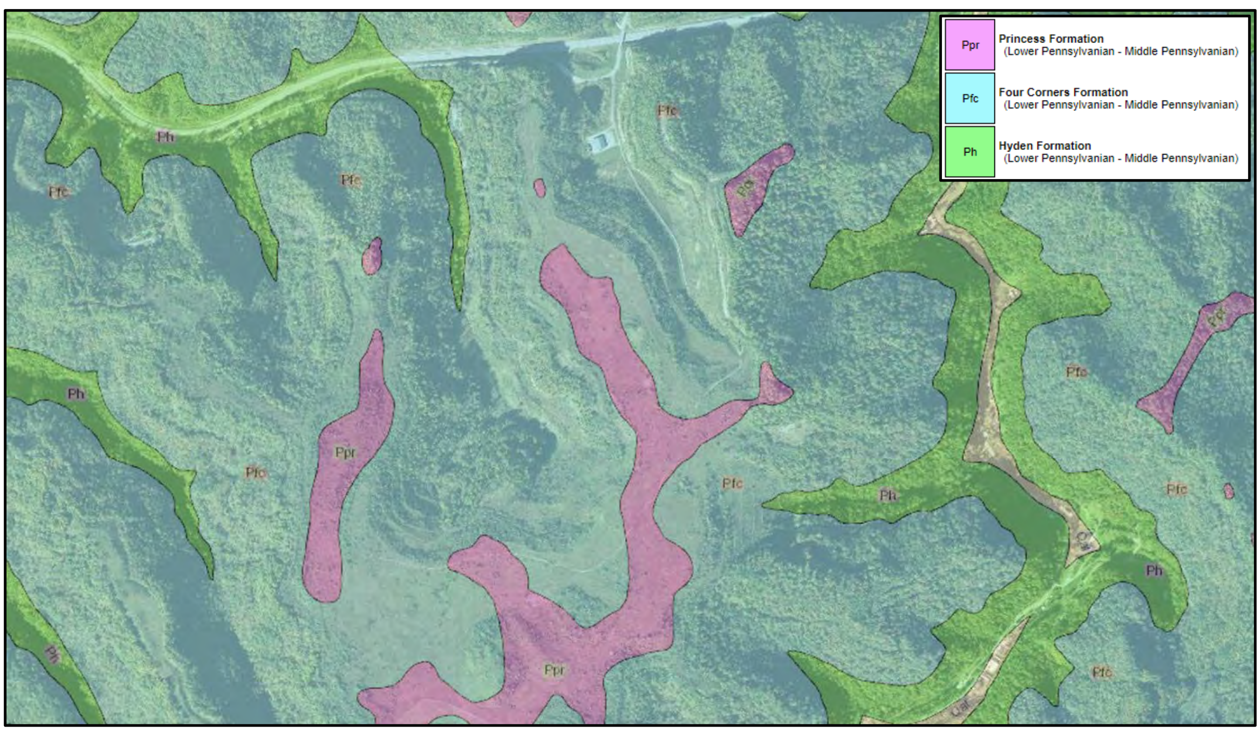
Geologic information was referenced from the *Geologic map of the Krypton quadrangle, Kentucky, and the Geologic map of the Hyden East quadrangle, Kentucky, 1965).* Materials underlying the site are of Lower to Middle Mississippian Age and are composed of the Four Corners Formation, the Princess Formation, and the Hyden Formation, which are all part of the Formation of the Breathitt Group.

The site is situated within the Eastern Coal Field physiographic region of the state, which is characterized by a topography of moderate to fairly high relief. Typically, the vicinity consists of forested hills and ridges, separated by narrow, stream-cut valleys.

The Four Corners Formation is composed of sandstone, shale, siltstone, and coal. The sandstone is generally light- to medium-gray, medium-grained, poorly sorted, and crossbedded. The shale and siltstone are generally olive-gray to medium-gray, poorly exposed, and forms a subdued bench at about the level of Francis coal bed. The Hazard No. 7 coal bed at the base of the unit generally has a massive sandstone roof and is extremely variable in thickness; rider coal from 2 to 20 ft. above the Hazard coal bed commonly is split by several thin shale partings.

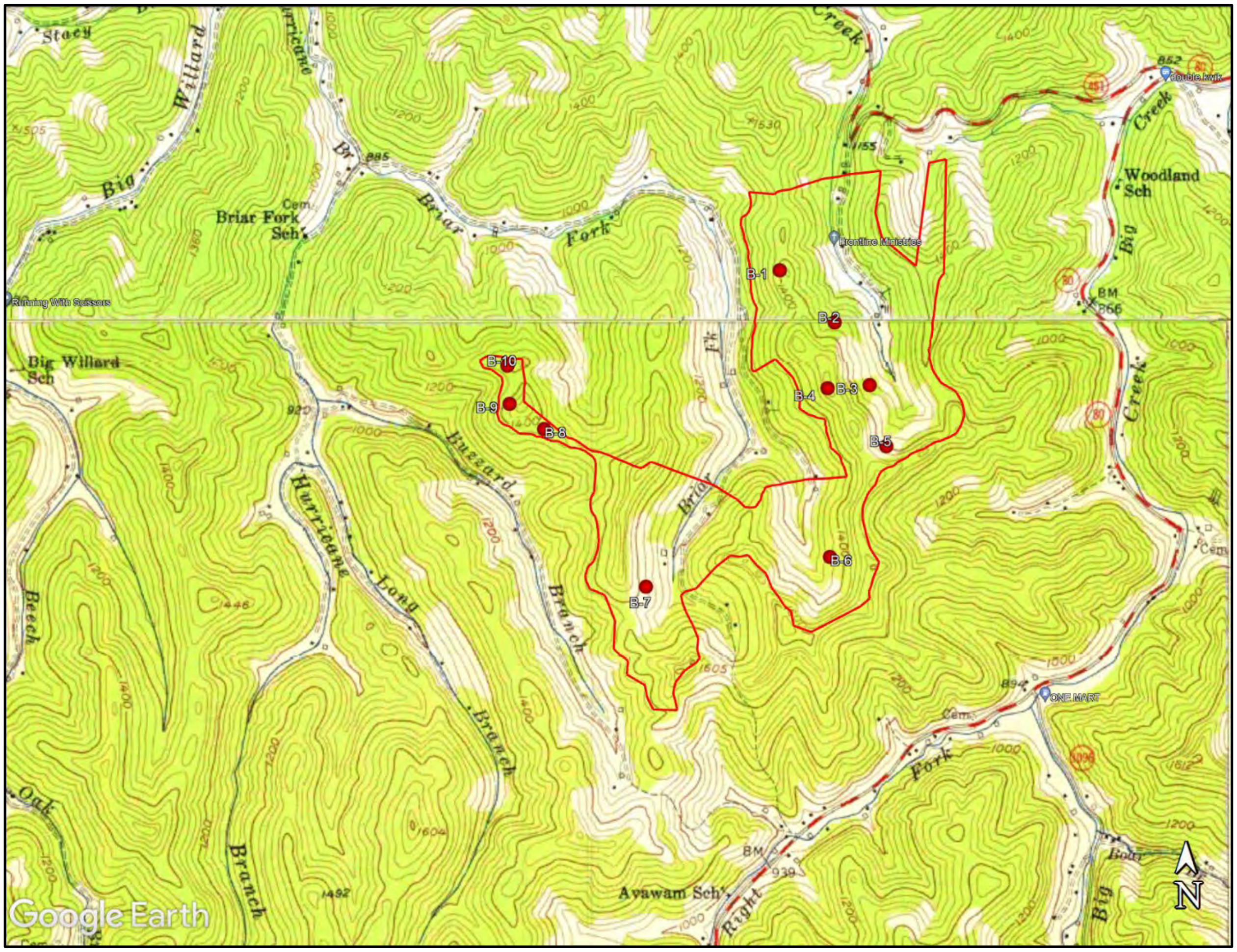
The Princess Formation also consists of sandstone, shale, siltstone, and coal. The sandstone is generally light- to medium-gray, medium- to coarse-grained, poorly sorted, and crossbedded. The sandstone above the Hindman coal bed characteristically forms bold cliffs and pinnacles. The shale and siltstone are generally olive-gray to dark-gray, micaceous and contain fossil plant fragments. A shale roof is most common in the southern part of quadrangle and a sandstone roof in the northern part.

The Hyden Formation consists of sandstone, siltstone, shale, underclay, and coal. The upper part of the unit is predominantly sandstone which is light-gray, fine- to medium-grained, thick- to very thick bedded, and generally crossbedded. The Hamlin coal zone includes 1 to 5 coal beds, each generally 4 to 10 in. thick. The coal beds appear to grade laterally into carbonaceous shale. The Lower part of the unit is mainly light- to dark-gray shale and siltstone except where replaced locally by channel sandstone. The Fire Clay rider coal bed is 8 to 40 ft. above the Fire Clay bed.



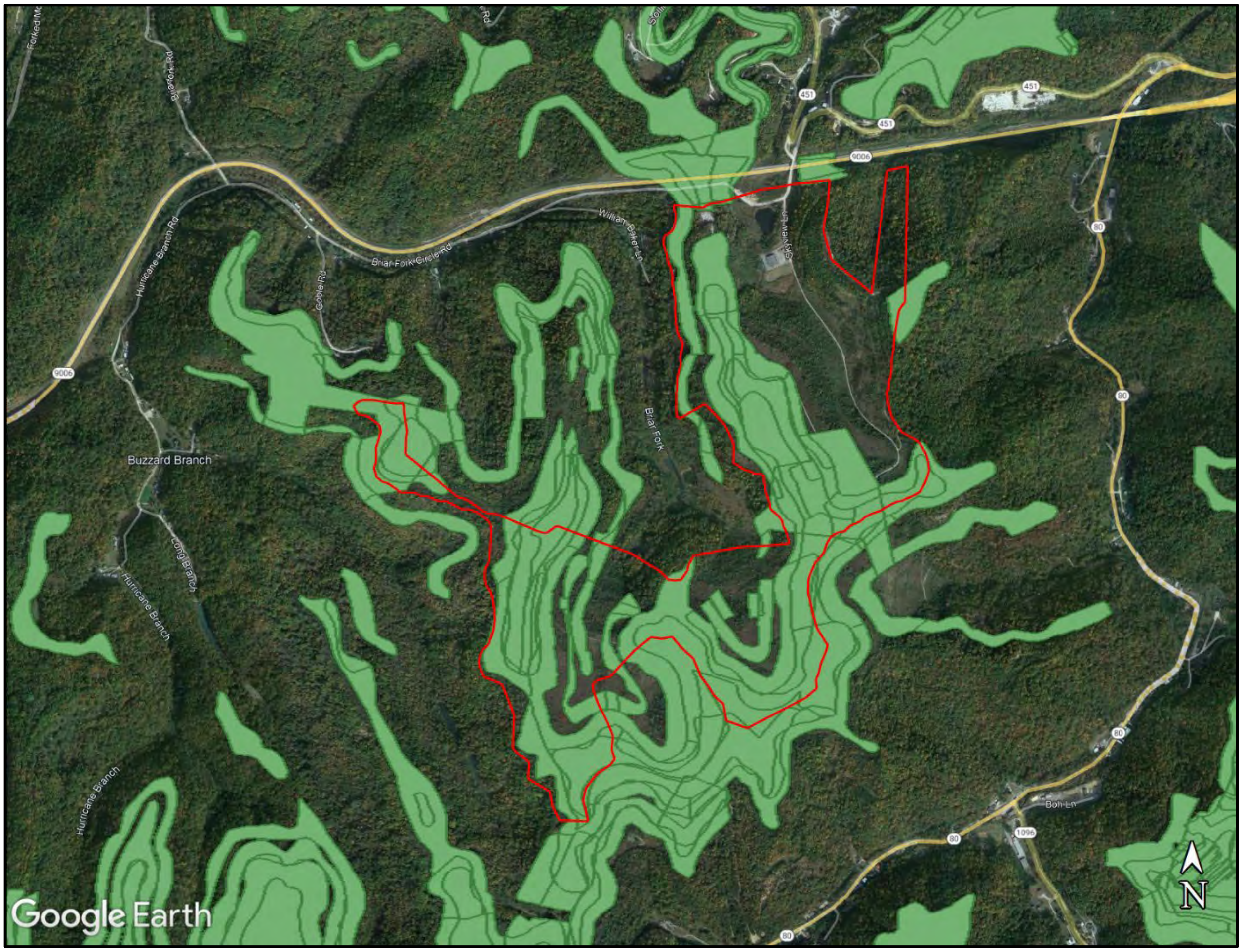
Picture 3: Bedrock Geology

Based on a review of the Kentucky Mine Mapping System (KMMS), there has been extensive mining, consisting of both underground and surface, in the area for coal since the early 1960's. As the result, numerous abandoned audits, strip benches, and other excavated depression-like features are found throughout the area. The site has been mined in the recent past and the original contours have been significantly altered by both mining and highway construction. The image below shows the contours present on the site in 1954. The image was taken from the Krypton 7.5 min. Topographic Quadrangle Map and the Hyden East 7.5 min. Topographic Quadrangle Map both published in 1954 by the United States Geological Survey. When comparing the contours present in 1954 with the current topographic mapping, there are significant differences caused by the mountaintop removal and contour mining that has been completed.



Picture 4: Site Topography in 1954

The KMMS indicates mined out areas on site which are shown below in green. As previously mentioned, the red outline is the approximate site boundary. A majority of the mining was completed in the 1960's and 1970's by various coal companies. Based on historical aerial imagery, mine maps obtained from the Commonwealth of Kentucky, and observations from the field exploration, the site has been reclaimed by the placement of mine spoils. A reclamation plan submitted by Leslie Resources, Inc. indicates that reclamation activities were completed by the end of 2000.



Picture 5: Formerly Mined Out Areas

Rocks from the Formation of the Breathitt Group should provide suitable bearing for most structures, if required. However, any coals and/or underclays should be avoided due to their highly plastic natures. The Breathitt is often found to be highly weathered at its soil/bedrock interface, and the depth of this weathering can be enhanced by the possible presence of vertical joints, which are known to exist in the area. These joints are usually soil-filled, and they are generally widest at the surface, tapering down to only a few fractions of an inch at depth. Weathering along such vertical joints is also a factor that should be considered in highwall or foundation design, but unfortunately, their occurrence, as well as their depths, cannot be predicted.

There are no faults found on or in the near vicinity of the site. Faults are common geologic structures across the Commonwealth of Kentucky and have been mapped in many counties. These faults represent seismic activity that has occurred several million years ago at the latest and there has been no activity along these faults in recorded history. Seismic risk associated with these faults is considered to be very low.

2.4 LABORATORY TESTING

The recovered soil samples were transported to L.E. Gregg's laboratory. Natural moisture content determinations (ASTM D2216), Atterberg limits (ASTM D4318), sieve analysis (ASTM D422), Standard Proctor Testing (ASTM D698), California Bearing Ratio testing (ASTM D1883), slake durability testing (ASTM D4644), and Unified Soil Classification System (UCSC) classifications (ASTM D2487) were conducted in general accordance with the American Society of Testing and Materials (ASTM) practices and standards.

3.0 EXPLORATION FINDINGS

3.1 SUBSURFACE CONDITIONS

General

Field testing procedures were performed in general accordance with ASTM practices, procedures, and standards. The borings were advanced using 4.25 in. hollow stem augers. Samples were recovered in the undisturbed material below the tip of the auger using the standard drive sample technique in accordance with ASTM D 1586. A 2 in. O.D. (outside diameter) by 1 ⅜ in. I.D. (inside diameter) split-spoon sampler was driven a total of 18 in. with the number of blows of a 140 lb. hammer falling 30 in. recorded for each 6 in. of penetration. The sum of the blows for the final 12 in. of penetration is referred to as the Standard Penetration Test (SPT) result, also known as the N-value, or blow count, which is recorded in blows per foot (bpf). Four (4) split spoon samples were generally recovered in the top 10 ft. of the soil column and at 5.0 ft. intervals thereafter. These intervals may be adjusted in the field if gravel, boulders, shot rock, asphalt, or concrete surfaces are encountered. The boreholes were backfilled immediately with auger cuttings and/or granular material for safety considerations.

Soil Conditions

The geotechnical exploration consisted of eleven (11) soil test borings, labeled B-1 through B-11. The borings were located in the field using a hand-held GPS device and based upon the boring plan discussed with the design team. The approximate boring locations are shown on the boring layout in Appendix C.

The following subsurface descriptions are of a generalized nature in order to highlight the subsurface stratification features and material characteristics at the boring locations. The boring logs included in Appendix B of this report should be reviewed for specific information at each boring location. Information on actual subsurface conditions exists only at the specific boring locations and is relevant only to the time period that this exploration was performed. Variations may occur and should be expected at the site. All measurements listed below are approximate.

The subsurface conditions are described as follows:

Mine Spoil Fill consisting of a mix of sand, silt, clay, shale, boulders, and rock fragments was encountered across the site from the surface to refusal or weathered rock depths. The fill was generally brown, gray, and/or black, silty and/or sandy, soft to hard, and dry to wet with Standard Penetration Test (SPT) "N"-values ranging from 3 to 50+ bpf. Higher blow counts are likely inflated due to the rock content of the fill. Natural moisture contents ranged from 3.2 to 24.5%

The results for the soil test borings are summarized in Table 1.

Table 1 – Summary of Drilling Depths

Location	*Elevation (ft.)	Refusal Depth (ft.)	Refusal Elevation (ft.)
B-1	1387.3	52.5	1334.8
B-2	1415.2	89.8	1325.4
B-3	1435.9	85.0	1350.9
B-4	1395.9	59.7	1336.2
B-5	1477.7	84.3	1393.4
B-6	1452.4	115.5	1336.9
B-7	1415.3	64.5	1350.8
B-8	1380.7	39.8	1340.9
B-9	1402.2	50.0	1352.2
B-10	1378.9	40.0	1338.9
B-11	1436.0	115.0	1321.0

Borings elevations are taken from the KY Digital Elevation Model and are approximate.

Rock Conditions

Refusal was encountered across the site at depths ranging from 39.8 to 115.5 ft. Weathered rock was generally encountered before refusal. Refusal generally indicates materials that cannot be penetrated with typical soil drilling methods. Therefore, refusal can indicate one or more of the following: coarse gravel, boulders, shot rock fill, buried concrete, weathered rock, thin rock seams, or the upper surface of sound, continuous bedrock. Core drilling is then required to determine the characteristics and soundness of the refusal materials. Coring was performed at all locations in order to verify the thickness of the mine spoil fill. The refusal materials were cored according to ASTM D 2113, which utilizes a diamond studded bit fastened to the end of a hollow double tube core barrel. The assembly is lowered to refusal depth and the boring is flooded with water to control overheating and to bring the cuttings to the surface. As the drill is rotated at high speeds, the core bit advances into the refusal material and core samples are retained within the inner core barrel. These samples are removed after core runs of up to ten feet and placed in boxes for storage. The core samples were taken back to the laboratory where they were classified as to type of rock, percent recovery, and rock quality designation by an L.E. Gregg geologist or engineer. The percent core recovery (REC) is a ratio of the recovered sample length versus the total length attempted and is expressed as a percentage. The REC is used to assess the continuity of the refusal material. The rock quality designation (RQD) is obtained by summing up the length of core recovered, including only the portions that are greater than or equal to 4 inches, and dividing by the total length attempted. This is also expressed as a percentage and is used to assess the quality of the refusal material.

All locations were cored with run lengths varying from 2.5 to 10 ft. The bedrock materials consisted mostly of shale interbedded with sandstone and/or thin layers of clay. No voids were encountered during the rock core drilling process. The recovery and rock quality designation values listed below indicate competent to continuous bedrock of very poor to very good quality.

Table 2 – Summary of Rock Coring Sampling

Boring	Core Run	Beginning Depth (ft.)	Ending Depth (ft.)	Core Length (ft.)	Recovery (%)	Rock Quality Designation (%)
B-1	1	52.5	60.5	8	89	81
	2	60.5	65.5	5	82	42
B-2	1	89.8	99.8	10	74	29
	2	99.8	104.8	5	100	94
B-3	1	85.0	90.0	5	60	30
	2	90.0	100.0	10	56	0
	3	100.0	108.0	8	51	0
	4	108.0	115.0	7	100	9
	5	115.0	120.0	5	100	4
	6	120.0	125.0	5	90	78
B-4	1	59.7	69.7	10	90	40
B-5	1	84.3	94.3	10	85	42
B-6	1	115.5	125.5	10	88	48
B-7	1	64.5	74.5	10	93	83
B-8	1	39.8	49.8	10	100	66
	2	49.8	59.8	10	50	16
	3	59.8	69.8	10	69	49
B-9	1	50.0	55.0	5	96	78
	2	55.0	60.5	5.5	98	80
B-10	1	40.0	48.5	8.5	80	42
	2	48.5	51.0	2.5	84	64
B-11	1	115.0	120.0	5	90	78
	2	120.0	126.0	5	100	97
	3	126.0	136.0	10	67	40
	4	136.0	146.0	10	100	100
	5	146.0	156.0	10	98	98
	6	156.0	166.0	10	95	82
	7	166.0	176.0	10	99	82
	8	176.0	186.0	10	100	59
	9	186.0	196.0	10	99	98
	10	196.0	206.0	10	100	100
	11	206.0	213.0	7	100	83

Boring	Core Run	Beginning Depth (ft.)	Ending Depth (ft.)	Core Length (ft.)	Recovery (%)	Rock Quality Designation (%)
B-11	12	213.0	221.0	8	100	96
	13	221.0	231.0	10	100	75
	14	231.0	241.0	10	100	98
	15	241.0	251.0	10	100	54

Water Conditions

Groundwater was encountered in several borings during the field investigation. Groundwater refers to any water that percolates through the soil and can refer to isolated or perched water pockets or water that occurs below the "water table", which is a zone that remains saturated and water-bearing. The groundwater levels encountered during drilling may fluctuate significantly over time due to weather influences and should not be considered a true static groundwater level.

3.2 SEISMIC SITE CLASSIFICATION

The Kentucky Building Code (current edition), Chapter 20 of ASCE 7-10, and the ASCE 7 Hazard Tool were reviewed to determine the Seismic Site Classification for the site based on the following coordinates, 37.24136, -83.267847. Based on review of geologic data, previous experience with similar projects, and the subsurface conditions encountered, a **Seismic Site Class "D"** is recommended for soil bearing foundations. We have assumed a seismic risk category of II for the structure.

Furthermore, using a Site Classification of **D**, we recommend the use of spectral response acceleration coefficients as follows:

0.2 second period: $\mathbf{S_S} = 0.217$ and Soil Factor = 1.6

1.0 second period: $\mathbf{S_I} = 0.092$ and Soil Factor = 2.4

The design spectral response acceleration factors are as follows:

$\mathbf{S_{DS}} = 0.231$

$\mathbf{S_{DI}} = 0.147$

4.0 GEOTECHNICAL RECOMMENDATIONS

4.1 GEOTECHNICAL CONSIDERATIONS

General

Based on the provided information, the subsurface conditions encountered and past experience with similar projects, the site is suitable for the proposed development provided the following considerations are addressed. These considerations are briefly summarized below.

Uncontrolled Mine Spoil Fill/Previous Mining Activity

Uncontrolled fill consisting of mine spoil materials were observed across the site. The thickness of these materials was observed to be between 40 and 110 ft. Due to the variability of the material, the placement methods, and thickness of the mine spoil, differential settlement can occur in these fills. The quantity of settlement and time for the completion of these settlements cannot be accurately predicted. We typically recommend complete removal or remediation of all uncontrolled fill within the footprint of proposed structures or within areas of slopes. If uncontrolled fills are not removed or remediated in some way and are used as a bearing surface, the owner must be aware of the risks involved with construction over uncontrolled fills and must accept all risks and liability involved with this practice.

Mine Subsidence

Mine subsidence causes settlement of the ground surface as a result of mine overburden readjusting to any underlying voids created during or after the mining process. This settlement can be caused by roof falls, pillar failure, coal fires, and other factors. Underground mines with a considerable thickness of consolidated rock over the roof of the mine can have subvertical fractures that propagate upward toward the surface, resulting in downward settling of the strata. Shallow mines overlain by a thinner rock overburden may collapse, causing the overlying soil and any structures to sink into the resulting void.

Excavation Sloping and/or Benching

All excavation work must be performed in accordance with OSHA and local building code requirements. The contractor is solely responsible for designing and constructing stable, temporary excavations and should shore, slope, or bench the sides of the excavations as required to maintain stability of both the excavation sides and bottom. The contractor's "responsible person", as defined in 29 CFR Part 1926, should evaluate the soil exposed in the excavations as part of the contractor's safety procedures. In no case should slope height, slope inclination, or excavation depth, including utility trench excavation depth, exceed those specified in local, state, and federal safety regulations.

Utility Trench Backfill

All trench excavations should be completed with sufficient working space to permit construction as well as proper backfill placement and compaction. If utility trenches are backfilled with relatively clean granular material, they should be capped with at least 18 in. of lean clay fill in order to reduce the infiltration and conveyance of surface water through the trench backfill.

Silty and/or Sandy Clays

Fill materials consisting of silty and/or sandy clays were encountered in each boring. These materials can be sensitive to changing moisture conditions and can degrade under repetitive loading and unloading. Heavy equipment traffic during construction can cause these materials to break down. Care will need to be taken to limit heavy construction traffic across the building pad and the contractor will need to consider changing moisture conditions during construction. The owner and contractor should consider seasonal weather patterns for construction scheduling as these soils will likely pump, rut, and loose strength with moisture contents outside the optimal range for compaction.

Ground Water or Free Water

Groundwater was encountered in several borings near the bedrock/surface interface during the field exploration. Groundwater levels may fluctuate significantly over time due to weather influences. The available geological information and past experience with similar projects indicates that it is possible that during construction ground water could be encountered. Ground water and/or free water encroaching upon construction excavations should be removed by placing a sump near the source of seepage and then pumping from the sump. Should heavy seepage or ponding of water occur, then L.E. Gregg should be contacted.

Site Drainage

Site drainage and adequate subgrade drainage are critical for performance of foundations. A surface drainage plan should be designed by a Civil Engineer or Landscape Architect. During construction, large quantities of water should not be allowed to accumulate on the site.

4.2 MINE SPOIL

As previously mentioned, the proposed site contains a significant amount of uncontrolled mine spoil fill which was placed during the reclamation process. Mine spoil poses significant risks of settlement and even greater risks of differential settlement. Mine spoil does not display the typical time dependent consolidation characteristics related to dissipation of excess pore pressure generally encountered in large soil earthworks projects, but rather, settlement by pore pressure dissipation, crushing of the spoil material under its own weight/load, and by hydrocompression. Hydrocompression occurs when rock fragments within the fill that are non-durable such as shales, siltstones, weak sandstones, become wet. Because of the nature of these materials and the angularity imparted by the mining process, the rock fragments slake (to fall apart or dissolve, generally become weaker) and crush at high stress points of contact allowing for sudden settlement to occur that is not uniform and leads to differential settlement of the mass.

Further, the slaking of these materials can lead to the development of void space in the spoil fill which can lead to the development of piping and sinkholes and additional subsurface voids, all of which can contribute to differential settlement.

The mine spoil present was most likely placed as end dumped material that was spread and tracked into place using a bulldozer. This was a typical approach during the time that the mine was in operation. This results in a spoil that is a mixture of soil, sandstone, siltstone, and non-durable shale. These spoils have effectively no compactive effort and often contain very large boulders which almost immediately begin forming voids within the fill. L.E. Gregg laboratory testing indicates that shale within the fill is subject to a 20-30 percent loss in volume via simple exposure to water, this will be exacerbated in the shale found at depth due to the increased pressure at depth.

Research has shown that spoil fills such at this can consolidate approximately 1 ft. per 100 feet of spoil in the first 10 years post placement, and an additional 1 ft. per 100 feet of spoil in the next 90 years. Based on the materials present on site, L.E. Gregg anticipates 2 to 4 inches of settlement in the next 20 years, depending on depth of the fill material.

The risks associated with mine spoil can be managed but not completely removed. Many of the management process are cost prohibitive for a residential development (deep foundations, mass spoil removal and replacement, dynamic compaction), however the following are viable means of risk management:

- Surcharge (Lessen the weight of the fill)
- Create a building support pad
- Control the depth of spoil
- Utilize structures that can withstand differential settlement
- Control of water infiltration

Surcharge

Placing fill materials on a building pad area that is greater than the weight of the new structure and allowing that surcharge material to sit there for an extended period of time while monitoring settlement will allow the primary settlement associated with the new loads on the site to go ahead and occur.

Alternatively, removal of material will achieve the same result if construction can be staged to cut material from one area to surcharge a different area – such as areas that need to receive grade raise fill.

Building Support Pad

Undercutting and replacing the spoil as a controlled engineered fill material would create a more homogeneous bearing surface for the building. This pad would extend beyond the limits of the building and act as a mat below the structure to limit the effects of differential settlement. See the figure below:

Figure 2: Undercuting and Replacement

Spoil Depth

The amount of potential settlement is greatly impacted by the depth of the spoil. Structures that span benches or other subsurface structures that generate a significant difference in spoil depth will experience much higher risk of differential settlement.

This risk can be controlled by master planning the development to ensure that the structures are all placed on similar depths of spoil. L.E. Gregg recommends generating a base rock elevation map for this purpose. This can be done utilizing a combination of seismic geophysical methods and drilling. Further, with this information it may be possible to more accurately predict the amount of settlement if the fill.

Structural Control

The buildings themselves should be designed to resist differential settlement. This means that the structural engineer and the architect need to design a flexible building that utilizes foundations that will resist angular deformation as well as vertical displacement, materials that are less susceptible to cracking (limit masonry and brick), use construction joints where possible, and avoid slabs on grade.

Water Infiltration

After a period of time mine spoil fills develop a “crust” in the upper portions of the fill, where the fine materials have sealed off small voids in the near surface and inhibit surface water infiltration into the remainder of the fill. This will be destroyed during construction and it is imperative that all water be controlled and removed from the building pad area in order to limit the hydrocompaction effects on the structures. This includes drainage for all downspouts, yard drainage, and not allowing road drainage to infiltrate to yards. Septic systems will also contribute to the hydrocompaction risk.

4.3 FOUNDATIONS

We have assumed that the proposed residential structures will be 1 to 2 story, lightly loaded structures. The total, differential, and rate of settlement in the mine spoil fill below the proposed development cannot be accurately predicted.

Undercut and Replace with Engineered Fill

In order to provide a uniform platform on which to build the proposed residential structures, we would recommend that the building pads be undercut a minimum of 5 ft. below the bottom of foundations and be replaced with engineered fill per Section 4.6 of this report. This will normalize the potential settlement over large areas. The onsite materials may be re-used for this purpose provided the shale material can be adequately broken down. This may require the addition of water to complete this process.

Standard spread foundations bearing in engineered fill should be designed for an allowable capacity of 2,500 psf.

General Design Considerations

We recommend that continuous footings be a minimum of 24 inches wide and isolated spread footings be a minimum of 24 inches by 24 inches. Further due to the risk of differential settlement we recommend utilizing a strip foundation with an integrated poured concrete stem wall. The minimum thickness of both continuous and spread footings should be 12 inches. The foundations should be placed a minimum of 30 in. below grade as required by the Kentucky Building Code.

General Construction Considerations

All vegetation, topsoil, unsuitable fill soil (if required), loose rock fragments greater than 6 inches, construction debris, water, and other debris should be removed from the proposed construction areas before concrete placement. Any trench excavations should have adequate shoring and/or benching per OSHA requirements. The foundation support and/or foundation side walls should be protected from freezing weather, severe drying, and water ponding. Positive drainage should be provided to direct surface runoff away from excavations. The foundation elements should not be formed so that concrete completely fills the opened excavations.

4.4 SLAB SUPPORT

We do not recommend utilizing slab on grade construction for these structures. They will be very prone to differential settlement and can conceal water leaks. We recommend utilizing a crawlspace construction.

4.5 SITE PREPARATION AND GRADING

All vegetation, topsoil, unsuitable fill soil (if required), loose rock fragments greater than 6 in., construction debris, and other debris should be removed from the proposed construction areas. After completion of stripping operations, we recommend that the subgrade be proofrolled with a fully-loaded, tandem-axle dump truck or other pneumatic-tired construction equipment of similar weight. The geotechnical engineer or their representative should observe proofrolling. Areas judged to perform unsatisfactorily should be stabilized by additional compaction or by one or more of the following methods: in-place stabilization using chemical methods (soil cement/lime stabilization), removal and replacement with engineered fill, partial depth removal and replacement with a crushed (angular) aggregate layer, or partial depth removal and replacement with a geogrid and crushed aggregate layer. The specific method of treatment will be based on the conditions present at the time of proofrolling and local availability of materials and economic factors. The selection of the appropriate method to mitigate degrading subgrade soils is dependent on the time of year site work is anticipated, cost, anticipated effectiveness, and scheduling impacts.

4.6 FILL PLACEMENT

Portions of the on-site materials should be reusable for structural fill. Any large-scale organics, organic layers (topsoil), or boulders would need to be removed from all building pad areas. This will likely require on-site sorting during cut/fill operations. If the material has more than 50% non-durable shale the material should be placed per Section 206.03.02 D of the KYTC Standard Specifications;

- Remove or break down rock fragments or slabs having thickness greater than 4 in. or having any dimension greater than 1.5 ft. before incorporating them into the lift. Construct in loose lifts not exceeding 8 in. Apply water to accelerate slaking. Uniformly incorporate the water throughout the lift using a multiple gang disk with a minimum disk diameter of 2 ft. or other suitable equipment the Engineer approves. Compact with 30-ton static tamping foot rollers in conjunction with vibratory tamping foot rollers that produce a minimum compactive effort of 27 tons and direct hauling equipment over the full width of the lift to aid in compaction.

Site grading should be completed so that cut/fill transitions do not occur directly beneath any structures. The differential fill depths beneath structures should not exceed 5 ft. This will reduce the potential for differential settlement and structural distress beneath structures.

Material considered suitable for use as structural fill should be clean soil free of organics, trash, or other deleterious materials, and contain no rock fragments greater than 6 in. in any one dimension. Preferably, structural soil fill material should have a standard Proctor maximum dry density of 90 pounds per cubic foot (pcf) or greater and a plasticity index (PI) of 25 percent or less. Materials with PI's greater than 25 may evaluated on a case-by-case basis for use in other areas of the site or in areas of deep fill. All material to be used as structural fill should be tested by the geotechnical engineer to confirm that it meets the project requirements before being placed.

Structural fill should be placed in loose, horizontal lifts not exceeding 8 in. thick. Each lift should be compacted per Table 3 below and within the range of minus (-) 2 percent to plus (+) 2 percent of the optimum moisture content. Each lift should be tested by geotechnical personnel to confirm that the contractors' method is capable of achieving the project requirements before placing any subsequent lifts. Any areas which have become soft or frozen should be removed before additional structural fill is placed. One in place density test should be performed a minimum of every 5,000 ft^2 for each 8 in. lift. Adequate surface drainage should be provided during all site grading and fill placement operations. **Please note that compaction efforts can be difficult to achieve using conventional construction methods during wet weather.**

Table 3 – Fill Placement (ASTM D 698)

Location	Maximum Dry Density (%)
Footings and Floor Slabs	98.0
Pavement Areas	95.0
Landscape Areas	85.0

4.7 DRAINAGE

Water infiltration during and after construction will be a major concern. As discussed previously, the construction process will disturb the "crust" and will allow water infiltration into the subsurface contributing to hydrocompaction until the crust has reestablished itself. All structures should have aggressive drainage away from the building. This is especially key from the outside of the building to the edge of the engineered building pad. Additionally, all gutter downspouts should be directed away from the buildings such that any water infiltration will not impact the building. The preference would be to make sure the downspouts are directed to constructed drainage and not allowed to sheet across the yard. Leaking within stormwater and/or septic sewer systems could pose a potential threat due to settlements. We would recommend that these systems be inspected regularly for leakage into the subgrade.

To reduce the potential for undercut and construction induced sinkholes, water should not be allowed to collect in the foundation excavations, on floor slab areas, or on prepared subgrades of the construction area either during or after construction. Undercut or excavated areas should be sloped toward one corner to facilitate removal of any collected rainwater, subsurface water, or surface runoff. Engineered fill or concrete should not be placed in excavations containing standing water or over-softened soils.

4.8 BELOW GRADE WALLS

The following parameters are recommended for below grade wall design and construction:

Material Backfill

- Plasticity Index of any soil material should be less than 25;
- Provide temporary bracing if the walls cannot accommodate construction phase stresses;
- Provide adequate drainage at the rear of the wall;

Table 4 – Lateral Earth Pressures

Description of Backfill	φ (°)	Moist Unit Weight, γ (pcf)	Active Coefficient, K_a	At-Rest Coefficient, K_0	Passive Coefficient, K_p
Low to Medium Plasticity Clay (CL)	28	120	0.36	0.53	2.80
Well Graded Gravel-Sand Mix (GW/SW)	36	130	0.26	0.41	3.90
Poorly Graded Clean Gravel or sand (GP/SP)	34	120	0.28	0.44	3.55

- The data presented in Table 4 are based on the following assumptions:
  - Soil Backfill material exhibits an angle of shear resistance of 28 degrees or greater;
  - Retaining wall analysis assumes a level backfill slope;
  - Retaining wall analysis assumes that the wall will be designed as a vertical wall with respect to the retained material;
  - Retaining wall analysis assumes the wall will be designed as a smooth wall with no friction.

4.9 LATERAL EARTH PRESSURES

The Kentucky Building Code (KBC), current edition, Table 1806.2, provides guidelines for allowable lateral pressure for use in foundation design. The following table summarizes the allowable lateral pressures.

Table 5 – Presumptive Load-Bearing Values (KBC/IBC Table 1806.2)

Type of Material	Vertical Foundation Pressure (psf)	Lateral Bearing Pressure (psf/ft below natural grade)	Lateral Sliding Resistance	
			Coefficient of friction[a]	Cohesion (psf)[b]
Crystalline bedrock	12,000	1,200	0.70	-
Sedimentary and foliated rock	4,000	400	0.35	-
Sandy gravel and/or gravel	3,000	200	0.35	-
Sand, silty sand, clayey sand, silty gravel, and clayey gravel	2,000	150	0.25	-
Clay, sandy clay, silty clay, clayey silt, silt, and sandy silt	1,500	100	-	130

a. Coefficient to be multiplied by the dead load
b. Cohesion value to be multiplied by the contact area, as limited by Section 1806.3.2

The values for lateral bearing pressure located above in Table 5, may be adjusted when considering load combinations, including wind or earthquake loads as permitted by Section 1605.3.2 of the KYBC.

4.10 MINE SUBSIDENCE

As previously mentioned, underground mining activity consisting of room and pillar mining has been completed at various locations around the site. The coal seam is accessed by deep vertical shafts with elevators from the surface down to the coal. In room and pillar mining, the coal seams are mined by creating a network of rooms into the seam. As the coal is removed creating rooms, pillars composed of coal are left behind to support the roof of the mine. Each room alternates with a pillar of greater width than the excavated room for support. As mining continues, roof bolts are placed in the ceiling to prevent ceiling collapse. The pillars may be left in place or under special circumstances they may sometimes be removed or pulled toward the end of mining in a process to retrieve the remaining coal. This is called retreat mining and can lead to roof falls, so the pillars are removed in the opposite direction from which the mine advanced. Several causes of mine subsidence are shown below in Figure 2.

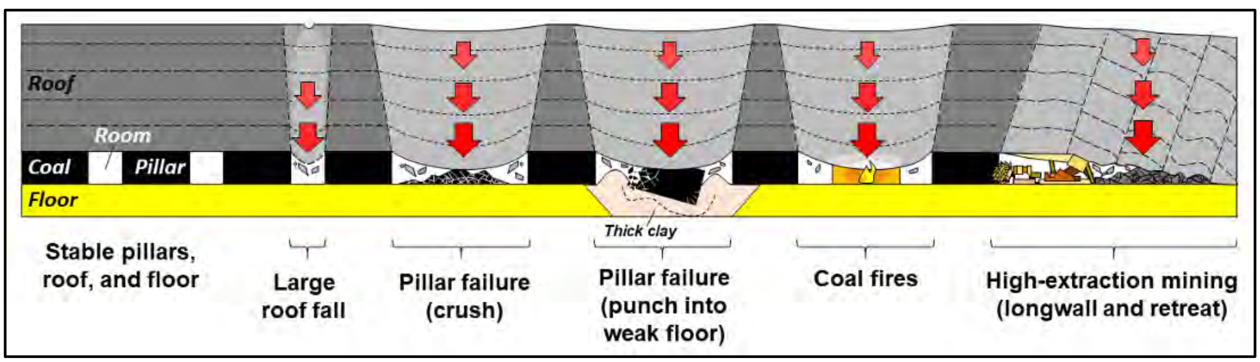


Figure 3: Underground Mine Subsidence Causes

Several different types of mine subsidence are known in the Midwestern and Eastern United States. Pit subsidence is a localized surface hole or pit that can develop above mines and is most common above collapsed rooms or entries in shallow (> 100 ft.) room and pillar mines. The majority of roof falls in underground mines only result in the collapse of the immediate roof; however, under certain conditions, these falls may continue upward and result in a sinkhole subsidence at the surface. A study in Pennsylvania found that more than half of recorded sinkhole subsidence events happened 50 or more years after mining, and a few occurred more than 100 years after mining (Gray and others, 1977; Gray and Bruhn, 1984).

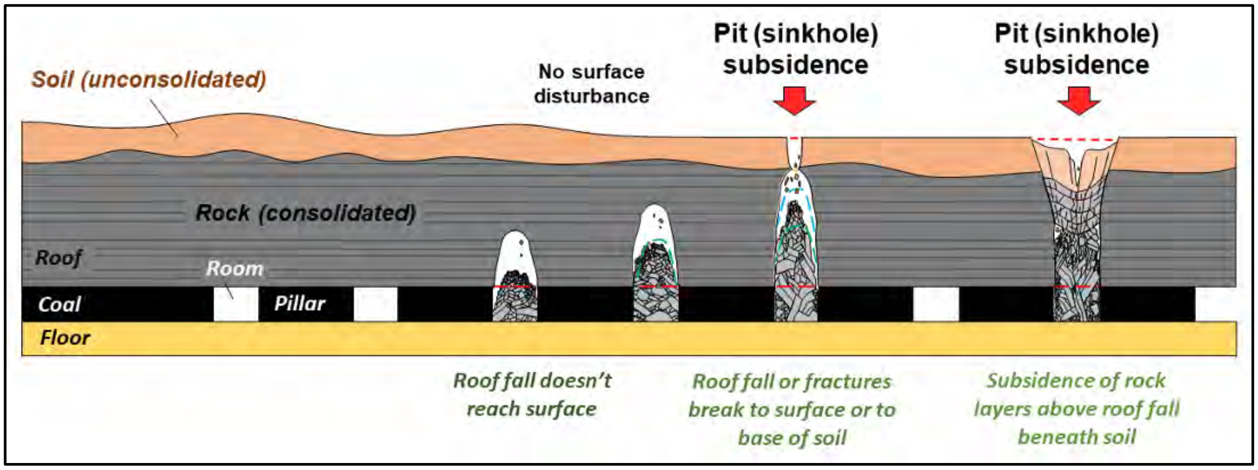


Figure 3: Examples of Pit Subsidence

Many factors are considered when evaluating the cause of mine subsidence. These are;

1. Age of mine
2. Seam thickness
3. Dimensions of rooms and pillars
4. Depth of mine, thickness of bedrock above mine, and thickness of soil cover
5. Competency of bedrock cover
6. Competency of mine floor
7. Water movement within the overburden as well as the mine
8. Number of underground mines in an isolated area

Because of the many factors listed above and the number of possible causes of mine subsidence, each potential instance of subsidence requires an individual assessment in order to determine the exact cause.

Boring B-11 was advanced to a refusal depth of 115 ft. and was then cored to a depth of 251 ft. This correlates to a refusal elevation of 1321 ft. and a coring termination of 1185 ft. A layer of sandstone of approximately 48 ft. in thickness was encountered from 1311 to 1359 ft. in elevation. Several coal seams were encountered below this and should correlate to the Hazard No.7 and Hazard No.0 coal seams. Four (4) samples of the sandstone obtained during the coring process were used for unconfined compression testing and achieved compression results of 600,000-950,000 psf.

Based on the observations in the field, the thickness of the sandstone bedrock above the coal seams, and the competency of the bedrock cover, we do not believe that there is a high risk for mine subsidence at this time.

4.11 SLOPE RECOMMENDATIONS

Cut Slopes

Permanent cut slopes are typically recommended to be no steeper than 2H:1V. If steeper slopes are required, they will depend on existing conditions and will need to be reviewed on a case-by-case basis. The upper two (2) ft. of all cut slopes should be graded to 2:1 in order to reduce the potential for sloughing and erosion. Temporary cut slopes may be constructed for retaining walls, below grade walls, etc. and should follow OSHA excavation standards.

Fill Slopes

Permanent fill slopes should be no steeper that 2H:1V. Steeper slopes may be feasible if reinforcement is used in the design/construction. The fill material should be placed and compacted in horizontal lifts according to the project specifications and plans. The slope should be constructed by overbuilding the slope face and then cutting it back to the design grade. New fill material should be properly benched into the existing slopes as shown in the diagram below. Fill slopes should not be constructed or extended horizontally by placing fill on an existing slope face and/or compacted by track walking.

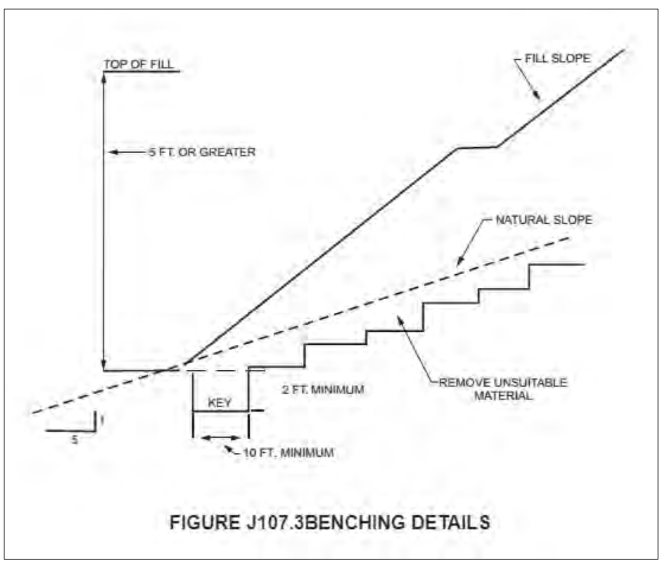


Figure 1: Benching Details (2015 IBC)

4.12 PAVEMENT DESIGN

General

A California Bearing Ratio (CBR) value of 2.0 when compacted to 95% of the Standard Proctor value was assumed for the pavement design listed below. The PaveXpress pavement design module created by the Plantmix Asphalt Industry of Kentucky (PAIKY) was utilized to evaluate the pavement recommendations and is based on the AASHTO Guide for Design of Pavement Structures (1993).

Table 6 – Pavement Design Assumptions

Design Life	**20 years**
Reliability	90%
Subgrade Resilient Modulus	3,500
Drainage Coefficient	1.0
Growth Potential	2 %
Initial Serviceability (Asphalt, Concrete)	4.5, 4.0
Terminal Serviceability	2.0
Asphalt Wearing Surface, layer coefficient	0.44
Asphalt Base Surface, layer coefficient	0.44
Dense Graded Aggregate Base, layer coefficient	0.14

The amount and type of traffic is unknown at this time. We have provided the following light and heavy duty flexible designs listed below which is based on the typical needs which include passenger cars, delivery trucks, and garbage trucks. The light duty design will provide approximately 50,000 ESAL's and the heavy duty design will provide approximately 150,000 ESAL's. L.E. Gregg should be contacted if the amount of ESAL's provided will not satisfy the final traffic loading.

Table 7 –Flexible Pavement Design

Component	**Light Duty Thickness (in.)**	**Heavy Duty Thickness (in.)**
Surface Course	1.5	1.5
Asphalt Base Course	2.5	3.5
Base Material (DGA)	8.0	8.0

Pavement Maintenance

It should be expected that cracks will appear in flexible pavement areas within 1 to 3 years due to thermal expansion and contraction and the loss of volatiles from the bituminous mixture. These cracks cannot be avoided. In order to maintain pavement areas, these cracks should be cleaned annually and patched with a hot bituminous sealant. Within 3 to 5 years, cracks and depressions may appear in heavily traveled areas. These areas should be cut out and repaired promptly to extend the life of the pavement.

Rigid Pavement

If heavy duty rigid pavements are required, we would recommend a 6 in. concrete section with a 6 in. DGA base. Prior to placing the crushed stone base for the rigid pavement, the area should be proofrolled and observed by L.E. Gregg. It is recommended that the concrete pads be large enough to accommodate the entire length of a truck while loading or unloading. In addition, it is recommended that a thickened curb be constructed around the perimeter of the pads to reduce the potential for damage typically associated with overstressing of the pad edges.

Reinforcement for the rigid pavements should consist of a wire mesh or fiber-reinforced concrete. If wire mesh is utilized, the mesh should be located in the middle third of the rigid pavement. It is recommended that control joints be placed at 15 ft. intervals each way in the apron and pad areas. These control joints should be filled with a fuel resistant seal to prevent intrusion of liquids into the subgrade.

5.0 BASIS FOR RECOMMENDATIONS

VARIATIONS

Since any general foundation or subsurface exploration can examine and report only that information which is obtained from the borings and samples taken there from, and since uniformity of subsurface conditions does not always exist, the following is recommended. If, during construction, any latent soil, bedrock, or water conditions are encountered that were not observed in the borings, contact L.E. Gregg so that the site may be inspected to identify any necessary modifications in the design or construction of the foundation.

OTHER INTERPRETATIONS

The conclusions and recommendations submitted in this report apply to the proposed project only. They are not applicable to on-site, subsequent construction, adjacent or nearby projects. In the event that conclusions or recommendations based on this report and relating to any other projects are made by others, such conclusions and recommendations are not the responsibility of L. E. Gregg Associates. The recommendations provided are based in part on project information provided to L.E. Gregg and only apply to the specific project and site discussed in this report. If the project information section in this report contains incorrect information or if additional information is available, the correct or additional information should be conveyed to L.E. Gregg for review.

It is recommended that this complete report be provided to the various design team members, the contractors, and the project owner. Potential contractors should be informed of this report in the "instructions to bidders" section of the bid documents. The report should not be included or referenced in the actual contract documents.

STANDARD OF CARE

The services provided by L. E. Gregg Associates for this exploration have been performed in a manner consistent with that degree of care and skill ordinarily exercised by members of the same profession currently practicing under similar circumstances.

Important Information about Your

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 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 your geotechnical engineering report without first conferring with the geotechnical engineer who prepared it. *And no one — not even you* — should apply the 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.

A Geotechnical Engineering Report Is Based on A Unique Set of Project-Specific Factors

Geotechnical engineers consider a number of 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,
- elevation, configuration, location, orientation, or weight of the proposed structure,
- 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 study was performed. *Do not rely on a geotechnical engineering report* whose adequacy may have been affected by: the passage of time; by man-made events, such as construction on or adjacent to the site; or by natural events, such as floods, earthquakes, or groundwater fluctuations. *Always* contact the geotechnical engineer before applying the 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 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 construction recommendations included in your report. *Those 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 recommendations if that engineer does not perform construction observation.*

A Geotechnical Engineering Report Is Subject to Misinterpretation

Other design team members' misinterpretation of geotechnical engineering reports has resulted in costly problems. Lower 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. Contractors can also misinterpret a geotechnical engineering report. Reduce that risk by having your geotechnical engineer participate in prebid and preconstruction conferences, and by providing 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 Contractors a Complete Report and Guidance

Some owners and design professionals mistakenly believe they can make contractors liable for unanticipated subsurface conditions by limiting what they provide for bid preparation. To help prevent costly problems, give contractors the complete geotechnical engineering report, *but* preface it with a clearly written letter of transmittal. In that letter, advise contractors 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 contractors have sufficient time* to perform additional study. Only then might you be in a position to give contractors 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 contractors do not 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.

Geoenvironmental Concerns Are Not Covered

The equipment, techniques, and personnel used to perform a *geoenvironmental* study differ significantly from those used to perform a *geotechnical* study. For that reason, a geotechnical engineering report does not usually relate any geoenvironmental 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 geoenvironmental 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, a number of 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 ASFE-Member Geotechncial Engineer for Additional Assistance

Membership in ASFE/The Best People on Earth exposes geotechnical engineers to a wide array of risk management techniques that can be of genuine benefit for everyone involved with a construction project. Confer with your ASFE-member geotechnical engineer for more information.

ASFE
THE BEST PEOPLE ON EARTH

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Telephone: 301/565-2733 Facsimile: 301/589-2017
e-mail: info@asfe.org www.asfe.org

KEY TO SYMBOLS AND DESCRIPTIONS

	GW	**Well graded gravels, little or no fines**
	GP	**Poorly graded gravels, little or no fines**
	GM	**Silty gravels, sand and silt mixtures**
	GC	**Clayey gravels, sand and clay mixtures**
	SW	**Well graded sand, little or no fines**
	SP	**Poorly graded sand, little or no fines**
	SM	**Silty sands, sand and silt mixtures**
	SC	**Clayey sands, sand and clay mixtures**
	ML	**Inorganic silts and very fine sands, rock flour, silty or clayey fine sands silts and with slight plasticity**
	CL	**Inorganic clays with low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays**
	OL	**Organic silts and organic silty clay of low plasticity**
	MH	**Inorganic silts, micaceous or diatomaceous fine sandy or silt soils, elastic silts**
	CH	**Inorganic clays of high plasticity, fat clays**
	OH	**Organic clays of medium to high plasticity, organic silts**
	Topsoil	**Usually top few inches of soil deposits and contains considerable amounts of organic matter**
	Asphalt	**Usually a black solid or semisolid mixture of bitumens mostly used in paving**
	Fill	**Soils that have been transported by man to their present location**
	Limestone	**Sedimentary rock consisting of predominantly of calcium carbonate**
	Sandstone	**Sedimentary rock consisting of sand with some cementitious material**
	Siltstone	**Fine grained rock of consolidated silt**
	Shale	**Fine grained sedimentary rock consisting of compacted clay, silt, or mud**
	Coal	**Natural black graphite like material formed from fossilized plants**
	Limestone interbedded with Shale	**Predominantly limestone interbedded with shale layers**
	Weathered	**Weathered rock**

CONSISTANCY AND RELATIVE DENSITY CORRELATED WITH STANDARD PENETRATION TEST (SPT)			
SILT AND CLAY		**SAND AND GRAVEL**	
Relative Density	**Blows Per Foot (BPF)**	**Relative Density**	**Blows Per Foot (BPF)**
Very Soft	0 to 1	Very Loose	0 to 4
Soft	2 to 4	Loose	5 to 10
Firm	5 to 8	Firm	11 to 20
Stiff	9 to 15	Very Firm	21 to 30
Very Stiff	16 to 30	Dense	31 to 50

ROCK PROPERTIES	
RELATIVE HARDNESS OF ROCK	
Very Soft	Can be scratched by fingernail
Soft	May be broken by fingers
Medium	Corner and edges may be broken by fingers
Moderately Hard	Moderate blow of hammer required to break sample
Hard	Hard blow of hammer required to break sample
Very Hard	Several hard blows of hammer required to break sample

Rock Continuity (REC)		**Rock Quality Designation (RQD)**	
Core Recovery (%)	Description	RQD (%)	Classification
0 – 40	Incompetent	<25	Very Poor
40 – 70	Competent	25 – 50	Poor
70 – 90	Fairly Continuous	50 – 75	Fair
90 – 100	Continuous	75 – 90	Good
		90 – 100	Very Good

Estimated Moisture Condition Relative to Optimum	
Dry	Under 5% of Optimum
Slightly Moist	Minus 2% of Optimum
Moist	± 2% of Optimum
Very Moist	Plus 2% of Optimum
Wet	Over 5% of Optimum

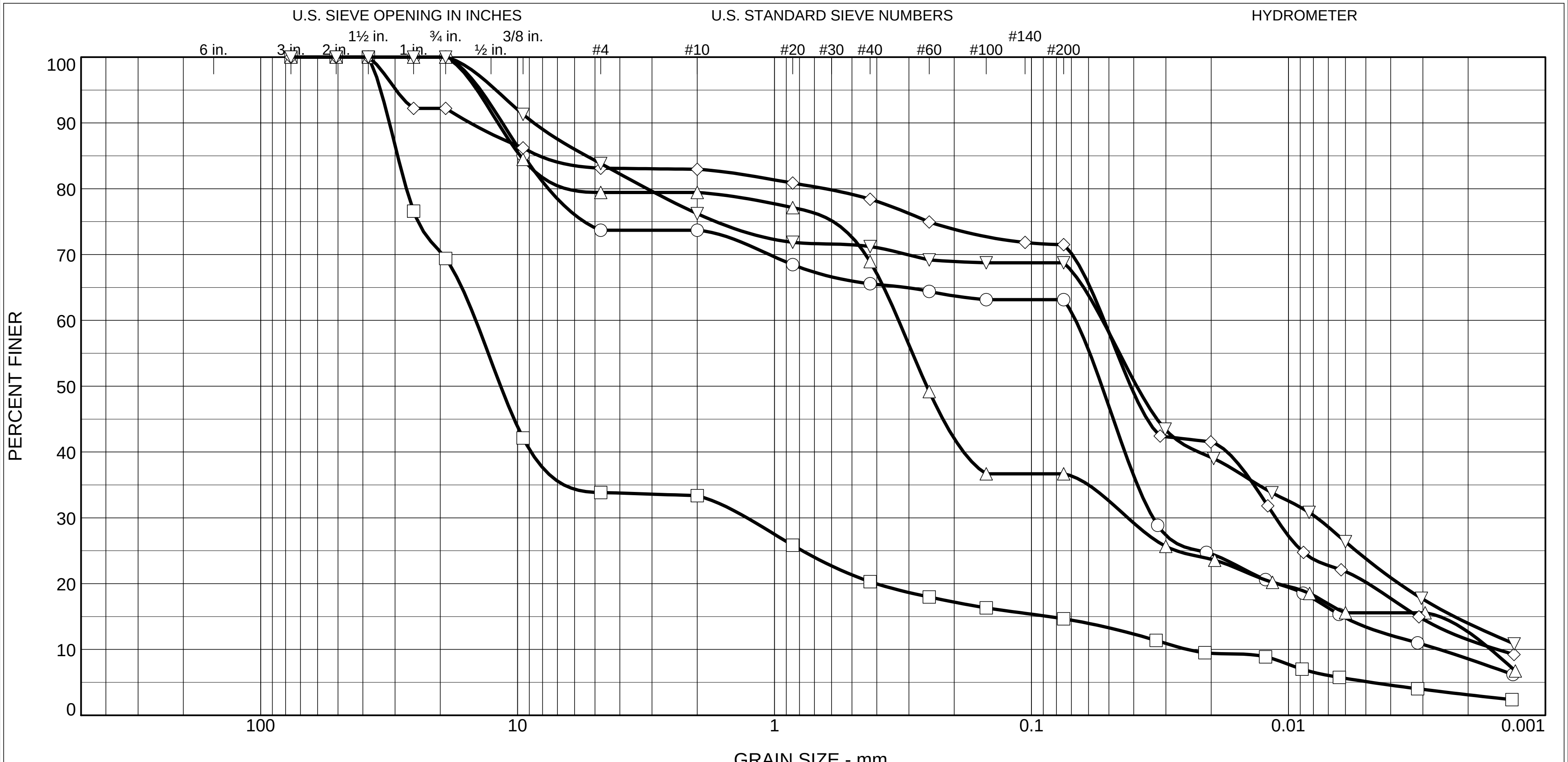
Misc. and Soil Sampler Symbols			
N	Blows Per Foot (BPF)		Undisturbed Sample
% W	Percent Water		Standard Penetration Test (SPT)
RQD	Rock Quality Designation		Boring Location
REC	Rock Core Recovery		Water Table while Drilling
CLA	Classification of Combined Samples		Water Table after Drilling
	Rock Core (RC)		Bulk Sample (BK)

LE Gregg ASSOCIATES

Geotechnical, Environmental & Materials Engineering
Since 1957

APPENDIX A

Summary of Laboratory and Drilling Data



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay

	Location	Source	Sample #	Depth/Elev.	Material Description
○	B-1		24379	9.0-10.5'	Gravelly Lean Clay (CL)
□	B-4		24380	44.5-46.0'	Clayey Gravel (GC)
△	B-6		24381	59.5-61.0'	Silty Clayey Sand with Gravel (SC-SM)
◇	B-7		24382	29.5-31.0'	Sandy Silt with Gravel (ML)
▽	B-10		24383	2.0-3.5'	Gravelly Silt with Sand (ML)

Project No. 2023004 **Client** Commonwealth of Kentucky, DECA **Figure**

Particle Size Distribution Report

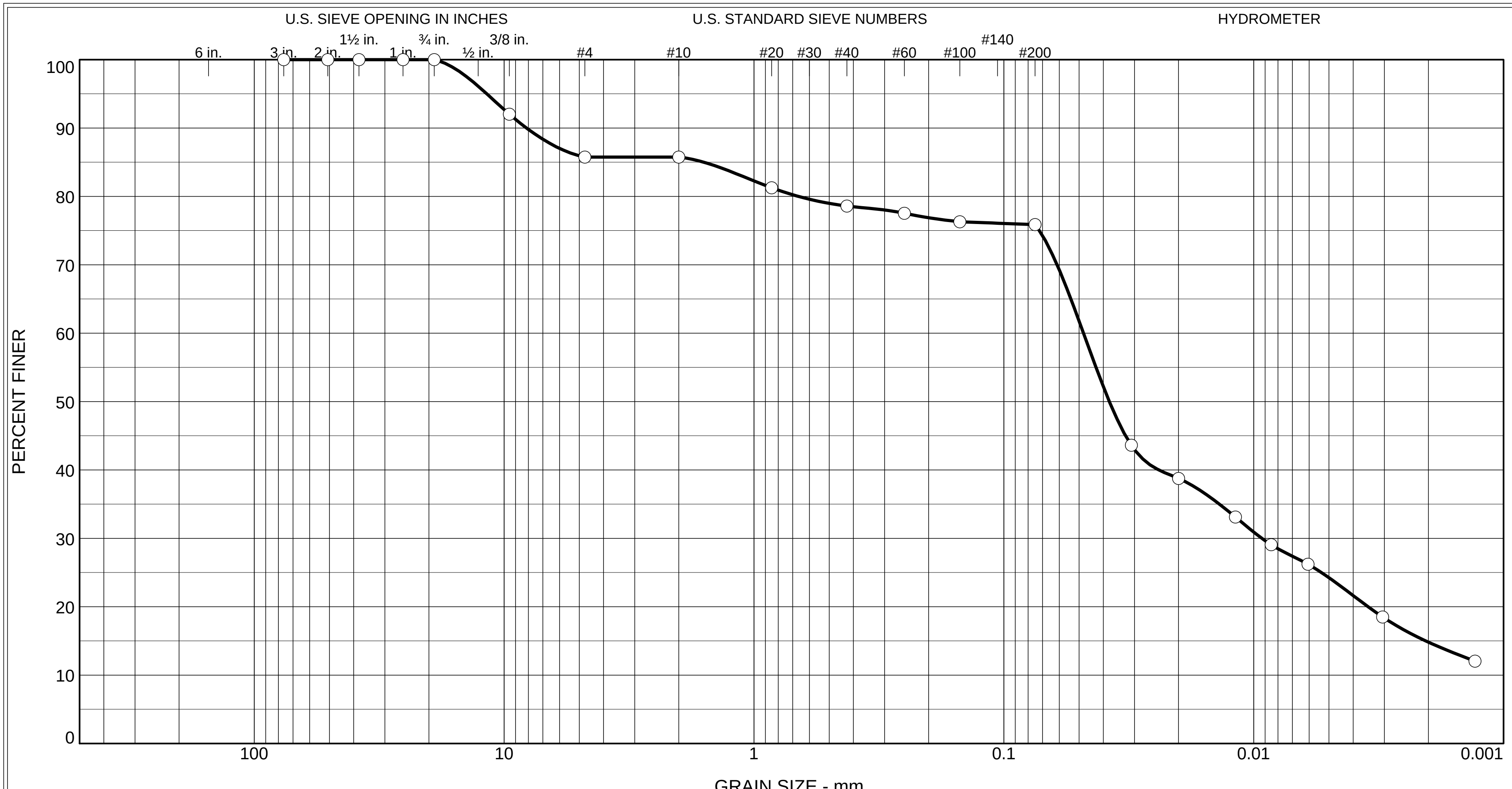
Skyview Estates

L.E. Gregg Associates, Inc.

2456 Fortune Dr, Ste 155, Lexington, KY 40509

Phone: 859-252-7558

Tested By: ● AH ■ AH ◆ SG **Checked By:** AH



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay

	Location	Source	Sample #	Depth/Elev.	Material Description
○	B-7 Bulk Sample		24386		Lean Clay with Gravel (CL)

Project No. 2023004 **Client** Commonwealth of Kentucky, DECA **Figure**

Particle Size Distribution Report

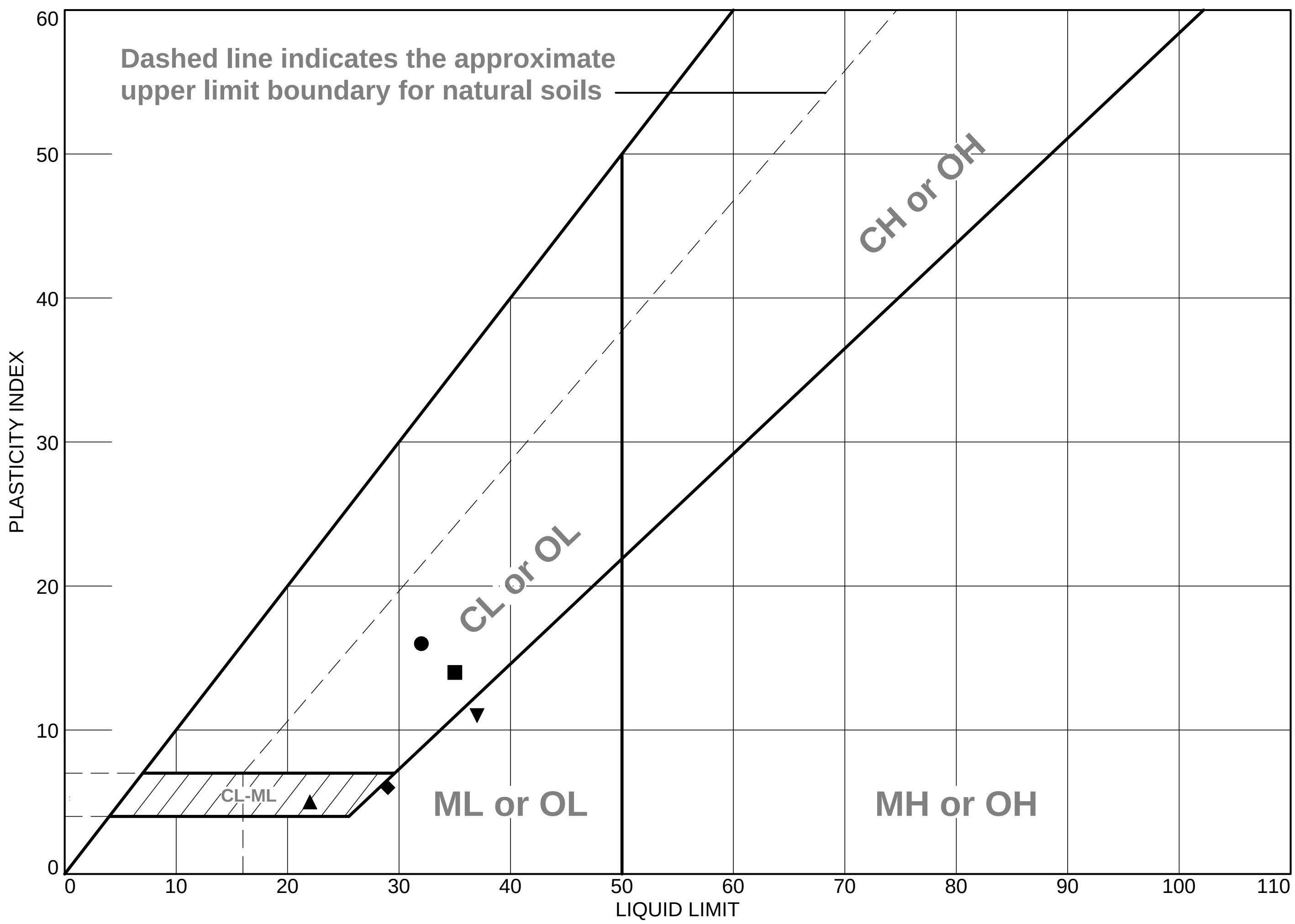
Skyview Estates

L.E. Gregg Associates, Inc.

2456 Fortune Dr, Ste 155, Lexington, KY 40509

Phone: 859-252-7558

LIQUID AND PLASTIC LIMITS TEST REPORT



	Material Description	Sampled	Tested	Technician	LL	PL	PI	%<#40	USCS
●	Gravelly Lean Clay (CL)			SG	32	16	16	65.6	CL
■	Clayey Gravel (GC)			LS	35	21	14	20.3	GC
▲	Silty Clayey Sand with Gravel (SC-SM)			JC	22	17	5	68.9	SC-SM
◆	Sandy Silt with Gravel (ML)			JC	29	23	6	78.4	ML
▼	Gravelly Silt with Sand (ML)			JC	37	26	11	71.2	ML

Project No. 2023004 **Client:** Commonwealth of Kentucky, DECA

Project: Skyview Estates

○ **Location:** B-1 **Depth:** 9.0-10.5' **Sample Number:** 24379

□ **Location:** B-4 **Depth:** 44.5-46.0' **Sample Number:** 24380

△ **Location:** B-6 **Depth:** 59.5-61.0' **Sample Number:** 24381

◇ **Location:** B-7 **Depth:** 29.5-31.0' **Sample Number:** 24382

▽ **Location:** B-10 **Depth:** 2.0-3.5' **Sample Number:** 24383

L.E. Gregg Associates, Inc.
2456 Fortune Dr, Ste 155, Lexington, KY 40509
Phone: 859-252-7558

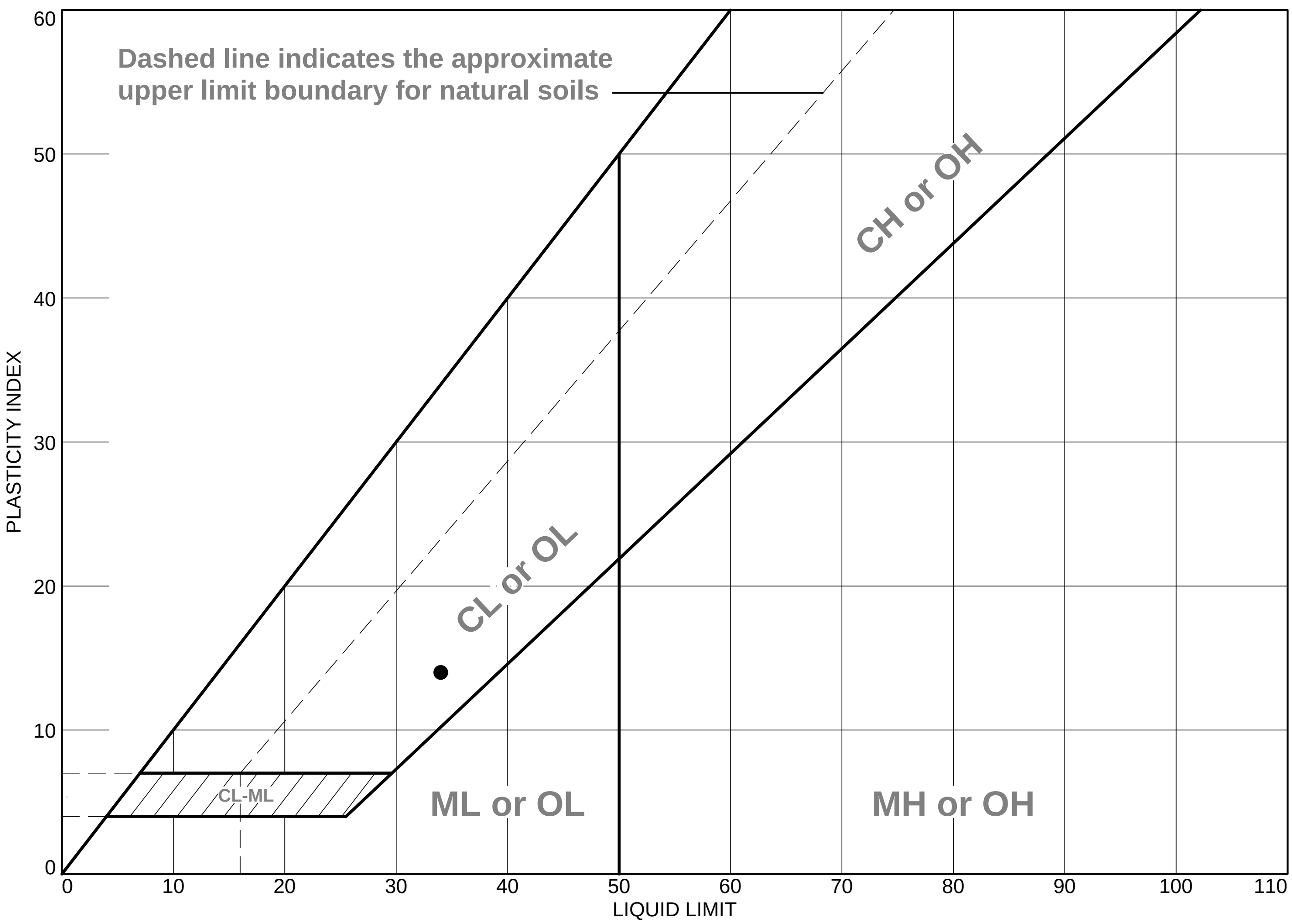
Checked by: AH

Title:

Figure

Tested By: ○ SG □ LS △ JC ◇ JC ▽ JC **Checked By:** AH

LIQUID AND PLASTIC LIMITS TEST REPORT



	Material Description	Sampled	Tested	Technician	LL	PL	PI	%<#40	USCS
●	Lean Clay with Gravel (CL)			SG	34	20	14	78.6	CL

Project No. 2023004 **Client:** Commonwealth of Kentucky, DECA

Project: Skyview Estates

○ **Location:** B-7 Bulk Sample **Sample Number:** 24386

L.E. Gregg Associates, Inc.
2456 Fortune Dr, Ste 155, Lexington, KY 40509
Phone: 859-252-7558

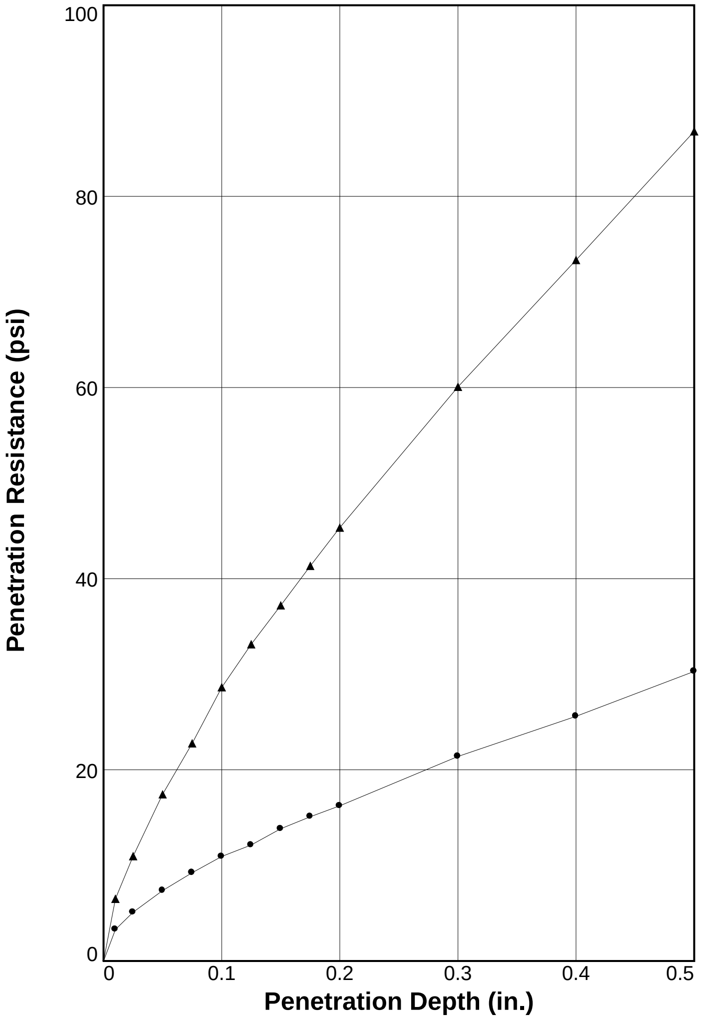
Checked by: AH

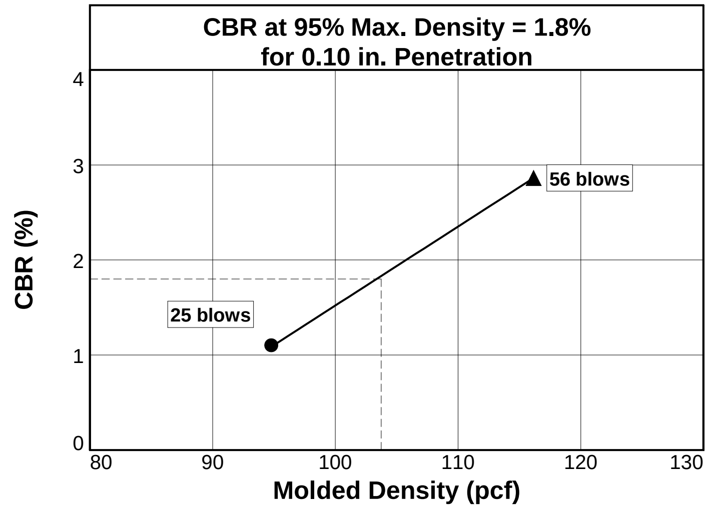
Title:

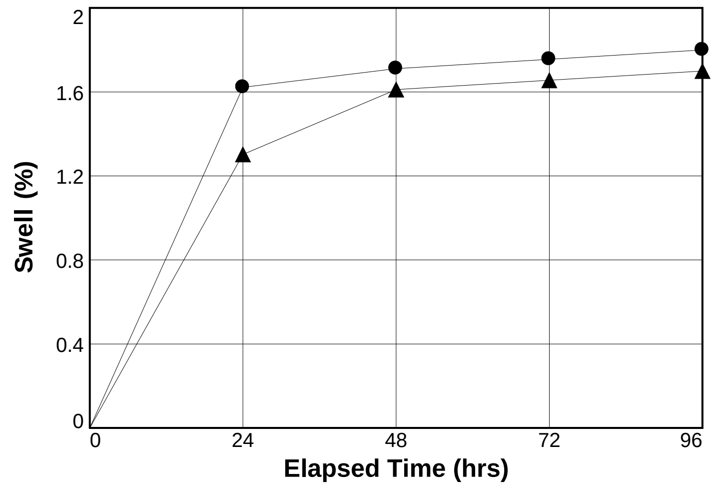
Figure

Tested By: SG **Checked By:** AH

BEARING RATIO TEST REPORT
ASTM D1883-16







	Molded			Soaked			CBR (%)		Linearity Correction (in.)	Surcharge (lbs.)	Max. Swell (%)
	Density (pcf)	Percent of Max. Dens.	Moisture (%)	Density (pcf)	Percent of Max. Dens.	Moisture (%)	0.10 in.	0.20 in.			
1 ○	94.9	86.9	12.0	93.2	85.3	19.2	1.1	1.1	0.000	12.58	1.8
2 △	116.2	106.4	12.0	114.2	104.6	17.1	2.9	3.0	0.000	12.62	1.7
3 □											

Material Description	USCS	Max. Dens. (pcf)	Optimum Moisture (%)	LL	PI
Lean Clay with Gravel (CL)	CL	109.2	12.4	34	14

Project No: 2023004

Project: Skyview Estates

Location: B-7 Bulk Sample

Sample Number: 24386

Date:

Test Description/Remarks:

BEARING RATIO TEST REPORT
L.E. Gregg Associates, Inc.
2456 Fortune Dr, Ste 155, Lexington, KY 40509

Figure ________

Date Started: 2/21/2023 Date Completed: 2/24/2023

LE Gregg Associates

Slake Durability Index

Project #: 2023004 Lab #: 24387

Project Name: Skyview Estates

Sample Location: B-4 29.5-31.0’

Sample Description: ____

Test Data

ID & Mass of Empty Drum (without lid)	ID: B		[D] Mass (g): 962.8	
Initial Mass of Rocks + Drum (g)	1148.74		Moisture Content: 4.2 %	
Mass of Oven-Dry Rocks + Drum (g)	1141.32	[a]		
	Cycle 1		Cycle 2	
Temperature Before Cycle (°F)	68		67	
Temperature After Cycle (°F)	69		68	
Final Mass of Oven-Dry Rocks + Drum (g)	1106.61		1098.06	[c]

Calculations

[(c-D) / (a-D)] * 100 = 75.8 %

Slake Durability Index (Cycle 2)

____

Ann Hislop, Lab Manager

Date Started: 2/21/2023

Date Completed: 2/24/2023

LE Gregg Associates

Slake Durability Index

Project #: 2023004

Lab #: 24389

Project Name: Skyview Estates

Sample Location: B-7 4.5-6.0”

Sample Description:

Test Data

ID & Mass of Empty Drum (without lid)	ID: A		[D] Mass (g): 967.27	
Initial Mass of Rocks + Drum (g)	1115.63		Moisture Content: 6.2 %	
Mass of Oven-Dry Rocks + Drum (g)	1106.99	[a]		
	Cycle 1		Cycle 2	
Temperature Before Cycle (°F)	68		66	
Temperature After Cycle (°F)	69		67	
Final Mass of Oven-Dry Rocks + Drum (g)	1087.48		1081.97	[c]

Calculations

[(c-D) / (a-D)] * 100 = 82.1 %

Slake Durability Index (Cycle 2)

____

Ann Hislop, Lab Manager

Date Started: 2/27/2023 Date Completed: 3/1/2023

LE Gregg Associates

Slake Durability Index

Project #: 2023004 Lab #: 24388

Project Name: Skyview Estates

Sample Location: B-1, 19.0’ - 20.5’

Sample Description: sandy, tan weathered shale

Test Data

ID & Mass of Empty Drum (without lid)	ID: A		[D] Mass (g): 967.29	
Initial Mass of Rocks + Drum (g)	1288.38		Moisture Content: 4.9 %	
Mass of Oven-Dry Rocks + Drum (g)	1277.1	[a]		
	Cycle 1		Cycle 2	
Temperature Before Cycle (°F)	67		66	
Temperature After Cycle (°F)	68		71	
Final Mass of Oven-Dry Rocks + Drum (g)	1220.59		1196.43	[c]

Calculations

[(c-D) / (a-D)] * 100 = 90.46 %

Slake Durability Index (Cycle 2)

Ann Hislop, Lab Manager

Date Started: 2/27/2023 Date Completed: 3/1/2023

LE Gregg Associates
Slake Durability Index

Project #: 2023004 Lab #: 24390

Project Name: Skyview Estates

Sample Location: B-6, 69.5' – 71.0'

Sample Description: ____

Test Data

ID & Mass of Empty Drum (without lid)	ID: B		[D] Mass (g): 962.87	
Initial Mass of Rocks + Drum (g)	1294.75		Moisture Content: 4.17 %	
Mass of Oven-Dry Rocks + Drum (g)	1281.55	[a]		
	Cycle 1		Cycle 2	
Temperature Before Cycle (°F)	67		66	
Temperature After Cycle (°F)	68		71	
Final Mass of Oven-Dry Rocks + Drum (g)	1191.28		1168.12	[c]

Calculations

[(c-D) / (a-D)] * 100 = 71.67 %

Slake Durability Index (Cycle 2)

Ann Hislop, Lab Manager

APPENDIX B

Logs of Borings

PROJECT: Skyview Estates
PROJECT NO.: 2023004
CLIENT: Commonwealth of Kentucky, DECA
DATE: 2/9/23
LOCATION: Skyview Estates, Hazard, KY
ELEVATION: 1387.3
DRILLER: Horn and Associates, Inc.
LOGGED BY:
DRILLING METHOD: 4.25" HSA
DEPTH TO WATER> INITIAL: 45.0 **AFTER 24 HOURS:** **CAVING>**

LE Gregg ASSOCIATES

BORING No. B-1

This information pertains only to this boring and should not be interpreted as being indicitive of the site.

ELEVATION (feet)	DEPTH (feet)	Description	Blows	Sample No.	NM	PL	LL	N	Rock Comp. Strength (psi)
1387.3	0	Topsoil - 0.0-0.2							
		Mine spoil fill, mix of sand, silt, clay, shale, rock fragments, brown and gray, dry, soft to hard							
			7-13-17	1	10.8			30	
			4-10-5	2	8.8			15	
1382.3	5								
			3-2-2	3	10.7			4	
1377.3	10		7-11-10	4	10.6			21	
1372.3	15		2-3-4	5	10.3			7	
1367.3	20		17-14-8	6	6.7			22	
1362.3	25		7-6-5	7	11.6			11	
1357.3	30		5-5-3	8	12.2			8	
1352.3	35		10-3-3	9	12.5			6	

Test Results legend: Plastic Limit ├─┤ Liquid Limit; Water Content - ●; Penetration - (hatched bar); scale 10 20 30 40 50

No water return during coring, water at 43 ft. after coring complete

PROJECT: Skyview Estates
PROJECT NO.: 2023004
CLIENT: Commonwealth of Kentucky, DECA
DATE: 2/9/23
LOCATION: Skyview Estates, Hazard, KY
ELEVATION: 1387.3
DRILLER: Horn and Associates, Inc.
LOGGED BY:
DRILLING METHOD: 4.25" HSA
DEPTH TO WATER> INITIAL: ▽ 45.0 **AFTER 24 HOURS:** ▼ ______ **CAVING>** ______

BORING No. B-1

ELEVATION (feet)	DEPTH (feet)	Description	Soil and Sampler Symbols, Blows	Sample No.	NM	PL	LL	N	Rock Comp. Strength (psi)
1347.3	40		15 13 8	10	11.3			21	
1342.3	45 ▽		7 6 8	11	15.2			14	
		Weathered shale	50/4	12	12.5			50+	
1337.3	50								
		Auger refusal at 52.5 ft. Begin core recovery. Run 1 - 52.5-60.5 ft. 52.5-59.3 - shale, dark gray	REC= 89% RQD= 81%						
1332.3	55								
1327.3	60	(59.3-60.1) - coal							
		(60.1-63.1) - shale, gray, sandy Run 2 - 60.5-65.5 ft.	REC= 82% RQD= 42%						
		(63.1-63.4) - coal							
		(63.4-64.5) - shale, dark gray, silty							
1322.3	65	(64.5-65.2) - coal							
		(65.2-65.5) - shale, gray, silty Core recovery terminated at 65.5 ft.							
1317.3	70								
1312.3	75								

TEST RESULTS: Plastic Limit ├─┤ Liquid Limit; Water Content - ●; Penetration - (hatched bar); scale 10 20 30 40 50

LE Gregg ASSOCIATES

PROJECT: Skyview Estates
PROJECT NO.: 2023004
CLIENT: Commonwealth of Kentucky, DECA
DATE: 2/9/23
LOCATION: Skyview Estates, Hazard, KY
ELEVATION: 1415.2
DRILLER: Horn and Associates, Inc.
LOGGED BY:
DRILLING METHOD: 4.25" HSA
DEPTH TO WATER> INITIAL: Dry **AFTER 24 HOURS:** **CAVING>**

BORING No. B-2

ELEVATION (feet)	DEPTH (feet)	Description	Soil and Sampler Symbols, Blows	Sample No.	NM	PL	LL	N	Rock Comp. Strength (psi)
1415.2	0	Mine spoil fill, mix of sand, silt, clay, shale, rock fragments, brown and gray, dry to slightly moist, firm to very stiff							
			8-10-11	1	9.3			21	
1410.2	5		10-5-6	2	7.9			11	
			4-5-3	3	11.3			8	
1405.2	10		6-4-4	4	9.0			8	
1400.2	15		2-4-6	5	6.6			10	
1395.2	20		4-3-3	6	11.5			6	
1390.2	25	Shale boulder - 25.0-26.1 ft.	50/1-0-0	7				50+	
		Mine spoil fill, mix of sand, silt, clay, shale, rock fragments, brown and gray, dry to slightly moist, firm to hard							
1385.2	30								
1380.2	35		4-3-5	8	11.2			8	

TEST RESULTS: Plastic Limit ├─┤ Liquid Limit; Water Content - ●; Penetration - (hatched bar); scale 10 20 30 40 50

No water return, water at 86.4 after coring

This information pertains only to this boring and should not be interpreted as being indicitive of the site.

PROJECT: Skyview Estates **PROJECT NO.:** 2023004
CLIENT: Commonwealth of Kentucky, DECA **DATE:** 2/9/23
LOCATION: Skyview Estates, Hazard, KY **ELEVATION:** 1415.2
DRILLER: Horn and Associates, Inc. **LOGGED BY:**
DRILLING METHOD: 4.25" HSA
DEPTH TO WATER> INITIAL: Dry **AFTER 24 HOURS:** **CAVING>**

BORING No. B-2

This information pertains only to this boring and should not be interpreted as being indicitive of the site.

ELEVATION (feet)	DEPTH (feet)	Description	Soil and Sampler Symbols, Blows	Sample No.	NM	PL	LL	N	Rock Comp. Strength (psi)
1375.2	40		3 8 10	9	6.4			18	
1370.2	45		4 4 3	10	6.7			7	
1365.2	50		50/1	11				50+	
1360.2	55		6 4 6	12	13.6			10	
1355.2	60		1 3 8	13	9.1			11	
1350.2	65		16 34 18	14	4.9			52	
1345.2	70		13 16 12	15	15.7			28	
1340.2	75		15 50/4	16	18.6			50+	

TEST RESULTS: Plastic Limit ├─┤ Liquid Limit; Water Content - ●; Penetration - (hatched bar); scale 10 20 30 40 50

LE Gregg ASSOCIATES

BORING No. B-2

PROJECT: Skyview Estates
PROJECT NO.: 2023004
CLIENT: Commonwealth of Kentucky, DECA
DATE: 2/9/23
LOCATION: Skyview Estates, Hazard, KY
ELEVATION: 1415.2
DRILLER: Horn and Associates, Inc.
LOGGED BY:
DRILLING METHOD: 4.25" HSA
DEPTH TO WATER> INITIAL: Dry **AFTER 24 HOURS:** **CAVING>**

This information pertains only to this boring and should not be interpreted as being indicitive of the site.

ELEVATION (feet)	DEPTH (feet)	Description	Soil and Sampler Symbols, Blows	Sample No.	NM	PL	LL	N	Rock Comp. Strength (psi)
1335.2	80		50/2	17	17.2			50+	
1330.2	85		50/3	18	18.5			50+	
1325.2	90	Auger refusal at 89.8 ft. Begin core recovery. Run 1 - 89.8-99.8 ft. 89.8-90.9 - shale, dark gray (90.9-91.2) - coal (91.2-98.2) - shale, silty, gray	50/3 REC= 74% RQD= 29%	19	19.3			50+	
1320.2	95								
1315.2	100	(98.2-98.5) - clay seam (98.5-104.8) - shale, sandy, gray	REC= 100% RQD= 94%						
1310.2	105	Core recovery terminated at 104.8 ft.							
1305.2	110								
1300.2	115								

TEST RESULTS: Plastic Limit ├──┤ Liquid Limit; Water Content - ●; Penetration - (hatched bar); scale 10 20 30 40 50

L E Gregg ASSOCIATES

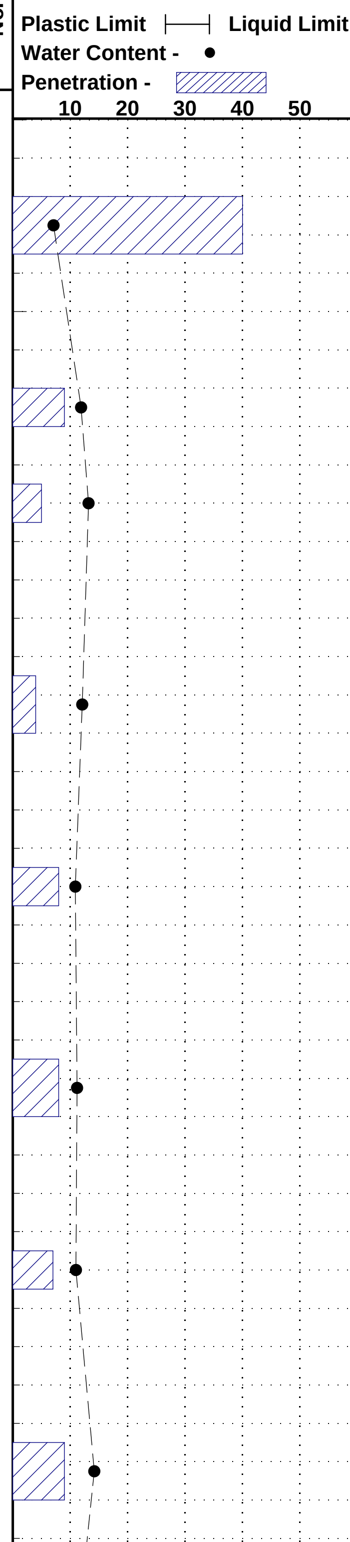
BORING No. B-3

PROJECT: Skyview Estates	**PROJECT NO.:** 2023004
CLIENT: Commonwealth of Kentucky, DECA	**DATE:** 2/9/23
LOCATION: Skyview Estates, Hazard, KY	**ELEVATION:** 1435.9
DRILLER: Horn and Associates, Inc.	**LOGGED BY:**
DRILLING METHOD: 4.25" HSA	

DEPTH TO WATER> INITIAL: Dry **AFTER 24 HOURS:** ______ **CAVING>** ______

ELEVATION (feet)	DEPTH (feet)	Description	Soil and Sampler Symbols, Blows	Sample No.	NM	PL	LL	N	Rock Comp. Strength (psi)
1435.9	0	Mine spoil fill, mix of sand, silt, clay, shale, rock fragments, brown and gray, dry, hard							
			11 17 23	1	7.1			40	
1430.9	5		50/1	2				50+	
		Sandstone boulder - 5.0-7.5 ft. - Offset 10 ft. and redrilled							
		Mine spoil fill, mix of sand, silt, clay, shale, rock fragments, brown and gray, dry to slightly moist, soft to very stiff	8 5 4	3	11.9			9	
1425.9	10		1 3 2	4	13.2			5	
1420.9	15		3 2 2	5	12.1			4	
1415.9	20		4 4 4	6	10.9			8	
1410.9	25		4 4 4	7	11.2			8	
1405.9	30		3 4 3	8	11.0			7	
1400.9	35		6 3 6	9	14.2			9	

TEST RESULTS



Water at 112.0 ft. after coring

This information pertains only to this boring and should not be interpreted as being indicitive of the site.

PROJECT: Skyview Estates
PROJECT NO.: 2023004
CLIENT: Commonwealth of Kentucky, DECA
DATE: 2/9/23
LOCATION: Skyview Estates, Hazard, KY
ELEVATION: 1435.9
DRILLER: Horn and Associates, Inc.
LOGGED BY:
DRILLING METHOD: 4.25" HSA
DEPTH TO WATER> INITIAL: Dry **AFTER 24 HOURS:** **CAVING>**

BORING No. B-3

ELEVATION (feet)	DEPTH (feet)	Description	Soil and Sampler Symbols, Blows	Sample No.	NM	PL	LL	N	Rock Comp. Strength (psi)
1395.9	40		7 9 7	10	10.7			16	
1390.9	45		7 5 6	11	6.2			11	
1385.9	50		5 6 7	12	8.6			13	
1380.9	55		5 4 5	13	7.0			9	
1375.9	60		5 6 8	14	7.0			14	
1370.9	65		5 4 0	15				4	
1365.9	70		1 13 10	16	8.5			23	
1360.9	75		3 0 0	17				0	

TEST RESULTS: Plastic Limit ├─┤ Liquid Limit; Water Content - ●; Penetration - (hatched bar); scale 10 20 30 40 50

This information pertains only to this boring and should not be interpreted as being indicitive of the site.

Figure

PROJECT: Skyview Estates **PROJECT NO.:** 2023004
CLIENT: Commonwealth of Kentucky, DECA **DATE:** 2/9/23
LOCATION: Skyview Estates, Hazard, KY **ELEVATION:** 1435.9
DRILLER: Horn and Associates, Inc. **LOGGED BY:**
DRILLING METHOD: 4.25" HSA
DEPTH TO WATER> INITIAL: Dry **AFTER 24 HOURS:** **CAVING>**

BORING No. B-3

This information pertains only to this boring and should not be interpreted as being indicitive of the site.

ELEVATION (feet)	DEPTH (feet)	Description	Soil and Sampler Symbols, Blows	Sample No.	TEST RESULTS: Plastic Limit ├─┤ Liquid Limit; Water Content - ●; Penetration - (10 20 30 40 50)	NM	PL	LL	N	Rock Comp. Strength (psi)
1355.9	80		5 12 15	18		14.7			27	
1350.9	85	Auger refusal at 85.0 ft. Begin core recovery. Run 1 - 85.0-90. ft. Sandstone boulder - 85.0-87.0 ft.	50/1 REC=60% RQD=30%	19					50+	
		(87.0-103.0) Mine spoil fill								
1345.9	90	Run 2 - 90.0-100.0 ft. Mine spoil fill	REC=56% RQD=0%							
1340.9	95									
1335.9	100	Run 3 - 100.0-108.0 ft. Mine spoil fill to 103.0 ft.	REC=51% RQD=0%							
		(103.0-108.0) - shale, black and gray								
1330.9	105									
		Run 4 - 108.0-115.0 ft. shale, gray	REC=100% RQD=9%							
1325.9	110									
1320.9	115	Run 5 - 115.0-120.0 ft. shale, gray	REC=100% RQD=4%							

PROJECT: Skyview Estates | **PROJECT NO.:** 2023004
CLIENT: Commonwealth of Kentucky, DECA | **DATE:** 2/9/23
LOCATION: Skyview Estates, Hazard, KY | **ELEVATION:** 1435.9
DRILLER: Horn and Associates, Inc. | **LOGGED BY:**
DRILLING METHOD: 4.25" HSA
DEPTH TO WATER> INITIAL: Dry **AFTER 24 HOURS:** **CAVING>**

BORING No. B-3

ELEVATION (feet)	DEPTH (feet)	Description	Soil and Sampler Symbols, Blows	Sample No.	TEST RESULTS: Plastic Limit ├─┤ Liquid Limit; Water Content - ●; Penetration - ▨ (10 20 30 40 50)	NM	PL	LL	N	Rock Comp. Strength (psi)
1315.9	120	Run 6 - 120.0-125.0 ft. shale, gray, sandy	REC= 90% RQD= 78%							
1310.9	125	Core recovery terminated at 125.0 ft.								
1305.9	130									
1300.9	135									
1295.9	140									
1290.9	145									
1285.9	150									
1280.9	155									

This information pertains only to this boring and should not be interpreted as being indicitive of the site.

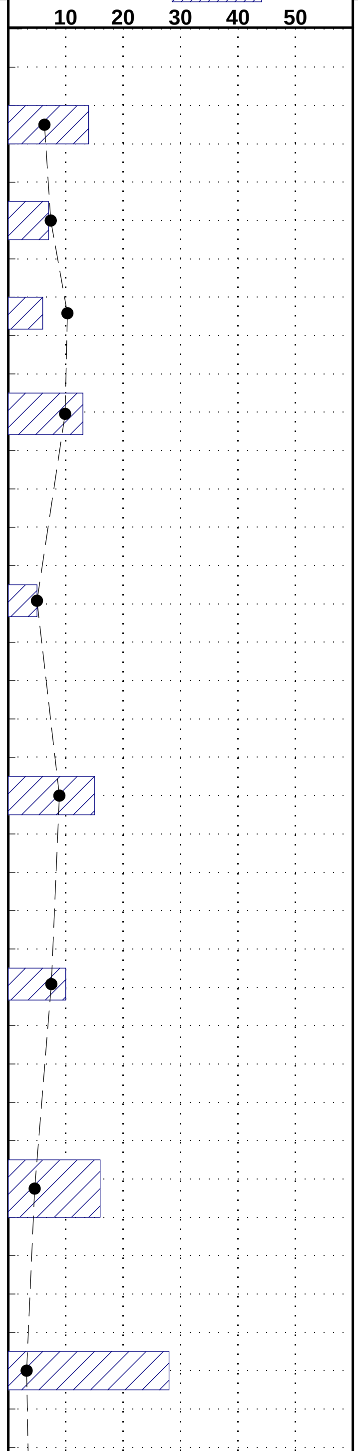
PROJECT: Skyview Estates | **PROJECT NO.:** 2023004
CLIENT: Commonwealth of Kentucky, DECA | **DATE:** 2/10/23
LOCATION: Skyview Estates, Hazard, KY | **ELEVATION:** 1395.9
DRILLER: Horn and Associates, Inc. | **LOGGED BY:**
DRILLING METHOD: 4.25" HSA
DEPTH TO WATER> INITIAL: Dry **AFTER 24 HOURS:** **CAVING>**

BORING No. B-4

ELEVATION (feet)	DEPTH (feet)	Description	Soil and Sampler Symbols, Blows	Sample No.	NM	PL	LL	N	Rock Comp. Strength (psi)
1395.9	0	Mine spoil fill, mix of sand, silt, clay, shale, rock fragments, brown and gray, firm to very stiff							
			9 7 7	1	6.3			14	
1390.9	5		4 3 4	2	7.4			7	
			3 3 3	3	10.3			6	
1385.9	10		3 5 8	4	9.9			13	
1380.9	15		2 2 3	5	5.0			5	
1375.9	20		7 7 8	6	8.9			15	
1370.9	25		5 6 4	7	7.5			10	
1365.9	30		6 7 9	8	4.6			16	
1360.9	35		10 17 11	9	3.2			28	

TEST RESULTS

Plastic Limit ├─┤ Liquid Limit
Water Content - ●
Penetration -



Water at 40 ft. after coring complete

This information pertains only to this boring and should not be interpreted as being indicitive of the site.

PROJECT: Skyview Estates **PROJECT NO.:** 2023004
CLIENT: Commonwealth of Kentucky, DECA **DATE:** 2/10/23
LOCATION: Skyview Estates, Hazard, KY **ELEVATION:** 1395.9
DRILLER: Horn and Associates, Inc. **LOGGED BY:**
DRILLING METHOD: 4.25" HSA
DEPTH TO WATER> INITIAL: Dry **AFTER 24 HOURS:** **CAVING>**

BORING No. B-4

ELEVATION (feet)	DEPTH (feet)	Description	Soil and Sampler Symbols, Blows	Sample No.	NM	PL	LL	N	Rock Comp. Strength (psi)
1355.9	40		9 21 8	10	3.8			29	
1350.9	45		9 11 7	11	8.3			18	
1345.9	50		50/4	12	12.8			50+	
1340.9	55								
1335.9	60	Auger refusal at 59.7 ft. Begin core recovery. Run 1 - 59.7-69.7 ft. (59.7-64.2) - shale, gray	50/2 REC= 90% RQD= 40%	13	21.5			50+	
1330.9	65	(64.2-65.0) - coal (65.0-67.1) - shale, gray (67.1-67.4) - coal (67.4-69.7) - shale, gray							
1325.9	70	Core recovery terminated at 69.7 ft.							
1320.9	75								

TEST RESULTS: Plastic Limit — Liquid Limit; Water Content - ●; Penetration - (hatched bar); scale 10 20 30 40 50

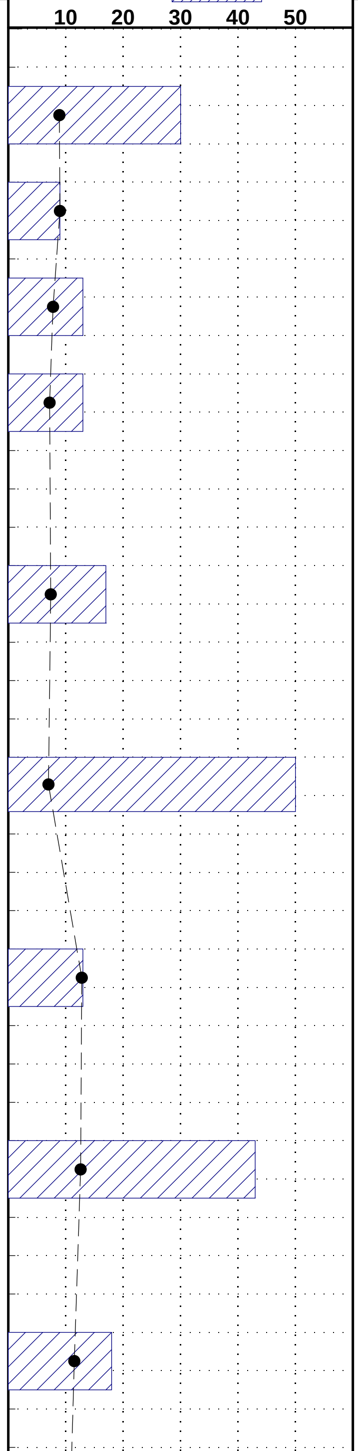
This information pertains only to this boring and should not be interpreted as being indicitive of the site.

PROJECT: Skyview Estates
PROJECT NO.: 2023004
CLIENT: Commonwealth of Kentucky, DECA
DATE: 2/10/23
LOCATION: Skyview Estates, Hazard, KY
ELEVATION: 1477.7
DRILLER: Horn and Associates, Inc.
LOGGED BY:
DRILLING METHOD: 4.25" HSA
DEPTH TO WATER> INITIAL: 83.0 **AFTER 24 HOURS:** **CAVING>**

BORING No. B-5

ELEVATION (feet)	DEPTH (feet)	Description	Soil and Sampler Symbols, Blows	Sample No.	NM	PL	LL	N	Rock Comp. Strength (psi)
1477.7	0	Mine spoil fill, mix of sand, silt, clay, shale, rock fragments, brown and gray, dry to moist, stiff to hard							
			10 10 20	1	8.9			30	
1472.7	5		8 4 5	2	9.0			9	
			6 6 7	3	7.8			13	
1467.7	10		5 7 6	4	7.2			13	
1462.7	15		8 8 9	5	7.4			17	
1457.7	20		11 12 50/4	6	7.0			50+	
1452.7	25		6 6 7	7	12.8			13	
1447.7	30		10 17 26	8	12.6			43	
1442.7	35		10 8 10	9	11.5			18	

TEST RESULTS
Plastic Limit ├──┤ Liquid Limit
Water Content - ●
Penetration -



Water at 83.0 ft. after SPT sampling, water at 78 ft. after coring complete

This information pertains only to this boring and should not be interpreted as being indicitive of the site.

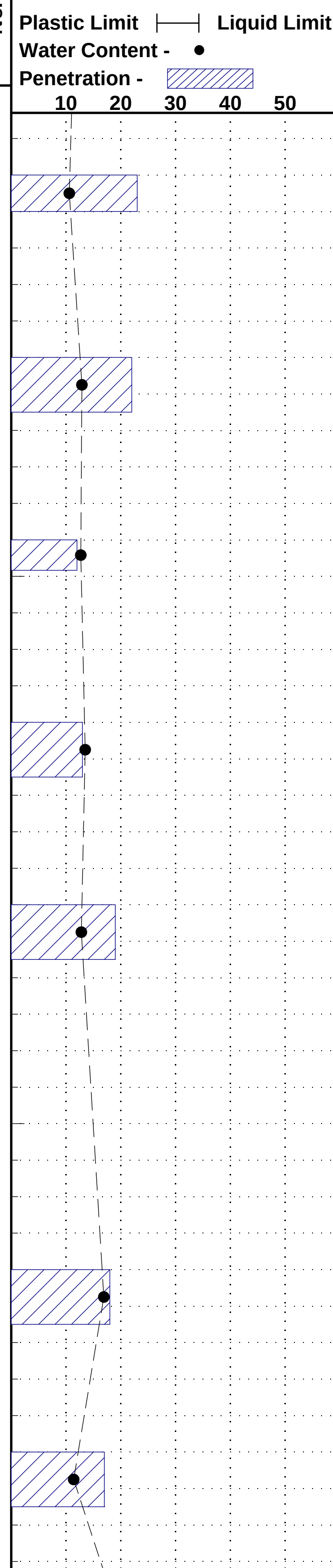
PROJECT: Skyview Estates **PROJECT NO.:** 2023004
CLIENT: Commonwealth of Kentucky, DECA **DATE:** 2/10/23
LOCATION: Skyview Estates, Hazard, KY **ELEVATION:** 1477.7
DRILLER: Horn and Associates, Inc. **LOGGED BY:**
DRILLING METHOD: 4.25" HSA
DEPTH TO WATER> INITIAL: 83.0 **AFTER 24 HOURS:** **CAVING>**

BORING No. B-5

This information pertains only to this boring and should not be interpreted as being indicitive of the site.

ELEVATION (feet)	DEPTH (feet)	Description	Soil and Sampler Symbols, Blows	Sample No.	NM	PL	LL	N	Rock Comp. Strength (psi)
1437.7	40		11 13 10	10	10.6			23	
1432.7	45		9 12 10	11	12.9			22	
1427.7	50		7 6 6	12	12.7			12	
1422.7	55		10 5 8	13	13.5			13	
1417.7	60		7 10 9	14	12.8			19	
1412.7	65		50/1	15				50+	
1407.7	70		4 8 10	16	16.9			18	
1402.7	75		12 9 8	17	11.4			17	

TEST RESULTS



PROJECT: Skyview Estates
PROJECT NO.: 2023004
CLIENT: Commonwealth of Kentucky, DECA
DATE: 2/10/23
LOCATION: Skyview Estates, Hazard, KY
ELEVATION: 1477.7
DRILLER: Horn and Associates, Inc.
LOGGED BY:
DRILLING METHOD: 4.25" HSA
DEPTH TO WATER> INITIAL: 83.0 **AFTER 24 HOURS:** **CAVING>**

BORING No. B-5

ELEVATION (feet)	DEPTH (feet)	Description	Soil and Sampler Symbols, Blows	Sample No.	NM	PL	LL	N	Rock Comp. Strength (psi)
1397.7	80	Weathered shale, gray	15 50/2	18	21.3			50+	
1392.7	85	Auger refusal at 84.3 ft. Begin core recovery. Run 1 - 84.3-94.3 ft. - shale, gray and black	50/3 REC= 85% RQD= 42%	19	12.8			50+	
1387.7	90	(91.5-92.8) - coal							
		(92.8-94.3) - shale, gray							
1382.7	95	Core recovery terminated at 94.3 ft.							
1377.7	100								
1372.7	105								
1367.7	110								
1362.7	115								

TEST RESULTS: Plastic Limit ├─┤ Liquid Limit; Water Content - ●; Penetration - (hatched bar); scale 10 20 30 40 50

This information pertains only to this boring and should not be interpreted as being indicitive of the site.

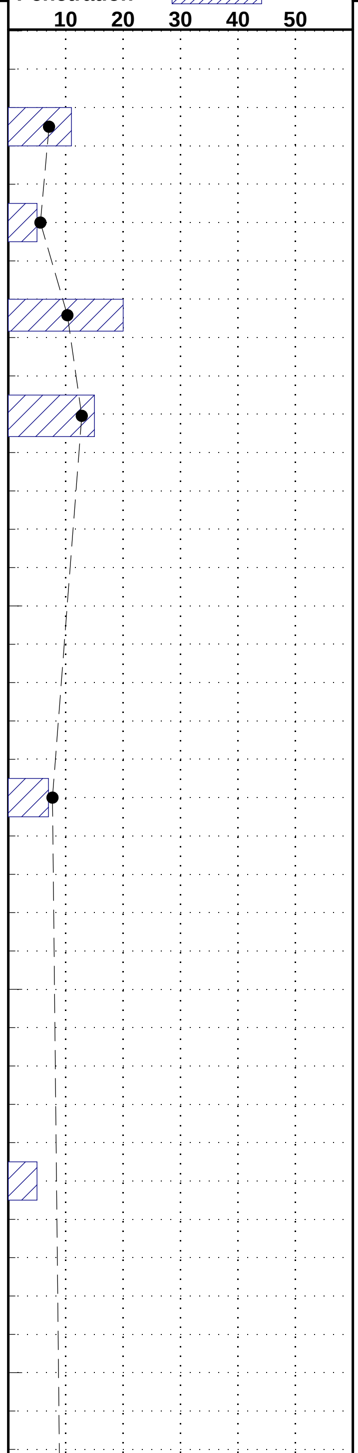
PROJECT: Skyview Estates **PROJECT NO.:** 2023004
CLIENT: Commonwealth of Kentucky, DECA **DATE:** 2/13/23
LOCATION: Skyview Estates, Hazard, KY **ELEVATION:** 1452.4
DRILLER: Horn and Associates, Inc. **LOGGED BY:**
DRILLING METHOD: 4.25" HSA
DEPTH TO WATER> INITIAL: 100.0 **AFTER 24 HOURS:** **CAVING>**

BORING No. B-6

ELEVATION (feet)	DEPTH (feet)	Description	Soil and Sampler Symbols, Blows	Sample No.	NM	PL	LL	N	Rock Comp. Strength (psi)
1452.4	0	Mine spoil fill, mix of sand, silt, clay, shale, rock fragments, brown and gray, dry to wet, firm to hard							
			5 6 5	1	7.1			11	
1447.4	5		4 3 2	2	5.6			5	
			3 9 11	3	10.3			20	
1442.4	10		3 5 10	4	12.8			15	
1437.4	15								
1432.4	20		8 9 7	5	7.7			7	
1427.4	25								
1422.4	30		11 8 6	6				5	
1417.4	35								

TEST RESULTS

Plastic Limit ├─┤ Liquid Limit
Water Content - ●
Penetration - ▨



Water at 100.0 ft. after SPT sampling, water at 80 ft. after coring complete

This information pertains only to this boring and should not be interpreted as being indicitive of the site.

PROJECT: Skyview Estates **PROJECT NO.:** 2023004
CLIENT: Commonwealth of Kentucky, DECA **DATE:** 2/13/23
LOCATION: Skyview Estates, Hazard, KY **ELEVATION:** 1452.4
DRILLER: Horn and Associates, Inc. **LOGGED BY:**
DRILLING METHOD: 4.25" HSA
DEPTH TO WATER> INITIAL: 100.0 **AFTER 24 HOURS:** **CAVING>**

BORING No. B-6

ELEVATION (feet)	DEPTH (feet)	Description	Soil and Sampler Symbols, Blows	Sample No.	TEST RESULTS (Plastic Limit / Liquid Limit, Water Content, Penetration: 10 20 30 40 50)	NM	PL	LL	N	Rock Comp. Strength (psi)
1412.4	40		6 6 8	7					6	
1407.4	45									
1402.4	50		10 6 5	8		9.8			7	
1397.4	55									
1392.4	60		10 5 5	9		13.6			15	
1387.4	65									
1382.4	70		11 8 29	10		6.1			40	
1377.4	75									

This information pertains only to this boring and should not be interpreted as being indicitive of the site.

PROJECT: Skyview Estates	**PROJECT NO.:** 2023004
CLIENT: Commonwealth of Kentucky, DECA	**DATE:** 2/13/23
LOCATION: Skyview Estates, Hazard, KY	**ELEVATION:** 1452.4
DRILLER: Horn and Associates, Inc.	**LOGGED BY:**
DRILLING METHOD: 4.25" HSA	

DEPTH TO WATER> INITIAL: 100.0 **AFTER 24 HOURS:** **CAVING>**

BORING No. B-6

ELEVATION (feet)	DEPTH (feet)	Description	Soil and Sampler Symbols, Blows	Sample No.	TEST RESULTS (Plastic Limit / Liquid Limit, Water Content, Penetration; 10 20 30 40 50)	NM	PL	LL	N	Rock Comp. Strength (psi)
1372.4	80		9 14 14	11		12.3			16	
1367.4	85									
1362.4	90		7 15 17	12		14.9			17	
1357.4	95									
1352.4	100		10 10 20	13		16.5			24	
1347.4	105									
1342.4	110	Weathered shale and sandstone	7 17 32	14		16.6			38	
1337.4	115									
		Auger refusal at 115.5 ft. Begin core recovery. Run 1 - 115.5-125.5 ft. Sandstone, grayish brown	REC= 88% RQD= 48%							

This information pertains only to this boring and should not be interpreted as being indicitive of the site.

Figure

PROJECT: Skyview Estates
PROJECT NO.: 2023004
CLIENT: Commonwealth of Kentucky, DECA
DATE: 2/13/23
LOCATION: Skyview Estates, Hazard, KY
ELEVATION: 1452.4
DRILLER: Horn and Associates, Inc.
LOGGED BY:
DRILLING METHOD: 4.25" HSA

BORING No. B-6

DEPTH TO WATER> INITIAL: 100.0 **AFTER 24 HOURS:** **CAVING>**

ELEVATION (feet)	DEPTH (feet)	Description	Soil and Sampler Symbols, Blows	Sample No.	TEST RESULTS: Plastic Limit ├─┤ Liquid Limit; Water Content - ●; Penetration - (10 20 30 40 50)	NM	PL	LL	N	Rock Comp. Strength (psi)
1332.4	120									
1327.4	125	Core recovery terminated at 125.5 ft.								
1322.4	130									
1317.4	135									
1312.4	140									
1307.4	145									
1302.4	150									
1297.4	155									

This information pertains only to this boring and should not be interpreted as being indicitive of the site.

PROJECT: Skyview Estates | **PROJECT NO.:** 2023004
CLIENT: Commonwealth of Kentucky, DECA | **DATE:** 2/14/23
LOCATION: Skyview Estates, Hazard, KY | **ELEVATION:** 1415.3
DRILLER: Horn and Associates, Inc. | **LOGGED BY:**
DRILLING METHOD: 4.25" HSA
DEPTH TO WATER> INITIAL: ___ **AFTER 24 HOURS:** ___ **CAVING>** ___

BORING No. B-7

ELEVATION (feet)	DEPTH (feet)	Description	Soil and Sampler Symbols, Blows	Sample No.	NM	PL	LL	N	Rock Comp. Strength (psi)
1415.3	0	Mine spoil fill, mix of sand, silt, clay, shale, rock fragments, brown and gray, dry to wet, firm to hard							
			8 11 16	1	7.0			27	
1410.3	5		23 13 7	2	3.6			20	
			14 4 4	3	5.7			8	
1405.3	10		7 11 13	4	8.9			24	
1400.3	15								
1395.3	20		4 50/4	5	5.4			50+	
1390.3	25								
1385.3	30		6 6 10	6	6.5			16	
1380.3	35								

TEST RESULTS: Plastic Limit ├─┤ Liquid Limit; Water Content - ●; Penetration - (hatched bar); scale 10 20 30 40 50

This information pertains only to this boring and should not be interpreted as being indicitive of the site.

LE Gregg ASSOCIATES

BORING No. B-7

PROJECT: Skyview Estates
PROJECT NO.: 2023004
CLIENT: Commonwealth of Kentucky, DECA
DATE: 2/14/23
LOCATION: Skyview Estates, Hazard, KY
ELEVATION: 1415.3
DRILLER: Horn and Associates, Inc.
LOGGED BY:
DRILLING METHOD: 4.25" HSA
DEPTH TO WATER> INITIAL: ☐ ______ **AFTER 24 HOURS:** ☐ ______ **CAVING>** ☐ ______

ELEVATION (feet)	DEPTH (feet)	Description	Soil and Sampler Symbols, Blows	Sample No.	Penetration (Plastic Limit / Liquid Limit, Water Content)	NM	PL	LL	N	Rock Comp. Strength (psi)
1375.3	40		7 50/4	7		8.4			50+	
1370.3	45									
1365.3	50		6 7 9	8		10.9			16	
1360.3	55									
1355.3	60		5 8 7	9		17.3			15	
1350.3	65	Auger refusal at 64.5 ft. Begin core recovery. Run 1 - 64.5-74.5 ft. - shale, gray and black	REC= 93% RQD= 83%							
1345.3	70									
1340.3	75	Core recovery terminated at 74.5 ft.								

Test results scale: 10 20 30 40 50

This information pertains only to this boring and should not be interpreted as being indicitive of the site.

PROJECT: Skyview Estates **PROJECT NO.:** 2023004

CLIENT: Commonwealth of Kentucky, DECA **DATE:** 2/14/23

LOCATION: Skyview Estates, Hazard, KY **ELEVATION:** 1380.7

DRILLER: Horn and Associates, Inc. **LOGGED BY:**

DRILLING METHOD: 4.25" HSA

DEPTH TO WATER> INITIAL: 26.0 **AFTER 24 HOURS:** **CAVING>**

BORING No. B-8

This information pertains only to this boring and should not be interpreted as being indicitive of the site.

ELEVATION (feet)	DEPTH (feet)	Description	Soil and Sampler Symbols, Blows	Sample No.	NM	PL	LL	N	Rock Comp. Strength (psi)
1380.7	0	Mine spoil fill, mix of sand, silt, clay, shale, rock fragments, brown, gray, and black, dry to wet, firm to hard							
			5 6 7	1	9.7			13	
1375.7	5		5 5 9	2	5.6			14	
			5 11 8	3	9.3			19	
1370.7	10		3 5 3	4	6.7			8	
1365.7	15								
1360.7	20		4 3 3	5	10.9			6	
1355.7	25								
1350.7	30		3 9 10	6	12.3			19	
1345.7	35	Weathered shale, gray							

TEST RESULTS: Plastic Limit ├─┤ Liquid Limit; Water Content - ●; Penetration - (hatched bar); scale 10 20 30 40 50

Water at 26.0 ft. after SPT sampling, water at 54.0 ft. after coring

This information pertains only to this boring and should not be interpreted as being indicitive of the site.

PROJECT: Skyview Estates **PROJECT NO.:** 2023004
CLIENT: Commonwealth of Kentucky, DECA **DATE:** 2/14/23
LOCATION: Skyview Estates, Hazard, KY **ELEVATION:** 1380.7
DRILLER: Horn and Associates, Inc. **LOGGED BY:**
DRILLING METHOD: 4.25" HSA
DEPTH TO WATER> INITIAL: 26.0 **AFTER 24 HOURS:** **CAVING>**

BORING No. B-8

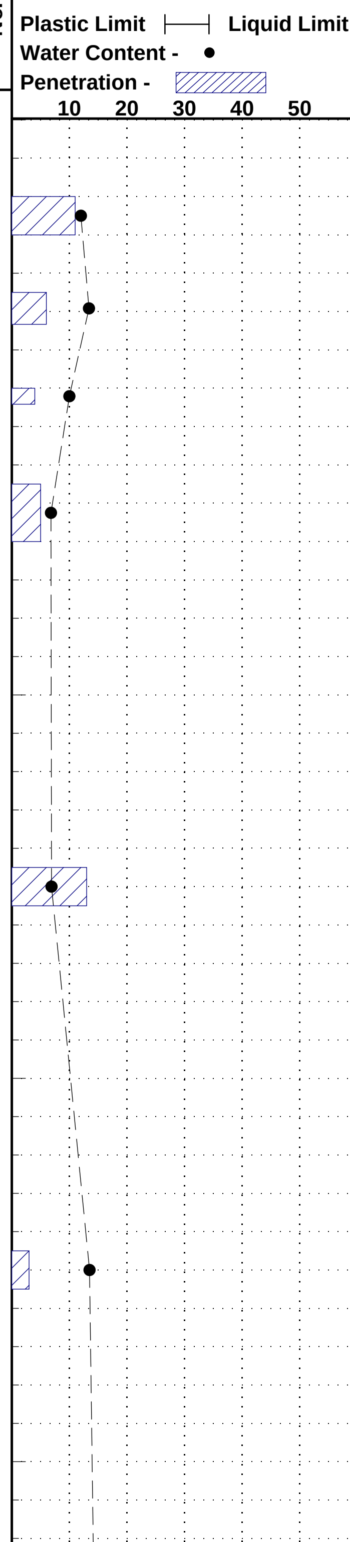
ELEVATION (feet)	DEPTH (feet)	Description	Soil and Sampler Symbols, Blows	Sample No.	TEST RESULTS (Plastic Limit / Liquid Limit, Water Content, Penetration: 10 20 30 40 50)	NM	PL	LL	N	Rock Comp. Strength (psi)
1340.7	40	Auger refusal at 39.8 ft. Begin core recovery. Run 1 - 39.8-49.8 ft. - shale, gray	50/3 REC= 100% RQD= 66%	7		24.5			50+	
1335.7	45									
1330.7	50		REC= 50% RQD= 16%							
		(53.6-54.9) - coal								
1325.7	55	(54.9-69.8) - shale, gray, silty								
1320.7	60		REC= 69% RQD= 49%							
1315.7	65									
1310.7	70	Core recovery terminated at 69.8 ft.								
1305.7	75									

PROJECT: Skyview Estates **PROJECT NO.:** 2023004
CLIENT: Commonwealth of Kentucky, DECA **DATE:** 2/15/23
LOCATION: Skyview Estates, Hazard, KY **ELEVATION:** 1402.2
DRILLER: Horn and Associates, Inc. **LOGGED BY:**
DRILLING METHOD: 4.25" HSA
DEPTH TO WATER> INITIAL: 36.0 **AFTER 24 HOURS:** **CAVING>**

BORING No. B-9

ELEVATION (feet)	DEPTH (feet)	Description	Soil and Sampler Symbols, Blows	Sample No.	NM	PL	LL	N	Rock Comp. Strength (psi)
1402.2	0	Mine spoil fill, mix of sand, silt, clay, shale, rock fragments, brown, gray, and black, dry to wet, soft to hard							
			6-5-6	1	12.0			11	
1397.2	5		3-2-4	2	13.4			6	
			3-2-2	3	10.0			4	
1392.2	10		6-2-3	4	6.8			5	
1387.2	15								
1382.2	20		3-7-6	5	6.9			13	
1377.2	25								
1372.2	30		3-1-2	6	13.5			3	
1367.2	35								

TEST RESULTS



Water at 36.0 ft. after SPT sampling, water at 30.0 ft. after coring

This information pertains only to this boring and should not be interpreted as being indicitive of the site.

PROJECT: Skyview Estates **PROJECT NO.:** 2023004
CLIENT: Commonwealth of Kentucky, DECA **DATE:** 2/15/23
LOCATION: Skyview Estates, Hazard, KY **ELEVATION:** 1402.2
DRILLER: Horn and Associates, Inc. **LOGGED BY:**
DRILLING METHOD: 4.25" HSA
DEPTH TO WATER> INITIAL: 36.0 **AFTER 24 HOURS:** **CAVING>**

BORING No. B-9

ELEVATION (feet)	DEPTH (feet)	Description	Soil and Sampler Symbols, Blows	Sample No.	NM	PL	LL	N	Rock Comp. Strength (psi)
1362.2	40		4 5 5	7	14.4			10	
1357.2	45	Weathered shale							
1352.2	50	Auger refusal at 50.0 ft. Begin core recovery. Run 1 - 50.0-55.0 ft. - shale, gray	50/1 REC=96% RQD=78%	8	7.6			50+	
1347.2	55	Run 2 - 55.0-60.5 ft. - shale, light gray (57.6-57.9) - coal (57.9-60.5) - shale, light gray	REC=98% RQD=80%						
1342.2	60	Core recovery terminated at 60.5 ft.							
1337.2	65								
1332.2	70								
1327.2	75								

TEST RESULTS: Plastic Limit ├─┤ Liquid Limit; Water Content - ●; Penetration - (hatched bar); scale 10 20 30 40 50

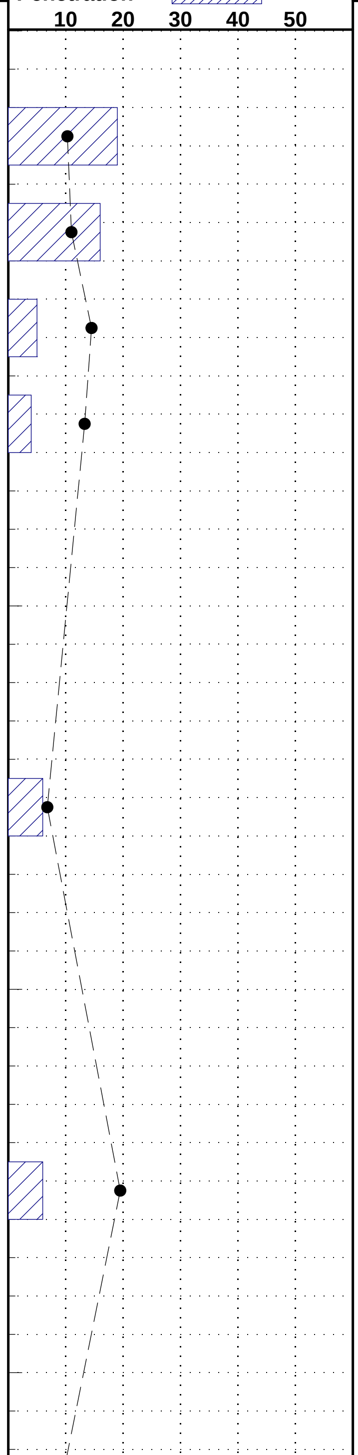
PROJECT: Skyview Estates **PROJECT NO.:** 2023004
CLIENT: Commonwealth of Kentucky, DECA **DATE:** 2/14/23
LOCATION: Skyview Estates, Hazard, KY **ELEVATION:** 1378.9
DRILLER: Horn and Associates, Inc. **LOGGED BY:**
DRILLING METHOD: 4.25" HSA
DEPTH TO WATER> INITIAL: 30.0 **AFTER 24 HOURS:** **CAVING>**

BORING No. B-10

ELEVATION (feet)	DEPTH (feet)	Description	Soil and Sampler Symbols, Blows	Sample No.	NM	PL	LL	N	Rock Comp. Strength (psi)
1378.9	0	Mine spoil fill, mix of sand, silt, clay, shale, rock fragments, brown, gray, and black, dry to wet, soft to very stiff							
			7 9 10	1	10.3			19	
1373.9	5		4 8 8	2	11.0			16	
			5 3 2	3	14.5			5	
1368.9	10		2 2 2	4	13.3			4	
1363.9	15								
1358.9	20		3 3 3	5	6.8			6	
1353.9	25								
1348.9	30		3 3 3	6	19.5			6	
1343.9	35	Weathered shale							

TEST RESULTS

Plastic Limit ├──┤ Liquid Limit
Water Content - ●
Penetration - (hatched bar)



Water at 30.0 ft. after SPT sampling, water at 23.0 ft. after coring

PROJECT: Skyview Estates | **PROJECT NO.:** 2023004
CLIENT: Commonwealth of Kentucky, DECA | **DATE:** 2/14/23
LOCATION: Skyview Estates, Hazard, KY | **ELEVATION:** 1378.9
DRILLER: Horn and Associates, Inc. | **LOGGED BY:**
DRILLING METHOD: 4.25" HSA
DEPTH TO WATER> INITIAL: 30.0 **AFTER 24 HOURS:** **CAVING>**

LE Gregg ASSOCIATES

BORING No. B-10

ELEVATION (feet)	DEPTH (feet)	Description	Soil and Sampler Symbols, Blows	Sample No.	TEST RESULTS (Plastic Limit / Liquid Limit; Water Content; Penetration)	NM	PL	LL	N	Rock Comp. Strength (psi)
1338.9	40		50/5	7		6.8			50+	
		Auger refusal at 40.0 ft. Begin core recovery. Run 1 - 40.0-48.5 ft. (40.0-42.8) - shale, gray	REC= 80% RQD= 42%							
		(42.8-43.1) - coal								
		(43.1-50.0) - shale, gray								
1333.9	45									
			REC= 84% RQD= 64%							
1328.9	50									
		(50.0-50.4) - coal								
		(50.4-51.0) - shale, gray								
		Core recovery terminated at 51.0 ft.								
1323.9	55									
1318.9	60									
1313.9	65									
1308.9	70									
1303.9	75									

Test results scale: 10 20 30 40 50

This information pertains only to this boring and should not be interpreted as being indicitive of the site.

PROJECT: Skyview Estates **PROJECT NO.:** 2023004
CLIENT: Commonwealth of Kentucky, DECA **DATE:** 2/15/23
LOCATION: Skyview Estates, Hazard, KY **ELEVATION:** 1436.0
DRILLER: Horn and Associates, Inc. **LOGGED BY:**
DRILLING METHOD: 4.25" HSA
DEPTH TO WATER> INITIAL: **AFTER 24 HOURS:** **CAVING>**

BORING No. B-11

ELEVATION (feet)	DEPTH (feet)	Description	Soil and Sampler Symbols, Blows	Sample No.	TEST RESULTS: Plastic Limit / Liquid Limit, Water Content - ●, Penetration - (10 20 30 40 50)	NM	PL	LL	N	Rock Comp. Strength (psi)
1436	0	Mine spoil fill - not sampled at this location								
1431	5									
1426	10									
1421	15									
1416	20									
1411	25									
1406	30									
1401	35									

This information pertains only to this boring and should not be interpreted as being indicitive of the site.

This information pertains only to this boring and should not be interpreted as being indicitive of the site.

PROJECT: Skyview Estates **PROJECT NO.:** 2023004
CLIENT: Commonwealth of Kentucky, DECA **DATE:** 2/15/23
LOCATION: Skyview Estates, Hazard, KY **ELEVATION:** 1436.0
DRILLER: Horn and Associates, Inc. **LOGGED BY:**
DRILLING METHOD: 4.25" HSA
DEPTH TO WATER> INITIAL: **AFTER 24 HOURS:** **CAVING>**

BORING No. B-11

ELEVATION (feet)	DEPTH (feet)	Description	Soil and Sampler Symbols, Blows	Sample No.	TEST RESULTS: Plastic Limit ├─┤ Liquid Limit; Water Content - ●; Penetration - (10 20 30 40 50)	NM	PL	LL	N	Rock Comp. Strength (psi)
1396	40									
1391	45									
1386	50									
1381	55									
1376	60									
1371	65									
1366	70									
1361	75									

Figure

PROJECT: Skyview Estates
CLIENT: Commonwealth of Kentucky, DECA
LOCATION: Skyview Estates, Hazard, KY
DRILLER: Horn and Associates, Inc.
DRILLING METHOD: 4.25" HSA
DEPTH TO WATER> INITIAL: AFTER 24 HOURS: CAVING>

PROJECT NO.: 2023004
DATE: 2/15/23
ELEVATION: 1436.0
LOGGED BY:

BORING No. B-11

ELEVATION (feet)	DEPTH (feet)	Description	Soil and Sampler Symbols, Blows	Sample No.	TEST RESULTS (Plastic Limit ├─┤ Liquid Limit; Water Content - ●; Penetration -) 10 20 30 40 50	NM	PL	LL	N	Rock Comp. Strength (psi)
1356	80									
1351	85									
1346	90									
1341	95									
1336	100									
1331	105									
1326	110	Weathered shale								
1321	115	Auger refusal at 115.0 ft. Begin core recovery. (115.0-115.8) - shale, gray (115.8-116.5) - coal (116.5-125.1) - shale, gray, sandy	REC= 90% RQD= 78%							

This information pertains only to this boring and should not be interpreted as being indicitive of the site.

Figure

PROJECT: Skyview Estates | **PROJECT NO.:** 2023004
CLIENT: Commonwealth of Kentucky, DECA | **DATE:** 2/15/23
LOCATION: Skyview Estates, Hazard, KY | **ELEVATION:** 1436.0
DRILLER: Horn and Associates, Inc. | **LOGGED BY:**
DRILLING METHOD: 4.25" HSA
DEPTH TO WATER> INITIAL: ___ **AFTER 24 HOURS:** ___ **CAVING>** ___

BORING No. B-11

ELEVATION (feet)	DEPTH (feet)	Description	Soil and Sampler Symbols, Blows	Sample No.	TEST RESULTS (Plastic Limit / Liquid Limit, Water Content, Penetration; 10 20 30 40 50)	NM	PL	LL	N	Rock Comp. Strength (psi)
1316	120		REC=100% RQD=97%							
1311	125	(125.1-131.0) - sandstone, gray, water staining	REC=67% RQD=40%							
1306	130	(131.0-136.0) - sandstone, gray, water staining, highly fractured								
1301	135	(136.0-173.4) - sandstone, gray, water staining	REC=100% RQD=100%							
1296	140									
1291	145		REC=98% RQD=98%							
1286	150									
1281	155		REC=95% RQD=							

This information pertains only to this boring and should not be interpreted as being indicitive of the site.

PROJECT: Skyview Estates
PROJECT NO.: 2023004
CLIENT: Commonwealth of Kentucky, DECA
DATE: 2/15/23
LOCATION: Skyview Estates, Hazard, KY
ELEVATION: 1436.0
DRILLER: Horn and Associates, Inc.
LOGGED BY:
DRILLING METHOD: 4.25" HSA
DEPTH TO WATER> INITIAL: ___ **AFTER 24 HOURS:** ___ **CAVING>** ___

BORING No. B-11

This information pertains only to this boring and should not be interpreted as being indicitive of the site.

ELEVATION (feet)	DEPTH (feet)	Description	Soil and Sampler Symbols, Blows	Sample No.	TEST RESULTS: Plastic Limit ├─┤ Liquid Limit; Water Content - ●; Penetration - (10, 20, 30, 40, 50)	NM	PL	LL	N	Rock Comp. Strength (psi)
			82%							
		(158.6-159.1) - vertical fracture								
1276	160	(160.2-160.8) - vertical fracture, loss of water return								
1271	165		REC= 99% RQD= 82%							
1266	170									
		(173.4-175.4) - shale, gray								
1261	175	(175.4-177.1) - sandstone, gray	REC= 100% RQD= 59%							
		(177.1-179.7) - coal								
1256	180	(179.7-182.3) - shale, gray, silty, fractured								
		(182.3-221.4) - shale, gray, sandy								
1251	185		REC= 99% RQD= 98%							
1246	190									
1241	195		REC= 100% RQD=							

LE Gregg ASSOCIATES

BORING No. B-11

PROJECT: Skyview Estates
PROJECT NO.: 2023004
CLIENT: Commonwealth of Kentucky, DECA
DATE: 2/15/23
LOCATION: Skyview Estates, Hazard, KY
ELEVATION: 1436.0
DRILLER: Horn and Associates, Inc.
LOGGED BY:
DRILLING METHOD: 4.25" HSA
DEPTH TO WATER> INITIAL: ___ **AFTER 24 HOURS:** ___ **CAVING>** ___

ELEVATION (feet)	DEPTH (feet)	Description	Soil and Sampler Symbols, Blows	Sample No.	TEST RESULTS (Plastic Limit ├─┤ Liquid Limit; Water Content - ●; Penetration -; 10 20 30 40 50)	NM	PL	LL	N	Rock Comp. Strength (psi)
			100%							
1236	200									
1231	205		REC=100% RQD=83%							
1226	210									
1221	215		REC=100% RQD=96%							
1216	220									
		(221.4-222.0) - coal	REC=100% RQD=75%							
		(222.0-223.0) - shale, gray, silty								
		(223.0-223.2) - coal								
		(223.2-231.5) - shale, gray, silty								
1211	225									
1206	230									
		(231.5-245.5) - sandstone interbedded with shale, gray	REC=100% RQD=98%							
1201	235									

This information pertains only to this boring and should not be interpreted as being indicitive of the site.

BORING No. B-11

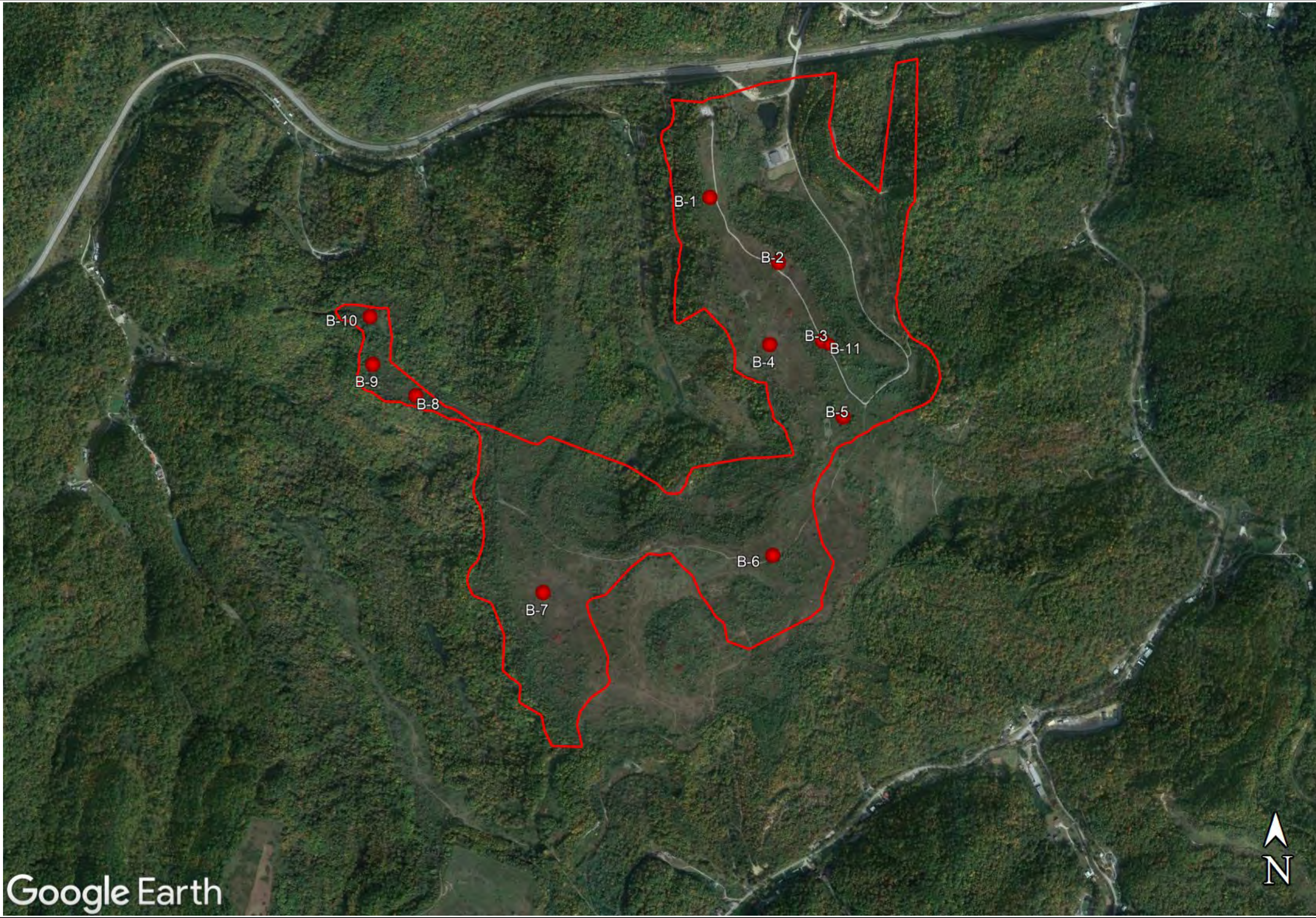
PROJECT: Skyview Estates **PROJECT NO.:** 2023004
CLIENT: Commonwealth of Kentucky, DECA **DATE:** 2/15/23
LOCATION: Skyview Estates, Hazard, KY **ELEVATION:** 1436.0
DRILLER: Horn and Associates, Inc. **LOGGED BY:**
DRILLING METHOD: 4.25" HSA
DEPTH TO WATER> INITIAL: ▽ ______ **AFTER 24 HOURS:** ▼ ______ **CAVING>** ☾ ______

ELEVATION (feet)	DEPTH (feet)	Description	Soil and Sampler Symbols, Blows	Sample No.	TEST RESULTS: Plastic Limit ├─┤ Liquid Limit; Water Content - ●; Penetration - ▨; 10 20 30 40 50	NM	PL	LL	N	Rock Comp. Strength (psi)
1196	240		REC=100% RQD=54%							
1191	245	(245.5-249.8) - coal								
1186	250	(249.8-251.0) - shale, gray, silty								
		Core recovery terminated at 251.0 ft.								
1181	255									
1176	260									
1171	265									
1166	270									
1161	275									

This information pertains only to this boring and should not be interpreted as being indicitive of the site.

APPENDIX C

Site Location Map
Drawings



L.E. Gregg Associates, Inc.
2456 Fortune Drive, Suite 155
Lexington, Kentucky 40509

Sky View Estates
Hazard, Kentucky

Project #2023004	**Boring Layout**

APPENDIX D

Seismic Design Information

ASCE 7 Hazards Report

Address:
No Address at This Location

Standard: ASCE/SEI 7-10
Risk Category: II
Soil Class: D - Stiff Soil

Latitude: 37.24136
Longitude: -83.267847
Elevation: 1454.52 ft (NAVD 88)

March 30, 2023

Mr. Jamie Emmons
KYTC
Office of the Secretary
200 Mero Street
Frankfort, KY 40622

RE: Review of Sky View Estates Geotechnical Report
Perry County, Kentucky
Vector Project No. 22050159SHE

As requested, Vector Engineers, Inc. conducted a review of the report entitled, "Geotechnical Engineering Exploration, Sky View Estates, Perry County Kentucky" by LE Gregg Associates dated March 1, 2023. The purpose of the review was to provide preliminary recommendations for site preparation and foundation recommendations for the proposed residential development. This letter does not supersede the information presented in the LE Gregg report and should be used in conjunction with those recommendations.

The proposed development as described in the geotechnical report is to consist of a 204 lot residential subdivision with new roads and utilities. The property size is unknown but appears to be about 200 acres. The site has been stripped mined, with mining reclamation completed in 2000 by Leslie Resources. The report indicates that underground mining has occurred under portions of the site, however, no indication of the depth or location was provided. Underground mining occurred in the early 1900's.

Surface mining on site consisted of contour mining and mountaintop removal with the spoils placed in the valleys, and on contour benches. There were 11 boring drilled on the site finding mine spoil extending to bedrock depths of 40 to 110 feet. The mine spoil fill consisted of sand, silt, clay, shale, boulders and rock fragments. Laboratory testing revealed slake durability of 71.7 to 90.5 which indicates a resistance to severe weathering when exposed to moisture. A CBR test was conducted and revealed a CBR value of 1 which indicates that soil will become very soft when wet.

Typically, geophysical testing is conducted to determine the depth of the underground bench and then confirmed with soil borings. Geophysical testing was not conducted on this site, therefore, the only data available is the refusal depths from the borings. The interpretation of the subsurface benches from the boring data should not be considered accurate.

Upon review of the boring data, the site ranges in elevation from about 1400 feet msl to 1470 feet msl. The bedrock depths range from 40 feet to about 115 feet which corresponds to elevation of about 1560 ft msl to 1290 feet msl. A rough profile is shown in Figure 1.

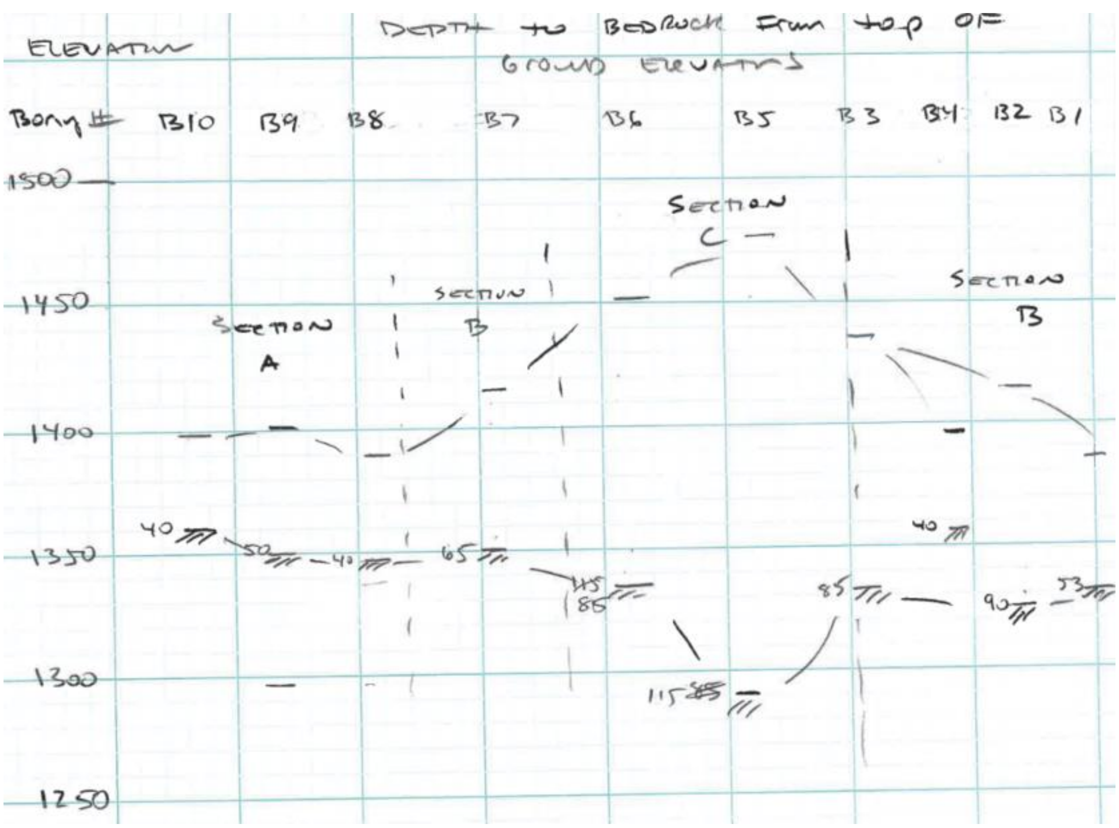


Figure 1: Rough profile sketch of mine spoil thicknesses

Based on the depths from the borings, an interpretation of the depths resulted in dividing the site into three distinct areas. Area A is for portions of the site with mine spoil fill depths less than about 50 feet, Area B is for portions of the site with mine spoil fill depths greater than 50 feet but less that about 75 feet and Areas C for portions of the site with mine spoil fill depths from 75 feet to about 115 feet. The drawing in Figure 2 shows the general areas identified from the boring data. From the limited boring data, there appears to be three distinct bedrock elevations. The bench in area A is about elevation 1350 ft, the bench in Area B about 1325 and in Area C, the mine spoil may have been placed in an old valley.

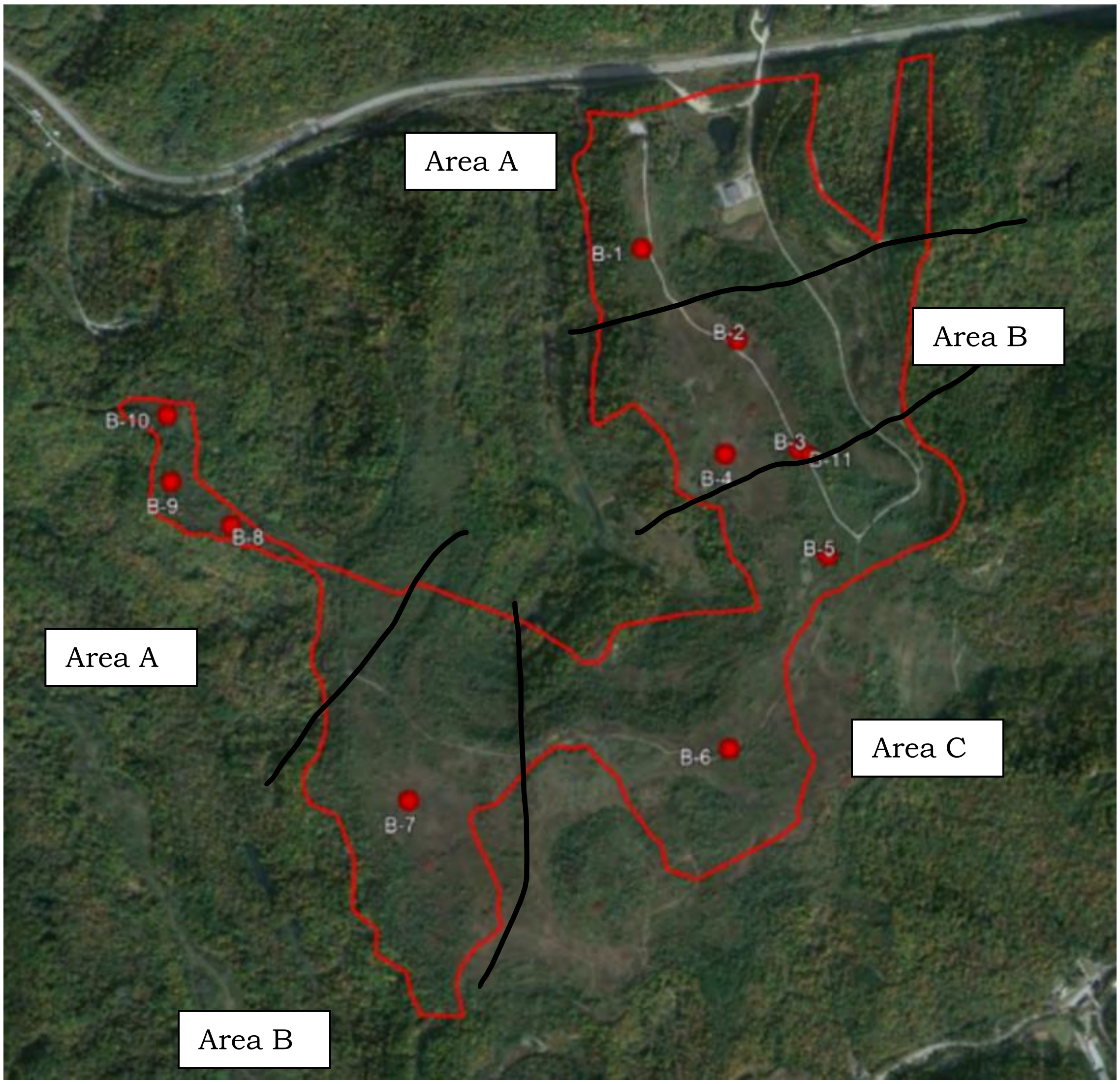


Figure 2: Aerial view and boring layout of site. The site is divided into areas based on the depth to bedrock from the boring data. It should be noted that no geophysical testing was conducted, therefore the depths to bedrock was only accurate at the specific boring location. The division lines are very approximate and interpreted from the adjacent boring.

Discussion

The site is similar to other mine spoil sites in the area. The site can be developed, however, there is a risk of detrimental settlement of the mine spoil when it is exposed to moisture from rainfall infiltration, septic tank lateral lines and surface water. The slake durability testing did indicate that the sandstone is generally durable, but the shale portion of the fill will likely degrade causing consolidation. Provided the owner understands and accepts this risk, the site can be developed. From the review of the LE Gregg boring data, the mine spoil materials had an average N value for the site of 20 with a standard deviation of about 15. There were some pockets of softer material, most likely pockets of clay and silt that if found within 15 to 20 feet of the surface could result in settlement concerns. Overall construction on this site does not have a higher level of risk than building on other mine spoil sites. Since the primary development will be homes, presumably less than about 2000 square feet, the amount of earthwork required should be small.

Based on our interpretation of the top of ground elevations, we anticipate that earthwork in Area A will be limited to cuts and/or fills of less than 5 to 10 feet, in Area B, less than 10 feet and in Area C less than 10 feet.

Site Preparation Recommendation

To reduce the risk of differential settlement, the mine spoil fill thickness must be consistent beneath any individual building footprint. Also, the depth to bedrock must also be relatively consistent beneath any proposed building location. The building must not straddle areas of large variations in bedrock depths between benches or be located over a site with a partially buried mine bench. Individual buildings should be completely in one specific Area as shown on Figure 2.

Due to the anticipated light loading conditions for the homes and commercial buildings, undercuts of no more than 3 feet below the bottom of the foundation should achieve an adequate uniform bearing surface for spread footings. If larger buildings such as commercial or education facilities are planned, an undercut of 5 feet below the foundation bearing depth should be considered. The undercut should extend at least 5 feet beyond the building footprint for houses and at least 10 feet for commercial or educational buildings.

The undercut area is backfilled with recompacted mine spoil fill placed in thin lifts of about 12 inches and recompacted using bulldozers and compactors. The recompacted mine spoil acts as a "mat" supporting the entire building within the uncompacted mine spoil. The type of equipment used for recompaction varies, however, typically consists of Caterpillar D-8 bulldozers or similar spreading the mine spoil and Caterpillar 825 sheepsfoot rollers or similar compacting the mine spoil. The compaction of the fill should be tested to at least 98 percent of the mine spoils maximum dry density as determined by the standard Proctor compaction test (ASTM D698). From previous research the maximum dry unit weight of mine spoil in this area ranges from about 120 pcf to 125 pcf with optimum moisture contents of 10 to 20 percent.

In addition to the undercutting and replacement, other options to create a suitable building pad includes surcharging a site to allow settlement of the building site prior to conducting the undercutting or using dynamic compaction to densify the subgrade after undercutting and prior to recompaction is often used. However, this is generally during the initial consolidation phase of the fill and for large commercial, industrial, or educational buildings.

For heavy buildings with column loads of over 200 kips or settlement sensitive buildings, foundation systems consisting of drilled piers bearing on competent bedrock should be considered. However, on this site, heavy loads are not anticipated. Due to the rocky nature of mine spoil fill sites, driven piles are not generally feasible.

Dynamic compaction is often used to densify the upper several feet of the mine spoil surface providing a uniform subgrade for development, especially for the construction of the roadways. Dynamic compaction utilizes a weight to impart energy to the mine spoil fill surface causing it to densify. Heavy weights or tampers up to 20 tons are dropped from heights of up to 100 feet with a crane. Dynamic compaction can accelerate stabilization of mine spoil fill still in its initial settlement phase by quickly reducing the void space within the fill. The depth of densification from dynamic compaction is generally limited to 20 feet depending upon the composition of the fill.

Foundation Recommendations

The homes can be supported on spread footing foundation. Due to the risk associated with building on mine spoil fill sites, we recommend a modified spread footing consisting of an inverted "T" type footing that is rigid to allow for uniform movements and reduce the risk of cracking masonry or brick walls. The foundation can be designed using a bearing capacity for the mine spoil of up to 3000 psf. The structural engineer should consider top and bottom reinforcement in all foundations as well as reinforcement in the stem wall. The recommended bearing capacity is based on some settlement of the foundation. In Area A, the settlement is expected to be less than 1 inch assuming slaking of the shale within the fill does not occur. In Area B, we anticipate less than 1 to 2 inches and in Area C less than 2 to 3 inches.

Even though the computed footing dimensions may be less, column footings should be at least 24 inches wide and strip footings should be at least 18 inches wide. These dimensions facilitate hand cleaning and allow for proper placement of the reinforcement bars. All exterior footings should be at least 30 inches below the lowest adjacent grade to reduce the risk of frost heave during winter months. Due to the risk of settlement on this site, we recommend that buildings limit the use of masonry or ceramic.

Floor Recommendations

For residential buildings, we recommend the use of a crawl space floor system. Grade supported floor slabs can be used but will have a risk of cracking due to subgrade movements. Concrete slab on grade floors are less susceptible to settlement of mine spoil than building foundations. However, differential movements can result in cracks. If grade supported floors are used, some cracking of the floor slab should be anticipated. Slab on grade floors should be separated from the structure and placed on a crushed stone base of at least 4 inches.

Site Drainage

Due to the high risk of slaking of the shale after construction activity opens the surface of the fill, surface water runoff is important. During construction, all surface water should be directed away from the construction area. When the surface of the mine spoil fill surface is breached, rainfall can and will infiltrate the subsurface causing degradation of the shale portion of the fill resulting in consolidation of the fill. The contractor should make an effort to remove surface water from the site. Additionally, after completion of the homes, the gutter downspouts and surface water should be directed away from the site to reduce the risk of the footing support materials from slaking and consolidating.

Recommended Additional Exploration

The information in this letter should be considered preliminary and for planning purposes only. Once specific building types, locations, loading and usage are determined, additional geotechnical exploration should be conducted. There is reported underground mining on portions of the site. The preliminary report did not discuss depths and locations, therefore, we recommend additional research be conducted to attempt to identify if underground mining is beneath the site and how thick the roof rock is over the mine. No geophysical surveys were conducted to assist in the subsurface characterization. The geophysical data can assist in determining the location of subsurface mine benches. The boring data is very limited to the specific boring location and interpretation of the depth to bedrock between borings cannot be accurately made. Therefore, we recommend a geophysical survey be conducted on this site to better delineate the subsurface bench locations.

Yours truly,
VECTOR ENGINEERS, INC.

Wayne A. Karem, PhD, PE, PG, D. GE
Licensed Engineer
Licensed Geologist

March 20, 2024

Mr. John Meyer
HMB Professional Engineers, Inc.
3 HMB Circle
Frankfort, KY 40601
Email: jmeyer@hmbpe.com

Subject: Follow up on Geotechnical Items from Meeting on March 13, 2024
Skyview Estates
Hazard, Kentucky
Project Number: 24020013SHE

Dear Mr. Meyer,

Based on the weekly meeting from March 13, 2024, we understood the following items needed clarification:

1. Clarification of the associated risks with incorporating the geophysical data.
2. Field density testing (FDT) versus visual method of replacement/recompacted mine spoil material.
3. Crushed stone backfill for utilities and compaction.
4. Use to geotextile fabric below lot undercuts.
5. Clay liner versus synthetic liner for stormwater detention basins.

As indicated in our review of LE Gregg's geotechnical report, the project is located on an old mine spoil site, which has inherent risks associated with development on these sites. Therefore, the owner must be aware of and accept this risk. The recommendations presented by Vector Engineers are methods to reduce, but not eliminate the risk of unsuitable structural performance. Therefore, Vector Engineers must be indemnified against any future performance issues on this site.

1. Clarification of the associated risks with incorporating the geophysical data:

Figures 1 and 2 illustrate the approximate locations of the original geotechnical borings and the MASW lines conducted within the planned development. The LE Gregg boring locations are illustrated in blue with the top of ground elevations at the time of drilling and the listed refusal depth elevation. B-1 and B-11 were adjusted higher for weathered shale above refusal. The Multi-channel Analysis of Surface Waves (MASW) lines are illustrated in red with the directional point, approximate top of ground elevations, and the approximate elevation that the shear wave velocity is greater than 2,500 feet/second indicative of bedrock. Within the MASW line is the approximate location of the benches observed in the geophysical data based on latitude and longitude. Note that the actual MASW Lines 1 and 3 along the existing gravel road were inline with the road rather than the depicted straight line. The white pins illustrate the approximate bench locations illustrated from our review of the geotechnical report based on the initial data.

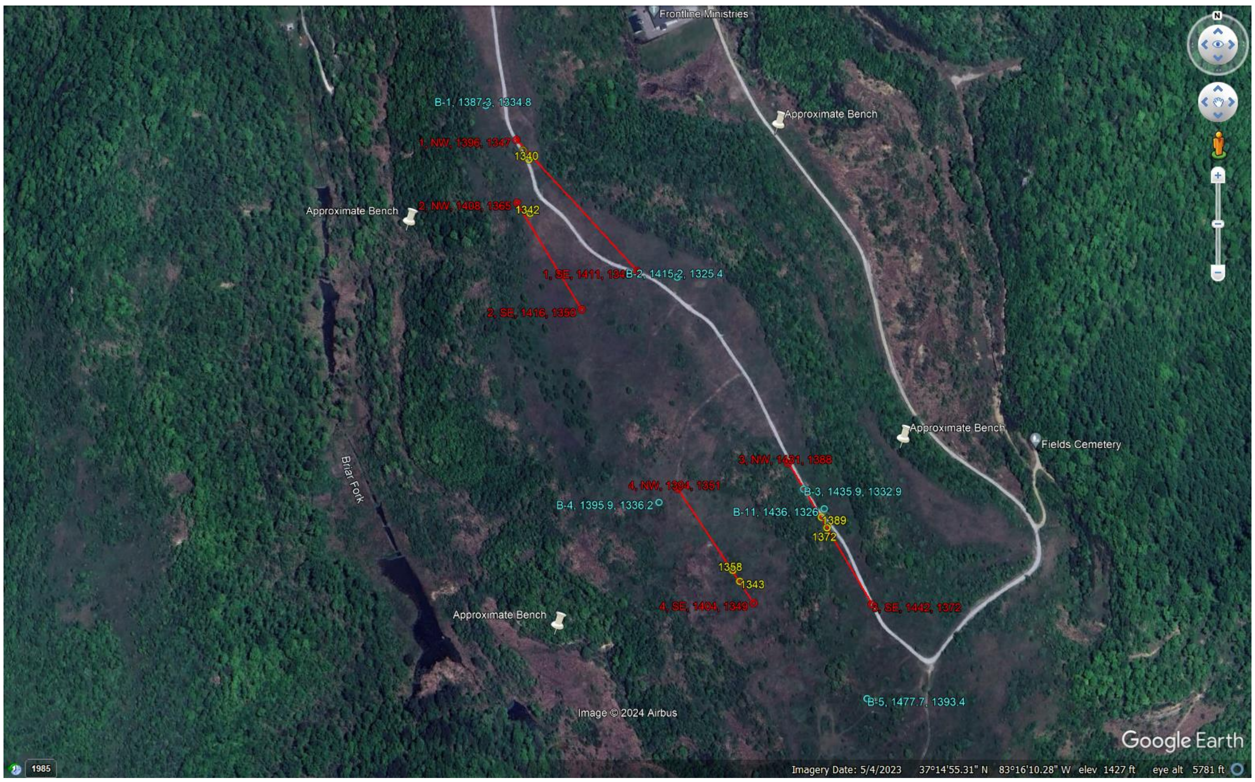


Figure 1: Arial photograph via Google Earth with the KMZ of the approximate boring locations provided by LE Gregg and the endpoint MASW lines provided by NSG.

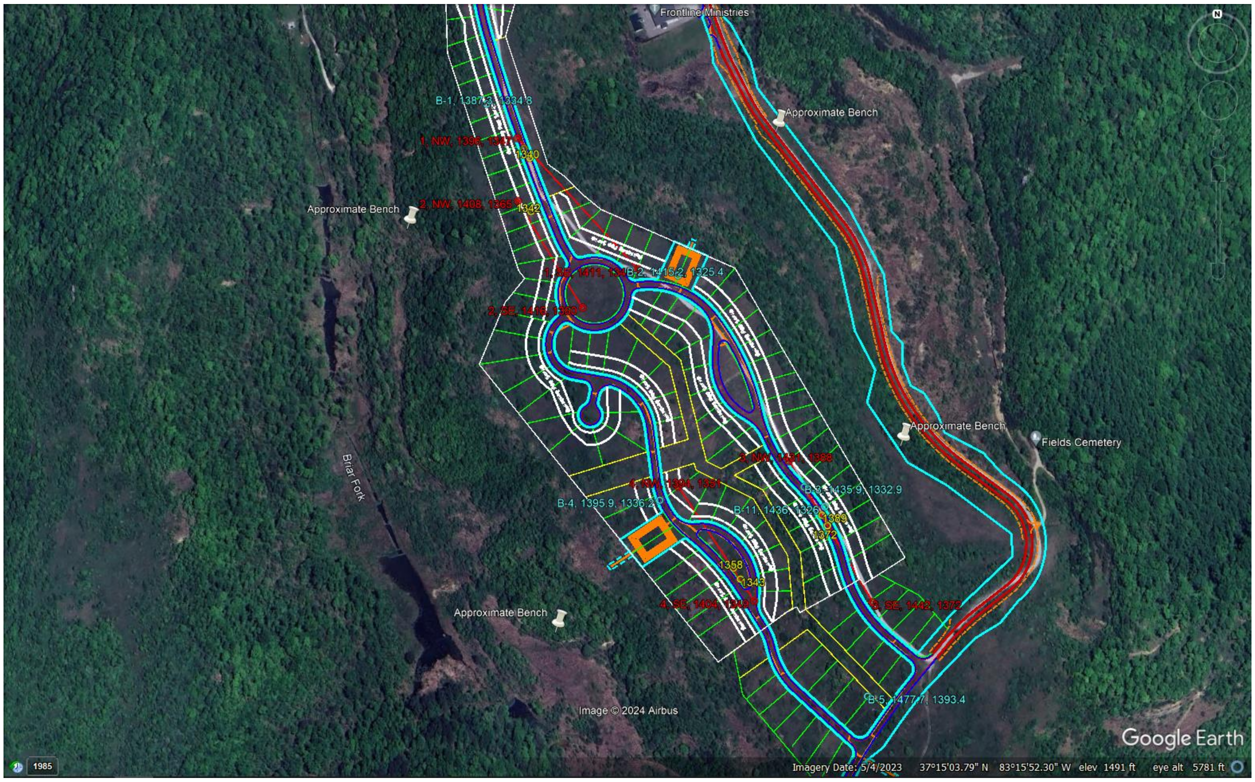


Figure 2: Arial photograph via Google Earth with the KMZ of the approximate boring locations provided by LE Gregg, the endpoint MASW lines provided by NSG, and the planned development provided by HMB.

As discussed the meeting, minor benches of approximately 10 to 20 feet in height were observed in Lines 1, 2, 3, and 4 running northwest to southeast. Based on the boring logs, the refusal/bench depths in B-1, B-2, and B-4 are relatively consistent with Lines 1, 2 and 4.

Borings B-3 and B-11 encountered the refusal material indicative of a bench near elevations 1332.9 feet and 1326 feet, whereas the Line 4 indicates 2,500 ft/sec velocities near 1388 to 1372. Boring 5 is more consistent with this line with refusal encountered at elevation 1393 feet. The transition indicates that there may be a 50-foot bench running parallel with Lines 3 and 4. Line 3 may have captured the extent of the bench to the east, however, it is unclear where the bench extends to the west. The elevational difference between Line 3 and Line 4 is approximately 20 to 30 feet.

Based on the overlay with the proposed development, Line 3 generally follows the planned roadway. Assuming that Borings B-3 and B-11 are located at the toe of the bench, then the residential lots east of the road overlay relatively consistent spoil depth (approximately around 100 feet). Depending on the extent of the bench west of the Line 3, then the lots west of the road may overlay varying spoil depths and may straddle a bench.

Prudent engineering would prove necessary to compliment the initial MASW lines with perpendicular lines to approximate the location/existence of the potential bench between Line 3 and Line 4 and if the bench extends further north on the site. However, as previously discussed, NSG's availability to perform additional lines would be in April and does not fit the design deadline.

We understand that the spoils used to backfill the hollow was completed at the end of 2000. Based on the age, it is possible that the primary consolidation of the spoil fill is complete or nearly complete. Therefore, the additional consolidation after loading the lots with lightly loaded homes will be as indicated in our review report (1 to 2 inches of differential settlement in Area B). This assumes that the spoil overburden is relatively consistent. If the constructed home(s) potentially straddle a bench, then additional differential settlement may occur.

A typical option to mitigate the risk of a home straddling a bench on a mine spoil site is use a deep rigid foundation system bearing on bedrock. However, at this site, we understood that the use of a deep foundation option was cost prohibited.

2. *Field density testing (FDT) versus visual method of replacement/recompacted mine spoil material:*

As indicated in our report, the fill areas and undercut areas can be filled by placing the mine spoil materials in a maximum of 12-inch loose lifts and compact to at least 98 percent of the maximum dry density as determined by the Standard Proctor compaction test. The lift thicknesses will require that no particles over about 6 inches in diameter be included in the fill matrix. If shale is encountered in large diameter pieces, the shale must be pulverized before placing as structural fill. The large boulders will require removal prior to use as fill soils. The fill moisture content must be within +/- 2 percent of the optimum moisture content as determined by the standard Proctor compaction test.

Prior to earthwork beginning, test pits should be conducted at various locations to obtain the bulk samples used for Standard Proctor testing. Note that spoils will likely vary from sample to sample and location to location. Therefore, numerous samples may be needed and the FDT may vary compared to Standard Proctor results. In addition to the FDT, it will be product to monitor the construction traffic while fill is being placed.

Depending on the amount of fines (soil) in the fill that could result in significant voids between particle sizes, then field density testing may not be conducive to compare against compaction of the material. Therefore, a combination of proofrolling and visually monitoring the moisture content of the fines during placement may be necessary.

3. *Crushed stone backfill for utilities and compaction:*

As previously discussed, the utilities are planned to be backfill with crushed stone and compared to a target compaction. KYTC #57 is typically not conducive to performing field density testing due to the amount of void within the aggregate matrix. Therefore, if compaction is required to be met, then a different gradation would be necessary. Sands and dense grade aggregate (DGA) can be tested against a Standard Proctor. We understand that KYTC Crushed Stone Base is being considered.

4. *Use of a geotextile fabric below lot undercuts:*

If there is concern about unsuitable (soft) materials below the undercut, then a geotextile fabric or geotextile grid may be used. Since rock fragments will likely be within the spoil, then there is a risk of ripping and/or tearing the fabric under the load of the construction equipment. Therefore, a more resilient non-woven fabric may be necessary such as a minimum 8-ounce fabric (Fabric-Geotextile Class 1).

5. *Clay liner versus synthetic liner for stormwater detention basins:*

A major source of settlement of mine spoil fills is due to the infiltration of water into the fill, degrading the shale portion of the fil matrix resulting in fill degradation and consolidation. Therefore, we recommend that the detention pond be lined using an impermeable liner system. Typical liners consist of Ethylene Propylene Diene Terpolymer (EPDM). The EPDM is a durable geomembrane that is compatible with aquatic life. The material is flexible and can function in a wide temperature range. The detention pond should drain off site to allow minimal water infiltration near the proposed housing development.

Respectfully Submitted,
VECTOR ENGINEERS, INC.

John Conway, PE
Construction Services Manager – KY

Wayne A. Karem, PE
Principal

Bringing the Subsurface into View

MASW GEOPHYSICAL SURVEY

Proposed Skyview Neighborhood
Hazard, Kentucky

Prepared for:

Mr. Wayne A. Karem, PhD, PE, PG, D.GE
Principal
Vector Engineers, Inc.
1535 Old Finchville Road, Shelbyville, KY

March 7, 2024

Prepared by:

NSG Innovations, LLC
Near Surface Geophysics
501 Nutwood Street,
Bowling Green KY 42103
859-462-2449

Respectfully submitted:
Thomas B. Brackman
Trent Edwards

Contents

1.0 Introduction

The purpose of this project was to perform a geophysical survey at a past strip mine located off Skyview Lane in Hazard, Kentucky. The location investigated is identified as the proposed Skyview Neighborhood and sits atop a strip-mined mountaintop. The site featured recently mowed fields at higher elevations of the study area, with dense vegetation across hillsides and select benches at lower elevations. The intent of this geophysical project was to evaluate the subsurface conditions and determine the presence/absence of bedrock, in addition, delineating benches from past mining activity. A total of four Multichannel Analysis of Surface Waves (MASW) survey lines were conducted across the site as directed by Vector Engineers personnel. A vicinity map showing the location of the site is included as Figure 1 and an aerial photograph or map (termed site map) showing the location of the survey area in relation to the project site is illustrated in Figure 2. Figure 3 is a detailed aerial view or map illustrating the approximate locations of the MASW 2-D shear-wave velocity profiles (line location map).

2.0 Technical Background

The challenge for this project was to select the correct non-intrusive tools and techniques to evaluate the subsurface on site and delineate the extent of strip-mining activity. In general, a variety of geophysical techniques can be applied to the mapping of subsurface features; however, certain methods, sensitive to a range of contrasting physical properties, can have attributes that make them more suitable than others, depending on site-specific conditions. Contrasting physical properties that typically are found to be useful for mapping soil and bedrock include electrical conductivity or resistivity, acoustic velocity, density, and magnetic susceptibility. Of these, MASW is commonly found to have a sufficient range of contrast and is most applicable for detailed characterization of sites. Given the desired depth of investigation (approximately 100 feet), two-dimensional (2-D) MASW was selected as the method of choice to document the soil-sediment-rock profile beneath the site. A description of techniques used in this field study is presented in the sections following basic geologic setting discussion.

2.1 Geological Setting

Study of available geologic maps and information (Figure 4) reveals that upper elevations of the site sit atop the Pennsylvanian-aged Princess Formation. This formation is part of the Breathitt Group and is described as sandstone, shale, siltstone, and coal. The sandstone is light- to medium-gray, coarse grained and contains crossbedding. Sandstone above the Hindman coal bed characteristically forms bold cliffs and pinnacles. The shale and siltstone are olive-gray to dark-gray, micaceous and contains fossil plant fragments. The shale units overlying the Hindman coal bed are carbonaceous locally and contains marine fossils and two or more thin shale partings. The Four Corners Formation lies at lower elevations of the site and consists of sandstone, siltstone, shale and coal as well. The shale and siltstone are olive-gray to medium-gray, poorly exposed and forms a subdued bench at about the level of the Francis coal bed. The Francis coal bed contains two or more shale partings; throughout most of area it apparently is split into several thin coals distributed in a 40-foot interval of shale. The descriptions and generalized geologic map of the site is made available by the Kentucky Geological Survey's Map Service and the generalized geologic map of the area is shown in Figure 4.

2.3 Multichannel Analysis of Surface Waves

Since its introduction in the late 1990s, use of surface-wave techniques has rapidly increased for two reasons: (1) they provide the shear-wave velocity (*Vs*) of ground materials, which is one of the most important geotechnical parameters in civil engineering, and (2) they are easier to use than are other common seismic approaches (e.g., refraction, reflection, and surface-wave surveys).

Elastic moduli are commonly used in geotechnical engineering to describe the behavior of Earth materials under stress, which is ultimately related to such tasks as properly designing earthworks and structural foundations, risk assessment under specific site conditions, and monitoring various types of existing infrastructure for public safety. Among three primary types of moduli: Young's (E), shear (μ), and bulk (κ) moduli—the first two are most commonly used because of what they represent. Young's modulus simply describes the deformation tendency along the axis of stress, whereas the shear modulus describes the tendency for shape deformation (shearing) that, in turn, is related to the viscosity or rigidity of material. Young's and shear moduli are determined from the parameters of density (ρ), *Vs*, and Poisson's ratio (ó). *Vs* plays the most important role as it is included as squared terms in expressions. In addition, *Vs*, in reality, changes through a broader range than do density and Poisson's ratio. Therefore, accurate evaluation of *Vs* can be extremely valuable in geotechnical engineering. The shear modulus can be determined fairly accurately once *Vs* is determined. Alternatively, Young's modulus requires Poisson's ratio to obtain a comparable accuracy. The *Vs* information of ground materials is obtained by processing Rayleigh-type surface waves that are dispersive when travelling through a layered media (i.e., different frequencies travel at different speeds). This dispersion property is determined from a material's *Vs* (by more than 95%), P-wave velocity (*V*p) (≤ 3%), and density (ρ) (≤2%). By analyzing dispersion properties, we can therefore determine *Vs* accurately by assuming some realistic values for *V*p and ρ. The accurate evaluation of the dispersion property is most important with any surface-wave method in this sense.

Table 1 Site Class definitions partially reproduced below

Site Class	Soil Profile Name	Average Properties in Top 100 feet (as per 2000 IBC section 1615.1.5) Soil Shear Wave Velocity, V_s	
		Feet/second	Meters/second
A	Hard Rock	$V_s > 5000$	$V_s > 1524$
B	Rock	$2500 < V_s \leq 5000$	$762 < V_s \leq 1524$
C	Very dense soil and soft rock	$1200 < V_s \leq 2500$	$366 < V_s \leq 762$
D	Stiff soil profile	$600 < V_s \leq 1200$	$183 < V_s \leq 366$
E	Soft soil profile	$V_s < 600$	$V_s < 183$

Site Classifications adopted from Table 1615 1.1 Site Class Definitions published in 2000 International Building code, International Code Council, Inc. on page 350.

By using a transformation function, the surface-wave method converts raw field data in a time-offset (*t*-*x*) domain into a frequency-slowness velocity (*f*-*p*) domain. The remaining procedure extracts a dispersion curve that is to be used in a subsequent process in search for the 1-D *Vs* profile. An accurate dispersion analysis is obviously an important part of data processing, and this is because shear-wave velocity (Vs) information is a good indicator of a given material's stiffness. The surface-wave method is commonly applied in civil engineering to address mechanical aspects of ground materials for example, assessment of load-bearing capacity, ground behavior under continuous and prolonged vibration, and ground amplification and liquefaction potential. The surface-wave method outputs are relatable to soil profiles as are observable in Table 1 and can be related to blow counts or N values and CPT (Cone Penetrometer Testing) values (Table 2). Note that both tables 1 and 2 have been inserted for convenience of viewing on all MASW profiles.

MASW is a surface-wave seismic method for measuring in-situ shear-wave (S-wave) velocity profiles. The MASW method is used to determine shear-wave velocity profiles for the subsurface. The Rayleigh wave method has since been used for delineation of landslides and tunnel assessment, soil-compaction control, mapping the subsurface and estimating the strength of subsurface materials. Testing is performed at the surface using the same conventional seismograph and vertical P-wave geophones that are used for refraction studies. The seismic source consists of a weight-drop system such as a sledgehammer or assisted weight drop and/or the use of ambient seismic noise which is constantly being generated via cultural and natural sources. Depending on the material properties of the subsurface, MASW can determine shear-wave velocities down to a maximum of 100 meters (approximately 300 feet) depth. The data acquisition procedure consists of stacking three to five records for two to three seconds using a conventional seismograph and 4.5 or 10 Hertz (Hz), P-wave geophones. The wave-field transformation of the noise record reveals the shear-wave dispersion curve. The shear-wave dispersion curve is then picked from the wave-field transformation and forward modeled to determine the subsurface shear-wave velocity profile.

Soft Soil	**Stiff Soil**	**Very Dense Soil and Soft Rock**	**Rock**
V_s<600 ft/s Standard penetration resistance, N N < 15 Undrained shear strength (psf) <1,000	600 < Vs< 1200 ft/s Standard penetration resistance, N 15 ≤ N ≤ 50 Undrained shear strength S_U (psf) 1,000≤S_U≤2,000	1200 < Vs < 2500 ft/s Standard penetration resistance, N N > 50 Undrained shear strength (psf) S_U > 2,000	2500 < Vs< 5000 ft/s Standard penetration resistance, N N/A Undrained shear strength (psf) N/A

Table 2: Scale used in velocity profile with site classification, standard penetration values (N) and undrained shear strength. Values from IBC 2006 Table 1613.5.2 Site Class Definitions (section 1613.5.50).

3.0 Procedures

Standard Operating Procedures (SOPs) for any geophysical project begins with a site safety check. Each site is evaluated for possible safety concerns and the surveys are modified to take these into account. Evaluation of the MASW data for the site was completed using the method described by Park (1999). A total of three seismic survey lines were conducted across the site. Seismic records were collected for 30 seconds with a two-millisecond sample rate. A sledgehammer, approximately 100 feet from geophone 1, struck a high-density poly-ethylene plate, triggering each record. Two records were collected at each shot station using a Seismic Source DAQ III data recorder and VibraScope Seismic software. Twenty-four, 4.5-hertz geophones, with 5-foot spacing between each geophone on a seismic land streamer were used for data collection. The land streamer was then moved 50 feet after the collection of every two records. The recorded data were exported to the Parkseis™ proprietary software for processing and modeling. Shear-wave velocities obtained from the forward modeling process are compiled into 1-D or 2-D shear-wave profiles and are included as a profile cross section to aid in interpretation.

Table 3 – MASW Lines Conducted

Field Name and Processed Name *	Report Figure	Sledgehammer Offset (feet)	Geophone 1 Position	Geophone 24 Position	Line Length (feet)
MASW Line 1	5	100	NW	SE	750
MASW Line 2	6	100	NW	SE	500
MASW Line 3	7	100	NW	SE	750
MASW Line 4	8	100	NW	SE	600

4.0 Summary of Findings

This site is located off highway Skyview Lane in Hazard, KY. The site was the location of a past strip mine resulting in multiple mine "benches" at different elevations across the site. The site is underlain by the Princess and Four Corners formations which feature sandstone, siltstone, shale, coal. Most of the soil at the surface is likely fill material left over from the former mining operation.

Study of the MASW profiles (Figures 5 through 8) suggests the locations of the mining benches can be seen as a drop in the Class B, Rock layer (yellow to red colors) or bedrock surface. MASW Line 1, Figure 5, data appears to show a decrease in elevation between Stations 50 and 100 feet. Note that the transition may occur between these points as the model interpolates between the two locations. MASW Line 2, Figure 6, data suggests a similar transition between Stations 0 and 50 feet. MASW Line 3, Figure 7, data reveals a possible transition between Stations 250 and 300 feet. MASW Line 4, Figure 8, a transition between Station 350 and 400 feet can be observed. Coordinates for the beginning and end of the inferred transition zones can be seen on each Figure indicating the approximate location of the past mining benches.

Figure 9 is an overlay of all the MASW lines conducted across the site. A red line was drawn to show the inferred location of the benches. Refer to Figures 5 – 8 for more accurate locations via coordinates.

5.0 Limitations

This study included a limited set of geophysical readings across limited portions of the site. The results and interpretations of the geophysical survey performed are considered generally reliable and were conducted in a manner generally consistent with practitioners in the field of geophysical engineering. The methods used in this investigation are considered reliable; however, localized subsurface variations may exist that have not been completely defined. The seismic results are not unique to geological features and more than one geologic feature or model may yield similar results. Therefore, properly conducted soil test borings and other exploratory techniques are necessary to more completely determine the subsurface conditions at the site.

The site features presented on the site base map are for informational purposes only and no representation is made as to the accuracy or completeness of this information. It is recommended that a practicing geosciences or geotechnical engineering professional be contacted prior to conducting verification drilling or excavating activities.

Figure 1 Vicinity Map

Figure 2 Site Map

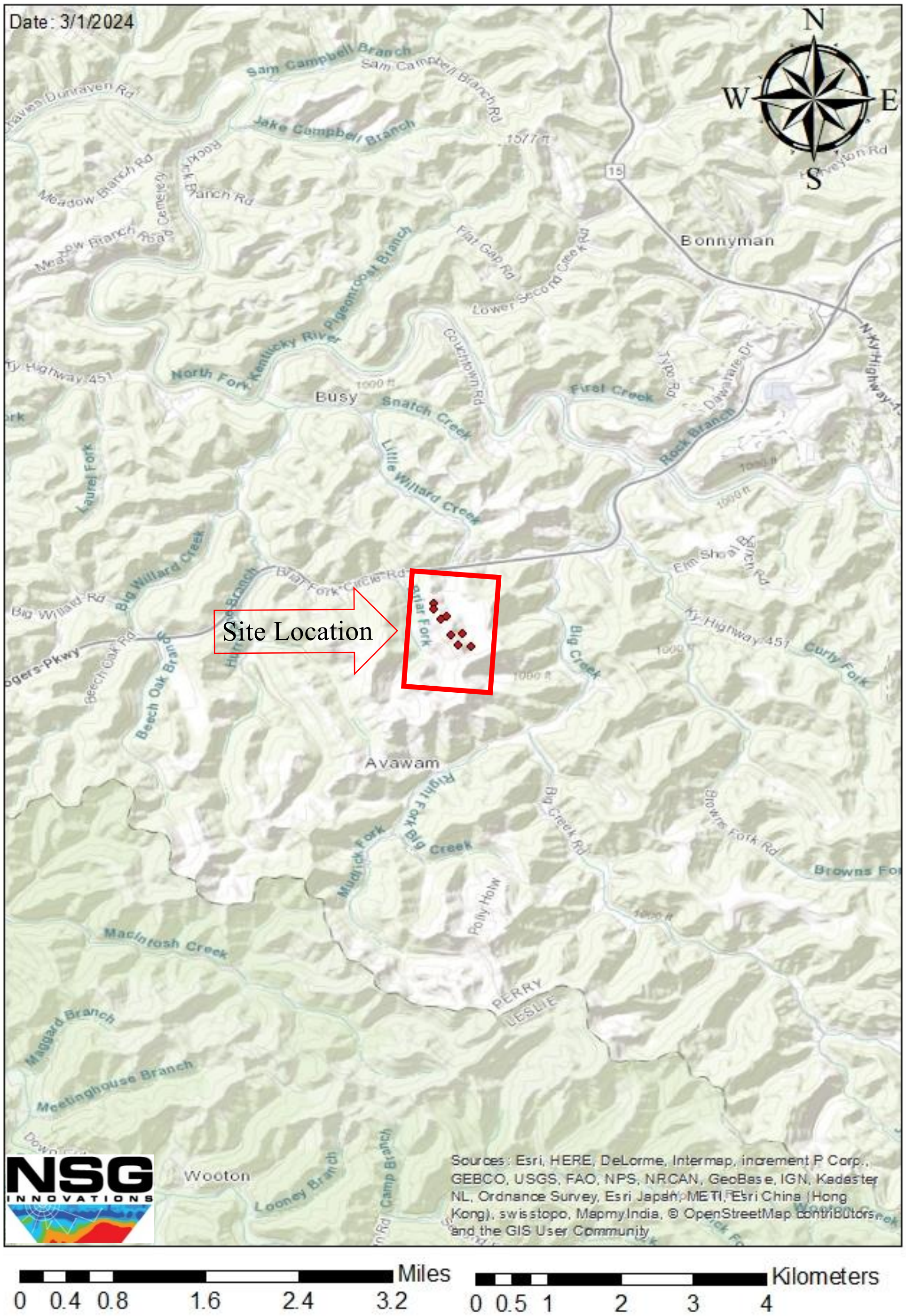


Figure 3 Line Location Map

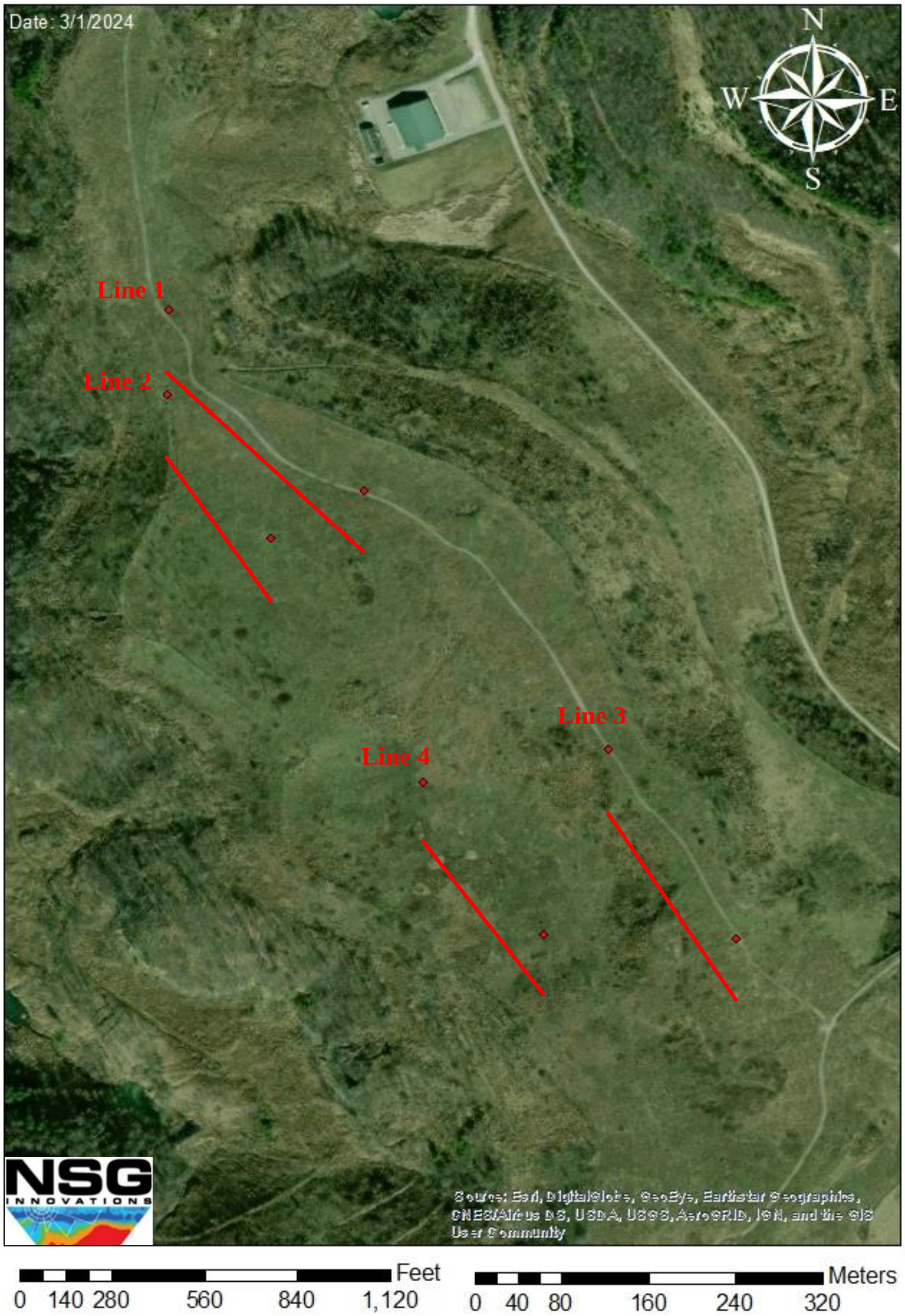


Figure 4 Geological Setting

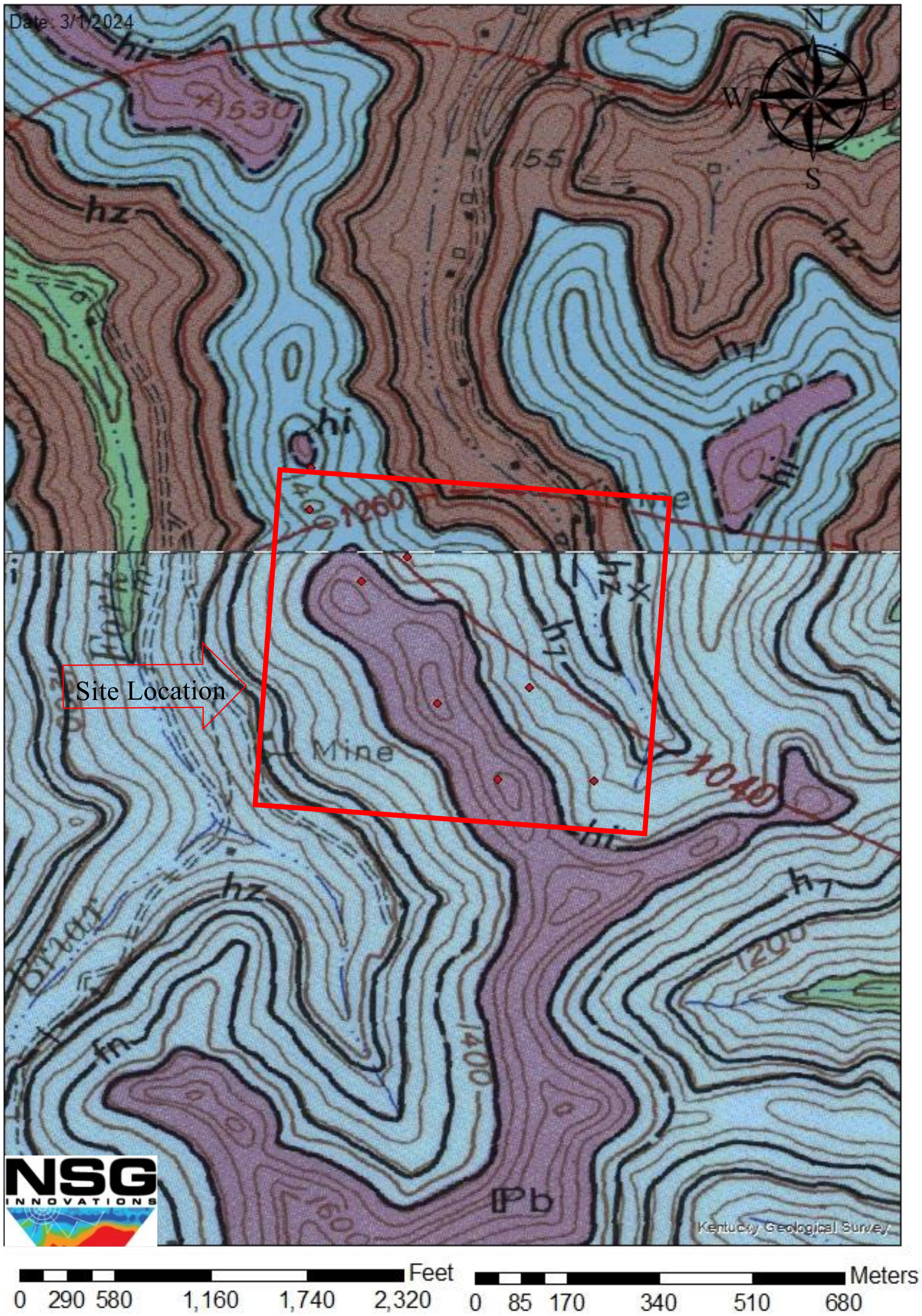


Figure 5 Line 1

Soft Soil	Stiff Soil	Very Dense Soil and Soft Rock	Rock
V_s<600 ft/s	600 < Vs< 1200 ft/s	1200 < Vs < 2500 ft/s	2500 < Vs< 5000 ft/s
Standard penetration resistance, N N < 15	Standard penetration resistance, N 15 ≤ N ≤ 50	Standard penetration resistance, N N > 50	Standard penetration resistance, N N/A
Undrained shear strength (psf) <1,000	Undrained shear strength S_U (psf) 1,000≤S_U≤2,000	Undrained shear strength (psf) S_U > 2,000	Undrained shear strength (psf) N/A

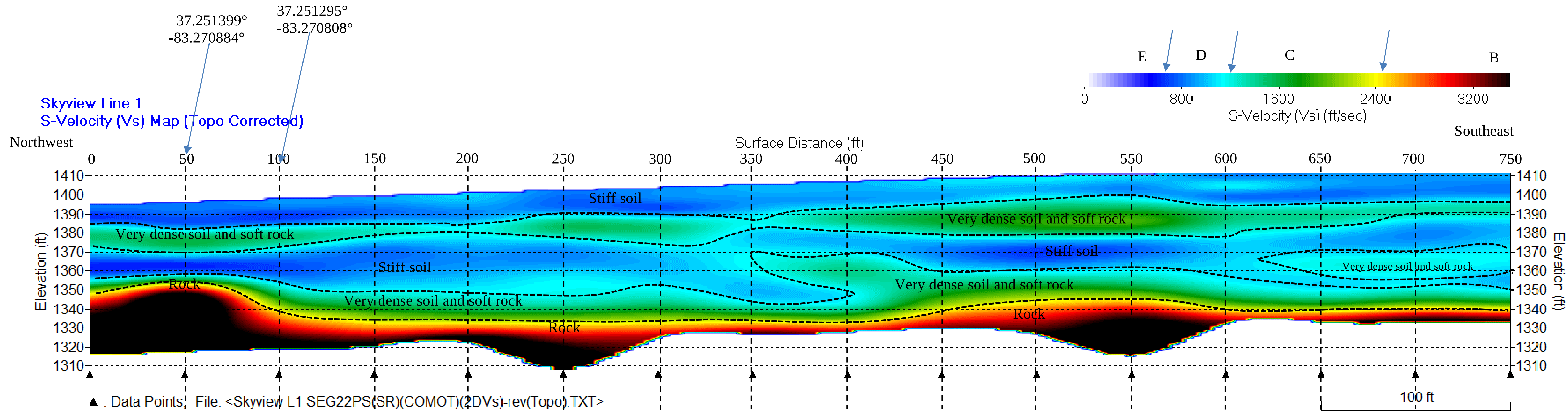
Table 2: Scale used in velocity profile with site classification, standard penetration values (N) and undrained shear strength. Values from IBC 2006 Table 1613.5.2 Site Class Definitions (section 1613.5.50).

MASW Profile L1
Figure 5

Table 1 Site Class definitions partially reproduced below

Site Class	Soil Profile Name	Average Properties in Top 100 feet (as per 2000 IBC section 1615.1.5) Soil Shear Wave Velocity, V_s	
		Feet/second	Meters/second
A	Hard Rock	V_s > 5000	V_s > 1524
B	Rock	2500 < V_s≤ 5000	762 <V_s≤ 1524
C	Very dense soil and soft rock	1200 < V_s ≤ 2500	366 < V_s ≤ 762
D	Stiff soil profile	600 < V_s≤ 1200	183 < V_s≤ 366
E	Soft soil profile	V_s < 600	V_s < 183

Site Classifications adopted from Table 1615 1.1 Site Class Definitions published in 2000 International Building code, International Code Council, Inc. on page 350.



NSG Innovations, LLC Near Surface Geophysics 741 Greenlawn Ave., Bowling Green, KY	Figure 5, MASW Profile Line 1 Drawn By: Thomas Brackman	Horizontal Scale (feet): as shown Vertical Scale (feet): as shown		MASW Survey Vector Engineers, Inc. Proposed Skyview Neighborhood Hazard, KY

Figure 6 Line 2

Soft Soil	Stiff Soil	Very Dense Soil and Soft Rock	Rock
V_s<600 ft/s Standard penetration resistance, N N < 15 Undrained shear strength (psf) <1,000	600 < Vs< 1200 ft/s Standard penetration resistance, N 15 ≤ N ≤ 50 Undrained shear strength S_U (psf) 1,000≤S_U≤2,000	1200 < Vs < 2500 ft/s Standard penetration resistance, N N > 50 Undrained shear strength (psf) S_U > 2,000	2500 < Vs< 5000 ft/s Standard penetration resistance, N N/A Undrained shear strength (psf) N/A

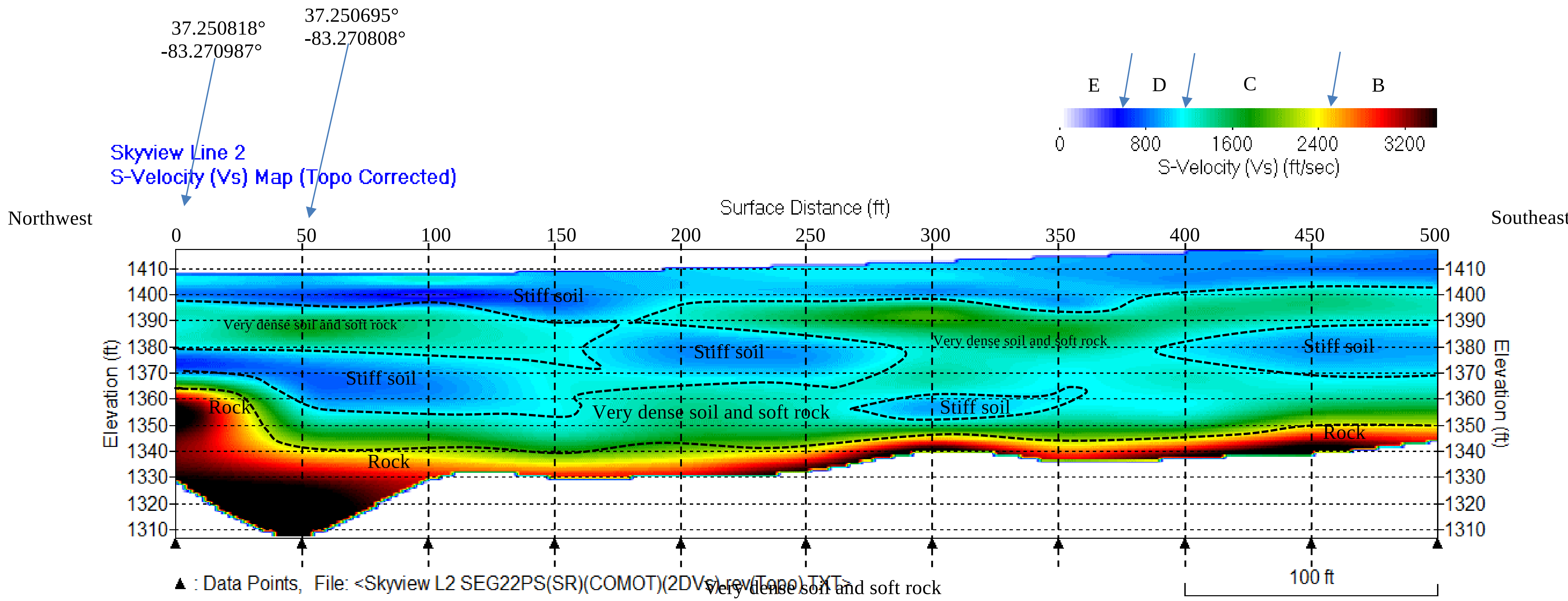
Table 2: Scale used in velocity profile with site classification, standard penetration values (N) and undrained shear strength. Values from IBC 2006 Table 1613.5.2 Site Class Definitions (section 1613.5.50).

MASW Profile L2
Figure 6

Table 1 Site Class definitions partially reproduced below

Site Class	Soil Profile Name	Average Properties in Top 100 feet (as per 2000 IBC section 1615.1.5) Soil Shear Wave Velocity, V_s	
		Feet/second	Meters/second
A	Hard Rock	V_s > 5000	V_s > 1524
B	Rock	2500 < V_s≤ 5000	762 <V_s≤ 1524
C	Very dense soil and soft rock	1200 < V_s ≤ 2500	366 < V_s≤ 762
D	Stiff soil profile	600 < V_s≤ 1200	183 < V_s≤ 366
E	Soft soil profile	V_s < 600	V_s < 183

Site Classifications adopted from Table 1615 1.1 Site Class Definitions published in 2000 International Building code, International Code Council, Inc. on page 350.



Very dense soil and soft rock
Rock

NSG Innovations, LLC
Near Surface Geophysics
741 Greenlawn Ave.,
Bowling Green, KY

Figure 6, MASW Profile Line 2
Drawn By: Thomas Brackman

Horizontal Scale (feet): as shown

Vertical Scale (feet): as shown

MASW Survey
Vector Engineers, Inc.
Proposed Skyview Neighborhood
Hazard, KY

Figure 7 Line 3

Soft Soil	**Stiff Soil**	**Very Dense Soil and Soft Rock**	**Rock**
V_s<600 ft/s	600 < Vs< 1200 ft/s	1200 < Vs < 2500 ft/s	2500 < Vs< 5000 ft/s
Standard penetration resistance, N	Standard penetration resistance, N	Standard penetration resistance, N	Standard penetration resistance, N
N < 15	15 ≤ N ≤ 50	N > 50	N/A
Undrained shear strength (psf)	Undrained shear strength S_U (psf)	Undrained shear strength (psf)	Undrained shear strength (psf)
<1,000	1,000≤S_U≤2,000	S_U > 2,000	N/A

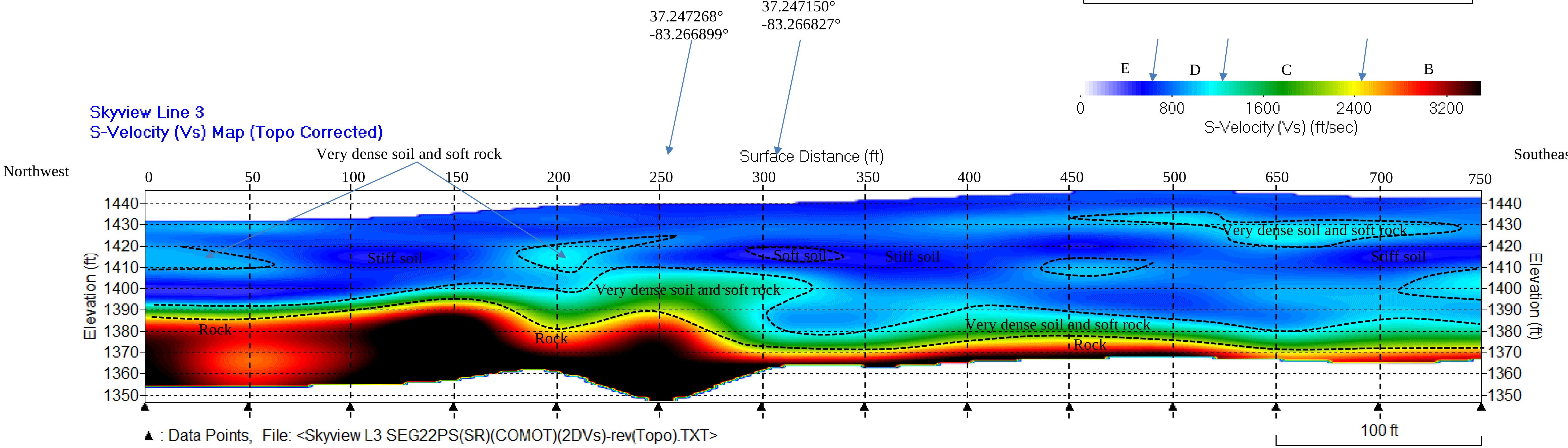
Table 2: Scale used in velocity profile with site classification, standard penetration values (N) and undrained shear strength. Values from IBC 2006 Table 1613.5.2 Site Class Definitions (section 1613.5.50).

MASW Profile L3
Figure 7

Table 1 Site Class definitions partially reproduced below

Site Class	Soil Profile Name	Average Properties in Top 100 feet (as per 2000 IBC section 1615.1.5) Soil Shear Wave Velocity, V_s	
		Feet/second	Meters/second
A	Hard Rock	V_s > 5000	V_s > 1524
B	Rock	2500 < V_s≤ 5000	762 <V_s≤ 1524
C	Very dense soil and soft rock	1200 < V_s ≤ 2500	366 < V_s≤ 762
D	Stiff soil profile	600 < V_s≤ 1200	183 < V_s≤ 366
E	Soft soil profile	V_s < 600	V_s < 183

Site Classifications adopted from Table 1615 1.1 Site Class Definitions published in 2000 International Building code, International Code Council, Inc. on page 350.



NSG Innovations, LLC Near Surface Geophysics 741 Greenlawn Ave., Bowling Green, KY	Figure 7, MASW Profile Line 3 Drawn By: Thomas Brackman	Horizontal Scale (feet): as shown Vertical Scale (feet): as shown		MASW Survey Vector Engineers, Inc. Proposed Skyview Neighborhood Hazard, KY

Figure 8 Line 4

Soft Soil	Stiff Soil	Very Dense Soil and Soft Rock	Rock
V_s<600 ft/s	600 < Vs< 1200 ft/s	1200 < Vs < 2500 ft/s	2500 < Vs< 5000 ft/s
Standard penetration resistance, N	Standard penetration resistance, N	Standard penetration resistance, N	Standard penetration resistance, N
N < 15	15 ≤ N ≤ 50	N > 50	N/A
Undrained shear strength (psf)	Undrained shear strength S_U (psf)	Undrained shear strength (psf)	Undrained shear strength (psf)
<1,000	1,000≤S_U≤2,000	S_U > 2,000	N/A

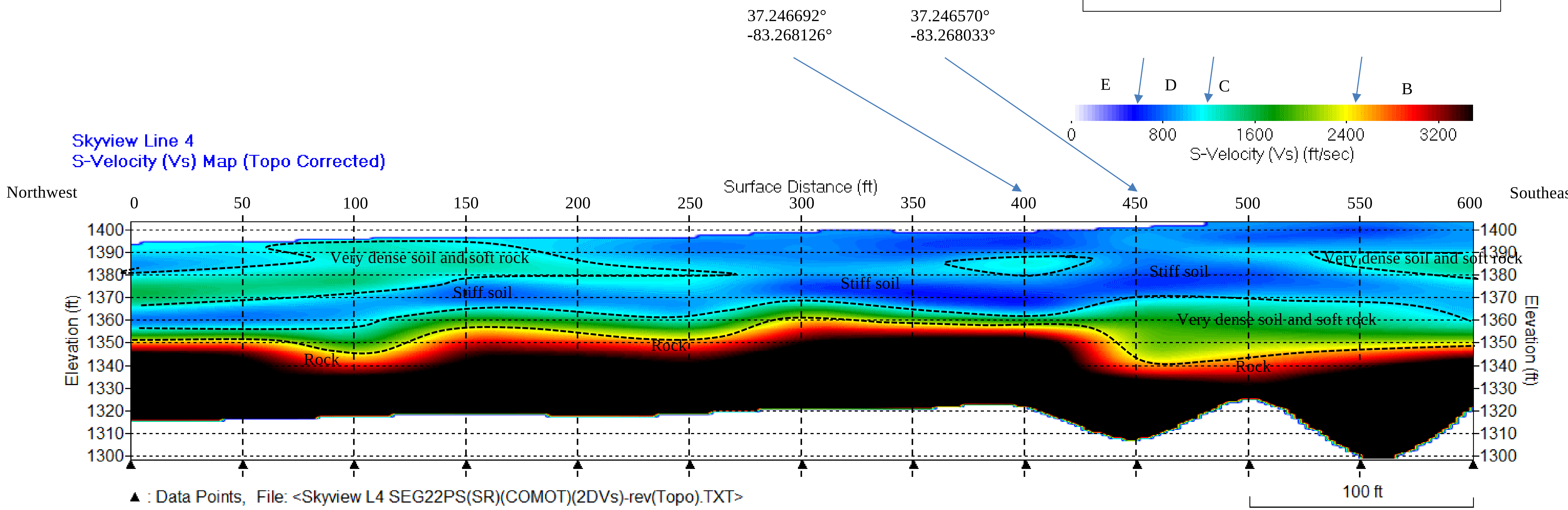
Table 2: Scale used in velocity profile with site classification, standard penetration values (N) and undrained shear strength. Values from IBC 2006 Table 1613.5.2 Site Class Definitions (section 1613.5.50).

MASW Profile L4
Figure 8

Table 1 Site Class definitions partially reproduced below

Site Class	Soil Profile Name	Average Properties in Top 100 feet (as per 2000 IBC section 1615.1.5) Soil Shear Wave Velocity, V_s	
		Feet/second	Meters/second
A	Hard Rock	V_s > 5000	V_s > 1524
B	Rock	2500 < V_s≤ 5000	762 <V_s≤ 1524
C	Very dense soil and soft rock	1200 < V_s ≤ 2500	366 < V_s≤ 762
D	Stiff soil profile	600 < V_s≤ 1200	183 < V_s≤ 366
E	Soft soil profile	V_s < 600	V_s < 183

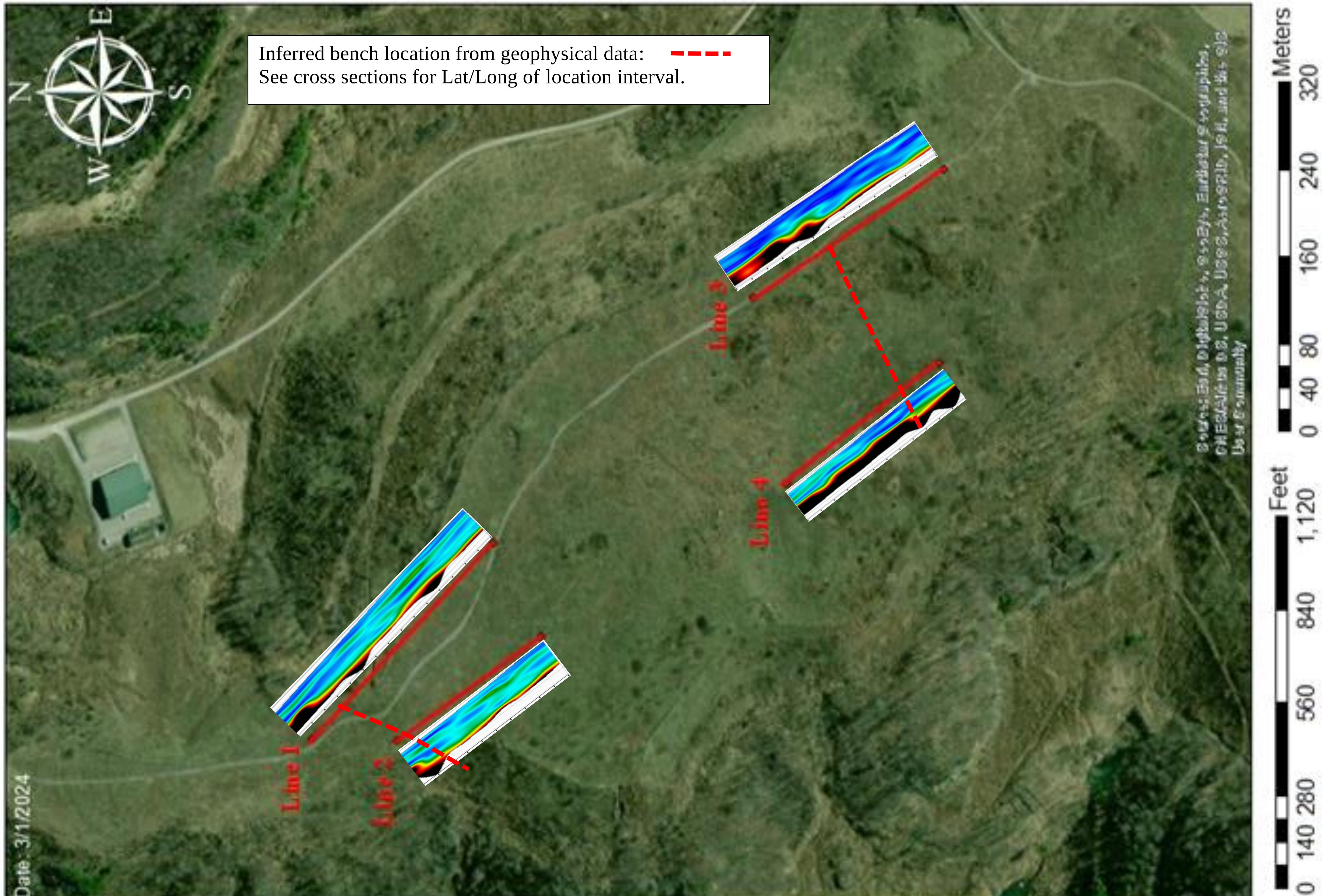
Site Classifications adopted from Table 1615 1.1 Site Class Definitions published in 2000 International Building code, International Code Council, Inc. on page 350.



NSG Innovations, LLC Near Surface Geophysics 741 Greenlawn Ave., Bowling Green, KY	Figure 8, MASW Profile Line 4 Drawn By: Thomas Brackman	Horizontal Scale (feet): as shown Vertical Scale (feet): as shown		MASW Survey Vector Engineers, Inc. Proposed Skyview Neighborhood Hazard, KY

MASW Overlay
Figure 9

Figure 9 MASW Overlay



NSG INNOVATIONS	NSG Innovations, LLC Near Surface Geophysics 741 Greenlawn Ave., Bowling Green, KY	Figure 9, MASW Overlay Drawn By: Thomas Brackman	Horizontal Scale (feet): as shown Vertical Scale (feet): as shown		MASW Survey Vector Engineers, Inc. Proposed Skyview Neighborhood Hazard, KY

April 5, 2024

Mr. John Meyer
HMB Professional Engineers, Inc.
3 HMB Circle
Frankfort, KY 40601
Email: jmeyer@hmbpe.com

Subject: Follow up on Geotechnical Items from Meeting on March 27, 2024
Skyview Estates
Hazard, Kentucky
Project Number: 24020013SHE

Dear Mr. Meyer,

Based on the weekly meeting from March 27, 2024, we understood the following items needed clarification:

1. Use of a High-density Polyethylene (HDPE) liner in-place of an Ethylene Propylene Diene Terpolymer (EPDM) liner.
2. Clarification on capping the crushed stone backfill used for utilities.
3. Concern associated with crushed stone backfill in utility trenches not being compacted to the required 95 percent outside of roadways.
4. Residential foundation type.
5. Risk of infiltration of surface water in swale between lots directed toward detention basin.

As indicated in our review of LE Gregg's geotechnical report, the project is located on an old mine spoil site, which has inherent risks associated with development on these sites. Therefore, the owner must be aware of and accept this risk. The recommendations presented by Vector Engineers are methods to reduce, but not eliminate the risk of unsuitable structural performance. Therefore, Vector Engineers must be indemnified against any future performance issues on this site.

1. Use of a High-density Polyethylene (HDPE) liner in-place of an Ethylene Propylene Diene Terpolymer (EPDM) liner:

In the previous follow up, Vector suggested EPDM as a typical liner be used for the detention pond. However, due to cost constraints, a HDPE liner is requested to be supplemented for the EPDM liner. A HDPE line with a minimum thickness of 60 millimeters is an acceptable alternative. The detention pond should drain off site to allow minimal water infiltration near the proposed housing development

2. *Clarification on capping the crushed stone backfill used for utilities:*

Vector understands that an open graded crushed stone (KYTC gradation #57, #8, or #9) is planned to encapsulate the planned utility conduits. KYTC Crushed Stone Base (CBS) or Dense Grade Aggregate (DGA) is planned to be used to backfill the remaining trench. As discussed in prior meetings, Vector recommended capping the utility trenches with soil to reduce surface water infiltration into the crushed stone backfill. Referencing L.E. Gregg report, the utility excavations should be capped with a minimum 18 inches of lean clay fill in order to reduce infiltration and conveyance of surface water through the trench backfill. Based on the sample recovery from the soil borings, the mine spoil generally consisted of a mixture of sand, silt, clay, shale, rock fragments, and boulders. The intent of the recommended 24-inch cap over utility trenches is to reuse select mine spoil soils such as a mixture of primarily clay and silt with little sand sized or larger particle to be implemented for the cap. The contractor will need to be selective with the excavated material to separate relatively clean fines to be reused and/or stockpile for cap. Based on the percentage of fines in KYTC CSB and DGA, a fabric should not be necessary to reduce soil fines migrating into the aggregate.

The soil cap does not need to be implemented directly below pavements or driveways.

3. *Concerns associated with crushed stone backfill in utility trenches not being compacted to the required 95 percent outside of roadways:*

In the previous follow up, Vector discussed the different gradations of crushed stone and the impacts of testing against 95 percent of a Standard Proctor. We understand that KYTC CSB was selected to be used as the primary backfill, which contains enough fines that field density testing with a nuclear density gauge can be performed adequately.

Since that time, we understand that there is concern related to added cost of the associated effort by the contractor to meet 95 percent of a Standard Proctor in areas outside of the roadway (excluding roadway crossings and utilities running directly below the roadway). We understand that a majority of the utilities run adjacent to the road (offset approximately 20 feet from the edge of the road and offset 10 feet from the edge of the sidewalk). Concurrently, the planned utilities will be within the disturbance area of the residential lots and are offset about 10 feet from the edge of the building pads and travel below the future driveways. The utility trench excavations will extend to various depths including down to 20 feet below planned grade.

In general, lack of compaction of backfill within utility trenches pose various risks which include subsidence at the surface, reduction of lateral support within the excavation sidewalls, potential to form conduits and increased water infiltration through loose material, and may strain the various utility conduits/structures from inconsistent bearing materials.

As indicated in our review, these residential undercuts extend a minimum of 5 feet beyond the building footprint and 3 feet below the proposed foundation bearing depth to provide uniform bearing surface. Loose backfilling of the utility trenches near the building could reduce the lateral supporting spoil adjacent to the building undercut resulting in building movements.

Subsidence at grade above the trench would create a low spot in the front yard of the lots allowing standing/ponding water. The ponded water will infiltrate the fill resulting in potential hydrocompression of the mine spoil. In addition, subsidence directly below the driveways will likely result in undesirable cracking of the pavements.

Vector understands that multiple utilities will be installed within the trench excavations. If adequate compaction is not maintained, then any settlement that occurs could damage the utility lines.

Ideally, all utility trenches would be compacted to these typical standards. Reduced specifications and oversight may result in, but not limited to, the various issues previously discussed. Utility backfills are generally placed in specified lifts and each lift compacted to reduce these risks. If the owner wishes to remove these compaction requirements for the contractor as cost prohibitive, there is a risk of isolated consolidation along the utility path.

4. *Residential foundation type:*

As referenced in our review, we recommended modifying the spread footing foundation for the lightly loaded, single story homes to consist of an inverted "T" type footing bearing on the undercut and replaced bearing pad. Please refer to *Foundation Recommendations* in our review of the geotechnical report for further information. The inverted "T" foundation type should be implemented for all the homes constructed on the development.

5. *Risk of infiltration of surface water in swale between lots directed toward detention basin:*

Older mine spoil sites have a surface that has weathered resulting in a crust that impedes/reduces the amount of water infiltration. However, once the site is disturbed, the scarification and excavation process destroys this crust allowing water infiltration to begin again until the site develops the crust again. The infiltration can result in consolidation of the mine spoil up to 10 percent of the wetted thickness. The recrusting process can take up to a year or more. This infiltration can impact the consolidation of the fill resulting in building settlement. Therefore, these swales should have some provisions to reduce infiltration. Options include capping the surface with lean to fat clay, using a concrete ditch, utilizing a geomembrane and/or installing some type of drainage system to quickly convey the water off the site.

Respectfully Submitted,
VECTOR ENGINEERS, INC.

John Conway, PE
Construction Services Manager – KY

Wayne A. Karem, PE
Principal