

March 22, 2024

Mr. Scott Baker, C.E.M.
Executive Director
Office of Facility Development and Efficiency
Finance and Administration Cabinet
Bush Building
403 Wapping Street
Frankfort, KY 40601

Re: Report of Geotechnical Engineering Subsurface Characterization
Evaluation of Mine Spoil Site for Residential Development
Grand View Neighborhood aka Johnson Property
Jenkins (Letcher County), Kentucky
Vector Project Number 24050001SHE

Dear Mr. Baker,

Vector Engineers, Inc. has completed a subsurface characterization of the Johnson Property for development as a residential neighborhood (Grand View). This report outlines our exploration methods, our understanding of the development, the results of our exploration, our opinion on the risk of development, and our recommendations for reducing that risk. Our services have been authorized by the Commonwealth of Kentucky Delivery Order Number 2300000522 dated January 3, 2024.

Background Information

Information concerning the proposed development was obtained from correspondence with Mr. Scott Baker with the Finance and Administration Department and Ms. Lisa Townes with H.A. Spalding Engineers. We were provided with the following documents:

1. A proposed development and plat map overlayed over an aerial photograph entitled *High Ground Neighborhood*, undated.
2. A summary document of mining maps, geology, and topography in the area, prepared by the Kentucky Abandoned Mine Lands (AML), dated November 4, 2023.
3. A mining and reclamation plan for the site, dated January 18th, 2000.

The site is located off Highway 23 just north of Jenkins, Kentucky (Figure 1). The site was mined by mountaintop removal to a coal seam and contour mining around the mountain to obtain coal from a lower seam. The spoils (soil and bedrock from above the seam) are placed in the valley, on the side benches and overtop the mined top of the mountain. Similar sites have been developed in the area. From our experience with mine spoil fill sites, there are several factors that will impact a successful development. Typically, they are:

- Backfill placement Methods
- Age of the Fill
- Composition of the fill materials
- Thickness of the fill
- Water infiltration/hydrocompression

The placement methods of the mine spoil on this site are assumed to be end dumped by using large dump trucks. The age of the fill is important. Newer fills (less than about 10 years old) and less than about 100 feet thick will settle up to 1 to 2 percent of the fill height.

The composition of the fill is also important. If the fills are mostly shale, then the degradation of the shale can be excessive, causing large settlements. Sandstone is a more durable material. Therefore, the determination of the makeup of the spoil fill is critical in evaluating a site.

Water infiltration is also a huge factor in the settlement of mine spoil fill. Once the surface is broken up during construction, water infiltration will occur, causing the shale portion of the fill to degrade and cause settlement.

Site and Geological Information

The site is located off Highway 23, in Jenkins, KY (Letcher County). The site is an old strip mine site with several tens of feet of mine spoil placed over top of a bedrock bench. The bench was created during past strip-mining activity.

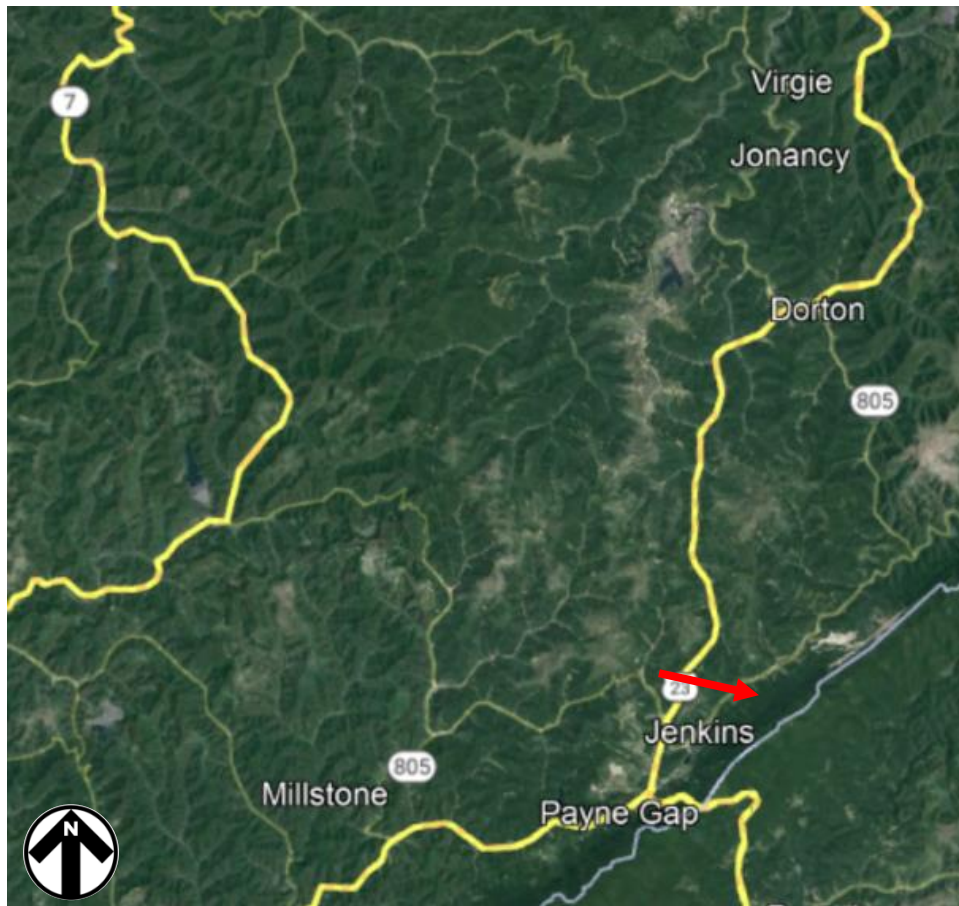


Figure 1: Site Location (Google Maps)



Figure 2: Aerial View of the site (Google Maps)

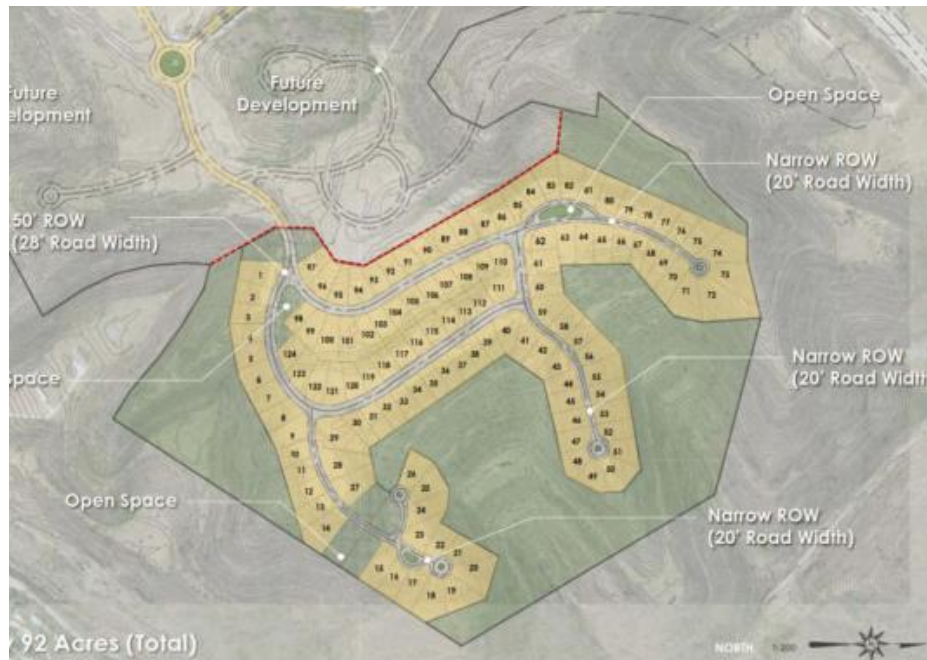


Figure 3: Preliminary Conceptual Plan of the Development

An overlay of the conceptual plan to the aerial photograph gives a general indication of the site boundary.



Figure 4: Overlay of the conceptual plan on the aerial photograph of the site.

Review of the available published geological and mining data revealed that the site geology consists of two formations: the Hyden Formation and the Pikeville Formation (Figure 5). The Hyden Formation consists of sandstone, siltstone, shale, and coal, and is generally located at higher elevations. The upper 20 to 30 feet of the formation is sandstone. The siltstone and shale, interbedded with sandstone, overlies a fire clay coal bed. The Pikeville Formation is generally mapped below an elevation of about 1800 feet, consisting of sandstone, siltstone, shale, and coal. The sandstone is light to medium gray and very fine to fine-grained and is above interbedded siltstone and shale.

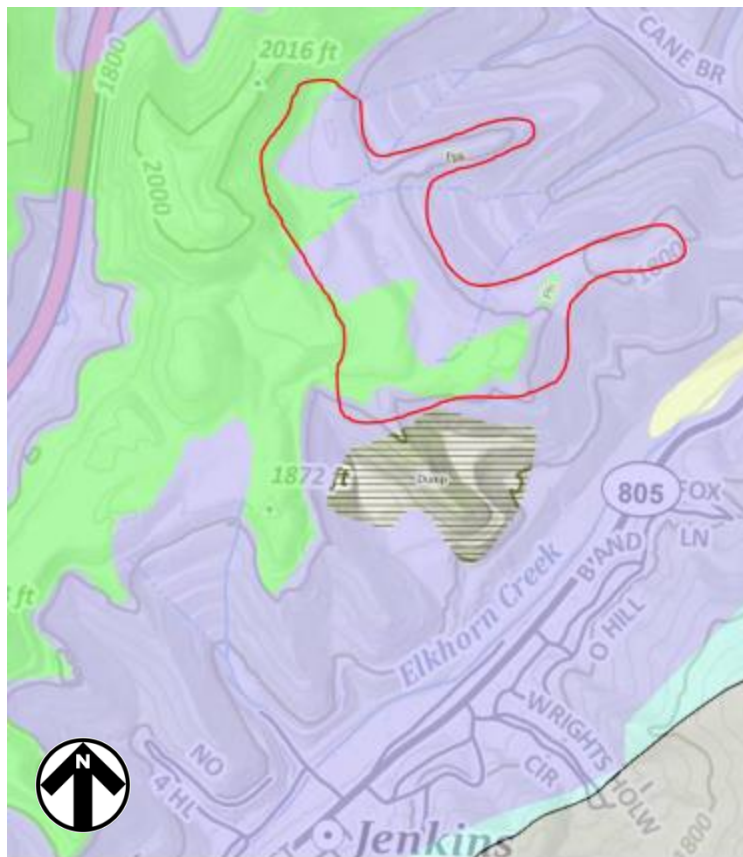


Figure 5: Geological Map of the Site. The green is the Hyden Formation while the lavender is the Pikeville Formation. The black-striped area just outside of the project area indicates a mine spoil dump.

The Kentucky Geological Survey shows several coal seams that were/are located within the upper portions of the geologic column. A review of the geologic map for the area of the site indicates two probably mined seams; the Amburgy coal bed and the Upper Elkhorn No. 3 coal bed (Figure 6). A rough review of the site topography would indicate that the Amburgy seam was at an approximate elevation of 1800 feet while the Upper Elkhorn No. 3 seam was at an approximate elevation of 1720 feet. According to the mapping obtained from the KY mine map, the lowest seam mined on this site was about elevation 1560 feet. However, this mapping may not be exact.

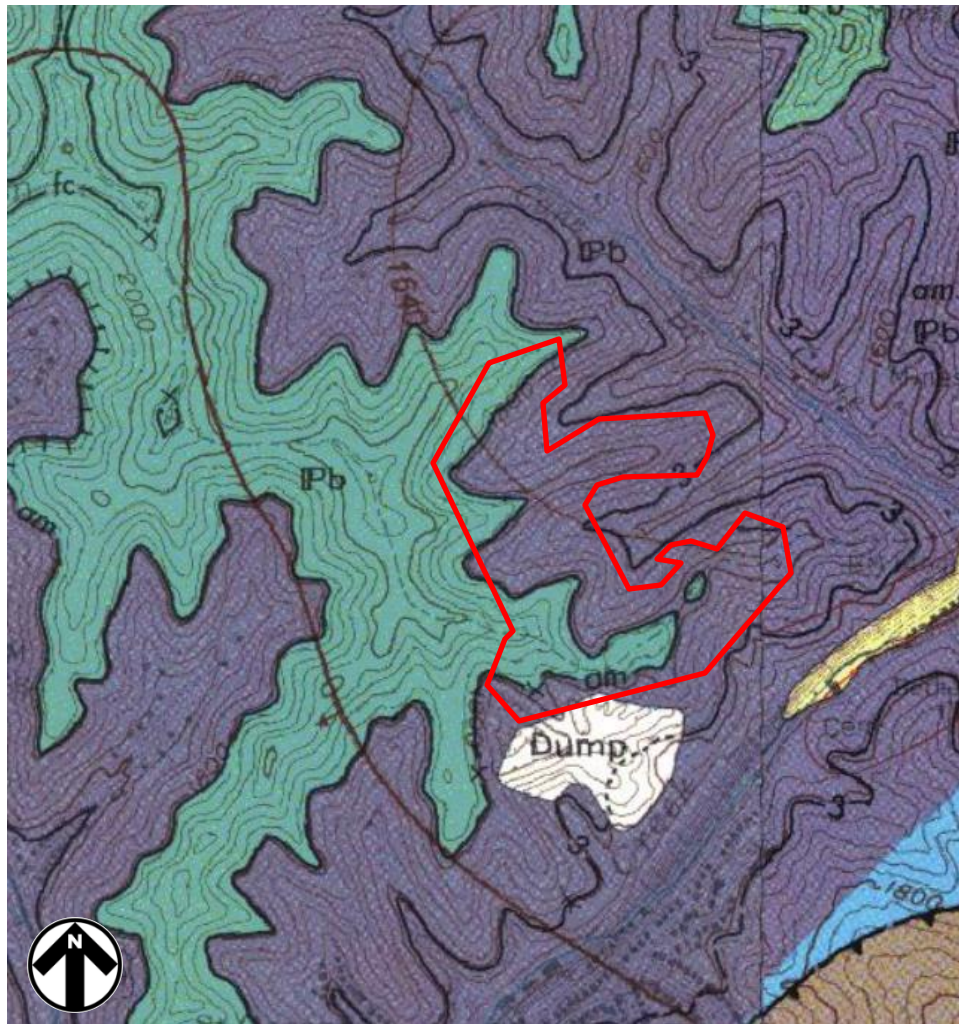


Figure 6: Geological Map showing coal seams and pre mining contours.

Based on the top of ground elevations from the KY DEM data and the elevations in the mine mapping, the depth of mine spoil fill ranges from 0 feet in unmined areas to up to 200 feet in the hollow fills. Based on the available mine maps and historical aerial photographs, it appears that mining was completed in the late 90's/early 2000's. Several areas within the project area were noted as spoil fill areas.

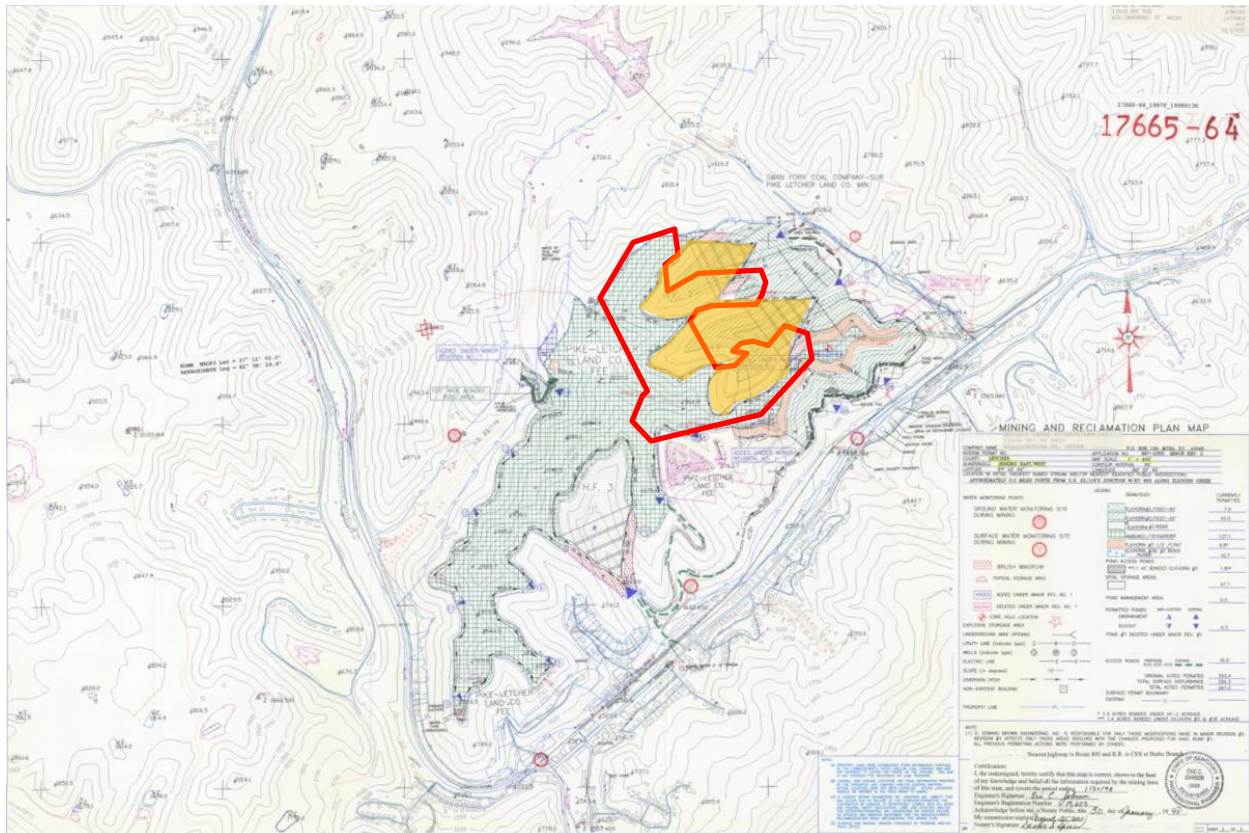


Figure 8: Most recent mining map with the approximate project area in red. The orange shaded areas are indicated as mine spoil fills.

Existing Conditions

The proposed development is located on top of an old coal surface mine with a small access road located off of Highway 23, that leads to the top of the surface mine. Based on the Kentucky DEM data, the topographic mapping on the most recent mine maps, and our site observations, the site has been extensively graded. The western portion of the site where borings B-1, B-4 and B-6 is benched and is higher in elevation than the eastern portion of the site, where borings B-2, B-3 and B-4 are located. The surface where mining occurred is covered by tall grass and brush and is surrounded by wooded hillsides. The area slopes down in all directions except the north where it slopes up in elevation. Drainage is generally judged to be excellent with runoff directed downslope into the valleys. The following photographs illustrate the current site conditions.



Photograph No. 1: View looking south with a stake at Boring B-6.



Photograph No. 2: View looking north where the site slopes up, likely indicating a mining bench. The clearing on the far right of the photo is the general location of Boring B-6.



Photograph No. 3: View looking east on top of western bench with a small clearing at the crest of the bench. Pink flags indicate the location of geophysics line 2.



Photograph No. 4: View looking north on the lower eastern bench. To the west is the rise of the western bench.



Photograph No. 5: View looking east on the eastern bench. Boring B-2 is located in the lighter colored grass on the right of the photo.

The elevations on site range from about 1920 at the northwest corner to about 1720 in some of the valleys, with most of the proposed development ranging from about 1880 to 1820 feet. Based on these elevations, we anticipate that significant grading may be necessary to reach a suitable grade on some of the lots extending along the ridges to the east.

Detailed mining methods for the site have not been conveyed to us, however, from our review of available mine mapping and our experience on similar sized mines in the area, we anticipate that the site was mined using contour mining and mountaintop removal mining methods. Typical contour mining consists of stripping and grubbing before constructing drill benches by bulldozers. The overburden is drilled and blasted to expose the coal seam. Bulldozers push the blasted rock to a front-end loader. The loader loads the overburden into haul trucks for transport to the deposition location.

Mountaintop or ridge top removal mining removes the entire top of a mountain ridge creating a level surface at the coal seam. The same type of equipment used for

contour mining is used in mountaintop removal. Mountaintop mining does affect much larger areas of land versus the relatively thin bands characteristic of contour mining.

Typically, the excavation begins along the deepest economically removable coal seam outcrop parallel to the ridgeline. To start the operation, the first cut is transferred by rock trucks to the hollow fill. After overburden drilling and blasting, front-end loaders and rock trucks work progressively toward the center of the mountain. Concentrically circling the mountain, the lower benches advance ahead of the upper excavations. The excavation continues with rock trucks hauling material to the mine spoil storage area using ramps connecting the series of benches until a level surface remains. The bench heights are determined by either the occurrence of a coal seam or by equipment limitations. Typically, the equipment used for placing the mine spoil consisted of bulldozers (most likely Caterpillar model D9's or similar) and Caterpillar model 777B (triple 7's) dump trucks. The dump trucks end dumped the mine spoil into the valley or onto the benches. The bulldozers were used to level the top of the mine spoil piles. No compactive effort was conducted in the hollow fills.

Based on our understanding of the site, the mine spoils were placed by end-dumping from the top of the mine bench into the valleys. The initial phase of the mining would have used the valleys to place spoil materials with later phases consisting of ridgetop removal and back stacking the spoils on against the highwalls created by contouring and on the plateau.

End dumping of the spoil creates a loose structure that tends to consolidate thereby reducing the void space between particles over a long period. In addition, water infiltration can cause slaking of the shale portion of the mine spoil fills, which can lead to a condition called hydrocompression where settlement can occur from loss of strength from the reduced rock-to-rock contact points and the creation of conduits that can collapse over time. Due to the variability of the constituents, placement methods and thickness of the mine spoil, differential settlement can occur in these fills. The quantity and time for completed settlements cannot be accurately predicted.

Subsurface Characterization

After researching the available information provided to us on the project, we developed a preliminary understanding of the subsurface conditions. In conjunction with conducting soil test borings and bedrock coring, we also conducted geophysical testing. The geophysical testing allows a larger area to be evaluated to determine the general makeup of the subsurface where a soil boring yields information at a specific location.

Based on the mine mapping, it appears that the ridge of the mountain was mined for the Amburgy coal seam down to an elevation of about 1810 feet. Additionally, contour/auger mining was conducted on the Elkhorn No. 3 ½, Elkhorn No. 3, and No.2 coal seams at 1760 feet, 1620 to 1640 feet and 1560 to 1580 feet, respectively.

The depth of the mine spoil in the areas range considerably. The top of ground elevations on site range from about 1920 at the northwest corner to about 1720 in some of the valleys, with most of the proposed development ranging from about 1880 to 1820 feet. Based upon topographic information, the native elevations in the project area range from about 1950 to 1650 feet with mine spoil fill depths ranging from about 20 feet deep in the high areas of the site to about 100 to 150 feet in the valleys.

To verify the accuracy of the mapping, we conducted geophysical surveys and soil test borings at various locations as shown on the location plans in the appendix. We conducted 3 geophysical arrays and 6 soil test borings to evaluate the mine spoil consistency.

Geophysical Testing

Geophysical testing on the site utilized Multichannel Analysis of Surface Waves (MASW). MASW evaluates ground stiffness by measuring shear wave velocity (Vs) of the subsurface materials. The seismic waves are generated using a steel plate and sledgehammer with the waves collected using geophones spaced along a line. The shear wave velocity is a direct indicator of the soil and bedrock stiffness. A low shear wave velocity indicates a soil material, and a high velocity would represent bedrock. Table 1 illustrates typical ranges for the various materials.

Site Class	General description	Detailed Description	Shear Wave velocity		Blows/Foot (N value)	Shear Strength S_u (psf)
			m/sec	ft/sec		
A	Hard Rock	Includes unweathered intrusive igneous rock. Soil types A and B do not contribute greatly to shaking amplification.	> 1,500	> 5,000		
B	Rock	Volcanics, slightly weathered intrusive igneous, and high-grade crystalline metamorphic bedrock (upper range) to well-cemented and lithified coarse-grained sedimentary or low-grade metamorphic rock (lower range)	750 - 1,500	2,500 - 5,000		
C	Soft rock and Very dense Soil	poorly-cemented coarse-grained to fine-grained sedimentary rock to dense Early to mid Pleistocene or older granular sediment	350 - 750	1,200 - 2,500	> 50	> 2,000
D	Stiff Soil	Mid to Late Pleistocene granular sediment or properly Engineered Fill (post 1985)	200 - 350	600 - 1,200	15 - 50	1,000 - 2,000
E	Soft Soil	Holocene granular sediment, pre-1985 artificial fill, includes some Late Quaternary muds, sands, gravels, silts and mud. Significant amplification of shaking by these soils is generally expected.	< 200	< 600	< 15	< 1,000
F	Unstable Soil	Includes water-saturated mud and undocumented or pre-1950 artificial fill. The strongest amplification of shaking due is expected for this soil type.	requires site specific measurement	requires site specific measurement		

Table 1: Shear Wave Velocities and Earth Material Type

Geophysical Survey

The purpose of our geophysical survey was to attempt to determine where the old subsurface mine benches are located. The bench locations will determine where the development should be constructed. Differing mine spoil thicknesses across the site will result in differential settlement which could be detrimental to the long-term performance of structures, buildings, roads and utilities.

Geophysical (seismic) data were collected along 3 survey lines to gather information about the density of subsurface materials. Specifically, a multichannel analysis of surface waves (MASW) survey was conducted to evaluate the subsurface compressional-wave velocity variation along each survey line. Compressional-wave velocity is a function of the density, bulk modulus, and shear modulus of the material. The data were used in combination with boring data to estimate the characteristics of the geologic materials. The MASW survey line locations are shown in Figure 9 and 10. Figure 10 illustrates the reported mining operations as well as the boring locations.

MASW data was collected in early 2024. The field procedures involved use of a 24-channel 4.5-Hz geophone array with a geophone spacing of five feet. The energy source used during the MASW surveys was a sledgehammer striking a steel plate. The seismic data were recorded digitally directly on the laptop computer used to control the seismograph.

The MASW data were processed using Parkseis™ proprietary software to produce compressional-wave velocity models of the subsurface. One velocity model (profile) was produced for each geophysical survey line. The ground surface of each model is based on available topographic data for the site and should be considered approximate.

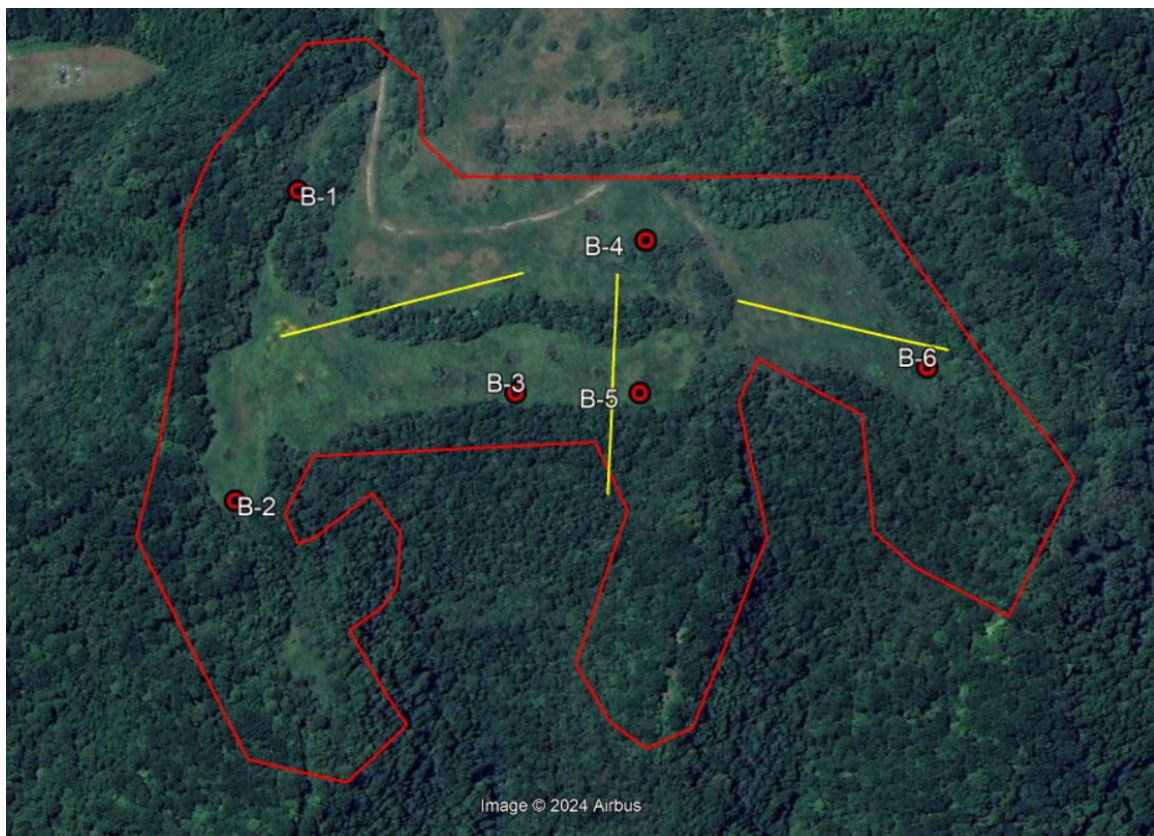


Figure 9: MASW lines (yellow) and boring locations. The approximate outline of the development is indicated in red.

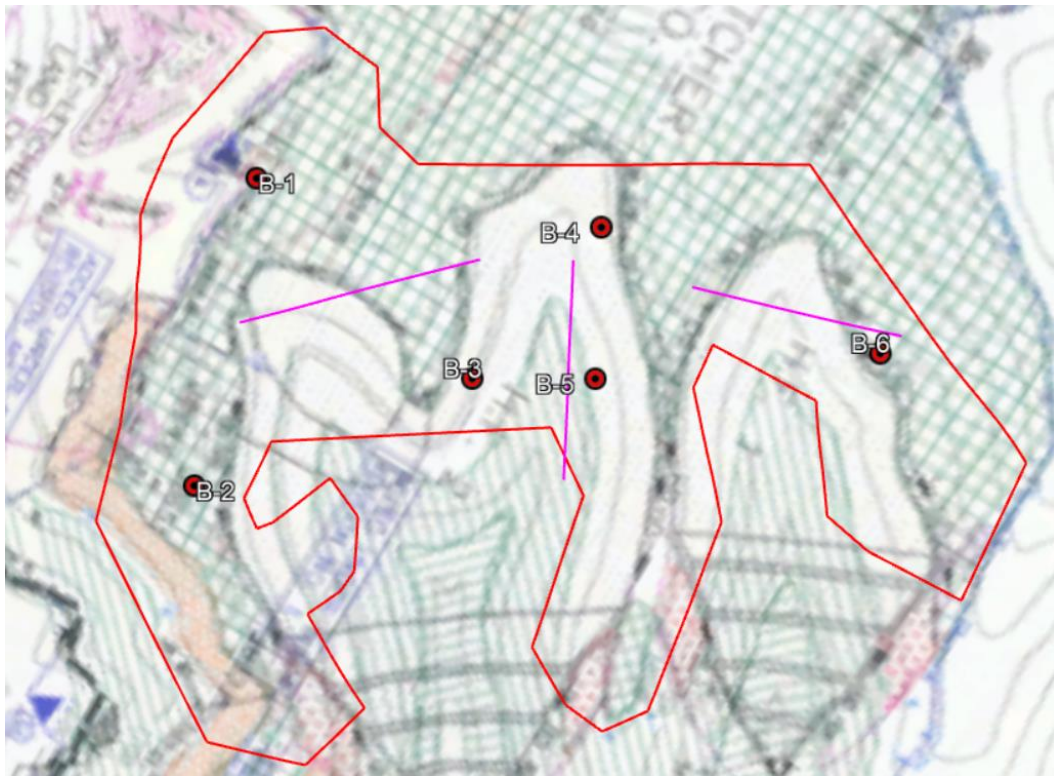


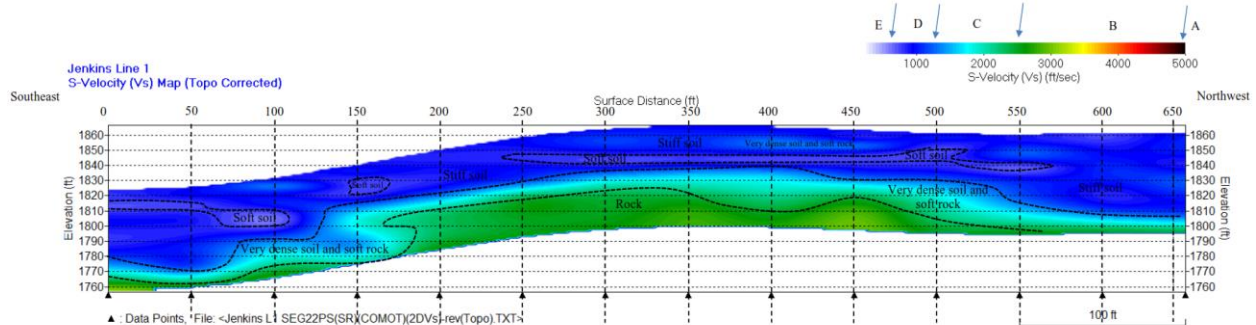
Figure 10: MASW line locations (pink) with respect to reported mining locations. The approximate outline of the development is indicated in red.

Findings

Compressional-wave (i.e. P-wave) velocities varied laterally and with depth based on the materials encountered. Shallow soil, fill, and weathered rock generally exhibited lower velocity values than materials at greater depths, indicating a weaker soil/fill structure near the surface. The results (MASW profiles) are shown in the *Appendix*. However, the results from line 1 are illustrated in Figure 11 for illustration. The MASW shear wave velocities over about 2500 feet per second would generally indicate bedrock, although it could represent very dense soil.

MASW Line 1 suggests bedrock exists at relatively shallow depths (about 30 to 60 feet) beneath the line location. The dark blue to green transition is the area where we interpret the transition between soil/mine spoil fill and bedrock. Boring B-1 was drilled within 350 feet (to the southwest) of the south end of MASW Line 1. Boring B-2 encountered refusal at a depth of 19.0 feet from the top of ground (elevation 1807). This corresponds well to the MASW data, which indicated more overburden but showed

MASW Line 3 suggests a depth to bedrock of about 35 feet at the north end of the line and 65 feet near the south end. This is generally consistent with the nearby boring at the north end of the line, B-6, which encountered bedrock at about 22 feet deep. Additionally, the mining map indicated that the deeper area of bedrock in Line 3 is likely within an area of valley fill.



Comparing the results of the MASW testing and the soil boring refusal depths, the data generally agrees with the available mine mapping for the site, although the “bedrock” indicated in Line 2 is apparently a dense boulder fill within a natural valley with bedrock closer to 100 to 150 feet deep.

Soil Borings

The borings generally encountered two profiles across the site; one with relatively shallow fill underlain by possible native soil and bedrock and one with deep fill extending to bedrock. The soil borings encountered a thin layer of topsoil (0 to 5 inches) underlain by mine spoils consisting of a mixture of lean clay, sand, silt, weathered shale and sandstone pieces, and sandstone boulders. The standard penetration tests ranged from 6 blows per foot (bpf) to in excess of 50 blows per inch. A statistical analysis of the N values indicates an average value of 24 bpf, a median value of 16 bpf, and a standard deviation of 16. The result of the statistical analysis matches well with penetration data from other sites in the area, therefore, we can incorporate our experience with the previous sites with this site.

Borings B-5 and B-6 encountered what appeared to be potential native clay soil near the bottom of the boring. The clay was judged to be lean in Boring B-5 and fat in Boring B-6. SPT N-values within the clay ranged from 27 bpf to 50 blows over 4 inches.

The borings were located at specific locations to verify the depths indicated on the available mining map. The borings generally encountered refusal within a reasonable depth that agreed with the mapping. Table 1 lists the interpreted depth to the bedrock based on our review of the soil and rock specimens. On the boring logs, some of the coring conducted through refusal material was judged to be large boulders within the fill and not actual bedrock.

Table 2: Depth to Estimated Bedrock from the Borings

Boring Number	Approximate Depth to Native Soil/Rock from Mining Map (Feet)	Depth to Refusal (Feet)	Approx. Depth from Geophysical Survey (Feet)	Judged Bedrock Depth (Feet)
B-1	10 to 20	19.0	35	19.0
B-2	0 to 10	19.0	-	19.0
B-3	70 to 80	101.0	65	101
B-4	80 to 90	93.7	65	93.7
B-5	80 to 90	94.5	65	94.5
B-6	20 to 30	22.3	45	22.3

In borings B-5 and B-6, suspected native soil was encountered at depths of 85 and 13 feet, respectively. Our laboratory testing consisted of conducting several moisture contents and Atterberg limits tests. The moisture contents ranged from 6.6 to 26.9 percent. The Atterberg limits testing indicated liquid limits ranging from 28 to 44 with plasticity indexes ranging from 7 to 16. Based on these values, the soil within the mine spoil fill matrix is borderline between lean clay (CL) and silt (ML), with three samples indicated as clay and one sample indicated as silt.

Groundwater

Groundwater was encountered on the drilling tools at a depth of 9 feet in Boring B-1 and 8 feet in Boring B-6. Groundwater was not encountered in our other borings at the time of drilling. However, our experience indicates that groundwater does exist at the bottom of the mine spoil fill and within perched zones within the fill. Additionally, some damp to wet samples were encountered in our borings, supporting the likelihood of perched water. Our previous experience on mine spoil fill sites and research conducted by the Kentucky Geological Survey suggests that groundwater typically enters the fill from infiltration of surface water and through buried coal seams. Typically, groundwater issues when working in mine spoil fills are related to trapped or perched water which occurs in irregular, discontinuous locations within the overburden, or near a bedrock/soil interface. When these water-bearing strata are exposed in excavations, such as cut slopes and utility or footing trenches, they can

produce widely varying seepage duration and rates depending on recent rainfall activity and other site-specific characteristics of the area.

Discussion

There have been several developments on mine spoil fill sites throughout the region ranging from residential, commercial, educational, and industrial. The primary concerns of building on mine spoil fill sites is the amount of differential settlement that can occur. Settlement will generally result from two primary processes: the consolidation settlement of the fill under its own weight and degradation of the shale portion of the fill over time due to water infiltration. The initial settlement of mine spoil fills is primarily due to a reduction in void space within the material from self-weight. The amount of time for this primary initial settlement to occur will vary based on the individual site conditions. However, previous research indicates that for fills less than about 100 feet thick, the majority of the settlement occurs within the first 8 to 10 years after the mine spoil was placed. Additionally, research conducted by the Kentucky Geological Survey also indicates that the initial settlement in mine spoil studied at an Eastern Kentucky mine had occurred within 8 years of placement. Once the void space reduction occurs, additional initial settlement results for short-term compression as the fine-grained material is loaded. Short-term compression will continue until the stresses are distributed uniformly throughout the fill at which time long-term or secondary settlement begins.

After the initial settlement phase of mine spoil fills has occurred, the secondary settlement phase can produce significant magnitudes of settlement, although they are not as severe as the settlement for the initial phase. However, changes in water infiltration through subsurface groundwater recharge and/or surface water infiltration drastically affects the settlement of mine spoil fills.

Observations of numerous mine spoil sites in Eastern Kentucky generally indicate that on relatively new sites and sites that have been recently regraded, evidence of water infiltration from rainfall such as sinkholes and piping into the subsurface are common. On older sites large amounts of water infiltration into the surface of the mine

spoil fill is not as prevalent. This is evidenced by the presence of ponds and wetland type vegetation. On established mine spoil fill sites, the surface will develop a crust. The weathering process of the upper materials results in voids within the upper portions of the mine spoil becoming filled by the downward migration of small particles, thus increasing the density of the spoil and prohibiting the infiltration of water. Desiccation of the surface layer of mine spoil may also contribute to the formation of a surface crust. Desiccation is a process where the soil moisture in clay is drawn to the surface and evaporated. During this process, the clay becomes stiffer. Since natural precipitation does not expel more than a small part of the air contained in the voids of surface soil, cohesion in the soil can survive wet periods of long duration. However, once a site is disturbed by construction activity, the crust is disturbed, and the weathering process is reinitiated.

The age, placement methods and type of mine spoil material would indicate that the primary consolidation period for the site has been achieved. However, as mentioned, there is a risk of secondary consolidation that could take many years. Based on our prior research on similar sites, we are anticipating secondary settlements over the next 10 to 20 years for the fills less than 50 feet thick to range from 1 to 2 inches. For fills over 50 feet and less than 100 feet, we anticipate additional long-term settlement over the next 10 to 20 years will range from 1 ½ to 3 inches. Therefore, to reduce the risk of differential settlements, individual buildings should be located on a generally uniform fill thickness.

A higher risk concern is the amount of water infiltration that can occur soon after construction has been completed. Water infiltration can rapidly (within a few years) cause detrimental settlement issues. As previously mentioned, the weathering process of the upper materials results in voids within the mine spoil being filled eventually preventing infiltration of surface water. However, the process of regrading and developing a site for construction destroys this crust. Therefore, newly disturbed construction sites will allow the infiltration of water until the crusting process reestablishes itself. Therefore, it is imperative that any building or structure have adequate positive drainage away from the building. Additionally, all gutter downspouts

should be directed away from the buildings such that any water infiltration will not impact the building.

Our previous experience and research suggests that the hydrocompression process is accelerated by introduction of water into the subsurface from the forementioned gutters, septic tank fields, poor site drainage and runoff from paved and landscaped areas.

Site Preparation Recommendations

The current state of practice for developments on mine spoil fill sites has been developed as a result of the numerous failures that have occurred. Due to the unknown risks associated with the inability to predict the long-term performance of structures founded on mine spoil fill sites, very conservative and costly site development methods have become typical. Due to the risk of settlement potential of mine spoil fill sites, site preparation for buildings typically consists of massive undercutting and replacement with engineered recompacted mine spoil, preloading the site and/or dynamic compaction. These methods are very expensive and cannot provide a higher-than-normal confidence that the building will not experience detrimental settlement. Since this site is a residential development with lightly loaded structures, massive undercuts will not be cost effective and most likely will not greatly reduce the risk for the cost.

From our experience with mine spoil sites and the information obtained on this site, we believe that this site is suitable for the proposed residential development provided the owner understands and accepts the risk of building on old mine spoil fill sites. Individual houses can be designed based on general subsurface information provided in this report. For planning purposes, we recommend the following:

1. To provide a uniform bearing surface for the building and the building foundations, we recommend undercutting the entire building pad about 3 feet below the bottom of the planned foundation bearing depth. The undercut should extend at least 5 feet beyond the house footprint. 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.

2. The mine spoil fill must be relatively consistent in composition and relative density as determined by exploration of the site. For the proposed residential structures, we recommend dynamic cone penetrometer (DCP) testing within the foundation excavations prior to placing concrete. Statistical comparisons of the DCP values obtained provide an indication of the degree of compaction of the fill.

3. The mine spoil fill thickness must be consistent beneath the proposed building footprint. The risk of differential settlement due to varying mine spoil thickness under the building is not quantifiable. Therefore, to reduce the risk, the fill thickness should be consistent under any individual building.

4. The depth to bedrock must also be relatively consistent beneath the building locations. The buildings must not straddle areas of large variations in bedrock depths between benches or be located over a site with a partially buried mine bench.

Foundation Recommendations

The selection of the foundation type for the proposed development would typically consist of conventional shallow spread footings. However, considering the settlement potential of the mine spoil fill on site, 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 of 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.

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.

Seismic Site Classification

The current seismic design procedures outlined in the NEHRP (National Earthquake Hazard Reduction Program) guidelines mandate structural design loads be based on the seismic coefficients of the site. Based on the results of our exploration and the geology of the area, we assigned a **site seismic classification of “D”**.

LIMITATIONS OF RECOMMENDATIONS

This report should be considered a general evaluation and not applicable to specific buildings or structures. Once specific building locations are determined, additional geotechnical information will be required. When building on old mine spoil sites, the owner must understand and accept that no matter how much evaluation and exploration is conducted, there will be a risk of unsuitable building and structure performance. There are numerous documented building settlement and distress issues when building on old mine sites. Therefore, the information provided in this report is to assist in understanding, but not eliminating, the risk of building on this site.

This report has been prepared for the exclusive use of the Commonwealth of Kentucky for specific application to the project site. Our recommendations have been prepared using generally accepted standards of geotechnical engineering practice in the Commonwealth of Kentucky. No other warranty is expressed or implied. This company is not responsible for the conclusions, opinions, or recommendations of others based on these data. Additionally, our conclusions and recommendations are based on the information provided to us, the data obtained from our subsurface exploration, and our experience. They do not reflect variations in the subsurface conditions which are likely to exist between borings and in unexplored areas of the site. These variations result from the geologic variability of the subsurface conditions. If conditions are different than those encountered in our exploration, it will be necessary for us to re-evaluate our conclusions and recommendations based upon on-site observation of the conditions.

If the overall design or location of any of the elements of the project is changed, the recommendations contained in this report for that element must not be considered valid unless our firm reviews the changes, and our recommendations are modified. When the design is finalized, we should be given the opportunity to provide the additional service of reviewing the grading plan and applicable portions of the project specifications. This review will allow us to check whether these documents are consistent with the intent of our recommendations.

We may recommend that a supplementary exploration be performed when significant design changes such as the movement of a project element are incorporated

in the final design after the geotechnical exploration has been completed. This supplementary exploration may include obtaining additional soil data along the new alignment to provide specific recommendations.

Valediction

We appreciate your consideration of Vector for this work. We look forward to working with you on this and future projects.

Yours truly

VECTOR ENGINEERS, INC.



Matthew J. Slusser, PE
Project Geotechnical Engineer
Licensed Kentucky 32059



Wayne A. Kareem, PhD, PE, PG, D.GE
Principal Engineer

Attachments: Important Information about your Geotechnical Engineering Report
 Field Testing Procedures
 Laboratory Testing Procedures
 MASW Line Locations
 MASW Line Data (1 through 3)
 Boring Location Plan
 Soil Test Borings (B-1 through B-6)
 Laboratory Data Summary

Important Information about This Geotechnical-Engineering Report

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

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

The Geoprofessional Business Association (GBA) has prepared this advisory to help you – assumedly a client representative – interpret and apply this geotechnical-engineering report as effectively as possible. In that way, clients can benefit from a lowered exposure to the subsurface problems that, for decades, have been a principal cause of construction delays, cost overruns, claims, and disputes. If you have questions or want more information about any of the issues discussed below, contact your GBA-member geotechnical engineer. Active involvement in the Geoprofessional Business Association exposes geotechnical engineers to a wide array of risk-confrontation techniques that can be of genuine benefit for everyone involved with a construction project.

Geotechnical-Engineering 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 given civil engineer will not likely meet the needs of a civil-works constructor or even a different civil engineer. Because each geotechnical-engineering study is unique, each geotechnical-engineering report is unique, prepared *solely* for the client. *Those who rely on a geotechnical-engineering report prepared for a different client can be seriously misled.* No one except authorized client representatives should rely on this geotechnical-engineering report without first conferring with the geotechnical engineer who prepared it. *And no one – not even you – should apply this report for any purpose or project except the one originally contemplated.*

Read this Report in Full

Costly problems have occurred because those relying on a geotechnical-engineering report did not read it *in its entirety*. Do not rely on an executive summary. Do not read selected elements only. *Read this report in full.*

You Need to Inform Your Geotechnical Engineer about Change

Your geotechnical engineer considered unique, project-specific factors when designing the study behind this report and developing the confirmation-dependent recommendations the report conveys. A few typical factors include:

- the client's goals, objectives, budget, schedule, and risk-management preferences;
- the general nature of the structure involved, its size, configuration, and performance criteria;
- the structure's location and orientation on the site; and
- other planned or existing site improvements, such as retaining walls, access roads, parking lots, and underground utilities.

Typical changes that could erode the reliability of this report include those that affect:

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

As a general rule, *always* inform your geotechnical engineer of project changes – even minor ones – and request an assessment of their impact. *The geotechnical engineer who prepared this report cannot accept responsibility or liability for problems that arise because the geotechnical engineer was not informed about developments the engineer otherwise would have considered.*

This Report May Not Be Reliable

Do not rely on this report if your geotechnical engineer prepared it:

- for a different client;
- for a different project;
- for a different site (that may or may not include all or a portion of the original site); or
- before important events occurred at the site or adjacent to it; e.g., man-made events like construction or environmental remediation, or natural events like floods, droughts, earthquakes, or groundwater fluctuations.

Note, too, that it could be unwise to rely on a geotechnical-engineering report whose reliability may have been affected by the passage of time, because of factors like changed subsurface conditions; new or modified codes, standards, or regulations; or new techniques or tools. *If your geotechnical engineer has not indicated an "apply-by" date on the report, ask what it should be, and, in general, if you are the least bit uncertain about the continued reliability of this report, contact your geotechnical engineer before applying it.* A minor amount of additional testing or analysis – if any is required at all – could prevent major problems.

Most of the "Findings" Related in This Report Are Professional Opinions

Before construction begins, geotechnical engineers explore a site's subsurface through various sampling and testing procedures. *Geotechnical engineers can observe actual subsurface conditions only at those specific locations where sampling and testing were performed.* The data derived from that sampling and testing were reviewed by your geotechnical engineer, who then applied professional judgment to form opinions about subsurface conditions throughout the site. Actual sitewide-subsurface conditions may differ – maybe significantly – from those indicated in this report. Confront that risk by retaining your geotechnical engineer to serve on the design team from project start to project finish, so the individual can provide informed guidance quickly, whenever needed.

This Report's Recommendations Are Confirmation-Dependent

The recommendations included in this report – including any options or alternatives – are confirmation-dependent. In other words, *they are not final*, because the geotechnical engineer who developed them relied heavily on judgment and opinion to do so. Your geotechnical engineer can finalize the recommendations *only after observing actual subsurface conditions* revealed during construction. If through observation your geotechnical engineer confirms that the conditions assumed to exist actually do exist, the recommendations can be relied upon, assuming no other changes have occurred. *The geotechnical engineer who prepared this report cannot assume responsibility or liability for confirmation-dependent recommendations if you fail to retain that engineer to perform construction observation.*

This Report Could Be Misinterpreted

Other design professionals' misinterpretation of geotechnical-engineering reports has resulted in costly problems. Confront that risk by having your geotechnical engineer serve as a full-time member of the design team, to:

- confer with other design-team members,
- help develop specifications,
- review pertinent elements of other design professionals' plans and specifications, and
- be on hand quickly whenever geotechnical-engineering guidance is needed.

You should also confront the risk of constructors misinterpreting this report. Do so by retaining your geotechnical engineer to participate in prebid and preconstruction conferences and to perform construction observation.

Give Constructors a Complete Report and Guidance

Some owners and design professionals mistakenly believe they can shift unanticipated-subsurface-conditions liability to constructors by limiting the information they provide for bid preparation. To help prevent the costly, contentious problems this practice has caused, include the complete geotechnical-engineering report, along with any attachments or appendices, with your contract documents, *but be certain to note conspicuously that you've included the material for informational purposes only*. To avoid misunderstanding, you may also want to note that "informational purposes" means constructors have no right to rely on the interpretations, opinions, conclusions, or recommendations in the report, but they may rely on the factual data relative to the specific times, locations, and depths/elevations referenced. Be certain that constructors know they may learn about specific project requirements, including options selected from the report, *only* from the design drawings and specifications. Remind constructors that they may

perform their own studies if they want to, and *be sure to allow enough time* to permit them to do so. Only then might you be in a position to give constructors the information available to you, while requiring them to at least share some of the financial responsibilities stemming from unanticipated conditions. Conducting prebid and preconstruction conferences can also be valuable in this respect.

Read Responsibility Provisions Closely

Some client representatives, design professionals, and constructors do not realize that geotechnical engineering is far less exact than other engineering disciplines. That lack of understanding has nurtured unrealistic expectations that have resulted in disappointments, delays, cost overruns, claims, and disputes. To confront that risk, geotechnical engineers commonly include 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 personnel, equipment, and techniques used to perform an environmental study – e.g., a "phase-one" or "phase-two" environmental site assessment – differ significantly from those used to perform a geotechnical-engineering study. For that reason, a geotechnical-engineering report does not usually relate any environmental findings, conclusions, or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. *Unanticipated subsurface environmental problems have led to project failures*. If you have not yet obtained your own environmental information, ask your geotechnical consultant for risk-management guidance. As a general rule, *do not rely on an environmental report prepared for a different client, site, or project, or that is more than six months old*.

Obtain Professional Assistance to Deal with Moisture Infiltration and Mold

While your geotechnical engineer may have addressed groundwater, water infiltration, or similar issues in this report, none of the engineer's services were designed, conducted, or intended to prevent uncontrolled migration of moisture – including water vapor – from the soil through building slabs and walls and into the building interior, where it can cause mold growth and material-performance deficiencies. Accordingly, *proper implementation of the geotechnical engineer's recommendations will not of itself be sufficient to prevent moisture infiltration*. Confront the risk of moisture infiltration by including building-envelope or mold specialists on the design team. *Geotechnical engineers are not building-envelope or mold specialists*.



Telephone: 301/565-2733

e-mail: info@geoprofessional.org www.geoprofessional.org

FIELD TESTING PROCEDURES

Vector Engineers performs field tests in general accordance with the American Society for Testing and Materials (ASTM). These procedures are generally recognized as the basis for uniformity and consistency of test results in the geotechnical engineering profession. All work is initiated and supervised by qualified geotechnical professionals.

Subsequent portions of this attachment briefly describe of our field testing procedures. Where applicable, we have referenced these procedures to ASTM standards which contain specific descriptions of apparatus, procedures, reporting, etc.

SOIL TEST BORING, ASTM D-1586

The borings were made with a hollow-stem auger powered by a drill rig. At regular intervals, soil samples were obtained through the hollow augers with a standard 1.4-inch I.D., 2.0-inch O.D. split-tube sampler. On this site a casing advancer was used to penetrate the mine spoil fills.

The sampler was initially seated 6 inches to penetrate any loose cuttings; then driven an additional foot with blows of a 140-pound hammer falling 30 inches. The number of hammer blows required to drive the sampler the final foot was recorded and is designated as the *standard penetration resistance (SPT N-value)*. Penetration resistance, when properly evaluated, is an index to soil consistency and strength.

In the field, our geotechnical professional logged and described the samples as they were obtained. Representative portions of each soil sample were labeled and sealed, then transported to our laboratory. The samples were examined by a graduate geotechnical engineer or geologist to visually check the field descriptions. Boring data, including sample intervals, penetration resistances, soil descriptions, and groundwater levels are shown on the attached Test Boring Records.

AUGER REFUSAL MATERIALS

Auger refusal is a term that describes subsurface materials sufficiently competent to prevent further penetration by our drilling augers. Our criterion for auger refusal is the inability of our drill rig to advance the augers with 300 psi down pressure. Typically, refusal materials exhibit penetration resistances in excess of 100 blows per foot. Refusal materials can be hard cemented soil, soft weathered rock, coarse gravel or boulders, rubble or other hard debris, thin rock seams, or the upper surface of sound, continuous rock. Core drilling procedures are required to determine the character and continuity of refusal materials.

FIELD TESTING PROCEDURES

CORRELATION OF STANDARD PENETRATION RESISTANCE WITH RELATIVE COMPACTNESS AND CONSISTENCY

Sand and Gravel

Standard Penetration Resistance

Blows/Foot

0-4
5-10
11-20
21-30
31-50
Over 50

Relative Compactness

Very Loose
Loose
Firm
Very Firm
Dense
Very Dense

Silt and Clay

Standard Penetration Resistance

Blows/Foot

0-2
3-4
5-8
9-15
16-30
31-50
Over 50

Consistency

Very Soft
Soft
Firm
Stiff
Very Stiff
Hard
Very Hard

FIELD TESTING PROCEDURES

ROCK CORING, ASTM D-2113

After we encountered refusal to the power auger, steel casing was inserted in the borehole so that overlying soil and rock materials would not collapse and block the drilling tools. Then refusal materials were cored using a diamond-studded bit fastened to the end of a hollow tube core barrel. This device was rotated at high speed by the drill rig, and the cuttings were brought to the surface by circulating water. Core samples of the materials penetrated were protected and retained in the swivel-mounted inner tube of the core barrel. Upon completion of each coring "run", the core barrel was brought to the surface and the samples removed and placed in core boxes. The samples were logged in the field by the driller, then returned to the laboratory.

At the laboratory, the rock's relative hardness, percent recovery, and rock quality designation were determined by a geotechnical engineer or geologist. Criteria for defining hardness are listed below

Recovery is the ratio of the sample length obtained to the length of core run, expressed as a percent. The percent recovery is related to rock soundness and continuity. Rock descriptions and recoveries are shown on the Test Boring Records.

The rock quality designation (RQD) is also a way of describing the rock soundness and continuity. RQD is the ratio of the sum of the lengths of rock pieces 4 or more inches long to the length of the core run expressed as a percent. Rock described as a function of RQD is as follows:

FIELD TESTING PROCEDURES

RELATIVE HARDNESS OF ROCK

Very Soft	Pieces 1 inch or more in thickness can be broken by finger pressure; can be scratched readily by fingernail
Soft	May be broken with fingers.
Medium	May be scratched with a nail; corners and edges may be broken with fingers.
Moderately Hard	Moderate blow of hammer required to break the sample.
Hard	Hard blow of hammer required to break the sample.
Very Hard	Several hard blows of hammer required to break the sample.

RELATIVE QUALITY OF ROCK CORES

<u>Quality:</u>	<u>RQD:</u>
Very Poor	0 to 25%
Poor	25 to 50%
Fair	50 to 75%
Good	75 to 90%
Excellent	90 to 100%

LABORATORY TESTING PROCEDURES

The laboratory tests are performed in general accordance with the American Society for Testing and Materials (ASTM). These procedures are generally recognized as the basis for uniformity and consistency of test results in the geotechnical engineering profession. The tests are performed by skilled technicians trained in ASTM procedures. The laboratory equipment is well maintained and calibrated at least yearly.

Subsequent portions of this attachment present briefly describe of our testing procedures. Where applicable, we have referenced these procedures to ASTM standards which contain specific descriptions of apparatus, procedures, reporting, etc.

MOISTURE CONTENT DETERMINATION, ASTM D-2216

The moisture content of soils is an indicator of various physical properties, including strength and compressibility. Selected samples obtained during exploratory drilling were taken from their sealed containers. Each sample was weighed and then placed in an oven heated to $110^{\circ}\text{C} \pm 5^{\circ}$. The sample remained in the oven until the free moisture had evaporated. The dried sample was removed from the oven, allowed to cool, and re-weighed. The moisture content was computed by dividing the weight of evaporated water by the weight of the dry sample. The results are expressed as a percent.

ATTERBERG LIMITS DETERMINATION, ASTM D-4318

Representative samples were subjected to Atterberg limits testing to determine the soil's plasticity characteristics. The plasticity index (PI) is the range of moisture content through which the soil deforms as a plastic material. It is bracketed by the liquid limit (LL) and the plastic limit (PL). The liquid limit is the moisture content at which the soil becomes wet enough to flow as a viscous fluid. To determine the liquid limit, a soil specimen is first washed through a No. 40 sieve. The materials finer than the No. 40 sieve are retained and dried until the soil is in a viscous fluid state. A portion of this soil is then placed in a brass cup of standardized dimensions. A groove is cut through the middle of the soil specimen with a grooving tool of standard dimensions. The cup is attached to a cam that lifts the cup 10 mm and then allows the cup to fall onto a hard rubber base. The cam is rotated at about 2 cps until the two halves of the soil specimen come in contact at the bottom of the groove for a distance of 1/2 inch. The number of blows required to achieve this 1/2 inch contact is recorded, and part of the specimen is subjected to a moisture content determination. The remainder of the specimen is allowed to air dry for a short time, and the grooving process and cam action repeated. This testing sequence is repeated until more than 25 blows are required to achieve the required groove contact. After the number of blows vs. moisture content for the various test points are plotted on arithmetic graph paper, the moisture content corresponding to 25 blows is designated the liquid limit.

The plastic limit (PL) is the lowest moisture content at which the soil is sufficiently plastic to be manually rolled into threads 1/8" in diameter. The plastic limit is

LABORATORY TESTING PROCEDURES

determined by taking a part of soil remaining from the liquid limit test, and repeatedly rolling, kneading, and air drying it until the soil breaks into threads about 1/8 inches in diameter and 3/8 inches long. The moisture content of these soil threads is then determined and is designated the plastic limit.

MASW Profile L1 Figure 5

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

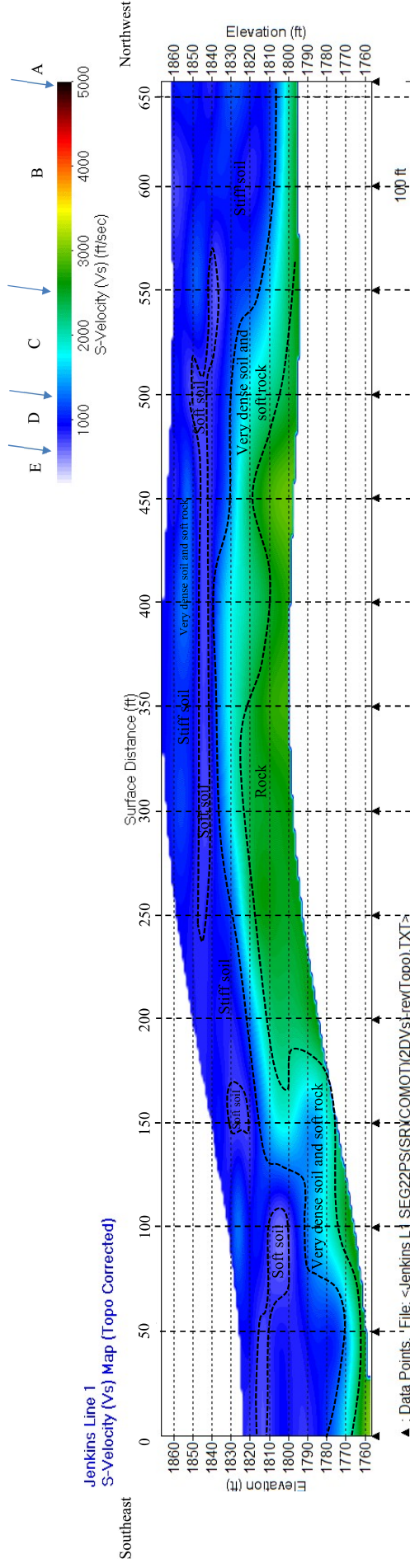
Table 2. Scale used in velocity profile with site classification, standard penetration values (N) and undrained shear strength. Values from IBC 2006 Table 1613.5.2 Site Class Definitions (section 1613.5.50).

Figure 5 Line 1

Table 1 Site Class definitions partially reproduced below

Site Class	Soil Profile Name	Average Properties in Top 100 feet (as per 2000 IBC section 1613.1.5) Soil Shear Wave Velocity, V_s
A	Hard Rock	Feet/second $V_s > 5000$
B	Rock	Meters/second $V_s > 1524$
C	Very dense soil and soft rock	$2500 < V_s \leq 5000$ $762 < V_s \leq 1524$
D	Stiff soil profile	$1200 < V_s \leq 2500$ $366 < V_s \leq 762$
E	Soft soil profile	$600 < V_s \leq 1200$ $183 < V_s \leq 366$

Site Classifications adopted from Table 1615.1.1 Site Class Definitions published in 2000 International Building code, International Code Council, Inc. on page 350.



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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 Grand View Neighborhood
Jenkins, KY

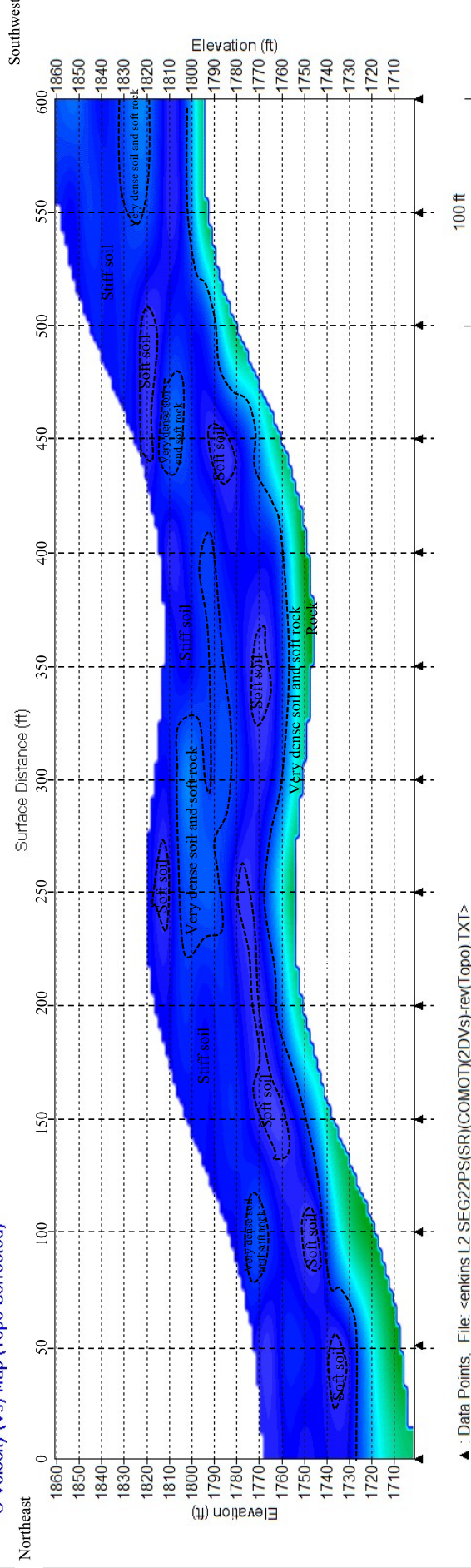
MASW Profile L2 Figure 6

Figure 6 Line 2

Soil Class	Soil Profile Name	Average Properties in Top 100 feet (as per 2000 IBC section 1613.1.5)
A	Hard Rock	Feet/second Meters/second $V_s > 5000$ $V_s > 1524$
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.

Jenkins Line 2
S-Velocity (Vs) Map (Topo Corrected)



▲ : Data Points, File: <enkins L2 SEG22PS(SR)(COMOT)(2DVs).rev(Topo).TXT>



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

Horizontal Scale (feet): as shown
Vertical Scale (feet): as shown

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Vector Engineers, Inc.
Proposed Grand View Neighborhood
Jenkins, KY

MASW Profile L3 Figure 7

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

Figure 7 Line 3

Jenkins Line 3
S-Velocity (Vs) Map (Topo Corrected)

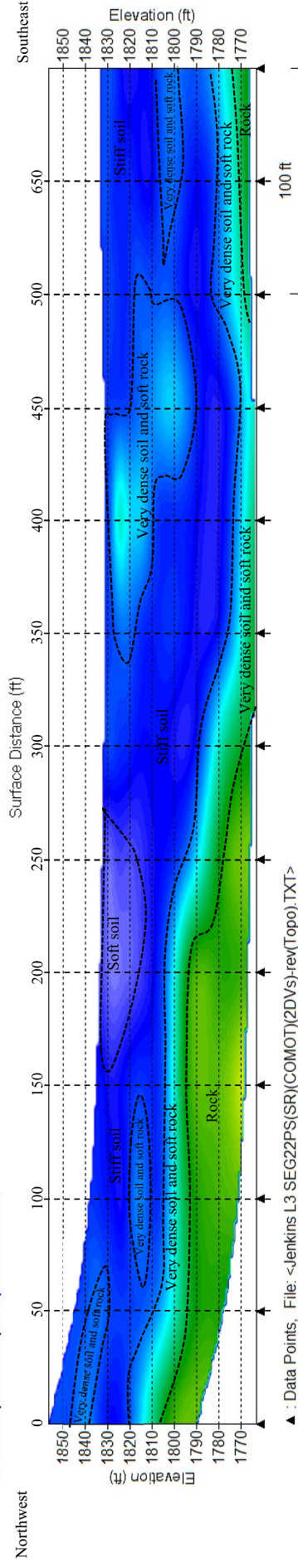


Table 1 Site Class definitions partially reproduced below

Site Class	Soil Profile Name	Average Properties in Top 100 feet (as per 2000 IBC section 1613.1.5) Soil Shear Wave Velocity, V_s
A	Hard Rock	Feet/second Meters/second $V_s > 5000$ $V_s > 1524$
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.



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Figure 7, MASW Profile Line 3
Drawn By: Thomas Brackman

Horizontal Scale (feet): as shown
Vertical Scale (feet): as shown

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Jenkins, KY

Figure 8 MASW Overlay

MASW Overlay
Figure 8



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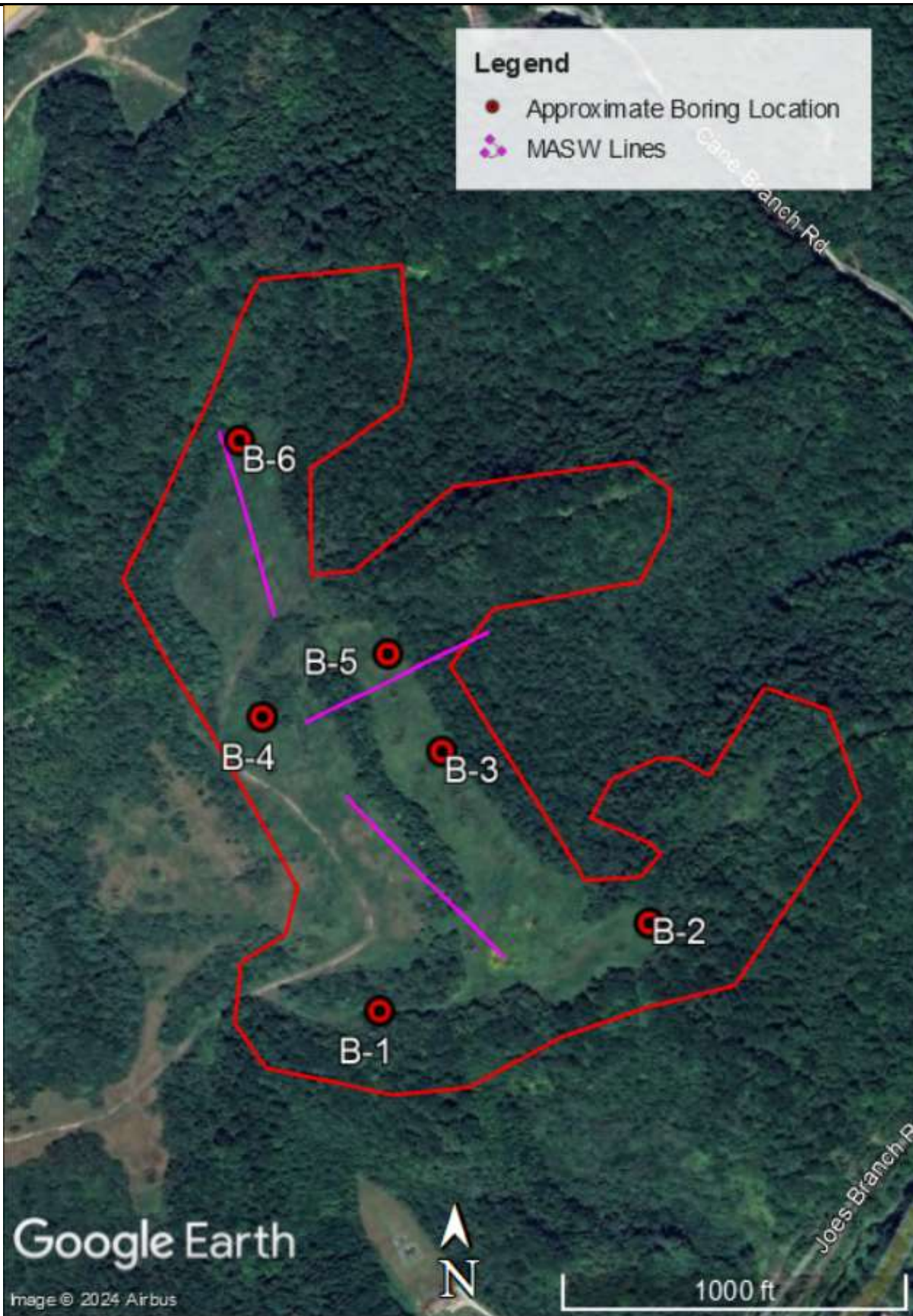
Figure 8, MASW Overlay
Drawn By: Thomas Brackman

Horizontal Scale (feet): as shown
Vertical Scale (feet): as shown

MASW Survey
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Legend

- Approximate Boring Location
- MASW Lines



Commonwealth of
Kentucky

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Boring Location Plan
Grandview Neighborhood
Jenkins, Kentucky
Vector Project 24050001SHE

TEST BORING RECORD

CLIENT : Kentucky Finance Cabinet
 PROJECT : Grand View Neighborhood - Johnson Property
 LOCATION : Jenkins, Kentucky
 PROJECT NO. : 24.05.0001SHE

BORING NO.: **B-1**
 SHEET 1 OF 1
 DATE STARTED : 02-19-24
 DATE COMPLETED : 02-19-24

BORING ELEVATION : 1826.0 Feet
 STATION :
 OFFSET :
 DEPTH : 24.0 Feet
 BORING METHOD : 2 1/4" S.F.A.
 RIG TYPE : Acker Rebel
 CASING DIA. :
 CORE SIZE : NQ
 HAMMER : Automatic
 DRILLER : Strata D Dunaway
 TEMPERATURE : 50s
 WEATHER : Sunny

GROUNDWATER: ☒ Encountered at 9 feet ☐ At completion ☐ Delayed Reading ☒ Caved in at

STRATUM ELEVATION	SAMPLE DEPTH	SOIL/MATERIAL DESCRIPTION	STRATUM DEPTH	SAMPLE NUMBER	SPT per 6"	BLOWS per 12" (N)	RECOVERY (in)	MOISTURE CONTENT	TOTAL UNIT WEIGHT pcf	UNCONF. COMP., ksf	ATTERBERG LIMITS		
											LL	PL	PI
1825.0		MINE SPOIL - HARD, gray, silty LEAN CLAY (CL), with coal, organics and abundant rock fragments, moist	1.0	SS-1	4	44	18						
1824.5		MINE SPOIL - WEATHERED SANDSTONE	1.5	SS-2	16	45	18						
1822.5		MINE SPOIL - HARD, gray, silty LEAN CLAY (CL), with rock fragments and coal, moist	3.5	SS-3	28								
	5	MINE SPOIL - HARD, light gray, silty LEAN CLAY (CL), with trace sand, dry Apparent boulder at 4 feet		SS-4	50/2"		2						
1817.0			9.0	SS-5	3	14	13	19			35	24	11
1812.5		MINE SPOIL - STIFF, light brown with gray, LEAN CLAY (CL), with rock fragments, moist Perched water at 9 feet	13.5	SS-6	6								
	15	MINE SPOIL - HARD, gray, LEAN CLAY (CL), moist Weathered rock starting at 14 feet			16		12	18					
1807.0			19.0		50/4"								
	20	Auger refusal at 19 feet; begin coring MEDIUM HARD, gray to black, fine grained SANDSTONE with trace to some mica		CR-1			56						
1802.0			24.0	RQD=									
	25	Coring terminated at 24 feet		98%									
	30												
	35												



BORING METHOD
 HSA - Hollow Stem Auger
 SFA - Solid Flight Auger
 RC - Rock Coring
 MD - Mud Drilling
 WD - Wash Drilling
 HA - Hand Auger

SAMPLING METHOD
 SS - Split Spoon Sample
 ST - Shelby Tube Sample
 CR - Rock Core Sample
 BS - Bag Sample

ABBREVIATIONS
 * - Hand Penetrometer
 LL - Liquid Limit
 PL - Plastic Limit
 PI - Plasticity Index
 SPT - Standard Penetration Test

TEST BORING RECORD

CLIENT : Kentucky Finance Cabinet
 PROJECT : Grand View Neighborhood - Johnson Property
 LOCATION : Jenkins, Kentucky
 PROJECT NO. : 24.05.0001SHE

BORING NO.: **B-2**
 SHEET 1 OF 1
 DATE STARTED : 02-19-24
 DATE COMPLETED : 02-20-24

BORING ELEVATION : 1843.0 Feet
 STATION :
 OFFSET :
 DEPTH : 24.0 Feet
 BORING METHOD : 2 1/4" S.F.A.
 RIG TYPE : Acker Rebel
 CASING DIA. :
 CORE SIZE : NQ
 HAMMER : Automatic
 DRILLER : Strata D Dunaway
 TEMPERATURE : 50s
 WEATHER : Sunny

GROUNDWATER: ☒ Encountered at Dry ☐ At completion ☐ Delayed Reading ☐ Caved in at

STRATUM ELEVATION	SAMPLE DEPTH	SOIL/MATERIAL DESCRIPTION	STRATUM DEPTH	SAMPLE NUMBER	SPT per 6"	BLOWS per 12" (N)	RECOVERY (in)	MOISTURE CONTENT	TOTAL UNIT WEIGHT pcf	UNCONF. COMP., ksf	ATTERBERG LIMITS		
											LL	PL	PI
1842.7		TOPSOIL (3 inches)	0.3		9								
1841.5		MINE SPOIL - STIFF, gray, LEAN CLAY (CL), with rock fragments and coal, moist	1.5	SS-1	10	15	11						
		MINE SPOIL - HARD, gray, LEAN CLAY (CL), with rock and coal fragments highly weathered sandstone, moist	3.5	SS-2	35	51	15						
1839.5					17								
	5	MINE SPOIL - STIFF, gray, LEAN CLAY (CL), with rock fragments, moist	6.0	SS-3	6	11	14						
1837.0					5								
		MINE SPOIL - HARD, gray, silty LEAN CLAY (CL), with rock fragments and highly weathered sandstone, dry	8.5	SS-4	2	45	8						
1834.5					2								
	10	MINE SPOIL - STIFF, gray, CLAYEY SAND (SC), with trace rock fragments, dry	13.5	SS-5	3	12	8						
					5								
1829.5					7								
	15	MINE SPOIL - HARD, black, silty LEAN CLAY (CL), with rock fragments, moist (weathered shale)	18.5	SS-6	3	26	15	26					
					5								
1824.5					21								
1824.0		MINE SPOIL - HARD, gray to brown, silty LEAN CLAY (CL) with few fine sand, moist (weathered shale and sandstone)	19.0	SS-7	50/2"	2	19						
	20	Auger refusal 19 feet; begin coring MEDIUM HARD, brown, fine grained SANDSTONE		CR-1									
				RQD=									
				77%									
1819.0			24.0										
	25	Coring terminated at 24 feet											
	30												
	35												



BORING METHOD
 HSA - Hollow Stem Auger
 SFA - Solid Flight Auger
 RC - Rock Coring
 MD - Mud Drilling
 WD - Wash Drilling
 HA - Hand Auger

SAMPLING METHOD
 SS - Split Spoon Sample
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ABBREVIATIONS
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OLD TEST BORING/PIT RECORD BORING LOGS B1 B6.GPJ NEW CTL.GDT 3/20/24

TEST BORING RECORD

CLIENT : Kentucky Finance Cabinet
 PROJECT : Grand View Neighborhood - Johnson Property
 LOCATION : Jenkins, Kentucky
 PROJECT NO. : 24.05.0001SHE

BORING NO.: B-3
 SHEET 1 OF 3
 DATE STARTED : 02-20-24
 DATE COMPLETED : 02-20-24

BORING ELEVATION : <u>1826.0 Feet</u>	BORING METHOD : <u>2 1/4" S.F.A.</u>	HAMMER : <u>Automatic</u>
STATION : _____	RIG TYPE : <u>Acker Rebel</u>	DRILLER : <u>Strata D Dunaway</u>
OFFSET : _____	CASING DIA. : _____	TEMPERATURE : <u>50s</u>
DEPTH : <u>101.0 Feet</u>	CORE SIZE : <u>NQ</u>	WEATHER : <u>Sunny</u>

GROUNDWATER: ☒ Encountered at Dry ☐ At completion ☐ Delayed Reading ☐ Caved in at

STRATUM ELEVATION	SAMPLE DEPTH	SOIL/MATERIAL DESCRIPTION	STRATUM DEPTH	SAMPLE NUMBER	SPT per 6"	BLOWS per 12" (N)	RECOVERY (in)	MOISTURE CONTENT	TOTAL UNIT WEIGHT pcf	UNCONF. COMP., ksf	ATTERBERG LIMITS		
											LL	PL	PI
1820.0	5	MINE SPOIL - VERY STIFF to STIFF, brown to gray, LEAN CLAY (CL), with shale, sandstone and coal, moist Note: About 75% of rock fragments are SHALE	6.0	SS-1	3 15	20	18						
				SS-2	15 12 10	22	14						
				SS-3	7 5 5	10	15						
				SS-4	4 4 3	7	12						
	10			SS-5	3 2 6	8	18						
1802.5	15	MINE SPOIL - FIRM to STIFF, brown to gray, LEAN CLAY (CL) with rock fragments, moist (WEATHERED SHALE and SANDSTONE) Note: About 60% of rock fragments were SANDSTONE	23.5	SS-6	3 6 8	14	18						
	20			SS-7	6 3 4	7	8						
	25			SS-8	6 5 6	11	12						
	30	MINE SPOIL - FIRM to STIFF, gray to black, LEAN CLAY (CL), with rock fragments, wet Changes to gray and brown at 29 feet with few fine sand, weathered rock at 32.5 feet		SS-9	6 3 5	8	12						
	35	Auger refusal at 34 feet; begin coring		SS-10	50/0		0						



BORING METHOD

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TEST BORING RECORD

CLIENT : Kentucky Finance Cabinet

BORING NO.: **B-3**

PROJECT : Grand View Neighborhood - Johnson Property

SHEET 2 OF 3

STRATUM ELEVATION	SAMPLE DEPTH	SOIL/MATERIAL DESCRIPTION	STRATUM DEPTH	SAMPLE NUMBER	SPT per 6"	BLOWS per 12" (N)	RECOVERY (in)	MOISTURE CONTENT	TOTAL UNIT WEIGHT pcf	UNCONF. COMP., ksf	ATTERBERG LIMITS		
											LL	PL	PI
1787.0	40	FILL - SANDSTONE Auger refusal at 34 feet; begin coring	39.0	SS-11	16 50/4"		6						
1782.5	45	MINE SPOIL - HARD, gray and black, LEAN CLAY (CL), with rock fragments, wet	43.5	SS-12	8 7 8	15	14						
	50	MINE SPOIL - STIFF, gray SANDY CLAY (CL), with weathered rock fragments, wet		SS-13	5 5 7	12	12						
1772.5	55		53.5	SS-14	6 7 11	18	12						
	60			SS-15	6 7 9	16	12						
	65	MINE SPOIL - STIFF to VERY STIFF, LEAN CLAY (CL), moist		SS-16	4 4 7	11	4						
	70	Note: brown at 64 feet back to gray at 69 feet. No recovery 74 - 75.5 and 89 to 90.5 feet		SS-17	5 5 5	10	4						
	75			SS-18	6 4 8	12	0						
	80			SS-19	8 8 14	22	1						



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OLD TEST BORING/PIT RECORD BORING LOGS B1 B6.GPJ NEW CTL.GDT 3/20/24

TEST BORING RECORD

CLIENT : Kentucky Finance Cabinet
PROJECT : Grand View Neighborhood - Johnson Property

BORING NO.: **B-3**
SHEET 3 OF 3

STRATUM ELEVATION	SAMPLE DEPTH	SOIL/MATERIAL DESCRIPTION	STRATUM DEPTH	SAMPLE NUMBER	SPT per 6"	BLOWS per 12" (N)	RECOVERY (in)	MOISTURE CONTENT	TOTAL UNIT WEIGHT pcf	UNCONF. COMP., ksf	ATTERBERG LIMITS		
											LL	PL	PI
	85	MINE SPOIL - STIFF to VERY STIFF, LEAN CLAY (CL), moist Note: brown at 64 feet back to gray at 69 feet. No recovery 74 - 75.5 and 89 to 90.5 feet											
	90			SS-21	4 4 5	9	0						
	95												
1728.0			98.0										
	100	MINE SPOIL - HARD, brown to gray, LEAN CLAY (CL), with rock fragments, moist		SS-23	24 17 16	33	0						
1725.0		Auger refusal at 101 feet; boring terminated	101.0										
	105												
	110												
	115												
	120												
	125												



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TEST BORING RECORD

CLIENT : Kentucky Finance Cabinet
 PROJECT : Grand View Neighborhood - Johnson Property
 LOCATION : Jenkins, Kentucky
 PROJECT NO. : 24.05.0001SHE

BORING NO.: **B-4**
 SHEET 1 OF 3
 DATE STARTED : 02-22-24
 DATE COMPLETED : 02-22-24

BORING ELEVATION : 1885.0 Feet
 STATION :
 OFFSET :
 DEPTH : 93.7 Feet
 BORING METHOD : 2 1/4" S.F.A.
 RIG TYPE : Acker Rebel
 CASING DIA. :
 CORE SIZE : NQ
 HAMMER : Automatic
 DRILLER : Strata D Dunaway
 TEMPERATURE : 50s
 WEATHER : Cloudy

GROUNDWATER: ☒ Encountered at Dry ☐ At completion ☐ Delayed Reading ☐ Caved in at

STRATUM ELEVATION	SAMPLE DEPTH	SOIL/MATERIAL DESCRIPTION	STRATUM DEPTH	SAMPLE NUMBER	SPT per 6"	BLOWS per 12" (N)	RECOVERY (in)	MOISTURE CONTENT	TOTAL UNIT WEIGHT pcf	UNCONF. COMP., ksf	ATTERBERG LIMITS		
											LL	PL	PI
1884.9		TOPSOIL (1 inch)	0.1	SS-1	11	16	16						
		MINE SPOIL - WEATHERED SHALE with some LEAN CLAY (CL) and sandstone and coal fragments, moist		SS-2	10	7	14						
1881.5		No coal fragments 1.5 to 3 feet	3.5		7								
	5			SS-3	6	7	12	9					
		MINE SPOIL - FIRM, gray to black, LEAN CLAY (CL), with rock fragments, moist		SS-4	6	7	12	7			28	21	7
1876.5			8.5		4								
	10	MINE SPOIL - WEATHERED SHALE		SS-5	12	29	12						
1874.0			11.0		10								
	15			SS-6	3	8	9						
					4								
	20	MINE SPOIL - VERY LOOSE to FIRM, CLAYEY GRAVEL (GC), with trace sand, wet (weathered shale)		SS-7	6	15	6						
					8								
	25			SS-8	3	7	9						
					4								
1857.0			28.0		5	10	6						
	30	MINE SPOIL - LOOSE, FINE to MEDIUM CLAYEY SAND (SC), with rock fragments, wet		SS-9	5								
					5								
1852.0			33.0		5		7						
	35	MINE SPOIL - WEATHERED SANDSTONE with trace clay		SS-10	50/3"								



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OLD TEST BORING/PIT RECORD BORING LOGS B1 B6.GPJ NEW.CTL.GDT 3/20/24

TEST BORING RECORD

CLIENT : Kentucky Finance Cabinet

BORING NO.: **B-4**

PROJECT : Grand View Neighborhood - Johnson Property

SHEET 2 OF 3

STRATUM ELEVATION	SAMPLE DEPTH	SOIL/MATERIAL DESCRIPTION	STRATUM DEPTH	SAMPLE NUMBER	SPT per 6"	BLOWS per 12" (N)	RECOVERY (in)	MOISTURE CONTENT	TOTAL UNIT WEIGHT pcf	UNCONF. COMP., ksf	ATTERBERG LIMITS		
											LL	PL	PI
1842.0	40	MINE SPOIL - WEATHERED SANDSTONE with trace clay	43.0	SS-11	8 10 11	21	5						
1837.0	45	MINE SPOIL - WEATHERED SHALE with some coal and trace sand	48.0	SS-12	5 6 22	28	11						
1827.0	50	MINE SPOIL - WEATHERED SANDSTONE with few sand and trace clay	58.0	SS-13	11 15 15	30	6						
	55												
	60			SS-14	19 50/5"		10						
	65												
	70	MINE SPOIL - HARD to VERY STIFF, brown and gray, LEAN CLAY (CL), moist, with sandstone fragments and trace organics around 80 feet		SS-15	5 9 12	21	14						
	75												
1807.0	80	MINE SPOIL - SHALE with sandstone fragments	78.0	SS-16	13 23 12	35	6						



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OLD TEST BORING/PIT RECORD BORING LOGS B1 B6.GPJ NEW CTL.GDT 3/20/24

TEST BORING RECORD

CLIENT : Kentucky Finance Cabinet
PROJECT : Grand View Neighborhood - Johnson Property

BORING NO.: **B-4**
SHEET 3 OF 3

STRATUM ELEVATION	SAMPLE DEPTH	SOIL/MATERIAL DESCRIPTION	STRATUM DEPTH	SAMPLE NUMBER	SPT per 6"	BLOWS per 12" (N)	RECOVERY (in)	MOISTURE CONTENT	TOTAL UNIT WEIGHT pcf	UNCONF. COMP., ksf	ATTERBERG LIMITS			
											LL	PL	PI	
1791.3	85	MINE SPOIL - SHALE with sandstone fragments		SS-17	11 50/5"		8							
	90													
	95	Auger refusal at 93.7 feet; boring terminated			93.7									
	100													
	105													
	110													
	115													
	120													
	125													



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TEST BORING RECORD

CLIENT : Kentucky Finance Cabinet
 PROJECT : Grand View Neighborhood - Johnson Property
 LOCATION : Jenkins, Kentucky
 PROJECT NO. : 24.05.0001SHE

BORING NO.: **B-5**
 SHEET 1 OF 3
 DATE STARTED : 02-21-24
 DATE COMPLETED : 02-21-24

BORING ELEVATION : 1819.0 Feet
 STATION :
 OFFSET :
 DEPTH : 94.5 Feet

BORING METHOD : 2 1/4" S.F.A.
 RIG TYPE : Acker Rebel
 CASING DIA. :
 CORE SIZE : NQ

HAMMER : Automatic
 DRILLER : Strata D Dunaway
 TEMPERATURE : 50s
 WEATHER : Sunny

GROUNDWATER: ☒ Encountered at Dry ☐ At completion ☐ Delayed Reading ☐ Caved in at

STRATUM ELEVATION	SAMPLE DEPTH	SOIL/MATERIAL DESCRIPTION	STRATUM DEPTH	SAMPLE NUMBER	SPT per 6"	BLOWS per 12" (N)	RECOVERY (in)	MOISTURE CONTENT	TOTAL UNIT WEIGHT pcf	UNCONF. COMP., ksf	ATTERBERG LIMITS		
											LL	PL	PI
1818.9		TOPSOIL (1 inch)	0.1	SS-1	7	28	15						
		MINE SPOIL - WEATHERED ROCK with sand and trace clay and coal fragments		SS-2	12	17	15						
1815.5		Transitions to brown, sandy clay towards bottom	3.5		11								
	5			SS-3	4	8	18						
				SS-4	2	7	8	16					
	10			SS-5	6	9	12						
		MINE SPOIL - FIRM TO STIFF, black to gray, LEAN CLAY (CL), with rock fragments, moist		SS-6	3	8	11	8			34	22	12
	15			SS-7	3	12	18	18					
	20				9								
1795.5			23.5	SS-8	50/4"		4						
	25	MINE SPOIL - HARD, gray, SANDY CLAY (CL), moist											
		Highly weathered sandstone boulder at 29-31.5 feet		SS-9	50/0"		0						
	30												
1786.0			33.0	SS-10	10	15	8						
	35	MINE SPOIL - STIFF, gray, LEAN CLAY (CL), with rock fragments, moist			7								
					8								



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OLD TEST BORING/PIT RECORD BORING LOGS B1 B6.GPJ NEW CTL.GDT 3/20/24

TEST BORING RECORD

CLIENT : Kentucky Finance Cabinet

BORING NO.: **B-5**

PROJECT : Grand View Neighborhood - Johnson Property

SHEET 2 OF 3

STRATUM ELEVATION	SAMPLE DEPTH	SOIL/MATERIAL DESCRIPTION	STRATUM DEPTH	SAMPLE NUMBER	SPT per 6"	BLOWS per 12" (N)	RECOVERY (in)	MOISTURE CONTENT	TOTAL UNIT WEIGHT pcf	UNCONF. COMP., ksf	ATTERBERG LIMITS		
											LL	PL	PI
1780.5		MINE SPOIL - STIFF, gray, LEAN CLAY (CL), with rock fragments, moist	38.5										
	40	MINE SPOIL - HARD, gray to black, LEAN CLAY (CL), with rock fragments, moist (Highly weathered shale)	43.0	SS-11	7 9 48	57	12						
1776.0													
	45			SS-12	6 7 4	11	10						
	50			SS-13	50/0"		0						
	55	MINE SPOIL - STIFF to VERY STIFF, gray to black, LEAN CLAY (CL), with weathered shale fragments, moist											
	60			SS-14	7 9 8	17	15						
	65												
1751.0			68.0										
	70	MINE SPOIL - STIFF to VERY STIFF, gray to black, LEAN CLAY (CL), with weathered sandstone fragments, moist		SS-15	11 10 16	26	13						
	75	Highly weathered sandstone from 70.3 to 70.5											
1741.0			78.0										
	80	FILL - Apparent BOULDERS with soft clay soil in between		SS-16	50/0"		0						



BORING METHOD

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OLD TEST BORING/PIT RECORD BORING LOGS B1 B6.GPJ NEW CTL.GDT 3/20/24

TEST BORING RECORD

CLIENT : Kentucky Finance Cabinet
PROJECT : Grand View Neighborhood - Johnson Property

BORING NO.: **B-5**
SHEET 3 OF 3

STRATUM ELEVATION	SAMPLE DEPTH	SOIL/MATERIAL DESCRIPTION	STRATUM DEPTH	SAMPLE NUMBER	SPT per 6"	BLOWS per 12" (N)	RECOVERY (in)	MOISTURE CONTENT	TOTAL UNIT WEIGHT pcf	UNCONF. COMP., ksf	ATTERBERG LIMITS		
											LL	PL	PI
1734.0	85	FILL - Apparent BOULDERS with soft clay soil in between	85.0	SS-17	7 14 27	41	18						
	90	POSSIBLE NATIVE SOIL - HARD, brown with gray mottling, LEAN CLAY (CL), with sand layer toward bottom, moist Hard drilling at 92 feet											
1724.5	95	Auger refusal at 94.5 feet; boring terminated	94.5										
	100												
	105												
	110												
	115												
	120												
	125												



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TEST BORING RECORD

CLIENT : Kentucky Finance Cabinet
 PROJECT : Grand View Neighborhood - Johnson Property
 LOCATION : Jenkins, Kentucky
 PROJECT NO. : 24.05.0001SHE

BORING NO.: **B-6**
 SHEET 1 OF 1
 DATE STARTED : 02-22-24
 DATE COMPLETED : 02-22-24

BORING ELEVATION : 1847.0 Feet
 STATION :
 OFFSET :
 DEPTH : 27.3 Feet

BORING METHOD : 2 1/4" S.F.A.
 RIG TYPE : Acker Rebel
 CASING DIA. :
 CORE SIZE : NQ

HAMMER : Automatic
 DRILLER : Strata D Dunaway
 TEMPERATURE : 50s
 WEATHER : Sunny

GROUNDWATER: ▼ Encountered at 8 feet ▼ At completion ▼ Delayed Reading ☒ Caved in at

STRATUM ELEVATION	SAMPLE DEPTH	SOIL/MATERIAL DESCRIPTION	STRATUM DEPTH	SAMPLE NUMBER	SPT per 6"	BLOWS per 12" (N)	RECOVERY (in)	MOISTURE CONTENT	TOTAL UNIT WEIGHT pcf	UNCONF. COMP., ksf	ATTERBERG LIMITS		
											LL	PL	PI
1846.6		TOPSOIL (5 inches)	0.4	SS-1	9 16 16	32	14						
	5	MINE SPOIL - HARD to VERY STIFF, gray, LEAN CLAY (CL), with sandstone fragments, moist											
		Boulders at 1.5 feet with shale fragments between boulders		SS-2	5 5 11	16	17						
1841.0		MINE SPOIL - FIRM, gray, clayey SILT (ML), dry	6.0	SS-3	7 4 2	6	11	16			44	28	16
	10	Note: Wet at 8 feet with rock fragments moist at 9.5 feet		SS-4	2 2 4	6	4						
1834.0		NATIVE - VERY STIFF to HARD, reddish brown to gray FAT CLAY (CH), moist	13.0	SS-5	6 9 18	27	17	22					
	15												
	20			SS-6	11 15 50/4"		16	27					
1824.7		Auger refusal at 22.3 feet; begin coring	22.3										
	25	MEDIUM HARD, light gray to gray, fine grain SANDSTONE with brown varnish and some mica		UNDIST-1			60						
1819.7		Coring terminated at 27.3 feet	27.3	RQD= 97%									
	30												
	35												



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