Report of Geotechnical Exploration

Bath County EMS

CSI Project No. LX220117

Prepared for :
Bath County Judge Executive

August 1, 2022

August 1, 2022

Bath County Judge Executive
P.O. Box 39
Owingsville, KY 40360

Attention: Mr. Bobby Rogers
Sent via e-mail: bcrogersbcje@gmail.com

Subject: **Report of Geotechnical Exploration**
Bath County EMS
Owingsville, Kentucky
CSI Project No. LX220117

Dear Mr. Rogers:

Consulting Services Incorporated of Kentucky (CSI) is pleased to present our report for the geotechnical services completed for your Bath County EMS project located in Owingsville, Kentucky. We provided our services in general accordance with CSI's proposal number 7940 dated June 24, 2022.

Our report represents information provided to us, readily available published data relevant to the site and site area, our observations and subsurface conditions encountered and our opinion of primary geotechnical conditions (discussion and recommendations) affecting design, construction and performance of the proposed earth supported portions of the project.

We appreciate the opportunity to provide our geotechnical services to you and the design team. Please do not hesitate to contact us for questions or comments about the information contained herein.

Cordially,

STATE OF KENTUCKY
BRUCE L. HATCHER
14,527
LICENSED
PROFESSIONAL ENGINEER

8-1-22

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INTRODUCTION

1 SCOPE OF THE GEOTECHNICAL EXPLORATION

We conducted a geotechnical exploration which is summarized in the following report. Our services included a review of the project information provided, conducting a geotechnical exploration that utilized soil test borings and rock coring to obtain samples for modeling the soil and rock conditions at the subject site, an analysis of the data and information obtained, and providing recommendations for the soil supported portions of the project site as listed in our proposal.

2 PROVIDED INFORMATION

Project information was provided to us via email correspondence from Mr. Glenn Ross, PE of MSE of Kentucky on June 23, 2022. We were provided with a preliminary site overlay.

Based on the information obtained, the following is our understanding of the project:

- The project site is located in the northeastern quadrant at the intersection of Rowland Avenue and Wells Avenue in Owingsville, Kentucky. Specifically, the project site is located at the existing ambulance service station. Reference the *Site Location Plan* in the Appendix for further details.

- We understand this project will consist of a new Emergency Medical Services (EMS) building. We expect the new building will consist of a Pre-Engineered Metal Building (PEMB) with an eave height of approximately 25 feet. At this time, the project does not include any basements, partial basements, or pits.

We have based our report on the following assumed information:

Table 1: Anticipated Conditions	
Site Grading - Building Pad	
Finished Floor Elevation	Near existing grades
Maximum anticipated cut	< 3 feet
Maximum anticipated fill	< 3 feet
Anticipated Foundation Loading Conditions	
Load Type	Load
Column	50 kips
Wall (if any)	2 kips/LF
Floor Slab	250 pounds/SF

If any of the aforementioned information is in error or if the information changes during the course of the project, please contact our office so that we can re-evaluate the new information with respect to our recommendations.

3 AREA/SITE INFORMATION

3A AREA TOPOGRAPHY/PHYSIOGRAPHY

The site is located in the Outer Bluegrass Physiographic Region of Kentucky. This area consists of a rolling plateau that becomes more rugged near the edges. The underlying limestone is often visible at the surface in road cuts and where eroded by streams. Published topographic mapping by the United States Geologic Survey (USGS) indicates the elevations in the site vicinity are approximately 990 to 1010 feet. Figure 1 depicts the location of the site with respect to the regional physiography.

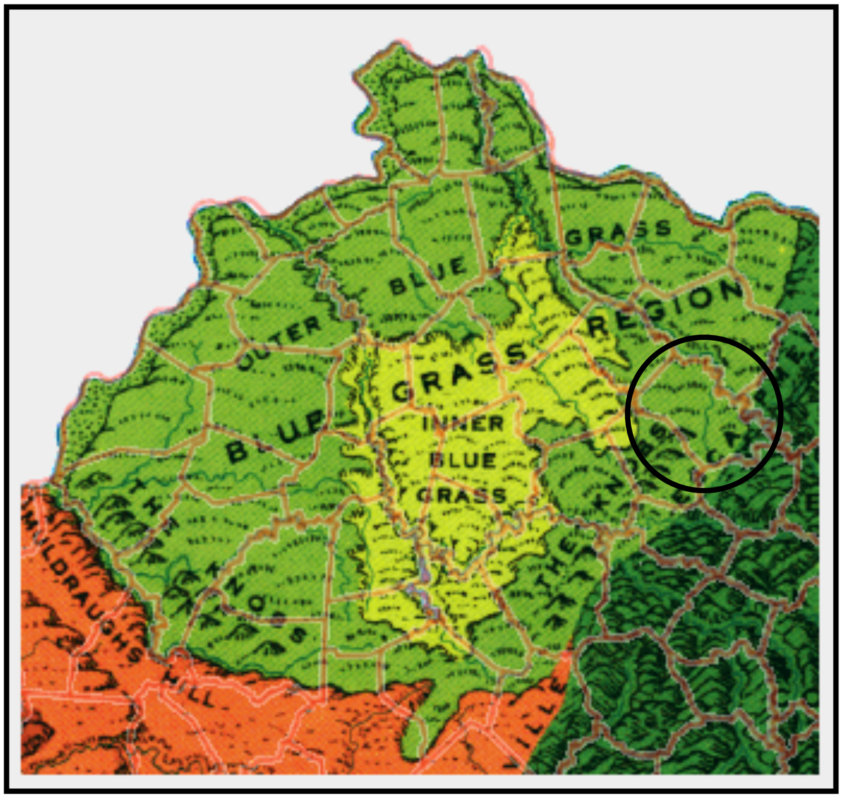


Figure 1. Kentucky Physiographic Map (site vicinity shown in the circle)

3B SITE GEOLOGY

A review of the *USGS Geologic Map of the Owingsville Quadrangle* (dated 1975) indicates the project site is located in an area underlain by the Upper Crab Orchard Formation.

As mapped, the Upper Crab Orchard Formation consists of shale. The shale is described as being mostly greenish-gray, in part dolomitic, and contains layers of dark greenish-gray siltstone.

There are no faults mapped within the project vicinity. The geologic dip near the project site is approximately 1 percent to the southeast. Please reference Figure 2 for further details regarding the site geology.

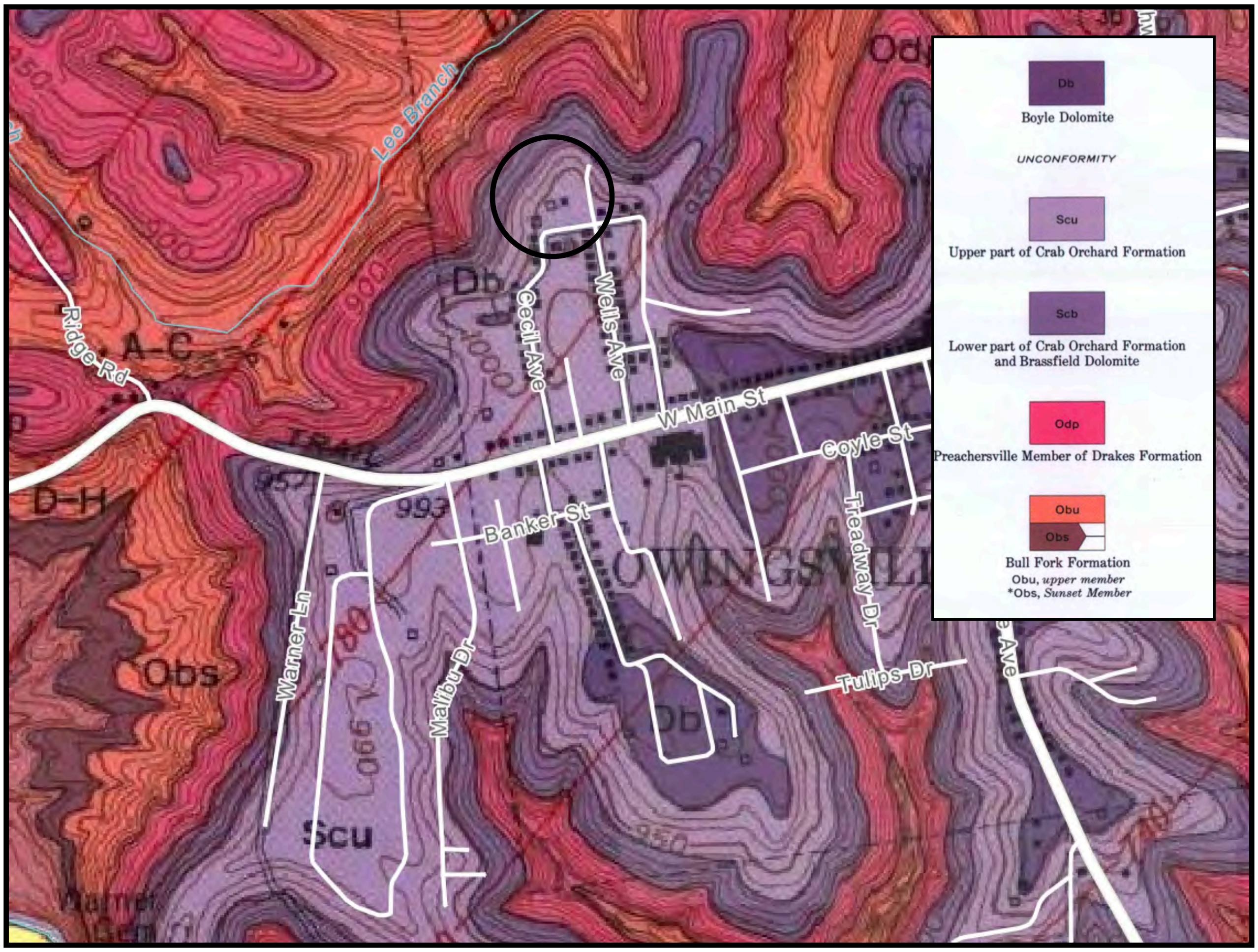


Figure 2. Site Geology USGS Owingsville Quadrangle, dated 1975
(site vicinity indicated by circle)

As with most of the geology of this portion of Kentucky, Karst (sinkholes, weathered bedrock, caverns, erratic bedrock, etc.) is associated with the site geology. No closed depressions were mapped within the immediate vicinity of the site. Additionally, no obvious signs of Karst activity were observed in our recovered soil samples, auger cuttings, or rock core. The Bath County Karst Areas map published by the Kentucky Geological Survey (KGS) indicates that the project site is in an area with non-Karst potential to low Karst potential. Figure 3 indicates the likelihood of Karst occurrence.

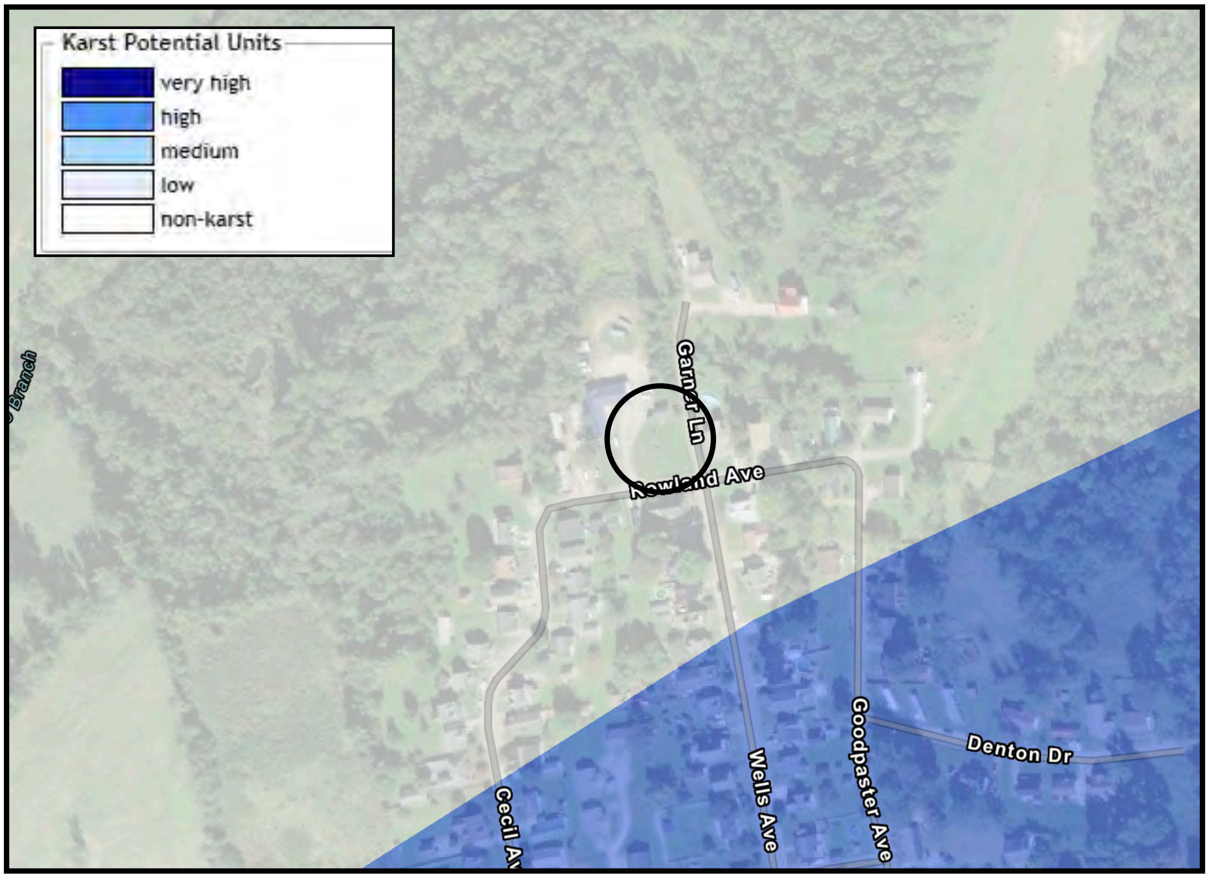


Figure 3. Karst Areas Map, KGS (site vicinity shown in circle)

3C PUBLISHED SITE SOIL CONDITIONS

According to the USDA Soil Survey of Bath County (NRCS website), the soils underlying the site consist of the following series:

- UsC—Urban land-alfie Udarents complex, clayey substratum over soft bedrock, 0 to 12 percent slopes

The following describes the soil series characteristics and limitations with respect to construction.

- Depth to restrictive feature for this soil series is generally listed as being greater than 80 inches.
- Depth to water table for this soil series is generally listed as being greater than 80 inches.
- This soil series is listed as being not rated for shallow excavations, small commercial buildings, and local roads and streets.

Due to the previous site development, the soil survey information listed above may no longer be useful since the site soils may have been altered. Thus, the soils described above may be on-site but not in their natural condition. Figure 4 shows the soils map from the USDA website.

Figure 4: USDA Soil Survey Map of Project Site (site vicinity outlined in orange)

3D OTHER PUBLISHED SITE INFORMATION

We have reviewed several available aerial photographs, dated as far back as February 1995. The February 1995 aerial photograph indicates the project site was primarily a vacant, grass covered lot. Between February 1995 and November 2004, the existing Ambulance Service Station was constructed on-site. No other changes were indicated within the project vicinity. Please reference the following aerial photographs for further details.

Figure 5: Aerial photograph, dated February 1995 from Google Earth (site vicinity shown in circle)

Figure 6: Aerial photograph, dated November 2004 from Google Earth (site vicinity shown in circle)

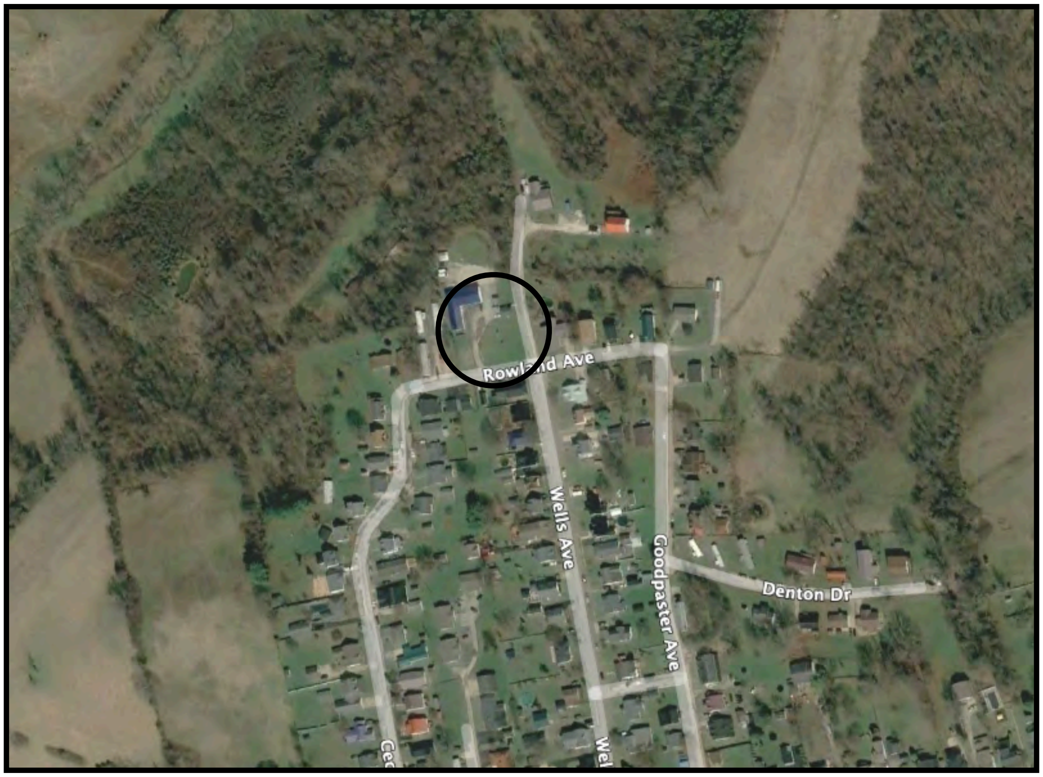


Figure 7: Aerial photograph, dated March 2021 from Google Earth (site vicinity shown in circle)

4 SITE SURFACE OBSERVATIONS

Mr. Kyle Pauley, PE and Mrs. Carole Gibbs of CSI conducted a site visit, performed a field reconnaissance, logged soil borings, and directed drilling operations within the proposed project area on July 12 and 13, 2022.

The project site is located in the northeastern quadrant at the intersection of Rowland Avenue and Wells Avenue in Owingsville, Kentucky. The building area is relatively flat to gently sloping. Based on our top of boring elevations, there is approximately 1 foot of vertical relief within the building area.

The project site is occupied by existing buildings, asphalt pavement areas, and a grass covered lot. At present, the building area is primarily a vacant grass covered area. It should be noted that significant cracking and ponding of water were observed in the existing asphalt. The project area is bordered by Rowland Drive to the south, Wells Avenue to the east, and the existing ambulance service station to the north and west.

Overhead electric lines were observed extending along the eastern and southern perimeters of the project site, as well as through the central portion of the building area. A gas line was observed along the southern perimeter of the site. No other marked utility lines were observed within the project area. The following photos depict the site conditions as they existed at the time of our geotechnical exploration.

Photo 1. View looking northeast across the project site.

Photo 2. View looking southeast at the building area.

Photo 3. View looking southwest across the building area.

Photo 4. View of poor asphalt conditions.

5 SUBSURFACE CONDITIONS

The subsurface conditions encountered at each of our soil boring locations are shown on the Boring Logs in the Appendix. It should be noted that our soil borings were sampled according to the procedures presented in the Appendix. The Boring Logs represent our interpretations of the subsurface conditions based on field logs, visual examination of field samples by an engineer, visual examination of auger cuttings, and tests of the samples collected. The letters in parentheses following the soil descriptions are the soil classifications in accordance with the Unified Soil Classification System. It should be noted that the stratification lines shown on the logs represent approximate transitions between material types. In-situ stratum changes could occur gradually or at slightly different depths. Water levels shown on the Boring Logs represent the conditions only at the time of our exploration.

5A SOIL CONDITIONS

We performed 6 borings within the new building footprint, including one offset boring. The offset boring was performed due to encountering a hard object at approximately 2 feet at boring B-103. Please reference the *Boring Location Plan* in the Appendix for the approximate locations.

In general, we encountered the following in our soil borings: a surficial layer of topsoil, overlying previously placed fill (where encountered), overlying residual soils, overlying bedrock (where encountered).

Topsoil was encountered at the surface of all 6 of our borings. The topsoil ranged in thickness from approximately 3 to 6 inches and generally consisted of the root mat.

Previously placed fill was encountered beneath the surficial layer in 2 of our 6 borings. The previously placed fill material generally consisted of brown clay, with black oxide nodules, some fine roots, and some gravel. The previously placed fill ranged in thickness from 1 foot to 2 feet and was generally sampled as firm.

Residual soils were encountered in all 6 of our boring locations beneath the surficial layer or previously placed fill. The residual soils generally encountered in two horizons. The upper horizon consisted of brown to reddish-brown lean clay (CL), with some orange mottling, some chert, and black oxide nodules. This upper horizon of residual soil ranged in thickness from approximately 4.5 to at least 15 feet and was generally sampled as stiff to very stiff. The lower horizon (where encountered) generally consisted of orangish-brown fat clay (CH), with some tan mottling, black oxide nodules, and some chert. This horizon was approximately 4.5 to 8 feet thick and was generally sampled as stiff to very stiff.

Table 2 summarizes the general subsurface conditions encountered at our boring locations.

Table 2: General Subsurface Strata		
Strata	Thickness	Notes
Surface Cover: Topsoil	Approximately 3 to 6 inches	Present in all 6 borings
Previously Placed Fill: brown clay, with fine roots, black oxide nodules and some gravel	Approximately 1 foot to 2 feet	Present in 2 borings
Residual Soils: brown to reddish-brown lean clay (CL), with some orange mottling, black oxide nodules, and some chert	Approximately 4.5 feet to at least 15 feet	Present in all 6 borings
Residual Soils: orangish-brown fat clay (CH), with some tan mottling, black oxide nodules, and some chert	Approximately 4.5 to 8 feet	Present in 3 borings
Weathered Shale	Approximately 2 feet	Present in boring B-101

5B GROUNDWATER CONDITIONS

Groundwater was not observed in any of our borings upon completion of soil augering. All of our borings were immediately backfilled with auger cuttings upon the completion of soil augering (due to safety concerns).

Water conditions that usually affect construction and performance of projects consist of trapped/ perched water zones which occur in various areas in the soil mass, at or near the bedrock bedding planes, or at or near the soil/rock interface. Perched water sources are often not linked to the more continuous relatively stable groundwater table that typically occurs at greater depths. Finally, water issues are also dependent upon recent rainfall activity and surface and subsurface drainage patterns in the area.

5C BEDROCK INFORMATION

Auger refusal was encountered in 5 of our 6 borings at depths ranging from approximately 2 feet to 24 feet. Please note, the shallower refusal encountered in boring B-103 was a false auger refusal encountered on a hard object. Thus, an offset boring was performed. Rock coring was not within our scope of work for this project.

6 LABORATORY TESTING

Laboratory tests were performed on selected recovered samples from our borings. Detailed descriptions of these tests and the results of our testing are included in the Appendix. Tests performed included:

- Natural moisture contents
- Atterberg limits
- Percent finer than No. 200 sieve

GEOTECHNICAL DISCUSSION AND RECOMMENDATIONS

7 DISCUSSION-GEOTECHNICAL ISSUES

Based on our experience with similar projects and the conditions observed during our subsurface exploration, we believe the site can be adapted for the proposed building addtion. However, this site will be more difficult (and more expensive) to develop when compared to some sites due to the previous site improvements and the presence of existing fill material. The primary geotechnical concerns are:

- Previous Site Improvements
- Previously Placed Fill
- High Plasticity (Fat) Clay Soils

The following sections discuss each issue. However, recommendations to address the issues are contained in later sections of the report.

7A PREVIOUS SITE IMPROVEMENTS

The project is currently occupied by the existing ambulance service station and associated pavement areas. Although not encountered in our borings, your budget should include a contingency for the removal and remediation of any encountered underground structures or utilities.

7B PREVIOUSLY PLACED FILL

Previously placed fill material was encountered in 2 of our 6 boring locations. Fills placed in an uncontrolled manner have proven to be very problematic. The problems generally arise not from general settlement, but from erratic differential settling of the fill. The settlement of large masses is dependent upon several factors such as fill thickness, degree of compaction, fill contents, and age of the fill mass. Also, fills tend to settle linearly with thickness.

Due to the relatively thin horizon of old fill (1 to 2 feet) in our borings, we recommend complete removal of any encountered previously placed fill within the proposed building or pavement areas. If any old fill is left in-place beneath any future site improvements, you must be aware of the risk of construction over old fill material and hold CSI harmless for poor performance of the site improvements due to construction in the old fill. We can provide recommendations to reduce (but not eliminate) the risk if you choose to leave any of the existing fill in-place.

7C HIGH PLASTICITY (FAT) CLAY SOILS

Atterberg limits testing was performed on 1 representative sample. Our laboratory testing indicated that the tested soil sample was lean clay (CL) with a maximum PI of 19 percent. However, based on our experience in the area and our observation of some of the obtained soil samples, we expect high plasticity fat clay (CH) soils are present on-site (at depths below 5 feet). Soils with a PI above 30 percent can have a tendency to shrink/swell with changes in moisture content. Soils with a PI greater than 50 are generally highly susceptible to volume change. Soils with a PI between these limits have moderate volume change potential.

Shrinking and swelling of bearing soils are generally not as severe in the central Kentucky area as in other areas because long periods of excessively wet or dry weather do not normally occur. Where the soil moisture fluctuates, movement may be ongoing throughout the building's life, resulting in deterioration and building distress. Strength loss may also affect building components, but is more likely to adversely affect parking lots - especially flexible asphalt pavements. Accumulation of water beneath pavement followed by repeated traffic loads, may result in the failure of both pavement and the subgrade materials.

Methods to control the adverse effects of these soils include soil modification methods (i.e.- undercut/ replace, lime stabilization, etc.), providing efficient drainage around the building and pavements, installation of foundation components at depths below levels where moisture contents are subject to significant fluctuation, and implementing more stringent fill specifications for new fill placement. Please reference the later sections of this report for specific details pertaining to these fat clay soils.

8 EARTHWORK

Historically, more change orders (in total number and costs) occur during the earthwork portion of construction than in almost any other part of the project. Further, the site preparation phase of construction always affects the future performance of project structures and pavements. Add into this, the fact that earthwork is the portion of work most influenced by wet weather and unknown conditions and time-wise, this section of the report could be the most important to prevent and minimize delays and costs during construction and for the life of the project.

Please review the concerns listed in section 7 prior to reading the following recommendations. If problems occur that the recommendations do not address or do not adequately remedy, please contact CSI as soon as possible.

8A SITE PREPARATION (WORK PRIOR TO FILLING)

- The site should be cleared/grubbed removing all topsoil and vegetation within the proposed building area. Organic materials should be wasted off-site. Topsoil can be stockpiled for use in landscape areas.
- If applicable, remove/relocate underground utilities as required by the construction plans.
- Remove all existing fill material within the building area to stiff or better residual soil. Any excavated fill material can be re-used as new fill material provided that it meets the requirements for new fill presented later in this report.
- On-site soils excavated below 5 feet (likely fat clay soils) should not be used as new fill material within the building pad.
- Areas ready to receive new fill should be proofrolled with a heavily loaded dump truck (GVW of 80,000 pounds) or similar equipment judged acceptable by a CSI geotechnical engineer.
- The level of proofroll for any site area should be determined by a CSI geotechnical engineer on a case-by-case basis.
- Perform the proofrolling after a suitable period of dry weather to avoid degrading the subgrade.

- Areas which pump, rut, or wave during proofrolling may require undercutting, depending on the location of the area and the use of the area, so the geotechnical engineer should be contacted for guidance.
- Backfill of undercut areas should be performed in accordance with sections 8B and 8C.
- Retain CSI to observe the proofrolling operations and make recommendations for any unstable or unsuitable conditions encountered. This can save time on the construction schedule and save unnecessary undercutting.

We recommend that site grading should take place between about late April to early November. Earthwork taking place outside this time period will likely encounter wet conditions and weather conditions that will provide little to no assistance with drying the soils.

8B NEW FILL OPERATIONS

If new fill material to needed to reach desired grades, we expect some of the existing on-site fill material can be re-used as new fill material. If off-site soil fill material is imported to the project site, representative samples should be obtained of the proposed fill material to determine the moisture-density relationship and overall classification of the material.

After the subgrade has been approved to receive new fill, the fill may commence with the following procedures and guidelines recommended:

- Place fill in maximum 8-inch thick loose lifts.
- Fill lifts should be compacted to at least 98 percent of the soil's maximum dry density (ASTM D698) and maintain the moisture content of compacted fill within 2 percent of optimum moisture.
- Fill compaction requirements should be extended to at least 5 feet outside the building footprint.
- Maximum particle size of the soil should be limited to 4 inches in any dimension with no large concentrations of large fragments.
- Density testing should be performed as a means to verify percent compaction and moisture content of the material as it is being placed and compacted.
- Observation of fill “stability” is also critical, so it is recommended to observe the operation of the filling equipment traversing over the new fill to document movement (similar to proofrolling).
- Soils should not be “overcompacted” and construction traffic should be kept to minimum to assure compaction is achieved and that the soil is not allowed to “break down”.
- Retain a representative of CSI to observe and document fill placement and compaction operations.

8C BACKFILL OPERATIONS (FOUNDATION WALLS, UTILITIES, ETC.)

These materials are placed in more confined areas than mass earthwork materials or pavement materials and therefore cannot be placed in full compliance with sections 8A or 8B. The following are general recommendations for backfill areas:

- Fill lift thicknesses will vary dependent on compaction equipment available and material types, but in no case should exceed 8 inches.
- For crushed stone/aggregate backfills in trenches or wall backfill and when using smaller compaction equipment (such as a plate compactor or trench compactor or similar) the lift thickness should not exceed 4 inches.
- Compaction/moisture percentages and density testing requirements should be the same as in section 8B.
- CSI should be retained to provide additional recommendations for backfill (if necessary).

8D GENERAL NOTES

- For all earthwork operations, positive surface drainage is prudent to keep water from ponding on the surface and to assist in maintaining surface stability.
- The surface should be sealed prior to expected wet weather. This can usually be accomplished with rubber-tired construction equipment or a steel-drum roller.
- If any soil placement problems occur, CSI should be retained to provide additional recommendations, as needed.

9 SITE DRAINAGE

During construction, water should not be allowed to pond in excavations or undercutting will likely be required. Additionally, allowing water to pond in deep excavations (especially those near the soil/rock interface) greatly increases the risk for activating latent Karst features. During the life of the project, slope the subgrade and other site features so that surface water flows away from the site structures. Structure roof drains should be piped away to proper storm drainage systems. Diversion ditches should be used to keep surface water from accumulating at or near site structures.

For excavations during construction, most free water (not observed in our soil borings) could likely be removed via sump pumps and open channel flow (ditches) at or near the source of seepage. Based on our experience with similar projects, we expect that perched (trapped) water within the existing fill material and/or existing utility trench backfill/bedding (if any) could be encountered. Typically, these pockets of trapped water dissipate rather quickly but can produce considerable amounts of water that will require removal. If normal dewatering measures prove insufficient due to shallow water conditions, CSI should be retained to provide recommendations on the issue.

10 FOUNDATIONS

We expect shallow spread foundations bearing on firm or better residual soil or newly placed engineered fill will be utilized for this project. If there are any changes in the project criteria, foundation types, or building location, CSI should be allowed to review the recommendations to determine if any modifications are required.

10A SHALLOW SPREAD FOUNDATIONS ON SOIL

Shallow spread footings may be sized using a **maximum allowable bearing pressure of 2,000 pounds per square foot (psf)**. Foundations should bear on firm or better residual soil or newly placed engineered soil fill. Foundations should not bear on existing fill material.

If rock is encountered within 2 feet of the design bottom of foundation (BOF) elevation (not expected), then the rock should be undercut to at least 2 feet below the design BOF. The undercut area should then be backfilled with compacted soil fill, DGA (dense graded aggregate), or sand. The use of No. 57 crushed stone as backfill material is not recommended.

A detailed settlement analysis was beyond the scope of this exploration. However, based on the expected structural loads, the anticipated behavior of soil types encountered during field activities, and our experience with similar projects, we expect that total settlements will not exceed 1 inch, and that differential settlements will not exceed ½ inch along continuous footing distances of 30 feet or less. We recommend the structure be designed to accommodate these magnitudes of total and differential settlements.

Additional design considerations for spread foundations bearing on soil are outlined as follows:

- Design all footings with a minimum 18 inches width;
- All exterior footing bottoms should bear at least 24 inches below finished exterior grading (KBC Table 1809.5 for Bath County);
- Interior footings (those not exposed to freezing) may be placed at nominal depths or 18 inches deep, whichever is deeper;

10B SHALLOW FOUNDATIONS ON SOIL - CONSTRUCTION NOTES

Any soils can lose strength if they become wet, so we recommend the foundation subgrades be protected from exposure to water. For foundations construction, we also recommend the following procedures.

- For soils that will remain exposed overnight or for an extended period of time, place a "lean" concrete mudmat over the bearing areas. The concrete should be at least 4 inches thick. Flowable fill concrete or low-strength concrete is suitable for this cover, as conditions allow.
- Disturbed soil should be removed prior to foundation concrete placement.
- Foundation bearing conditions should be benched level.

- Areas loosened by excavation operations should be recompacted prior to reinforcing steel placement.
- Loose soil, debris, and excess surface water should be removed from the bearing surface prior to concrete placement.
- Retain a CSI geotechnical engineer to observe all foundation excavations and provide recommendations for treatment of any unsuitable conditions encountered.

11 SEISMIC SITE CLASSIFICATION

The latest edition of the Kentucky Building Code (KBC) was reviewed to determine the Site Seismic Classification. Based on our review of geologic data, our experience and subsurface conditions encountered and the use of soil bearing foundations, we recommend a Seismic **SITE CLASS "C"** for foundation design purposes.

A detailed geotechnical earthquake engineering analysis was not performed since it was beyond the scope of our authorized work. However, based on a review of published literature and our experience with similar subsurface conditions, we believe the potential for slope instability, liquefaction, and surface rupture due to faulting or lateral spreading resulting from earthquake motions is low. However, this potential could be elevated during wet periods of the year unless adequate drainage is provided.

12 CONCRETE SLABS-ON-GRADE

A grade supported floor slab bearing on residual soil or newly placed fill material is suitable for the proposed building. Additionally, all soils (in slab areas) must pass a level of proofrolling recommended by a CSI geotechnical engineer.

If rock is encountered within 1 foot of the slab subgrade elevation (not expected), we recommend that the rock be undercut at least 1 foot below slab subgrade elevation and the excavation be backfilled with compacted soil fill or crushed stone up to the design slab subgrade elevation.

The following features are recommended as part of the concrete slab construction:

- Adequate joint patterns (ACI and ICC guidelines) should be used to permit slab movement due to normal soil settlement, normal subgrade disturbance and material expansion/contraction.
- Place a minimum of 4 inches of clean, compacted gravel or crushed stone beneath the slab to provide a working base. The actual thickness of the gravel layer should be based on design requirements.
- Keep the crushed stone or gravel moist, but not wet, immediately prior to slab concrete placement to minimize curling of the slab due to differential curing conditions between the top and bottom of the slab.
- Retain CSI to review the actual subgrade conditions prior to slab construction and make recommendations for any unsuitable conditions encountered.

Note: Slab subgrade conditions are also considered earthwork areas and the recommendations contained in the Earthwork section of the report. See Section 8 of this report for specific details.

13 PAVEMENT RECOMMENDATIONS

We expect that the traffic in the pavement areas will be limited primarily to automobiles, ambulances, and an occasional garbage truck. Adequate soil/subgrade support is critical for any pavement area. Please refer to the recommendations contained in the Earthwork section of this report for subgrade preparation.

Adequate drainage and slope of the pavement subgrade and pavement section should be provided to promote adequate drainage. Edges of the pavement should be provided a means of water outlet by extending the aggregate base course through to side ditches or providing drain pipes and weep holes at catch basin walls.

The following pavement recommendations are based on our experience with similar materials and loading conditions. The recommendations are based on the assumption that the soil subgrade will be compacted and/or remediated according to the recommendations contained in this report.

13A ASPHALT PAVEMENT

Typically, pavement design is based on supplied traffic loads and California Bearing Ratio (CBR) values. No traffic loads were provided to us for this project and a CBR value was assumed based on our experience. We expect CBR values around 3 percent for the on-site soils. We recommend that the light duty pavement section be utilized in areas restricted mostly to automobiles (i.e. - parking areas, etc.) and that the heavy duty pavement section may be used in the main drive lanes due to the heavier expected loads. Generalized pavement designs for both light duty and heavy duty pavement (based on the assumed ESAL's of 2 for light duty and 5 for heavy duty) and empirical correlations with laboratory determined soil classifications are given below.

Table 3. Light Duty Asphalt Pavement Section

Pavement Section Component	Thickness (in)
Bituminous Surface Course	1.5
Bituminous Binder Course	1.5
Dense Graded Aggregate (DGA)*	8.0

*DGA to be placed in 6 inch thick maximum, compacted lifts

Table 4. Heavy Duty Asphalt Pavement Section

Pavement Section Component	Thickness (in)
Bituminous Surface Course	1.5
Bituminous Binder Course	2.5
Dense Graded Aggregate (DGA)*	10.0

*DGA to be placed in 6 inch thick maximum, compacted lifts

The dense graded aggregate (DGA) should be placed and compacted in accordance with Kentucky Department of Highways Standard Specifications, latest edition. The asphalt should be mixed, placed, and compacted in accordance with Kentucky Department of Highways Standard Specifications, latest edition. It is common practice to place the base stone and binder course prior to completion of construction without placing the surface course. It should be noted that repeated passes of heavily loaded construction traffic on the binder course will likely decrease the service life of your pavement.

13B RIGID PAVEMENT (CONCRETE)

We anticipate reinforced concrete pavement will be used in areas where the pavement is subjected to high stresses such as entrances/exits, drive lanes, truck bays and dumpster pads. Prior to stone base placement, we recommend an additional heavy proofroll of the subgrade be performed to verify subgrade conditions. Recommendations for undercutting/repair of the subgrade can be made at that time by a CSI geotechnical engineer.

We recommend a minimum DGA thickness of 8 inches beneath new concrete pavement and a minimum concrete thickness of 6 inches for new concrete pavement areas. Obviously, thicker concrete pavement sections can be used in select areas where heavy wheel loads are expected. For dumpster pads and refuse container pads (if any), the concrete pads should be large enough to accommodate both the refuse container and all axles of the truck. Additionally, we recommend the use of reinforcing steel, not welded wire fabric or fibre mesh.

14 NOTES ON REPORT AND RECOMMENDATIONS

We recommend 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. A geotechnical exploration, such as the one we performed, uses widely spaced borings to attempt to model the subsurface conditions at the site. Because no exploration contains complete data or a complete model, there is always a possibility that conditions between borings will be different from those at specific boring locations. Thus, it is possible that some subsurface conditions will not be as anticipated by the project team or contractor. If this report is included or referenced in the actual contract documents, **it shall be explicitly understood that this report is for informational purposes only**. CSI shall not be responsible for the opinions of, or conclusions drawn by, others.

It has been our experience that the construction process often disturbs soil conditions and this process, no matter how much experience we use to anticipate construction methodology, is not completely predictable. Therefore, changes or modifications to our recommendations are likely needed due to these possible variances. Experienced CSI geotechnical personnel should be used to observe and document the construction procedures and the conditions encountered. Unanticipated conditions and inadequate procedures should be reported to the design team along with timely recommendations to solve the problems created. We recommend that the Owner retain CSI to provide this service based upon our familiarity with the project, the subsurface conditions and the intent of our recommendations.

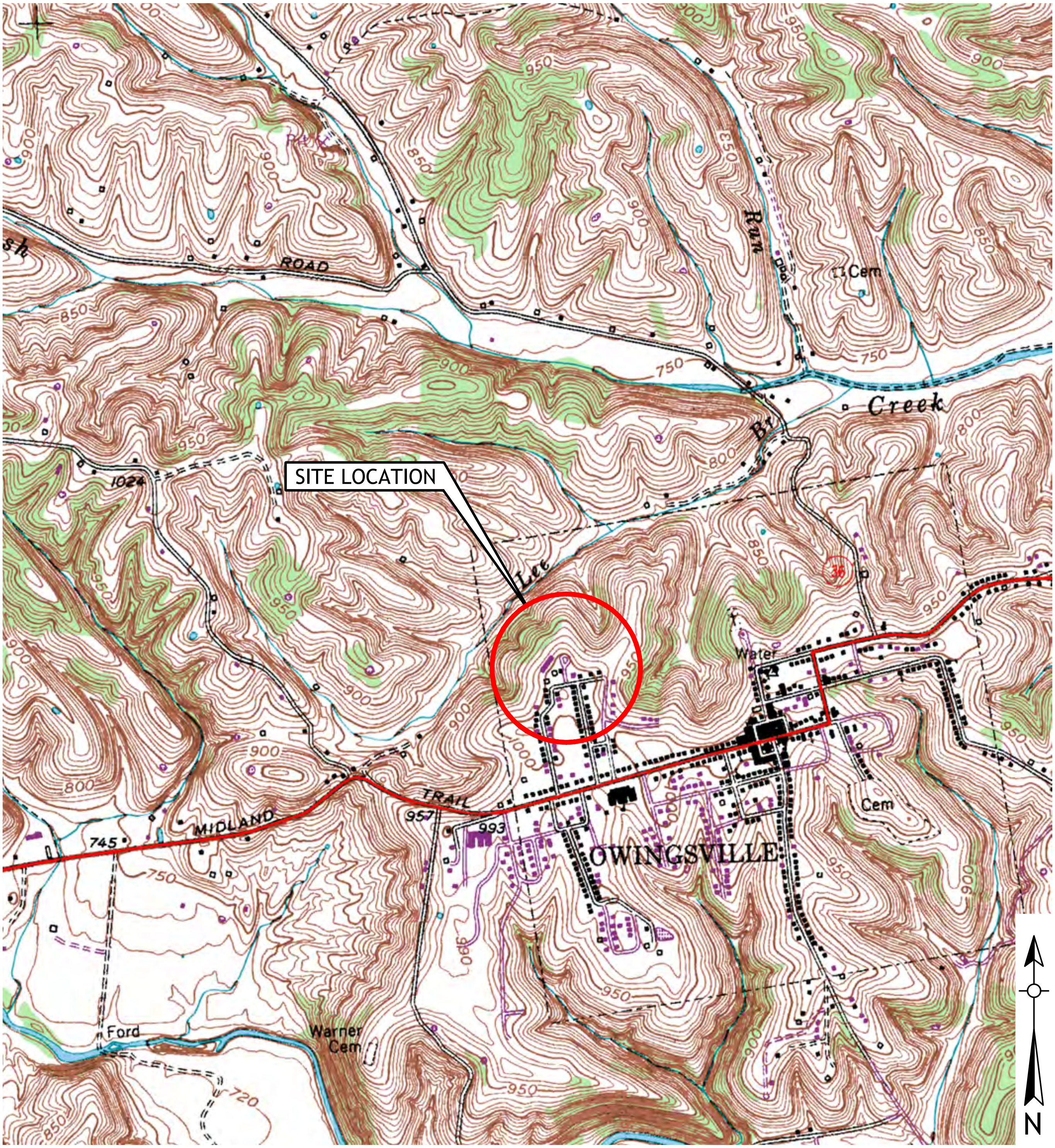
This report is based on the supplied project information, the subsurface conditions observed at the time of the report, and our experience with similar conditions. As such, it cannot be applied to other project sites, types, or combinations thereof. If the Project Information section in this report contains incorrect information or if additional information is available, you should convey the correct or additional information to us and retain us to review our recommendations. Our recommendations may then require modification.

No section or portion of this report (including Appendix information) can be used as a stand alone article to make distinct changes or assumptions. The entire report and Appendix should be used together as one resource.

While this report deals with samples of subsurface materials and some comments on water conditions at the site, no assessment of site environmental conditions or the presence of contaminants were performed.

We wish to remind you that our exploration services include storing the soil samples collected and making them available for inspection for 30 days. The soil samples are then discarded unless you request otherwise. Please inform us if you wish to keep any of the obtained samples.

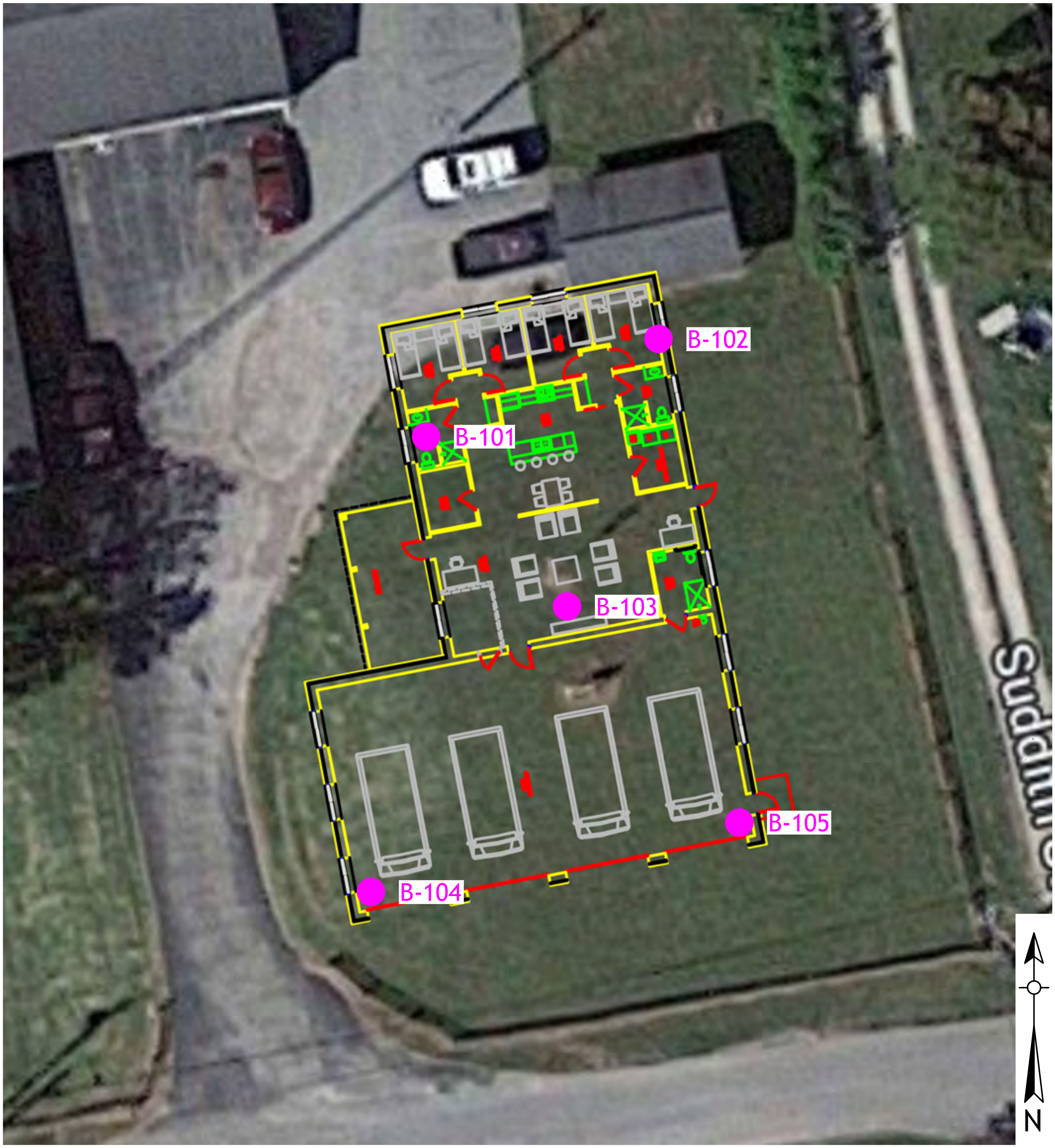
APPENDIX



Site Location Plan adapted from USGS Owingsville, KY Topographic Quadrangle map (dated 1952 photoinspected 1975), with further adaptation by CSI personnel.

FOR ILLUSTRATION PURPOSES ONLY

Consulting Services Incorporated of Kentucky 858 Contract Street Lexington, Kentucky 40505 859.309.6021 Office|888.792.3121 Fax www.csikentucky.com	SITE LOCATION PLAN	Project No: LX220117	Drawn By: SM
	Bath County EMS Owingsville, Kentucky	Date: 8/01/2022	Checked By: BH
		Scale: Not To Scale	Drawing No: SLP - 1



Boring Location Plan adapted from provided Bath Co EMS - prelim site overlay, not dated, and aerial imagery with further adaptation by CSI personnel.

FOR ILLUSTRATION PURPOSES ONLY

LEGEND	
B-XXX	BORING LOCATIONS

Consulting Services Incorporated of Kentucky
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Lexington, Kentucky 40505
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www.csikentucky.com

BORING LOCATION PLAN	Project No: LX220117	Drawn By: SM
Bath County EMS Owingsville, Kentucky	Date: 8/01/2022	Checked By: BH
	Scale: Not To Scale	Drawing No: BLP - 1

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Geotechnical Boring Information Sheet

Sample Type Symbols

- Splitspoon (SPT)
- Shelby Tube
- Grab
- Rock Core
- Auger Cuttings

Surface Symbols

- Topsoil
- Asphalt
- Concrete
- Lean Clay
- Fat Clay
- Glacial Till
- Sandy Clay
- Silt
- Elastic Silt
- Lean Clay to Fat Clay
- Gravelly Clay
- Sandy Silt
- Gravelly Silt
- Sand
- Gravel
- Fill
- Limestone
- Sandstone
- Shale/Siltstone
- Weathered Rock

Samples Strength Descriptors

Cohesive Soils:	N
Very Soft	0-1
Soft	2-4
Firm	5-8
Stiff	9-15
Very Stiff	16-30
Hard	31+
Non-cohesive Soils:	
Very Loose	0-4
Loose	5-10
Firm	11-20
Very Firm	21-30
Dense	30-50
Very Dense	51+

Definitions

SPT-"Splitspoon" or standard penetration test. Blow counts are number of drops required for a 140 lb hammer dropping 30 inches to drive the sampler 6 inches.

N-value is the addition of the last two intervals of the 18-inch sample.

Shelby tubes are often called "undisturbed samples". They are directly pushed into the ground, twisted, allowed to rest for a small period of time and then pulled out of the ground. Tops and bottoms are cleaned and then sealed.

Sample classification is done in general accordance with ASTM D2487 and 2488 using the Unified Soil Classification System (USCS) as a general guide.

Soil moisture descriptions are based on the recovered sample observations. The descriptors are dry, slightly moist, moist, very moist and wet. These are typically based on relative estimates of the moisture condition of a visual estimation of the soils optimum moisture content (EOMC). Dry is almost in a "dusty" condition usually 6 or more percent below EOMC. Slightly moist is from about 6 to 2 percent below EOMC at a point at which the soil color does not readily change with the addition of water. Moist is usually 2 percent below to 2 percent above EOMC and the point at which the soil will tend to begin forming "balls" under some pressure in the hand. Very moist is usually from about 2 percent to 6 percent above EOMC and also the point at which it's often considered "muddy". Wet soil is usually 6 or more percent above EOMC and often contains free water or the soil is in a saturated state.

Silt or Clay is defined at material finer than a standard #200 US sieve (<0.075mm) Sand is defined as material between the size of #200 sieve up to #4 sieve. Gravel is from #4 size sieve material to 3". Cobbles are from 3" to 12". Boulders are over 12".

Rock hardness is classified as follows:

Very Soft:	Easily broken by hand pressure
Soft:	Ends can be broken by hand pressure; easily broken with hammer
Medium:	Ends easily broken with hammer; middle requires moderate blow
Hard:	Ends require moderate hammer blow; middle requires several blows
Very Hard:	Many blows with a hammer required to break core

Rock Quality Designation (RQD) is defined as total combined length of 4" or longer pieces of core divided by the total core run length; defined in percentage.

Water or cave-in observed in borings is at completion of drilling each boring unless otherwise noted.

Strata lengths shown on borings represents a rough estimate. Transition may be more abrupt or gradual. Soil borings are representative of that estimated location at that time and are based on recovered samples. Conditions may be different between borings and between sample intervals. Boring information is not to be considered stand alone but should be taken in context with comments and information in the geotechnical report and the means by which the borings are logged, sampled and drilled.

BORING LOG

Consulting Services Incorporated
858 Contract Street
Lexington, Kentucky 40505
Phone: 859.309.6021
Fax: 888.792.3121

BORING: B-101

Project Number: LX220117	Weather: 90's Sunny	Contractor: CSI
Name: Bath County EMS	*Elevation (ft): 1009.1	Drill Rig: Mobile B-57
Client: Bath Co. Judge Executive	Date Started: 7/12/22	Method: SFA
Location: Owingsville, Kentucky	Date Completed: 7/13/22	Hole Size (in): 4
Logged By: K. Pauley, PE	Checked By: B. Hatcher, PE	

Elev. (ft)	Depth (ft)	Symbol	Description	Blow Counts (N Value)	Recov. (in)	WC (%)	LL	PL	PI	%<#200	Water Level	Remarks
			Topsoil - 5 inches									
1008			LEAN CLAY (CL) - FIRM to STIFF with VERY STIFF and SOFT zone, brown, with black oxide nodules and fine roots, moist	3-4-3 (7)	12							Dry upon completion of soil augering
1006	2			3-3-2 (5)	10	23.4						
1004	4			3-3-6 (9)	14	22.1						
1002	6			3-4-7 (11)	16	24.3						
1000	8 / 10			11-10-11 (21)	14							
998 / 996	12											
994	14			2-2-2 (4)	15							
992	16		Weathered Shale									
990	18 / 20			11-37-50/2"	12							
988 / 986	22											
	24		Boring Terminated at 24.0 feet									

*Elevations were determined using Real Time Kinematic Differential GPS referencing the KYCORS network.

Left Photo: Photo of Approximate Boring Location
Right Photo: Photo of Boring

BORING LOG

Consulting Services Incorporated
858 Contract Street
Lexington, Kentucky 40505
Phone: 859.309.6021
Fax: 888.792.3121

BORING: **B-102**

Project Number: LX220117	Weather: 90's Sunny	Contractor: CSI
Name: Bath County EMS	*Elevation (ft): 1008.8	Drill Rig: Mobile B-57
Client: Bath Co. Judge Executive	Date Started: 7/12/22	Method: SFA
Location: Owingsville, Kentucky	Date Completed: 7/13/22	Hole Size (in): 4
Logged By: K. Pauley, PE	Checked By: B. Hatcher, PE	

Elev. (ft)	Depth (ft)	Description	Blow Counts (N Value)	Recov. (in)	WC (%)	LL	PL	PI	%<#200	Water Level	Remarks
1008.8	0	Topsoil - 5 inches									
		LEAN CLAY (CL) - FIRM to STIFF with a VERY STIFF zone, brown, with orange and tan mottling, black oxide nodules, and fine roots, moist	3-3-4 (7)	12							Dry upon completion of soil augering
			3-6-8 (14)	14	22.3						
			3-7-8 (15)	14	20.1						
			3-8-10 (18)	16							
			10-9-7 (16)	16							
			11-8-4 (12)	17							
993.3	15.5	Boring Terminated at 15.5 feet									

*Elevations were determined using Real Time Kinematic Differential GPS referencing the KYCORS network.

Left Photo: Photo of Approximate Boring Location
Right Photo: Photo of Boring

BORING LOG

Consulting Services Incorporated
858 Contract Street
Lexington, Kentucky 40505
Phone: 859.309.6021
Fax: 888.792.3121

BORING: B-103

Project Number: LX220117 Name: Bath County EMS Client: Bath Co. Judge Executive Location: Owingsville, Kentucky Logged By: C. Gibbs	Weather: 90's Sunny *Elevation (ft): 1009.0 Date Started: 7/12/22 Date Completed: 7/13/22 Checked By: B. Hatcher, PE	Contractor: CSI Drill Rig: Mobile B-57 Method: SFA Hole Size (in): 4

Elev. (ft)	Depth (ft)	Symbol	Description	Blow Counts (N Value)	Recov. (in)	WC (%)	LL	PL	PI	%<#200	Water Level	Remarks
			Topsoil - 4 inches									
1008			FILL - Sampled as FIRM, brown clay, with black oxide nodules, fine roots, and gravel, moist	3-4-3 (7)	8							Dry upon completion of soil augering
	2			10-50/3"	0							
			Auger Refusal at 2.0 feet (encountered hard object)									
1006												
	4											
1004												
	6											
1002												
	8											
1000												
	10											
998												
	12											
996												
	14											
994												
	16											
992												
	18											
990												
	20											
988												
	22											
986												
	24											

*Elevations were determined using Real Time Kinematic Differential GPS referencing the KYCORS network.

Left Photo: Photo of Approximate Boring Location
Right Photo: Photo of Boring

BORING LOG

Consulting Services Incorporated
858 Contract Street
Lexington, Kentucky 40505
Phone: 859.309.6021
Fax: 888.792.3121

BORING: **B-103A**

Project Number: LX220117 Name: Bath County EMS Client: Bath Co. Judge Executive Location: Owingsville, Kentucky Logged By: C. Gibbs	Weather: 90's Sunny *Elevation (ft): 1009.0 Date Started: 7/12/22 Date Completed: 7/13/22 Checked By: B. Hatcher, PE	Contractor: CSI Drill Rig: Mobile B-57 Method: SFA Hole Size (in): 4

Elev. (ft)	Depth (ft)	Symbol	Description	Blow Counts (N Value)	Recov. (in)	WC (%)	LL	PL	PI	%<#200	Water Level	Remarks
1009.0–1005.0	0–4		Offset from B-103 due to encountering hard object									Dry upon completion of soil augering
1005.0–1000.5	4–8.5		LEAN CLAY (CL) - FIRM, brown, with some red and tan mottling and black oxide nodules, moist	1-2-3 (5)	16	21.7						
				3-2-4 (6)	18	18.7						
1000.5–996.5	8.5–12.5		FAT CLAY (CH) - STIFF, orangish-brown, with some tan mottling, black oxide nodules, and trace chert, wet	4-6-9 (15)	18	44.2						
996.5	12.5		Auger Refusal at 12.5 feet									

*Elevations were determined using Real Time Kinematic Differential GPS referencing the KYCORS network.

Left Photo: Photo of Approximate Boring Location
Right Photo: Photo of Boring

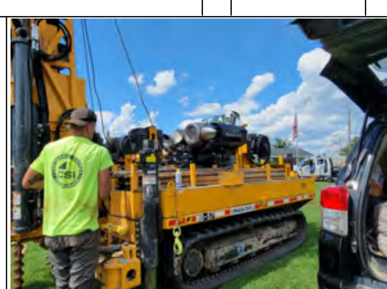
BORING LOG

Consulting Services Incorporated
858 Contract Street
Lexington, Kentucky 40505
Phone: 859.309.6021
Fax: 888.792.3121

BORING: **B-104**

Project Number: LX220117 Name: Bath County EMS Client: Bath Co. Judge Executive Location: Owingsville, Kentucky Logged By: C. Gibbs	Weather: 90's Sunny *Elevation (ft): 1008.5 Date Started: 7/12/22 Date Completed: 7/13/22 Checked By: B. Hatcher, PE	Contractor: CSI Drill Rig: Mobile B-57 Method: SFA Hole Size (in): 4

Elev. (ft)	Depth (ft)	Description	Blow Counts (N Value)	Recov. (in)	WC (%)	LL	PL	PI	%<#200	Water Level	Remarks
1008.5–1008.25	0–0.25	Topsoil - 3 inches	3-3-3 (6)	15							Dry upon completion of soil augering
1008.25–1007	0.25–1.5	FILL - Sampled as FIRM, brown clay, with black oxide nodules, fine roots, and gravel, moist	4-5-6 (11)	18	20.2	38	19	19	89		
1007–1000	1.5–8.5	LEAN CLAY (CL) - STIFF to FIRM, brown to reddish-brown, with black oxide nodules and fine roots, moist	3-3-4 (7)	18	24.7						
			2-3-3 (6)	17							
1000–995.4	8.5–13.1	FAT CLAY (CH) - VERY STIFF, orangish-brown, with black oxide nodules and chert, moist	11-8-16 (24)	18							
	13.1	Auger Refusal at 13.1 feet									



*Elevations were determined using Real Time Kinematic Differential GPS referencing the KYCORS network.

Left Photo: Photo of Approximate Boring Location
Right Photo: Photo of Boring

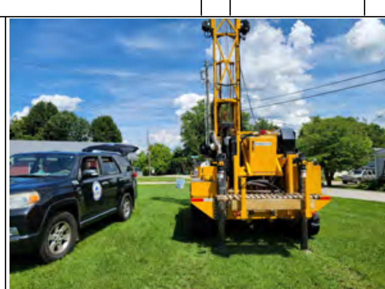
BORING LOG

Consulting Services Incorporated
858 Contract Street
Lexington, Kentucky 40505
Phone: 859.309.6021
Fax: 888.792.3121

BORING: B-105

Project Number: LX220117 Name: Bath County EMS Client: Bath Co. Judge Executive Location: Owingsville, Kentucky Logged By: C. Gibbs	Weather: 90's Sunny *Elevation (ft): 1008.5 Date Started: 7/12/22 Date Completed: 7/13/22 Checked By: B. Hatcher, PE	Contractor: CSI Drill Rig: Mobile B-57 Method: SFA Hole Size (in): 4

Elev. (ft)	Depth (ft)	Symbol	Description	Blow Counts (N Value)	Recov. (in)	WC (%)	LL	PL	PI	%<#200	Water Level	Remarks
1008			Topsoil - 3 inches									Dry upon completion of soil augering
			LEAN CLAY (CL) - FIRM, brown, with black oxide nodules and fine roots, moist	2-3-3 (6)	15							
1006	2			3-4-4 (8)	16	19.3						
1004	4			4-5-6 (11)	18	20.9						
1002	6		FAT CLAY (CH) - STIFF to HARD, orangish-brown, with some tan mottling, black oxide nodules, and chert below 9.5 feet, moist	3-5-6 (11)	18	19.2						
1000	8											
998	10			6-12-29 (41)	17							
996	12		Auger Refusal at 12.8 feet									
994	14											
992	16											
990	18											
988	20											
986	22											
984	24											



*Elevations were determined using Real Time Kinematic Differential GPS referencing the KYCORS network.

Left Photo: Photo of Approximate Boring Location
Right Photo: Photo of Boring

FIELD TESTING PROCEDURES

Field Operations: The general field procedures employed by CSI are summarized in ASTM D 420 which is entitled "Investigating and Sampling Soils and Rocks for Engineering Purposes." This recommended practice lists recognized methods for determining soil and rock distribution and ground water conditions. These methods include geophysical and in situ methods as well as borings.

Borings are drilled to obtain subsurface samples using one of several alternate techniques depending upon the subsurface conditions. These techniques are:

a. Continuous 2-1/2 or 3-1/4 inch I.D. hollow stem augers;

b. Wash borings using roller cone or drag bits (mud or water);

c. Continuous flight augers (ASTM D 1425).

These drilling methods are not capable of penetrating through material designated as "refusal materials." Refusal, thus indicated, may result from hard cemented soil, soft weathered rock, coarse gravel or boulders, 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.

The subsurface conditions encountered during drilling are reported on a field test boring record by the chief driller. The record contains information concerning the boring method, samples attempted and recovered, indications of the presence of various materials such as coarse gravel, cobbles, etc., and observations between samples. Therefore, these boring records contain both factual and interpretive information. The field boring records are on file in our office.

The soil and rock samples plus the field boring records are reviewed by a geotechnical engineer. The engineer classifies the soils in general accordance with the procedures outlined in ASTM D 2488 and prepares the final boring records, which are the basis for all evaluations and recommendations.

The final boring records represent our interpretation of the contents of the field records based on the results of the engineering examinations and tests of the field samples. These records depict subsurface conditions at the specific locations and at the particular time when drilled. Soil conditions at other locations may differ from conditions occurring at these boring locations. Also, the passage of time may result in a change in the subsurface soil and ground water conditions at these boring locations. The lines designating the interface between soil or refusal materials on the records and on profiles represent approximate boundaries. The transition between materials may be gradual. The final boring records are included with this report.

The detailed data collection methods using during this study are discussed on the following pages.

Soil Test Borings: Soil test borings were made at the site at locations shown on the attached Boring Plan. Soil sampling and penetration testing were performed in accordance with ASTM D 1586.

The borings were made by mechanically twisting a hollow stem steel auger into the soil. At regular intervals, the drilling tools were removed and soil samples obtained with a standard 1.4 inch I.D., 2 inch O.D., split tube sampler. The sampler was first 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 the "penetration resistance". The penetration resistance, when properly evaluated, is an index to the soil strength and foundation supporting capability.

Representative portions of the soil samples, thus obtained, were placed in glass jars and transported to the laboratory. In the laboratory, the samples were examined to verify the driller's field classifications. Test Boring Records are attached which graphically show the soil descriptions and penetration resistances.

Core Drilling: Refusal materials are materials that cannot be penetrated with the soil drilling methods employed. Refusal, thus indicated, may result from hard cemented soil, soft weathered rock, coarse gravel or boulders, 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.

Prior to coring, casing is set in the drilled hole through the overburden soils, if necessary, to keep the hole from caving. Refusal materials are then cored according to ASTM D 2113 using a diamond-studded bit fastened to the end of a hollow double tube core barrel. This device is rotated at high speeds, and the cuttings are brought to the surface by circulating water. Core samples of the material penetrated are protected and retained in the swivel-mounted inner tube. Upon completion of each drill run, the core barrel is brought to the surface, the core recovered is measured, the samples are removed and the core is placed in boxes for storage.

The core samples are returned to our laboratory where the refusal material is identified and the percent core recovery and rock quality designation is determined by a soils engineer or geologist. The percent core recovery is the ratio of the sample length obtained to the depth drilled, expressed as a percent. The rock quality designation (RQD) is obtained by summing up the length of core recovered, including only the pieces of core which are four inches or longer, and dividing by the total length drilled. The percent core recovery and RQD are related to soundness and continuity of the refusal material. Refusal material descriptions, recoveries, and RQDs are shown on the "Test Boring Records".

Hand Auger Borings and Dynamic Cone Penetration Testing: Hand auger borings are performed manually by CSI field personnel. This consists of manually twisting hand auger tools into the subsurface and extracting “grab” or baggie samples at intervals determined by the project engineer. At the sample intervals, dynamic cone penetration (DCP) testing is performed. This testing involves the manual raising and dropping of a 20-pound hammer, 18 inches. This “driver” head drives a solid-13⁄4 inch diameter cone into the ground. DCP “counts” are the number of drops it takes for the hammer to drive three 13⁄4 inch increments, recorded as X-Y-Z values.

Test Pits: Test pits are excavated by the equipment available, often a backhoe or trackhoe. The dimensions of the test pits are based on the equipment used and the power capacity of the equipment. Samples are taken from the spoils of typical buckets of the excavator and sealed in jars or “Ziploc” baggies. Dynamic Cone Penetration or hand probe testing is often performed in the upper few feet as OSHA standards allow. Refusal is deemed as the lack of advancement of the equipment with reasonable to full machine effort.

Water Level Readings: Water table readings are normally taken in conjunction with borings and are recorded on the "Test Boring Records". These readings indicate the approximate location of the hydrostatic water table at the time of our field investigation. Where impervious soils are encountered (clayey soils) the amount of water seepage into the boring is small, and it is generally not possible to establish the location of the hydrostatic water table through water level readings. The ground water table may also be dependent upon the amount of precipitation at the site during a particular period of time. Fluctuations in the water table should be expected with variations in precipitation, surface run-off, evaporation and other factors.

The time of boring water level reported on the boring records is determined by field crews as the drilling tools are advanced. The time of boring water level is detected by changes in the drilling rate, soil samples obtained, etc. Additional water table readings are generally obtained at least 24 hours after the borings are completed. The time lag of at least 24 hours is used to permit stabilization of the ground water table, which has been disrupted by the drilling operations. The readings are taken by dropping a weighted line down the boring or using an electrical probe to detect the water level surface.

Occasionally the borings will cave-in, preventing water level readings from being obtained or trapping drilling water above the caved-in zone. The cave-in depth is also measured and recorded on the boring records.

Summary of Laboratory Results

Borehole	Depth	Sample Type	Liquid Limit	Plastic Limit	Plasticity Index	Class-ification	Water Content (%)	Unconfined Compressive Strength (ksf)	Dry Density (pcf)	Wet Density (pcf)	Max. Dry Density (pcf)	Opt. Water Content (%)	CBR	Swell (%)	RQD	Percent Recovery	k (cm/sec)	% Finer #200
B-101	1.5	SS					23.4											
B-101	4.0	SS					22.1											
B-101	6.5	SS					24.3											
B-102	1.5	SS					22.3											
B-102	4.0	SS					20.1											
B-103A	4.0	SS					21.7											
B-103A	6.5	SS					18.7											
B-103A	9.0	SS					44.2											
B-104	1.5	SS	38	19	19	CL	20.2											89.2
B-104	4.0	SS					24.7											
B-105	1.5	SS					19.3											
B-105	4.0	SS					20.9											
B-105	6.5	SS					19.2											

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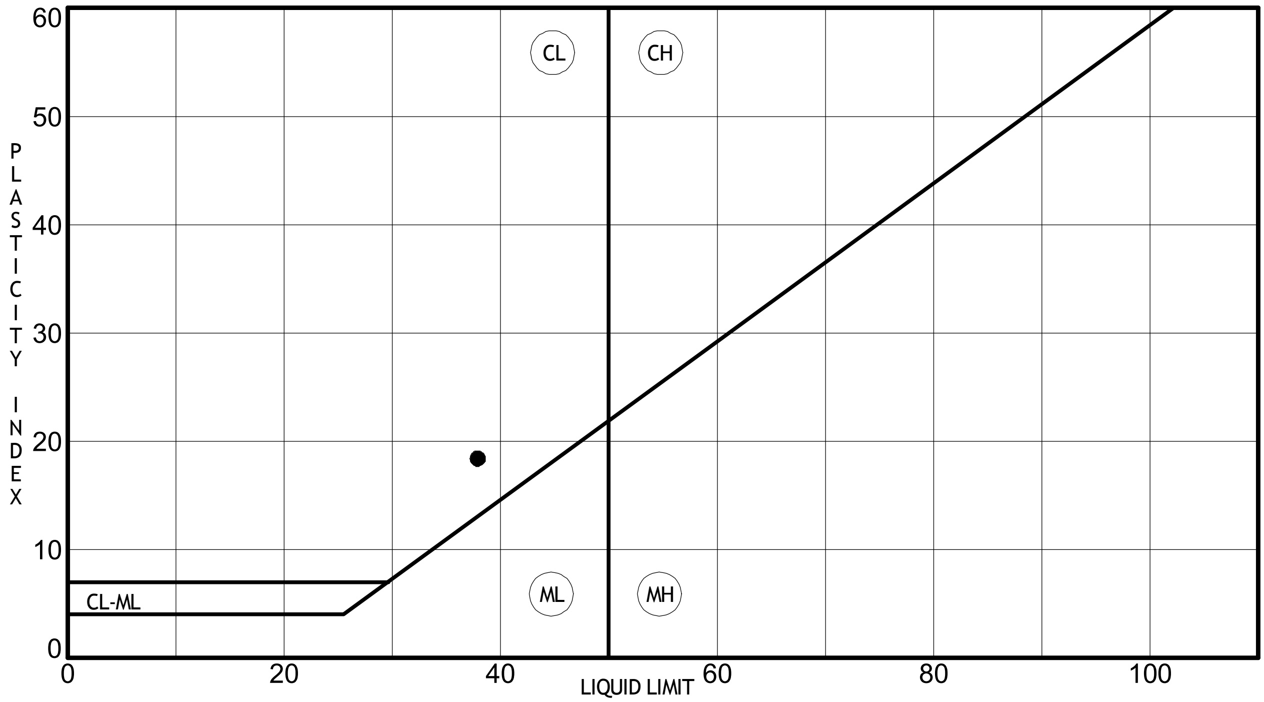
SS - Split Spoon Sample
GRAB - Bulk Grab Sample
k - Coefficient of Permeability
- See Attached test Results

PROJECT INFORMATION

Client: Bath Co. Judge Executive
Project Name: Bath County EMS
Project Number: LX220117
Project Location: Owingsville, Kentucky

Liquid and Plastic Limits Test Report



	Boring	Depth (ft)	LL	PL	PI	Water Content	% < #40	% < #200	USCS	Description
●	B-104	1.5	38	19	19	20.2		89.2	CL	brown LEAN CLAY

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Fax: 888.792.3121

PROJECT INFORMATION

Client: Bath Co. Judge Executive
Project Name: Bath County EMS
Project Number: LX220117
Project Location: Owingsville, Kentucky

LABORATORY TESTING PROCEDURES

Soil Classification: Soil classifications provide a general guide to the engineering properties of various soil types and enable the engineer to apply past experience to current problems. In our investigations, samples obtained during drilling operations are examined in our laboratory and visually classified by an engineer. The soils are classified according to consistency (based on number of blows from standard penetration tests), color and texture. These classification descriptions are included on our "Test Boring Records."

The classification system discussed above is primarily qualitative and for detailed soil classification two laboratory tests are necessary: grain size tests and plasticity tests. Using these test results the soil can be classified according to the AASHTO or Unified Classification Systems (ASTM D 2487). Each of these classification systems and the in-place physical soil properties provides an index for estimating the soil's behavior. The soil classification and physical properties obtained are presented in this report.

Rock Classification: Rock classifications provide a general guide to the engineering properties of various rock types and enable the engineer to apply past experience to current situations. In our explorations, rock core samples obtained during drilling operations are examined in our laboratory and visually classified by an engineer. The rock cores are classified according to relative hardness and RQD (see Guide to Rock Classification Terminology), color, and texture. These classification descriptions are included on our Test Boring Records.

Atterberg Limits: Portions of the samples are taken for Atterberg Limits testing to determine the plasticity characteristics of the soil. The plasticity index (PI) is the range of moisture content over 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 sufficiently "wet" to flow as a heavy viscous fluid. The plastic limit is the lowest moisture content at which the soil is sufficiently plastic to be manually rolled into tiny threads. The liquid limit and plastic limit are determined in accordance with ASTM D 4318.

Moisture Content: The Moisture Content is determined according to ASTM D 2216.

Percent Finer Than 200 Sieve: Selected samples of soils are washed through a number 200 sieve to determine the percentage of material less than 0.074 mm in diameter.

Rock Strength Tests: To obtain strength data for rock materials encountered, unconfined compression tests are performed on selected samples. In the unconfined compression test, a cylindrical portion of the rock core is subjected to increasing axial load until it fails. The pressure required to produce failure is recorded, corrected for the length to diameter ratio of the core and reported.

Compaction Tests: Compaction tests are run on representative soil samples to determine the dry density obtained by a uniform compactive effort at varying moisture contents. The results of the test are used to determine the moisture content and unit weight desired in the field for similar soils. Proper field compaction is necessary to decrease future settlements, increase the shear strength of the soil and decrease the permeability of the soil.

The two most commonly used compaction tests are the Standard Proctor test and the Modified Proctor test. They are performed in accordance with ASTM D 698 and D 1557, respectively. Generally, the Standard Proctor compaction test is run on samples from building or parking areas where small compaction equipment is anticipated. The Modified compaction test is generally performed for heavy structures, highways, and other areas where large compaction equipment is expected. In both tests a representative soil sample is placed in a mold and compacted with a compaction hammer. Both tests have three alternate methods.

Test	Metho d	Hammer Wt./ Fall	Mold Diam.	Run on Material Finer Than	No. of Layer s	No. of Blows/ Layer
Standard D 698	A	5.5 lb./12”	4”	No. 4 sieve	3	25
	B	5.5 lb./12”	4”	3/8” sieve	3	25
	C	5.5 lb./12”	6”	3/4” sieve	3	56

Test	Metho d	Hammer Wt./ Fall	Mold Diam.	Run on Material Finer Than	No. of Layer s	No. of Blows/ Layer
Modified D 15557	A	10 lb./18”	4”	No. 4 sieve	5	25
	B	10 lb./18”	4”	3/8” sieve	5	25
	C	10 lb./18”	6”	3/4” sieve	5	56

The moisture content and unit weight of each compacted sample is determined. Usually 4 to 5 such tests are run at different moisture contents. Test results are presented in the form of a dry unit weight versus moisture content curve. The compaction method used and any deviations from the recommended procedures are noted in this report.

<u>Laboratory California Bearing Ratio Tests:</u> The California Bearing Ratio, generally abbreviated to CBR, is a punching shear test and is a comparative measure of the shearing resistance of a soil. It provides data that is a semi-empirical index of the strength and deflection characteristics of a soil. The CBR is used with empirical curves to design pavement structures.

A laboratory CBR test is performed according to ASTM D 1883. The results of the compaction tests are utilized in compacting the test sample to the desired density and moisture content for the laboratory California Bearing Ratio test. A representative sample is compacted to a specified density at a specified moisture content. The test is performed on a 6-inch diameter, 4.58-inch-thick disc of compacted soil that is confined in a cylindrical steel mold. The sample is compacted in accordance with Method C of ASTM D 698 or D 1557.

CBR tests may be run on the compacted samples in either soaked or unsoaked conditions. During testing, a piston approximately 2 inches in diameter is forced into the soil sample at the rate of 0.05 inch per minute to a depth of 0.5 inch to determine the resistance to penetration. The CBR is the percentage of the load it takes to penetrate the soil to a 0.1 inch depth compared to the load it takes to penetrate a standard crushed stone to the same depth. Test results are typically shown graphically.

<u>Consolidation Tests:</u> Consolidation tests are conducted on representative soil samples to determine the change in height of the sample with increasing load. The results of these tests are used to estimate the settlement and time rate of settlement of structures constructed on similar soils. A consolidation test is performed according to ASTM D2435 on a single section of an undisturbed sample extruded from a sample tube. The sample is trimmed into a disc 2.5 inches in diameter and 0.75 inch thick. The disc is confined in a stainless steel ring and sandwiched between porous plates. It is then subjected to incrementally increasing vertical loads, and the resulting deformations are measured with a micrometer dial gauge. Void ratio are then calculated from these deformation readings. The test results are typically provided in tabular form or in the form of plots of void ratio versus applied stress (e-log p curves).

Organic Content: The Organic Content is determined according to ASTM D2974. The moisture content is first determined by drying portions of the sample at 105 degrees Celsius. The ash content is then determined by igniting the oven-dried sample from the moisture content determination in a muffle furnace at 440 degrees Celsius. The substance remaining after ignition is the ash. The organic content is expressed as a percentage by subtracting the percent ash from one hundred.

Direct Shear Tests: Direct shear tests are performed according to ASTM D3080 to determine the shear strength parameters of the soil. The specimen of soil is placed in a rigid box that is divided horizontally into two frames. The specimen is then confined under a vertical or normal stress and horizontal force is applied to fail the specimen along a horizontal plane at its mid-height.

Because drainage of the soil specimen cannot be easily controlled, undrained tests (i.e., UU and CU tests) are possible only on impervious soils and pore pressure measurements cannot be made. Drained tests (i.e., CD tests), however, are possible on all soil types. Since the drainage paths through the specimen are short and pore water pressures are dissipated fairly rapidly, the direct shear test is well suited to the CD test.

A minimum of three test specimens are required to establish the strength envelope of a soil. The soil parameters obtained are the cohesion and angle of internal friction.

Unconfined Compression Tests: The unconfined compression test is an unconsolidated-undrained triaxial shear test with no lateral confining pressure. This test is used to determine the shear strength of clayey soils. An unconfined compression test is performed according to ASTM D2166 on a single section of an undisturbed sample extruded from a sampling tube. The sample is trimmed to a length-to-diameter ratio of about 2 and placed in the testing device. Incrementally increasing vertical loads are applied until the sample fails. Test results are provided in the form of a stress-strain curve or a value representing the unconfined compressive strength of the sample.

Grain Size Tests: Grain Size Tests are performed to determine the soil classification and the grain size distribution. The soil samples are prepared for testing according to ASTM D421 (dry preparation) or ASTM D2217 (wet preparation). The grain size distribution of soils coarser than a number 200 sieve (0.074 mm opening) is determined by passing the samples through a standard set of nested sieves. Materials passing the number 200 sieve are suspended in water and the grain size distribution calculated from the measured settlement rate. These tests are conducted in accordance with ASTM D422.

Triaxial Shear Tests: Triaxial shear tests are used to determine the strength characteristics and friction angle of a given soil sample. Triaxial tests are also used to determine the elastic properties of the soil specimen. Triaxial shear tests are performed on several sections of a relatively undisturbed sample extruded from the sampling tube. The samples are trimmed into cylinders 1.4 to 2.8 inches in diameter and encased in rubber membranes. Each is then placed in a compression chamber and confined by all around water pressure. Samples are then subjected to additional axial and/or lateral loads, depending on the soil and the field conditions to be simulated. The test results are typically presented in tabular form or in the form of stress-strain curves and Mohr envelopes or p-q plots.

Three types of triaxial tests are normally performed. The most suitable type of triaxial test is determined by the loading conditions imposed on the soil in the field and the soil characteristics.

1. Consolidated-Undrained (designated as a CU or R Test).

2. Consolidated-Drained (designated as a CD or S Test).

3. Unconsolidated-Undrained (designated as a UU or Q Test).