The Geiger House for Veterans Geotechnical Report

Prepared for

Model Group
1826 Race Street
Cincinnati, Ohio

December 21, 2022

Project No. CN220255

CONSULTING SERVICES INCORPORATED
Geotechnical & Materials Engineering | IBC Special Inspection | Material Testing

December 21, 2022

David Daugherty
Model Group
1826 Race Street
Cincinnati, Ohio

Attention: Mr. David Daugherty
Sent via e-mail: ddaugherty@modelgroup.net

Subject: Geotechnical Report for The Geiger House for Veterans
2631 Gilbert Avenue
Cincinnati, Ohio
CSI Project No. CN220255

Dear Mr. Daugherty,

Consulting Services Incorporated of Cincinnati (CSI) is pleased to present our geotechnical report for the proposed Geiger House for Veterans project located at 2631 Gilbert Avenue, Cincinnati, Ohio. We provided our services in general accordance the CSI Proposal 8171, dated November 9, 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 site work and foundation design for the project.

Again, we greatly appreciate the opportunity to provide our services and look forward to working with you and the project team on this (and hopefully) more projects in the future. Please do not hesitate to contact us for questions or comments about the information contained herein.

Cordially,

James P. Haines, P.E.
Senior Project Engineer

STATE OF OHIO
JAMES P. HAINES
P.E. 81881
REGISTERED
PROFESSIONAL ENGINEER

Joseph S. Burkhardt, P.E.
Principal Geotechnical Engineer

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INTRODUCTION

1 SCOPE OF THE GEOTECHNICAL EXPLORATION

As proposed, CSI conducted a geotechnical exploration for the proposed Geiger House for Veterans development located at 2631 Gilbert Avenue in Cincinnati, Ohio. Our services included a review of the project information provided, conducting a subsurface exploration that utilized soil borings to obtain samples for modeling the soil conditions at the proposed development, an analysis of data and information obtained, providing foundation recommendations for the site conditions and providing recommendations for site earth work.

2 SITE AND PROJECT INFORMATION

In preparing for this final report, CSI was provided with Architectural Plan Sheets A1.0 through A8.0 titled "The Geiger House for Veterans" prepared by PCA Architecture which depicts the layout of the proposed development. Based on the provided information, CSI understands the proposed project consists of a 3-story rectangular shaped building with a partial lower/basement level and associated surface parking. A summary of the site and project information is presented in Tables 1 and 2 below.

Table 1: Site Information

Item	Description
Site Location	The site is located off the west side of Gilbert Avenue at address 2631 Gilbert Avenue, Cincinnati, Ohio.
Size of Site	The overall property is about 0.9 acres.
Surrounding Area	The site is situated within a residential/light commercial area east of Cincinnati. The site is bordered by Gilbert Avenue to the east, 3-story apartment building to the north, residential development to the west and Walker Funeral Home to the south.
Existing Conditions	The property is currently occupied by the Queen City Kitchen which is a 3-story building positioned within the northern portion of the site with asphalt pavement occupying the southern portion of the site. The existing building has a lower level that walks out to the west side of the site. The exterior grades surrounding the existing building slope downward from west to east ranging in elevations of about 830 to 822 feet amsl. The asphalt parking lot to the south is relatively flat resting at about elevation 830 feet amsl. An existing concrete retaining wall is positioned within the central/western portion of the site aligned in an east-west direction that provides grade separation between the level parking lot and sloping ground surface along the building. The retaining wall ranges in height of about 1 to 8 feet.
Existing/Previous Structures(s)	A 3-story building with lower level currently occupies the northern portion of the site with the remainder of the site comprised of asphalt pavement. The lower level of the 3-story building is below grade at the east end of the building that transitions to an at grade level along the west end of the building.
Existing/Previous Utilities	Underground gas, electric and communications utilities are present at the northeast side of the building.
Previous Site Use	The existing development currently serves as the Queen City Kitchen. It is assumed the current development is the original development for the site.

Table 2: Project Information

Item	Description
Site Layout and Grading	The proposed structure will be positioned within the northern portion of the site within the footprint of the existing structure. Proposed parking and drive lanes will occupy the southern portion of the site. Proposed final grading and finish floor elevation was not provided at the time of this report.
Proposed Structure(s)	The proposed building will consist of a 3-story rectangular shaped building positioned within the footprint of the existing building. The proposed structure will occupy a footprint of approximately 10,250 square feet. A below grade/basement level is planned within the western third of the building. Proposed parking and drive lanes will occupy the southern half of the site.
Building Construction	The building will be a wood framed structure with slab on grade floor.
Finish Floor Elevation	Not provided. It is assumed the finish floor of the ground level will be about 830 feet amsl. The partial basement level is assumed to be established at about 820 feet amsl.
Maximum Loads	The following foundation loads were provided by Advantage Group Engineers: Wall Foundation: 3.5 kips per foot. Column Foundation: 20 kips. The floor slab load is assumed to be less than 125 psf.

3 AREA/SITE INFORMATION

3A AREA PHYSIOGRAPHY / TOPOGRAPHY

The site is located within the vicinity of the transition between the Southern Ohio Loamy Till Plain and Illinoian Till Plain of Ohio. The Southern Ohio Loamy Till Plain is characterized by Wisconsinan age till, outwash and loess over lower Paleozoic age carbonate rocks and shales in the east. Surface of loamy till, end and recessional moraines, commonly associated with boulder belts, between relatively flat lying ground moraine, cut by steep valleyed large streams fill with outwash. The Illinoian Till Plain is characterized as silt-loam, high-lime, Illinoian-age till with loess cap underlain by Ordovician and Silurian age carbonate rocks and shales. The exterior grades surrounding the existing building slope downward from west to east ranging in elevations of about 830 to 822 feet amsl. The asphalt parking lot to the south is relatively flat resting at about elevation 830 feet amsl. The site location in relation to the Ohio Physiographic Map is shown in Figure 1 on the following page. The existing site topography is depicted on Figure 2.

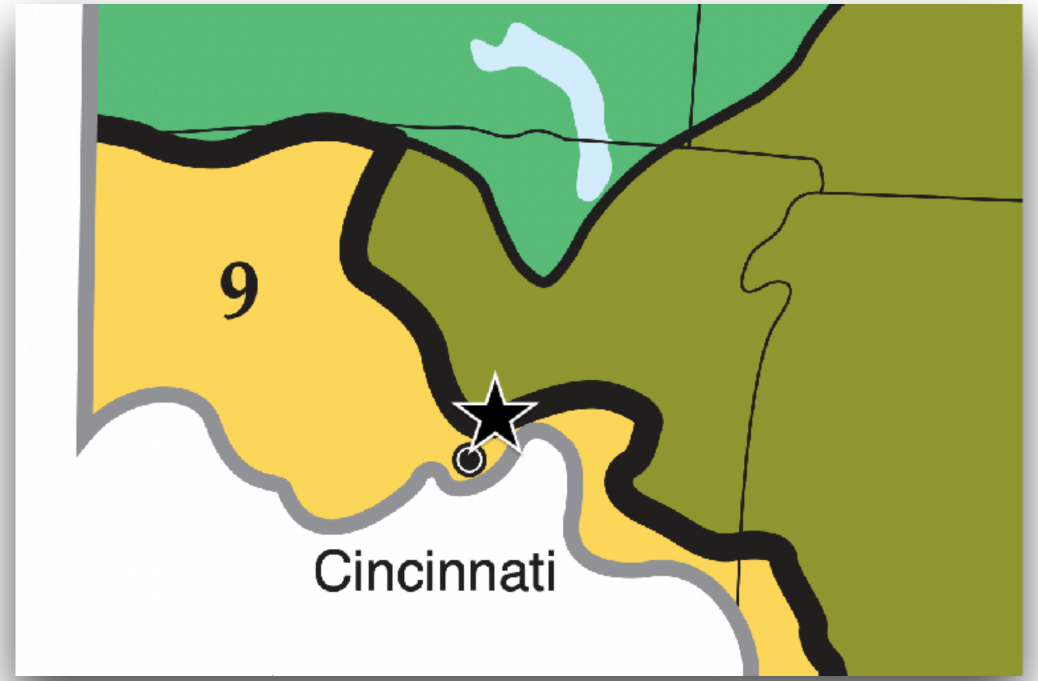


Figure 1: Ohio Physiographic Map

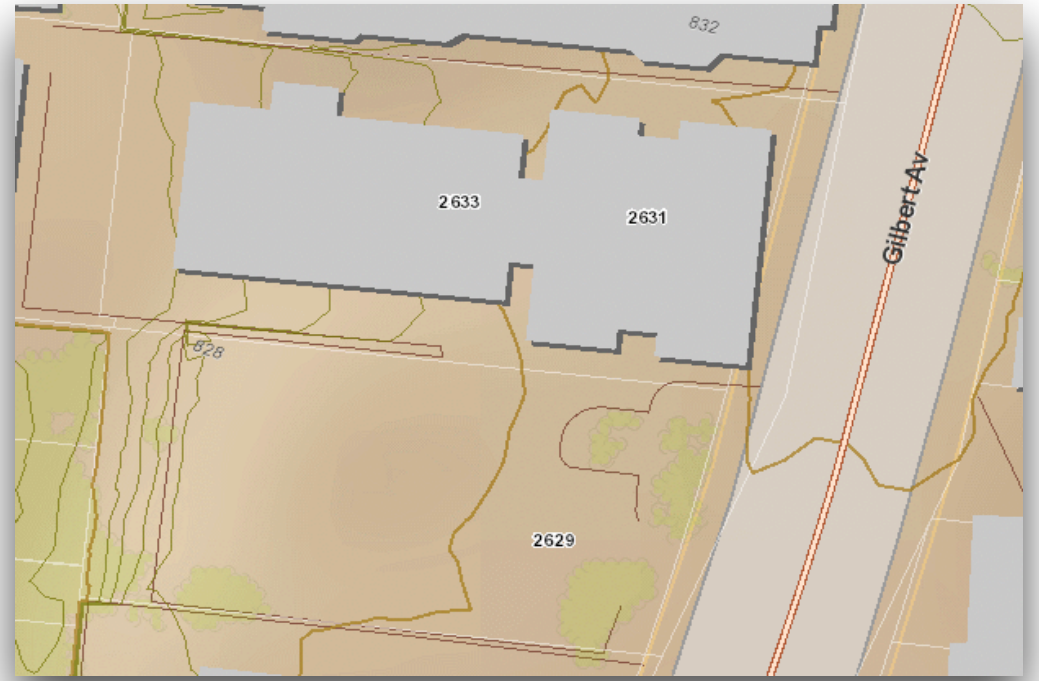


Figure 2: CAGIS Online Topography

3B SITE GEOLOGY

A review of the Surficial Geology of the Ohio Portions of the Cincinnati and Falmouth Quadrangles shown in Figure 3, indicates the site is mapped with about 30 feet of Illinoian-age loam till overlain by loess. The till is predominately silt with nearly equal parts (about 30 percent) sand and clay. The underlying bedrock is mapped Ordovician-age limestone interbedded with shale. The limestone comprises approximately 50 to 85 percent of the bedrock unit. The actual subsurface conditions encountered at the site and described in Section 5, vary relatively significantly from the referenced mapping.

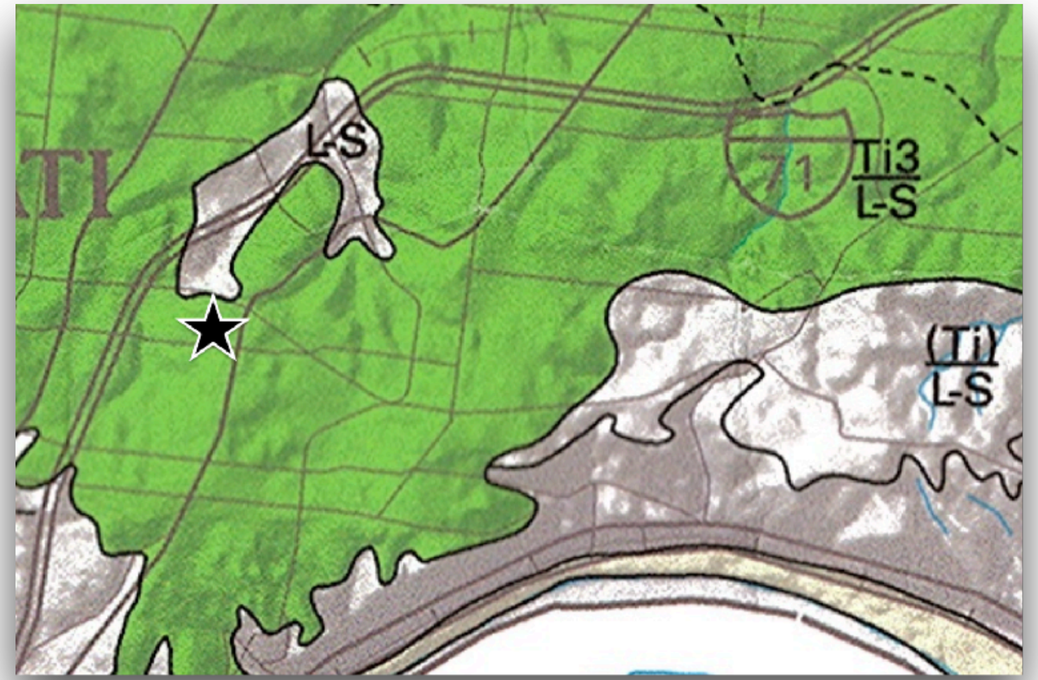


Figure 3: Surficial Geology of the Ohio Portions of the Cincinnati and Falmouth Quadrangles

3C PUBLISHED SITE SOIL CONDITIONS

Published surficial soil mapping from the USDA soil survey indicates the surficial soils on the site are associated with Urban Land Complex. Soils of this type are those that have been associated with prior development and/or man-placed fills. The mapping suggests these soils are within 100 percent of the area of construction with the depth to restrictive features and water table, greater than 80 inches.

Figure 4: USDA Soil Survey Map

3D AERIAL PHOTOGRAPHS (GOOGLE EARTH)

Review of historical aerial images since about 1994 indicate that the site has has been relatively unchanged over the last 28 years. Representative aerial photographs between 1994 and 2021 are provided in Figures 5 through 8 below.

Figure 5: March 1994 Aerial Image

Figure 6: March 2004 Aerial Image

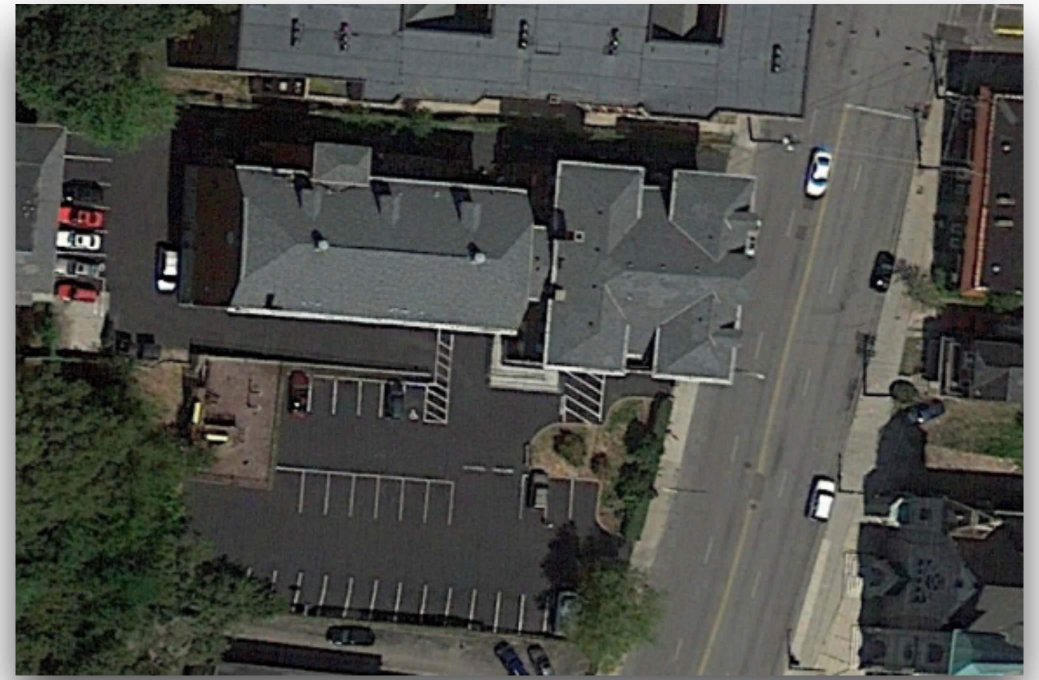


Figure 7: August 2012 Aerial Image

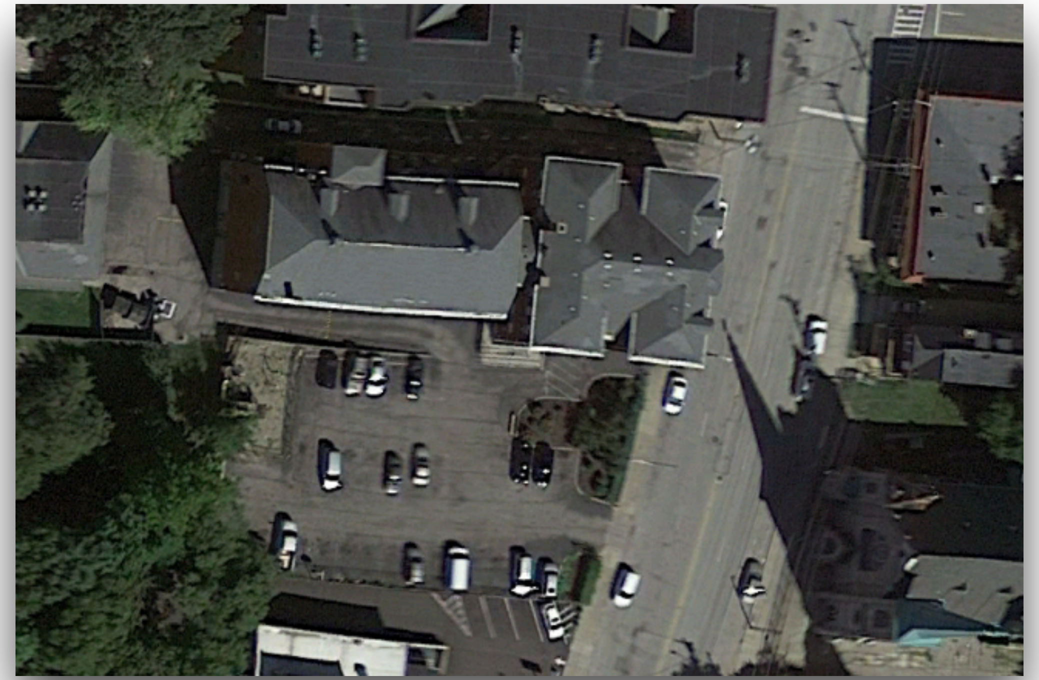


Figure 8: September 2021 Aerial Image

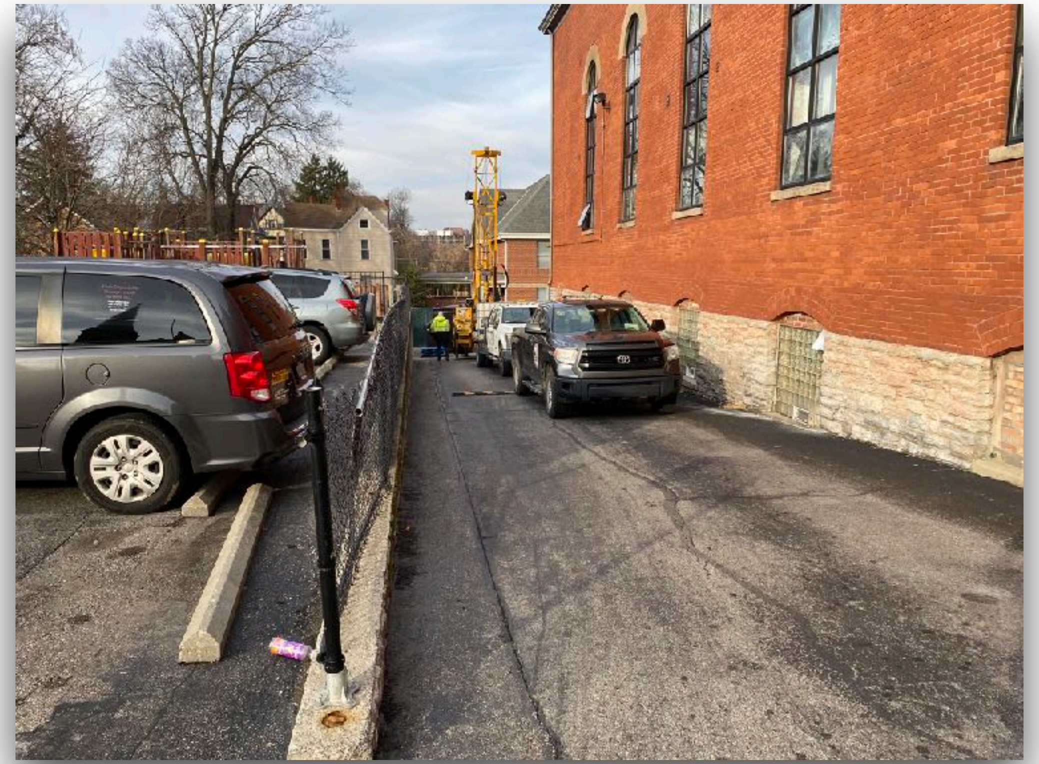
4 SITE PHOTOGRAPHS

Representative photographs of the site from November 29, 2022 are shown below.

Photograph 1: South end of site facing northeast toward existing building.

Photograph 2: South end of site facing northwest toward existing building.

Photograph 3: Boring B-4 facing northeast.



Photograph 4: Drilling Boring B-3. Concrete retaining wall providing grade separation from parking lot.

Photograph 5: View of existing parking lot facing west.

Photograph 6: Drilling Boring B-2. Existing underground utilities at northeast portion of the site.

FINDINGS

5 SUBSURFACE CONDITIONS

CSI performed six (6) soil test borings to explore the subsurface conditions at the site. In general, our borings encountered asphalt pavement at the ground surface that was underlain by previously placed fill atop alluvial deposits of sand and silt that transition into deep lacustrine clay deposits. Bedrock was encountered underlying the lacustrine soil at a depth of about 65 feet. Groundwater was encountered at a depth of 13.5 feet at one boring location.

5A SUBSURFACE STRATA INFORMATION

The subsurface conditions encountered at the test boring locations are shown on the Test Boring Logs in the Appendix. These records represent our interpretation of the subsurface conditions based on the field logs, visual examination of field samples by an engineer, and field and laboratory tests of the samples collected. The letters in parentheses following the soil descriptions are the soil classifications in general accordance with the Unified Soil Classification System (USCS). It should be noted that dashed stratification lines shown on the soil boring logs and Cross Sections A-A’ and B-B’ in the appendix represent approximate transitions between material types. In-situ stratum changes could occur gradually or at slightly different depths.

Boring location coordinates and ground surface elevations were determined using a Real Time Kinetics (RTK) type GPS unit.

ASPHALT PAVEMENT

Asphalt pavement was present at each boring location and ranged in thickness of about 2 to 5 inches. The asphalt pavement was underlain by approximately 2 to 3 inches of aggregate base, corresponding to a total pavement thickness of 4 to 8 inches. The asphalt pavement and aggregate base thicknesses encountered at each boring location are included on the boring logs within the appendix.

EXISTING FILL

Existing fill soils were encountered underlying the existing pavement at Borings B-1 through B-4 and B-6 that extended to depths between about 3.5 to 13.5 feet bgs (corresponding to elevations between about 808.5 and 826.5 feet amsl). The existing fill in Boring B-6 extended to the maximum explored depth of about 5 feet bgs (elevation of about 825.2 feet amsl). The fill soil is variable with respect to material type and is described as gravel, sandy lean clay, lean clay, clayey sand and sand on the boring logs. The fill at Borings B-4 and B-6 contained shale and brick fragments, respectively. Standard Penetration Test (SPT) N-Values were reported to range from 2 to 25 blows per foot (bpf). Unconfined compressive strengths (estimated using a Hand Penetrometer) of the existing fill ranged from 0.5 to 1.5 tons per square foot (tsf). The consistency of the cohesive fill ranged from very soft to firm and the relative density of the granular fill is considered very loose to medium dense. One moisture content test was performed on a sample of fill from Boring B-4 from 1 to 2.5 feet that resulted in a in-situ moisture content of about 19 percent.

ALLUVIUM SOIL

Natural soils designated as alluvium were encountered underlying the existing fill and asphalt pavement within Borings B-1 through B-5 and extended to depths between about 13.5 and 23.5 feet bgs (between about elevations 798.5 and 811.5 feet amsl). The alluvial soil extended to the maximum explored depth of 30 feet and 5 feet within Borings B-4 and B-5, respectively. The alluvial soil is described as unconsolidated mixtures/interbedded layers of silt, sandy silt, lean clay, sandy lean clay and silty sand. SPT N-Values were reported to range from 4 to 12 bpf corresponding to consistency descriptions of soft to stiff and relative density descriptions of very loose to medium dense. Unconfined compressive strengths of the cohesive alluvium soil types ranged from 0.5 to 2 tsf. Moisture content tests were performed on representative samples of alluvium that ranged from 18 to 27 percent.

LACUSTRINE

Underlying the alluvium stratum are deep deposits of lacustrine soil that were encountered within Borings B-1 through B-3 at a depth of about 13.5 to 23.5 feet bgs (about elevations 798.5 to 811.5 feet amsl) and extended to depths of about 63.5 feet bgs (elevations of about 758.5 to

766.5 feet amsl). The lacustrine soil is classified as highly plasticity fat clay with a varved/ laminated structure. The lacustrine soil is considered very soft to firm based on SPT N values ranging from weight of hammer to 7 bpf and unconfined compressive strengths generally near about 0.25 tsf. Atterberg Limits tests performed on samples of the lacustrine clay resulted in Liquid Limits between 56 and 63 percent, Plastic Limits ranging from 21 to 32 percent and Plasticity Indices from 30 to 35 percent. The moisture content of the lacustrine clay ranged from 36 to 59 percent; however, was generally between 36 and 39 percent.

GLACIAL TILL

A firm layer of glacial till soil was encountered within Boring B-2 underlying the lacustrine deposits at a depth of about 63.5 feet bgs (about elevation 766.5 feet amsl) and extended to the underlying bedrock at a depth of about 66.8 feet (about elevation 763.2 feet amsl). The corresponding thickness of the glacial till stratum is about 3.3 feet based on the findings from B-2. The glacial till was not encountered in the remaining borings. The glacial till is described as lean clay with trace amounts of sand and gravel and considered very stiff based on an SPT N value of 22 bpf and unconfined compressive strength of 4.5 tsf.

BEDROCK

Bedrock was encountered at Borings B-2 and B-3 at depths of about 66.8 feet and 63.5 feet bgs, respectively. One SPT sample was obtained of the bedrock within Boring B-3 upon encountering auger refusal, which confirmed the surface of the underlying bedrock consists of limestone. Based on the depth/elevation of the bedrock encountered in the two referenced borings, it appears the bedrock surface is relatively level across the site.

For details of subsurface conditions encountered at a particular boring location please refer to the boring logs contained in the Appendix. It should be noted that our borings were drilled and sampled according to the procedures presented in the appendix. The boring locations shown in the appendix should be considered accurate only to the degree implied by the method used.

5B GROUNDWATER CONDITIONS

Groundwater was encountered during drilling in Boring B-2 at a depth of about 18.5 feet bgs (elevation of about 816.6 feet amsl). The remaining borings did not encounter a noticeable amount of groundwater at the time or at the completion of the explorations. In many areas of Ohio with similar geology, water conditions that can affect construction and performance of projects is often related to trapped/perched water zones, which can be erratic, but often observed in granular soils. Perched water sources are typically not linked to the more continuous relatively stable ground water table that typically occurs at greater depths. In addition to perched water surfaces, groundwater may also be encountered at the interface between existing fill and natural soil. Site excavation activities or ground disturbance can expose these features and the resulting seepage can vary greatly. Groundwater issues are also dependent upon recent rainfall activity and surface and subsurface drainage patterns in the area that may change depending on climatic conditions.

6 LABORATORY TESTING

Laboratory tests were performed on selected recovered samples from the borings to assist with classification of the soils and provide recommendations for earthwork. Details for the test methods and results are shown in the Appendix. Tests performed included:

- 14 Moisture Content Tests
- 4 Atterberg Limits Tests
- 4 Particle Size Distribution Tests

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 is suitable for the proposed construction, provided the recommendations outlined in this report are followed. The primary geotechnical concerns associated with the subsurface conditions and proposed development are as follows:

- **BUILDING FOUNDATION SUPPORT**
- **SUBGRADE SUPPORT**
- **SITE EXCAVATIONS**
- **SITE DEMOLITION AND TEMPORARY EARTH RETENTION**

7A BUILDING FOUNDATION SUPPORT

The borings performed at the site revealed a variable thickness of previously placed fill material overtop deep deposits of weak alluvial and lacustrine soil. Based on the assumed finish floor elevations of 830 feet amsl and 820 feet amsl for the first floor and basement level portion of the proposed building, either previously placed fill soil or weak natural alluvial soil will be present at the foundation bearing elevation. Given the variability of the existing fill with respect to material type and strength, it is CSI's opinion that the existing fill is not suitable for direct support of building foundations. In addition, the underlying natural soils are soft and/or loose, high in moisture and exhibit low strength properties resulting in unsatisfactory foundation support conditions. In general, the weak natural soils will undergo settlement when subject to new loads associated with building foundations and/or surcharge loads associated with new fill placement that could exceed typical settlement tolerances for a multi story structure. As a result, it is CSI's opinion that, similar to the existing fill materials, the underlying natural soils are also unsuitable for direct support of the proposed building foundations.

Given the depth of the weak natural soil, typical foundation undercut/over-excavation solutions to remove unsuitable foundation material is not feasible at this site; therefore, it is CSI's opinion that the foundation support for the proposed building will need to consist of either rammed aggregate piers to stabilize the existing fill and weak natural soil or a deep foundation system consisting of auger cast in place piles. Based on discussions with representatives of Geopier and Model Group, it is understood that rammed aggregate piers is a feasible foundation option for the given subsurface conditions and foundation loads of the structure. While auger cast in place piles is also a practical option for foundation support, it is CSI's opinion that auger cast in place piles would not be a cost effective alternative to rammed aggregate piers for the given foundation loads; and therefore, the primary foundation support option recommended in this report is rammed aggregate piers.

7B SUBGRADE PREPARATION

It is CSI's opinion that the site demolition, stripping and/or excavation activities will expose moist and weak existing fill and/or natural subgrade soil within majority of the site. Specifically, the variable existing fill and soft/loose alluvial soils will be susceptible to yielding and deflection during earthwork construction activities and proof rolls. For areas of the site exposing these subgrade conditions, the earthwork construction protocols should include scarification, moisture conditioning and re-compaction of the top 12 inches of the exposed subgrade soils prior to proofrolling. Based on the potential depth and extent of the weak soils present within the planned development areas, these initial efforts to stabilize yielding subgrades may not be sufficient. In addition, typical stabilization methods (i.e., undercut to firm subgrade soil and replacement with engineered fill) may not be viable. Therefore, other stabilization methods will likely be required in areas of the site where the weak subgrade soils are present. The most cost effective stabilization method will vary depending on the specific site conditions, grading requirements, available materials, weather conditions, etc.; however, common forms of subgrade stabilization in lieu of typical methods may consist of geogrid or fabric overlain by aggregate or chemical modification. It is CSI's opinion that consideration should be given to including a contingency budget in the project cost to address subgrade stabilization efforts within the building footprint and pavement areas of the site.

7C SITE EXCAVATIONS

Site excavations performed at the site (i.e., underground utilities, basement excavations, etc.) are expected to encounter variably compact existing fill soil and soft/loose natural soil that will be prone to instability and sloughing of excavation side slopes and will likely contain areas of perched water. As a result, temporary excavations may require: 1) flatter excavation side slopes beyond the minimum OSHA requirements and/or use of bracing/trench box; 2) possible dewatering where water seepage is encountered; and, 3) additional backfill material as a result of wider excavations associated with flatter side slopes and/or sloughing of excavation side slopes.

7D SITE DEMOLITION AND TEMPORARY EARTH RETENTION

Demolition and removal of the existing building, foundations, pavements underground utilities, etc., within the planned development areas will be critical to the successful long term performance of the new structure and associated development. It is understood the existing structure has a lower level that borders portions of the north property limit containing a neighboring structure and east property boundary aligned along Gilbert Avenue. As a result, it is possible that excavations and demolition activities required to remove the existing buildings lower level may not allow for minimum temporary slopes needed to protect adjacent property boundaries, easements, structures, underground utilities and/or Gilbert Avenue. As a result, it is possible that a temporary earth retention system may be required in some areas prior to or as the excavations associated with the demolition activities are made. For this project, a feasible temporary earth retention system to consider is driven sheet piles or H-piles with wood lagging. Recommendations regarding site demolition are provided in Section 8. Lateral earth pressure recommendations for use in design of temporary or permanent soil retention/retaining walls are provided in Section 13.

8 SITE DEMOLITION

In accordance with the discussions section of this report, demolition and removal of the existing building, pavements, underground utilities, etc., within the planned development footprint will be required prior to earthwork, foundation and building construction. It is important that both the existing at-grade and below-ground structures are removed and the associated debris is hauled to an appropriate landfill, properly recycled or stockpiled in an approved area of the site. CSI recommends that below ground and at grade structures (building foundations, floor slabs, underground utilities, sidewalks, pavements, etc.) be completely removed from within the planned building footprint including a 10-feet wide buffer, where possible. CSI recommends that prior to demolition activities, the limits of the lower level of the existing building be evaluated in comparison with the existing grades, easement and/or property boundaries and associated underground utilities to determine if the minimum temporary slope recommendations contained in Section 9B can be adequately maintained and/or if a temporary earth retention system is required.

Existing structures and underground utilities located at least 10 feet beyond the building limits and extending at least 2 feet below the planned finish grades may remain in place, if approved by the Geotechnical Engineer and owner. CSI recommends any pipe or cavity left in place (beyond the building limits) must be fully grouted or backfilled with engineered fill. Construction debris generated demolition activities is not considered suitable for use in on-site fills.

9 EARTHWORK

Historically, more change orders (in orders 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 geotechnical concerns listed in Section 7 prior to reading the following recommendations. We recommend that cuts and fills should not be performed without being evaluated by CSI. If problems occur and the recommendations do not address or do not adequately remedy, please contact CSI as soon as possible.

9A TEMPORARY EXCAVATIONS

Normal earth excavation equipment should be suitable for excavation operations that are associated with the on-site soils. All excavations should comply with OSHA requirements. For below-grade excavations, the existing fill soils and natural soils should be classified as an OSHA Type C soil with slope excavations of 1½ H:1V. If soil types other than what has been mentioned above are encountered, CSI should be contacted to evaluate stability.

9B SITE PREPARATION (WORK PRIOR TO FILLING)

- Site demolition should be performed in accordance with the recommendations contained within Section 8;
- The area should be stripped of any topsoil and/or vegetative cover prior to commencing fill operations;
- As noted in Section 7B, it is expected that soils exposed at the subgrade elevations will yield to construction traffic and earthwork equipment. Therefore, CSI recommends that for areas exhibiting yielding and deflection under construction equipment traffic, the earthwork contractor scarify the exposed surface to a minimum depth of 12 inches, uniformly moisture condition the entire 12 inch lift and re-compact the surface layer in-place prior to proofrolling, in an effort to establish a firm subgrade surface.
- Areas ready to receive new fill should be proofrolled with a heavily loaded dump truck or similar equipment judged acceptable by the geotechnical engineer;
- The level of proofroll should be determined by the 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 done in accordance with section 9D;
- Deleterious materials such as topsoil, roots, wood or other materials that will decay should be removed from the site;

- 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.

9C NEW FILL OPERATIONS (MASS EARTHWORK)

Before new fill construction, representative samples should be obtained of the proposed fill material to determine the moisture-density, classification of the material, and whether the material is suitable to be used as structural fill. After the subgrade has been approved to receive new fill, the fill may commence with the following procedures and guidelines recommended:

- Place cohesive fill (clay) in maximum 8-inch thick loose lifts. Granular soils may be placed in maximum 12 inch thick loose lifts provided properly sized equipment is used in the compaction process;
- Fill lifts should be compacted to at least 98 percent of the soil's maximum dry density (ASTM D698) in areas beneath structures (buildings and pavements). If necessary due to material or equipment size, a modified Proctor may also be considered. CSI can provide specific recommendations if needed.
- Non-structural areas (i.e., grassed and/or landscape areas) can utilize a lower compaction requirement of 90 percent if approved by the owner and geotechnical engineer. In general, non-structural areas should be considered 5 feet beyond the limits of structural entities (i.e., building, pavements, sidewalks, etc.).
- For soils which are high plasticity, maintain the moisture content of compacted fill between minus 1 and plus 2 percent of optimum moisture. Lower plasticity soils can have a variance of plus or minus 2 percent of optimum moisture;
- Soils with a plasticity index (PI) of greater than 35 should not be used in the upper 4 feet of new fill within roadways or buildings where the slab will be within 4 feet of the exterior surface grade. The on-site soils are generally non-plastic; however, CSI recommends any import soils that will be used as engineered fill be evaluated and tested by CSI prior to use to confirm plasticity;
- Maximum particle size of the soil should be limited to half the lift thickness. Equipment should be large enough that any limestone slabs are thoroughly broken up. Large pieces not able to be satisfactorily broken up should be removed from the fill;
- 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 proof rolling);
- Density testing should be performed at a rate of at least one per 10,000 square feet per lift with a minimum of 3 tests per lift;
- Soils should not be “over compacted” 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.

9D 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 the recommendations below. 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 clay and 12 inches for granular soils.
- For crushed stone/aggregate backfills in trenches or wall backfill and when using smaller compaction equipment the lift thickness should be based on the type of aggregate and equipment. For well-graded granular soils such as Dense Grade Aggregate, a thickness of 4 to 6 inches is typically required. If open-graded stone is used, the lift thickness may be able to be increased. This should be evaluated by the geotechnical engineer.
- Fill lifts should be compacted to at least 98 percent of the soil's maximum dry density (ASTM D 698) in areas beneath structures (buildings, equipment foundations and pavements).
- For granular and lean clay soils, maintain the moisture content of compacted fill between minus 2 and plus 2 percent of optimum moisture.
- Maximum particle size of the soil should be limited to half the lift thickness. Equipment should be large enough that any large particles are thoroughly broken up. Large pieces not able to be satisfactorily broken up should be removed from the fill.
- 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.
- Density testing should be performed at a rate of at least 3 tests per lift; CSI should be retained to provide additional recommendations for backfill.

9E PERMANENT CUT/FILL SLOPES

The following are general slope construction guidelines:

- Any permanent cut or fill slope should be designed and constructed no steeper than a gradient of 3H:1V.

- Any area within 10 horizontal feet of a structure should be slightly sloped to allow surface water drainage away from the structure;

9F 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

10 SITE DRAINAGE

During construction, water should not be allowed to pond in excavations and fill areas or undercutting will likely be required. During the life of the project, slope the subgrade and other site features so that surface water flows away from the site structures.

For excavations during construction, most free water from the subsurface conditions could likely be removed via sump pumps and open channel flow (if possible) at or near the source of seepage. However, if normal dewatering measures prove insufficient, CSI should be retained to provide recommendations on the issue.

11 FOUNDATIONS

Based on the information provided, the subsurface conditions encountered, discussions with Geopier and in accordance with the conclusions section (Section 7) of this report, CSI recommends the building addition be supported on a foundation soil improvement system such as rammed aggregate piers with shallow spread foundations. CSI has provided recommendations for the recommended foundation option in the subsection below. If there are any changes in the project criteria or building locations, CSI should be allowed to review the recommendations to determine if any modifications are required.

11A RAMMED AGGREGATE PIERS

CSI recommends that a viable foundation support system for the proposed multi-story building is to stabilize the existing fill and weak natural soils using rammed aggregate piers or Geopiers in conjunction with shallow depth spread foundations bearing at conventional depths. The advantage of foundation soil stabilization with rammed aggregate piers is that conventional spread type foundations can be designed and constructed as planned without the need to locally or globally remove unsuitable foundation soils or utilize a deep foundation system. Rammed aggregate pier elements are installed by advancing 20 to 30 inch diameter holes and ramming thin lifts of well-graded aggregate within the holes to form very stiff, high-density aggregate piers. The stone is placed is successive lifts and compacted using direct vertical ramming energy. The result is a pre-stressing of the existing soil around the “piers” within the influence zone of the foundation and a partial transfer of foundation loads to a deeper stratum effectively reducing foundation settlement. These elements effectively increase the bearing capacity and reduce the settlement potential when compared to the supporting the structure on the native soils and also can provide a cost effective solution when compared to deep foundations. Rammed aggregate pier stabilization or improvement techniques are typically proprietary systems (I.e., Geopier) that are designed and installed by a specialty contractor. Therefore, the size, depth, spacing, performance criteria (I.e., bearing capacity, settlement, etc.) and cost of the rammed aggregate pier system should be determined by the designer, specialty contractor or designated representative.

12 GRADE SUPPORTED FLOOR SLABS

Grade supported floor slabs are suitable for the proposed structure, provided the subgrade is prepared according to the recommendations contained within this report. As noted in this report, the subgrade soils exposed will likely yield to construction traffic and proof rolls. If the exposed subgrade continues to yield to proof rolls and construction traffic subsequent to performing the 12-inch scarification and re-compaction recommended in Section 9B, additional stabilization efforts may be required that could consist of geogrid or woven geosynthetic fabric with compacted aggregate. The specific geogrid/fabric and fill material thickness above the geogrid/fabric should be established by the CSI Geotechnical Engineer; however, for preliminary planning, a minimum design would include a subgrade reinforcing geotextile and 18 inches of compacted aggregate base material. We recommend the floor slab be supported on a minimum of 4 inches of compacted granular base. The slab should be designed to be structurally independent of any building footings or walls and should be appropriately reinforced to support the proposed loads. The following features are also recommended as part of the floor slab construction:

- Provide isolation joints between the slab and columns and along footing supported walls
- 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
- 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
- DO NOT allow soils directly below the slab to become overly wet or dry prior to placement of concrete; and
- 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 should be followed.

13 TEMPORARY AND PERMANENT EARTH RETENTION AND RETAINING WALLS

CSI recommends that temporary or permanent soil retention structures and retaining walls for the project be designed to meet the site needs including maximum retention height, location, tolerable deflection at the top of the structure, and constructibility. It is recommended that the retention structure(s) or retaining wall(s) be designed and sealed by a professional engineer licensed in the state of Ohio acknowledging that the appropriate internal, external, and global stability factors of safety for the particular retaining wall structure or soil retention system are met.

Soil retention structures and retaining walls should be designed to resist lateral loads imposed by the surrounding soils, hydrostatic pressure (if adequate drainage of the backfill is not provided), and surface surcharge loads adjacent to the wall (i.e., structures, foundations, pavements, traffic loads, stockpiles, inclined backfill, etc.). Depending on the lateral movement acceptance criteria, the structure may be designed as: 1) cantilevered (not fixed at the top allowing lateral deflection); or, 2) restrained or anchored (fixed at the top). With respect to the lateral earth pressure design, CSI recommends that "active" earth pressures be used for cantilevered designs and “at-rest” lateral earth pressures be used for restrained/anchored designs (i.e., basement foundation walls). Should wall backfill be placed before floor joists are constructed, it may be necessary to provide temporary bracing if the walls cannot accommodate construction phase stresses, or the walls should be designed for the active earth pressure condition as self-supporting cantilever walls.

The lateral earth pressure coefficients should be selected based on the predominate soil within the retained zone of the soil retention structure or retaining wall. The retained zone should be considered as an imaginary line drawn upward at a 45 degree angle from the top of footing. The following table presents granular backfill and on-site materials earth pressure design parameters for Equivalent Fluid Density’s (EFD’s) and Earth Pressure coefficients. The values given assume the backfill surface is level, drained or undrained backfill, the zone of backfill conforms to the minimum zone size given above, and no surcharge is placed on the backfill.

Table 3: Equivalent Fluid Density (EFD) and Earth Pressure Coefficient

Condition	Granular Backfill		On-Site Materials (1)		
	Coefficients	EFD (Drained) (pcf)	Coefficients	EFD (Drained) (pcf)	EFD (Undrained) (pcf)
At-Rest	Ko = 0.35	45	Ko = 0.56	70	97
Active	Ka = 0.22	30	Ka = 0.39	49	87
Passive	Kp = 2.75	300	Kp = 2.56	320	220

(1) On-site soil having a unit weight of 125 pcf and friction angle of 26 degrees.

The above table provides drained and undrained (i.e., includes hydrostatic pressure of 62.4 pcf) lateral earth pressure design parameters. For all retaining walls, where possible, CSI recommends that the wall design include sufficient drainage of the backfill soils to relieve hydrostatic pressure. For this purpose, CSI recommends that drainage backfill be constructed immediately behind the wall and extend from the foundation elevation to the top of the wall. This backfill should be effectively drained using a piping system connected to a storm sewer, gravity outlet, weep holes or a sump. Where possible, CSI recommends that the immediate backfill soils (within a minimum of 2 feet laterally from the wall) consist of a free-draining compacted granular material. The free-draining granular material should consist of a uniformly-graded aggregate that is between ½ inch to 1-inch in size and contain less than 5 percent passing a #200 size sieve. The free draining granular backfill should be separated from clayey soil using a non-woven geotextile filter fabric. Alternately, a drainage geocomposite may be used as the drainage layer behind the back face of the wall. CSI recommends that the drainage system be comprised of a minimum 8 inch diameter perforated pipe placed at the base of the free draining granular backfill (i.e., adjacent to and continuously along the wall foundation) or geocomposite and gravity drained to a storm outlet, weep holes or sump.

14 NOTES ON THE 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, used six 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. 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.

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 samples are then discarded unless you request otherwise. Please inform us if you wish to keep any of the obtained samples.

APPENDIX

ADAPTED FROM TOPOGRAPHIC MAPPING
FOR ILLUSTRATION PURPOSES

CSI Cincinnati, LLC
11785 Highway Drive
Cincinnati, Ohio 45241
513.252.2059 Office | 888.792.3121 Fax
www.csiohio.com

TITLE: SITE LOCATION PLAN

PROJECT NO: CN220255

DRAWN BY: JPH

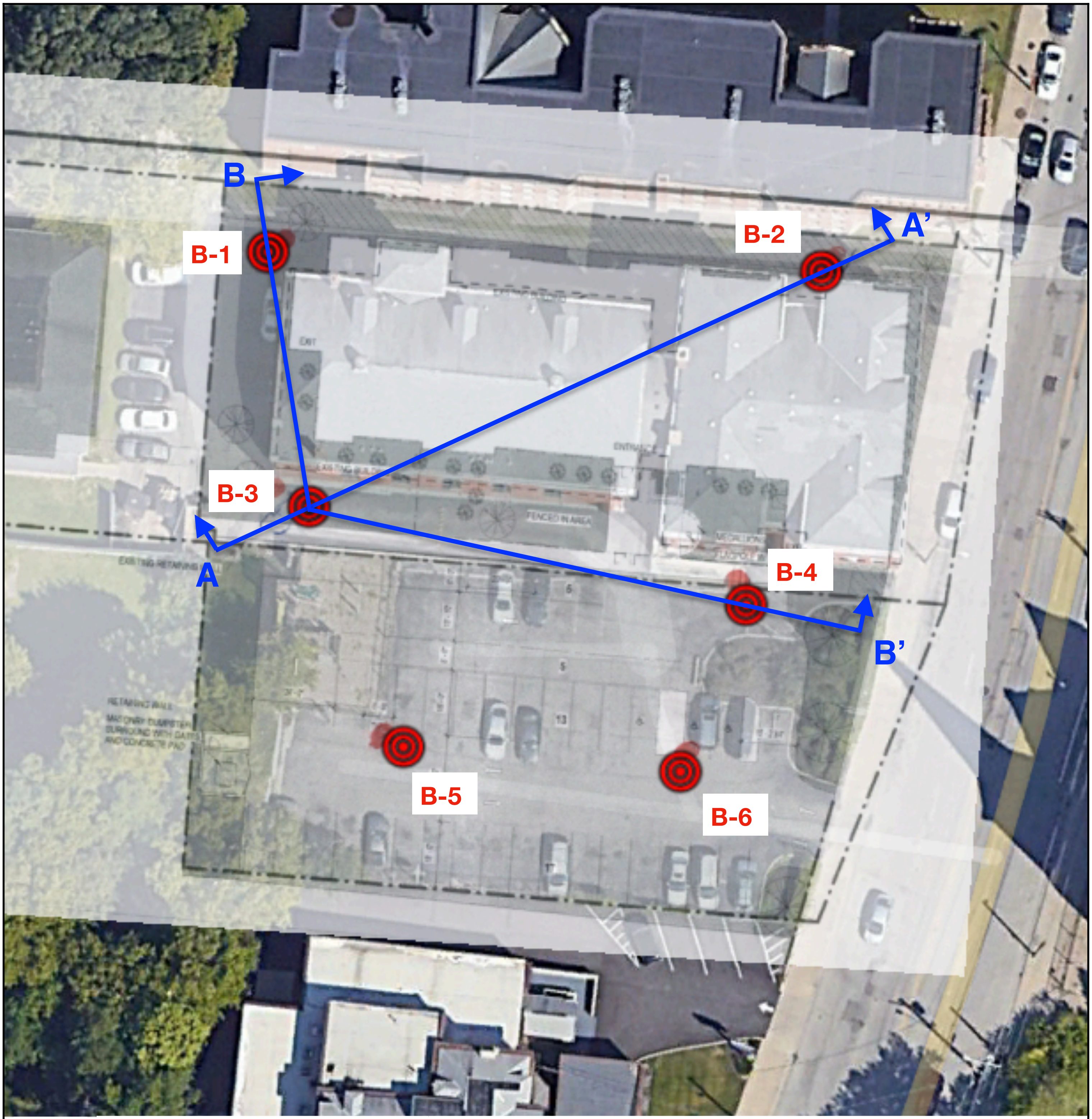
PROJECT: GEIGER HOUSE FOR VETERANS
2631 GILBERT AVENUE
CINCINNATI, OHIO

DATE: 12/14/2022

CHECKED BY: JB

NOT TO SCALE

DRAWING NO 1 OF 2



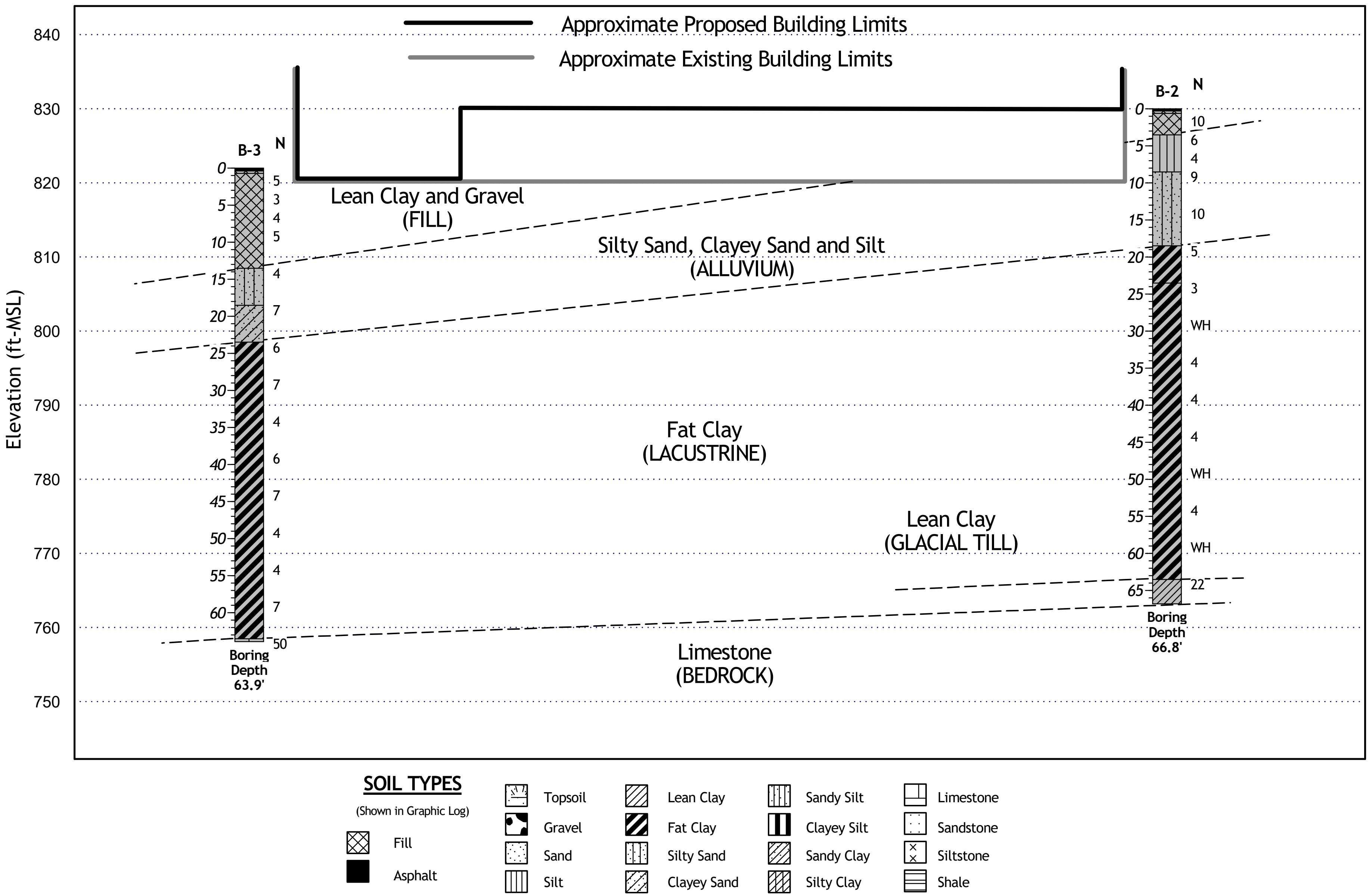
N

FOR ILLUSTRATION PURPOSES

CSI Cincinnati, LLC
11785 Highway Drive
Cincinnati, Ohio 45241
513.252.2059 Office | 888.792.3121 Fax
www.csiohio.com

TITLE:	SITE LOCATION PLAN	PROJECT NO: CN220255	DRAWN BY: JPH
PROJECT:	GEIGER HOUSE FOR VETERANS 2631 GILBERT AVENUE CINCINNATI, OHIO	DATE: 12/14/2022	CHECKED BY: JB
		NOT TO SCALE	DRAWING NO 2 OF 2

CROSS SECTION A-A'
N.T.S.



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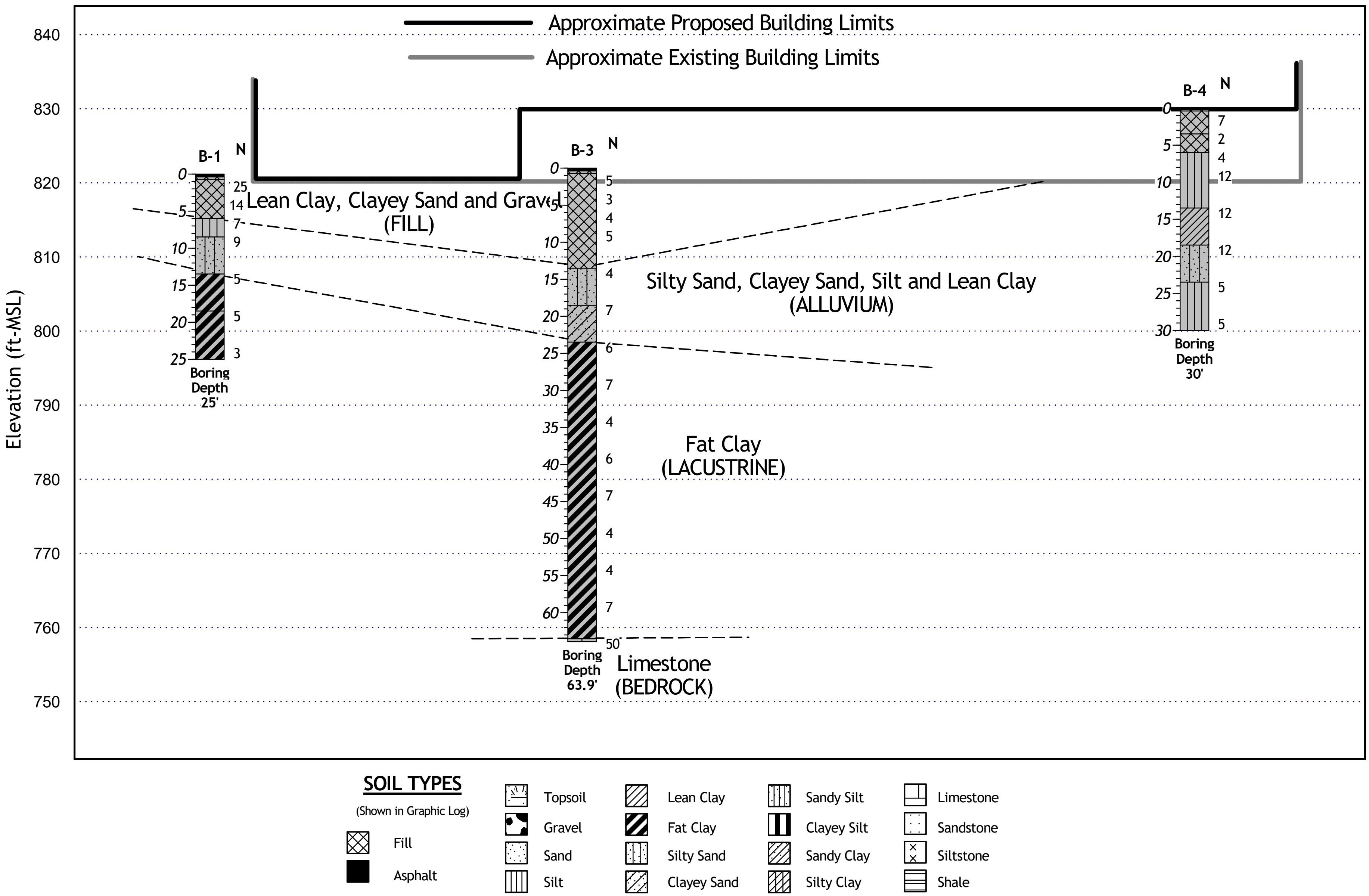
Geiger House for
Veterans
CN220255

CROSS SECTION A-A'

Fig. 1

CSI STRATIGRAPHY (GINT 7) CN220255 - GEIGER HOUSE FOR VETERANS BORING LOGS.GPJ GINT STD US LAB.GDT 12/19/22

CROSS SECTION B-B'
N.T.S.



CSI STRATIGRAPHY (GINT 7) CN220255 - GEIGER HOUSE FOR VETERANS BORING LOGS.GPJ GINT STD US LAB.GDT 12/19/22

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Geiger House for Veterans
CN220255

CROSS SECTION B-B'

Fig. 1

Consulting Services Incorporated
LEXINGTON | LOUISVILLE | CINCINNATI

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.

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TEST BORING LOG

CLIENT **Model Group**
PROJECT NAME **Geiger House for Veterans**
PROJECT LOCATION **2631 Gilbert Avenue, Cicinnati, Ohio**

BORING # **B-1**
JOB # **CN220255**
LOGGED BY **CG**
APPROVED BY **JPH**

DRILLING and SAMPLING INFORMATION

Date Started	**11/30/2022**	Contractor	**CSI**
Date Completed	**11/30/2022**	Boring Size	**7** in.
Drill Rig	**Mobile B-57**	Boring Method	**3.25" I.D. HSA**
Weather	**Overcast**	Hammer Type	**Automatic**

TEST DATA

Elev. (ft)	Depth Scale	Water Level	SOIL CLASSIFICATION SURFACE ELEVATION: 821.2	Sample No.	Sample Type	Sample Graphics	Recovery (in)	Standard Penetration Test Blows per 6" [N-Value] blows/foot	Qu-tsf Unconfined (Pocket Pen.) Compressive Strength	Moisture Content %	Liquid Limit (LL)	Plasticity Index (PI)	Percent Passing #200 Sieve	Remarks
820	2		Asphalt Pavement (5 inches) Aggregate Base (3 inches)	1	SS	☒	8	18-16-9 [*25*]						
818 816	4 6		Gray GRAVEL (GW) with sand, trace silt, trace clay [FILL] - moist to dry, medium dense	2	SS	☒	3	10-8-6 [*14*]	1.5					
814	8		Brown SILT (ML) with clay, trace sand [ALLUVIUM] - moist, firm	3	SS	☒	6	4-3-4 [*7*]		20.1				
812 810 808	10 12	●	Brown mottled with gray SILTY SAND (SM) [ALLUVIUM] - moist, loose	4	SS	☒	6	3-5-4 [*9*]						
806 804	14 16 18		Brown FAT CLAY (CH) with trace silt [LACUSTRINE] - moist, firm	5	SS	☒	14	2-2-3 [*5*]	1.5	36.4				
802 800 798	20 22 24		Gray FAT CLAY (CH) with trace silt [LACUSTRINE] - moist, firm to soft	6	SS	☒	14	4-2-3 [*5*]	0.5	38.0				
				7	SS	☒	18	2-1-2 [*3*]	0.25					
796 794 792 790 788	26 28 30 32 34		Boring Terminated at 25 feet											

Depth to Groundwater
● Noted on Drilling Tools **13.5** ft.
⊻ At Completion ________ ft.
▼ After ________ hours ________ ft.
▨ Cave Depth ________ ft.

Sample Type
SPT- Standard Penetration Test
SS- Split Spoon
ST- Shelby Tube
RC- Rock Core
CU- Auger Cuttings

Boring Method
HSA- Hollow Stem Augers
CFA- Continuous Flight Augers
MD- Mud Drilling

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TEST BORING LOG

CLIENT **Model Group**
PROJECT NAME **Geiger House for Veterans**
PROJECT LOCATION **2631 Gilbert Avenue, Cicinnati, Ohio**

BORING # **B-2**
JOB # **CN220255**
LOGGED BY **CG**
APPROVED BY **JPH**

DRILLING and SAMPLING INFORMATION

Date Started **11/30/2022**
Date Completed **11/30/2022**
Drill Rig **Mobile B-57**
Weather **Overcast**
Contractor **CSI**
Boring Size **7** in.
Boring Method **3.25" I.D. HSA**
Hammer Type **Automatic**

SOIL CLASSIFICATION						TEST DATA								
Elev. (ft)	Depth Scale	Water Level	SURFACE ELEVATION: 830.0	Sample No.	Sample Type	Sample Graphics	Recovery (in)	Standard Penetration Test Blows per 6" [*N-Value*] *blows/foot*	Qu-tsf Unconfined (Pocket Pen.) Compressive Strength	Moisture Content %	Liquid Limit (LL)	Plasticity Index (PI)	Percent Passing #200 Sieve	Remarks
			Asphalt Pavement (4 inches)											
828	2		Aggregate Base (3 inches)	1	SS	☒	6	7-5-5 [*10*]						
			Gray GRAVEL (GW) with sand [FILL] - moist, loose											
826	4		Brown SILT (ML) with clay, trace sand [ALLUVIUM] - moist, firm to soft	2	SS	☒	11	4-3-3 [*6*]	0.5	21.5			93	
824	6			3	SS	☒	10	1-2-2 [*4*]	1					
822	8													
820	10		Brown SILTY SAND (SM) with clay [ALLUVIUM] - moist, loose	4	SS	☒	9	3-3-6 [*9*]						
818	12													
816	14			5	SS	☒	11	4-4-6 [*10*]						
814	16													
812	18													
810	20		Brown FAT CLAY (CH) with trace silt [LACUSTRINE] - moist, firm	6	SS	☒	18	2-2-3 [*5*]	1.5	38.9	60	30		
808	22													
806	24		Gray FAT CLAY (CH) with trace silt [LACUSTRINE] - moist, very soft to soft	7	SS	☒	18	2-1-2 [*3*]	0.25					
804	26													
802	28													
800	30			8	SS	☒	18	WH-WH- [**WH**] [*WH*]	0.25	38.4	56	35		
798	32													
796	34			9	SS	☒	18		0.25					

Depth to Groundwater
● Noted on Drilling Tools ________ ft.
▽ At Completion ________ ft.
▼ After ________ hours ________ ft.
Cave Depth ________ ft.

Sample Type
SPT- Standard Penetration Test
SS- Split Spoon
ST- Shelby Tube
RC- Rock Core
CU- Auger Cuttings

Boring Method
HSA- Hollow Stem Augers
CFA- Continuous Flight Augers
MD- Mud Drilling

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Fax: 888.792.3121

TEST BORING LOG

CLIENT **Model Group**

PROJECT NAME **Geiger House for Veterans**

PROJECT LOCATION **2631 Gilbert Avenue, Cicinnati, Ohio**

BORING # **B-2**

JOB # **CN220255**

LOGGED BY **CG**

APPROVED BY **JPH**

DRILLING and SAMPLING INFORMATION

Date Started	**11/30/2022**	Contractor	**CSI**
Date Completed	**11/30/2022**	Boring Size	**7** in.
Drill Rig	**Mobile B-57**	Boring Method	**3.25" I.D. HSA**
Weather	**Overcast**	Hammer Type	**Automatic**

TEST DATA

Elev. (ft)	Depth Scale	Water Level	SOIL CLASSIFICATION (continued)		Sample No.	Sample Type	Sample Graphics	Recovery (in)	Standard Penetration Test Blows per 6" [N-Value] blows/foot	Qu-tsf Unconfined (Pocket Pen.) Compressive Strength	Moisture Content %	Liquid Limit (LL)	Plasticity Index (PI)	Percent Passing #200 Sieve	Remarks
794	36		Gray FAT CLAY (CH) with trace silt [LACUSTRINE] - moist, very soft to soft	▨					2-2-2 [4]						
792	38			▨											
790	40			▨	10	SS	☒	18	2-2-2 [4]	0.25	38.7				
788	42			▨											
786	44			▨	11	SS	☒	18	2-2-2 [4]	0.25					
784	46			▨											
782	48			▨											
780	50			▨	12	SS	☒	18	WH-WH- [WH] [WH]	0.25	37.8				
778	52			▨											
776	54			▨	13	SS	☒	18	1-1-3 [4]	0.25					
774	56			▨											
772	58			▨											
770	60			▨	14	SS	☒	18	WH-WH- [WH] [WH]	0.25	58.8				
768	62			▨											
766	64		Blueish gray LEAN CLAY (CL) with trace gravel [GLACIAL TILL] - moist, very stiff	▨	15	SS	☒	14	6-7-15 [22]	4.5					
764	66			▨											
762	68		Auger Refusal on Apparent Bedrock at about 66.8'												

Depth to Groundwater

● Noted on Drilling Tools ________ ft.

⊻ At Completion ________ ft.

▼ After ________ hours ________ ft.

⊠ Cave Depth ________ ft.

Sample Type

SPT- Standard Penetration Test
SS- Split Spoon
ST- Shelby Tube
RC- Rock Core
CU- Auger Cuttings

Boring Method

HSA- Hollow Stem Augers
CFA- Continuous Flight Augers
MD- Mud Drilling

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TEST BORING LOG

CLIENT **Model Group**

PROJECT NAME **Geiger House for Veterans**

PROJECT LOCATION **2631 Gilbert Avenue, Cicinnati, Ohio**

BORING # **B-3**

JOB # **CN220255**

LOGGED BY **CG**

APPROVED BY **JPH**

DRILLING and SAMPLING INFORMATION

Date Started	11/29/2022	Contractor	CSI
Date Completed	11/29/2022	Boring Size	7 in.
Drill Rig	Mobile B-57	Boring Method	3.25" I.D. HSA
Weather	Overcast	Hammer Type	Automatic

TEST DATA

SOIL CLASSIFICATION

Elev. (ft)	Depth Scale	Water Level	SURFACE ELEVATION: 822.0	Sample No.	Sample Type	Sample Graphics	Recovery (in)	Standard Penetration Test Blows per 6" [*N-Value*] *blows/foot*	Qu-tsf Unconfined (Pocket Pen.) Compressive Strength	Moisture Content %	Liquid Limit (LL)	Plasticity Index (PI)	Percent Passing #200 Sieve	Remarks
			Asphalt Pavement (5 inches)											
820	2		Aggregate Base (3 inches)	1	SS	☒	9	4-3-2 [5]	0.5					
818	4		Brown, gray and dark gray sandy LEAN CLAY (CLS) with silt, trace gravel [FILL] - moist, very soft to firm	2	SS	☒	5	4-1-2 [3]	0.5					
816	6			3	SS	☒	8	4-2-2 [4]	0.5					
814	8			4	SS	☒	6	2-2-3 [5]	0.5					
812	10													
810	12													
808	14		Brown mottled with gray SILTY SAND (SM) with clay [ALLUVIUM] - moist, very loose	5	SS	☒	14	2-2-2 [4]		18.4			62	
806	16													
804	18		Brown CLAYEY SAND (SC) with silt [ALLUVIUM] - moist, loose	6	SS	☒	18	3-3-4 [7]						
802	20													
800	22													
798	24		Gray FAT CLAY (CH) with trace silt [LACUSTRINE] - moist, soft to firm	7	SS	☒	18	2-2-4 [6]	0.25	39.7	63	31		
796	26													
794	28			8	SS	☒	18	3-3-4 [7]	0.25					
792	30													
790	32													
788	34			9	SS	☒	18		0.25					

Depth to Groundwater
- ● Noted on Drilling Tools ________ ft.
- ▽ At Completion ________ ft.
- ▼ After ________ hours ________ ft.
- Cave Depth ________ ft.

Sample Type
- SPT- Standard Penetration Test
- SS- Split Spoon
- ST- Shelby Tube
- RC- Rock Core
- CU- Auger Cuttings

Boring Method
- HSA- Hollow Stem Augers
- CFA- Continuous Flight Augers
- MD- Mud Drilling

TEST BORING LOG

CLIENT **Model Group**
PROJECT NAME **Geiger House for Veterans**
PROJECT LOCATION **2631 Gilbert Avenue, Cicinnati, Ohio**

BORING # **B-3**
JOB # **CN220255**
LOGGED BY **CG**
APPROVED BY **JPH**

DRILLING and SAMPLING INFORMATION

Date Started **11/29/2022**
Date Completed **11/29/2022**
Drill Rig **Mobile B-57**
Weather **Overcast**
Contractor **CSI**
Boring Size **7** in.
Boring Method **3.25" I.D. HSA**
Hammer Type **Automatic**

TEST DATA

Elev. (ft)	Depth Scale	Water Level	SOIL CLASSIFICATION (continued)	Sample No.	Sample Type	Sample Graphics	Recovery (in)	Standard Penetration Test Blows per 6" [*N-Value*] *blows/foot*	Qu-tsf Unconfined (Pocket Pen.) Compressive Strength	Moisture Content %	Liquid Limit (LL)	Plasticity Index (PI)	Percent Passing #200 Sieve	Remarks
786	36		Gray FAT CLAY (CH) with trace silt [LACUSTRINE] - moist, soft to firm					WH-2-2 [*4*]						
784	38													
				10	SS	☒	18	2-3-3 [*6*]	0.25					
782	40													
780	42													
778	44			11	SS	☒	18	4-3-4 [*7*]	0.25					
776	46													
774	48													
				12	SS	☒	18	WH-WH-4 [*4*]	0.25					
772	50													
770	52													
768	54			13	SS	☒	18	WH-2-2 [*4*]	0.25					
766	56													
764	58													
				14	SS	☒	18	WH-3-4 [*7*]	0.25					
762	60													
760	62													
758	64		Dark gray LIMESTONE [BEDROCK], slightly weathered, hard	15	SS	☒	4	50-- [*50*]						
756	66		Auger Refusal on Bedrock at about 63.9'											
754	68													

Depth to Groundwater
● Noted on Drilling Tools ________ ft.
⊻ At Completion ________ ft.
▼ After ________ hours ________ ft.
▨ Cave Depth ________ ft.

Sample Type
SPT- Standard Penetration Test
SS- Split Spoon
ST- Shelby Tube
RC- Rock Core
CU- Auger Cuttings

Boring Method
HSA- Hollow Stem Augers
CFA- Continuous Flight Augers
MD- Mud Drilling

CSI of Cincinnati
11785 Highway Drive
Cincinnati, OH 45241
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Fax: 888.792.3121

TEST BORING LOG

CLIENT	**Model Group**	BORING #	**B-4**
PROJECT NAME	**Geiger House for Veterans**	JOB #	**CN220255**
PROJECT LOCATION	**2631 Gilbert Avenue, Cicinnati, Ohio**	LOGGED BY	**CG**
		APPROVED BY	**JPH**

DRILLING and SAMPLING INFORMATION

Date Started	**11/29/2022**	Contractor	**CSI**
Date Completed	**11/29/2022**	Boring Size	**7** in.
Drill Rig	**Mobile B-57**	Boring Method	**3.25" I.D. HSA**
Weather	**Overcast**	Hammer Type	**Automatic**

SOIL CLASSIFICATION

SURFACE ELEVATION: 830.1

Elev. (ft)	Depth Scale	Water Level
828	2	
826	4	
824	6	
822	8	
820	10	
818	12	
816	14	
814	16	
812	18	●
810	20	
808	22	
806	24	
804	26	
802	28	
800	30	
798	32	
796	34	

- Asphalt Pavement (2 inches)
- Aggregate Base (2 inches)
- Gray LEAN CLAY (CL) with shale fragments [FILL] - moist, firm
- Brown and dark brown CLAYEY SAND (SC) with trace gravel [FILL] - moist, very loose
- Dark brown becoming brown SILT (ML) with sand, trace clay [ALLUVIUM] - moist, soft to stiff
- Brown mottled with gray SANDY LEAN CLAY (CLS) with silt [ALLUVIUM] - moist, stiff
- Brown SILTY SAND (SM) with trace clay [ALLUVIUM] - wet, medium dense
- Brown SILT (ML) with trace clay, trace sand [ALLUVIUM] - wet, firm
- Boring Terminated at 30'

TEST DATA

Sample No.	Sample Type	Sample Graphics	Recovery (in)	Standard Penetration Test Blows per 6" [*N-Value*] *blows/foot*	Qu-tsf Unconfined (Pocket Pen.) Compressive Strength	Moisture Content %	Liquid Limit (LL)	Plasticity Index (PI)	Percent Passing #200 Sieve	Remarks
1	SS	☒	10	3-2-5 [*7*]		18.7				
2	SS	☒	3	1-1-1 [*2*]						
3	SS	☒	14	1-2-2 [*4*]	0.5	26.5				
4	SS	☒	11	4-6-6 [*12*]	2					
5	SS	☒	17	5-5-7 [*12*]	2					
6	SS	☒	6	1-6-6 [*12*]						
7	SS	☒	15	2-2-3 [*5*]					99	
8	SS	☒	12	2-2-3 [*5*]						

Depth to Groundwater
● Noted on Drilling Tools **18.5** ft.
▽ At Completion ______ ft.
▼ After ______ hours ______ ft.
☒ Cave Depth ______ ft.

Sample Type
SPT- Standard Penetration Test
SS- Split Spoon
ST- Shelby Tube
RC- Rock Core
CU- Auger Cuttings

Boring Method
HSA- Hollow Stem Augers
CFA- Continuous Flight Augers
MD- Mud Drilling

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TEST BORING LOG

CLIENT **Model Group**
PROJECT NAME **Geiger House for Veterans**
PROJECT LOCATION **2631 Gilbert Avenue, Cicinnati, Ohio**

BORING # **B-5**
JOB # **CN220255**
LOGGED BY **CG**
APPROVED BY **JPH**

DRILLING and SAMPLING INFORMATION

Date Started	11/29/2022	Contractor	CSI
Date Completed	11/29/2022	Boring Size	7 in.
Drill Rig	Mobile B-57	Boring Method	3.25" I.D. HSA
Weather	Overcast	Hammer Type	Automatic

SOIL CLASSIFICATION

SURFACE ELEVATION: 828.6

Elev. (ft)	Depth Scale	Water Level	Description
828			Asphalt Pavement (3 inches)
			Aggregate Base (3 inches)
			Brown mottled with gray LEAN CLAY (CL) with sand [ALLUVIUM] - moist, firm
			Brown CLAYEY SAND (SC) with gravel [ALLUVIUM] - moist, very loose
			Boring Terminated at 5'

TEST DATA

Sample No.	Sample Type	Sample Graphics	Recovery (in)	Standard Penetration Test Blows per 6" [*N-Value*] *blows/foot*	Qu-tsf Unconfined (Pocket Pen.) Compressive Strength	Moisture Content %	Liquid Limit (LL)	Plasticity Index (PI)	Percent Passing #200 Sieve	Remarks
1	SS	☒	7	3-2-3 [5]	1.75	22.8	47	28		
2	SS	☒	9	2-2-2 [4]						

Depth to Groundwater
- ● Noted on Drilling Tools ________ ft.
- ⊻ At Completion ________ ft.
- ▼ After ________ hours ________ ft.
- ⊠ Cave Depth ________ ft.

Sample Type
- SPT- Standard Penetration Test
- SS- Split Spoon
- ST- Shelby Tube
- RC- Rock Core
- CU- Auger Cuttings

Boring Method
- HSA- Hollow Stem Augers
- CFA- Continuous Flight Augers
- MD- Mud Drilling

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TEST BORING LOG

CLIENT **Model Group**

PROJECT NAME **Geiger House for Veterans**

PROJECT LOCATION **2631 Gilbert Avenue, Cicinnati, Ohio**

BORING # **B-6**

JOB # **CN220255**

LOGGED BY **CG**

APPROVED BY **JPH**

DRILLING and SAMPLING INFORMATION

Date Started	**11/29/2022**	Contractor	**CSI**
Date Completed	**11/29/2022**	Boring Size	**7** in.
Drill Rig	**Mobile B-57**	Boring Method	**3.25" I.D. HSA**
Weather	**Overcast**	Hammer Type	**Automatic**

TEST DATA

SOIL CLASSIFICATION SURFACE ELEVATION: 830.2	Sample No.	Sample Type	Sample Graphics	Recovery (in)	Standard Penetration Test Blows per 6" [*N-Value*] *blows/foot*	Qu-tsf Unconfined (Pocket Pen.) Compressive Strength	Moisture Content %	Liquid Limit (LL)	Plasticity Index (PI)	Percent Passing #200 Sieve	Remarks
Asphalt Pavement (3 inches)											
Aggregate Base (3 inches)											
Brown and gray LEAN CLAY (CL) with shale fragments [FILL] - moist, firm	1	SS	☒	12	2-3-4 [*7*]	1.5					
Brown well graded SAND (SW) with brick fragments, trace silt, trace clay [FILL] - moist to dry, medium dense	2	SS	☒	12	5-7-4 [*11*]						
Boring Terminated at 5'											

Depth to Groundwater

- ● Noted on Drilling Tools ________ ft.
- ⊻ At Completion ________ ft.
- ▼ After ________ hours ________ ft.
- Cave Depth ________ ft.

Sample Type

SPT- Standard Penetration Test
SS- Split Spoon
ST- Shelby Tube
RC- Rock Core
CU- Auger Cuttings

Boring Method

HSA- Hollow Stem Augers
CFA- Continuous Flight Augers
MD- Mud Drilling

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-1¾ inch diameter cone into the ground. DCP “counts” are the number of drops it takes for the hammer to drive three 1¾ 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 “Ziplock” 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

Sheet 1 of 1

Borehole	Depth	Sample Type	Liquid Limit	Plastic Limit	Plasticity Index	Classification	Water Content (%)	Unconfined Compressive Strength (tsf)	Dry Density (pcf)	Wet Density (pcf)	Max. Dry Density (pcf)	Opt. Water Content (%)	CBR	Swell (%)	RQD	Percent Recovery	Percent Finer (No. 200)
B-1	6.0	SS					20.1										
B-1	13.5	SS					36.4										
B-1	18.5	SS					38.0										
B-2	3.5	SS					21.5										93
B-2	18.5	SS	60	30	30		38.9										
B-2	28.5	SS	56	21	35		38.4										
B-2	38.5	SS					38.7										
B-2	48.5	SS					37.8										
B-2	58.5	SS					58.8										
B-3	13.5	SS					18.4										62
B-3	23.5	SS	63	31	32		39.7										
B-4	1.0	SS					18.7										
B-4	6.0	SS					26.5										
B-4	23.5	SS															99
B-5	1.0	SS	47	19	28		22.8										

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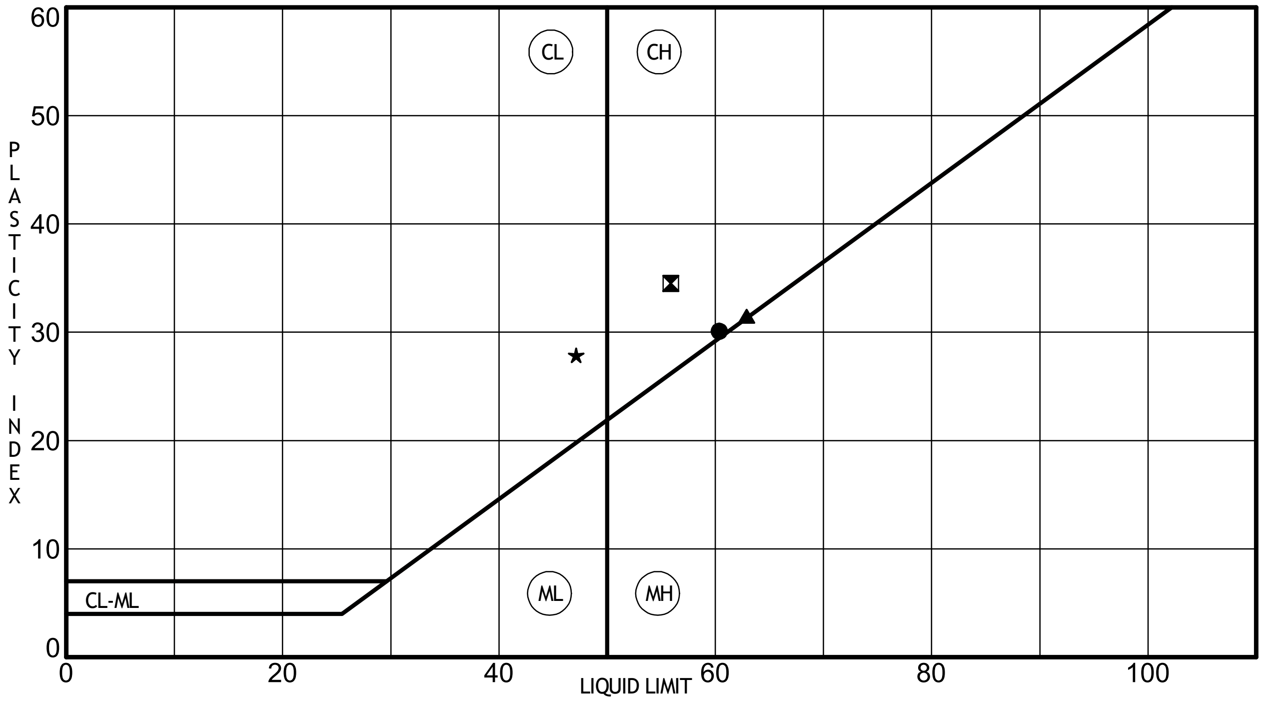
SS - Split Spoon Sample
GRAB - Bulk Grab Sample

PROJECT INFORMATION

Client: Model Group
Project Name: Geiger House for Veterans
Project Number: CN220255
Project Location: 2631 Gilbert Avenue, Cicinnati, Ohio

Liquid and Plastic Limits Test Report



	Boring	Depth (ft)	LL	PL	PI	Water Content	% < #40	% < #200	USCS	Description
●	B-2	18.5	60	30	30	38.9				
☒	B-2	28.5	56	21	35	38.4				
▲	B-3	23.5	63	31	32	39.7				
★	B-5	1.0	47	19	28	22.8				

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PROJECT INFORMATION

Client: Model Group
Project Name: Geiger House for Veterans
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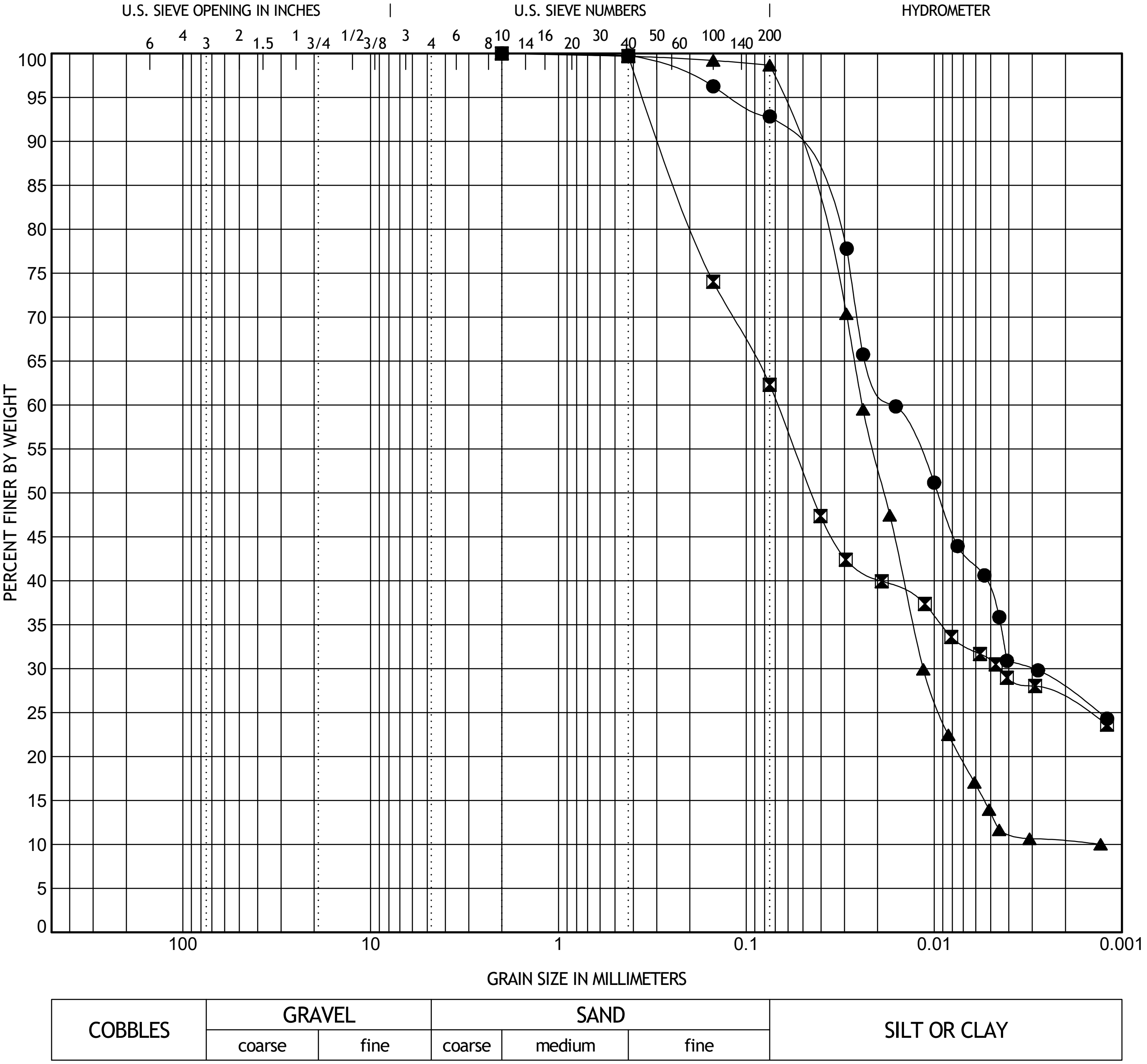
Project Location: 2631 Gilbert Avenue, Cicinnati, Ohio

GRAIN SIZE DISTRIBUTION



Boring	Depth (ft)	Classification	LL	PL	PI	Cc	Cu
● B-2	3.5						
☒ B-3	13.5						
▲ B-4	23.5						

Boring	Depth (ft)	D95	D60	D50	D30	D10	%Gravel	%Sand	%Silt	%Clay
● B-2	3.5	0.116	0.016	0.01	0.003		0.0	7.2	54.2	38.6
☒ B-3	13.5	0.351	0.068	0.045	0.004		0.0	37.7	31.4	30.9
▲ B-4	23.5	0.066	0.024	0.018	0.011		0.0	1.3	85.1	13.6

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PROJECT INFORMATION

Client: Model Group
Project Name: Geiger House for Veterans
Project Number: CN220255
Project Location: 2631 Gilbert Avenue, Cicinnati, Ohio

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	Method	Hammer Wt./Fall	Mold Diam.	Run on Material Finer Than	No. of Layers	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	Method	Hammer Wt./Fall	Mold Diam.	Run on Material Finer Than	No. of Layers	No. of Blows/ Layer
Modified D 1557	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.

Laboratory California Bearing Ratio Tests: 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.