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GEOTECHNICAL EXPLORATION REPORT
Proposed Pergola Park 4th-6th Plats
New Longview
Lee's Summit, Missouri

GSI Project No. 1973059
April 16, 2019

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I hereby certify that this engineering document was prepared by me or under my direct personal supervision and that I am a duly licensed Professional Engineer under the laws of the State of Missouri.

4/16/2019
Jacob P. Engler, P.E. Date

My license renewal date is December 31, 2019.
Sections covered by this seal: Sections 1 through 6 and all pages included as appendices within this bound document.

Important Information about This

Geotechnical-Engineering Report

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

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

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

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

Read the Full Report

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

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

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

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

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

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

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

Subsurface Conditions Can Change

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

Most Geotechnical Findings Are Professional Opinions

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

A Report's Recommendations Are Not Final

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

A Geotechnical-Engineering Report Is Subject to Misinterpretation

Other design-team members' misinterpretation of geotechnical-engineering reports has resulted in costly

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

Do Not Redraw the Engineer's Logs

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

Give Constructors a Complete Report and Guidance

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

Read Responsibility Provisions Closely

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

Environmental Concerns Are Not Covered

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

Obtain Professional Assistance To Deal with Mold

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

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

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

GEOTECHNICAL BUSINESS COUNCIL
of the Geoprofessional Business Association

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APPENDICES

1. INTRODUCTION

1.1 General

This report summarizes the findings of our geotechnical exploration for the proposed Pergola Park 4th, 5th, and 6th plats located at the New Longview subdivision in Lee's Summit, Missouri. The scope of work was outlined in our proposal dated March 8, 2019. Mr. Russell Pearson of NLV Pergola Park, LLC authorized this exploration on March 14, 2019.

The purpose of this geotechnical study is to explore the subsurface conditions at the proposed site with exploratory borings, evaluate the engineering properties of the subsurface materials with appropriate field and laboratory tests, and perform engineering analyses for developing design and construction recommendations for the proposed project.

1.2 Project Description

The proposed project will be located at the New Longview residential development in Lee's Summit, Missouri. We understand that the project will consist of the development of the residential areas and associated drives and alleyways within the proposed 4th, 5th, and 6th plats of the existing subdivision. We understand that the main focus of this exploration is to evaluate the subsurface conditions at the site for mass site grading purposes, as well as to complete a pavement design section for both the drives and alleyways that transverse throughout the proposed plats.

We anticipate that the pavements will support predominately light passenger cars with less frequent panel delivery vans, passenger vans, and trash trucks.

We understand that approximately 5 to 8 feet of fill has been placed in certain portions of the site. A site grading plan was unavailable at the time of this report, but we understand that large cuts may be required in order to achieve the desired elevations of the development.

A site plan is included in Appendix A for reference.

2. FIELD EXPLORATION

We drilled 15 borings for this geotechnical exploration on April 4th and 5th, 2019 with a CME 55 track-mounted drilling rig using 3.25-inch inside diameter hollow stem augers. We drilled 15 borings at various locations within the pavement footprints to depths between approximately 9.5 and 20 feet below the site grade at the time of our exploration. The boring schedule was to drill 11 borings to depths of 10 feet in areas with less existing fill, and drill 4 borings to depth of 20 feet in areas with greater fill near the edge of the lake. Some of the borings were extended to a depth of 11.5 feet to tag the native shale bedrock, while some borings were terminated prior to their scheduled depths upon encountering sampler penetration refusal on the native limestone bedrock.

We selected boring locations based on a preliminary site plan provided to us by Ms. Allsion Sperber of Sperber Contracting on March 5, 2019. GSI personnel established field locations by using a handheld GPS unit. Locations of the borings in relation to existing and proposed features are indicated on the Boring Location Plan included in Appendix A. The locations of the borings should be considered accurate only to the degree implied by the methods used in their determination.

Our drill crew obtained soil samples at the intervals shown on the boring logs in Appendix B. Recovered samples were sealed in plastic containers, labeled, and protected for transportation to the laboratory for further examination, testing, and classification.

We obtained split-barrel samples (designated "Split Spoon" or "S" samples) while performing Standard Penetration Tests (SPT) with a 1-3/8 inch I.D. thick-walled sampler, driven using an automatic hammer in general accordance with ASTM D1586, "*Penetration Test and Split-Barrel Sampling of Soils*." The "N" value, reported in blows per foot (bpf), equals the number of blows required to drive the sampler through the last 12 inches of the 18-inch sample interval using a 140-pound hammer falling 30 inches.

We obtained undisturbed samples (designated "Shelby Tube" or "U" samples) with 3-inch O.D. thin-walled tube samplers, hydraulically pushed in general accordance with ASTM D1587, "*Thin-Walled Tube Sampling of Soils for Geotechnical Purposes*."

We obtained disturbed bulk samples from auger cuttings at the borings and depth intervals as indicated in Table 2.1 below.

Table 2.1 Disturbed Bulk Sample Locations

Boring Number	***Sample Depth Interval (ft.)***
B-1	1.0-5.0
B-3	0.0-5.0
B-5	0.0-5.0
B-7	2.0-5.0
B-10	1.0-5.0
B-13	3.0-7.0

Our drilling personnel prepared field boring logs during drilling operations. These field logs report drilling and sampling methods, sampling intervals, groundwater measurements and the subsurface conditions we encountered. At the conclusion of drilling, our drill crew made groundwater measurements and backfilled the borings in accordance with Missouri state regulations.

3. SITE CONDITIONS

3.1 Regional Geology

Soils in the greater Kansas City area are generally residual soils, alluvial deposits, or till. Residual soils formed as a result of weathering of bedrock, or by weathering of sediments that were transported by water, ice, wind or a combination of these. Regional soils derived from shale, limestone, and loess have high shrink-swell potentials. Major alluvial deposits occur along the Missouri and Kansas rivers and their tributaries. These consist of clay, sand and gravel sized sediments. Northern parts of the city were glaciated during the early Pleistocene time resulting in till deposits. Surface bedrock in northeastern Kansas and northwestern Missouri generally consist of limestone and shale (with sandstone found in prehistoric channels) arranged in nearly horizontal beds or layers that can be followed continuously over long distances. These bedrocks are part of the Pennsylvanian bedrock system.

3.2 Surface Conditions

The project site comprises a grass and tree covered field that slopes downgradient towards the lake on all sides for a maximum elevation change of approximately 10 feet. A pergola resides near the center of the site, near the edge of the lake. This site is bound by Old Longview Lake to the south, the Longview Mansion and associated parking lot to the west, and by various access roads associated with the development of the existing plats of the subdivision.

3.3 Subsurface Conditions

Although we observed some variability, the subsurface materials we encountered within the depths of exploration generally comprised 6 inches of topsoil or 6 inches of gravel pavement overlying lean to fat clay fill materials overlying native lean to fat clay, which in turn is underlain by shale and limestone bedrock. General descriptions of the strata we encountered are presented below, while more detailed subsurface information is presented on the boring logs located in Appendix B. Please note that the indicated depths are relative to the site grade at the time of our exploration.

Stratum 1

We encountered lean to fat clay fill materials in borings B-8 thru B-15, underlying the topsoil and gravel pavement at the surface, and extending to depths between 2.5 and 13.5 feet below the current site grade. This material was generally described as dark yellowish brown, light olive brown to dark olive brown, pale olive to olive and olive yellow, greenish gray to bluish gray, strong brown to dark

reddish brown, reddish yellow, or dark gray to gray, and moist to very moist. We measured Standard Penetration Test (SPT) N-values between 5 and 20 blows per foot (bpf), indicating that the cohesive fill materials are in a medium stiff to very stiff condition.

Stratum 2

We encountered native lean to fat clay in each of our borings, underlying the topsoil at the surface in borings B-1 thru B-7, and extending to depths between 5 feet and the termination depth of the borings at 11.5 feet, and underlying the fill materials in borings B-8 thru B-15, and extending to depths between 5 feet and the termination depth of the borings at 10 and 20 feet below the current site grade. This material was generally described as black to very dark brown, dark grayish brown to grayish brown, gray to dark gray, dark yellowish brown to light yellowish brown, olive brown, bluish gray, or reddish brown to strong brown, and moist to wet. We measured SPT N-values between 4 and 52 bpf and unconfined compressive strengths between 2.28 and 5.63 kips per square foot (ksf), indicating that the native lean to fat clay is in a soft to hard condition.

Stratum 3

We encountered shale bedrock in borings B-1, B-2, B-4, B-5, B-7 thru B-10, and B-14, underlying the native fat clay, and extending to depths between 7 feet and the boring termination depths at 9.5,10, 11.5, and 20 feet below the current site grade. This material was generally described as yellowish brown to olive gray, light olive brown to olive brown, pale olive to greenish gray, or bluish gray to very dark gray, very soft to soft rock, in a decomposed to slightly weathered condition. We measured SPT N-values between 12 bpf and 50 blows for 5.5 inches of sampler penetration.

We encountered limestone in borings B-7, B-13, and B-15, underlying the native fat clay or shale, and extending to the boring termination depths of the respective borings at 8.1, 17.13, and 13.04 feet below the current site grade. This material was generally described as gray, very soft to moderately hard rock, in a moderately weathered condition. We measured SPT N-values between 50 blows for 1.5 inches and 50 blows for one inch of sampler penetration.

3.4 Groundwater Conditions

Our drill crew made water level observations during drilling and after completion of the borings to evaluate groundwater conditions. We noted groundwater in the borings and at the depths indicated in the following table.

Table 3.4-1: Groundwater Levels

Boring Number	*Depth Below Grade During Drilling (ft.)*	*Depth Below Grade After Drilling (ft.)*
B-1	N.E.	N.E.
B-2	N.E.	N.E.
B-3	N.E.	N.E.
B-4	N.E.	N.E.
B-5	10.0	9.5
B-6	10.0	9.5
B-7	N.E.	N.E.
B-8	N.E.	N.E.
B-9	N.E.	N.E.
B-10	N.E.	N.E.
B-11	N.E.	N.E.
B-12	N.E.	N.E.
B-13	N.E.	N.E.
B-14	15.5	18.5
B-15	13.0	13.0

N.E.—None Encountered

The groundwater conditions we observed during our exploration program should not be construed to represent an absolute or permanent condition. Uncertainty is involved with short-term water level observations in boreholes. The slow percolation rate of the on-site fat clay and shale and nearly impermeable limestone surface, can cause water to pond or become perched for extended time periods.

The free groundwater surface or groundwater table within unconfined aquifers is generally a subdued reflection of surface topography. Water generally flows downward from upland positions (recharge zones) to low lying areas or surface water bodies (discharge zones). As such, the groundwater level and the amount and level of any perched water on the site may be expected to fluctuate with variations in precipitation, site grading, drainage and adjacent land use. Long-term monitoring utilizing piezometers or observation wells is required to evaluate the potential range of groundwater conditions.

4. LABORATORY TESTING

Our engineering staff reviewed the field boring logs to outline the depth, thickness and extent of the soil strata. The samples taken from the borings were examined in our laboratory and visually classified in general accordance with ASTM D2488, "*Description and Identification of Soils (Visual-Manual Procedure)*." We established a testing program to evaluate the engineering properties of the recovered samples. A GSI technician performed laboratory testing in general accordance with the following current ASTM test methods:

- Moisture Content (ASTM D2216, "*Laboratory Determination of Water (Moisture) Content of Soil and Rock*")
- Unit Weight (ASTM D7263, "*Laboratory Determination of Density (Unit Weight) of Soil Specimens*")
- Atterberg Limits (ASTM D4318, "*Liquid Limit, Plastic Limit, and Plasticity Index of Soils*")
- Minus No. 200 Sieve Wash (ASTM D1140, *"Amount of Material in Soils Finer Than the No. 200 (75-µm) Sieve")*
- Unconfined Compressive Strength (ASTM D2166, *"Unconfined Compressive Strength of Cohesive Soil")*
- Standard Proctor (ASTM D698, *"Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft^3 (600 kN-m/m^3))")*
- California Bearing Ratio (ASTM D1883, *"CBR (California Bearing Ratio of Laboratory-Compacted Soils")*

Laboratory test results are presented on the boring logs in Appendix B and tabulated in Appendix C.

Moisture content and unit weight tests were used to evaluate the existing moisture-density condition of the soils. The Atterberg limits and Minus No. 200 sieve tests were used to help classify the soils under the Unified Soils Classification System. The Atterberg limits were also used to evaluate the plasticity characteristics of the soils. Unconfined compression tests were used to define the stress-strain characteristics and related shear strength of the soils. The standard proctor test was used to determine the moisture-density relationship of the soils. The California Bearing Ratio test evaluated the support characteristics of the proposed pavement subgrade soils.

The following data summarize our laboratory test results. We used these data to develop the allowable bearing values, anticipated settlements, and other geotechnical design criteria for the project.

- Natural Moisture Content..... 11.8 to 29.7%
- Wet Density..... 124.6 to 141.5 lb/ft^3
- Dry Density..... 100.0 to 117.3 lb/ft^3
- Unconfined Compressive Strength .....2.28 to 5.63 kips/ft^2
- Liquid Limit.....44 to 57
- Plastic Limit.....19 to 25
- Plasticity Index .....23 to 36
- Percent Passing the No. 200 Sieve .....95.5 to 96.1%
- Standard Penetration Test (SPT 'N' blows per foot) .....4 to 50/0.5"
- Maximum Dry Density ..... 100.7 to 106.8 lb/ft^3
- Optimum Moisture Content.....18.0 to 21.1%
- CBR .....3.7 to 5.6

Based on the results of this testing program, we reviewed and supplemented the field logs to arrive at the final logs as presented in Appendix B. The final logs represent our interpretation of the field logs and reflect the additional information obtained from the laboratory testing. Stratification boundaries indicated on the boring logs were based on observations made during drilling, an extrapolation of information obtained by evaluating samples from the borings, and comparisons of similar engineering characteristics. Locations of these boundaries are approximate and the transitions between soil types may be gradual rather than clearly defined.

5. CONCLUSIONS AND RECOMMENDATIONS

5.1 General Geotechnical Considerations

We understand that approximately 5 to 8 feet of fill has been placed in certain portions of the site. A site grading plan was unavailable at the time of this report, but we understand that large cuts may be required in order to achieve the desired elevations of the development.

We understand that the City of Lee's Summit has recently changed their standard street cross section, which would be required for the asphalt access drives throughout the subdivision. We understand that the client would prefer to reuse the pavement thicknesses as used in the Pergola Park 3rd Plat in 2006, rather than the 2018 City of Lee's Summit standard section, and may be approved with the recommendations provided within this report.

The near-surface clay soils we encountered at the site are classified as moderately to highly plastic and may be susceptible to changes in strength and volume (shrink/swell) with changes in moisture content. These soils are not recommended for direct support of pavements, unless chemically stabilized as outlined later in this report.

We did not encounter groundwater within the anticipated depth of excavations for large cuts associated with mass site grading operations.

5.2 Earthwork

5.2.1 Site Preparation

Trees within the areas to be prepared for development must be removed. The root-balls and surrounding soils containing observable organic material must also be removed. We expect the root-balls will extend to substantially greater depths than the topsoil stripping depth. The root-ball excavations must be filled with an engineered structural fill that is placed, moisture conditioned and compacted in accordance with Section 5.2.4.

In preparing the site for construction, existing gravel pavements, surface vegetation and topsoil containing a significant percentage of organic matter should be removed from the areas beneath structures and any other areas that are to be paved, cut or receive fill. The removal depth for this site is expected to be approximately 6 inches. However, the removal depth should be monitored during stripping and adjusted as required. This material should either be removed from the site or stockpiled for later use in landscaping of unpaved or non-structural areas.

Prior to fill placement, the top 8 inches of the ground surface in fill areas should be scarified, moisture conditioned and recompacted in accordance with Section 5.2.4 to eliminate a plane of weakness along the contact surface.

The subgrade should be proof rolled with a loaded tandem axle dump truck or equivalent (loaded water truck, loaded concrete mixer or motor grader with a minimum weight of 20 tons). A proof-roll is considered acceptable if no ruts greater than one inch deep appear behind the loaded vehicle, and no pumping or weaving is observed as the wheels pass over the area. Any soft or unsuitable areas should be compacted or removed and replaced with stable fill material similar in composition to the surrounding soils. If necessary, clean materials such as crushed concrete or crushed stone may be used to stabilize areas where wet soil or water is present. Geogrid or structural geotextile may be used in conjunction with crushed concrete or stone to provide additional stabilization.

Whether in cut or fill, the final subgrade surface must be maintained in a stable condition at the moisture content and level of compaction identified in Section 5.2.4. Verification and maintenance of the completed subgrade may require scarification, moisture conditioning, recompaction, and proof rolling.

5.2.2 General Structural Fill

General structural fill should be used for mass site grading, landscaping applications or as utility trench backfill outside of building areas. General structural fill may also be used to within 8 inches of the base of any vehicular pavements. In the former applications, low volume change materials are required immediately below the pavements (low volume change material is discussed in the following section).

General structural fill may comprise cohesive or granular material but should be free from organic matter or debris. Granular materials used as general structural fill should be well graded, have a maximum particle size of 1.5 inches, and meet MoDOT freeze/thaw durability and sulfate soundness requirements.

If free of organic matter or debris, the on-site soils may be reused as general structural fill within the areas outlined above.

5.2.3 Chemical Stabilization of Soil

The moderately to highly plastic clay soils we encountered in this exploration are considered moisture sensitive and may lose strength and undergo volume changes with fluctuations in moisture content. Chemical stabilization may be achieved by amending the soil with 14 to 16 percent class "C" fly ash, 6 to 8 percent cement kiln dust (CKD), or 3 to 5 percent Portland cement.

We recommend a laboratory standard Proctor Moisture-Density Relationship (ASTM D698, *"Laboratory Compaction Characteristics of Soil Using Standard Effort"*) be performed prior to field mixing using a sample of the soil to be stabilized and the proposed amendment (fly ash, CKD or Portland cement). The sample should be prepared in advance to match the intended field mix proportions, using the same amendment source as will be utilized in the field.

Fly Ash Stabilization

Prior to the introduction of fly ash, the soil material should be thoroughly pulverized to reduce clods to ½ inch or less. During the pulverization process, we recommend that water be added to reach a moisture content at or above the optimum moisture content as determined by ASTM D698 for the proposed fly ash-soil mixture. The fly ash should remain dry and be protected from external sources of moisture during transportation and storage. Fly ash material that is introduced to moisture prior to incorporation with the soil must be discarded.

The fly ash and soil should be thoroughly mixed within ½ hour after introduction. The moisture content should be field tested immediately following mixing and adjusted as needed to maintain a range between optimum and 4 percent above optimum. The fly ash-soil mixture should not be allowed to air dry. If the moisture content is determined to be in excess of 4 percent of optimum, additional fly ash should be applied to achieve the specified moisture content. Compaction of the fly ash supplemented soil should be completed within 2 hours after incorporation. Additional compaction after 2 hours may cause degradation of the soil strength. The fly ash-soil mixture should be compacted as noted in Section 5.2.4.

Fly ash mixing should not be performed at ambient air temperatures below 50 degrees Fahrenheit.

Cement Kiln Dust

Cement kiln dust can also be used as a soil stabilization agent and should be incorporated into the soils using the procedures outlined for fly ash stabilization. Cement kiln dust may be used at temperatures below 50 degrees Fahrenheit, provided the soil to be amended is frost-free.

Portland Cement

Type I/II Portland cement can be used as a soil stabilization agent using dry application methods as outlined above, or by injection of a liquefied cementitious mixture into the soil to be treated. Cement treatment and mixing can be performed at temperatures below 50 degrees Fahrenheit, provided the soil to be amended is frost-free.

Stabilized Subgrade Maintenance

Stabilized soil that will be utilized as pavement subgrade should be covered with a minimum of 3.5 inches of asphalt or the full Portland cement concrete pavement section prior to being subjected to freezing conditions. If paving does not immediately follow soil stabilization, the supplemented soil should be protected from extreme weather, kept moist, and minimally trafficked until slab placement occurs. In areas that are to be paved, an asphalt prime coat could be applied over the stabilized material surface as an alternative to periodic moisture additions to maintain acceptable moisture throughout curing.

If the stabilized subgrade deteriorates prior to paving or slab placement, we recommend any unstable areas be scarified and recompacted. We recommend an additional 3 percent class "C" fly ash be incorporated in areas that are to be scarified and recompacted. Expansive soils stabilized with cement kiln dust or Portland cement may be reworked without additional amendment. Other soil types may require the incorporation of additional cement kiln dust or Portland cement to restore the desired strength characteristics.

5.2.4 Compaction of Engineered Structural Fills

Unless otherwise noted, fill materials should be placed in loose lifts not to exceed 9 inches and be compacted to a minimum of 95 percent of the maximum dry unit weight obtained from ASTM D698 (Standard Proctor). Moisture content at the time of compaction should be controlled to between optimum and 4 percent above optimum moisture content.

Granular fill materials which produce a definable moisture-density curve when tested according to ASTM D698 should be compacted to a minimum of 95 percent of the maximum dry unit weight obtained from ASTM D698. Granular fill materials which do not produce a definable moisture-density curve should be compacted to a minimum of 75 percent relative density (ASTM D4253, *"Maximum Index Density and Unit Weight of Soils Using a Vibratory Table"* and ASTM D4254, "*Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density"*). Granular materials should be placed at a moisture content that will achieve the desired densities. Please note that relative density and standard Proctor tests measure different parameters and are not interchangeable.

In general, proper compaction of cohesive soils can be achieved with sheepsfoot or pneumatic-type compactors, while compaction of granular soils can be achieved with smooth-drum or smooth-plate vibratory compactors. Water flooding is not an acceptable compaction method for any soil type.

5.2.5 Excavation Slopes

Vertical cuts and excavations may stand for short periods of time, but should not be considered stable in any case. All excavations should be sloped back, shored, or shielded for the protection of workers. As a minimum, trenching and excavation activities should conform to federal and local regulations.

The lean to fat clay fill materials and native soils and shale we encountered in the test borings generally classify as a type "B" soil according to OSHA's Construction Standards for Excavations. In general, the maximum allowable slope for shallow excavations of less than 20 feet in a type "B" soil is 1.0H:1.0V, although other provisions and restrictions may apply. If different soil types are encountered, the maximum allowable slope may be different.

The Contractor is responsible for designing any excavation slopes or temporary shoring. The Contractor must also be aware that slope height, slope inclination, and excavation depths (including utility trench excavations) should in no case exceed those specified in federal, state, or local safety regulations, such as OSHA Health and Safety Standards for Excavations, 29 CFR Part 1926, or successor regulations.

The information presented in this section is solely for our client's reference. **GSI assumes no responsibility for site safety or the implementation of proper excavation techniques.**

5.2.6 Rock Excavation

We anticipate the shale bedrock in mass site grading areas can be excavated with standard excavation equipment. However, lenses of harder shale or limestone may be present, requiring the use of rock excavation equipment such as rock rippers or hydraulic breakers.

5.3 Pavement Recommendations

The asphalt and Portland cement concrete pavement recommendations provided below are separated into The City of Lee's Summit standard pavement section and an alternative we have provided to both the city's standard section and the pavement design used in the development of the Pergola Park 3rd Plat. The pavement sections as presented in Section 5.3.2 are structurally equivalent to one another, but may differ in initial construction cost and future potential pavement maintenance costs. To perform properly, the pavement sections require that the subgrade be prepared in accordance with the recommendations in Section 5.3.1.

5.3.1 Pavement Subgrade Preparation

Pavement performance is directly affected by the degree of compaction, uniformity, and stability of the subgrade. The stability and quality of the pavement subgrade is particularly important where high traffic volume and heavy axle loads are anticipated. Based on the two design options, the pavement subgrade may comprise a combination of aggregate and chemically stabilized on-site soils. Chemical stabilization of on-site soils should be performed in accordance with Section 5.2.3.

The top 8 inches of pavement subgrade should be compacted to a minimum of 95 percent of the maximum dry unit weight determined by ASTM D698. The moisture content should also be controlled to between optimum and 4 percent above the optimum moisture content.

To detect any localized areas of instability, the final subgrade should be proof rolled with a loaded tandem axle dump truck or equivalent (loaded water truck, loaded concrete mixer or motor grader with a minimum weight of 20 tons) immediately prior to placement of the concrete or asphalt. Unstable areas should be removed and replaced or reworked to provide a more uniform subgrade. If necessary, clean materials such as crushed concrete or crushed stone may be used to stabilize areas where wet soil or water is present.

We also recommend the moisture content of the subgrade be checked prior to paving. If the moisture content is below optimum, we recommend the subgrade be scarified, moisture conditioned and recompacted according to Section 5.2.4.

5.3.2 Recommended Design Sections

The pavement sections for this project are based on our experience with similar pavements and a design life of 15 to 20 years. The pavement sections recommended below are intended for passenger car and light truck traffic and parking areas. Portland cement concrete pavements are recommended for areas with frequent start-stop or turning traffic such as entrance and exit aprons, as well as areas that support stationary loads such as dumpsters. Our recommendations for asphalt and Portland cement concrete pavement sections are presented in the following tables.

Table 5.3.2-1: Full-Depth ACC Pavement Design Recommendations for Access Drives

	Thickness (Inches)	
	City of Lee's Summit Standard Section	***GSI Alternative Pergola Park Section***
Asphalt Surface Course	2.0	2.0
Asphalt Base Course	4.0	5.0
Aggregate Base	6.0	--
Chemically Stabilized Subgrade	6.0	8.0

Chemically stabilized subgrade placed and compacted in accordance with Section 5.3.1.

Table 5.3.2-2: PCC Pavement Design Recommendations for Alleys

	Thickness (Inches)	
	City of Lee's Summit Standard Section	***GSI Alternative Pergola Park Section***
4,000 psi Air Entrained Portland Cement Concrete	6.0	6.0
Aggregate Base	4.0	--
Chemically Stabilized Subgrade	6.0	8.0

Chemically stabilized subgrade placed and compacted in accordance with Section 5.3.1.

5.3.3 Asphaltic Cement Concrete Pavement Construction

Asphalt should be placed at an ambient temperature above 40 degrees Fahrenheit. Asphalt temperature at the time of compaction should be between 265 and 330 degrees Fahrenheit. We recommend the initial asphalt lift placed directly on the subgrade should be compacted to a minimum of 94 percent of the Marshall density with subsequent asphalt lifts compacted to a minimum of 96 percent of the Marshall density. Please note that recommendations regarding compaction temperature and percentage for a specific pavement design should supersede these recommendations.

All asphaltic concrete mix designs should be submitted to GSI and reviewed to determine if the designs are consistent with the recommendations given in this report. We also recommend a GSI representative be present during paving operations to help ensure adherence to project pavement specifications.

5.3.4 General Pavement Considerations

Pavement service life can be significantly reduced if the pavement is constructed on a poor subgrade, if poor surface or subsurface drainage is present, or if the pavement is not maintained properly. We emphasize the importance of preparing the pavement subgrade in accordance with the procedures listed in the previous sections of this report.

Drainage of surface and subsurface water is also a critical component of pavement performance. Wetting of the subgrade soils or base course will cause loss of support strength resulting in premature pavement distress. Surface drainage should be designed to remove all water from paved areas. All curbs, including those surrounding pavement islands, should be backfilled as soon as possible after construction of the pavement. Backfill should be compacted and sloped to prevent water from ponding and infiltrating under the pavement. Regular active maintenance of pavements, which includes filling of cracks and joints, is required to minimize water infiltration and lengthen pavement life.

5.4 Construction Considerations

If construction of the project is to be performed during periods of freezing temperatures, steps should be taken to prevent the soils under pavements from freezing. In no case should the fill materials, pavements, or other exterior flat work be placed on frozen or partially frozen materials. Frozen materials should be removed and replaced with a suitable material as described in earlier sections of this report.

Construction performed during periods of high precipitation may result in saturated unstable soils, and caving or sloughing of excavations. Control of soil moisture will be necessary for successful soil compaction, and to maintain soil bearing capacity.

5.5 Construction Observation and Quality Assurance

We recommend that GSI review those portions of the plans and specifications that pertain to foundations and earthwork to evaluate consistency with our findings and recommendations. GSI will provide up to 2 hours of engineering support services at no charge to review project documents for adherence to our recommendations.

Site grading, including proof-rolling, replacement or recompaction of material, and placement of fill and backfill, should be observed by a quality assurance technician from GSI under the direction of a registered professional engineer. The technician should perform density tests and make any other observations necessary to assure that the requirements of the specifications are being achieved.

It is the opinion of GSI that construction observation by the geotechnical engineer of record or his designated representative is necessary to complete the design process. Field observation services

are viewed as essential and a continuation of the design process. Unless these services are provided by GSI, the geotechnical engineer will not be responsible for improper use of our recommendations or failure by others to recognize conditions which may be detrimental to the successful completion of the project.

GSI will be available to make field observations and provide consultation services as may be necessary. A written proposal outlining the cost of construction testing services such as soil, concrete, steel and pavement quality assurance can be provided upon request.

6. CLOSING REMARKS AND LIMITATIONS

This report is presented in broad terms to provide an assessment of the subsurface conditions and their potential effect on the adequate design and economical construction of the proposed pavement sections. The analyses, conclusions, and recommendations contained in this report are based on the site conditions existing at the time of the exploration, the project layout described herein, and the assumption that the information obtained from our 15 borings is representative of subsurface conditions throughout the site.

Any changes in the design or location of the proposed structure should be assumed to invalidate the conclusions and recommendations given in this report until we have had the opportunity to review the changes and, if necessary, modify our conclusions and recommendations accordingly. If subsurface conditions different from those encountered in the explorations are observed during construction or appear to be present beneath excavations, GSI should be advised at once so that the conditions can be reviewed and recommendations reconsidered where necessary.

If there is a substantial lapse in time between the submission of this report and the start of construction, or if site conditions or the project layout have significantly changed (due to further development of grading plans, natural causes, or construction operations at or adjacent to the site), we recommend that this report be reviewed to determine the applicability of our previous conclusions and recommendations.

Our geotechnical exploration and subsequent recommendations address only the design and construction considerations contained in this report. We make no warranty for the contents of this report, neither expressed nor implied, except that our professional services were performed in accordance with engineering principles and practices generally accepted at this time and location.

The scope of services for this exploration did not include a wetlands evaluation, an environmental assessment, or an investigation for the presence of hazardous or toxic materials in the soil, surface water, groundwater, or air within or adjacent to this site. If contamination is suspected or is a concern, we recommend the scope of this study be expanded to include an environmental assessment.

This report was prepared by the firm of GSI Engineering, LLC (GSI) under the supervision of a professional engineer registered in the State of Missouri. Report preparation was in accordance with

generally accepted geotechnical engineering practices for the exclusive use of our client for evaluating the design of the project as it relates to the geotechnical aspects discussed herein. Recommendations are based on the applicable standards of the profession at the time of this report within this geographic area. GSI Engineering, LLC will not be responsible for misrepresentation of this report resulting from partial reproduction or paraphrasing of its contents.

We appreciate the opportunity to be of service on this project. Please contact us if we can provide further information regarding the contents of this report or the scope and cost of additional services.

Respectfully submitted,
GSI Engineering, LLC

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4/16/19
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CDP/JPE

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APPENDIX A

General Vicinity Map
Boring Location Plan

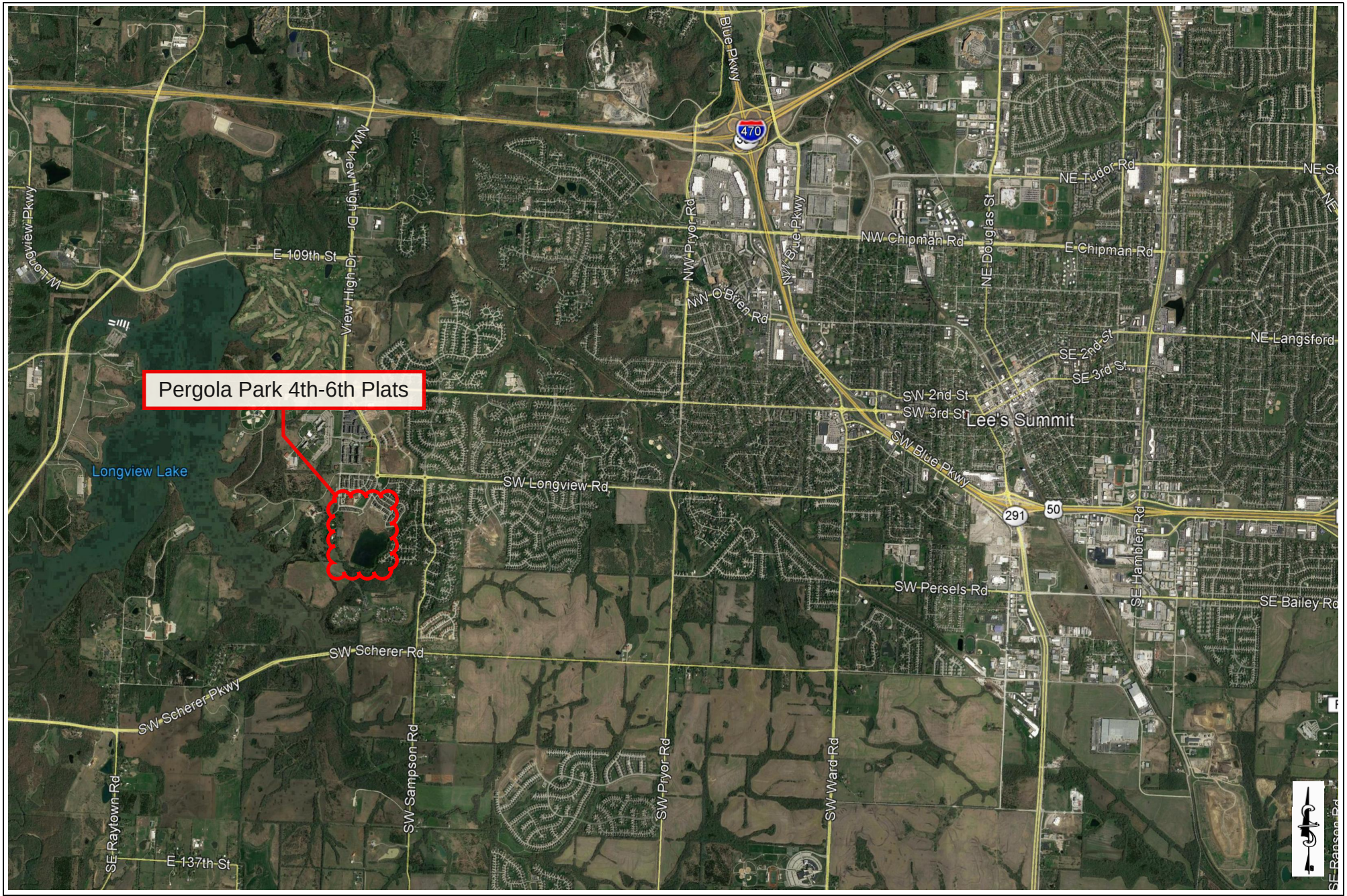

FIG. #: 1	PROJ. #: 1973059	GSI Engineering	GSI Engineering, LLC 4503 E. 47th Street South Wichita, KS 67210 (316) 554-0725 www.gsinetwork.com
DATE: 4/15/2019	SCALE: NTS		
DRAWN BY: CDP	PROJECT MANAGER: MNT		

GENERAL VICINITY MAP
PERGOLA PARK 4TH-6TH PLATS
LEE'S SUMMIT, MISSOURI

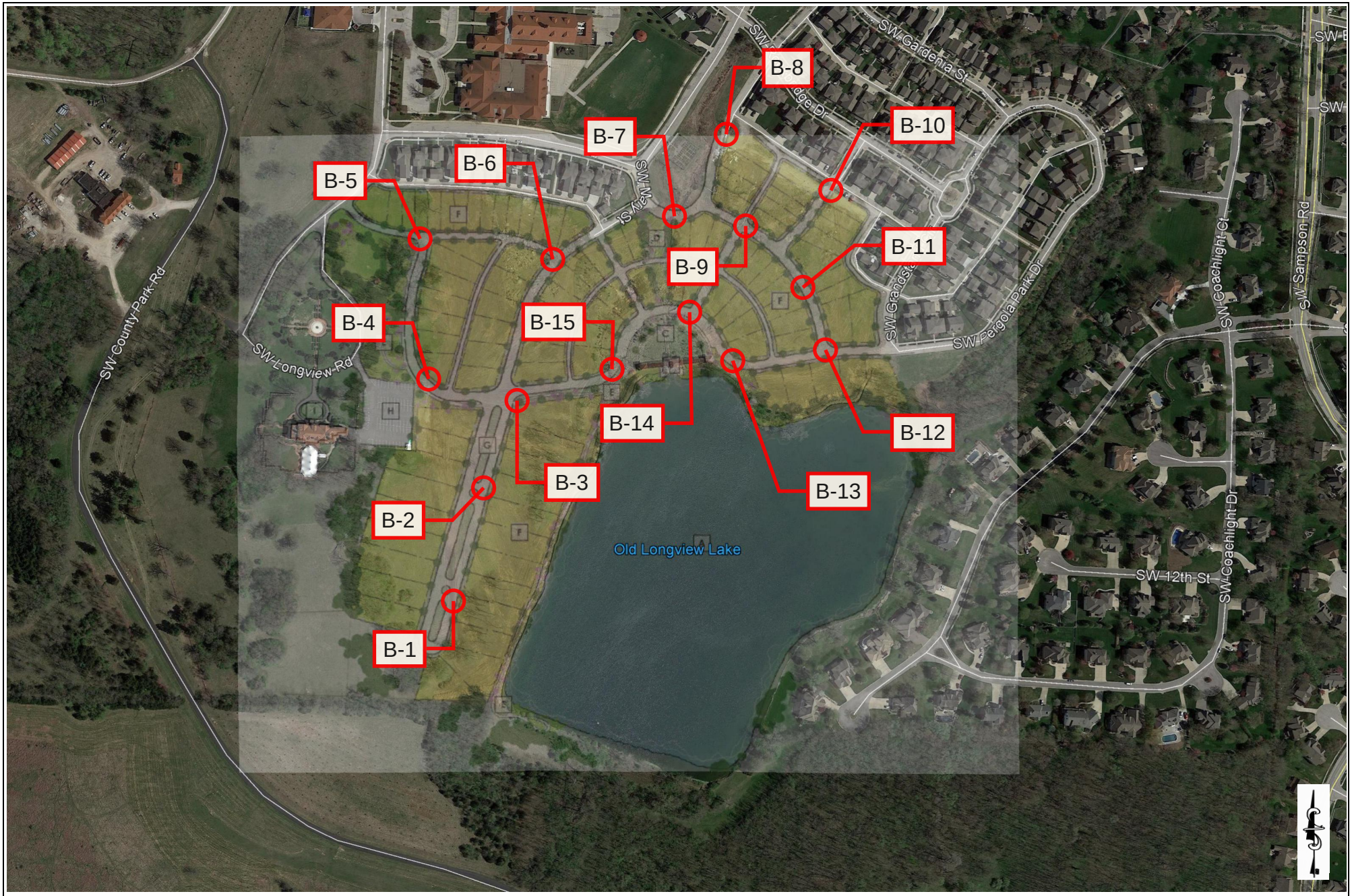

FIG. #: 2	PROJ. #: 1973059	GSI Engineering	**BORING LOCATION PLAN** **PERGOLA PARK 4TH-6TH PLATS** **LEE'S SUMMIT, MISSOURI**
DATE: 4/15/2019	SCALE: NTS		
DRAWN BY: CDP	PROJECT MANAGER: MNT		

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APPENDIX B

Boring Logs
Key to Symbols
Legend & Nomenclature
Unified Soil Classification System (USCS)
Rock Descriptors

BORING LOG No. B-1

BORING NO.	LOCATION OF BORING	ELEVATION	DATUM	DRILLER	LOGGER
B-1	See Boring Location Plan			J. Lear	K. Hudson

WATER LEVEL OBSERVATIONS				TYPE OF SURFACE	DRILL RIG
WHILE DRILLING	END OF DRILLING	24 HOURS AFTER DRILLING	AFTER DRILLING	Grass Field	CME 55
				DRILLING METHOD	TOTAL DEPTH
N.E.	N.E.	Boring Plugged After Drilling		3.25-inch Inside Diameter Hollow Stem Augers	9.5

DEP. FT.	SAMPLE DATA: SAMPLE NO. & TYPE	"N" BLOWS (FT)	% REC.	SOIL DESCRIPTION: COLOR, CONSISTENCY, MOISTURE / GEOLOGIC DESCRIPTION & OTHER REMARKS	USCS CLASS.	LABORATORY DATA: MC %	Dry Dens. pcf	q_u ksf	ELEV. FT.
				6" TOPSOIL (0.5')					
	S-1	9		FAT CLAY - very dark brown, very moist, stiff, trace roots, trace rust stains LL=56; PL=25; PI=31		25.1			
	S-2	12		- grayish brown, else as above	CH	22.8			
5									
	U-3	N/A		- as above		20.6	117.3	5.63	
				SHALE - olive gray, decomposed, very soft rock, trace rust stains, trac iron nodules (6.5')					
	S-4	50/5.5"		- as above		11.8			
10				Bottom of Boring @ 9.5' (9.5')					
15									
20									
25									
30									
35									
40									

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JOB NO.: 1973059
DATE: April 4, 2019

BORING LOG No. B-2

BORING NO.	LOCATION OF BORING	ELEVATION	DATUM	DRILLER	LOGGER
B-2	See Boring Location Plan			J. Lear	K. Hudson

WATER LEVEL OBSERVATIONS				TYPE OF SURFACE	DRILL RIG
WHILE DRILLING	END OF DRILLING	24 HOURS AFTER DRILLING	AFTER DRILLING	Grass Field	CME 55
				DRILLING METHOD	TOTAL DEPTH
N.E.	N.E.	Boring Plugged After Drilling		3.25-inch Inside Diameter Hollow Stem Augers	11.5 ft.

DEP. FT.	SAMPLE DATA: SAMPLE NO. & TYPE	"N" BLOWS (FT)	% REC.	SOIL DESCRIPTION: COLOR, CONSISTENCY, MOISTURE / GEOLOGIC DESCRIPTION & OTHER REMARKS	USCS CLASS.	LABORATORY DATA: MC %	Dry Dens. pcf	q_u ksf	ELEV. FT.
				6" TOPSOIL					
	S-1	4		LEAN CLAY - black, very moist, medium stiff, trace roots — 0.5'	CL	28.4			
	U-2	N/A		FAT CLAY - grayish brown, very moist, stiff, trace rust stains, trace iron nodules — 2.5'		24.8	100.0	4.42	
5	S-3	16		- stiff to very stiff, else as above	CH	21.1			
10	S-4	18		- yellowish brown, very stiff, else as above		19.9			
	S-5	26		SHALE - yellowish brown to olive gray, decomposed, very soft rock, trace rust stains, trace iron nodules — 10.0'					
				Bottom of Boring @ 11.5' — 11.5'					
15									
20									
25									
30									
35									
40									

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BORING LOG No. B-3

BORING NO.	LOCATION OF BORING	ELEVATION	DATUM	DRILLER	LOGGER
B-3	See Boring Location Plan			J. Lear	K. Hudson

WATER LEVEL OBSERVATIONS				TYPE OF SURFACE	DRILL RIG
WHILE DRILLING	END OF DRILLING	24 HOURS AFTER DRILLING	AFTER DRILLING	Grass Field	CME 55
				DRILLING METHOD	TOTAL DEPTH
N.E.	N.E.	Boring Plugged After Drilling		3.25-inch Inside Diameter Hollow Stem Augers	11.5 ft.

DEP. FT.	SAMPLE DATA: SAMPLE NO. & TYPE	SAMPLE DATA: "N" BLOWS (FT)	SAMPLE DATA: % REC.	SOIL DESCRIPTION: COLOR, CONSISTENCY, MOISTURE / GEOLOGIC DESCRIPTION & OTHER REMARKS	USCS CLASS.	LABORATORY DATA: MC %	LABORATORY DATA: Dry Dens. pcf	LABORATORY DATA: q_u ksf	ELEV. FT.
				6" TOPSOIL (0.5')					
	S-1	7		LEAN CLAY - black, very moist, medium stiff, trace roots	CL	29.7			
	S-2	10		FAT CLAY - grayish brown, very moist, stiff, trace rust stains, trace iron seams (2.5')		21.8			
5	U-3	N/A		- grayish brown with gray mottles, else as above	CH	23.5	100.9	3.04	
10	S-4	12		- as above		21.4			
	S-5	16		- grayish brown, else as above					
				Bottom of Boring @ 11.5' (11.5')					
15									
20									
25									
30									
35									
40									

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BORING LOG No. B-4

BORING NO.	LOCATION OF BORING	ELEVATION	DATUM	DRILLER	LOGGER
B-4	See Boring Location Plan			J. Lear	K. Hudson

WATER LEVEL OBSERVATIONS				TYPE OF SURFACE	DRILL RIG
WHILE DRILLING	END OF DRILLING	24 HOURS AFTER DRILLING	AFTER DRILLING	Grass Field	CME 55
				DRILLING METHOD	TOTAL DEPTH
N.E.	N.E.	Boring Plugged After Drilling		3.25-inch Inside Diameter Hollow Stem Augers	11.5 ft.

DEP. FT.	SAMPLE DATA: SAMPLE NO. & TYPE	SAMPLE DATA: "N" BLOWS (FT)	SAMPLE DATA: % REC.	SOIL DESCRIPTION: COLOR, CONSISTENCY, MOISTURE / GEOLOGIC DESCRIPTION & OTHER REMARKS	USCS CLASS.	LABORATORY DATA: MC %	LABORATORY DATA: Dry Dens. pcf	LABORATORY DATA: q_u ksf	ELEV. FT.
				6" TOPSOIL (0.5')					
	S-1	8		FAT CLAY - dark grayish brown, very moist, medium stiff to stiff, trace roots, trace iron seams, trace rust stains		25.4			
	S-2	14		- reddish brown, stiff, trace iron nodules, trace root holes, else as above		23.5			
5	S-3	12		- no roots, else as above	CH	23.5			
	S-4	15		- light yellowish brown, else as above		24.5			
10	S-5	26		SHALE - greenish gray, decomposed, very soft rock, trace rust stains, trace iron nodules (10.0')					
				Bottom of Boring @ 11.5' (11.5')					
15									
20									
25									
30									
35									
40									

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BORING LOG No. B-5

BORING NO.	LOCATION OF BORING	ELEVATION	DATUM	DRILLER	LOGGER
B-5	See Boring Location Plan			J. Lear	K. Hudson

WATER LEVEL OBSERVATIONS				TYPE OF SURFACE	DRILL RIG
WHILE DRILLING	END OF DRILLING	24 HOURS AFTER DRILLING	AFTER DRILLING	Grass Field	CME 55
				DRILLING METHOD	TOTAL DEPTH
10.0 ft.	9.5 ft.	Boring Plugged After Drilling		3.25-inch Inside Diameter Hollow Stem Augers	11.5 ft.

DEP. FT.	SAMPLE DATA: SAMPLE NO. & TYPE	"N" BLOWS (FT)	% REC.	SOIL DESCRIPTION: COLOR, CONSISTENCY, MOISTURE / GEOLOGIC DESCRIPTION & OTHER REMARKS	USCS CLASS.	LABORATORY DATA: MC %	Dry Dens. pcf	q_u ksf	ELEV. FT.
				6" TOPSOIL (0.5')					
	S-1	10		LEAN CLAY - very dark brown, very moist, stiff, trace iron nodules, trace rust stains (2.5')	CL	26.4			
	S-2	17		FAT CLAY - reddish brown, very moist, very stiff, trace iron nodules		23.7			
5	S-3	11		- as above	CH	23.0			
	S-4	52		FAT CLAY w/ GRAVEL - dark yellowish brown, moist, hard, fine to coarse limestone nodules & fragments (8.5')	CH	17.3			
10	S-5	23		SHALE - olive gray, decomposed, very soft rock, trace rust stains, trace iron nodules (10.0')					
				Bottom of Boring @ 11.5' (11.5')					

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BORING LOG No. B-6

BORING NO.	LOCATION OF BORING	ELEVATION	DATUM	DRILLER	LOGGER
B-6	See Boring Location Plan			J. Lear	K. Hudson

WATER LEVEL OBSERVATIONS				TYPE OF SURFACE	DRILL RIG
WHILE DRILLING	END OF DRILLING	24 HOURS AFTER DRILLING	AFTER DRILLING	Grass Field	CME 55
				DRILLING METHOD	TOTAL DEPTH
10.0 ft.	9.5 ft.	Boring Plugged After Drilling		3.25-inch Inside Diameter Hollow Stem Augers	11.5 ft.

DEP. FT.	SAMPLE DATA: SAMPLE NO. & TYPE	"N" BLOWS (FT)	% REC.	SOIL DESCRIPTION: COLOR, CONSISTENCY, MOISTURE / GEOLOGIC DESCRIPTION & OTHER REMARKS	USCS CLASS.	LABORATORY DATA: MC %	Dry Dens. pcf	q_u ksf	ELEV. FT.
				6" TOPSOIL (0.5')					
	S-1	11		LEAN CLAY - black, moist, stiff, trace roots	CL	20.1			
				(2.5')					
	S-2	12		FAT CLAY - black to gray, very moist, stiff, trace iron nodules, trace rust stains		24.8			
5									
	S-3	10		- gray, extensive rust staining, else as above		23.7			
					CH				
	S-4	7		- medium stiff, trace rust stains, else as above		24.1			
10									
	S-5	8		- grayish brown, wet, medium stiff to stiff, else as above					
				(11.5') Bottom of Boring @ 11.5'					
15									
20									
25									
30									
35									
40									

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BORING LOG No. B-7

BORING NO.	LOCATION OF BORING	ELEVATION	DATUM	DRILLER	LOGGER
B-7	See Boring Location Plan			J. Lear	K. Hudson

WATER LEVEL OBSERVATIONS				TYPE OF SURFACE	DRILL RIG
WHILE DRILLING	END OF DRILLING	24 HOURS AFTER DRILLING	AFTER DRILLING	Grass Field	CME 55
				DRILLING METHOD	TOTAL DEPTH
N.E.	N.E.	Boring Plugged After Drilling		3.25-inch Inside Diameter Hollow Stem Augers	10.0 ft.

DEP. FT.	SAMPLE DATA: SAMPLE NO. & TYPE	SAMPLE DATA: "N" BLOWS (FT)	SAMPLE DATA: % REC.	SOIL DESCRIPTION: COLOR, CONSISTENCY, MOISTURE / GEOLOGIC DESCRIPTION & OTHER REMARKS	USCS CLASS.	LABORATORY DATA: MC %	LABORATORY DATA: Dry Dens. pcf	LABORATORY DATA: q_u ksf	ELEV. FT.
				6" TOPSOIL (0.5')					
	S-1	10		FAT CLAY - grayish brown, very moist, stiff, trace iron nodules, trace rust stains, trace roots		21.2			
	S-2	20		- grayish brown to dark brown, moist, very stiff, no rust, no iron, else as above	CH	21.4			
5									
	S-3	12		SHALE - olive gray, highly weathered, very soft rock (5.0')		20.1			
				LIMESTONE - gray, moderately weathered, very soft to soft rock (7.0')					
	S-4	50/1"		Bottom of Boring @ 8.1' (8.1')					
10									
15									
20									
25									
30									
35									
40									

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BORING LOG No. B-8

BORING NO.	LOCATION OF BORING	ELEVATION	DATUM	DRILLER	LOGGER
B-8	See Boring Location Plan			J. Lear	K. Hudson

WATER LEVEL OBSERVATIONS				TYPE OF SURFACE	DRILL RIG
WHILE DRILLING	END OF DRILLING	24 HOURS AFTER DRILLING	AFTER DRILLING	Grass Field	CME 55
				DRILLING METHOD	TOTAL DEPTH
N.E.	N.E.	Boring Plugged After Drilling		3.25-inch Inside Diameter Hollow Stem Augers	10.0 ft.

DEP. FT.	SAMPLE DATA: SAMPLE NO. & TYPE	"N" BLOWS (FT)	% REC.	SOIL DESCRIPTION: COLOR, CONSISTENCY, MOISTURE / GEOLOGIC DESCRIPTION & OTHER REMARKS	USCS CLASS.	LABORATORY DATA: MC %	Dry Dens. pcf	q_u ksf	ELEV. FT.
				6" TOPSOIL — 0.5'					
	S-1	13		FILL (FAT CLAY) - dark yellowish brown with olive brown, strong brown, and dark gray, very moist, stiff, trace rust stains, trace iron nodules, trace decomposed shale — 2.5'	FILL	22.1			
	S-2	13		FAT CLAY - dark gray, moist, stiff, trace rust stains, trace topsoil		19.5			
5	S-3	10		- olive brown with dark gray, else as above	CH	24.6			
	S-4	14		SHALE - light olive brown with gray, decomposed, very soft to soft rock, trace rust stains, trace iron nodules — 8.5'		22.4			
10				Bottom of Boring @ 10' — 10.0'					
15									
20									
25									
30									
35									
40									

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JOB NO.: 1973059
DATE: April 5, 2019

BORING LOG No. B-9

BORING NO.	LOCATION OF BORING	ELEVATION	DATUM	DRILLER	LOGGER
B-9	See Boring Location Plan			J. Lear	K. Hudson

WATER LEVEL OBSERVATIONS				TYPE OF SURFACE	DRILL RIG
WHILE DRILLING	END OF DRILLING	24 HOURS AFTER DRILLING	AFTER DRILLING	Grass Field	CME 55
				DRILLING METHOD	TOTAL DEPTH
N.E.	N.E.	Boring Plugged After Drilling		3.25-inch Inside Diameter Hollow Stem Augers	10.0 ft.

DEP. FT.	SAMPLE DATA: SAMPLE NO. & TYPE	SAMPLE DATA: "N" BLOWS (FT)	SAMPLE DATA: % REC.	SOIL DESCRIPTION: COLOR, CONSISTENCY, MOISTURE / GEOLOGIC DESCRIPTION & OTHER REMARKS	USCS CLASS.	LABORATORY DATA: MC %	LABORATORY DATA: Dry Dens. pcf	LABORATORY DATA: q_u ksf	ELEV. FT.
				6" TOPSOIL — 0.5'					
	S-1	6		FILL (LEAN CLAY) - light olive brown to olive with dark gray, very moist, medium stiff LL=44; PL=21; PI=23					
	S-2	8		- medium stiff to stiff, trace rust stains, trace iron nodules, else as above	FILL	26.3			
5									
	S-3	11		FAT CLAY - dark reddish brown, very moist, stiff, trace rust stains, trace iron nodules — 5.0'	CH	27.8			
				SHALE - olive brown with gray, decomposed, soft rock, trace rust stains, trace iron nodules — 8.5'					
10	S-4	13				22.9			
				Bottom of Boring @ 10' — 10.0'					
15									
20									
25									
30									
35									
40									

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LOCATION: Lee's Summit, Missouri
JOB NO.: 1973059
DATE: April 5, 2019

BORING LOG No. B-10

BORING NO.	LOCATION OF BORING	ELEVATION	DATUM	DRILLER	LOGGER
B-10	See Boring Location Plan			J. Lear	K. Hudson

WATER LEVEL OBSERVATIONS				TYPE OF SURFACE	DRILL RIG
WHILE DRILLING	END OF DRILLING	24 HOURS AFTER DRILLING	AFTER DRILLING	Gravel Roadway	CME 55
				DRILLING METHOD	TOTAL DEPTH
N.E.	N.E.	Boring Plugged After Drilling		3.25-inch Inside Diameter Hollow Stem Augers	10.0 ft.

DEP. FT.	SAMPLE DATA: SAMPLE NO. & TYPE	SAMPLE DATA: "N" BLOWS (FT)	SAMPLE DATA: % REC.	SOIL DESCRIPTION: COLOR, CONSISTENCY, MOISTURE / GEOLOGIC DESCRIPTION & OTHER REMARKS	USCS CLASS.	LABORATORY DATA: MC %	LABORATORY DATA: Dry Dens. pcf	LABORATORY DATA: q_u ksf	ELEV. FT.
				6" GRAVEL (0.5')					
	S-1	16		FILL (FAT CLAY) - olive brown with dark reddish brown, moist, stiff to very stiff, trace rust stains, trace iron nodules, trace decomposed shale (2.5')	FILL	17.2			
	S-2	10		FAT CLAY - strong brown with gray, very moist, stiff, trace rust stains, trace iron nodules (5.0')	CH	21.4			
5									
	S-3	33		SHALE - pale olive with gray, decomposed, very soft to soft rock, trace rust stains, trace iron nodules		20.1			
	S-4	95/11"		- pale olive to olive brown with strong brown and gray, highly to moderately weathered, soft rock, friable, else as above (10.0')		17.1			
10				Bottom of Boring @ 10'					
15									
20									
25									
30									
35									
40									

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BORING LOG No. B-11

BORING NO.	LOCATION OF BORING	ELEVATION	DATUM	DRILLER	LOGGER
B-11	See Boring Location Plan			J. Lear	K. Hudson

WATER LEVEL OBSERVATIONS				TYPE OF SURFACE	DRILL RIG
WHILE DRILLING	END OF DRILLING	24 HOURS AFTER DRILLING	AFTER DRILLING	Grass Field	CME 55
				DRILLING METHOD	TOTAL DEPTH
N.E.	N.E.	Boring Plugged After Drilling		3.25-inch Inside Diameter Hollow Stem Augers	10.0 ft.

DEP. FT.	SAMPLE DATA: SAMPLE NO. & TYPE	SAMPLE DATA: "N" BLOWS (FT)	SAMPLE DATA: % REC.	SOIL DESCRIPTION: COLOR, CONSISTENCY, MOISTURE / GEOLOGIC DESCRIPTION & OTHER REMARKS	USCS CLASS.	LABORATORY DATA: MC %	LABORATORY DATA: Dry Dens. pcf	LABORATORY DATA: q_u ksf	ELEV. FT.
				6" TOPSOIL — 0.5'					
	S-1	7		FILL (FAT CLAY) - pale olive to olive brown, very moist, medium stiff, trace decomposed shale, trace rust stains, trace iron nodules, trace limestone fragments		26.9			
	S-2	7		- olive brown with strong brown, dark gray, and pale olive, else as above	FILL	28.8			
5									
	S-3	21		FAT CLAY - olive brown with gray, moist, very stiff, trace rust stains, trace iron nodules — 5.0'		21.4			
					CH				
	S-4	11		- gray with strong brown mottles, very moist, stiff, else as above		27.3			
10				Bottom of Boring @ 10' — 10.0'					
15									
20									
25									
30									
35									
40									

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BORING LOG No. B-12

BORING NO.	LOCATION OF BORING	ELEVATION	DATUM	DRILLER	LOGGER
B-12	See Boring Location Plan			J. Lear	K. Hudson

WATER LEVEL OBSERVATIONS				TYPE OF SURFACE	DRILL RIG
WHILE DRILLING	END OF DRILLING	24 HOURS AFTER DRILLING	AFTER DRILLING	Grass Field	CME 55
				DRILLING METHOD	TOTAL DEPTH
N.E.	N.E.	Boring Plugged After Drilling		3.25-inch Inside Diameter Hollow Stem Augers	20.0 ft.

DEP. FT.	SAMPLE DATA: SAMPLE NO. & TYPE	"N" BLOWS (FT)	% REC.	SOIL DESCRIPTION: COLOR, CONSISTENCY, MOISTURE / GEOLOGIC DESCRIPTION & OTHER REMARKS	USCS CLASS.	LABORATORY DATA: MC %	Dry Dens. pcf	q_u ksf	ELEV. FT.
				6" TOPSOIL — 0.5'					
	S-1	7		FILL (FAT CLAY) - dark olive brown to olive with gray, moist, medium stiff, trace rust stains, trace iron nodules, trace decomposed shale		24.4			
				LL=57; PL=21; PI=36					
	S-2	15		- greenish gray to pale olive with reddish yellow to strong brown mottles, else as above		24.2			
5									
	U-3	N/A		- pale olive with dark reddish brown trace fine gravel, else as above					
					FILL				
	S-4	20		- trace limestone fragments, else as above		20.5			
10									
	S-5	12		FAT CLAY - dark gray with yellowish brown, moist, stiff, trace rust stains — 13.5'					
15									
					CH				
	S-6	12		- gray to bluish gray with yellowish brown, trace iron nodules, else as above					
20				Bottom of Boring @ 20' — 20.0'					
25									
30									
35									
40									

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DATE: April 5, 2019

BORING LOG No. B-13

BORING NO.	LOCATION OF BORING	ELEVATION	DATUM	DRILLER	LOGGER
B-13	See Boring Location Plan			J. Lear	K. Hudson

WATER LEVEL OBSERVATIONS				TYPE OF SURFACE	DRILL RIG
WHILE DRILLING	END OF DRILLING	24 HOURS AFTER DRILLING	AFTER DRILLING	Grass Field	CME 55
				DRILLING METHOD	TOTAL DEPTH
N.E.	N.E.	Boring Plugged After Drilling		3.25-inch Inside Diameter Hollow Stem Augers	17.13 ft.

DEP. FT.	SAMPLE DATA: SAMPLE NO. & TYPE	"N" BLOWS (FT)	% REC.	SOIL DESCRIPTION: COLOR, CONSISTENCY, MOISTURE / GEOLOGIC DESCRIPTION & OTHER REMARKS	USCS CLASS.	LABORATORY DATA: MC %	Dry Dens. pcf	q_u ksf	ELEV. FT.
				6" TOPSOIL (0.5')					
	S-1	12		FILL (FAT CLAY) - strong brown, moist, stiff, trace rust stains, trace iron nodules, trace decomposed shale, trace limestone fragments		20.1			
	S-2	9		- dark olive brown with strong brown and pale olive, else as above	FILL	23.5			
5									
	S-3	14		FAT CLAY - dark gray with strong brown mottles, moist, stiff, trace rust stains, trace iron nodules (5.0')		25.9			
10	U-4	N/A		- medium stiff, else as above	CH	26.9	100.1	2.28	
15	S-5	12		- dark gray, stiff, slightly blocky, trace decomposed shale, else as above					
	S-6	50/1.5"		LIMESTONE - gray, moderately weathered, soft to moderately hard rock (16.8' / 17.1')					
				Bottom of Boring @ 17.13'					
20									
25									
30									
35									
40									

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BORING LOG No. B-14

BORING NO.	LOCATION OF BORING	ELEVATION	DATUM	DRILLER	LOGGER
B-14	See Boring Location Plan			J. Lear	K. Hudson

WATER LEVEL OBSERVATIONS				TYPE OF SURFACE	DRILL RIG
WHILE DRILLING	END OF DRILLING	24 HOURS AFTER DRILLING	AFTER DRILLING	Grass Field	CME 55
				DRILLING METHOD	TOTAL DEPTH
15.5 ft.	18.5 ft.	Boring Plugged After Drilling		3.25-inch Inside Diameter Hollow Stem Augers	20.0 ft.

DEP. FT.	SAMPLE DATA: SAMPLE NO. & TYPE	"N" BLOWS (FT)	% REC.	SOIL DESCRIPTION: COLOR, CONSISTENCY, MOISTURE / GEOLOGIC DESCRIPTION & OTHER REMARKS	USCS CLASS.	LABORATORY DATA: MC %	Dry Dens. pcf	q_u ksf	ELEV. FT.
				6" TOPSOIL — 0.5'					
	S-1	6		FILL (FAT CLAY) - strong brown, very moist, medium stiff, trace rust stains, trace iron nodules, trace roots		22.7			
	S-2	10		- olive to olive brown with bluish gray and olive yellow, stiff, trace decomposed shale, else as above	FILL	23.6			
5									
	S-3	14		FAT CLAY - dark gray with strong brown mottles, moist, stiff, trace rust stains, trace iron nodules — 5.0'		21.1			
	S-4	9		- very dark gray to black, else as above	CH	28.3			
10									
	S-5	13		SHALE - pale olive to bluish gray with yellowish brown mottles, decomposed, soft rock, trace rust stains, trace iron nodules — 13.5'					
15									
	S-6	55		- very dark gray, slightly weathered, no rust, no iron, else as above					
20				Bottom of Boring @ 20' — 20.0'					
25									
30									
35									
40									

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BORING LOG No. B-15

BORING NO.	LOCATION OF BORING	ELEVATION	DATUM	DRILLER	LOGGER
B-15	See Boring Location Plan			J. Lear	K. Hudson

WATER LEVEL OBSERVATIONS				TYPE OF SURFACE	DRILL RIG
WHILE DRILLING	END OF DRILLING	24 HOURS AFTER DRILLING	AFTER DRILLING	Grass Field	CME 55
				DRILLING METHOD	TOTAL DEPTH
13.0 ft.	13.0 ft.	Boring Plugged After Drilling		3.25-inch Inside Diameter Hollow Stem Augers	13.04 ft.

DEP. FT.	SAMPLE DATA: SAMPLE NO. & TYPE	"N" BLOWS (FT)	% REC.	SOIL DESCRIPTION: COLOR, CONSISTENCY, MOISTURE / GEOLOGIC DESCRIPTION & OTHER REMARKS	USCS CLASS.	LABORATORY DATA: MC %	Dry Dens. pcf	q_u ksf	ELEV. FT.
				6" TOPSOIL — 0.5'					
	S-1	5		FILL (FAT CLAY) - dark olive brown to olive brown, very moist, medium stiff, trace rust stains, trace iron nodules, trace decomposed shale		27.8			
	S-2	8		- medium stiff to stiff, else as above	FILL	24.5			
5									
	S-3	9		FAT CLAY - olive brown to olive, very moist, stiff, trace rust stains, trace iron nodules — 5.0'		26.8			
10	U-4	N/A		- dark gray, medium stiff, trace decomposed shale, else as above	CH	27.5	103.0	2.35	
	S-5	50/1.5"		LIMESTONE - gray, moderately weathered, moderately hard rock — 13.0' / 13.0'					
15				Bottom of Boring @ 13.04'					
20									
25									
30									
35									
40									

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KEY TO SYMBOLS

Symbol Description

Strata symbols

 **Topsoil**

 **Fat Clay**

 **Shale**

 **Lean Clay**

 **Fat Clay with Gravel**

 **Limestone**

 **Fill - Cohesive**

 **Gravel**

Misc. Symbols

 Water table during drilling

 **Water table at the conclusion of drilling**

Notes:

1. **The exploratory borings were drilled on April 4 and 5, 2019 using 3.25-inch inside diameter hollow stem augers.**

2. **These logs are subject to the limitations, conclusions, and recommendations in this report.**

3. **Results of tests conducted on samples recovered are reported on the logs.**

Boring Log
Legend and Nomenclature

Items shown on boring logs refer to the following:

1. **Depth** - Depth below ground surface or drilling platform

2. **Sample** -Types designated by letter:

   A - Disturbed sample, obtained from auger cuttings or wash water.

   S - Split barrel sample, obtained by driving a 2-inch split-barrel sampler unless otherwise noted.

   C - California liner sample, obtained using a thick-walled liner sampler containing 2-inch-diameter liner tubes.

   U - Undisturbed sample, obtained using a thin-walled tube, 3-inch-diameter, or as noted, and open sampling head.

   Recovery - Recovery is expressed as a percentage of the length recovered to the total length pushed, driven or cored.

   Resistance - Resistance is designated as follows:

   P - Sample pushed in one continuous movement by hydraulic rig action.

   12 - The Standard Penetration Resistance is the number of blows for the last 12 inches of penetration of split spoon sampler, driven by a 140-pound hammer falling 30 inches.

   50/4" - Number of blows to drive sampler distance shown.

3. **Soil Description** - Description of material according to the Unified Soil Classification: word description giving soil constituents, consistency or density, and other appropriate classification characteristics. Geologic name or type of deposit and other pertinent information, where appropriate, is shown under Geologic Description or other Remarks. A solid line indicates the approximate location of stratigraphic change.

4. **Lab Data** – Laboratory test data.

5. **Legend**

A.D.	—	After drilling	N.A.	—	Not Applicable
A.T.D.	—	At time of drilling	N.D.	—	Not detectable due to drilling method
C.F.A.	—	Continuous flight auger			
D.W.L.	—	Drill water loss	N.E.	—	None encountered
D.W.R.	—	Drill water return	N.R.	—	Not recorded
E.D.	—	End of drilling	R.Q.D.	—	Rock quality designation
H.B.	—	Hole backfilled	R.W.B.	—	Rotary wash boring

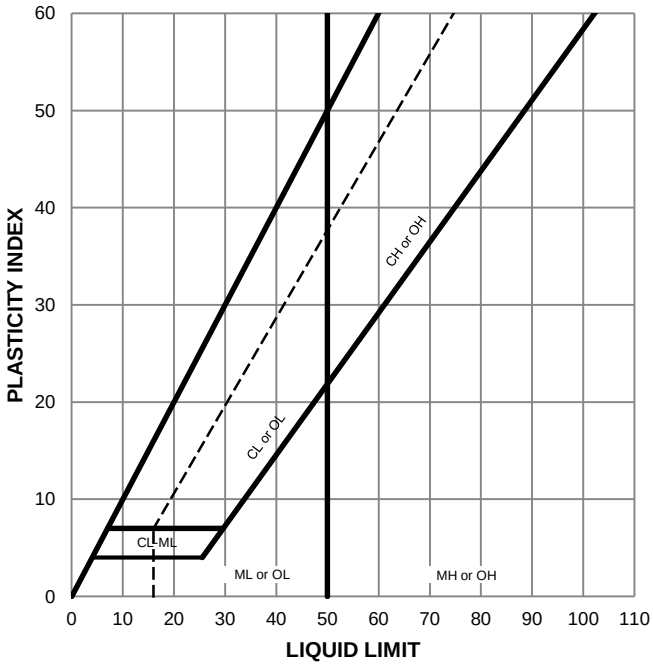
6. **Limitations** - The lines between materials shown on the boring logs represent approximate boundaries between material types and the changes may be gradual. Water level readings shown on the logs were made at the time and under the conditions indicated. Fluctuations in the water levels may occur with time. The boring logs in this report are subject to the limitations, explanations and conclusions of this report.

UNIFIED SOIL CLASSIFICATION SYSTEM

GROUP NAME	GROUP SYMBOL	SOIL DESCRIPTION	COMMENTS
Peat	Pt	Highly Organic Soils	50% or More Is Smaller than No. 200 Sieve
Fat Clay	CH	Clay - Liquid Limit => 50*	
Elastic Silt	MH	Silt - Liquid Limit => 50*	
Lean Clay	CL	Clay - Liquid Limit < 50*	
Silt	ML	Silt - Liquid Limit < 50*	
Silty Clay	CL-ML	Silty Clay*	
Clayey Sand	SC	Sands with 12 to 50% Smaller than No. 200 Sieve	More than 50% Is Larger than No. 200 Sieve and % Sand > % Gravel
Silty Sand	SM		
Poorly-Graded Sand with Clay	SP-SC	Sands with 5 to 12% Smaller than No. 200 Sieve	
Poorly-Graded Sand with Silt	SP-SM		
Well-Graded Sand with Clay**	SW-SC		
Well-Graded Sand with Silt**	SW-SM		
Poorly-Graded Sand	SP	Sands with Less than 5% Smaller than No. 200 Sieve	
Well-Graded Sand**	SW		
Clayey Gravel	GC	Gravels with 12 to 50% Smaller than No. 200 Sieve	More than 50% Is Larger than No. 200 Sieve and % Gravel > % Sand
Silty Gravel	GM		
Poorly-Graded Gravel with Clay	GP-GC	Gravels with 5 to 12% Smaller than No. 200 Sieve	
Poorly-Graded Gravel with Silt	GP-GM		
Well-Graded Gravel with Clay**	GW-GC		
Well-Graded Gravel with Silt**	GW-GP		
Poorly-Graded Gravel	GP	Gravels with Less than 5% Smaller than No. 200 Sieve	
Well-Graded Gravel**	GW		

*See Plasticity Chart for definition of silts and clays. If organic, use OL or OH.
**See definition of well-graded

PLASTICITY CHART



LEGEND OF TERMS

MOISTURE CONDITIONS
Dry, Slightly Moist, Moist, Very Moist, Wet (Saturated)

SOIL CONSISTENCY

Fine-Grained Soils

Description	SPT (N)	UCS (q_u, tsf)
Very Soft	0-2	0-0.25
Soft	2-4	0.25-0.50
Medium Stiff	4-8	0.50-1.0
Stiff	8-16	1.0-2.0
Very Stiff	16-32	2.0-4.0
Hard	>32	>4.0

Coarse-Grained Soils

Description	SPT (N)
Very Loose	0-4
Loose	4-10
Medium Dense	10-30
Dense	30-50
Very Dense	>50

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CLASSIFICATION OF SANDS & GRAVELS

Boulders	Cobbles	Coarse Gravel	Fine Gravel	Coarse Sand	Medium Sand	Fine Sand	Fines (Silt or Clay)
	10"	3"	3/4"	#4	#10	#40	#200

Well-Graded Sands (SW): $C_u \geq 6$ and $1 \leq C_c \leq 3$

Well-Graded Gravels (GW): $C_u \geq 4$ and $1 \leq C_c \leq 3$

ROCK DESCRIPTORS

DEGREE OF WEATHERING

Descriptor	Definition
Unweathered	No evidence of any chemical or mechanical alteration
Slightly Weathered	Slight discoloration on surface, slight alteration along discontinuities, less than 10% of the rock volume atlered
Moderately Weathered	Discoloring evident, surface pitted and altered with alteration penetrating well below rock surfaces, weathering "halos" evident, 10% to 50% of the rock altered
Highly Weathered	Entire mass discolored, alteration pervading nearly all of the rock with some pockets of slightly weathered rock noticeable, some minerals leached away
Decomposed	Rock reduced to a soil with relict rock texture, generally molded and crumbled by hand

HARDNESS

Descriptor	Definition
Very Soft	Can be deformed by hand
Soft	Can be scratched with a fingernail
Moderately Hard	Can be scratched easily with a knife
Hard	Can be scratched with difficulty with a knife
Very Hard	Cannot be scratched with a knife

TEXTURE*

Texture	Grain Diameter	Particle Name	Rock Name
*	80 mm	Cobble	Conglomerate
*	5 - 80 mm	Gravel	
Coarse Grained	2 - 5 mm		
Medium Grained	0.4 - 2 mm	Sand	Sandstone
Fine Grained	0.1 - 0.4 mm		
Very Fine Grained	0.1 mm	Clay, silt	Shale, Claystone, Siltstone

* Sedimentary Rocks

ROCK STRUCTURE

Descriptor	Definition
Massive	3 feet thick or greater
Thick Bedded	Beds from 1 foot to 3 feet thick
Medium Bedded	Beds from 4 in. to 1 foot thick
Thin Bedded	4 inches thick or less

DISCONTINUITIES

Joints

1.) Type: Type of joint if it can be readily determined (i.e., bedding, cleavage, foliation, schistosity, or extension.)

2.) Degree of joint wall weathering:

(i) Unweathered: No visible signs are noted of weathering; joint wall rock is fresh, crystal bright.

(ii) Slightly weathered joints: Discontinuities are stained or discolored and may contain a thin coating of altered material. Discoloration may extend into the rock from the discontinuity surfaces to a distance of up to 20% of the discontinuity spacing.

(iii) Moderately weathered joints: Slight discoloration extends from discontinuity planes for greater than 20% of the discontinuity spacing. Discontinuities may contain filling of altered material. Partial opening of grain bounderies may be observed.

(iv) Highly weathered joints: Entire mass discolored, alteration pervading nearly all of the rock with some pockets of slightly weathered rock noticeable, some minerals leached away.

(v) Completely weathered joints: Rock reduced to a soil with relicit rock texture, generally molded and crumbled by hand.

From EM 1110-1-2908

APPENDIX C

Field & Laboratory Test Results

SUMMARY OF FIELD AND LABORATORY TESTS

BORING NO.	SAMPLE NO.	SAMPLE DEPTH (ft.)	DIA. (in.)	MOISTURE CONTENT (%)	UNIT WEIGHT WET (pcf)	UNIT WEIGHT DRY (pcf)	VOID RATIO (e)	SAT. (%)	UNCONF. COMPR. STR. (ksf)	ATTERBERG LIMITS LL	ATTERBERG LIMITS PL	ATTERBERG LIMITS PI	PASS NO. 200 (%)	SPT "N" (blows /ft)	USCS SOIL CLASS.
B-1	S-1	0.5-2.0		25.1						56	25	31		9	CH
	S-2	2.5-4.0		22.8										12	CH
	U-3	5.0-7.0	2.78	20.6	141.5	117.3	0.409	100	5.63					N/A	CH - Shale
	S-4	8.5-9.5		11.8										50/5.5"	Shale
B-2	S-1	0.5-2.0		28.4										4	CL
	U-2	2.5-4.5	2.78	24.8	124.8	100.0	0.653	100	4.42					N/A	CH
	S-3	5.0-6.5		21.1										16	CH
	S-4	8.5-10.0		19.9										18	CH
	S-5	10.0-11.5												26	Shale
B-3	S-1	0.5-2.0		29.7										7	CL
	S-2	2.5-4.0		21.8										10	CH
	U-3	5.0-7.0	2.89	23.5	124.6	100.9	0.639	97	3.04					N/A	CH
	S-4	8.5-10.0		21.4										12	CH
	S-5	10.0-11.5												16	CH
B-4	S-1	0.5-2.0		25.4										8	CH
	S-2	2.5-4.0		23.5										14	CH
	S-3	5.0-6.5		23.5										12	CH
	S-4	8.5-10.0		24.5										15	CH
	S-5	10.0-11.5												26	Shale
B-5	S-1	0.5-2.0		26.4										10	CL
	S-2	2.5-4.0		23.7										17	CH
	S-3	5.0-6.5		23.0										11	CH
	S-4	8.5-10.0		17.3										52	CH w/ GP
	S-5	10.0-11.5												23	Shale
B-6	S-1	0.5-2.0		20.1										11	CL
	S-2	2.5-4.0		24.8										12	CH
	S-3	5.0-6.5		23.7										10	CH
	S-4	8.5-10.0		24.1										7	CH
	S-5	10.0-11.5												8	CH
B-7	S-1	0.5-2.0		21.2										10	CH
	S-2	2.5-4.0		21.4										20	CH
	S-3	5.0-6.5		20.1										12	Shale
	S-4	8.0-8.1												50/1"	Limestone
B-8	S-1	0.5-2.0		22.1										13	Fill (CH)
	S-2	2.5-4.0		19.5										13	CH
	S-3	5.0-6.5		24.6										10	CH
	S-4	8.5-10.0		22.4										14	Shale

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PROJECT
Pergola Park 4th-6th Plats

LOCATION
Lee's Summit, Missouri

PROJECT NUMBER
1973059

DATE
April 15, 2019

SUMMARY OF FIELD AND LABORATORY TESTS

BORING NO.	SAMPLE NO.	SAMPLE DEPTH (ft.)	DIA. (in.)	MOISTURE CONTENT (%)	UNIT WEIGHT WET (pcf)	UNIT WEIGHT DRY (pcf)	VOID RATIO (e)	SAT. (%)	UNCONF. COMPR. STR. (ksf)	ATTERBERG LIMITS LL	ATTERBERG LIMITS PL	ATTERBERG LIMITS PI	PASS NO. 200 (%)	SPT "N" (blows /ft)	USCS SOIL CLASS.
B-9	S-1	0.5-2.0								44	21	23		6	Fill (CL)
	S-2	2.5-4.0		26.3										8	Fill (CL)
	S-3	5.0-6.5		27.8										11	CH
	S-4	8.5-10.0		22.9										13	Shale
B-10	S-1	0.5-2.0		17.2										16	Fill (CH)
	S-2	2.5-4.0		21.4										10	CH
	S-3	5.0-6.5		20.1										33	Shale
	S-4	8.5-10.0		17.1										95/11"	Shale
B-11	S-1	0.5-2.0		26.9										7	Fill (CH)
	S-2	2.5-4.0		28.8										7	Fill (CH)
	S-3	5.0-6.5		21.4										21	CH
	S-4	8.5-10.0		27.3										11	CH
B-12	S-1	0.5-2.0		24.4						57	21	36		7	Fill (CH)
	S-2	2.5-4.0		24.2										15	Fill (CH)
	U-3	5.0-7.0												N/A	Fill (CH)
	S-4	8.5-10.0		20.5										20	Fill (CH)
	S-5	13.5-15.0												12	CH
	S-6	18.5-20.0												12	CH
B-13	S-1	0.5-2.0		20.1										12	Fill (CH)
	S-2	2.5-4.0		23.5										9	Fill (CH)
	S-3	5.0-6.5		25.9										14	CH
	U-4	8.5-10.5	2.79	26.9	127.0	100.1	0.652	100	2.28					N/A	CH
	S-5	13.5-15.0												12	CH
	S-6	17.0-17.13												50/1.5"	Limestone
B-14	S-1	0.5-2.0		22.7										6	Fill (CH)
	S-2	2.5-4.0		23.6										10	Fill (CH)
	S-3	5.0-6.5		21.1										14	CH
	S-4	8.5-10.0		28.3										9	CH
	S-5	13.5-15.0												13	Shale
	S-6	18.5-20.0												55	Shale
B-15	S-1	0.5-2.0		27.8										5	Fill (CH)
	S-2	2.5-4.0		24.5										8	Fill (CH)
	S-3	5.0-6.5		26.8										9	CH
	U-4	8.5-10.5	2.79	27.5	131.4	103.0	0.605	100	2.35					N/A	CH
	S-5	13.0-13.04												50/1.5"	Limestone
B-3	A-1	0.0-5.0		3.6 (Air Dry)						53	22	31	96.1	N/A	CH
B-1,-5,-7	A-1	Varies		2.3 (Air Dry)						47	19	28	95.5	N/A	CL
B-10,-13	A-1	Varies		2.3 (Air Dry)						57	23	34	95.7	N/A	Fill (CH) - CH

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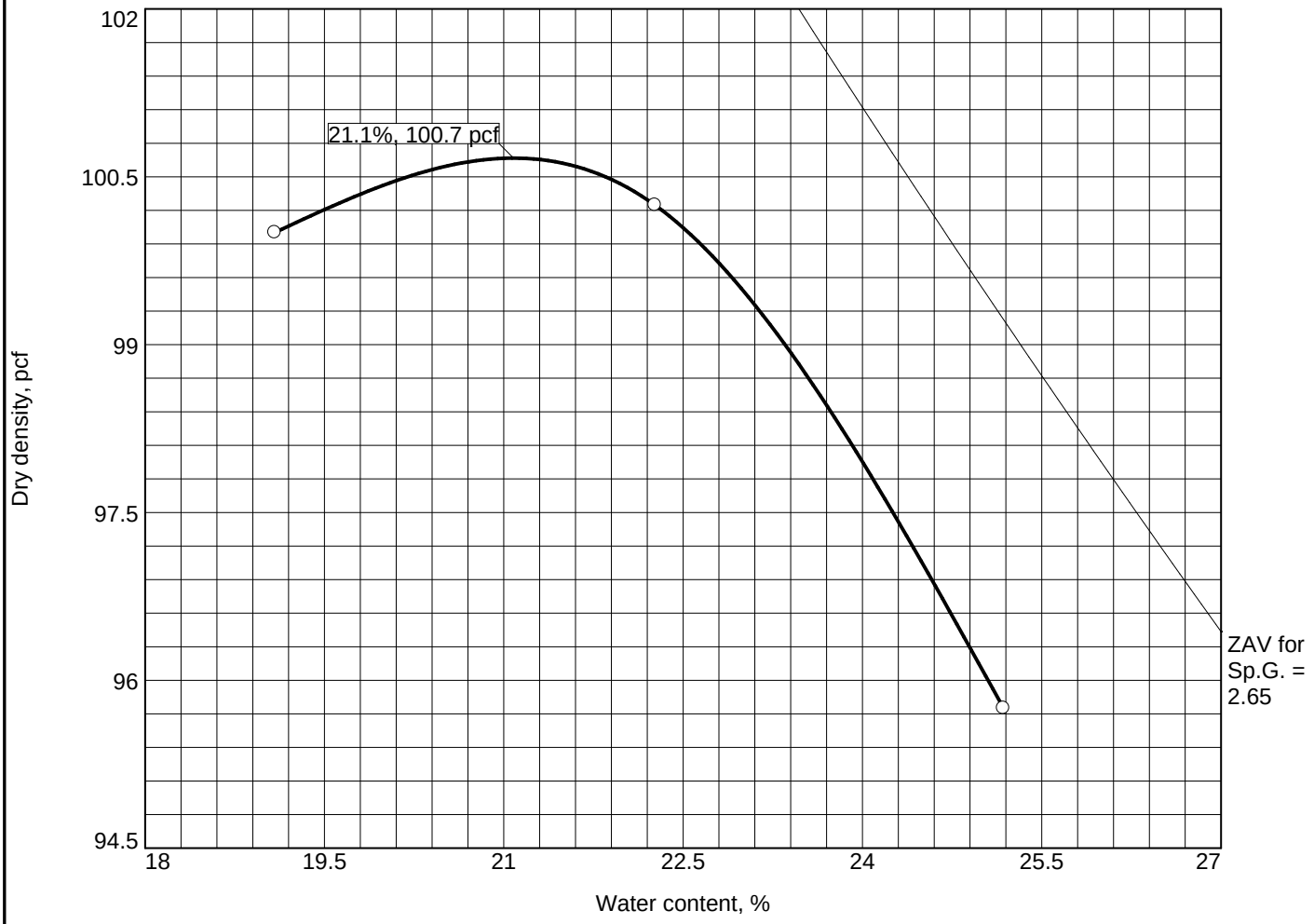
PROJECT
Pergola Park 4th-6th Plats

LOCATION
Lee's Summit, Missouri

PROJECT NUMBER
1973059

DATE
April 15, 2019

MOISTURE-DENSITY TEST REPORT



Test specification: ASTM D 698-07 Method A Standard

Elev/ Depth	Classification		Air Dry Moist.	Sp.G.	LL	PI	% > #4	% < No.200
	USCS	AASHTO						
0.0-5.0	CH		3.6	2.65	53	31		96.1

TEST RESULTS	MATERIAL DESCRIPTION
Maximum dry density = 100.7 pcf Optimum moisture = 21.1 %	FAT CLAY - black to grayish brown, very moist, trace rust stains, trace iron seams

Project No. 1973059 **Client:** NLV Pergola Park, LLC

Project: Pergola Park 4th-6th Plats

Date: 4/10/19

○ **Location:** B-3 **Sample Number:** A-1

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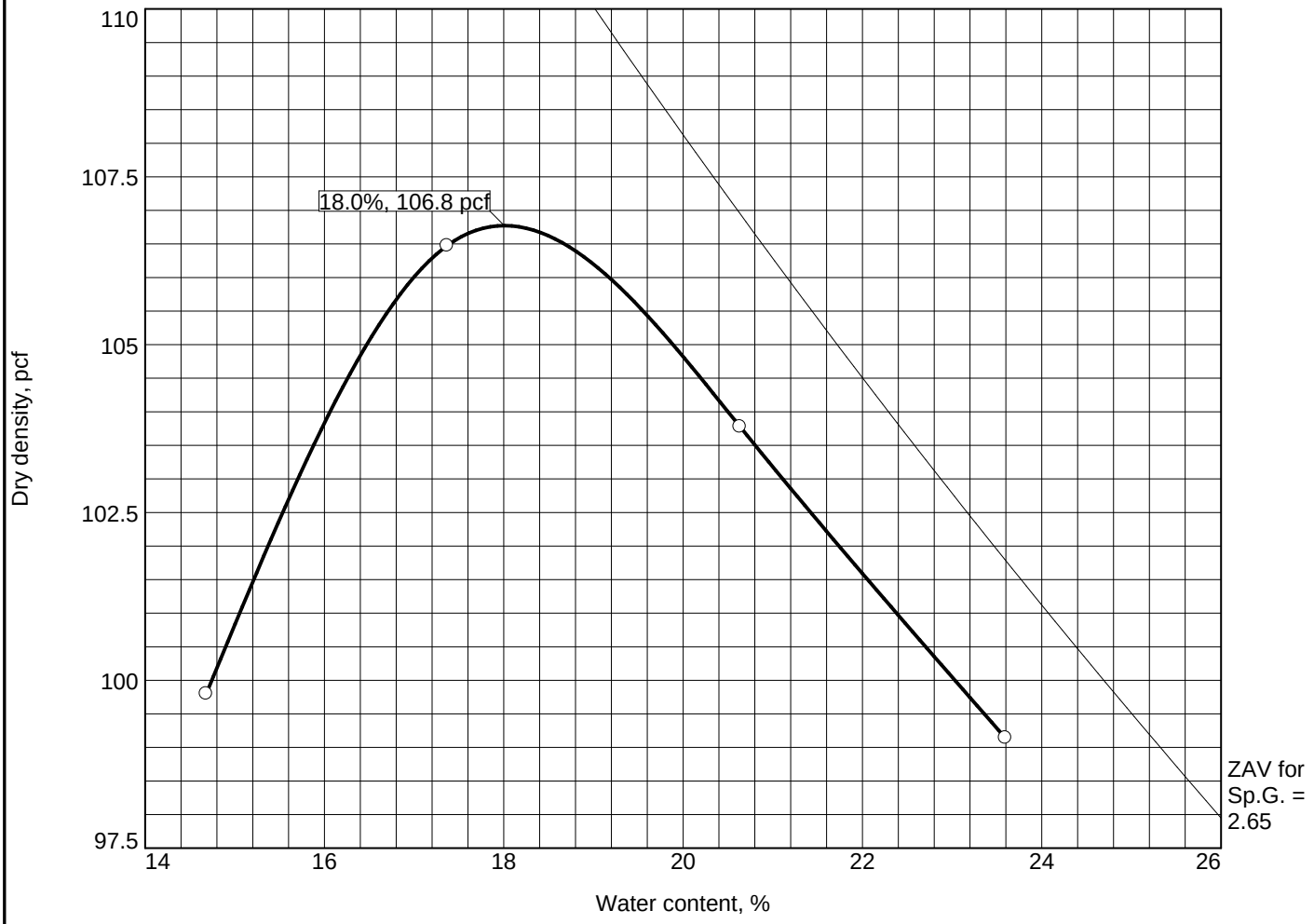
Remarks:

Figure 1

Tested By: T. Boone **Checked By:** C. Parker

MOISTURE-DENSITY TEST REPORT



Test specification: ASTM D 698-07 Method A Standard

Elev/ Depth	Classification		Air Dry Moist.	Sp.G.	LL	PI	% > #4	% < No.200
	USCS	AASHTO						
Varies	CL		2.3	2.65	47	28		95.5

TEST RESULTS	MATERIAL DESCRIPTION
Maximum dry density = 106.8 pcf Optimum moisture = 18.0 %	LEAN CLAY - black to very dark brown, grayish brown, or reddish brown, very moist, trace rust stains, trace iron nodules

Project No. 1973059 **Client:** NLV Pergola Park, LLC

Project: Pergola Park 4th-6th Plats

Date: 4/10/19

○ **Location:** B-1, B-5, & B-7 **Sample Number:** A-1

Remarks:

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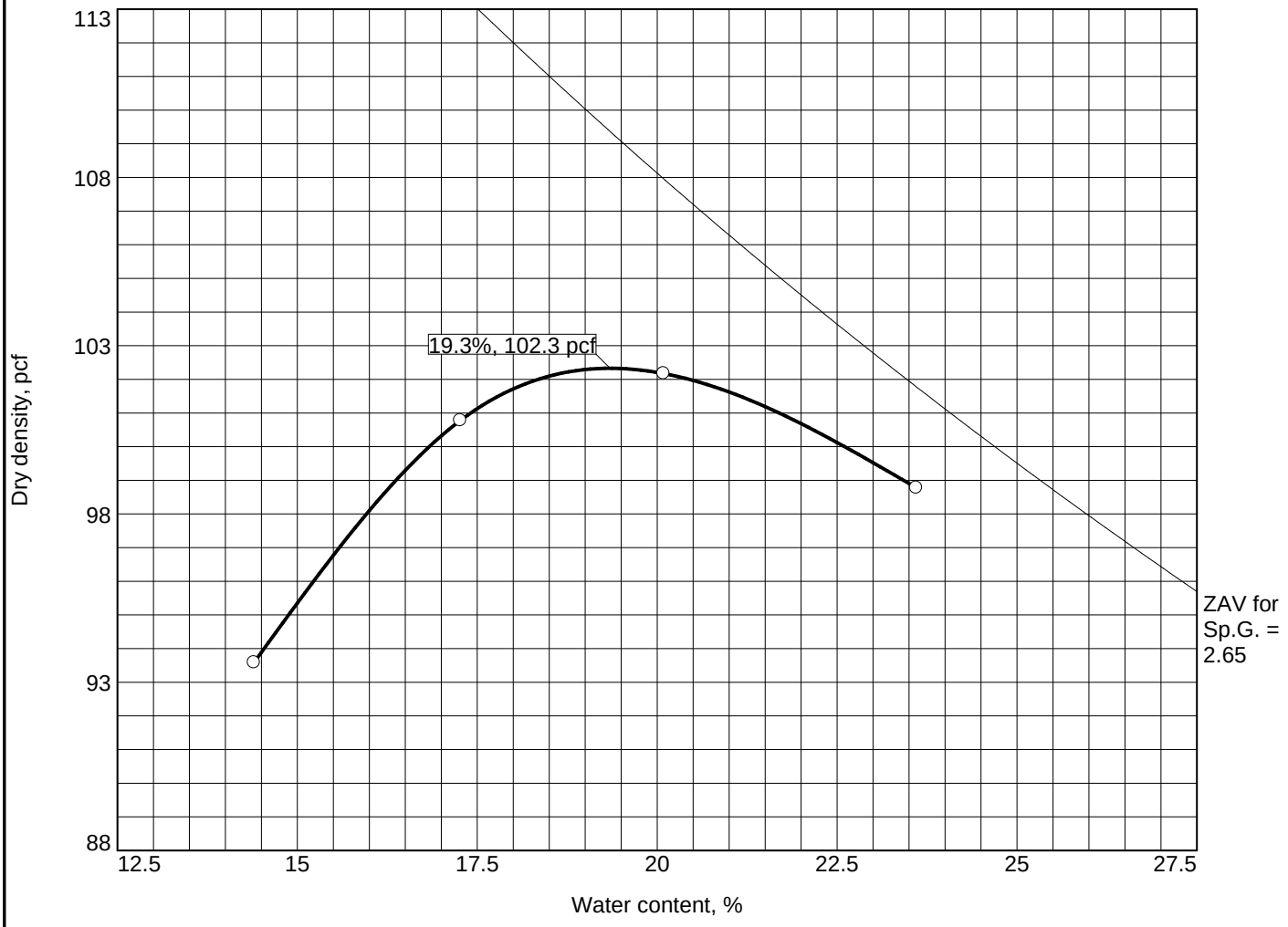
Figure 2

Tested By: T. Boone **Checked By:** C. Parker

MOISTURE-DENSITY TEST REPORT



Test specification: ASTM D 698-07 Method A Standard

Elev/ Depth	Classification		Air Dry Moist.	Sp.G.	LL	PI	% > #4	% < No.200
	USCS	AASHTO						
Varies	CH		2.3	2.65	57	34		95.7

TEST RESULTS	MATERIAL DESCRIPTION
Maximum dry density = 102.3 pcf Optimum moisture = 19.3 %	FILL (FAT CLAY) to FAT CLAY - dark olive brown to olive brown, gray, or dark reddish brown to strong brown, very moist, trace rust

Project No. 1973059 **Client:** NLV Pergola Park, LLC

Project: Pergola Park 4th-6th Plats

Date: 4/9/19

○ **Location:** B-10 & B-13 **Sample Number:** A-1

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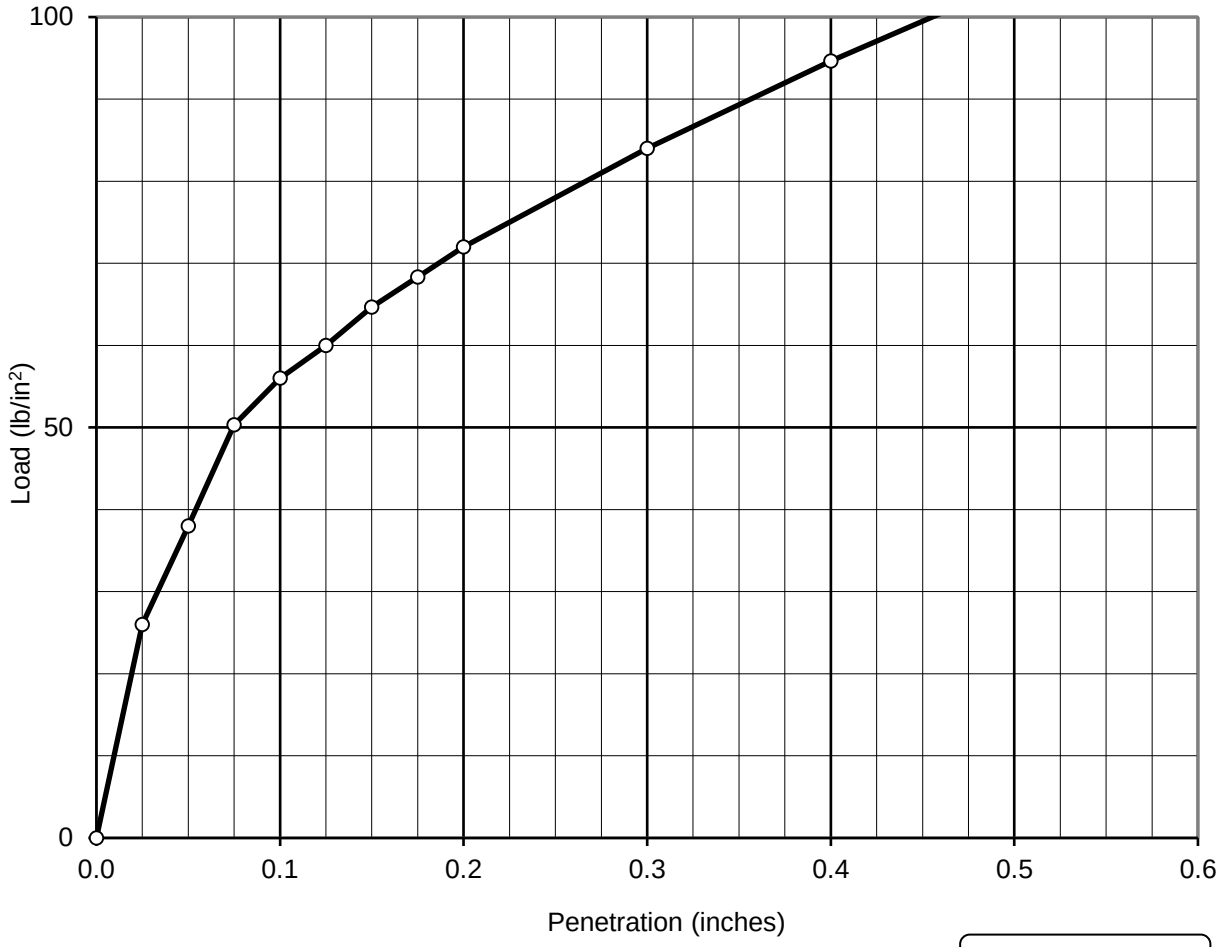
Remarks:

Figure 3

Tested By: T. Boone **Checked By:** C. Parker

CALIFORNIA BEARING RATIO TEST



Lab No. 4

Test conducted in general accordance with ASTM D1883.

Sample Identification		**Moisture Content**	
Boring:	B-1, B-5, B-7	Before Soaking:	20.1 %
Sample:	A-1	Top 1 inch After Soaking:	23.3 %
Depth (ft.):	Varies	Average After Soaking:	23.3 %
Description		**Dry Unit Weight**	
Lean Clay - very dark brown to grayish brown, very moist		Before Soaking:	101.8 lb/ft^3
		After Soaking:	98.5 lb/ft^3
Sample Preparation		**Percent Swell**	3.0 %
Compaction Method:	Manual Rammer	**California Bearing Ratio**	
Surcharge:	10 lbs.	Penetration = 0.1 inches:	5.6
Soaking Duration:	96 hrs.	Penetration = 0.2 inches:	4.8

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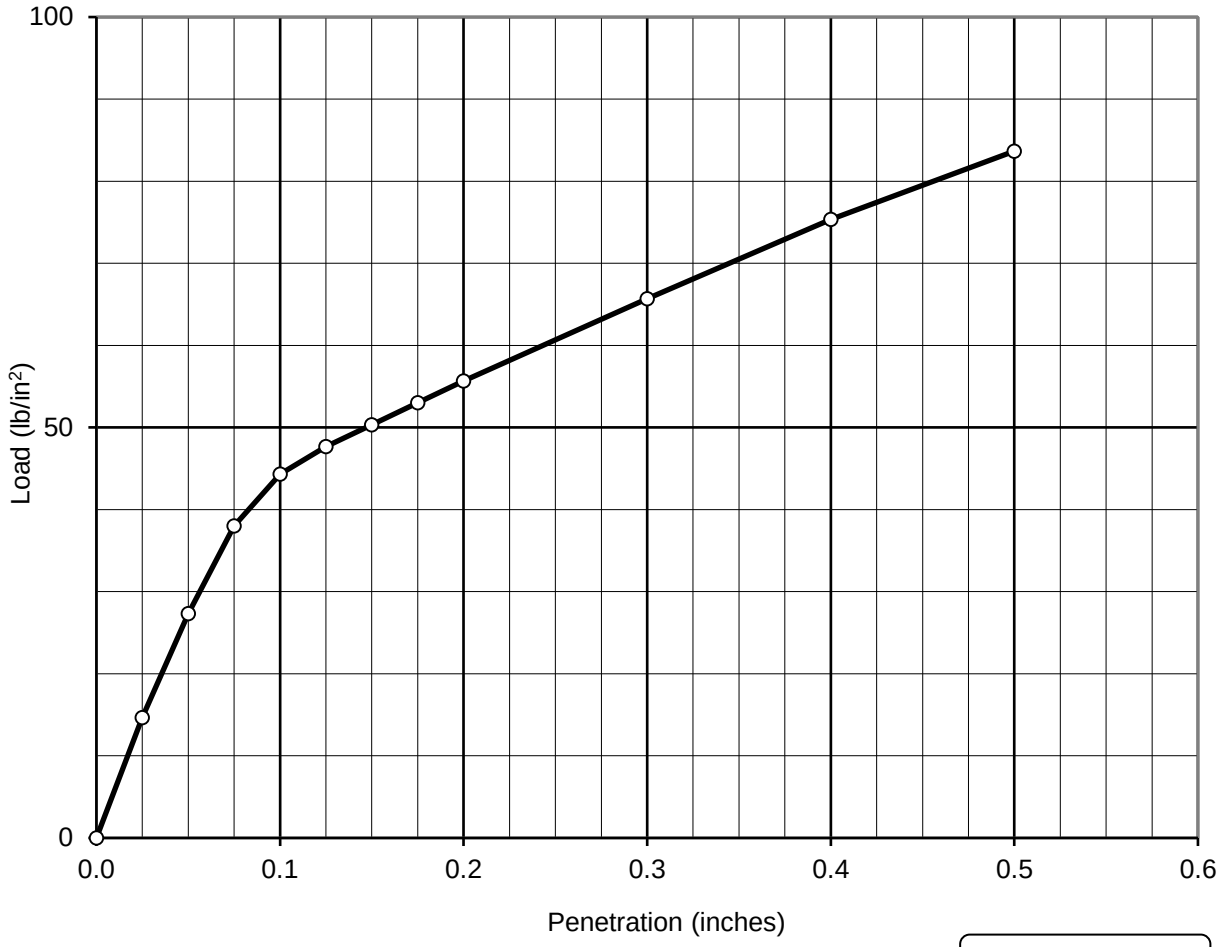
CALIFORNIA BEARING RATIO TEST



Lab No. 5

Test conducted in general accordance with ASTM D1883.

Sample Identification		**Moisture Content**	
Boring:	B-10 & B-13	Before Soaking:	21.8 %
Sample:	A-1	Top 1 inch After Soaking:	27.7 %
Depth (ft.):	Varies	Average After Soaking:	27.7 %
Description		**Dry Unit Weight**	
Fill/Native Fat Clay - gray to olive brown, very moist		Before Soaking:	96.0 lb/ft^3
		After Soaking:	91.8 lb/ft^3
Sample Preparation		**Percent Swell**	3.0 %
Compaction Method:	Manual Rammer	**California Bearing Ratio**	
Surcharge:	10 lbs.	Penetration = 0.1 inches:	4.4
Soaking Duration:	96 hrs.	Penetration = 0.2 inches:	3.7

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