CFS ENGINEERS

GEOTECHNICAL EXPLORATION AND FOUNDATION RECOMMENDATIONS

LEE'S SUMMIT MIDDLE SCHOOL #4 - REVISED
Lee's Summit, Missouri

CFS Project No. 20-1074

Prepared for:

Lee's Summit R-7 School District
301 NE Tudor Road
Lee's Summit, Missouri 64086
June 8, 2020

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SYNOPSIS

A subsurface exploration and an evaluation were performed at the planned Lee's Summit Middle School #4 project site to provide geotechnical engineering related recommendations for design and construction of the proposed project.

Exploratory soil borings have been drilled and a laboratory testing program was conducted on selected soil samples. The data has been analyzed based upon the project information provided DLR Group and the project team.

The results of this exploration and analysis indicate conventional spread and continuous wall footings appear to be a suitable foundation system for support of the proposed structure. However, to mitigate the risk of total and differential settlement exceeding the tolerable limits, surcharging of the building subgrade will be necessary after completion of grading operations and prior to additional loading. Alternatively, if time restrictions prohibit surcharging of the building footprint, rammed aggregate piers (RAPs) or concrete drilled piers can be utilized to support the planned structure.

Detailed analysis of subsurface conditions, any alternate foundation types, and pertinent design recommendations are included, herein.

Groundwater conditions are not expected to cause any major difficulties. These conditions will be further discussed in the report. Please note, groundwater levels should be expected to fluctuate based on seasonal changes and precipitation events.

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Project Number: 20-1074
May 19, 2020

1 INTRODUCTION

1.1 PURPOSE

The purpose of this geotechnical exploration was to evaluate the underlying materials at the proposed Lee's Summit Middle School #4 project site, and based upon this information, provide geotechnical engineering related recommendations for design and construction of the planned project. This exploration was performed in accordance with the requirements outlined by the project team and the Lee's Summit R-7 School district's request for proposal (RFP) number R19/20-04 titled "Geotechnical 7 Construction Testing Services" and dated March 17, 2020.

This report includes geotechnical recommendations and considerations pertaining to site development, foundation support, concrete slab on grade, pavement construction, and synthetic turf field and athletic tack subgrade support. Also, included in this report are earthwork, construction and drainage considerations associated with the proposed project.

1.2 SCOPE OF SERVICES

This exploration and analysis include an engineering reconnaissance of the planned site, a subsurface exploration as outlined below, a field and laboratory testing program, and an engineering analysis and evaluation of the subsurface materials.

The scope of services did not include any environmental assessment for wetlands or hazardous materials in the soil, surface water, groundwater, air, or surrounding area. Any statement in this report or on the boring logs regarding odors, colors, or unusual or suspicious items is strictly for the information of the client.

1.3 GENERAL

The general subsurface conditions used in this analysis are based upon an interpolation of the subsurface data between the borings; varying conditions may be encountered between boring locations. If deviations from the noted subsurface conditions are encountered during construction, they should be brought to the attention of the Geotechnical Engineer.

The recommendations submitted for the proposed structure are based on the available soil information and the preliminary design details. Any revision in the plans for the proposed structure from those described in this report should be brought to the attention of the Geotechnical Engineer to determine if changes in the foundation recommendations are required.

The Geotechnical Engineer warrants that the findings, recommendations, specifications, and professional advice contained, herein, have been presented after being prepared in accordance with generally accepted professional engineering practice in the fields of foundation engineering, soil mechanics and engineering geology. No other warranties are implied or expressed.

After the plans and specifications are complete, it is recommended that the Geotechnical Engineer be provided the opportunity to review the final design and specifications, in order to verify that the earthwork and foundation recommendations are properly interpreted and implemented.

2 PROJECT DESCRIPTION

CFS Engineers understands the planned project consists of constructing a new, approximately 125,000 square feet, two-story, slab on grade middle school in Lee's Summit, Missouri with a finish floor elevation of 1011 feet above sea level. The middle school will be a combination of structural steel framing and structural concrete masonry unit (CMU) walls with anticipated typical wall and column loads on the order of five (5) kips per linear foot (klf) and 250 kips, respectively. A heavily loaded auxiliary gym (shelter area) is included in the school design with increased wall loads on the order of 12 to 15 klf.

In addition to the school building, the project comprises 4 new baseball fields with an associated concession stand building, a new football field with an athletic track, two (2) mechanically stabilized earth (MSE) retaining walls, one (1) concrete cast-in-place retaining wall, and associated parking and drive lanes. CFS understands the football field and/or baseball fields will consist of synthetic turf surfaces.

CFS understands the southeast portion of the planned structure will require fill depths on the order of approximately eleven (11) feet while the northwest corner of the planned structure will require approximately five (5) feet of cut to achieve the desired construction elevation.

If any changes to the project occur, please notify CFS to allow for review of these changes and, if necessary, amend this report.

2.1 SITE DESCRIPTION

Currently, the planned site is an agricultural field that slopes downward from the northwest to the southeast. The project site is located south of the intersection of SE Bailey Road and Country Lane in Lee's Summit, Missouri. The planned site is approximately 1,000 feet wide by 2,000 feet long. It is bounded by SE Bailey Road to the north and a tree row to the east and south. The western border is a row of residential homes.

2.2 SITE GEOLOGY

Jackson County is located in the Central Lowland province of the Interior Plains and is near the middle of an approximate 150 mile-wide, north-south trending band of Pennsylvanian-Age Rocks that is located in western Missouri and eastern Kansas. Generally, the rock beds exhibit a subtle prevailing dip to the west-northwest of about 10 feet per mile. The region is underlain by rock units of the Pennsylvanian

System, Missourian Series (Kansas City Group, Lansing Group, and Pleasanton Group) in the Time Stratigraphic Unit age classification.

3 SUBSURFACE EXPLORATION

Based on the project information as outlined above, CFS Engineers conducted a field exploration to determine the underlying materials at the proposed project site and to establish their engineering characteristics.

3.1 SCOPE OF WORK

This geotechnical exploration consisted of drilling thirty (30) borings throughout the planned project site. Structural borings had a planned termination depth of twenty (20) feet beneath existing grade while pavement and synthetic turf field borings had a planned termination depth of five (5) feet beneath existing grade. The borings were advanced to their planned depths or auger refusal, whichever occurred first. Fifteen (15) structural borings were drilled in the planned school's footprint, one (1) structural boring was drilled at the planned concession stand, six (6) structural borings were drilled along the retaining walls' alignment, and eight (8) pavement/turf borings were drilled in the parking and field areas. The boring locations can be seen on the Boring Location Plan included in Appendix A.

The boring locations were surveyed in the field by Cook, Flatt & Strobel Engineers. The elevation and location of the borings can be seen on the boring logs in Appendix B.

Boring logs representing the materials encountered in the borings are included in Appendix B. The boring logs represent the CFS Engineers' interpretation of the field logs combined with laboratory observations and testing of the samples. The stratification boundaries indicated on the boring logs were based on field observations, an extrapolation of information obtained by examining samples from the borings, and comparisons of soils and/or bedrock types with similar engineering characteristic. As such, the boundaries between subsurface strata should be expected to vary from the logs to some extent.

The depth to groundwater, if encountered, was recorded in each test boring during drilling and can be seen in Section 3.5, Groundwater Conditions. After completion of drilling, sampling, and field testing, the excavations were backfilled with auger cuttings.

3.2 DRILLING AND SAMPLING PROCEDURES

The auger borings were drilled using a truck mounted SIMCO 2400 drill rig equipped with a rotary head. 3.25-inch solid-stem augers were used to drill the holes. During drilling, field logs were created and maintained by CFS personnel to catalog the materials encountered.

Representative samples were obtained during drilling using split-barrel sampling procedures in general accordance with the procedures for "Standard Test Methods for Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils" (ASTM D 1586).

Upon completion of drilling, the samples were then sealed and returned to CFS's laboratory for further examination, classification, and testing. The samples recovered were identified, classified, and evaluated by a Geotechnical Engineer.

3.3 Field Tests and Measurements

During the soil boring procedure, Standard Penetration Tests (SPT) were performed at pre-determined intervals to obtain the standard penetration value of the soil as outlined in the ASTM D1586 test method. The standard penetration value (N) is defined as the number of blows of a 140-pound hammer falling 30 inches, required to advance the split-barrel sampler one foot into the soil. The sampler is lowered to the bottom of the previously cleaned drill hole and advanced by blows from the hammer.

The number of blows is recorded for each of three successive increments of six inches penetration. The "N" value is then obtained by adding the second and third incremental numbers. The results of the standard penetration test are shown on the Boring Logs and indicate the relative density of cohesionless soils and comparative consistency of cohesive soils, and thereby provide a basis for estimating the relative strength and compressibility of the soil profile components.

The Standard Penetration Test (SPT) was also used to evaluate the consistency of the in-situ materials. The N-values for the site's materials were found to range from 3 to 40 blows/foot.

3.4 Subsurface Conditions

The materials encountered in the test borings have been visually classified according to the Unified Soil Classification System (USCS). They are described on the Boring Logs in Appendix B. The results of the field tests, water level observations, and laboratory tests are presented on the Boring Logs (Appendix B).

The following presents a general summary of the major strata encountered during this subsurface exploration and includes a discussion of field and laboratory tests conducted. Specific subsurface conditions encountered—including field tests, lab tests, and water level observations—at the boring locations are also presented on the individual boring logs found in Appendix B of this report.

3.4.1 Overburden Material

Approximately twelve (12) inches of topsoil was encountered at the surface of the borings. The topsoil was generally underlain by gray-brown and gray fat clay (CH) with consistencies ranging from medium stiff to stiff. The fat clay material continued to the refusal material, occasionally taking on a shaley characteristic.

3.4.2 Refusal Materials

Auger refusal on highly weathered shale and limestone was encountered throughout the borings below the soil overburden. Some sandstone was encountered prior to refusal in some of the borings. Auger refusal was encountered at depths ranging from 7.0 to 18.75 feet beneath existing grade.

3.5 Groundwater Conditions

Free water was encountered during drilling in borings B1, B13 and B27 at depths of 19.5, 8.5, and 13.5, respectively. The remaining borings stayed dry and no free water was encountered at the time of drilling.

Please note, the reported groundwater levels reflect the conditions observed at the time the borings were drilled. Groundwater levels should be expected to fluctuate with changes in grading, precipitation changes and seasonal changes. The water levels included in this report do not indicate a permanent groundwater condition. Additionally, the materials encountered during this exploration are, generally, low permeable soils.

4 LABORATORY TESTING

Upon completion of drilling, the samples were returned to CFS's laboratory located in Kansas City, Kansas for laboratory testing. A supplemental laboratory testing program was conducted to evaluate additional engineering characteristics of the in-situ soils necessary in analyzing the behavior of the support systems for the proposed building.

The laboratory testing program included the following tests:

- Supplementary visual classification (ASTM D2488) of all samples,
- Water content (ASTM D2216) of all samples, and
- Atterberg limit tests (ASTM D4318) on a selected sample.

The results of the laboratory testing program can be seen in on the boring logs in Appendix B. The Atterberg limits can be seen in the following table.

Table 1: Atterberg Limits Results

Boring ID	Sample #	Moisture Content (%)	Atterberg Limits			USCS Classification
			Liquid Limit	Plastic limit	Plasticity Index	
B1	SS2	25.0	40	22	18	LEAN CLAY (CL)
B9	SS1	23.0	38	13	25	LEAN CLAY (CL)
B16	SS1	30.0	53	25	28	FAT CLAY (CH)
B25	SS2		46	19	27	LEAN TO FAT CLAY (CL/CH)
B29	SS1		55	23	32	FAT CLAY (CH)
B30	SS1		55	21	34	FAT CLAY (CH)

Based on the Atterberg limits, the gray-brown overburden material classifies as Lean Clay (CL), Lean to Fat Clay 9CL/CH), and Fat Clay (CH) and is considered highly expansive. To limit the risk of differential slab movements, all concrete slabs on grade should be constructed in accordance with Section 7.2, "Slab On Grade" of this report.

5 GEOTECHNICAL CONCERNS

The following geotechnical concerns are based upon the subsurface materials encountered during this exploration and CFS's understanding of the project as described in Section 2, Project Description of this report. If any changes to the planned structure's location, loading or elevations occur, CFS must be allowed to review these changes, and if necessary, issue amendments to this report and its recommendations.

1. *Significant Fill Amounts*: CFS understands fill amounts of five (5) to eleven (11) feet are scheduled across the southern half of the planned new structure, while approximately four (4) feet of cut is planned in the northwest corner of the building footprint. To mitigate the risk of settlement from

the induced load attributed to the planned fill depths and to allow for utilization of shallow foundations, CFS recommends the entire building pad be surcharged upon completion of grading. The recommended surcharge load should consist of a minimum of a five (5) feet-thick layer of compacted clay soil (wet density of 120 lbs/ft^3) and should remain in place for a minimum of two (2) months to allow for consolidation of the overburden materials prior to constructing the school. Settlement monitoring plates should be installed to track the consolidation process. See Section 7.1.1 for settlement monitoring recommendations. Alternatively, if time restrictions prohibit surcharging of the building footprint, rammed aggregate piers (RAPs) or concrete drilled piers can be utilized to support the planned structure.

2. *Expansive Clay Soils*: Expansive clay soils were encountered during this exploration. The on-site materials are NOT suitable for direct support of concrete slabs. All slabs on grade should be supported by a minimum 24-in-thick mat of low volume change material (LVC) constructed in accordance with Section 7.2, Slab on Grade Recommendations of this report.

6 EARTHWORK & SITE DEVELOPMENT

6.1 SITE PREPARATION

Prior to filling, the grass and topsoil should be stripped from all structural areas and be stockpiled for later use in landscape areas or it should be wasted. Any trees and shrubs should be properly removed including the entirety of the root ball and root systems. The upper 12-inches of the subgrade should be moisture conditioned and recompacted, as necessary, to provide a stable subgrade upon which to begin placement of engineered fill.

Upon completion of stripping and prior to filling, the newly exposed subgrade should be evaluated by a qualified professional for stability by means of proofrolling. The proofroll should be conducted using a fully loaded, tandem axle dump truck weighing in excess of 20 tons. Any soft or unsuitable areas identified during the proofroll should be corrected by means of additional moisture conditioning and recompacting, or removal and replacement with an acceptable material.

Additionally, although not encountered during this exploration, any undocumented fill encountered during construction should be completely removed from beneath the structure footprint. Undocumented fill is any foreign material that was placed or dumped in an uncontrolled manner (i.e. no records of testing exist from the time of placement). Undocumented fill is inconsistent and unpredictable in nature, and it should not be used in support of any structures or foundation systems.

6.2 GRADING

6.2.1 Suitable Fill Material

All general and structural fill should be free of debris and defined by ASTM 2487 as CH, CL, ML, GW, GP, SM, SW, SC, and SP. The onsite soils tend to meet this requirement; however, please note that CH (fat clay) classification materials should NOT be used as structural fill within two (2) feet of the finished grade supporting the building slab and within ten (10) feet laterally outside of the building footprint. Fat clays (CH) with Liquid Limits of greater than 55 should not be used in the upper one (1) foot beneath the pavement or athletic track without being treated with cement as outlined later in this report.

6.2.2 Unsuitable Fill Material

The on-site topsoil contains organic material and is unsuitable for use as structural fill. Unsuitable materials are those defined by ASTM 2487 as MH, OL, OH, and PT.

6.2.3 Engineered Fill Placement

CFS understands fill amounts on the order of five (5) to eleven (11) feet are scheduled across the southern portion of the planned new structure. *To mitigate the risk of differential settlement attributed to long term consolidation of the engineered fill, any structural fill beneath the planned structure, which exceeds four (4) feet in depth, must be compacted to 98% of the materials dry unit weight as determined by standard Proctor ASTM 698. For the upper four (4) feet of building subgrade, engineered fill should be compacted to a minimum of 95% of the materials dry unit weight as determined by standard Proctor ASTM 698.*

Structural fill materials should be free of organic matter. Moisture contents should be within 0% and +4% of the optimum for soils with a liquid limit of greater than 40, and +/-3% of the optimum for soils with a liquid limit of less than 40. Maximum dry density and optimum moisture content should be determined by the Standard Proctor test (ASTM D 698).

Fill should be placed in six (6) inch lifts (compacted thickness) in mass fill areas, and as needed to obtain the proper compaction in utility trenches and behind walls.

Structural fill should extend a minimum of five (5) feet laterally in all directions beyond the planned structure footprint and a minimum of two (2) feet beyond any pavement lines.

A representative of the Geotechnical Engineer should monitor filling operations on a full-time basis. A sufficient number of density tests should be taken to verify that the specified compaction is obtained. See Table 3 below for required testing frequency.

Table 2: Density Testing Frequency

Location or Area	Standard Proctor Density (ASTM D 698)	Testing Frequency One per lift per …
Building Walkways	95%	20,000 sf
Retaining Walls	95%	1,000 sf
Trenches	95%	150 lf
Lawn or Unimproved Areas	92%	20,000 sf
General Building and Pavement Subgrades (*)	95%	10,000 sf
Out-Parcels	95%	20,000 sf
*If RAPs are utilized in accordance with Section 7, compaction requirements increase to 98% for fill areas exceeding 4-feet in depth.		

6.3 EXCAVATIONS & TRENCHES

All temporary slopes and excavations should conform to Occupational Safety and Health Administration (OSHA) Standards for the Construction Industry (29 CFR Part 1926, Subpart P). Excavations at this site are *expected* to be made in "Type B" clayey soil. Soil types should be verified in the field by a competent individual.

All excavations should be kept dry during subgrade preparation. Storm water runoff should be controlled and removed to prevent severe erosion of the subgrade and eliminate free standing water. Subgrade that has been rendered unsuitable from erosion or excessive wetting should be removed and replaced with controlled fill.

Trenches should be excavated so that pipes and culverts can be laid straight at uniform grade between the terminal elevations. Trench width should provide adequate working space and sidewall clearances. Trench subgrade should be removed and replaced with controlled fill if found to be wet, soft, loose, or frozen. Trench sub-grades should be compacted above 95% of the maximum dry density in accordance with ASTM D 698 at moisture contents between -3% to +3% of the optimum moisture content.

Granular bedding materials for pipes, such as well-graded sand or gravel, may be used provided that the bottom of the trench is graded so that water flows away from building

Bedding material should be graded to provide a continuous support beneath all points of the pipe and joints. Embedment material should be deposited and compacted uniformly and simultaneous on each side of the pipe to prevent lateral displacement. Compacted control fill material will be required for the full depth of the trench above the embedment material except in area landscape area with the compaction may be reduced to 90% Standard Proctor ASTM D 698. No backfill should be deposited or compacted in standing water.

Precautions should be taken by the contractor to avoid undermining the newly constructed foundations/ rammed aggregate piers. Shoring and excavations supports may need to be designed to account for the existing building loads.

Permanent slopes greater than 3 horizontals to 1 vertical should not be used unless additional testing and slope analysis is performed.

6.4 DRAINAGE AND DEWATERING

Normal seasonal weather conditions should be anticipated and planned for during earthwork. It is recommended that the Contractor determine the actual groundwater levels at the site at the time of the construction activities to assess the impact groundwater may have on construction. Water should not be allowed to collect in the foundation excavation, on floor slab areas, or on prepared subgrades of the construction area either during or after construction. Undercut or excavated areas should be sloped toward one corner to facilitate removal of collected rainwater, groundwater, or surface runoff. Positive site drainage should be provided to reduce infiltration of surface water around the perimeter of the building and beneath the floor slabs. The grades should be sloped away from the building and surface drainage should be collected and discharged such that water is not permitted to infiltrate the backfill and floor slab areas of the building.

The site should be graded such that positive drainage (normally 2% minimum) is provided away from any structures. Where sidewalks or paving do not immediately adjoin the building, protective slopes of at least 5% for a minimum of 10 feet from the perimeter walls are recommended. Roof drains and downpours should also be directed away from the building. Open-graded stone is not recommended for use under sidewalks unless the stone is adequately drained to prevent collection of water under the walks.

The site should also be graded to avoid water flows, concentrations, or pools behind retaining walls, curbs or similar structures. When swales are designed at the top of the walls, proper line and slope should be considered to avoid any flow down behind walls. Special attention is needed for sources of storm water from slopes, building roofs, gutter downspouts and paved areas draining to one point.

In paved areas where seasonal water potentially accumulates behind curbs, gutters and planters ensure concrete extends 6-inches into impervious material to reduce seepage under the curbs, saturating and weakening the pavement subgrade.

Perforated plastic pipes should be placed on the backfilled side of the walls near the bottom and day-lighted. Six inches of open graded crushed rock wrapped with geo-textile fabric should be placed behind the walls up to a depth of two feet below the finished grade. As an alternative to the open graded crushed rock, a manufactured geo-composite sheet drain such as Mirafi G100N, Contech C-Drain, or equivalent, may be used in conjunction with the perforated pipe.

6.5 LANDSCAPING

Landscaping and irrigation should be limited adjacent to buildings and pavements to reduce the potential for large moisture changes. Trees and large bushes can develop intricate root systems that can draw moisture from the subgrade, resulting in shrinkage of the bearing material during dry periods of the year. Desiccation of bearing material below foundations may result in foundation settlement.

Landscaped areas near pavements and sidewalks should include a drainage system that prevents over saturation of the subgrade beneath asphalt and concrete surfaces. Drainage systems in irrigation areas should be incorporated into the storm drain system.

7 GEOTECHNICAL ENGINEERING RECOMMENDATIONS

7.1 FOUNDATIONS RECOMMENDATIONS

Based on CFS’s understand of the planned project and the large amount of fill planned beneath the proposed school, three (3) independent foundation alternatives have been provided for a cost analysis. Please note, to accommodate a shallow foundation system either surcharging of the building pad or a ground improvement system such as rammed aggregate piers prior to loading is required. If neither option is desirable, concrete drilled piers can be used to support the planned structure.

Please note, the concession stand can be supported on shallow foundations designed and constructed as outlined below without the need for surcharging of the building pad.

7.1.1 Shallow Foundations (Spread and Continuous Wall Footings)

Conventional spread and continuous wall footings are, generally, most economical when the existing soil conditions allow them to be founded at shallow depths on existing materials. Based on the materials encountered during this exploration, it is CFS Engineers' opinion that the planned structure can be supported by a shallow foundation system, such as spread and/or trench footings bearing in native clay soils and engineered fill given the building pad has been surcharged prior to loading in accordance with this report.

CFS understands five (5) to eleven (11) feet of fill is scheduled across the southern half of the planned new structure. To mitigate the risk of differential settlement from the induced load attributed to the planned fill depths, and to allow for utilization of shallow foundations, CFS recommends the entire building pad be surcharged upon completion of grading. The recommended surcharge load should consist of a minimum five (5) feet-thick layer of compacted clay soil (wet density of 120 lbs/ft^3) and should remain in place for a minimum of two (2) months to allow for consolidation of the overburden materials prior to constructing the building. Topsoil is considered a suitable material for surcharging. A settlement monitoring program as outlined below should be conducted in conjunction with surcharging.

Prior to placement of fill on the building pad, five (5) settlement plates should be installed uniformly across the pad at existing grade as directed by the Geotechnical Engineer. Rigid steel settlement plates should be a minimum of two (2) feet by two (2) feet. A rod(s) should be located in the center of the plate that extends above the proposed fill. The rod should be encapsulated by a 2 inch diameter PVC pipe to permit free movement of the plate and rod. The rods should be painted for visibility and protected from construction traffic. Settlement/movement of the plates should be performed initially prior to fill placement and twice per week by the project registered surveyor. Settlement plate elevations should be surveyed and evaluated until movement is within tolerable limits as determined by the Geotechnical Engineer.

Additionally, it is recommended that spread and trench footings have a minimum width of 24 and 16-inches, respectively. Footings should be suitably reinforced to reduce the effects of differential movement that may occur due to variations in the properties of the supporting soils. Top and bottom reinforcing steel is recommended for continuous wall footings to reduce differential settlement due to possible varying bearing capacities of the existing fill soils.

Every effort should be made to keep the footing excavations dry as the soils will tend to soften when exposed to free water. Footing bottoms should be free of loose soil and concrete should be placed as soon as possible to prevent drying of the foundation soils.

7.1.1.1 Bearing Capacity Analysis

The bearing capacity of the subsurface materials was evaluated from the results of the field and laboratory tests. Based on this information, shallow foundation systems bearing on the surcharged subgrade, and constructed as recommended above, can be proportioned for a maximum allowable soil bearing capacity of 2,500 psf.

A representative of the Geotechnical Engineer should test the soils in the footing excavations to verify the design soils bearing pressure. If undercutting of any footing is required to reach design bearing capacity backfill of the undercut footing should be done with a closed grade stone (such as KDOT AB-3) or lean concrete. If compacted structural fill is used to back fill the excavation, widening of the excavation one-half (1/2) the depth of the excavation on either side should be performed. The structural fill should be compacted to at least 95% of the material's maximum dry density within -2 to 3% of the optimum moisture content as determined by ASTM D-698.

Based on the seasonal freeze-thaw cycles associated with the project site, shallow foundation systems should bear a minimum of 36-inches beneath the ground surface for adequate frost protection.

7.1.1.2 Settlement Analysis

To help mitigate the risk of differential foundation movements such as settlement, the foundation system should bear on the engineered fill and native clay soils that have been surcharged appropriately. For spread and/or trench footings designed in accordance with these recommendations, total settlements of less than 1-inch and differential settlements of less than 3/4-inches can be anticipated.

7.1.2 Foundation Alternative 1: Rammed Aggregate Piers

In lieu of surcharging, the existing conditions and planned project are such that a ground improvement system such as rammed aggregate piers (RAPs) are a suitable and recommended method to support conventional spread footings and the floor slab of the proposed building. Please note, CFS recommends RAPs be utilized to strengthen the in-situ soils located beneath the southern portion of the planned structure (including slab on grade area) where the scheduled amount of fill will exceed four (4) feet in depth.

Please note, to mitigate the risk of differential settlement attributed to long term consolidation of the engineered fill, any structural fill beneath the planned structure, which exceeds four (4) feet in depth, must be compacted to 98% of the materials dry unit weight as determined by ASTM 698. For the upper four (4) feet of building subgrade, engineered fill should be compacted to a minimum of 95% of the materials dry unit weight as determined by ASTM 698.

RAPs are used to improve the load carrying capacity of soils by ramming aggregate into the unstable subgrade. Generally, a hole is first drilled into the subgrade and successive layers of aggregate are placed and driven into the unstable soils forming an "aggregate bulb" at the base, and thus providing lateral and vertical strengthening of the existing materials. RAPs are a patented design-build intermediate foundation system. The respective companies should be contacted to design the foundation system.

Although final design and analysis must be conducted by RAPs contactor/engineer, typical bearing capacities achieved by this rammed aggregate piers are on the order of 3,000 to 5,000 pounds per square foot (psf) with settlements on the order of 1-inch for total settlement and ½-inch for differential settlement.

In conjunction with the recommended ground improvement system, it is recommended that spread and trench footings be designed and constructed as outlined in Section 7.1.1.

7.1.3 Foundation Alternative 2: Concrete Drilled Piers

In leu of rammed aggregate piers and surcharging the building pad, a deep foundation system such as drilled concrete piers can be utilized to support the foundation system and slab on grade. A structural slab beneath may be required to achieve this. Drilled piers are used most advantageously where a soft or unsuitable soil strata overlies a hard foundation material. Soil conditions and the magnitude of the proposed loads indicate that drilled piers would be a suitable foundation system.

Limestone and shale bedrock were encountered throughout this exploration at relatively shallow depths (Reference the boring logs in Appendix B). Drilled piers should bear on competent limestone using a maximum allowable end bearing pressure of 20 kips per square foot (ksf). Drilled piers should extend through all upper broken limestone and shale layers and be socketed a minimum of two (2) feet or one (1) pier diameter, whichever is more, into competent limestone. Piers should be suitably reinforced to resist lateral movement. A representative of the geotechnical engineer should be in the field to evaluate embedment and a suitable bearing stratum has been reached. Down hole inspection is not anticipated to be required by the inspector.

Please note, shallow groundwater and wet, soft soils were and are often encountered above the restrictive bearing layer (rock). The contractor should have equipment onsite to dewater the pier excavation and/or prevent sloughing of wet, soft soils into the excavation in case it becomes necessary. Temporary steel casing may be required in some holes to prevent sloughing of the upper soils and to permit down-hole cleaning and inspection (if required). Conventional drilling equipment with bullet nose rock teeth is expected to be able to penetrate the upper soils and reach the bearing surface. Coring is not expected to be required to reach the limestone.

A minimum shaft diameter of 30 inches is recommended to facilitate clean out and inspection. Drilling of test holes is not required, however the contractor should provide a price for tests holes should rock conditions dictate further investigation to confirm design parameters. The bottom of the hole should be free of water and loose soils prior to placement of reinforcing steel and concrete.

To help mitigate the risk of differential foundation movements such as settlement, a uniform bearing condition should exist beneath the entirety of the foundation system for a given structure. For a drilled pier foundation system, total settlements of less than ½ -inch and differential settlements of less than ½-inch can be anticipated.

7.1.4 Seismic Analysis

The typical profile at this site consists of soil to a depth of six (6) to 18 feet where bedrock /was encountered. The seismic properties of the soil were interpolated from the standard penetration test values. A Seismic Site Class "C" was determined for this site. In addition, there is no significant risk of liquefaction or mass movement of the on-site soils due to a seismic event.

7.2 SLAB ON GRADE RECOMMENDATIONS

CFS recommends all concrete slabs on grade be supported by a minimum of 24-inches of Low Volume Change (LVC) material. LVC material should consist of lean clay (CL), KDOT AB3, crushed limestone screenings or equivalent. A low volume change material is defined as a material with a liquid limit less than 45 and a plasticity index less than 25. The subgrade can be constructed as outlined below.

1. Cut the subgrade to a minimum depth of 24-inches beneath the planned bottom of slab elevation.
2. Twenty (20) inches of a compacted LCV material should be placed atop the exposed slab subgrade. The LVC should be placed in lifts no greater than 8-inches-thick (compacted thickness) and compacted to 95% of the maximum dry density as determined by ASTM 698. Limestone based LVC material should be compacted at a moisture content sufficient to achieve the desired compaction, and lean clay (CL) material should be compacted at a moisture content between 0 and +4% of optimum.
3. A 4-inch-thick layer of open graded stone (ASTM C33 or equivalent material) should be placed atop the 20-inches of compacted LVC material to return the subgrade to the original bottom of slab elevation. The open-graded stone will ease construction and provide a capillary break between the LVC and concrete slab.

Every floor slab should be evaluated to determine if a vapor retarder under the concrete floor is required. The slab designer should refer to ACI 302 and/or ACI 360 for procedures regarding the use and placement of a vapor retarder.

To reduce the effects of differential movement, slabs-on-grade should not be rigidly connected to columns, walls, or foundations unless it is designed to withstand the additional resultant forces. Floor slabs should not extend beneath exterior doors or over foundation grade beams, unless saw cut at the beam after construction. Expansion joints may be used to allow unrestrained vertical movement of the slabs. The floor slabs should be designed to have an adequate number of joints to reduce cracking resulting from differential movement and shrinkage. CFS suggests joints be provided on a minimum spacing of twelve (12) feet on center. For additional recommendations refer to the ACI Design Manual. The requirements for the slab reinforcement should be established by the designer based on experience and the intended slab use.

7.3 LATERAL EARTH PRESSURES

Lateral earth pressures are determined by multiplying the vertical applied pressure by the appropriate lateral earth pressure coefficient. If the foundation walls are rigidly attached to the building and not free to rotate or deflect at the top, CFS recommends designing the walls for the *at-rest* earth pressure coefficient. Walls that are permitted to rotate and deflect at the top can be designed for the *active* lateral earth pressure condition. Horizontal loads acting on shallow foundations are resisted by friction along the foundation base and by *passive* pressure against the footing face that is perpendicular to the line of applied force.

Table 3: Earth Pressure and Friction Coefficients

	Active (K_a)	Passive (K_p)	At-Rest (K_o)	Allowable Base Friction	Unit Weight (pcf)
Open-graded crushed limestone	0.27	3.69	0.43	0.47	130-140
In-situ lean clay soils	0.40	2.5	0.68	0.32	95-115
In-situ fat clay soils	0.49	2.04	0.66	0.24	90-110
Lean clay – conditioned and compacted	0.32	3.12	0.48	0.35	95-115
Fat clay – conditioned and compacted	0.45	2.2	0.63	0.27	90-110

These earth pressure coefficients do not include the effect of surcharge loads, hydrostatic loading, or a sloping backfill. Nor do they incorporate a factor of safety. Also, these earth pressure coefficients do not account for high lateral pressures that may result from volume changes when expansive clay soils are used as backfill behind walls with unbalanced fill depths. In addition, any disturbed soils that are relied upon to provide some level of passive resistance should be placed in lifts not exceeding six (6) inches in thickness and compacted to a minimum density of 95% of the Standard Proctor (ASTM D698) maximum dry density at a moisture content within +- 3% of the optimum moisture content. It is recommended that a representative of CFS should verify the compaction of any such materials relied upon to provide passive pressure.

The actual earth pressure on the walls will vary according to material types and backfill materials used and how the backfill is compacted. If the backfill conditions are different than the ones used above, CFS should be notified so the recommendations can be modified. The buildup of water behind a wall will increase the lateral pressure imposed on below-grade walls. Adequate drainage should be provided behind any below grade walls as described in this report. The walls should also be designed for appropriate surcharge pressures such as adjacent traffic, interior building floor slab loads, and construction equipment.

7.4 SYNTHETIC TURF FIELDS & ATHLETIC TRACK RECOMMENDATIONS

CFS understands the project requirements include restricting the synthetic turf fields to less than ½-inch of vertical movement, if possible, and little to no movement tolerance for the athletic track. The in-situ materials encountered beneath the planned synthetic turf fields and the athletic track, generally, consist of Fat Clay (CH) materials. Fat clay is considered highly expansive, and as such, is susceptible to significant volume changes with changes in moisture. To limit movements to tolerable amounts, it is recommended that the synthetic turf fields and the athletic track be supported by a minimum 9-inch-thick Portland cement stabilized subgrade. Where possible, the cement stabilized subgrade layers should extend at least five (5) feet beyond all boundary lines. The surfaces should be sloped accordingly to allow for proper shedding of all water during a precipitation event. Proper drainage and dewatering measures should be implemented to prevent water infiltration of the subgrade. Additionally, the track and turf manufacturers should be consulted prior to construction and CFS should be allowed to review final design to evaluate potential geotechnical related concerns. Reference Table 4 for the recommended thicknesses of the athletic track.

Table 4: Athletic Track Section

Recommended Thicknesses (inches)	
APWA Type 3-01 AC Surface	2
APWA Type 1-01 AC Base	3
Portland Cement Stabilized Subgrade	9

Portland cement should be thoroughly mixed with the existing subgrade materials to the recommended depths given above at a concentration of 5% by dry unit weight of the in-situ materials dry unit weight. Water should be added, as necessary, to hydrate the cement. The mixture should be compacted to a minimum of 98% of the combined materials dry unit weight at a moisture content between 0 and +3% of the optimum moisture content as determined by ASTM D698. The specified compaction should be achieved within two (2) hours of the materials being combined and hydrated.

It is recommended that the subgrade be hydrated daily and protected from drying for the first five (5) days after stabilization occurs. Additionally, CFS recommends microcracking of the subgrade be completed by a vibratory, sheep's foot roller 36 to 48 hours after completion of stabilization. Microcracking will reduce the risk of water conduits forming in the subgrade as a result of shrinkage cracks that may develop during the cement curing period. Except for water trucks and microcracking equipment, the subgrade should be protected from all loading and construction traffic for a minimum of five (5) days. Reference Appendix C for more information on cement stabilization.

7.5 PAVEMENT RECOMMENDATIONS

The pavement sections presented below are considered typical and minimum for the report basis parameters. The client should be aware that thinner pavement sections might result in increased maintenance costs and lower than anticipated pavement life. The pavement area subgrade consists of moisture sensitive soils.

The soils expected beneath the pavement are fine silty sands to clayey silts to silty clays. Should the clayey silts to silty clays be the pavement subgrade, they tend to expand and contract with changes in moisture and weather conditions and are very moisture susceptible, losing strength quickly. The on-site silts and clays can be stabilized with 5% by weight Portland Type 1/2 Cement for a depth of nine (9) inches, constructed as outlined in Section 7.4, to extend the life of the pavement.

Table 5: Recommended Light Duty Pavement Sections (Parking lots)

Recommended Thicknesses (inches)			
Asphalt		Concrete	
APWA Type 3-01 AC Surface	2	Concrete	5
APWA Type 1-01 AC Base	3	Aggregate Base Course	4
Aggregate Base Course	6	Moisture Conditioned & Recompacted Subgrade (Section 7.4.4)	12
Moisture Conditioned & Recompacted Subgrade (Section 7.4.4)	12		

Table 6: Heavy Duty Pavement Thicknesses (Truck areas and drives)

Recommended Thicknesses (inches)			
Asphalt		Concrete	
APWA Type 3-01 AC Surface	2	Concrete	7
APWA Type 1-01 AC Base	6	Aggregate Base Course	4
Aggregate Base Course	6	Moisture Conditioned & Recompacted Subgrade (Section 7.4.4)	12
Moisture Conditioned & Recompacted Subgrade (Section 7.4.4)	12		

Note: When base is to be placed in the fall and surface in the spring, APWA Type 2-01 is recommended to improve performance of base due to lower permeability. Eight (8) inches of concrete and four (4) inches of base rock is recommended for trash and/or recycling dumpster areas.

7.5.1 Asphalt Pavement Construction

The granular base course should be built at least 2 feet wider than the pavement on each side to support the tracks of the slip form paver. This extra width is structurally beneficial for wheel loads applied at pavement edge.

Asphalt cement (bitumen) used in the manufacture of asphalt pavement should conform to the Performance Grading system. In the project area, the provincial grade asphalt binder course is PG 64-22. The asphaltic mix for conventional roadway should be designed for 4% air voids. During production, the voids can be expected to vary ±1% of the design value of 4%. Under these conditions, the minimum allowable VMA for base and surface course shall be 12% and 14%, respectively.

Immediately after spreading, each course of the pavement mixture should be compacted by rolling. The initial or "breakdown" rolling shall be accomplished with a steel-wheeled vibratory roller. The motion of the roller should be slow enough at all times to avoid displacement of the hot mixture. The surface of the mixture after compaction should be smooth and true to established section and grade. The completed asphalt concrete paving should have a density equal to or greater than 95% for the base and 96% for the surface of theoretical density.

All asphaltic concrete mix designs and Marshall Characteristics should be submitted to our office and reviewed in order to determine if they are consistent with the recommendations given in this report.

All materials to be employed and field operations required in connection with the pavement reconstruction should follow requirements and procedural details as per APWA 2001. In addition, representative of CFS should observe and monitor the pavement construction to assure satisfactory compliance with our engineering recommendations.

7.5.2 Concrete Pavement Construction

The pavement on this site will be subjected to freeze-thaw cycles. Sufficient air entrainment in the range of 6% to 8% is required to provide freeze-thaw durability in the concrete. Concrete with a 28-day specified compressive strength of 4,000 psi is recommended. The concrete mix should contain at least 564 pounds of concrete per cubic yard. A mixture with a maximum slump of 4 inch +/- 1 inch is acceptable. If a water-reducing admixture is specified, slump can be higher. For better performance and crack control, synthetic fiber reinforcement such as Fibermesh® 300 is recommended for the concrete instead of welded wire mesh. Add synthetic fiber reinforcement to concrete mixture in accordance with manufacturer's instructions.

7.5.3 Pavement Subgrade Preparation

The upper 12 inches of exposed subgrade, extended a minimum of two (2) feet laterally beyond all pavement lines, should be moisture conditioned and recompacted, as necessary, to pass a proofroll evaluation as described in Section 6.1, "Site preparation" of this report.

Any localized soft, wet, or loose areas identified during the proof rolling should be repaired prior to paving. Fill material should be placed in loose lifts up to a maximum of eight (8) inches in thickness and compacted to at least 95% of the maximum dry density in accordance with ASTM D698 at moisture contents outlined in the Earthwork section. Construction traffic, including foot traffic, should be minimized to prevent unnecessary disturbance of the pavement subgrade. Disturbed areas, as verified by CFS's geotechnical engineer, should be removed and replaced with properly compacted material.

Fat clays (CH) with Liquid Limits of greater than 55 should not be used in the upper one (1) foot beneath the pavement without being treated with a nine (9) inch layer of cement as outlined previously in this report. Consideration should be given to treating all non-LVC clays so as to extend the life of the pavement, improve performance and reduce maintenance costs.

The granular base should be placed in loose lifts up to a maximum of twelve (12) inches in thickness a minimum lateral distance of two (2) feet beyond the pavement, and compacted to at least 98% of the maximum dry density in accordance with ASTM D698.

If open graded stone is used under the pavement, the pavement subgrade should be graded to provide positive drainage of the granular base section. Provision should be made to provide drainage into the storm water system. The use of a granular blanket drain near storm water inlets that provides weep holes from the drain to the inlets is recommended.

8 General Comments

When the plans and specifications are complete, or if significant changes are made in the character or location of the proposed building, a consultation should be arranged to review the changes with respect to the prevailing soil conditions. At that time, it may be necessary to submit supplementary recommendations.

It is recommended that the services of Cook, Flatt & Strobel Engineers be engaged to test and evaluate the compaction of any additional fill materials and to test and evaluate the bearing value of the soils in the footing excavations.

Respectfully submitted,

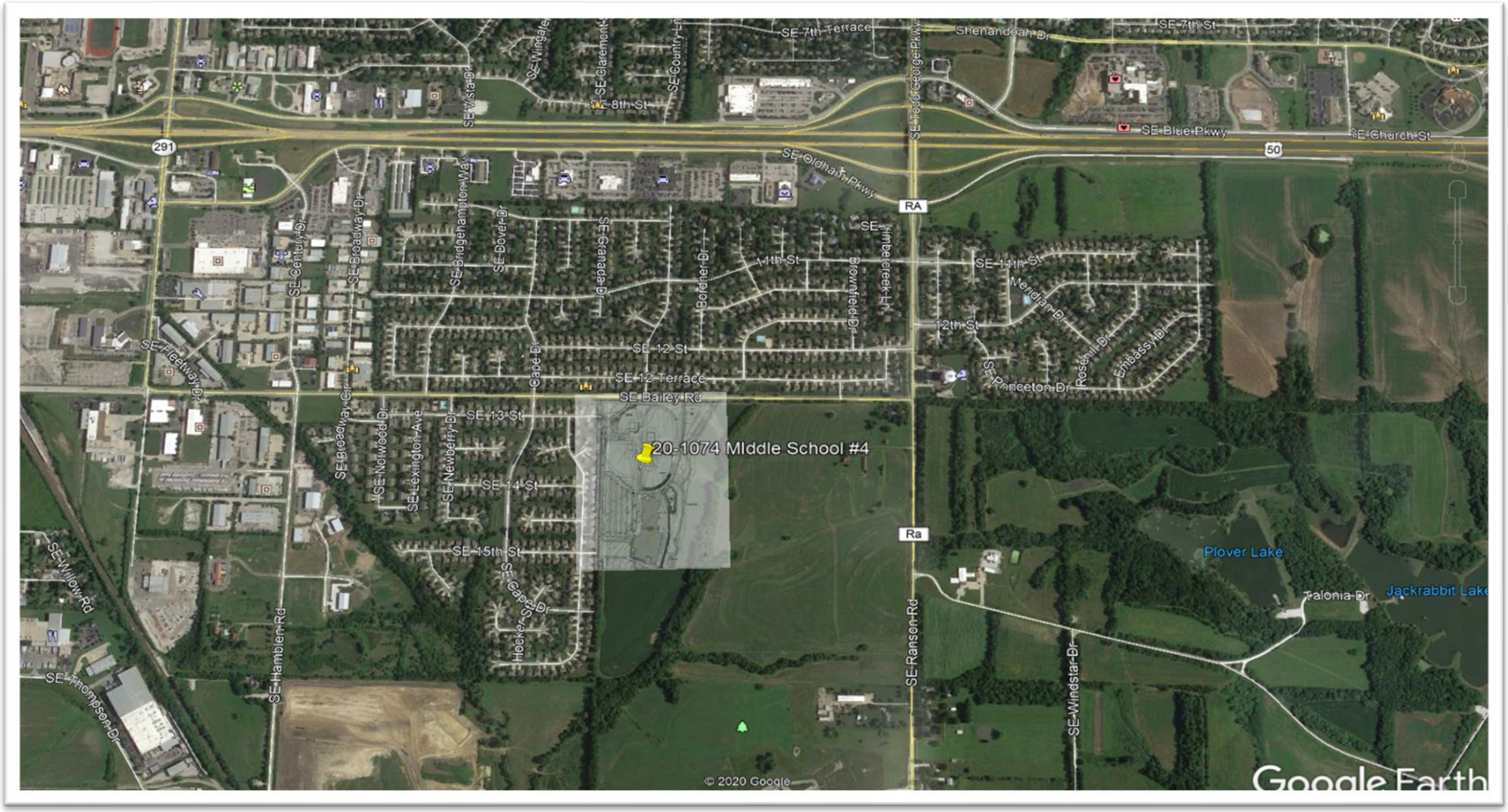
COOK, FLATT & STROBEL ENGINEERS, P.A.

STATE OF MISSOURI
JACOB PHILLIP ENGLER
NUMBER
PE-2017018964
6/8/20
PROFESSIONAL ENGINEER

Jacob Engler, P.E.
Geotechnical Engineer

Adam McEachron, P.E.
Senior Geotechnical Engineer

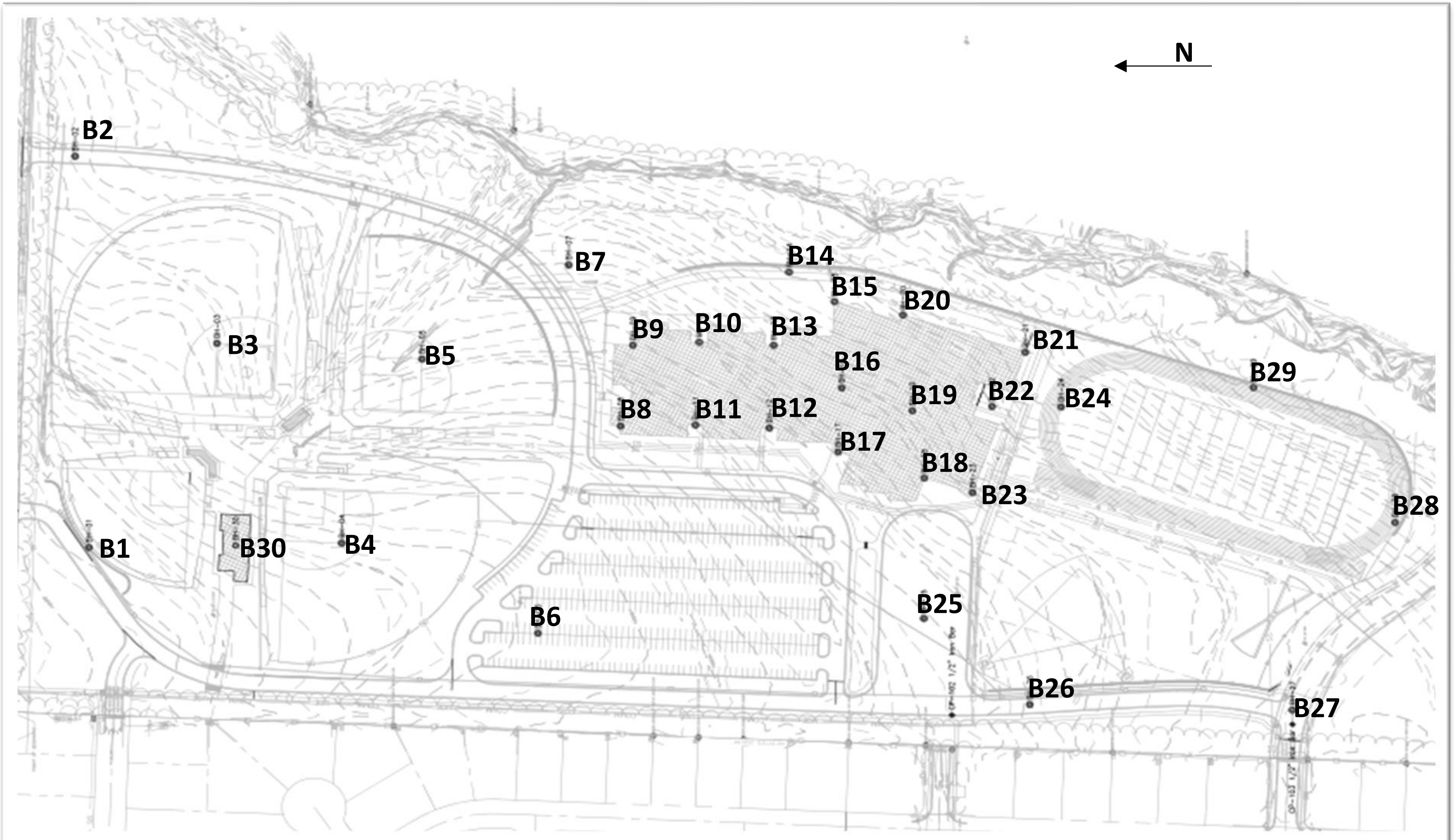
Appendix A: Figures



CFS ENGINEERS

1100 W. Cambridge Circle Dr, Ste 700
Kansas City, Kansas 66103

Project:	**LEE'S SUMMIT MIDDLE SCHOOL #4**	Project #: 20-1074	Figure 1: **SITE LOCATION PLAN**
Project Location:	Lee's Summit, MO	Comments:	
Client:	Lee's Summit R7 School District		
Date:	5/19/2020		



Project:	**LEE'S SUMMIT MIDDLE SCHOOL #4**	Project #: 20-1074	Figure 2: **BORING LOCATION PLAN**
Project Location:	Lee's Summit, MO	Comments:	
Client:	Lee's Summit R7 School District		
Date:	5/19/2020		

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Kansas City, Kansas 66103

Appendix B: Boring Logs

BORING NUMBER B1

CFS Engineers, Inc
1100 W. Cambridge Circle Drive, Suite 700
Kansas City, Kansas 66103

CLIENT Lee's Summit R-7 School District
PROJECT NAME Lee's Summit Middle School #4
PROJECT NUMBER 20-1074
PROJECT LOCATION Lee's Summit, Missouri
DATE STARTED 04/30/20 **COMPLETED** 04/30/20
GROUND ELEVATION 1027.142 ft **HOLE SIZE** 3.25 inches
DRILLING CONTRACTOR CFS Engineers
GROUND WATER LEVELS:
DRILLING METHOD 3.25-inch Continuous Flight
AT TIME OF DRILLING --- Not Recorded
LOGGED BY TP **CHECKED BY** JE
AT END OF DRILLING --- Not Recorded
NOTES
AFTER DRILLING 18.50 ft / Elev 1008.64 ft

DEPTH (ft)	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	FINES CONTENT (%)
0	TOPSOIL with vegetation										
	(CL) gray-brown, medium stiff LEAN CLAY with iron nodules	SPT 1	100	2-3-4 (7)			26				
	(CH) gray-brown and gray mottled reddish brown, medium stiff FAT CLAY with iron nodules	SPT 2	100	2-3-4 (7)			25	40	22	18	
5		SPT 3	100	2-3-4 (7)			22				
	stiff below 8.5'	SPT 4	100	2-4-5 (9)			27				
10											
15		SPT 5	100	3-5-6 (11)			22				
	tan, highly weathered SANDSTONE, clayey	SPT 6	100	50/3"							

Refusal at 18.8 feet.
Bottom of borehole at 18.8 feet.

BORING NUMBER B2

CFS Engineers, Inc
1100 W. Cambridge Circle Drive, Suite 700
Kansas City, Kansas 66103

CLIENT Lee's Summit R-7 School District
PROJECT NAME Lee's Summit Middle School #4
PROJECT NUMBER 20-1074
PROJECT LOCATION Lee's Summit, Missouri
DATE STARTED 04/30/20 **COMPLETED** 04/30/20
GROUND ELEVATION 1012.351 ft **HOLE SIZE** 3.25 inches
DRILLING CONTRACTOR CFS Engineers
GROUND WATER LEVELS:
DRILLING METHOD 3.25-inch Continuous Flight
AT TIME OF DRILLING --- No Free Water Encountered
LOGGED BY TP **CHECKED BY** JE
AT END OF DRILLING --- No Free Water Encountered
NOTES
AFTER DRILLING --- No Free Water Encountered

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
0		TOPSOIL with vegetation										
		(CH) gray-brown and gray mottled reddish brown, medium stiff FAT CLAY with iron nodules	SPT 1	100	1-2-4 (6)	3.25		25				
5			SPT 2	100	2-3-4 (7)	2		27				

Bottom of borehole at 5.0 feet.

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CFS Engineers, Inc
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Kansas City, Kansas 66103

BORING NUMBER B3

CLIENT Lee's Summit R-7 School District

PROJECT NAME Lee's Summit Middle School #4

PROJECT NUMBER 20-1074

PROJECT LOCATION Lee's Summit, Missouri

DATE STARTED 04/30/20 **COMPLETED** 04/30/20

GROUND ELEVATION 1016.143 ft **HOLE SIZE** 3.25 inches

DRILLING CONTRACTOR CFS Engineers

GROUND WATER LEVELS:

DRILLING METHOD 3.25-inch Continuous Flight

AT TIME OF DRILLING --- No Free Water Encountered

LOGGED BY TP **CHECKED BY** JE

AT END OF DRILLING --- No Free Water Encountered

NOTES

AFTER DRILLING --- No Free Water Encountered

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
0		TOPSOIL with vegetation										
		(CH) gray-brown and gray, medium stiff FAT CLAY with iron nodules	SPT 1	94	1-2-4 (6)	3.5		27				
5			SPT 2	100	2-3-4 (7)	4.25		25				

Bottom of borehole at 5.0 feet.

BORING NUMBER B4

CFS ENGINEERS
CFS Engineers, Inc
1100 W. Cambridge Circle Drive, Suite 700
Kansas City, Kansas 66103

CLIENT Lee's Summit R-7 School District
PROJECT NAME Lee's Summit Middle School #4
PROJECT NUMBER 20-1074
PROJECT LOCATION Lee's Summit, Missouri
DATE STARTED 04/30/20 **COMPLETED** 04/30/20
GROUND ELEVATION 1022.37 ft **HOLE SIZE** 3.25 inches
DRILLING CONTRACTOR CFS Engineers
GROUND WATER LEVELS:
DRILLING METHOD 3.25-inch Continuous Flight
AT TIME OF DRILLING --- No Free Water Encountered
LOGGED BY TP **CHECKED BY** JE
AT END OF DRILLING --- No Free Water Encountered
NOTES
AFTER DRILLING --- No Free Water Encountered

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	FINES CONTENT (%)
0		TOPSOIL with vegetation										
		(CH) gray-brown, medium stiff FAT CLAY with iron nodules	SPT 1	94	1-3-4 (7)	3.25		26				
		gray-brown, gray and reddish brown below 3.5'	SPT 2	100	1-3-4 (7)	3.25		27				
5			SPT 3	100	2-2-4 (6)	3.25		23				
			SPT 4	100	2-3-4 (7)	4.25		25				
10												
		trace of fine sand below 13.5'										
		tan, hard, highly weathered SANDSTONE	SPT 5	100	3-4-20 (24)	2.25		28				
15												

Refusal at 15.0 feet.
Bottom of borehole at 15.0 feet.

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CFS Engineers, Inc
1100 W. Cambridge Circle Drive, Suite 700
Kansas City, Kansas 66103

BORING NUMBER B5

CLIENT Lee's Summit R-7 School District
PROJECT NAME Lee's Summit Middle School #4
PROJECT NUMBER 20-1074
PROJECT LOCATION Lee's Summit, Missouri
DATE STARTED 04/30/20 **COMPLETED** 04/30/20
GROUND ELEVATION 1010.145 ft **HOLE SIZE** 3.25 inches
DRILLING CONTRACTOR CFS Engineers
GROUND WATER LEVELS:
DRILLING METHOD 3.25-inch Continuous Flight
AT TIME OF DRILLING --- No Free Water Encountered
LOGGED BY TP **CHECKED BY** JE
AT END OF DRILLING --- No Free Water Encountered
NOTES
AFTER DRILLING --- No Free Water Encountered

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
0		TOPSOIL with vegetation										
		(CH) gray-brown and gray, medium stiff FAT CLAY with iron nodules	SPT 1	97	2-4-4 (8)	3.25		22				
5			SPT 2	100	2-2-4 (6)			17				

Bottom of borehole at 5.0 feet.

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CFS Engineers, Inc
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Kansas City, Kansas 66103

BORING NUMBER B6

CLIENT Lee's Summit R-7 School District
PROJECT NAME Lee's Summit Middle School #4
PROJECT NUMBER 20-1074
PROJECT LOCATION Lee's Summit, Missouri
DATE STARTED 04/30/20 **COMPLETED** 04/30/20
GROUND ELEVATION 1021.25 ft **HOLE SIZE** 3.25 inches
DRILLING CONTRACTOR CFS Engineers
GROUND WATER LEVELS:
DRILLING METHOD 3.25-inch Continuous Flight
AT TIME OF DRILLING --- No Free Water Encountered
LOGGED BY TP **CHECKED BY** JE
AT END OF DRILLING --- No Free Water Encountered
NOTES
AFTER DRILLING --- No Free Water Encountered

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
0		TOPSOIL with vegetation										
		(CH) dark gray-brown, medium stiff FAT CLAY with iron nodules	SPT 1	94	2-2-4 (6)	2.5		29				
		gray-brown, gray and reddish brown below 3.5'	SPT 2	100	2-2-4 (6)	3		27				
5												

Bottom of borehole at 5.0 feet.

CFS Engineers, Inc
1100 W. Cambridge Circle Drive, Suite 700
Kansas City, Kansas 66103

BORING NUMBER B7

CLIENT Lee's Summit R-7 School District
PROJECT NAME Lee's Summit Middle School #4
PROJECT NUMBER 20-1074
PROJECT LOCATION Lee's Summit, Missouri
DATE STARTED 05/10/20 **COMPLETED** 05/10/20
GROUND ELEVATION 1005.888 ft **HOLE SIZE** 3.25 inches
DRILLING CONTRACTOR CFS Engineers
GROUND WATER LEVELS:
DRILLING METHOD 3.25-inch Continuous Flight
AT TIME OF DRILLING --- No Free Water Encountered
LOGGED BY TP **CHECKED BY** JE
AT END OF DRILLING --- No Free Water Encountered
NOTES
AFTER DRILLING --- No Free Water Encountered

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
0		TOPSOIL with vegetation										
		(CH) dark gray-brown, medium stiff FAT CLAY with iron nodules	SPT 1	89	2-3-5 (8)	3		25				
		gray-brown, gray and reddish brown below 3.5'	SPT 2	89	2-3-4 (7)	2.75		25				
5												

Bottom of borehole at 5.0 feet.

BORING NUMBER B8

CFS ENGINEERS

CFS Engineers, Inc
1100 W. Cambridge Circle Drive, Suite 700
Kansas City, Kansas 66103

CLIENT Lee's Summit R-7 School District
PROJECT NAME Lee's Summit Middle School #4
PROJECT NUMBER 20-1074
PROJECT LOCATION Lee's Summit, Missouri
DATE STARTED 04/30/20 **COMPLETED** 04/30/20
GROUND ELEVATION 1015.079 ft **HOLE SIZE** 3.25 inches
DRILLING CONTRACTOR CFS Engineers
GROUND WATER LEVELS:
DRILLING METHOD 3.25-inch Continuous Flight
AT TIME OF DRILLING --- No Free Water Encountered
LOGGED BY TP **CHECKED BY** JE
AT END OF DRILLING --- No Free Water Encountered
NOTES
AFTER DRILLING --- No Free Water Encountered

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	FINES CONTENT (%)
0		TOPSOIL with vegetation										
		(CH) gray-brown, stiff FAT CLAY with iron nodules	SPT 1	100	2-3-5 (8)	3		26				
		gray-brown, gray and reddish brown, medium stiff below 3.5'	SPT 2	100	2-3-4 (7)	3.5		20				
5		stiff below 6'	SPT 3	100	2-3-5 (8)	4.5		25				
		medium stiff below 8.5'	SPT 4	100	2-2-3 (5)	3.5		25				
10		trace of fine sand below 13.5'	SPT 5	88	3-5-50/5"	4.5		22				
15		highly weathered SANDSTONE										
		highly weathered LIMESTONE										

Refusal at 15.2 feet.
Bottom of borehole at 15.2 feet.

BORING NUMBER B9

CFS ENGINEERS

CFS Engineers, Inc
1100 W. Cambridge Circle Drive, Suite 700
Kansas City, Kansas 66103

CLIENT Lee's Summit R-7 School District
PROJECT NAME Lee's Summit Middle School #4
PROJECT NUMBER 20-1074
PROJECT LOCATION Lee's Summit, Missouri
DATE STARTED 05/10/20 **COMPLETED** 05/10/20
GROUND ELEVATION 1009.821 ft **HOLE SIZE** 3.25 inches
DRILLING CONTRACTOR CFS Engineers
GROUND WATER LEVELS:
DRILLING METHOD 3.25-inch Continuous Flight
AT TIME OF DRILLING --- No Free Water Encountered
LOGGED BY TP **CHECKED BY** JE
AT END OF DRILLING --- No Free Water Encountered
NOTES
AFTER DRILLING --- No Free Water Encountered

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	FINES CONTENT (%)
0		TOPSOIL with vegetation										
		(CL) gray-brown, medium stiff LEAN CLAY with iron nodules	SPT 1	100	2-4-5 (9)	3.5		23	38	13	25	
		(CH) gray-brown, gray and reddish brown, stiff FAT CLAY with iron nodules	SPT 2	100	2-3-5 (8)	4.25		21				
5			SPT 3	100	2-3-5 (8)	4.5		25				
			SPT 4	100	2-3-12 (15)	4.5		23				
10		highly weathered limestone fragments below 10'										
		highly weathered LIMESTONE										

Refusal at 10.5 feet.
Bottom of borehole at 10.5 feet.

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BORING NUMBER B10

CLIENT Lee's Summit R-7 School District
PROJECT NAME Lee's Summit Middle School #4
PROJECT NUMBER 20-1074
PROJECT LOCATION Lee's Summit, Missouri
DATE STARTED 05/10/20 **COMPLETED** 05/10/20
GROUND ELEVATION 1008.964 ft **HOLE SIZE** 3.25 inches
DRILLING CONTRACTOR CFS Engineers
GROUND WATER LEVELS:
DRILLING METHOD 3.25-inch Continuous Flight
AT TIME OF DRILLING --- No Free Water Encountered
LOGGED BY TP **CHECKED BY** JE
AT END OF DRILLING --- No Free Water Encountered
NOTES
AFTER DRILLING --- No Free Water Encountered

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
0		TOPSOIL with vegetation										
		(CH) dark gray-brown, medium stiff FAT CLAY with iron nodules	SPT 1	100	1-3-4 (7)	2.5		30				
		gray-brown, gray and reddish brown and stiff below 3.5'	SPT 2	100	2-3-5 (8)	4.5		21				
5			SPT 3	100	2-4-5 (9)	4.5		25				
			SPT 4	100	2-3-5 (8)	3		27				
10												
		tan and gray, highly weathered SHALE	SPT 5	100	4-50/3"			20				
15		highly weathered LIMESTONE										

Refusal at 15.0 feet.
Bottom of borehole at 15.0 feet.

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BORING NUMBER B11

CLIENT Lee's Summit R-7 School District
PROJECT NAME Lee's Summit Middle School #4
PROJECT NUMBER 20-1074
PROJECT LOCATION Lee's Summit, Missouri
DATE STARTED 04/30/20 **COMPLETED** 04/30/20
GROUND ELEVATION 1014.085 ft **HOLE SIZE** 3.25 inches
DRILLING CONTRACTOR CFS Engineers
GROUND WATER LEVELS:
DRILLING METHOD 3.25-inch Continuous Flight
AT TIME OF DRILLING --- No Free Water Encountered
LOGGED BY TP **CHECKED BY** JE
AT END OF DRILLING --- No Free Water Encountered
NOTES
AFTER DRILLING --- No Free Water Encountered

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
0		TOPSOIL with vegetation										
		(CH) dark gray-brown, medium stiff FAT CLAY with iron nodules	SPT 1	78	2-3-4 (7)	2.5		27				
		gray-brown, gray and reddish brown, stiff below 3.5'	SPT 2	100	2-3-5 (8)	2.75		25				
5			SPT 3	100	2-3-5 (8)	4		21				
			SPT 4	100	2-3-4 (7)	2.5		32				
10												
		highly weathered LIMESTONE	SPT 5	100	3-50/1"	3.5		27				

Refusal at 14.3 feet.
Bottom of borehole at 14.3 feet.

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BORING NUMBER B12

CLIENT Lee's Summit R-7 School District
PROJECT NAME Lee's Summit Middle School #4
PROJECT NUMBER 20-1074
PROJECT LOCATION Lee's Summit, Missouri
DATE STARTED 05/07/20 **COMPLETED** 05/07/20
GROUND ELEVATION 1010.193 ft **HOLE SIZE** 3.25 inches
DRILLING CONTRACTOR CFS Engineers
GROUND WATER LEVELS:
DRILLING METHOD 3.25-inch Continuous Flight
AT TIME OF DRILLING --- No Free Water Encountered
LOGGED BY TP **CHECKED BY** JE
AT END OF DRILLING --- No Free Water Encountered
NOTES
AFTER DRILLING --- No Free Water Encountered

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
0		TOPSOIL with vegetation										
		(CH) gray-brown, medium stiff FAT CLAY with iron nodules	SPT 1	100	1-2-4 (6)	3		28				
		gray-brown, gray and reddish brown below 3.5'	SPT 2	100	2-2-3 (5)	3		23				
5			SPT 3	100	2-2-4 (6)	2.25		31				
			SPT 4	100	2-3-4 (7)	2.25		29				
10												

Refusal at 13.5 feet.
Bottom of borehole at 13.5 feet.

BORING NUMBER B13

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CLIENT Lee's Summit R-7 School District
PROJECT NAME Lee's Summit Middle School #4
PROJECT NUMBER 20-1074
PROJECT LOCATION Lee's Summit, Missouri
DATE STARTED 05/10/20 **COMPLETED** 05/10/20
GROUND ELEVATION 1004.54 ft **HOLE SIZE** 3.25 inches
DRILLING CONTRACTOR CFS Engineers
GROUND WATER LEVELS:
DRILLING METHOD 3.25-inch Continuous Flight
AT TIME OF DRILLING --- Not Recorded
LOGGED BY TP **CHECKED BY** JE
AT END OF DRILLING --- Not Recorded
NOTES
AFTER DRILLING 8.50 ft / Elev 996.04 ft

DEPTH (ft)	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	FINES CONTENT (%)
0	TOPSOIL with vegetation										
	(CH) gray-brown, stiff FAT CLAY with iron nodules	SPT 1	100	2-4-4 (8)	3.75		22				
	gray-brown, gray and reddish brown below 3.5'	SPT 2	100	2-3-6 (9)	4.25		23				
5	medium stiff below 6'	SPT 3	100	1-3-4 (7)	4.25		25				
	▽ (water level 8.5 ft)	SPT 4	100	1-2-3 (5)	2.5		34				
10											
	tan and gray, highly weathered SHALE	SPT 5	100	9-13-15 (28)			23				
15											
	highly weathered LIMESTONE										

Refusal at 18.0 feet.
Bottom of borehole at 18.0 feet.

BORING NUMBER B14

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CLIENT Lee's Summit R-7 School District
PROJECT NAME Lee's Summit Middle School #4
PROJECT NUMBER 20-1074
PROJECT LOCATION Lee's Summit, Missouri
DATE STARTED 05/10/20 **COMPLETED** 05/10/20
GROUND ELEVATION 999.561 ft **HOLE SIZE** 3.25 inches
DRILLING CONTRACTOR CFS Engineers
GROUND WATER LEVELS:
DRILLING METHOD 3.25-inch Continuous Flight
AT TIME OF DRILLING --- No Free Water Encountered
LOGGED BY TP **CHECKED BY** JE
AT END OF DRILLING --- No Free Water Encountered
NOTES
AFTER DRILLING --- No Free Water Encountered

DEPTH (ft)	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
0	TOPSOIL with vegetation										
	(CH) dark gray-brown, medium stiff FAT CLAY with iron nodules	SPT 1	78	1-3-3 (6)	2.5		29				
	gray-brown, gray and reddish brown below 3.5'	SPT 2	94	2-2-3 (5)	3		26				
5		SPT 3	100	2-2-4 (6)	3.5		26				
	stiff and shaley below 8.5'	SPT 4	100	2-4-8 (12)			27				
10											
	highly weathered LIMESTONE										

Refusal at 13.2 feet.
Bottom of borehole at 13.2 feet.

BORING NUMBER B15

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CLIENT Lee's Summit R-7 School District
PROJECT NAME Lee's Summit Middle School #4
PROJECT NUMBER 20-1074
PROJECT LOCATION Lee's Summit, Missouri
DATE STARTED 05/10/20 **COMPLETED** 05/10/20
GROUND ELEVATION 999.6 ft **HOLE SIZE** 3.25 inches
DRILLING CONTRACTOR CFS Engineers
GROUND WATER LEVELS:
DRILLING METHOD 3.25-inch Continuous Flight
AT TIME OF DRILLING --- No Free Water Encountered
LOGGED BY TP **CHECKED BY** JE
AT END OF DRILLING --- No Free Water Encountered
NOTES
AFTER DRILLING --- No Free Water Encountered

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
0		TOPSOIL with vegetation										
		(CH) dark gray-brown, medium stiff FAT CLAY with iron nodules	SPT 1	97	2-3-4 (7)	3.5		26				
		gray-brown, gray and reddish brown below 3.5'	SPT 2	89	1-2-3 (5)	2.75		29				
5			SPT 3	100	2-2-3 (5)	2.75		34				
		shaley below 8.5'	SPT 4	94	2-3-4 (7)	4.5+		30				
10												

Refusal at 13.0 feet.
Bottom of borehole at 13.0 feet.

BORING NUMBER B16

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CLIENT Lee's Summit R-7 School District
PROJECT NAME Lee's Summit Middle School #4
PROJECT NUMBER 20-1074
PROJECT LOCATION Lee's Summit, Missouri
DATE STARTED 05/10/20 **COMPLETED** 05/10/20
GROUND ELEVATION 1005.259 ft **HOLE SIZE** 3.25 inches
DRILLING CONTRACTOR CFS Engineers
GROUND WATER LEVELS:
DRILLING METHOD 3.25-inch Continuous Flight
AT TIME OF DRILLING --- No Free Water Encountered
LOGGED BY TP **CHECKED BY** JE
AT END OF DRILLING --- No Free Water Encountered
NOTES
AFTER DRILLING --- No Free Water Encountered

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	FINES CONTENT (%)
0		TOPSOIL with vegetation										
		(CH) dark gray-brown, stiff FAT CLAY with iron nodules	SPT 1	83	2-3-5 (8)	2.75		30	53	25	28	
		gray-brown, gray and reddish brown below 3.5'	SPT 2	94	3-3-6 (9)	3.25		24				
5		medium stiff below 6'	SPT 3	100	1-3-3 (6)	2.25		31				
			SPT 4	94	2-3-4 (7)	3		27				
10												
		tan and gray, highly weathered SHALE	SPT 5	100	7-9-14 (23)			23				
15												
		highly weathered LIMESTONE										

Refusal at 17.1 feet.
Bottom of borehole at 17.1 feet.

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BORING NUMBER B17

CLIENT Lee's Summit R-7 School District
PROJECT NAME Lee's Summit Middle School #4
PROJECT NUMBER 20-1074
PROJECT LOCATION Lee's Summit, Missouri
DATE STARTED 05/07/20 **COMPLETED** 05/07/20
GROUND ELEVATION 1008.754 ft **HOLE SIZE** 3.25 inches
DRILLING CONTRACTOR CFS Engineers
GROUND WATER LEVELS:
DRILLING METHOD 3.25-inch Continuous Flight
AT TIME OF DRILLING --- No Free Water Encountered
LOGGED BY TP **CHECKED BY** JE
AT END OF DRILLING --- No Free Water Encountered
NOTES
AFTER DRILLING --- No Free Water Encountered

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
0		TOPSOIL with vegetation										
		(CH) gray-brown, medium stiff FAT CLAY with iron nodules	SPT 1	89	2-3-3 (6)	3		28				
		gray-brown, gray and reddish brown, stiff below 3.5'	SPT 2	100	2-4-6 (10)	3		24				
5		medium stiff below 6'	SPT 3	100	2-3-4 (7)	2.5		27				
			SPT 4	100	1-3-4 (7)	3.5		25				
10		trace of fine sand below 13.5'	SPT 5	100	2-2-4 (6)	2		40				
15		shaley below 15'										
		tan, highly weathered SHALE	SPT 6	100	8-13-16 (29)			27				
20												

Bottom of borehole at 20.0 feet.

BORING NUMBER B18

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CLIENT Lee's Summit R-7 School District
PROJECT NAME Lee's Summit Middle School #4
PROJECT NUMBER 20-1074
PROJECT LOCATION Lee's Summit, Missouri
DATE STARTED 05/07/20 **COMPLETED** 05/07/20
GROUND ELEVATION 1005.996 ft **HOLE SIZE** 3.25 inches
DRILLING CONTRACTOR CFS Engineers
GROUND WATER LEVELS:
DRILLING METHOD 3.25-inch Continuous Flight
AT TIME OF DRILLING --- No Free Water Encountered
LOGGED BY TP **CHECKED BY** JE
AT END OF DRILLING --- No Free Water Encountered
NOTES
AFTER DRILLING --- No Free Water Encountered

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	FINES CONTENT (%)
0		TOPSOIL with vegetation										
		(CH) gray-brown, medium stiff FAT CLAY with iron nodules	SPT 1	78	1-3-3 (6)	3.75		27				
		gray-brown, gray and reddish brown, stiff below 3.5'	SPT 2	100	2-3-5 (8)	3.75		22				
5			SPT 3	100	3-3-6 (9)	3.25		23				
		medium stiff below 8.5'	SPT 4	100	3-3-4 (7)	2.75		25				
10												
		shaley below 13.5'	SPT 5	100	2-4-5 (9)	3.75		29				
15												

Refusal at 18.5 feet.
Bottom of borehole at 18.5 feet.

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BORING NUMBER B19

CLIENT Lee's Summit R-7 School District
PROJECT NAME Lee's Summit Middle School #4
PROJECT NUMBER 20-1074
PROJECT LOCATION Lee's Summit, Missouri
DATE STARTED 05/10/20 **COMPLETED** 05/10/20
GROUND ELEVATION 1004.232 ft **HOLE SIZE** 3.25 inches
DRILLING CONTRACTOR CFS Engineers
GROUND WATER LEVELS:
DRILLING METHOD 3.25-inch Continuous Flight
AT TIME OF DRILLING --- No Free Water Encountered
LOGGED BY TP **CHECKED BY** JE
AT END OF DRILLING --- No Free Water Encountered
NOTES
AFTER DRILLING --- No Free Water Encountered

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
0		TOPSOIL with vegetation										
		(CH) gray-brown, medium stiff FAT CLAY with iron nodules	SPT 1	89	2-2-4 (6)	2.75		30				
		gray-brown, gray and reddish brown, stiff below 3.5'	SPT 2	94	3-4-7 (11)	4.5		22				
5			SPT 3	100	3-3-5 (8)	3		28				
			SPT 4	100	2-3-5 (8)	2.5		26				
10												
		shaley below 13.5'	SPT 5	100	3-4-10 (14)	4.5		28				
		tan and gray, highly weathered SHALE										
15		highly weathered LIMESTONE										

Refusal at 15.5 feet.
Bottom of borehole at 15.5 feet.

BORING NUMBER B20

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CLIENT Lee's Summit R-7 School District
PROJECT NAME Lee's Summit Middle School #4
PROJECT NUMBER 20-1074
PROJECT LOCATION Lee's Summit, Missouri
DATE STARTED 05/10/20 **COMPLETED** 05/10/20
GROUND ELEVATION 999.381 ft **HOLE SIZE** 3.25 inches
DRILLING CONTRACTOR CFS Engineers
GROUND WATER LEVELS:
DRILLING METHOD 3.25-inch Continuous Flight
AT TIME OF DRILLING --- No Free Water Encountered
LOGGED BY TP **CHECKED BY** JE
AT END OF DRILLING --- No Free Water Encountered
NOTES
AFTER DRILLING --- No Free Water Encountered

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
0		TOPSOIL with vegetation										
		(CH) dark gray-brown, medium stiff FAT CLAY with iron nodules	SPT 1	100	1-3-4 (7)	3.5		24				
5			SPT 2	89	2-2-4 (6)	2.75		27				
		gray-brown, gray and reddish brown, stiff below 3.5'	SPT 3	100	2-4-5 (9)	3.25		26				
10			SPT 4	100	3-3-5 (8)	4.5		21				
		highly weathered LIMESTONE										

Refusal at 11.5 feet.
Bottom of borehole at 11.5 feet.

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BORING NUMBER B21

CLIENT Lee's Summit R-7 School District
PROJECT NAME Lee's Summit Middle School #4
PROJECT NUMBER 20-1074
PROJECT LOCATION Lee's Summit, Missouri
DATE STARTED 05/07/20 **COMPLETED** 05/07/20
GROUND ELEVATION 996.623 ft **HOLE SIZE** 3.25 inches
DRILLING CONTRACTOR CFS Engineers
GROUND WATER LEVELS:
DRILLING METHOD 3.25-inch Continuous Flight
AT TIME OF DRILLING --- No Free Water Encountered
LOGGED BY TP **CHECKED BY** JE
AT END OF DRILLING --- No Free Water Encountered
NOTES
AFTER DRILLING --- No Free Water Encountered

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
0		TOPSOIL with vegetation										
		(CH) gray-brown, medium stiff FAT CLAY with iron nodules	SPT 1	100	1-2-3 (5)	2.5		26				
			SPT 2	89	1-2-4 (6)	3		29				
5												
		gray-brown, gray and reddish brown, stiff below 3.5'	SPT 3	100	2-3-5 (8)	3.75		25				
			SPT 4	100	2-4-35 (39)	3.5		30				
10		gray-brown, highly weathered SHALE										

Refusal at 12.0 feet.
Bottom of borehole at 12.0 feet.

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BORING NUMBER B22

CLIENT Lee's Summit R-7 School District
PROJECT NAME Lee's Summit Middle School #4
PROJECT NUMBER 20-1074
PROJECT LOCATION Lee's Summit, Missouri
DATE STARTED 05/07/20 **COMPLETED** 05/07/20
GROUND ELEVATION 1001.695 ft **HOLE SIZE** 3.25 inches
DRILLING CONTRACTOR CFS Engineers
GROUND WATER LEVELS:
DRILLING METHOD 3.25-inch Continuous Flight
AT TIME OF DRILLING --- No Free Water Encountered
LOGGED BY TP **CHECKED BY** JE
AT END OF DRILLING --- No Free Water Encountered
NOTES
AFTER DRILLING --- No Free Water Encountered

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	FINES CONTENT (%)
0		TOPSOIL with vegetation										
		(CH) dark gray-brown, medium stiff FAT CLAY with iron nodules	SPT 1	78	1-2-3 (5)	3.5		30				
		gray-brown, gray and reddish brown, stiff below 3.5'	SPT 2	89	2-4-6 (10)	3.75		22				
5			SPT 3	100	2-5-6 (11)	3.75		23				
			SPT 4	100	2-3-5 (8)	3.25		28				
10												
		highly weathered LIMESTONE										

Refusal at 13.0 feet.
Bottom of borehole at 13.0 feet.

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BORING NUMBER B23

CLIENT Lee's Summit R-7 School District
PROJECT NAME Lee's Summit Middle School #4
PROJECT NUMBER 20-1074
PROJECT LOCATION Lee's Summit, Missouri
DATE STARTED 05/07/20 **COMPLETED** 05/07/20
GROUND ELEVATION 1005.432 ft **HOLE SIZE** 3.25 inches
DRILLING CONTRACTOR CFS Engineers
GROUND WATER LEVELS:
DRILLING METHOD 3.25-inch Continuous Flight
AT TIME OF DRILLING --- No Free Water Encountered
LOGGED BY TP **CHECKED BY** JE
AT END OF DRILLING --- No Free Water Encountered
NOTES
AFTER DRILLING --- No Free Water Encountered

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
0		TOPSOIL with vegetation										
		(CH) dark gray-brown, medium stiff FAT CLAY with iron nodules	SPT 1	83	1-2-4 (6)	3		29				
		gray-brown, gray and reddish brown below 3.5'	SPT 2	94	2-3-4 (7)	3.75		24				
5		stiff below 6'	SPT 3	100	2-3-5 (8)	3		26				
10			SPT 4	100	2-4-5 (9)	3		28				
		tan and gray-brown, highly weathered SHALE	SPT 5	100	3-6-50/1"	4.5		26				

Refusal at 14.6 feet.
Bottom of borehole at 14.6 feet.

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BORING NUMBER B24

CLIENT Lee's Summit R-7 School District
PROJECT NAME Lee's Summit Middle School #4
PROJECT NUMBER 20-1074
PROJECT LOCATION Lee's Summit, Missouri
DATE STARTED 05/07/20 **COMPLETED** 05/07/20
GROUND ELEVATION 997.526 ft **HOLE SIZE** 3.25 inches
DRILLING CONTRACTOR CFS Engineers
GROUND WATER LEVELS:
DRILLING METHOD 3.25-inch Continuous Flight
AT TIME OF DRILLING --- No Free Water Encountered
LOGGED BY TP **CHECKED BY** JE
AT END OF DRILLING --- No Free Water Encountered
NOTES
AFTER DRILLING --- No Free Water Encountered

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
0		TOPSOIL with vegetation										
		(CH) gray-brown, medium stiff FAT CLAY with iron nodules	SPT 1	83	1-3-4 (7)	2.75		26				
		gray-brown, gray and reddish brown below 3.5'	SPT 2	100	2-2-4 (6)	3.25		27				
5												
		stiff below 6'	SPT 3	100	2-3-5 (8)	2.5		25				
			SPT 4	100	2-3-10 (13)	4		26				
10		shaley below 10'										

Refusal at 12.0 feet.
Bottom of borehole at 12.0 feet.

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BORING NUMBER B25

CLIENT Lee's Summit R-7 School District
PROJECT NAME Lee's Summit Middle School #4
PROJECT NUMBER 20-1074
PROJECT LOCATION Lee's Summit, Missouri
DATE STARTED 05/11/20 **COMPLETED** 05/11/20
GROUND ELEVATION 1011.671 ft **HOLE SIZE** 3.25 inches
DRILLING CONTRACTOR CFS Engineers
GROUND WATER LEVELS:
DRILLING METHOD 3.25-inch Continuous Flight
AT TIME OF DRILLING --- No Free Water Encountered
LOGGED BY TP **CHECKED BY** JE
AT END OF DRILLING --- No Free Water Encountered
NOTES
AFTER DRILLING --- No Free Water Encountered

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS			FINES CONTENT (%)
									LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	
0		TOPSOIL with vegetation										
		(CH) gray-brown, medium stiff LEAN TO FAT CLAY with iron nodules	SPT 1	100	2-3-4 (7)	3.5		26				
		gray-brown, gray and reddish brown, stiff below 3.5'	SPT 2	100	2-4-5 (9)	3.5		27	43	19	24	
5		Bottom of borehole at 5.0 feet.										

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BORING NUMBER B26

CLIENT Lee's Summit R-7 School District
PROJECT NAME Lee's Summit Middle School #4
PROJECT NUMBER 20-1074
PROJECT LOCATION Lee's Summit, Missouri
DATE STARTED 05/11/20 **COMPLETED** 05/11/20
GROUND ELEVATION 1009.189 ft **HOLE SIZE** 3.25 inches
DRILLING CONTRACTOR CFS Engineers
GROUND WATER LEVELS:
DRILLING METHOD 3.25-inch Continuous Flight
AT TIME OF DRILLING --- No Free Water Encountered
LOGGED BY TP **CHECKED BY** JE
AT END OF DRILLING --- No Free Water Encountered
NOTES
AFTER DRILLING --- No Free Water Encountered

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
0		TOPSOIL with vegetation										
		(CH) gray-brown, medium stiff FAT CLAY with iron nodules	SPT 1	83	2-2-5 (7)	3.75		28				
		gray-brown, gray and reddish brown below 3.5'	SPT 2	100	1-3-4 (7)	2.5		28				
5			SPT 3	100	1-3-4 (7)	2.5		30				
		stiff with trace of fine sand below 8.5'	SPT 4	100	3-5-4 (9)	2.5		43				
10												
		highly weathered LIMESTONE										

Refusal at 11.4 feet.
Bottom of borehole at 11.4 feet.

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BORING NUMBER B27

CLIENT Lee's Summit R-7 School District
PROJECT NAME Lee's Summit Middle School #4
PROJECT NUMBER 20-1074
PROJECT LOCATION Lee's Summit, Missouri
DATE STARTED 05/11/20 **COMPLETED** 05/11/20
GROUND ELEVATION 1000.457 ft **HOLE SIZE** 3.25 inches
DRILLING CONTRACTOR CFS Engineers
GROUND WATER LEVELS:
DRILLING METHOD 3.25-inch Continuous Flight
AT TIME OF DRILLING --- Not Recorded
LOGGED BY TP **CHECKED BY** JE
AT END OF DRILLING --- Not Recorded
NOTES
AFTER DRILLING 13.50 ft / Elev 986.96 ft

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
0		TOPSOIL with vegetation										
		(CH) dark gray-brown, medium stiff FAT CLAY with iron nodules	SPT 1	100	1-3-3 (6)	2.25		30				
		gray-brown, gray and reddish brown, stiff below 3.5'	SPT 2	100	2-4-5 (9)	3.25		27				
5		medium stiff below 6'	SPT 3	100	2-2-4 (6)	2.75		28				
		stiff below 8.5'	SPT 4	100	2-4-4 (8)	3.25		29				
10												
		tan, weathered SHALE	SPT 5	100	50			13				

Refusal at 14.0 feet.
Bottom of borehole at 14.0 feet.

BORING NUMBER B28

CFS Engineers, Inc
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CLIENT Lee's Summit R-7 School District
PROJECT NAME Lee's Summit Middle School #4
PROJECT NUMBER 20-1074
PROJECT LOCATION Lee's Summit, Missouri
DATE STARTED 05/07/20 **COMPLETED** 05/07/20
GROUND ELEVATION 993.991 ft **HOLE SIZE** 3.25 inches
DRILLING CONTRACTOR CFS Engineers
GROUND WATER LEVELS:
DRILLING METHOD 3.25-inch Continuous Flight
AT TIME OF DRILLING --- No Free Water Encountered
LOGGED BY TP **CHECKED BY** JE
AT END OF DRILLING --- No Free Water Encountered
NOTES
AFTER DRILLING --- No Free Water Encountered

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
0		TOPSOIL with vegetation										
		(CH) reddish brown, stiff LEAN TO FAT CLAY	SPT 1	94	2-3-5 (8)	2.5		23				
		hard, highly weathered LIMESTONE fragments and CLAY	SPT 2	100	14-10-15 (25)			30				
5												
		orangish brown, very stiff, highly weathered SANDSTONE with clay seams	SPT 3	100	6-10-8 (18)			38				
		tan, very stiff, highly weathered SHALE	SPT 4	100	3-10-13 (23)			21				
10												

Refusal at 11.0 feet.
Bottom of borehole at 11.0 feet.

BORING NUMBER B29

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CFS Engineers, Inc
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Kansas City, Kansas 66103

CLIENT Lee's Summit R-7 School District
PROJECT NAME Lee's Summit Middle School #4
PROJECT NUMBER 20-1074
PROJECT LOCATION Lee's Summit, Missouri
DATE STARTED 05/07/20 **COMPLETED** 05/07/20
GROUND ELEVATION 988.686 ft **HOLE SIZE** 3.25 inches
DRILLING CONTRACTOR CFS Engineers
GROUND WATER LEVELS:
DRILLING METHOD 3.25-inch Continuous Flight
AT TIME OF DRILLING --- No Free Water Encountered
LOGGED BY TP **CHECKED BY** JE
AT END OF DRILLING --- No Free Water Encountered
NOTES
AFTER DRILLING --- No Free Water Encountered

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
0		TOPSOIL with vegetation										
		(CH) gray-brown, medium stiff FAT CLAY with iron nodules	SPT 1	83	1-3-4 (7)	2		31	55	23	32	
		gray-brown, gray and reddish brown, stiff below 3.5'	SPT 2	83	2-3-5 (8)	3		30				
5												
		highly weathered LIMESTONE										

Refusal at 7.0 feet.
Bottom of borehole at 7.0 feet.

BORING NUMBER B30

CFS Engineers, Inc
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CLIENT Lee's Summit R-7 School District
PROJECT NAME Lee's Summit Middle School #4
PROJECT NUMBER 20-1074
PROJECT LOCATION Lee's Summit, Missouri
DATE STARTED 04/30/20 **COMPLETED** 04/30/20
GROUND ELEVATION 1022.919 ft **HOLE SIZE** 3.25 inches
DRILLING CONTRACTOR CFS Engineers
GROUND WATER LEVELS:
DRILLING METHOD 3.25-inch Continuous Flight
AT TIME OF DRILLING --- No Free Water Encountered
LOGGED BY TP **CHECKED BY** JE
AT END OF DRILLING --- No Free Water Encountered
NOTES
AFTER DRILLING --- No Free Water Encountered

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	FINES CONTENT (%)
0		TOPSOIL with vegetation										
		(CH) gray-brown, medium stiff FAT CLAY with iron nodules	SPT 1	97	1-3-4 (7)	3.75		24	55	21	34	
		gray-brown, gray and reddish brown below 3.5'	SPT 2	100	1-3-4 (7)	2.5		22				
5		stiff below 6'	SPT 3	100	2-4-5 (9)	3.5		22				
			SPT 4	100	3-3-4 (7)	4		28				
10		shaley below 13.5'										
		orangish-brown, hard, highly weathered SANDSTONE	SPT 5	100	3-50	3.25		29				

Refusal at 14.5 feet.
Bottom of borehole at 14.5 feet.

Appendix C: Portland Cement Stabilization

GUIDELINE FOR CEMENT STABILIZATION

Cement stabilized soils should not be constructed without the presence of the geotechnical engineer’s designated representative.

MATERIALS. The material used in stabilization should meet the chemical and physical characteristics of Type I cement ASTM C150. Cement should be kept free from moisture prior to use. Cement stored on the project should be placed in weatherproof bins or buildings with adequate protection from ground dampness.

CONSTRUCTION. The cement stabilized soil should be constructed as described herein. The cement should be spread uniformly across the prepared soil surface at the full application rate by using an agricultural seed spreader, mechanical bulk cement spreader, or other equipment acceptable to the geotechnical engineer’s designated representative.

Cement stabilized material should be placed in approximately horizontal layers not to exceed 9 inches in uncompacted thickness.

Subgrade Preparation. Prior to the beginning of cement treatment, the Contractor should construct the subgrade to an elevation which will provide a subgrade surface conforming to the contract documents upon completion of the cement treatment.

The clay soils should be scarified and pulverized prior to application of the cement. A disc should be used to break up the surface of the material to be stabilized. The mixer or tiller should be used for the full depth of stabilization to break up the clay.

Application. Cement should be spread only on those areas where mixing operations can be completed during the same working day. Mixing and spreading should not be performed during freezing temperatures. When the temperature is below 40 degrees F, the completed stabilized fill should be protected against freezing by a sufficient covering of straw, or by other approved methods. Any areas of completed stabilized subgrade course that are damaged by freezing, rainfall, or other weather conditions should be repaired by the contractor.

The cement should be applied with an approved spreader at an application rate that has been established by the geotechnical engineer, based on laboratory tests with the site soils.

The cement should be distributed at a uniform rate and in such a manner to prevent the scattering of cement by wind. Cement should not be added when wind or weather conditions are not favorable in the opinion of the geotechnical engineer’s designated representative. A motor grader should not be used to spread the cement.

Mixing. The cement, material, and required water should be thoroughly mixed, blended, and pulverized by approved road mixers or by a depth-controlled rotary tiller. Except as provided hereinafter, the Contractor should continue mixing and drying the soil until all material will pass a 1/2-inch screen. Scarifying and mixing should be controlled to provide uniform depth within 0.1 ft of the depth specified. If, in the opinion of the geotechnical engineer's designated representative the material was mixed to a depth greater than indicated on the drawing or as specified herein, additional cement should be added to achieve the desired application rate. If in the opinion of the geotechnical engineer's designated representative, the material was mixed to a depth less than indicated on the drawing or specified, the material should be remixed.

Moisture content of the mixture should be determined in preparation for final mixing. Moisture in the mixture following final mixing should not be less than the water content determined to be optimum based on dry weight of soil and should not exceed the optimum water content by more than 5 percentage points. Water may be added in increments as large as the equipment will permit; however, such increment of water should be partially incorporated in the mix to avoid concentration of water near the surface. After the last increment of water has been added, mixing should be continued until the water is uniformly distributed throughout the full depth of the mixture, including satisfactory moisture distribution along the edges of the section.

Compaction. The cement stabilized subgrade should be compacted in accordance with the requirements for controlled fill. The compaction should be a minimum of 95% of the maximum density in accordance with ASTM D698 and within +0% to +5% of the optimum moisture content of the cement-stabilized soil.

Not more than 60 minutes should elapse between the time of final mixing and the beginning of compaction.

Protection and Curing. The Contractor should protect the finished treated subgrade from rapid drying, for 7 days, by sprinkling with water as often as is necessary to prevent drying of the surface of the cement-treated subgrade, or by application of the overlying base course. The Contractor should not allow any vehicles or operations which will distort the surface onto the treated surface during the curing period.