REPORT OF GEOTECHNICAL EXPLORATION
LXT EASTSIDE DEVELOPMENT
LEE'S SUMMIT, MISSOURI

Presented to:

CRAWFORD, MURPHY, & TILLY
Kansas City, Missouri

Attn: Mr. Tyler Horn

Prepared by:
Otto J. Kruger, Jr., P.E.

KTI
Lenexa, Kansas

KTI Project No. 223110G

July 18, 2023

KRUGER TECHNOLOGIES, INC.

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July 18, 2023

Mr. Tyler Horn
Crawford, Murphy, & Tilly
1627 Main Street Suite 600
Kansas City, Missouri 64108

Re: KTI Project No. 223110G
LXT Eastside Development
Lee's Summit, Missouri

Dear Mr. Horn:

KTI has completed the subsurface exploration and geotechnical report for the above referenced project. The purpose of this report is to describe the surface and subsurface conditions encountered at the site, analyze and evaluate this information, and prepare a summary of existing conditions, subsurface material characteristics, and geotechnical design recommendations.

We thank you for the opportunity to work with Crawford, Murphy, & Tilly. If you have any questions, please contact us at 913.498.1114.

Respectfully submitted,
Kruger Technologies, Inc.

Otto J. Kruger, Jr., P.E.
Missouri: PE 23994

TABLE OF CONTENTS

AUTHORIZATION 1
PURPOSE AND SCOPE 1
SITE CONDITIONS 1
PROJECT DESCRIPTION 2
FIELD EXPLORATION PROCEDURES 2
LABORATORY TESTS 2
GEOLOGY/SUBSURFACE CONDITIONS 3
DESIGN CRITERIA AND RECOMMENDATIONS 3
Seismic Considerations 4
Site Preparation and Engineered Fill 4
Foundation Options 5
Slab on Grade 8
Surface Drainage 8
Subsurface Drainage 9
Excavation Considerations 9
Trench Backfill 9
Manhole/Inlet Structure Backfill 10
PAVEMENT RECOMMENDATIONS 10
Pavement Subgrade Preparation 10
Asphaltic Cement Concrete Pavement 11
Portland Cement Concrete Pavement 12
Construction Considerations 13
Pavement Drainage 13
REMARKS 15
BORING LOCATION DIAGRAM 16
APPENDIX I 18
Boring Logs 19
APPENDIX II 27
Laboratory Results 28
GLOSSARY OF GEOTECHNICAL TERMS 37

REPORT OF GEOTECHNICAL EXPLORATION
LXT EASTSIDE DEVELOPMENT
LEE'S SUMMIT, MISSOURI

AUTHORIZATION

The following table presents the authorization documentation history for the work performed and presented in this report by Kruger Technologies, Inc.

Project: LXT Eastside Development in Lee's Summit, Missouri		
Document:	**Date:**	**Requested/Provided:**
Request for Proposal	8-9-22	Andy Bodine – Crawford, Murphy &Tilly
KTI Proposal 22GT121	8-10-22	Dylan Kruger – Kruger Technologies, Inc.
Notice to Proceed	5-22-23	Wade Cumpton – Crawford Murphy & Tilly

PURPOSE AND SCOPE

The purpose of this investigation was to explore the surface and subsurface conditions present within the site and provide recommendations regarding the following:

- Seismic Considerations
- Site Preparation and Engineered Fill
- Foundation Options
- Slab on Grade
- Surface and Subsurface Drainage
- Excavation Considerations
- Trench Backfill Recommendations
- Manhole/Inlet Structure Backfill Recommendations
- Pavement Recommendations

SITE DESCRIPTION

The proposed site is located along the east side of an existing airfield apron within the existing City of Lee's Summit Airport in Lee's Summit, Missouri. Based on Google Earth mapping, the overall site has an elevation difference of approximately 15 feet (989 to 1004) and is currently grass and partially gravel covered.

PROJECT DESCRIPTION

We understand the project to consist of the design and construction of a new hangar building with a mezzanine in the lower portion of the building that will be comprised of office spaces, related site improvements and pavements to be built along the east side of an existing airfield apron within the existing City of Lee's Summit Airport in Lee's Summit, Missouri. No building structure type information was provided at the time of this report preparation, however, slab on grade construction is assumed for this report preparation. Based on finish floor elevations (993.1) identified and with assumed Google Earth mapping in the current site plan, it appears that 3 to 10 feet of cut/fill operations will be necessary within the building footprint site.

FIELD EXPLORATION PROCEDURES

Eight (8) total test borings were completed for the above referenced project on June 18, 2023. The boring locations were selected by the client and field located by KTI using the plan drawing provided by the client. The boring locations are shown on the plan provided by the client. In addition, KTI used assumed elevations based on Google Earth Mapping.

The borings were drilled using a track mounted drill rig. Advancement of the test holes was accomplished using 4-inch O.D. continuous flight augers. Soil sampling was performed by hydraulically pushing thin wall steel (Shelby) tubes and Standard Penetration Test (SPT).

Site soils were visually and manually classified in general accordance with ASTM D 2488 by the drill crew chief as drilling progressed. All of the soil samples were delivered to the laboratory for verification of the field classifications. The boring logs were created as the borings were advanced and supplemented with information for lab test results; the boring logs are attached in Appendix I.

LABORATORY TESTS

Laboratory tests were performed on the recovered samples to determine the engineering characteristics and for additional verification of the field classifications in accordance with ASTM D 2487. The results of these tests, including in-situ moisture content, dry density, plasticity (Atterberg Limits), and unconfined compressive strength of soil are presented in Appendix II.

GEOLOGY/SUBSURFACE CONDITIONS

The site soils consist of existing topsoil/gravel, fill soil and natural clay soils; **fills were encountered at the majority of test borings at depths ranging from 5.0 to 13.5 feet from existing grade. The auger refusal encountered at boring B-2 at 13.0 feet below existing grade is assumed to be the part of the fills.** Topsoil was encountered in all of the test borings with the exception of boring B-7 and B-8 located on the contractor's storage yard covered with gravel. Topsoil extended from the ground surface to approximate depths ranging from 6 inches to 12 inches below existing grade. The majority of the upper 1.0 to 5.0 feet of the existing fill clay is comprised of high plasticity (fat) clay soils. The underlying existing fill or native clay materials are comprised of low plasticity (lean) clay and high plasticity clay soils. The existing native and fill clay soils are generally moist to wet and exhibit soft to very stiff consistency. The Unified Soil Classification System classifies low plasticity (lean) clay soils as CL and high plasticity (fat) clay soils as CH.

During advancement of the borings, free water was not encountered in any of the test borings. It should be noted that water level determinations made in relatively impervious (clay) soils might not present a reliable indication of the actual water table. However, water level determinations made in relatively pervious (sand/silt) soils are considered an accurate indication of the water table at the time that those measurements are made. Fluctuations in the water table should be expected with changing seasons and annual differences.

DESIGN CRITERIA AND RECOMMENDATIONS

Laboratory test results of the recovered samples showed the following characteristics that were used as criteria for determining the recommendations for bearing values and design data:

In-Situ Moisture .... 10.8 to 30.2%
Dry Density.. 94.8 to 107.1 pcf
Liquid Limit .... 51 to 64
Plasticity Index .... 24 to 40
Unconfined Compressive Strength .... 2,379 to 6,142 psf

Seismic Considerations

Based on the International Building Code (IBC) Section 1613.1 of the 2021 IBC, the subsurface stratigraphy, and the use of shallow foundations bearing on existing site soils, the general Site Class Definition for the structures bearing on soil is Site Class D.

Site Preparation and Engineered Fill

Proposed finish floor elevation was identified as 993.1. Based on the given finish floor elevation and estimated elevations from Google Earth Mapping, it appears that 3 to 10' cut operations would be anticipated, and appropriate mass grading would be required to accommodate finish floor elevations, appropriate taxiway/drive lane pavement grades and stormwater detention facilities.

Areas to receive fill should be stripped of vegetation, topsoil, pavement, and any other deleterious materials. Any isolated areas of soft or deleterious materials encountered at subgrade elevation should be removed and replaced with engineered fill. The moisture content of the subgrade soils should be appropriate to achieve the required compaction.

Proper drainage of the construction area should be provided to protect foundations, floor slabs, and pavement subgrades from the detrimental effects of weather conditions. Excavations should be kept as dry as possible. Any loose or soft materials which accumulate or develop on subgrade or bearing surfaces should be removed prior to the placement of concrete or pavement sections. The natural soil is lean and silty and by nature easily disturbed by construction traffic. Construction traffic, including foot traffic, should be minimized. Concrete should be placed in footing excavations as soon as possible after excavations are complete.

Trucks and other heavy construction vehicles should be restricted as much as possible from trafficking on the finished subgrade in the building to prevent unnecessary disturbances of subgrade soils. Excessive rutting or pumping of the subgrade could occur from construction traffic, particularly during periods of wet weather. If such disturbed areas develop, the subgrade may have to be excavated and replaced with properly compacted fill.

Concrete for foundations should be placed as soon after completion of the excavations as possible to avoid disturbance of the bearing material by inflow of surface water, groundwater, or precipitation.

Supplemental engineered fill should be placed in uniform horizontal lifts, with loose thicknesses not exceeding eight inches. The thickness must be appropriate for the method of compaction and the type of equipment used. The geotechnical engineer should approve any off-site material proposed for use as fill. Engineered fill should be compacted to a minimum of 95 percent of maximum density as determined by ASTM D698 (standard Proctor test) at moisture content between 0 and 4 percent above optimum moisture for high plasticity clay material and from -2 to +2 from optimum moisture content for low plasticity clays. The existing site soils may be used for fill material so long as they meet the requirements presented in the Building Pad Fill or Parking Lot Fill sections below.

The fill should be benched in any sloped areas greater than one vertical to five horizontal in order to maintain relatively horizontal lifts. The benching should be placed at not less than 12-inch rises over those areas where it is required as the work is brought up in layers.

Building Pad – The soils encountered on site below one foot from existing grade are classified as unacceptable for use as LVC below slab on grade and pavement subgrade due to the inconsistent composition of existing fill. Material used in the top 18 inches of the building pad should be a low volume change (LVC) material. Acceptable LVC material is any soil type that has a Liquid Limit (LL) of less than 45 and a Plasticity Index (PI) of less than 25. Crushed rock or sand materials are also considered to be LVC material. The soils encountered on site do not meet the requirements for LVC material.

<u>Foundation Options</u>

The existing fill soils present at the site exhibit varying unconfined strengths ranging from 2379 to 6142 psf. We believe the soils at this site within the zone of influence of foundation loads to be uncontrolled/undocumented fills. Because of this condition and the varying bearing capacity of the existing site fill soils, we have identified several options for foundation bearing for the building. Options 1 and 2 identify potential shallow foundation applications but do indicate the potential of varying degrees of potential overall and differential settlement in the fill soils and structure. Option 3 identifies a recommended deep foundation alternative that we believe is appropriate for the proposed structure.

Option 1: Shallow foundations bearing on controlled fill. This option would involve removal and replacement of the existing uncontrolled fills from beneath the proposed foundation elements and backfilled with compacted structural fill. If the owner is willing to accept the risk of potential post construction settlement, the building foundation could be supported on properly placed structural fill with a minimum thickness of 5 feet below bearing elevations extending at least 3 feet beyond each side of the foundation element. The bearing capacity achievable with this option using properly compacted soil can be assumed 1,500 pounds per square foot (psf) for continuous, and 2,000 pounds per square foot (psf) for rectangular footings. Estimated differential settlement from foundations load ranges from 3 to 4 over 50 feet. The minimum frost depth for this area is 36 inches.

Option 2: Shallow foundations bearing on reinforced engineered fill. The entire building addition area plus a minimum of 2 feet all around would be excavated to a depth of 7 feet beneath existing ground surface. A geogrid reinforced engineered fill 24 inches thick would then be placed in the excavation. The fill material should be crusher-run limestone with fines, such as MODOT Type V or other road base rock. Tensar BX-1200 geogrids would be placed at the bottom and in the middle of the 24-inch crushed stone fill. Controlled fill within the building area would then be placed over the geogrid-reinforced fill up to slab elevation. Footing excavations would be dug directly into and bear on the controlled structural fill above the reinforced engineered fill. An allowable bearing capacity of 2,000 psf could be assumed for both continuous and rectangular footings bearing on the engineered reinforced fill.

Excavated site materials placed per the Site Preparation and Engineered Fill section included earlier are acceptable as Controlled Fill for Options 1 and 2.

Options 1 & 2 would not reduce settlement to the extent that Option 3 would. It is our opinion that Option 2 would reduce total settlement to some extent and would also tend to reduce differential settlement. The reinforced engineered fill would also provide a stable platform on which to compact the infill.

As previously discussed, it is difficult to model uncontrolled fill deposits and bearing conditions might vary within the footprint of the building. It is anticipated that about 4 inches (+/-) of total settlement could occur. The structural engineer and the owner should weigh the risk and impact to the structure of settlement of this magnitude before employing Option 1 and 2. If Option 1 is chosen, settlement plates could be installed during construction to monitor settlement. This information could be used to estimate when enough settlement has occurred over time that buried utilities, if needed, could be safely placed. If the owner chooses not to accept the risk of settlement, we recommend using a deep foundation system of rammed aggregate piers as outlined below.

We recommend that all foundation excavations be evaluated and tested by the geotechnical engineer immediately prior to placement of foundation concrete. Unsuitable areas identified at this time should be corrected. Corrective procedures would be dependent upon conditions encountered and may include deepening of foundation elements or undercutting of unsuitable materials and replacement with controlled structural fill. The base of all footing excavations should be free of all water and loose material prior to placing concrete. Concrete should be placed as soon as possible after excavating so that excessive drying or disturbance of bearing materials does not occur. Should the materials at bearing level become excessively dry or saturated, we recommend that the affected material be removed prior to placing concrete.

Option 3: Stone Columns/Rammed Aggregate Piers. The site appears to be a good candidate for the use of stone columns or rammed aggregate piers. These foundation types utilize proprietary design and installation techniques. Local installers should be contacted to provide design for these systems. Firms with installation experience in this area include:

- Ground Improvement Engineering
- Hayward Baker Geotechnical Construction

Stone columns or rammed aggregate pier foundation elements will provide several benefits. The column or pier will provide dense high modulus element which will act like a deep foundation element and transmit the building loads through questionable soil to a deeper more competent soil layer. The installation process will also densify the upper layers of soil which will reduce anticipated settlements below the new structure. Although the final bearing capacity would be identified by the rammed aggregate pier designer values in the range of 4000 psf are attainable.

Slab on Grade

Recommendations for type and placement of fill material are presented in the Site Preparation and Engineered Fill section of this report. The existing fill site soils were found to be unacceptable for use in the upper 18 inches of the subgrade below the slab on grade as they are not classified as LVC material. Well graded crushed aggregate materials such as MoDOT Type 5 are acceptable for use as LVC material below the slab and the 6 inches of drainage layer.

Movement between slabs on grade and walls may occur. To minimize the effects of this movement, we recommend that slip joints be incorporated between all slabs and walls. All slabs should contain crack control and construction joints, which are formed on 15 to 25 foot centers, each way, or as designed by the project structural engineer. To prevent moisture movement through the slab on grade a capillary moisture barrier is recommended to be placed under the slabs. This barrier should be a minimum of a 6-inch thick layer of clean granular material extending to the limits of the foundation walls. Should additional moisture protection be desired, it should consist of 6-mil polyethylene sheeting placed between the slab and the base course. The use of clean gravel for a capillary break or polyethylene would not be necessary if another form of moisture protection is planned to be used. Appropriate consideration of slab curling for this condition should be undertaken. For the purpose of slab design, a modulus of subgrade reaction (k) of 100 pounds/cubic inch is suggested for a subgrade consisting of well-compacted, plastic clay fill and a modulus of subgrade reaction (k) of 200 pounds/cubic inch is suggested for a subgrade consisting of compacted well graded aggregate or modified site soils. Actual slab thickness will depend on anticipated loading but is not recommended to be less than 4 inches.

Surface Drainage

In order to reduce the problems related to water infiltration, it is recommended that the final grade around the structure perimeters have a positive slope extending at least six feet away from the structure. Backfill of soils around the foundation should be compacted at a minimum of 95 percent of maximum dry density at moisture content between optimum and four percent above optimum in accordance with ASTM D 698.

Subsurface Drainage

Groundwater was not encountered and is not expected to be a problem, although infiltration of surface water and/or perched groundwater could occur. It would be prudent to construct a drain system around the perimeter of below-grade structures or footings. The perimeter drain system should consist of 4-inch PVC or equivalent pipe with at least ¼-inch perforations routed to a sump or by gravity to the exterior. The pipe should be laid with the perforations down and enveloped with gravel. The gravel should be surrounded with Mirafi 140 filter cloth or equivalent.

Excavation Considerations

We believe that the project soils are Type B as classified in the OSHA Excavation Standard Handbook 29 CFR Parts 1926.650 through 1926.652. Type B soils are characterized by cohesive soils above the water table with unconfined compressive strengths greater than 0.5 tons per square foot (tsf) but less than and 1.5 tsf. Type B soils include any fill soils meeting or exceeding the above criteria, as well as undisturbed soils with unconfined compressive strengths of >1.5 tsf which are subject to vibration from traffic. Temporary excavation slopes for Type B soils can be one horizontal to one vertical with a maximum excavation depth of 20 feet.

Excavations deeper than 20 feet may require the use of supplemental shoring and will require the preparation of an excavation design prepared by a registered professional engineer.

Excavation of trenches may extend into the weathered bedrock materials. Excavation of the upper zones of the weathered bedrock material may be performed with conventional excavation equipment. At borings and elevations where augur refusal was encountered, additional effort may be required to excavate the weathered bedrock materials (i.e. rock hammer, etc.).

Trench Backfill

According to our findings, excavated site materials may be used as backfill for trench excavation. Backfill should not be placed on soft materials or frozen ground. Soil backfill overlying the bedding should be placed in uniform horizontal lifts, with loose thicknesses not exceeding eight inches. The thickness must be appropriate for the method of compaction and the type of equipment used. The geotechnical engineer should approve any off-site material proposed for use as fill. Trench backfill under driveways/parking lots should be compacted to a minimum of 95 percent of maximum density as defined by Standard Proctor (ASTM D 698) at moisture content according to the recommendations presented in the Site Preparation and Engineered Fill section of this report. In common yard areas, the soil backfill should be compacted to a minimum of 90 percent of maximum density (ASTM D 698) using the above moisture parameters. After preparation of the trench bottom, a pipe bed of a minimum of 6" shall be prepared using crushed stone or crushed gravel meeting the following requirements:

Nominal Pipe Size Diameter	AASHTO M43 Size
15" or Less	67, 7, 8 or washed #9
Greater than 15"	57, 6, or 67

Manhole/Inlet Structure Backfill

Soil backfill around structures should be placed in uniform horizontal lifts, with loose thicknesses not exceeding eight inches. The thickness must be appropriate for the method of compaction and the type of equipment used. The geotechnical engineer should approve any off-site material proposed for use as fill. Backfill should be compacted to a minimum of 95 percent of maximum density as defined by Standard Proctor (ASTM D 698) at a moisture content between 0 and 4 percent above optimum moisture (preferred average of plus 2 percent). Another option is to backfill with a Controlled Low Strength Material (CLSM), or flowable fill. The flowable fill should exhibit a minimum unconfined compressive strength of 250 psi after 28 days. Bedding material for manhole/inlet structure should be clean crushed rock conforming to the following gradation:

Sieve Designation	Percent Passing by Weight
1 ½"	100
No. 4	0 – 35
No. 200	0 – 8

PAVEMENT RECOMMENDATIONS

Pavement Subgrade Preparation

Pavement subgrades should be prepared in accordance with the recommendations presented in the SITE PREPARATION and ENGINEERED FILL section of this report. Construction scheduling, involving paving and grading by separate contractors, typically results in a time lapse between the end of grading operations and the commencement of paving. Disturbance, desiccation, and/or wetting of the subgrade between grading and paving can result in deterioration of the previously completed subgrade. A non-uniform subgrade can result in poor pavement performance and local failures relatively soon after pavements are constructed.

We recommend that the pavement subgrade be proofrolled and the moisture content and density of the top 12 inches checked within two days prior to placement of pavement. If any significant event, such as precipitation, occurs after proofrolling, the subgrade should be reviewed by a representative of KTI immediately prior to placing the pavement. The subgrade should be in its finished form at the time of the final review.

The existing parking/drive/taxiway subgrade soils were not tested for the California Bearing Ratio (CBR); however, unconfined compressive strength tests were conducted on samples of in-place clay soils at the anticipated parking lot subgrade elevation. The estimated California Bearing Ratio (CBR) of the subgrade sample is 1 to 3.0%. **The majority of the top two feet of the native soils are highly expansive and we recommend stabilizing the top 12 inches of the parent soil with 15% flyash, 6% cement or hydrated lime compacted to 95% of maximum dry density at 0 to 2% above the optimum moisture content as determined by ASTM D698.**

The following options for construction of the parking/drive/taxiway areas are being considered by the project. It is understood that moderate to high levels of truck/airplane traffic may be experienced by the proposed pavement areas.

<u>Asphaltic Cement Concrete Pavements</u>

Full depth recommended flexible pavement sections are presented in Table 1. The pavement profiles presented below for drive lanes and parking stalls assume only passenger vehicle loading. A heavy-duty pavement section is presented for planes, emergency vehicles and garbage trucks. Passenger vehicles are defined as two-axle, four-wheel vehicles (cars, trucks, vans and SUVs).

Table 1

Asphaltic Cement Concrete Pavement on Modified Subgrade (Minimum)

Material	Parking Stalls	Drive Lanes	Heavy Duty
Surface Course	1.5-inch	2-inch	2-inch
Base Course	2.5-inch	4-inch	6-inch
Aggregate Base	6-inch	6-inch	6-inch

The asphaltic base course should be compacted to a minimum of 95 percent of the mixture's Marshall density, when determined in accordance with ASTM D 6926. The surface course should have a minimum Marshall stability of 1800 pounds and be compacted to a minimum of 97 percent of the mixture's Marshall density, when determined in accordance with ASTM D 6926.

Portland Cement Concrete Pavements

Based on the soil types encountered in the proposed parking/drive areas and previous experience with materials of this type, an effective resilient modulus of 100-pci was estimated for design of ridged pavements on unimproved subgrades. If a stabilized subgrade is used, a resilient modulus of 200-pci is suggested.

Portland cement concrete (PCC) pavements are recommended for drive approaches; loading dock aprons, trash dumpster pads and approaches, loading/unloading areas, and other areas where heavy wheel loads will be concentrated. We recommend that the concrete pavements in areas receiving heavy truck traffic have a minimum thickness of 8 inches. If PCC pavements are considered for passenger vehicle areas, we recommend a minimum thickness of 5 inches.

It is also recommended that a 4-inch leveling and drainage course of clean, crushed rock be placed below all PCC pavements and that appropriate sub drainage or connection to a suitable gravity outfall be provided to remove water from the drainage layer.

The mixture should be designed to develop a minimum compressive strength of 4000 psi at 28 days with a 4-inch maximum slump and 5 to 7 percent entrained air. Where Portland cement concrete is used, load transfer devices should be installed at all construction joints or post-placement sawed joints.

Construction Considerations

Construction traffic on the pavements has not been considered in the recommended typical sections. If construction scheduling dictates the pavements will be subject to traffic by construction equipment/vehicles, the pavement thickness should be reconsidered to include the effects of the additional traffic loading. Construction traffic should not be allowed on partially completed pavements as the pavements will not have adequate structural capacity and could be damaged.

Periodic maintenance of all of the pavements should be anticipated. This should include sealing of cracks and joints and by maintaining proper surface drainage to avoid ponding water on or near the pavement areas.

Pavement Drainage

The granular section should be graded to adjacent storm sewer inlets or drainage ditches and provisions should be made to provide drainage from the granular section into the storm sewer. Drainage of the granular base is particularly important where two different sections of pavements (such as full-depth asphaltic concrete and Portland cement concrete with aggregate base) abut, so that water does not pond beneath the pavements and saturate the subgrade soils.

The performance of pavements will be dependent upon a number of factors, including subgrade conditions at the time of paving, rainwater runoff, and traffic. Rainwater runoff should not be allowed to seep below pavements from adjacent areas. All pavements should be sloped approximately 1/4 inch per foot to provide rapid surface drainage. Proper drainage below the pavement section helps prevent softening of the subgrade and has a significant impact on pavement performance and pavement life. Therefore, we recommend that a granular blanket drain be constructed at all storm sewer inlets within the pavement areas. The blanket drain should consist of clean, crushed stone aggregate extending a minimum of 6 inches below pavement subgrade level. The blanket drains should extend radially a minimum of 8 feet from each of the storm sewer inlets. The grade within the blanket drain should be sloped toward the storm sewer inlet, and weep holes should be drilled through the inlet to provide drainage of the granular section into the inlet. Placement of geotextile filter fabric across the weep holes could be considered to prevent loss of aggregate through the weep holes. These recommendations are very important for long-term performance of the pavements. Because pavements typically have relatively low factors of safety, it will be very important that the specifications are followed closely during pavement construction.

Based on our experience with similar projects, irrigation systems are commonly installed in the landscaped areas adjacent to portions of the pavement areas. If such an irrigation system is to be installed, we recommend that consideration be given to installing subsurface drainage lines between irrigated areas and the planned pavements. It has been our experience that the quantity of subsurface seepage originating from irrigated areas can be substantial and can adversely affect the performance of the pavement subgrade. Therefore, consideration should be given to constructing edge drain lines along the pavements located adjacent to irrigated areas, to intercept and divert subsurface water flows from beneath the pavements. These lines should be constructed behind the curb lines, on the upgradient side of the pavements, and should be sloped to provide positive gravity flow to a suitable outfall.

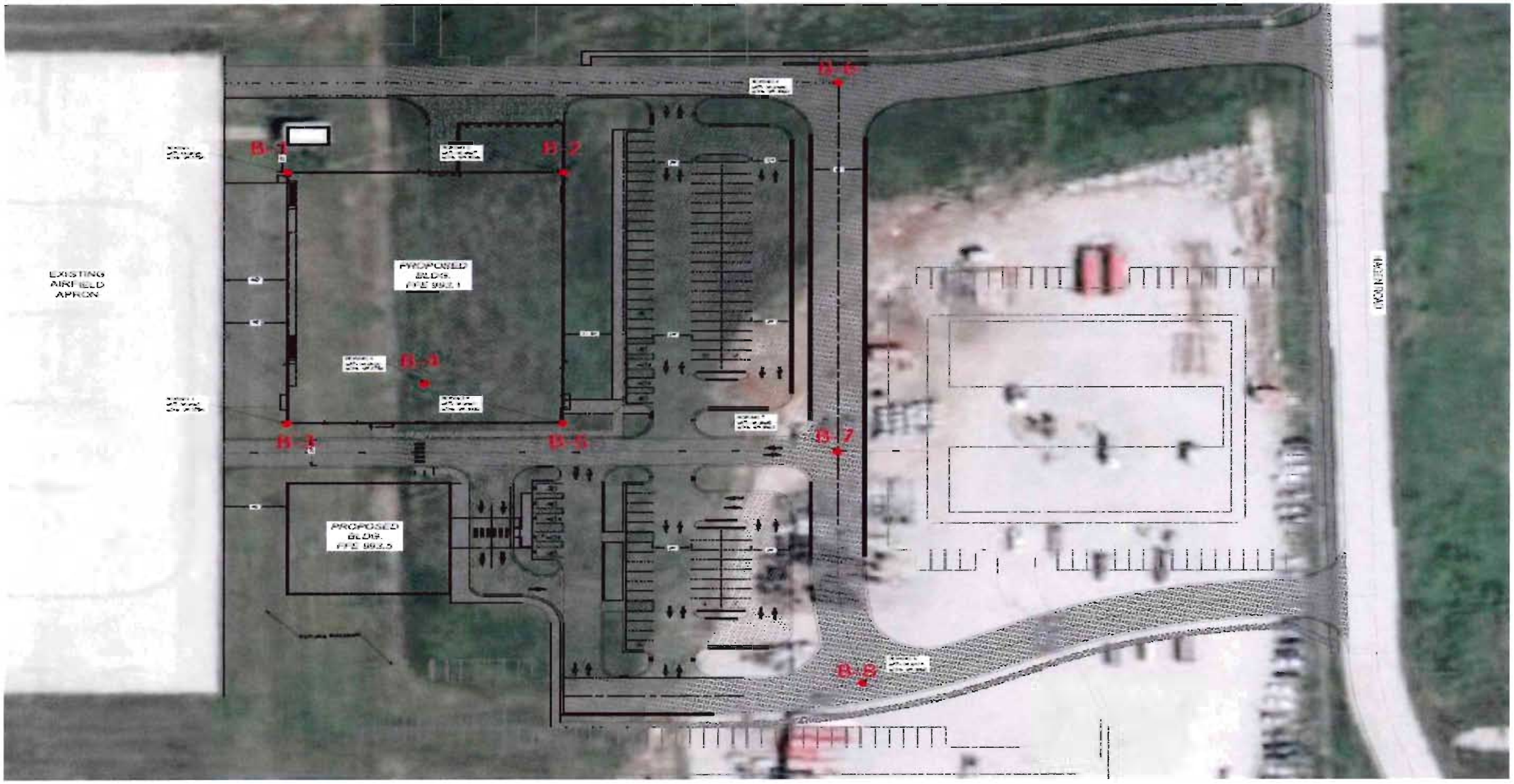
REMARKS

It is recommended that the geotechnical engineer be retained to review the plans and specifications for the project so that an evaluation and comments can be provided regarding the proper incorporation of information from this geotechnical report into the final construction documents. We further recommend that the geotechnical engineer be retained during construction phases for earthwork, pavement, and foundations to provide observation and testing to aid in determining that design intent has been accomplished.

The findings, recommendations, and suggestions contained in this report are our opinions based on data acquired to date and are assumed to be representative of conditions at locations between borings. Due to the fact that the area at the borings is very small relative to the overall site, and for other reasons, we make no statement warranting the conditions below our borings or at other locations throughout the site. In addition, we do not warrant that the general strata logged at the borings are necessarily typical of the remaining areas of the site.

Reports shall not be reproduced except in full, without written approval of KTI. Information in this report applies only to the referenced project in its present configuration and location and shall not be used for any other project or location.

BORING LOCATION DIAGRAM



Boring Location Diagram
LXT Eastside Development
Lee's Summit, Missouri

KRUGER TECHNOLOGIES, INC.

Drawn: TMA	**Date:** 7/11/23	**KTI Project No.** 223110G

APPENDIX I

Boring Logs

LOG OF TEST BORING

BORING B-1

PROJECT: CMT (Crawford, Murphy, & Tilly)-KC
DATE: 7/18/2023
CLIENT: LXT Eastside Development
ELEVATION: 996
PROJECT NO.: 223110G **START:** 6/13/23
FINISH: 6/13/23
BORING LOCATION: See Boring Location Plan
METHOD OF DRILLING: 4" Continuous Flight Augers
LOGGER:
DEPTH TO - water None0 **caving**
DATE CHECKED:

ELEVATION/ DEPTH	SOIL SYMBOLS SAMPLER SYMBOLS AND FIELD TEST DATA	USCS	Description	Sample # & Type	Density pcf	Moist- ure, %	Qu, psf
996 / 0		T	Topsoil				
		CH	Fill, fat clay with gravel, stiff, brown, moist	1, ST	94.8	18.6	
993 / 3		FILL	Fill, lean to fat clay, trace gravel, very stiff, dark brown and orange, moist	2, ST	98.5	21.8	6142
990 / 6							
987 / 9	4/6" 4/6" 6/6"	CL	Lean clay, stiff, gray, moist	1, SS		23.1	
984 / 12							
	3/6" 3/6" 4/6"		Lean clay, medium stiff, grayish brown, moist	2, SS		20.6	
981 / 15							
978 / 18	3/6" 5/6" 7/6"		Lean to fat clay, stiff, brown, moist	3, SS		24.3	
			Drilling discontinued at 20.0 feet				
975 / 21							

Notes:

LOG OF TEST BORING
BORING B-2

PROJECT: CMT (Crawford, Murphy, & Tilly)-KC
CLIENT: LXT Eastside Development
PROJECT NO.: 223110G **START:** 6/13/23
BORING LOCATION: See Boring Location Plan
METHOD OF DRILLING: 4" Continuous Flight Augers
DEPTH TO - water None0 **caving**

DATE: 7/18/2023
ELEVATION: 998
FINISH: 6/13/23
LOGGER:
DATE CHECKED:

ELEVATION/ DEPTH	SOIL SYMBOLS SAMPLER SYMBOLS AND FIELD TEST DATA	USCS	Description	Sample # & Type	Density pcf	Moist-ure, %	Qu, psf
0		T	Topsoil				
996		FILL	Fill, lean to fat clay with gravel, stiff, brown, moist	1, ST	107.1	14.5	
3		FILL	Fill, fat clay with organics and trace gravel, stiff, dark brown to black, moist	2, ST	99.0	22.9	3755
9	3/6" 3/6" 4/6"	FILL	Fill, lean to fat clay, medium stiff, brown and gray, moist	1, SS		28.5	
13.5			Drilling discontinued at auger refusal at 13.5 feet				

Depth scale: 0, 3, 6, 9, 12, 15, 18, 21; Elevation scale: 996, 993, 990, 987, 984, 981, 978

Notes:

LOG OF TEST BORING
BORING B-3

PROJECT: CMT (Crawford, Murphy, & Tilly)-KC
CLIENT: LXT Eastside Development
PROJECT NO.: 223110G **START:** 6/13/23
BORING LOCATION: See Boring Location Plan
METHOD OF DRILLING: 4" Continuous Flight Augers
DEPTH TO - water None0 **caving**

DATE: 7/18/2023
ELEVATION: 996
FINISH: 6/13/23

LOGGER:
DATE CHECKED:

ELEVATION/ DEPTH	SOIL SYMBOLS SAMPLER SYMBOLS AND FIELD TEST DATA	USCS	Description	Sample # & Type	Density pcf	Moist-ure, %	Qu, psf
996 — 0		T	Topsoil				
		FILL	Fill, fat clay trace organics, stiff, dark brown and light brown, moist	1, ST	98.2	22.1	
993 — 3		FILL	Fill, fat clay with organics, stiff, greenish gray, moist	2, ST	101.7	23.7	5347
990 — 6							
987 — 9	4/6" 4/6" 6/6"	CL-CH	Lean to fat clay, stiff, brown, moist	1, SS		21.2	
984 — 12							
	3/6" 4/6" 6/6"	CL-CH	Lean to fat clay, stiff, brown, moist	2, SS		24.9	
981 — 15							
978 — 18							
	2/6" 3/6" 3/6"	CH	Fat clay, medium stiff, gray, moist	3, SS		29.4	
			Drilling discontinued at 20.0 feet				
975 — 21							

Notes:

LOG OF TEST BORING
BORING B-4

PROJECT: CMT (Crawford, Murphy, & Tilly)-KC
CLIENT: LXT Eastside Development
PROJECT NO.: 223110G **START:** 6/13/23
BORING LOCATION: See Boring Location Plan
METHOD OF DRILLING: 4" Continuous Flight Augers
DEPTH TO - water None0 **caving**

DATE: 7/18/2023
ELEVATION: 1004
FINISH: 6/13/23
LOGGER:
DATE CHECKED:

ELEVATION/ DEPTH: 0, 1002, 3, 999, 6, 996, 9, 993, 12, 990, 15, 987, 18, 984, 21

SOIL SYMBOLS SAMPLER SYMBOLS AND FIELD TEST DATA	USCS	Description	Sample # & Type	Density pcf	Moist-ure, %	Qu, psf
	T	Topsoil				
	FILL	Fill, fat clay with gravel, stiff, orange and light brown, moist	1, ST	97.4	19.9	
	FILL	Fill, fat clay with gravel and organics, very stiff, dark brown, moist	2, ST	103.9	22.0	3574
3/6" 4/6" 5/6"	FILL	Fill, lean to fat clay, stiff, brown and gray, moist	1, SS		24.8	
3/6" 50/6"	FILL	Fill fat clay with boulders, hard, gray and brown	2, SS		20.1	
3/6" 5/6" 6/6"	CL	Lean clay, stiff, gray, wet	3, SS		29.0	
		Drilling discontinued at 20.0 feet				

Notes:

LOG OF TEST BORING

BORING B-5

PROJECT: CMT (Crawford, Murphy, & Tilly)-KC
CLIENT: LXT Eastside Development
PROJECT NO.: 223110G **START:** 6/13/23
BORING LOCATION: See Boring Location Plan
METHOD OF DRILLING: 4" Continuous Flight Augers
DEPTH TO - water None0 **caving**

DATE: 7/18/2023
ELEVATION: 1003
FINISH: 6/13/23

LOGGER:
DATE CHECKED:

SOIL SYMBOLS SAMPLER SYMBOLS AND FIELD TEST DATA	USCS	Description	Sample # & Type	Density pcf	Moist-ure, %	Qu, psf
	T	Topsoil				
	FILL	Fill, fat clay with gravel, dark brown, moist	1, ST	101.3	10.8	
	FILL	Fill, fat clay with gravel, light grayish brown, moist	2, ST	100.1	21.6	2379
4/6" 4/6" 5/6"		Fill, lean to fat clay, stiff, gray and brown, wet	1, SS		30.2	
4/6" 5/6" 7/6"	CL	Lean clay, stiff, brown, moist	2, SS		23.0	
4/6" 5/6" 6/6"	CL	Lean clay, stiff, brown, moist	3, SS		20.9	
		Drilling discontinued at 20.0 feet				

ELEVATION/DEPTH scale: 0, 1002, 3, 999, 6, 996, 9, 993, 12, 990, 15, 987, 18, 984, 21, 981

Notes:

LOG OF TEST BORING
BORING B-6

PROJECT: CMT (Crawford, Murphy, & Tilly)-KC
CLIENT: LXT Eastside Development
PROJECT NO.: 223110G **START:** 6/13/23
BORING LOCATION: See Boring Location Plan
METHOD OF DRILLING: 4" Continuous Flight Augers
DEPTH TO - water None0 **caving**

DATE: 7/18/2023
ELEVATION: 991
FINISH: 6/13/23
LOGGER:
DATE CHECKED:

ELEVATION/ DEPTH	SOIL SYMBOLS SAMPLER SYMBOLS AND FIELD TEST DATA	USCS	Description	Sample # & Type	Density pcf	Moist-ure, %	Qu, psf
0		T	Topsoil				
990		FILL	Fill, fat clay trace gravel, stiff, dark brown, moist	1, ST	97.8	21.3	3489
3 / 987	1/6" 1/6" 2/6"	FILL	Fill, fat clay trace gravel, soft, dark brown, moist	1, SS		22.9	
			Drilling discontinued at 5.0 feet				

Depth scale: 0, 3, 6, 9, 12, 15, 18, 21
Elevation scale: 990, 987, 984, 981, 978, 975, 972, 969

Notes:

LOG OF TEST BORING

BORING B-7

PROJECT: CMT (Crawford, Murphy, & Tilly)-KC
DATE: 7/18/2023
CLIENT: LXT Eastside Development
ELEVATION: 989
PROJECT NO.: 223110G **START:** 6/13/23
FINISH: 6/13/23
BORING LOCATION: See Boring Location Plan
METHOD OF DRILLING: 4" Continuous Flight Augers
LOGGER:
DEPTH TO - water None0 **caving**
DATE CHECKED:

ELEVATION/ DEPTH	SOIL SYMBOLS SAMPLER SYMBOLS AND FIELD TEST DATA	USCS	Description	Sample # & Type	Density pcf	Moist-ure, %	Qu, psf
0		GP	Poorly graded gravel				
		FILL	Fill, fat clay with gravel, brown, moist to dry				
987		FILL	Fill, lean to fat clay with gravel. very stiff, orange brown, moist	1, ST		23	
3	5/6" 6/6" 8/6"	CL-CH	Lean to fat clay, stiff, gray, moist	1, SS		23.3	
984			Drilling discontinued at 5.0 feet				

Depth scale: 0, 3, 6, 9, 12, 15, 18, 21; Elevation scale: 987, 984, 981, 978, 975, 972, 969

Notes:

LOG OF TEST BORING
BORING B-8

PROJECT: CMT (Crawford, Murphy, & Tilly)-KC
CLIENT: LXT Eastside Development
PROJECT NO.: 223110G **START:** 6/13/23
BORING LOCATION: See Boring Location Plan
METHOD OF DRILLING: 4" Continuous Flight Augers
DEPTH TO - water None0 **caving**

DATE: 7/18/2023
ELEVATION: 993
FINISH: 6/13/23
LOGGER:
DATE CHECKED:

ELEVATION/ DEPTH	SOIL SYMBOLS SAMPLER SYMBOLS AND FIELD TEST DATA	USCS	Description	Sample # & Type	Density pcf	Moist-ure, %	Qu, psf
993 — 0		GP	Poorly graded gravel				
		FILL	Fill, fat clay with gravel, brown, moist to dry				
		FILL	Fill, fat clay with gravel, very stiff, olive gray, moist	1, ST	102.9	15.7	2985
990 — 3							
	5/6" 6/6" 8/6"	FILL	Fill, lean to fat clay trace gravel, stiff, grayish brown, moist	1, SS		20.9	
			Drilling discontinued at 5.0 feet				
987 — 6							
984 — 9							
981 — 12							
978 — 15							
975 — 18							
972 — 21							

Notes:

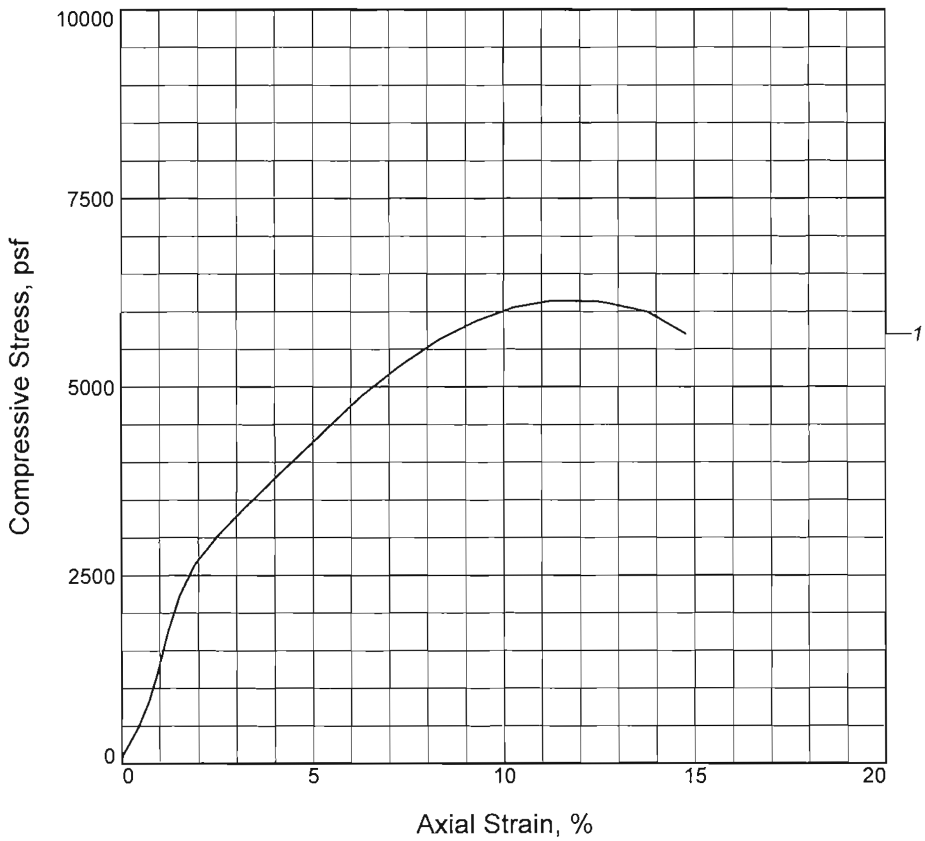
APPENDIX II

Laboratory Results

SUMMARY OF LABORATORY TEST RESULTS

Boring	Depth (Ft)	Sample No./Type	Natural Moisture %	Natural Dry Density (pcf)	Unconfined Compressive Strength (psf)	Atterberg Limits		Soil Type
						Liquid Limit %	Plasticity Index %	
B-1	1.0-3.0	ST-1	18.6	94.8		51	24	CH
B-1	3.0-5.0	ST-2	21.8	98.5	6142			
B-1	8.5-10.0	SS-1	23.1					
B-1	13.5-15.0	SS-2	20.6					
B-1	18.5-20.0	SS-3	24.3					
B-2	1.0-3.0	ST-1	14.5	107.1				
B-2	3.0-5.0	ST-2	22.9	99.0	3755			
B-2	8.5-10.0	SS-1	28.5					
B-3	1.0-3.0	ST-1	22.1	95.2		64	40	CH
B-3	3.0-5.0	ST-2	23.7	101.7	5347			
B-3	8.5-10.0	SS-1	21.2					
B-3	13.5-15.0	SS-2	24.9					
B-3	18.5-20.0	SS-3	29.4					
B-4	1.0-3.0	ST-1	19.9	97.4				
B-4	3.0-5.0	ST-2	22.0	103.9	3574			
B-4	8.5-10.0	SS-1	24.8					
B-4	13.5-15.0	SS-2	20.1					
B-4	18.8-20.0	SS-3	29.0					
B-5	1.0-3.0	ST-1	10.8	101.3				
B-5	3.0-5.0	ST-2	21.6	100.1	2379			
B-5	8.5-10.0	SS-1	30.2					
B-5	13.5-15.0	SS-2	23.0					
B-5	18.5-20.0	SS-3	20.9					
B-6	1.0-3.0	ST-1	21.3	97.8	3489	52	30	CH
B-6	3.5-5.0	SS-1	22.9					
B-7	1.0-3.0	ST-1	23					
B-7	3.5-5.0	SS-1	23.3					
B-8	1.0-3.0	ST-1	15.7	102.1	2985	53	31	CH
B-8	3.5-5.0	SS-1	20.9					

UNCONFINED COMPRESSION TEST



Sample No.	1			
Unconfined strength, psf	6142			
Undrained shear strength, psf	3071			
Failure strain, %	11.3			
Strain rate, in./min.	0.050			
Water content, %	21.8			
Wet density, pcf	120.0			
Dry density, pcf	98.5			
Saturation, %	82.0			
Void ratio	0.7247			
Specimen diameter, in.	2.82			
Specimen height, in.	5.71			
Height/diameter ratio	2.02			

Description: Fill, lean to fat clay, trace gravel, very stiff, dark brown and orange, moist

LL =	**PL =**	**PI =**	**Assumed GS=** 2.72	**Type:** ST

Project No.: 223110G
Date Sampled: 6/18/23
Remarks:

Client: LXT Eastside Development

Project: CMT (Crawford, Murphy, & Tilly)-KC

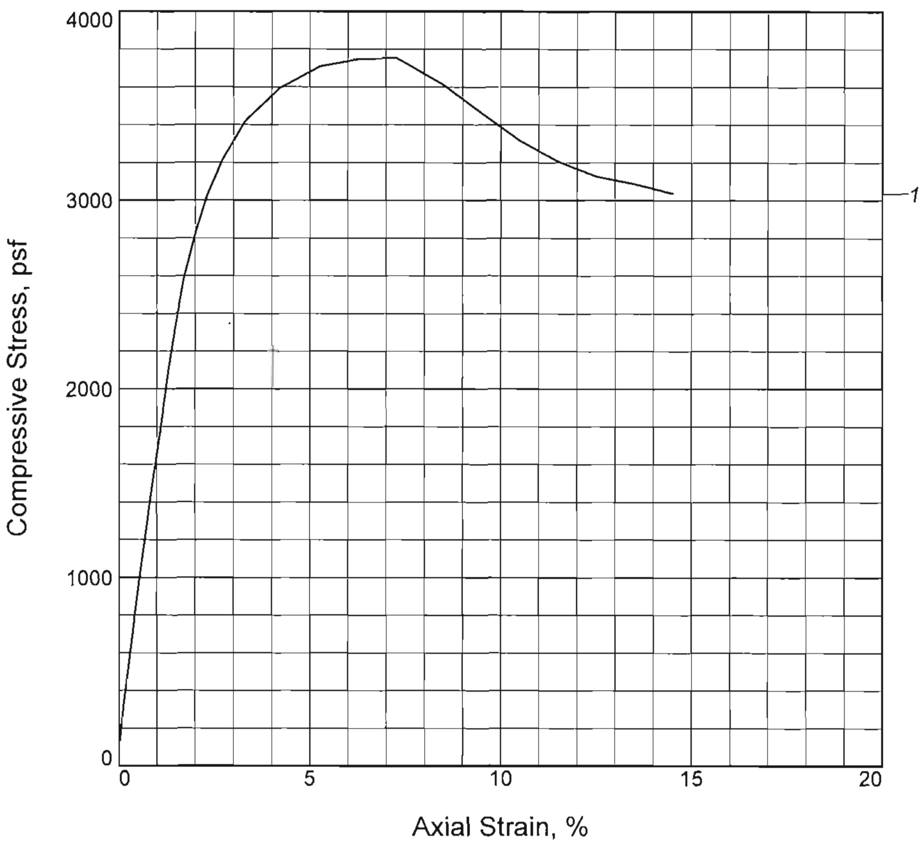
Source of Sample: B-1 **Depth:** 3
Sample Number: 2

KTI

Figure ________

Tested By: TMA **Checked By:** OJK

UNCONFINED COMPRESSION TEST



Sample No.	1			
Unconfined strength, psf	3755			
Undrained shear strength, psf	1878			
Failure strain, %	7.3			
Strain rate, in./min.	0.050			
Water content, %	22.9			
Wet density, pcf	121.7			
Dry density, pcf	99.0			
Saturation, %	87.0			
Void ratio	0.7144			
Specimen diameter, in.	2.81			
Specimen height, in.	5.91			
Height/diameter ratio	2.10			

Description: Fill, fat clay with organics and trace gravel, stiff, dark brown to black, moist

LL =	**PL =**	**PI =**	**Assumed GS=** 2.72	**Type:** ST

Project No.: 223110G
Date Sampled: 8/16/23
Remarks:

Figure _______

Client: LXT Eastside Development

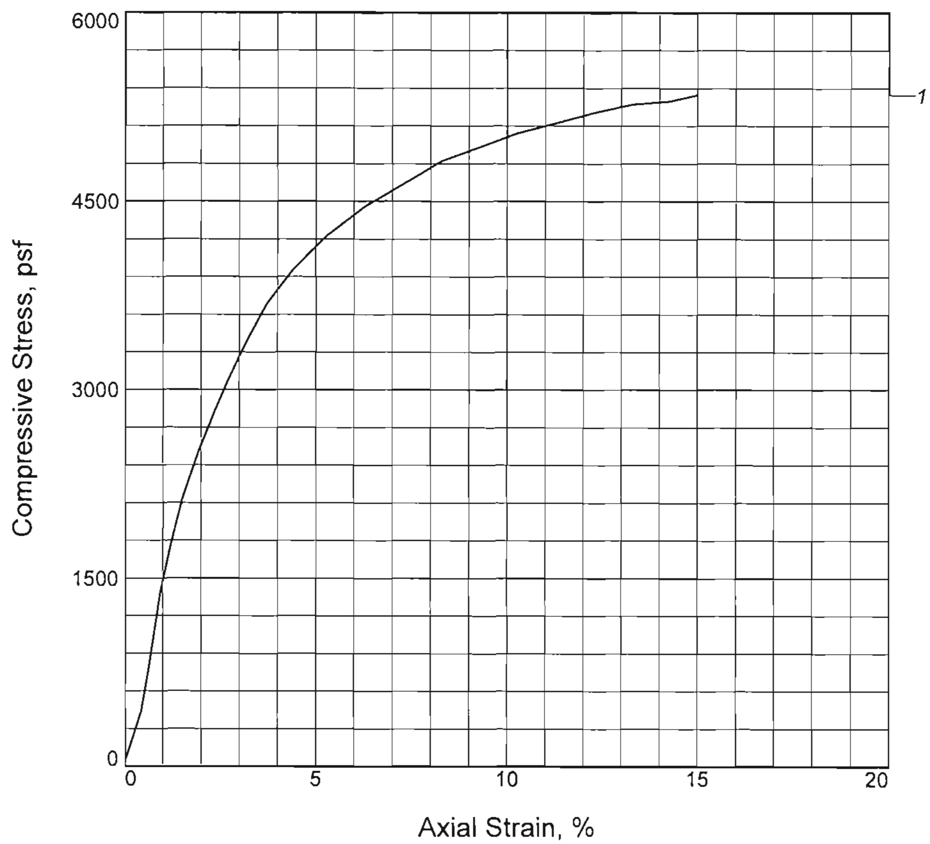
Project: CMT (Crawford, Murphy, & Tilly)-KC

Source of Sample: B-2 **Depth:** 3
Sample Number: 2

KTI

Tested By: TA **Checked By:** OJK

UNCONFINED COMPRESSION TEST



Sample No.	1			
Unconfined strength, psf	5347			
Undrained shear strength, psf	2674			
Failure strain, %	15.0			
Strain rate, in./min.	0.050			
Water content, %	23.7			
Wet density, pcf	125.2			
Dry density, pcf	101.2			
Saturation, %	95.0			
Void ratio	0.6778			
Specimen diameter, in.	2.84			
Specimen height, in.	5.60			
Height/diameter ratio	1.97			

Description: Fill, fat clay with organics, stiff, greenish gray, moist

LL =	PL =	PI =	Assumed GS= 2.72	Type: ST

Project No.: 223110G
Date Sampled: 6/18/23
Remarks:

Client: LXT Eastside Development

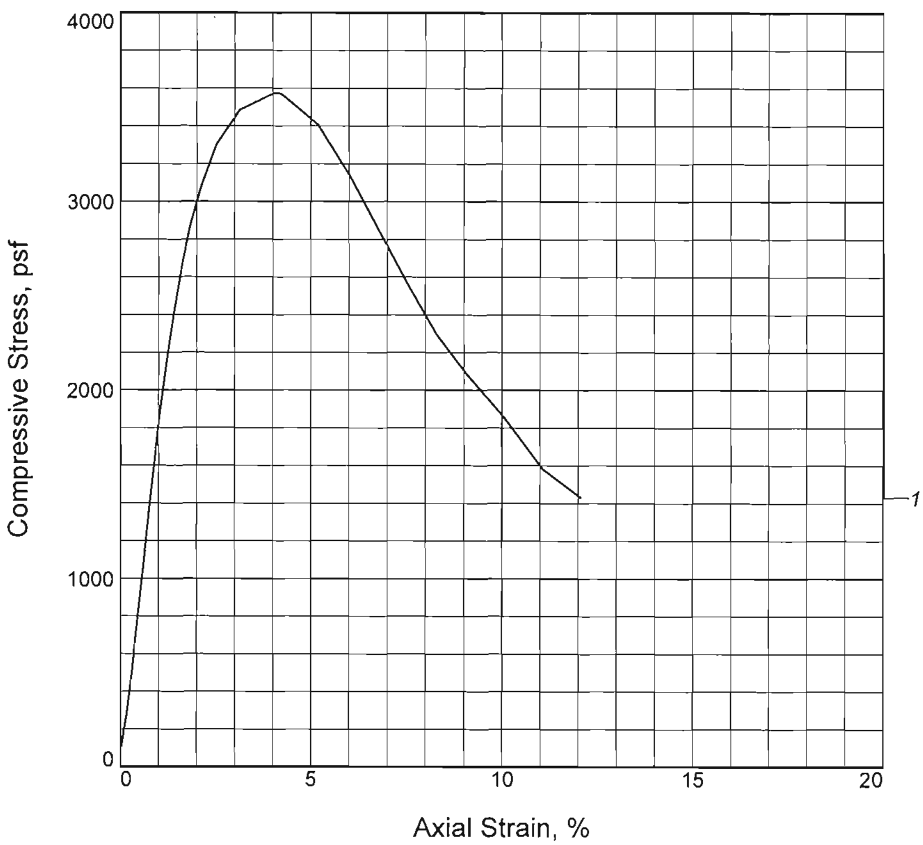
Project: CMT (Crawford, Murphy, & Tilly)-KC

Source of Sample: B-3 **Depth:** 3
Sample Number: 2

Figure ________

Tested By: TA **Checked By:** OJK

UNCONFINED COMPRESSION TEST



Sample No.	1			
Unconfined strength, psf	3574			
Undrained shear strength, psf	1787			
Failure strain, %	4.1			
Strain rate, in./min.	0.050			
Water content, %	22.0			
Wet density, pcf	126.7			
Dry density, pcf	103.9			
Saturation, %	94.1			
Void ratio	0.6345			
Specimen diameter, in.	2.82			
Specimen height, in.	5.62			
Height/diameter ratio	1.99			

Description: Fill, fat clay with gravel and organics, stiff, dark brown, moist

LL =	PL =	PI =	Assumed GS= 2.72	Type: ST

Project No.: 223110G
Date Sampled: 6/18/23
Remarks:

Client: LXT Eastside Development

Project: CMT (Crawford, Murphy, & Tilly)-KC

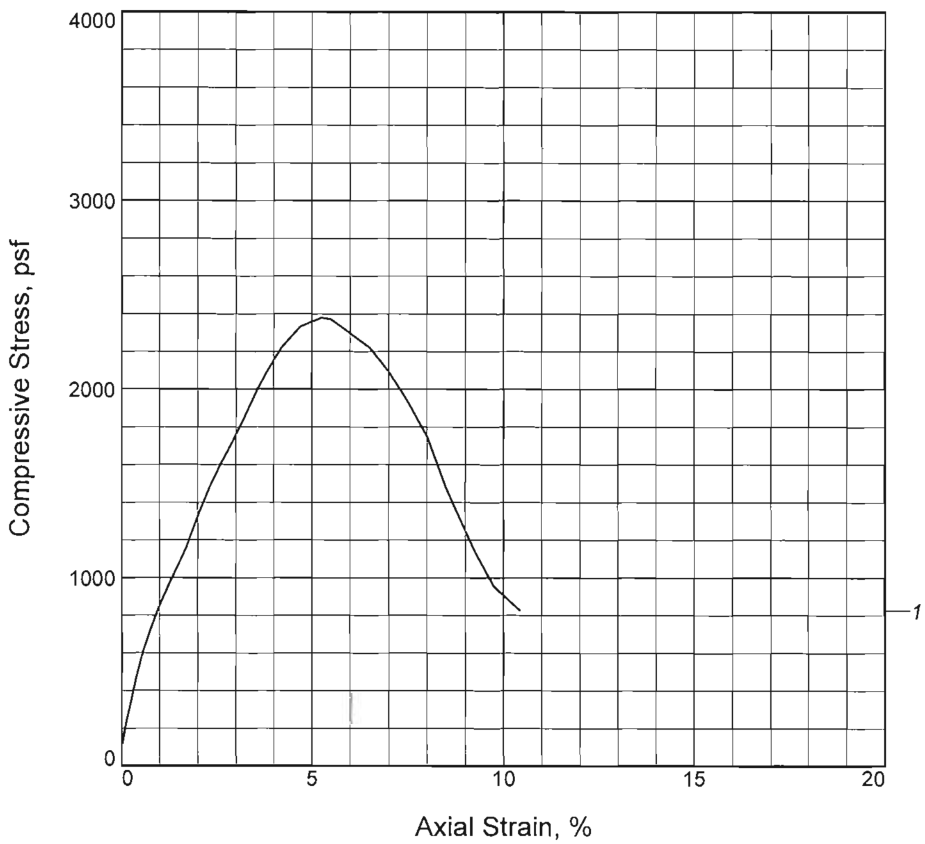
Source of Sample: B-4 **Depth:** 3
Sample Number: 2

KTI

Figure ________

Tested By: TA **Checked By:** OJK

UNCONFINED COMPRESSION TEST



Sample No.	1			
Unconfined strength, psf	2379			
Undrained shear strength, psf	1189			
Failure strain, %	5.3			
Strain rate, in./min.	0.050			
Water content, %	21.6			
Wet density, pcf	121.7			
Dry density, pcf	100.1			
Saturation, %	84.4			
Void ratio	0.6963			
Specimen diameter, in.	2.80			
Specimen height, in.	5.60			
Height/diameter ratio	2.00			

Description: Fill, fat clay with gravel, medium stiff, light grayish brown, moist

LL =	PL =	PI =	Assumed GS= 2.72	Type: ST

Project No.: 223110G
Date Sampled: 6/18/23
Remarks:

Client: LXT Eastside Development

Project: CMT (Crawford, Murphy, & Tilly)-KC

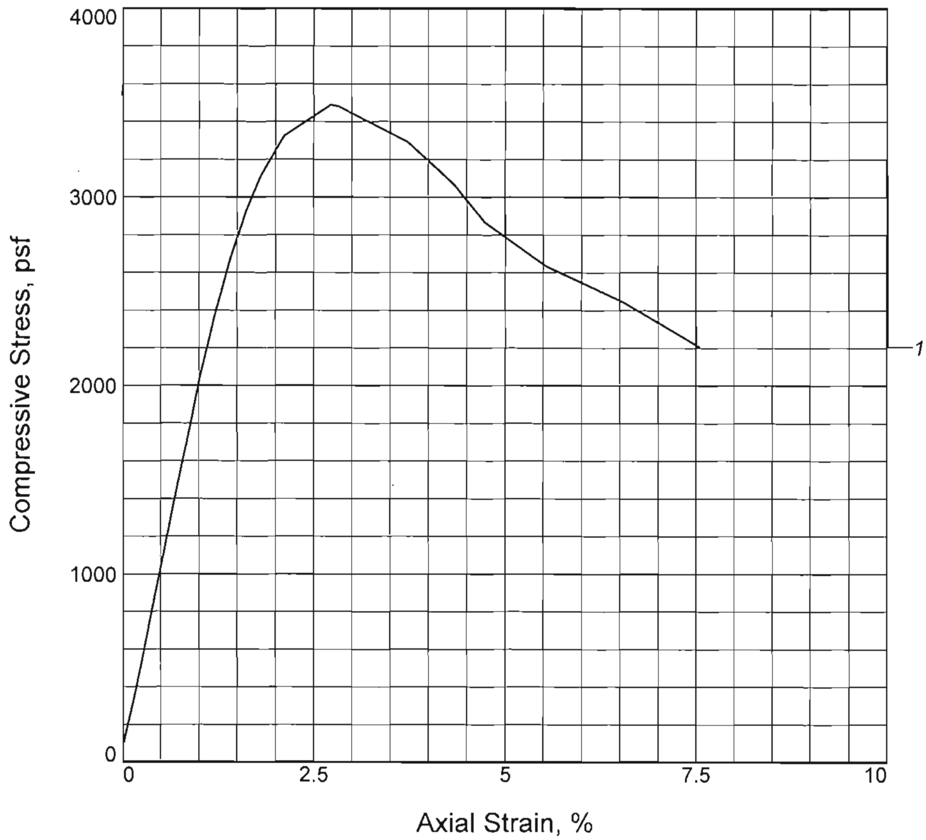
Source of Sample: B-5 **Depth:** 3
Sample Number: 2

KTI

Figure ________

Tested By: TA **Checked By:** OJK

UNCONFINED COMPRESSION TEST



Sample No.	1			
Unconfined strength, psf	3489			
Undrained shear strength, psf	1745			
Failure strain, %	2.7			
Strain rate, in./min.	0.050			
Water content, %	21.3			
Wet density, pcf	118.7			
Dry density, pcf	97.8			
Saturation, %	78.8			
Void ratio	0.7359			
Specimen diameter, in.	2.83			
Specimen height, in.	5.64			
Height/diameter ratio	1.99			

Description: Fiill, fat clay trace gravel, stiff, dark brown, moist

LL = 52	**PL =** 22	**PI =** 30	**Assumed GS=** 2.72	**Type:** ST

Project No.: 223110G
Date Sampled: 6/18/23
Remarks:

Figure ________

Client: LXT Eastside Development

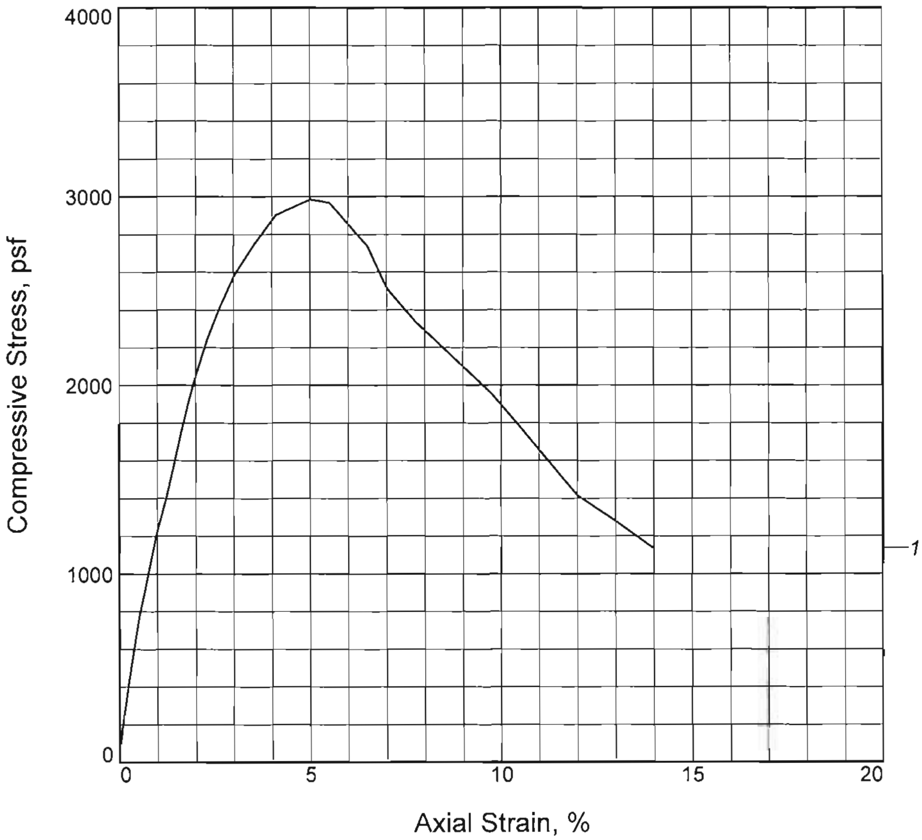
Project: CMT (Crawford, Murphy, & Tilly)-KC

Source of Sample: B-6 **Depth:** 1
Sample Number: 1

KTI

Tested By: TA **Checked By:** OJK

UNCONFINED COMPRESSION TEST



Sample No.	1			
Unconfined strength, psf	2985			
Undrained shear strength, psf	1493			
Failure strain, %	5.0			
Strain rate, in./min.	0.050			
Water content, %	15.7			
Wet density, pcf	118.1			
Dry density, pcf	102.1			
Saturation, %	64.3			
Void ratio	0.6628			
Specimen diameter, in.	2.85			
Specimen height, in.	5.64			
Height/diameter ratio	1.98			

Description: Fill, fat clay with gravel, very stiff, olive gray, moist

LL = 53	**PL =** 22	**PI =** 31	**Assumed GS=** 2.72	**Type:** ST

Project No.: 223110G
Date Sampled: 6/18/23
Remarks:

Figure ________

Client: LXT Eastside Development

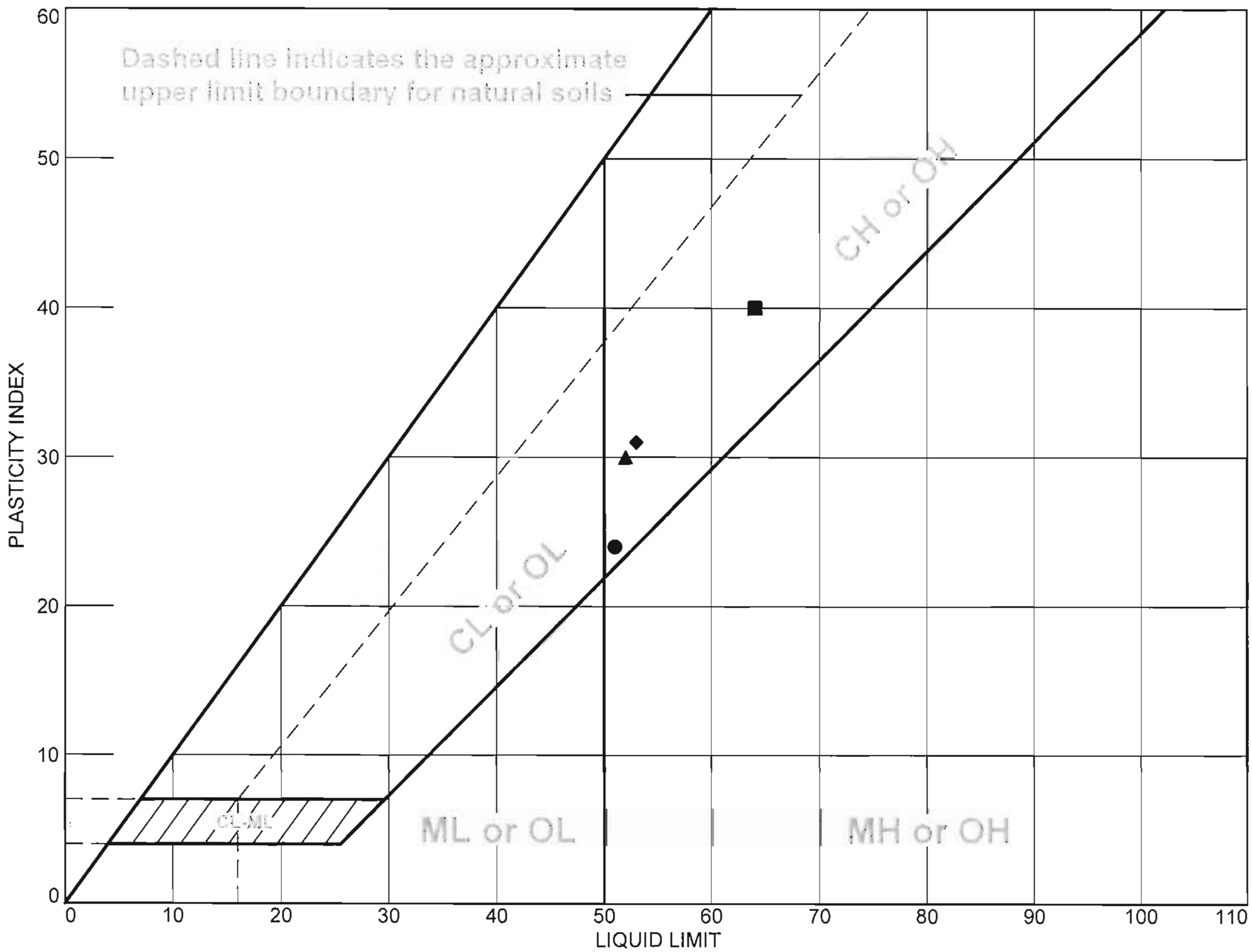
Project: CMT (Crawford, Murphy, & Tilly)-KC

Source of Sample: B-8 **Depth:** 1
Sample Number: 1

KTI

Tested By: TA **Checked By:** OJK

LIQUID AND PLASTIC LIMITS TEST REPORT ASTM D 4318



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Fill, fat clay with gravel, stiff, brown, moist	51	27	24			CH
■	Fill, fat clay trace organics, stiff, dark brown and light brown, moist	64	24	40			CH
▲	Fiill, fat clay trace gravel, stiff, dark brown, moist	52	22	30			CH
◆	Fill, fat clay with gravel, very stiff, olive gray, moist	53	22	31			CH

Project No. 223110G **Client:** LXT Eastside Development

Project: CMT (Crawford, Murphy, & Tilly)-KC

● **Source of Sample:** B-1 **Depth:** 1 **Sample Number:** 1
■ **Source of Sample:** B-3 **Depth:** 1 **Sample Number:** 1
▲ **Source of Sample:** B-6 **Depth:** 1 **Sample Number:** 1
◆ **Source of Sample:** B-8 **Depth:** 1 **Sample Number:** 1

KTI

Remarks:

Figure

GLOSSARY OF GEOTECHNICAL TERMS

ALLUVIUM	Sediments deposited by streams, including riverbeds and floodplains.
ARGILLACEOUS	Rocks composed of or having a notable portion of fine silt and/or clay in their composition.
ATTERBERG LIMITS	Water contents, in percentage of dry weight of soil, that correspond to the boundaries between the states of consistency, i.e. the boundary between the liquid and plastic states (liquid limit) and the boundary between the plastic and solid states (plastic limit).
BEDROCK-IN-PLACE	Continuous rock mass which essentially has not moved from its original depositional position.
CALCAREOUS	Containing calcium carbonate determined by effervescence when tested with dilute hydrochloric acid.
CHANNEL SANDSTONE	Sandstone that has been deposited in a streambed or other channel eroded into the underlying beds.
COLLUVIAL	Rock debris of various sizes loose from in-place bedrock mass, often shifted down gradient in conjunction with soil.
CROSS-BEDDING	Stratification which is inclined to the original horizontal surface upon which the sediment accumulated.
FISSILE BEDDING	Term applied to bedding which consists of laminae less than 2 millimeters in thickness.
FORMATION	A distinctive body of rock that serves as a convenient unit for study and mapping.
FOSSIL DETRITUS	The accumulation of broken, fragmented fossil debris.
FOSSILIFEROUS	Containing organic remains.
GLACIAL ERRATIC	A transported rock fragment different from the bedrock on which it lies, either free or as part of a sediment.
GLACIAL TILL	Nonsorted, nonstratified sediment carried or deposited by a glacier.
GLACIOFLUVIAL	Primarily deposited by streams from glaciers.
GROUP	A lithostratigraphic unit consisting of two or more formations.
JOINT	A fracture in a rock along which no appreciable displacement has occurred.
LIMESTONE	A sedimentary rock composed mostly of calcium carbonate ($CaCO_3$).

LOESS	A homogenous, nonstratified, unindurated deposit consisting predominantly of silt, with subordinate amounts of very fine sand and/or clay.
MICA	A mineral group, consisting of phyllosilicates, with sheetlike structures.
MEMBER	A specially developed part of a varied formation is called a member, if it has considerable geographic extent.
NODULE	A small, irregular, knobby, or rounded rock that is generally harder than the surrounding rock.
PERMEABILITY	The capacity of a material to transmit a fluid.
RECOVERY	The percentage of bedrock core recovered from a core run length.
RELIEF	The difference in elevation between the high and low points of a land surface.
RESIDUAL SOIL	Soil formed in place by the disintegration and decomposition of rocks and the consequent weathering of the mineral materials.
ROCK QUALITY DESIGNATION (RQD)	Refers to percentage of core sample recovered in unbroken lengths of 4 inches or more.
SANDSTONE	Sedimentary rock composed mostly of sand sized particles, usually cemented by calcite, silica, or iron oxide.
SERIES	A time-stratigraphic unit ranked next below a system.
SHALE	A fine-grained plastic sedimentary rock formed by consolidation of clay and mud.
STRATIGRAPHY	Branch of geology that treats the formation, compositions, sequence, and correlation of the stratified rocks as parts of the earth's crust.
SYSTEM	Designates rocks formed during a fundamental chronological unit, a period.
UNCONFORMITY	A surface of erosion or nondeposition, usually the former, which separates younger strata from older rocks.
WEATHERING	The physical and chemical disintegration and decomposition of rocks and minerals.

General Notes

Laboratory Test Symbols	
Symbol	**Definition**
LL	Liquid Limit (ASTM D4318)
PL	Plastic Limit (ASTM D4318)
PI	Plasticity Index (LL minus PL)
Qu	Unconfined Compressive Strength, Pounds per Square Foot (psf)
Qp	Pocket Penetrometer Reading, Tons per Square Foot (TSF)
RQD	Rock Quality Designation % (Sum of rock core pieces >4 inches/length of core run)

Common Soil Classification Symbols

Clay	
Symbol	**Soil Type**
CL	Low plasticity clay
CL-ML	Low plasticity clay and silt
CL/CH	Medium plasticity clay
CH	High plasticity clay

Silt	
Symbol	**Soil Type**
ML	Low plasticity silt
MH	High plasticity silt

Sand	
Symbol	**Soil Type**
SW	Well graded sand
SP	Poorly graded sand
SM	Silty sand
SC	Clayey sand

Gravel	
Symbol	**Soil Type**
GW	Well graded gravel
GP	Poorly graded gravel
GM	Silty gravel
GC	Clayey gravel

Descriptive Terminology

Cohesionless Soils

Relative Density Term	"N" Value
Very Loose	0 - 4
Loose	5 - 9
Medium Dense	10 - 29
Dense	30 – 49
Very Dense	50 or more

Cohesive Soils

Consistency Term	"N" Value
Very soft	0 – 2
Soft	3 – 4
Medium	5 – 8
Stiff	9 – 15
Very Stiff	16 - 30
Hard	> 30

Relative Proportions and Sizes

Term	Range
Trace	< 5%
A Little	5 – 15%
Some	15 – 30%
With	30 – 50%

Material	Size
Boulder	> 12"
Cobble	3" – 12"
Gravel	4.75 - 76.2 mm
Sand	0.075 – 4.75 mm
Silt and Clay	< 0.075 mm