

Russell Apartments

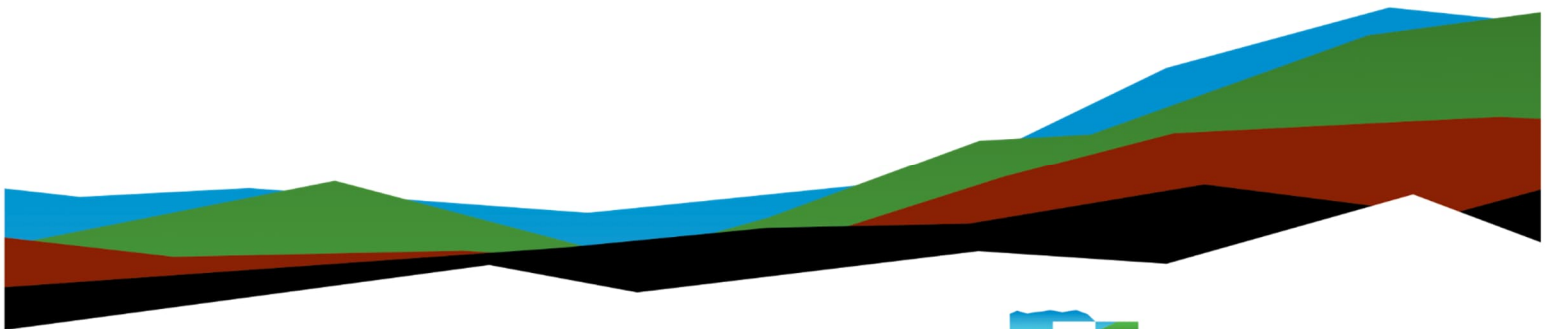
Geotechnical Engineering Report

Kansas City, Missouri

December 16, 2025 | Terracon Project No. 02255311

Prepared for:

MoKan Lake Investments, LLC
Bucyrus, KS 66013



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December 16, 2025

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Attn: Dina Blackmore
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Re: Geotechnical Engineering Report
Russell Apartments
3832 N Wayne Ave
Kansas City, Missouri
Terracon Project No. 02255311

Dear Ms. Blackmore:

We have completed a subsurface exploration and geotechnical engineering evaluation for the referenced project in general accordance with Terracon Proposal No. P02255311.R1 dated October 27, 2025. This report presents the findings of the subsurface exploration and provides geotechnical recommendations concerning earthwork and the design and construction of foundations, floor slabs, and pavements for the project.

We appreciate the opportunity to be of service to you on this project. If you have any questions concerning this report or if we may be of further service, please contact us.

Sincerely,

Terracon

Stacey L. Bonderer, E.I.T.
Staff Engineer

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Missouri: PE2013010325

Table of Contents


Introduction.....	1
Project Description.....	1
Site Conditions.....	2
Geotechnical Characterization	3
Seismic Site Class.....	4
Geotechnical Overview	4
Earthwork	5
Site Preparation.....	5
Excavation.....	6
Fill Material Types.....	6
Fill Placement and Compaction Requirements	7
Utility Trench Backfill	8
Grading and Drainage.....	9
Earthwork Construction Considerations	9
Construction Observation and Testing	10
Shallow Foundations	10
Shallow Foundation Design Parameters	11
Foundation Construction Considerations	11
Floor Slabs	13
Floor Slab Design Parameters	13
Floor Slab Construction Considerations.....	14
Lateral Earth Pressures	15
Lateral Earth Pressure Design Parameters.....	15
Subsurface Drainage for Below-Grade Walls	17
Considerations for Segmental Retaining Walls	17
Retaining Wall Design Parameters	18
Retaining Wall Drainage.....	19
Pavements	19
Pavement Subgrade Preparation	19
Opinions of Minimum Pavement Thicknesses	20
General Comments	22

Figures

GeoModel

Attachments

Exploration and Testing Procedures
Site Location and Exploration Plans
Exploration and Laboratory Results
Supporting Information

Note: This report was originally delivered in a web-based format. **Blue Bold** text in the report indicates a referenced section heading. The PDF version also includes hyperlinks which direct the reader to that section and clicking on the  logo will bring you back to this page. For more interactive features, please view your project online at client.terracon.com.

Refer to each individual Attachment for a listing of contents.

Introduction

This report presents the results of our subsurface exploration and Geotechnical Engineering services performed for the proposed apartment complex to be located at 3832 N Wayne Ave in Kansas City, Missouri. The purpose of these services was to provide information and geotechnical engineering recommendations relative to:

- Subsurface soil and rock conditions
- Groundwater conditions
- IBC seismic site class
- Site preparation and earthwork
- Foundations
- Floor slabs
- Lateral earth pressure parameters
- Considerations for segmental retaining walls
- Pavements

Drawings showing the site and boring locations are shown on the attached [Site Location Plan](#) and [Exploration Plan](#). The results of the laboratory testing performed on soil samples obtained from the site during our field exploration are included on the boring logs in [Exploration Results](#).

Project Description

Our initial understanding of the project was provided in our proposal and was discussed during project planning. A period of collaboration has transpired since the project was initiated, and our final understanding of the project conditions is as follows:

Item	Description
Information Provided	An email request for proposal was provided on September 26, 2025. The request included conceptual plan drawings of the layout of the planned development.
Project Description	An approximately 5-acre apartment complex is planned to be constructed southwest of the intersection of N Wayne Avenue and NE Parvin Road. The complex will include 15 buildings with a total of 56 apartment units. We assume all units will be rentals, not owner-occupied. Approximate building footprints range from 2,600 to 5,000 square feet. Buildings are assumed to be two-story, wood-framed, and slab-on-grade (no basement). The three buildings along the

Item	Description
	western edge of the development will have walkout basements. Associated infrastructure such as utilities and streets will be included within the development.
Finished Floor Elevation (FFE)	The FFEs of the buildings were not provided. We anticipate the FFE will be within 5 feet of existing grades.
Maximum Loads	<p>Anticipated structural loads were not provided. We have assumed the following maximum loads based on our experience with similar projects.</p> <ul style="list-style-type: none"> ■ Columns: 50 kips ■ Walls: 2 kips per linear foot (klf) ■ Slabs: 100 pounds per square foot (psf) <p>We request that updated loading information be provided by the design team for use in our analyses.</p>
Grading	A preliminary site grading plan was provided. We have considered no more than 5 feet of cut and 20 feet of fill will be required to develop final grades.
Below-Grade Structures	Three buildings along the western edge of the development will include walk-out basements.
Free-Standing Retaining Walls	Retaining walls of unknown construction are planned along the northern, western, and southern boundaries of the site. Based on the drawings provided, the anticipated maximum wall height is 10 feet.
Pavements	No information regarding anticipated vehicle types, axle loads, or traffic volumes was provided. We anticipate the pavements will be utilized primarily by passenger vehicles (cars, pickup trucks, SUV's) with occasional 2-axle delivery trucks and 3-axle trash collection trucks.

Terracon should be notified if any of the above information is inconsistent with the planned construction, especially the grading limits, as modifications to our recommendations may be necessary.

Site Conditions

The following description of site conditions is derived from our site visit in association with the field exploration and our review of publicly available geologic and topographic maps.

Item	Description
Project Location	The project is located at 3832 N Wayne Ave in Kansas City, Missouri. See Site Location . Approximate Latitude/Longitude: 39.1649, -94.5614
Existing Improvements	Undeveloped
Current Ground Cover	Heavily vegetated
Existing Topography	Based on the site topographic plan provided by the client, site elevations range from 860 to 902 feet.

Geotechnical Characterization

We have developed a general characterization of the subsurface conditions based on the subsurface exploration, laboratory data, geologic setting, and our understanding of the project. This characterization, termed GeoModel, forms the basis of our geotechnical evaluation. Conditions observed at each boring location are indicated on the individual logs. The individual logs are in the [Exploration Results](#) and the GeoModel is in the [Figures](#) attachment of this report.

As part of our analyses, we identified the following model layers within the subsurface profile. For a more detailed view of the model layer depths at each boring location, refer to the GeoModel.

Model Layer	Layer Name	General Description
1	Fat Clay	Fat clay (CH), soft to very stiff
2	Shale	Completely to moderately weathered
3	Limestone	Moderately to slightly weathered

The borings were observed during drilling and shortly after completion of drilling for the presence and level of water. Groundwater was observed at depths ranging from 9 to 13½ feet in Borings B-102 and B-107. Groundwater was not encountered in the other borings at these times. A longer period of time may be required for groundwater to develop and stabilize in a borehole. Longer term observations in piezometers or observation wells, sealed from the influence of surface water, are often required to define groundwater levels.

Groundwater levels may fluctuate due to seasonal variations in the amount of rainfall, runoff, and other factors not evident at the time the borings were performed. “Perched”

water could occur above lower permeability soil layers and/or near the soil/bedrock interface. Therefore, groundwater conditions at other times may be different than the conditions encountered in our exploratory borings. The potential for water level fluctuations and perched water should be considered when developing design and construction plans and specifications for the project.

Seismic Site Class

The seismic design requirements for buildings and other structures are based on Seismic Design Category. The Site Class is required to determine the Seismic Design Category for a structure. The Site Class is based on the upper 100 feet of the site profile defined by a weighted average value of either shear wave velocity, standard penetration resistance, or undrained shear strength in accordance with Section 20.4 of ASCE 7 and the International Building Code (IBC). Based on the soil and bedrock encountered in our subsurface exploration, Seismic Site Class C can be considered for design of the project. The subsurface exploration at this site extended to a maximum depth of 15 feet and terminated in native clay, shale, and limestone. The site properties below the maximum boring depth were estimated based on our experience and knowledge of geologic conditions of the general area. Upon request, we could perform deeper borings or geophysical testing to confirm the conditions below the current maximum boring depth.

Geotechnical Overview

Based on conditions encountered at the boring locations, it appears feasible to support the new buildings on shallow spread footings bearing on native soils, engineered fill materials, or intact bedrock. The depth to bedrock varied across the site. Each building should be evaluated individually and the bearing material should be determined prior to construction. The footings for each individual building should either bear entirely on native soil and engineered fill or entirely on intact bedrock or lean concrete that extends to intact bedrock.

Expansive fat clay soils were encountered at the site. These materials have the potential to shrink and swell with seasonal fluctuations in the soil moisture content. We recommend the floor slabs be supported on at least 24 inches of low volume change (LVC) material. In areas that are currently above or less than 2 feet below the planned bottom of floor slab level, native fat clay soils should be undercut to accommodate placement of LVC material. In areas where more than 2 feet of fill will be placed below the bottom-of-floor-slab level, at least the upper 24 inches of new engineered fill should consist of LVC material. Placement of a layer of LVC material below floor slabs, as recommended in this report, will not eliminate all future subgrade volume change and resultant floor slab

movements. However, use of an LVC zone should reduce the potential for subgrade volume change. Details regarding the LVC zone are provided in [Earthwork](#).

This report provides recommendations to help mitigate the effects of soil shrinkage and expansion. However, even if these procedures are followed, some movement and at least minor cracking in the structure could still occur. The severity of cracking and other cosmetic damage caused by movement of the floor slabs will probably increase if any modification of the site results in excessive wetting or drying of the expansive soils. Eliminating the risk of movement and cosmetic distress may not be feasible, but it may be possible to further reduce the risk of movement if significantly more expensive measures are used during construction. We would be pleased to discuss other construction alternatives with you upon request.

The recommendations contained in this report are based upon the results of field and laboratory testing (presented in the [Exploration Results](#)), engineering analyses, and our current understanding of the proposed project. The [General Comments](#) section provides an understanding of the report limitations.

Earthwork

Site preparation, excavation, subgrade preparation, and placement of engineered fill should follow the recommendations presented in this section. The recommendations presented for design and construction of earth-supported elements including foundations, slabs, and pavements are contingent upon the recommendations outlined in this section being followed. We recommend earthwork on this project be observed and evaluated by the Geotechnical Engineer. The evaluation of earthwork should include observation and testing of subgrade preparation, engineered fill, foundation bearing soils, and other geotechnical conditions exposed during the construction of the project.

Site Preparation

Vegetation, topsoil, and any loose, soft, or otherwise unsuitable soils present within the proposed construction areas should be stripped. Based on information obtained at the boring locations, stripping depths on the order of 6 inches should be anticipated to remove the root zone materials. However, greater stripping depths may be required in areas not explored by the borings such as in drainage swales where a greater thickness of organic soils tends to accumulate. Existing trees within proposed construction areas should be thoroughly grubbed to remove all stumps, root balls, and roots larger than ½-inch in diameter. Organic soils removed during site preparation should not be used as fill beneath the proposed new building and pavement areas.

The soils within the planned building areas should be further undercut as necessary to accommodate placement of the recommended 24-inch thick LVC layer below floor slabs.

The undercut areas should extend a minimum of 5 feet laterally outside the building wall lines. Undercutting to facilitate placement of the LVC layer would not be necessary in areas where more than 2 feet of fill will be placed to develop the floor slab subgrade level.

Following initial stripping and any necessary undercutting, the exposed soils should be proofrolled. A Terracon representative should observe the proofrolling. Proofrolling can be accomplished using a loaded tandem-axle dump truck with a gross weight of at least 20 tons, or similarly loaded equipment. Areas that display excessive deflection (pumping) or rutting during proofroll operations should be improved by scarification/compaction or by removal and replacement with engineered fill.

Excavation

Bedrock strata were encountered at relatively shallow depths at some of the boring locations. Rock excavation methods may be required for deeper excavations, such as utility trenches, depending upon the depth of excavation and the type of rock encountered. In our experience, completely to highly weathered shale bedrock strata that can be easily penetrated with a flight auger can typically be excavated using track-hoes with rock teeth or ripper equipped dozers. Excavation of harder bedrock (such as limestone or less weathered shale) will likely require the use of jackhammers or pneumatic breakers. Excavation of rock in confined areas (such as trenches) is usually difficult, even above the level of auger refusal. The bottom of excavations should be thoroughly cleaned of loose soils and disturbed materials prior to backfill placement and/or construction.

Fill Material Types

Fill required to achieve design grade should be classified as engineered fill and general fill. Engineered fill is material used below, or within 5 feet of structures, pavements, or constructed slopes. General fill is material used to achieve grade outside of these areas.

Regardless of its source, compacted fill should consist of approved materials that are free of organic matter and debris. Frozen material should not be used, and fill should not be placed on a frozen subgrade.

Reuse of On-Site Soil: Excavated on-site soil may be selectively reused as fill below pavement and landscaping areas. Excavated on-site soil should not be placed beneath settlement sensitive structures and within foundation bearing zones

Material property requirements for on-site soil for use as engineered fill are noted in the table below:

Fill Type	USCS Classification	Acceptable Location for Placement
Native Fat Clays	CH	Pavement areas and at depths greater than 24 inches below building finished grade

Imported Fill Materials: Imported fill materials should meet the following material property requirements.

Fill Type ¹	USCS Classification	Acceptable Location for Placement
Low Volume Change (LVC) material	GM ² or CL (LL<45 and PI<23)	All locations and elevations, except where free-draining material is required
Free Draining Granular ³	GW, GP, SW, SP	Where free-draining material is required

1. Engineered fill should consist of approved materials that are free of organic matter and debris. Frozen material should not be used, and fill should not be placed on a frozen subgrade.
2. MoDOT Type 5 or an approved alternate gradation of crushed limestone aggregate
3. Granular materials with less than 5 percent fines (material passing the #200 sieve), such as ASTM C33 Size No. 57 aggregate or an approved alternate gradation

Fill Placement and Compaction Requirements

Engineered fill and general fill should meet the following compaction requirements.

Item	Engineered Fill	General Fill
Maximum Lift Thickness	8 inches or less in loose thickness when heavy, self-propelled compaction equipment is used 4 to 6 inches in loose thickness when hand-guided equipment (i.e., a jumping jack or plate compactor) is used	Same as engineered fill
Minimum Compaction Requirements ^{1,2}	95% of max. below and above foundations, below floor slabs, and below pavements	92% of max.

Item	Engineered Fill	General Fill
Water Content Range ¹	Low plasticity cohesive: -2% to +3% of optimum High plasticity cohesive: 0 to +4% of optimum Granular: -3% to +3% of optimum	As required to achieve min. compaction requirements

1. Maximum density and optimum water content as determined by the standard Proctor test (ASTM D698).
2. If the granular material is a coarse sand or gravel, or of a uniform size, or has a low fines content, compaction comparison to relative density may be more appropriate. In this case, granular materials should be compacted to at least 70% relative density (ASTM D4253 and D4254). Materials not amenable to density testing should be placed and compacted to a stable condition observed by the Geotechnical Engineer or representative.

Utility Trench Backfill

Any soft or unsuitable materials encountered at the bottom of utility trench excavations should be removed and replaced with engineered fill or bedding material in accordance with public works specifications for the utility being supported. This recommendation is particularly applicable to utility work requiring grade control and/or in areas where subsequent grade raising could cause settlement in the subgrade supporting the utility. Trench excavation should not be conducted below a downward 1:1 projection from existing foundations without engineering review of shoring requirements and geotechnical observation during construction.

Trench backfill should be mechanically placed and compacted as discussed earlier in this report. Compaction of initial lifts should be accomplished with hand-operated tampers or other lightweight compactors. Where trenches are placed beneath slabs or footings, the backfill should satisfy the requirements of engineered fill discussed in this report. Flooding or jetting for placement and compaction of backfill is not recommended.

Utility trenches are a common source of water infiltration and migration. Utility trenches that penetrate beneath the building should be effectively sealed to restrict water intrusion and flow through the trenches, which could migrate below the building. Each trench should be provided with an effective trench plug that extends at least 5 feet from the face of the building exterior. The plug material should consist of cementitious flowable fill or low permeability clay. The trench plug material should be placed to surround the utility line. If clay is used to construct the trench plug, the clay should be placed and compacted in accordance with the water content and compaction recommendations for engineered fill provided in this report.

Grading and Drainage

The site should be graded to provide effective drainage away from the building during and after construction, and these conditions should be maintained throughout the life of the structure. Accumulation of water adjacent to the structure could contribute to significant moisture increases in the subgrade soils and subsequent softening/settlement or expansion/heave, which could result in soil movements greater than those discussed in this report. Greater movements can result in unacceptable differential floor slab and/or foundation movements, cracked slabs and walls, and roof leaks.

After building construction and landscaping have been completed, final grades should be verified to document effective drainage has been achieved. Grades around the structure should also be periodically inspected and adjusted, as necessary, as part of the structure's maintenance program. Where paving or flatwork abuts the structure, a maintenance program should be established to effectively seal and maintain joints and prevent surface water infiltration.

Earthwork Construction Considerations

The Geotechnical Engineer should be retained during the construction phase of the project to observe earthwork and to perform necessary tests and observations during subgrade preparation, proofrolling, placement and compaction of engineered fill, backfilling of excavations into completed subgrades, and just prior to construction of foundations, slabs, and pavements.

Care should be taken to avoid disturbance of prepared subgrades. Unstable subgrade conditions can develop during general construction operations, particularly if the soils are wetted and/or subjected to repetitive construction traffic. If unstable subgrade conditions develop, stabilization measures will need to be employed. Construction traffic over the completed subgrade should be avoided to the extent practical. If the subgrade becomes frozen, desiccated, saturated, or disturbed, the affected materials should be removed or these materials should be scarified, moisture conditioned, and compacted prior to floor slab construction.

Based on conditions encountered in the borings, significant seepage is generally not expected in excavations for this project (e.g., for footing construction and utility installation). If seepage is encountered in excavations during construction, the contractor is responsible for designing, implementing, and maintaining appropriate dewatering methods to control seepage and facilitate construction. In our experience, dewatering of excavations in clay soils can typically be accomplished using sump pits and pumps.

As a minimum, excavations should be performed in accordance with OSHA 29 CFR, Part 1926, Subpart P, "Excavations" and its appendices, and in accordance with any applicable

local, state, and federal safety regulations. The contractor should be aware that slope height, slope inclination, and excavation depth should in no instance exceed those specified by these safety regulations. Flatter slopes than those dictated by these regulations may be required depending upon the soil conditions encountered and other external factors. These regulations are strictly enforced and if they are not followed, the owner, contractor, and/or earthwork and utility subcontractor could be liable and subject to substantial penalties. Under no circumstances should the information provided in this report be interpreted to mean that Terracon is responsible for construction site safety or the contractor's activities. Construction site safety is the sole responsibility of the contractor who shall also be solely responsible for the means, methods, and sequencing of the construction operations.

Construction Observation and Testing

The earthwork efforts should be observed by the Geotechnical Engineer (or others under their direction). Observation should include documentation of adequate removal of surficial materials (vegetation, topsoil, and pavements), evaluation and remediation of existing fill materials, as well as proofrolling and mitigation of unsuitable areas delineated by the proofroll.

Each lift of compacted fill should be tested, evaluated, and reworked, as necessary, as recommended by the Geotechnical Engineer prior to placement of additional lifts. Each lift of fill should be tested for density and water content at a frequency of at least one test for every 2,500 square feet of compacted fill in the building areas and 5,000 square feet in pavement areas. Where not specified by local ordinance, one density and water content test should be performed for every 100 linear feet of compacted utility trench backfill and a minimum of one test performed for every 12 vertical inches of compacted backfill.

In areas of foundation excavations, the bearing subgrade should be evaluated by the Geotechnical Engineer. If unanticipated conditions are observed, the Geotechnical Engineer should prescribe mitigation options.

In addition to the documentation of the essential parameters necessary for construction, the continuation of the Geotechnical Engineer into the construction phase of the project provides the continuity to maintain the Geotechnical Engineer's evaluation of subsurface conditions, including assessing variations and associated design changes.

Shallow Foundations

The depth to bedrock varied across the site. Each building should be evaluated individually and the bearing material should be determined prior to construction. The footings for each individual building should either bear entirely on native soil and

engineered fill or entirely on intact bedrock or lean concrete that extends to intact bedrock. Bearing on multiple material types may result in abrupt differential settlement resulting in cracking and differential movement of buildings.

Shallow Foundation Design Parameters

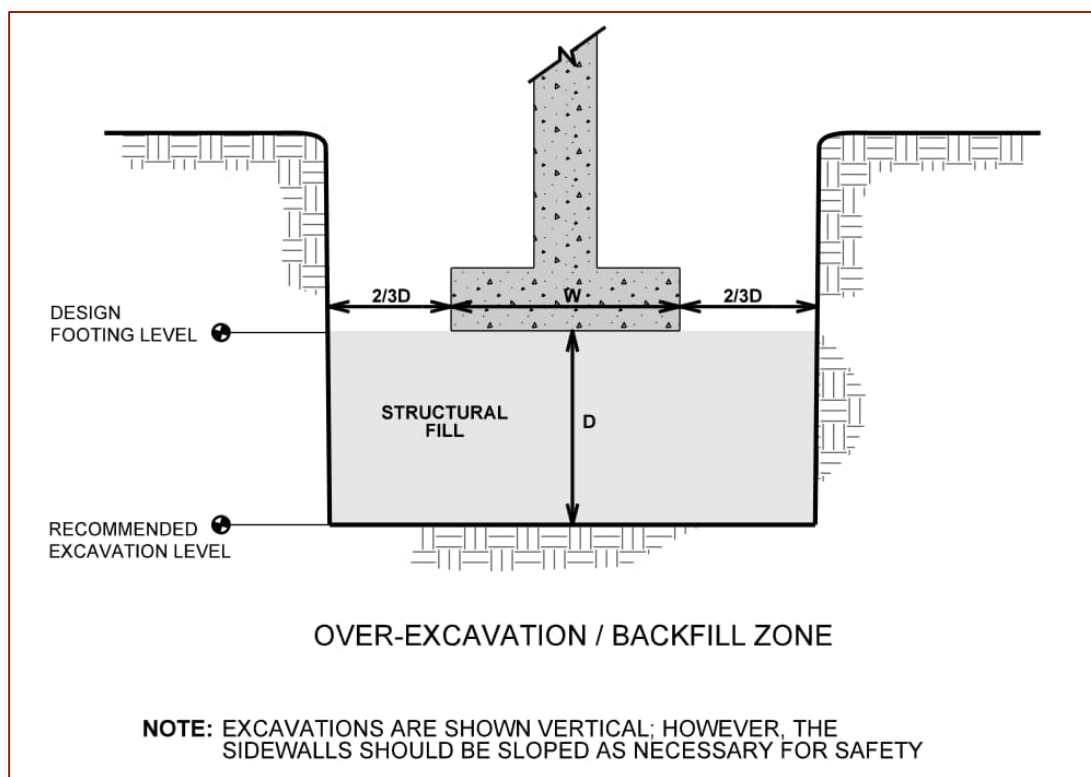
Item	Description
Maximum Net Allowable Bearing Pressure ^{1, 2, 3}	<u>Bearing on Native Soil or Newly Placed Engineered Fill:</u> 2,000 psf <u>Bearing on Intact Shale, Limestone Bedrock or Lean Concrete Extending to Intact Bedrock:</u> 4,000 psf
Minimum Foundation Dimensions	Per IBC 1809.7
Minimum Embedment below Finished Grade ⁴	3 feet
Estimated Total Settlement from Structural Loads ²	On the order of 1 inch
Estimated Differential Settlement ^{2, 5}	About 1/2 to 2/3 of total settlement

1. The maximum net allowable bearing pressure is the pressure in excess of the minimum surrounding overburden pressure at the footing base elevation.
2. Values provided are for maximum loads noted in [Project Description](#). Additional geotechnical consultation will be necessary if higher loads are anticipated.
3. Unsuitable or soft soils should be overexcavated and replaced per the recommendations presented in [Earthwork](#).
4. Embedment necessary to minimize the effects of frost and/or seasonal water content variations
5. Differential settlements are noted for equivalent-loaded foundations and bearing elevation as measured over a span of 50 feet.

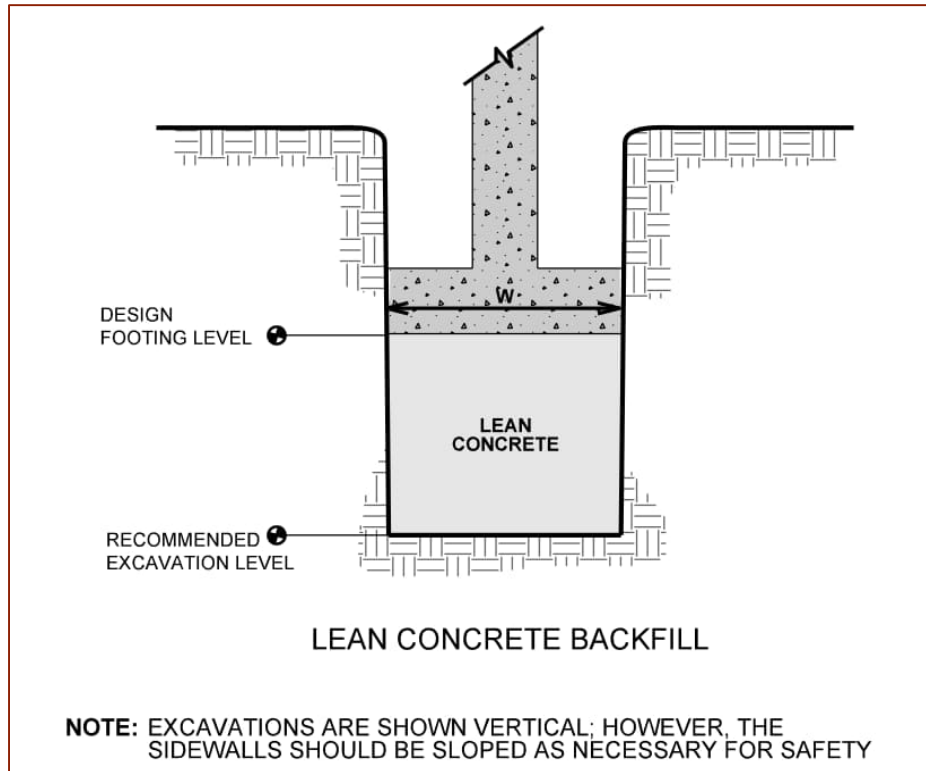
Foundation Construction Considerations

The base of all foundation excavations should be free of water and loose soil prior to placing concrete. Concrete should be placed soon after excavating to reduce bearing soil disturbance. Care should be taken to prevent wetting or drying of the bearing materials during construction. If the soils at the bearing level become excessively dry, disturbed, saturated, or frozen, the affected soil should be removed prior to placing concrete. If the excavations must remain open overnight or for an extended period of time, placement of a lean concrete mud-mat over the bearing soils should be considered.

Native soil bearing footings: The bearing materials at the base of each soil bearing footing excavation should be evaluated by a representative of the Geotechnical Engineer. If unsuitable bearing materials are observed, the excavation should be extended deeper to suitable soils. Soil bearing footings (designed for 2,000 psf) could also bear on properly compacted engineered fill extending down to suitable soils as shown in the following figure. Overexcavation for compacted engineered fill placement below footings should extend laterally beyond all edges of the footings at least 8 inches per foot of overexcavation depth below footing elevation. The overexcavation should then be backfilled up to the footing base elevation with well graded granular material (e.g., MoDOT Type 5 aggregate or an approved alternate gradation) placed and compacted as recommended in the [Earthwork](#) section.



Bedrock bearing footings: Intact bedrock bearing footings (designed for 4,000 psf) should be evaluated by a representative of the Geotechnical Engineer. If native soils or completely weathered (soil-like) bedrock is encountered at the bearing elevation, the excavation should be extended to intact bedrock. Intact bedrock bearing footings could bear directly on intact bedrock at the lower level or on lean concrete backfill that extends to intact bedrock as shown on the following figure.



Floor Slabs

Design parameters for floor slabs assume the requirements for [Earthwork](#) have been followed. Specific attention should be given to positive drainage away from the structure and positive drainage of the aggregate base beneath the floor slab.

Floor Slab Design Parameters

Item	Description
Floor Slab Support ¹	At least 24 inches of low volume change (LVC) material
Granular Leveling Course Layer Thickness ^{2, 3}	4 inches (minimum)
Estimated Modulus of Subgrade Reaction ⁴	100 pounds per square inch per inch (psi/in) for point loads

1. Floor slabs should be structurally independent of building footings or walls to reduce the possibility of floor slab cracking caused by differential movements between the slab and foundation.
2. Well graded crushed stone (e.g., MoDOT Type 5) or open-graded crushed stone (e.g., ASTM C33, Size No. 57 aggregate) can be used as the leveling course.

Item	Description
3.	These granular materials can be considered part of the LVC zone.
4.	Modulus of subgrade reaction is an estimated value based upon our experience with the subgrade condition, the requirements noted in Earthwork , and the floor slab support as noted in this table. It is provided for point loads. For large area loads, the modulus of subgrade reaction would be lower.

The use of a vapor retarder should be considered beneath concrete slabs on grade covered with wood, tile, carpet, or other moisture sensitive or impervious coverings, when the project includes humidity-controlled areas, or when the slab will support equipment sensitive to moisture. When conditions warrant the use of a vapor retarder, the slab designer should refer to ACI 302 and/or ACI 360 for procedures and cautions regarding the use and placement of a vapor retarder.

Joints should be placed in slabs at regular intervals as recommended by ACI to help control the locations of cracks. Joints or any cracks that develop in the floor slab should be sealed with a waterproof, non-extruding compressible compound.

If floor slabs are tied to perimeter walls or turn-down slabs to meet structural or other construction objectives, our experience indicates differential movement between the walls and slabs will likely be observed in adjacent slab expansion joints or floor slab cracks beyond the length of the structural dowels. The Structural Engineer should account for potential differential settlement through use of sufficient control joints, appropriate reinforcing, or other means.

Floor Slab Construction Considerations

The subgrade should be maintained within the moisture content range recommended for engineered fill until the floor slab is constructed. If the subgrade becomes desiccated prior to construction of the floor slab, the affected material should be removed or the materials should be scarified, moistened, and compacted. Upon completion of grading operations in the building area, care should be taken to maintain the subgrade within the moisture content and density ranges recommended for engineered fill prior to construction of the building floor slab.

On most project sites, the site grading is generally accomplished early in the construction phase. However, as construction proceeds, the subgrade may be disturbed due to utility excavations, construction traffic, desiccation, rainfall etc. As a result, the floor slab subgrade soils may not be suitable for placement of the granular course and/or concrete at the time of building construction, and corrective action may be required.

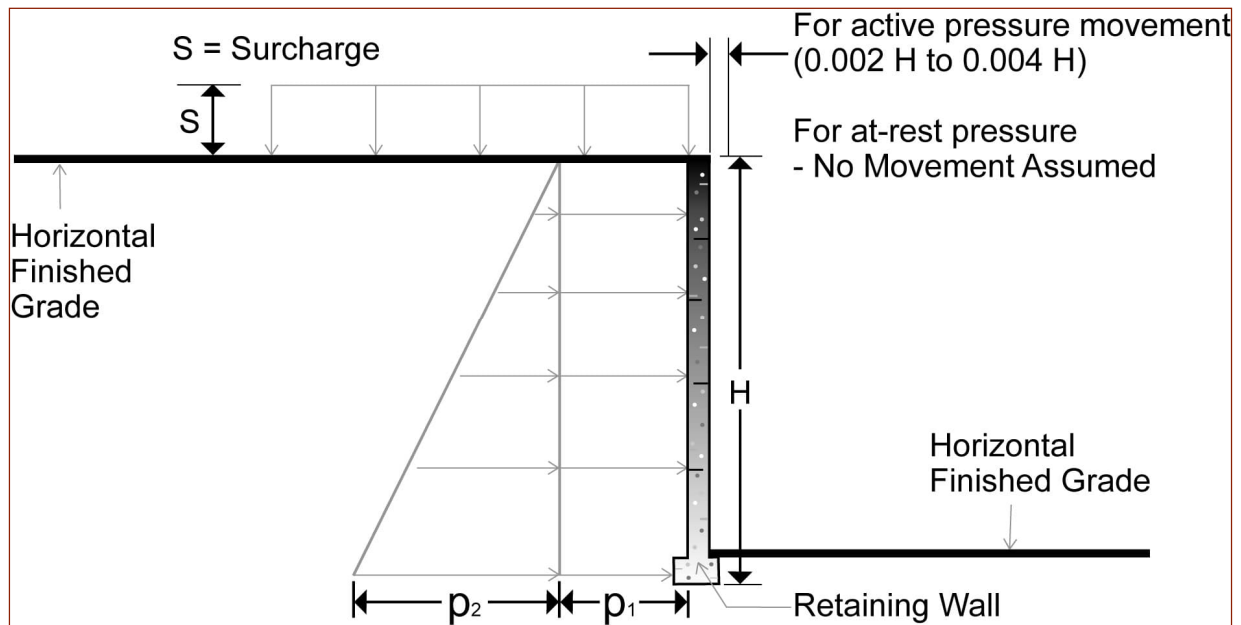
The Geotechnical Engineer should observe the condition of the floor slab subgrades immediately prior to placement of the floor slab support course, reinforcing steel, and

concrete. Attention should be paid to high traffic areas that were rutted and disturbed earlier, and to areas where backfilled trenches are located.

Lateral Earth Pressures

Lateral Earth Pressure Design Parameters

Basement walls with unbalanced backfill levels on opposite sides should be designed for earth pressures at least equal to values indicated in the following table. Earth pressures will be influenced by structural design of the walls, conditions of wall restraint, methods of construction, methods and degree of compaction, and the strength of the materials being restrained. Two wall restraint conditions are shown in the diagram below. Active earth pressure is commonly used for design of free-standing cantilever retaining walls where wall movement is acceptable. The "at-rest" condition assumes no wall movement and is commonly used for design of basement walls, loading dock walls, or other walls restrained at the top. The recommended design lateral earth pressures do not include a factor of safety. The drained parameters do not provide for possible hydrostatic pressure on the walls.



Lateral Earth Pressure Design Parameters

Earth Pressure Condition ¹	Coefficient for Backfill Type ^{2,3}	Surcharge Pressure ⁴ p ₁ (psf)	Equivalent Fluid Unit Weight (pcf) ^{2,5}	
			Drained ⁵	Undrained ⁵
Active (K _a)	Granular - 0.31	(0.31)S	40	80
	Clay - 0.42	(0.42)S	50	85
At-Rest (K _o)	Granular - 0.47	(0.47)S	60	90
	Clay - 0.58	(0.58)S	70	95
Passive (K _p)	Granular - 3.3	---	420	290
	Clay - 2.4	---	290	200

1. For active earth pressure, wall must rotate about base, with top lateral movements 0.002 H to 0.004 H, where H is wall height. For passive earth pressure, wall must move horizontally to mobilize resistance.
2. Uniform, horizontal backfill, with a maximum unit weight of 120 pcf for clay soils and 130 pcf for granular soils.
3. Granular material backfill phi = 32 degrees (minimum); Clay soil phi = 24 degrees (minimum)
4. Uniform surcharge, where S is surcharge pressure.
5. Loading from heavy compaction equipment is not included.
6. To achieve "Drained" conditions, follow guidelines in Subsurface Drainage for Below-Grade Walls below. "Undrained" conditions are recommended when drainage behind walls is not incorporated into the design.

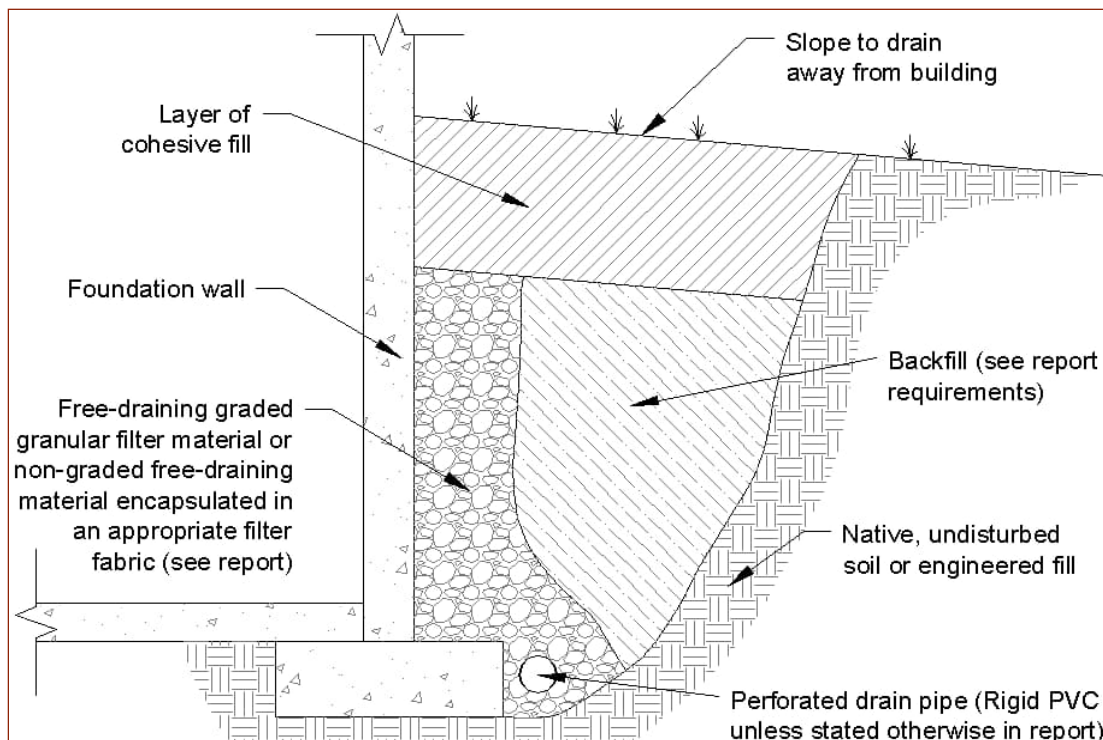
Backfill placed against structures should consist of granular soils or low plasticity cohesive soils. For the granular values to be valid, the granular backfill must extend out and up from the base of the wall at an angle of at least 45 degrees from vertical for the active and at-rest cases, and at an angle of 60 degrees from vertical for the passive case. To calculate the resistance to sliding, a value of 0.3 should be used as the ultimate coefficient of friction where the footing bears on native clay soils or engineered fill.

Footings, floor slabs, or other loads bearing on backfill behind walls may have a significant influence on the lateral earth pressure. Placing footings within wall backfill and in the zone of active soil influence on the wall should be avoided unless structural analyses indicate the wall can safely withstand the increased pressure.

The lateral earth pressure recommendations given in this section are applicable to the design of rigid retaining walls subject to slight rotation, such as cantilever or gravity type concrete walls. These recommendations are not applicable to the design of modular block - geogrid reinforced backfill walls (also termed MSE walls).

Subsurface Drainage for Below-Grade Walls

A perforated rigid plastic drain line installed behind the base of below-grade walls is recommended to prevent hydrostatic loading on the walls. The invert of a drain line around a below-grade building area or exterior retaining wall should be placed near foundation bearing level. The drain line should be sloped to provide positive gravity drainage to daylight or to a sump pit and pump. The drain line should be surrounded by clean, free-draining granular material having less than 5% passing the No. 200 sieve, such as No. 57 aggregate. The free-draining aggregate should be encapsulated in a filter fabric. The granular fill should extend to within 2 feet of final grade, where it should be capped with compacted cohesive fill to reduce infiltration of surface water into the drain system.



As an alternative to free-draining granular fill, a prefabricated drainage structure may be used. A prefabricated drainage structure is a plastic drainage core or mesh which is covered with filter fabric to prevent soil intrusion and is fastened to the wall prior to placing backfill.

Considerations for Segmental Retaining Walls

We understand that retaining walls of unknown construction are planned along the northern, western, and southern boundaries of the site. Based on the drawings provided,

the anticipated maximum wall height is 10 feet. We have not evaluated internal stability, external stability, or global stability of the walls. It is the responsibility of the wall designer to evaluate these conditions based upon the following provided soil parameters.

Retaining Wall Design Parameters

Based on available laboratory tests performed for this project, our experience with similar soils, and drained shear strength correlations in the published literature^{1,2,3,4,5}, we developed the following geotechnical design parameters for use in the analysis.

Material Type	Total Unit Weight (pcf)	Effective Stress (Drained) Shear Strength Parameters	
		c', psf	φ', degrees
Reinforced Zone (Densely Graded Aggregate - MoDOT Type 5 or Similar)	130	0	34
Reinforced Zone (Open Graded Aggregate - ASTM C33 No. 57 or Similar)	100	0	34
Retained Soils (Native Clay Soils)	125	0	24
Native Clay (Foundation Soil)	125	0	24

Internal stability analyses should conform to the latest design methodology accepted for use by either the Federal Highway Administration (FHWA), AASHTO or the National

¹ Kulhawy, F. H., & Mayne, P. W. (1990). Manual on Estimating Soil Properties for Foundation Design, Final Report EL-6800. Cornell University, Ithaca, New York. Palo Alto, CA: EPRI.

² Stark, T. D., & Eid, H. T. (1994). Drained Residual Strength of Cohesive Soils. J. Geotech. Eng., 120 (5), 856-871.

³ Stark, T. D., & Eid, H. T. (1997). Slope Stability Analyses in Stiff Fissured Clays. J. Geotech. Geoenviron. Eng., 123 (4), 335-343.

⁴ Stark, T.D., Choi, H., & McCone, S. (2005). Drained Shear Strength Parameters for Analysis of Landslides. J. Geotech. Geoenviron. Eng., 131 (5), 575-588.

⁵ Stark, T. D., & Hussain, M. (2013). Empirical Correlations: Drained Shear Strength for Slope Stability Analyses. J. Geotech. Geoenviron. Eng., 139 (6), 853-862.

Concrete Masonry Association (NCMA). We recommend that proposed wall backfill consist of granular materials.

Retaining Wall Drainage

To reduce the potential for the build-up of hydrostatic pressure behind the retaining walls, we recommend that a 2-foot wide chimney of open graded aggregate (ASTM C33 No. 57) be placed behind the walls and that a drain line be installed at the base of the open graded aggregate. The drain lines should be positively sloped to drain to a suitable discharge point (daylight or a nearby storm sewer). The drain lines should consist of a perforated plastic pipe with appropriate slot sizes. The pipes should be surrounded by free-draining, granular material, and the granular material should be encapsulated with an approved geotextile filter fabric. The granular material should extend from the drainage pipes to within 12 inches of final grade and should be capped with an approved geotextile filter fabric and cohesive (clay) fill material to reduce surface water infiltration.

Pavements

Pavement Subgrade Preparation

Pavement subgrades are expected to consist of on-site native clay soils. The pavement subgrades should be proofrolled as recommended in [Earthwork](#). If soft or otherwise unsuitable areas are observed, additional overexcavation and replacement will be needed.

Grading and paving are commonly performed by separate contractors and there is often a time lapse between the end of grading operations and the commencement of paving. Subgrades prepared early in the construction process may become disturbed by construction traffic. Non-uniform subgrades often result in poor pavement performance and local failures relatively soon after pavements are constructed. Depending on the paving equipment used by the contractor, measures may be required to improve subgrade strength to greater depths for support of heavily loaded concrete/asphalt trucks.

We recommend the moisture content and density of the subgrade be evaluated and the pavement subgrades be proofrolled (using a loaded tandem-axle dump truck with a minimum gross weight of 20 tons or similarly loaded rubber-tire equipment) within two days prior to commencement of actual paving operations. Areas not in compliance with the required ranges of moisture or density should be scarified, moisture conditioned, and compacted. Particular attention should be paid to high traffic areas that were rutted and disturbed earlier and to areas where backfilled trenches are located. Areas where unsuitable conditions are located should be repaired by removing and replacing the

materials with properly compacted fills. The subgrade should be in its finished form at the time of the final review.

Support characteristics of subgrade for pavement design do not account for shrink/swell movements of an expansive clay subgrade, such as soils observed on this project. Thus, the pavement may be adequate from a structural standpoint, yet still experience cracking and deformation due to shrink/swell related movement of the subgrade.

Opinions of Minimum Pavement Thicknesses

The pavement sections provided here should be considered for cost estimating purposes only. These thicknesses are based on the project assumptions (summarized below) and limited information available at the time this report was prepared. Development of a more specific pavement thickness design would require specific information about the anticipated traffic volumes, vehicle types, axle loads, and design period for each pavement area and pavement surfacing type.

Pavement thickness depends upon many factors including but not limited to:

- applied wheel/axle loads and number of repetitions
- subgrade and pavement material characteristics
- climate conditions
- site and pavement drainage

Specific information regarding anticipated vehicle types, axle loads, and traffic volumes was not provided at the time of this report. The “Parking Lots” pavement section considers 4-tire, 2-axle personal vehicle traffic only (cars, vans, pickups, and SUVs). The “Drives” pavement section considers personal vehicle traffic and a maximum of ten delivery trucks/trash collection trucks per week. Our recommendations for asphaltic cement concrete (ACC) pavement and portland cement concrete (PCC) pavement sections are outlined in the following table.

Opinions of Minimum Pavement Thickness

Pavement Type	Parking Lots	Drives
ACC	2 inches ACC surface 2 inches ACC base 6 inches aggregate base (MoDOT Type 5 or similar)	2 inches ACC surface 4 inches ACC base 6 inches aggregate base (MoDOT Type 5 or similar)
PCC	5 inches PCC 4 inches aggregate base (MoDOT Type 5 or similar)	6 inches PCC 4 inches aggregate base (MoDOT Type 5 or similar)

1. For trash container pads, we recommend a PCC pavement section be used consisting of 7 inches (minimum) of PCC over 4 inches (minimum) aggregate base (MoDOT Type 5 or similar) on a compacted soil subgrade. The trash container pad should be large enough to support the container and the tipping axle of the collection truck.

PCC pavements will perform better than ACC in areas where short radius turning and braking are expected (i.e., entrance/exit aprons) due to better resistance to rutting and shoving. In addition, PCC pavement will perform better in areas subject to heavy static loads.

Construction traffic on the pavements was not considered in developing our opinions of minimum pavement thickness. If the pavements will be subject to construction equipment/vehicles, the pavement sections should be revised to consider the additional loading.

Pavements and subgrades will be subject to freeze-thaw cycles and seasonal fluctuations in moisture content. Pavement thickness design methods are intended to provide adequate thickness of structural materials over a particular subgrade such that wheel loads are reduced to a level that the subgrade can support. The subgrade support parameters for pavement thickness design do not account for shrink/swell movements of a subgrade constructed of expansive clay soils. Therefore, the pavement may be adequate from a structural standpoint, yet still experience cracking and deformation due to shrink/swell related movement of the subgrade.

The pavement sections provided above consider that the subgrade soils will not experience significant increases in moisture content. Paved areas should be sloped to provide rapid drainage of surface water and to drain water away from the pavement edges. Pavements should be designed so water does not accumulate on or adjacent to the pavement, since this could saturate and soften the subgrade soils and subsequently accelerate pavement deterioration.

Openings in pavements, such as decorative landscaped areas, are sources for water infiltration into surrounding pavement systems. Water can collect in the islands and migrate into the surrounding subgrade soils thereby degrading support of the pavement. Islands with raised concrete curbs, irrigated foliage, and low permeability near-surface soils are particular areas of concern. The civil design for the pavements with these conditions should include features to restrict or collect and discharge excess water from the islands. Examples of features are edge drains connected to the stormwater collection system, longitudinal subdrains, or other suitable outlets and impermeable barriers preventing lateral migration of water such as a cutoff wall installed to a depth below the pavement structure.

Periodic maintenance of the pavements will be required. Cracks should be sealed, and areas exhibiting distress should be repaired promptly to help prevent further

deterioration. Even with periodic maintenance, some movement and related cracking may still occur and repairs may be required.

General Comments

Our analysis and opinions are based upon our understanding of the project, the geotechnical conditions in the area, and the data obtained from our site exploration. Variations will occur between boring locations or due to the modifying effects of construction or weather. The nature and extent of such variations may not become evident until during or after construction. Terracon should be retained as the Geotechnical Engineer, where noted in this report, to provide observation and testing services during pertinent construction phases. If variations appear, we can provide further evaluation and supplemental recommendations. If variations are noted in the absence of our observation and testing services on-site, we should be immediately notified so that we can provide evaluation and supplemental recommendations.

Our Scope of Services does not include either specifically or by implication any environmental or biological (e.g., mold, fungi, bacteria) assessment of the site or identification or prevention of pollutants, hazardous materials or conditions. If the owner is concerned about the potential for such contamination or pollution, other studies should be undertaken.

Our services and any correspondence are intended for the sole benefit and exclusive use of our client for specific application to the project discussed and are accomplished in accordance with generally accepted geotechnical engineering practices with no third-party beneficiaries intended. Any third-party access to services or correspondence is solely for information purposes to support the services provided by Terracon to our client. Reliance upon the services and any work product is limited to our client and is not intended for third parties. Any use or reliance of the provided information by third parties is done solely at their own risk. No warranties, either express or implied, are intended or made.

Site characteristics as provided are for design purposes and not to estimate excavation cost. Any use of our report in that regard is done at the sole risk of the excavating cost estimator as there may be variations on the site that are not apparent in the data that could significantly impact excavation cost. Any parties charged with estimating excavation costs should seek their own site characterization for specific purposes to obtain the specific level of detail necessary for costing. Site safety, cost estimating, excavation support, and dewatering requirements/design are the responsibility of others. Construction and site development have the potential to affect adjacent properties. Such impacts can include damages due to vibration, modification of groundwater/surface water flow during construction, foundation movement due to undermining or subsidence from excavation, as well as noise or air quality concerns. Evaluation of these items on

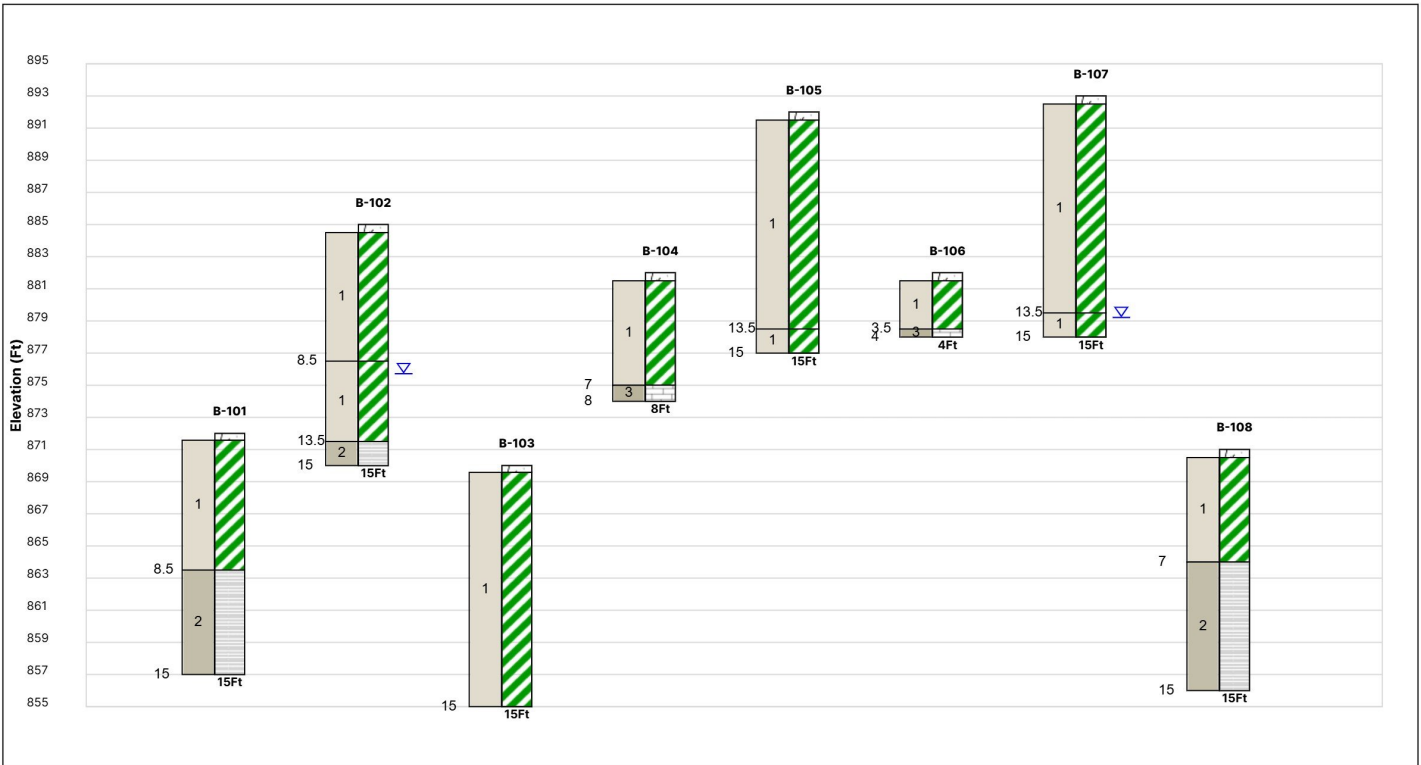
nearby properties are commonly associated with contractor means and methods and are not addressed in this report. The owner and contractor should consider a preconstruction/precondition survey of surrounding development. If changes in the nature, design, or location of the project are planned, our conclusions and recommendations shall not be considered valid unless we review the changes and either verify or modify our conclusions in writing.

Figures

Contents:

GeoModel

GeoModel : North Borings



This is not a cross section. This is intended to display the Geotechnical Model only. See individual logs for more detailed conditions

#	Layer Name	General Description
---	------------	---------------------

- | | | |
|---|-----------|------------------------------------|
| 1 | Fat Clay | Fat clay (CH), soft to very stiff |
| 2 | Shale | Completely to moderately weathered |
| 3 | Limestone | Moderately to slightly weathered |

Legend

- | | | | |
|--|---------|--|-----------|
| | TOPSOIL | | Fat Clay |
| | Shale | | Limestone |

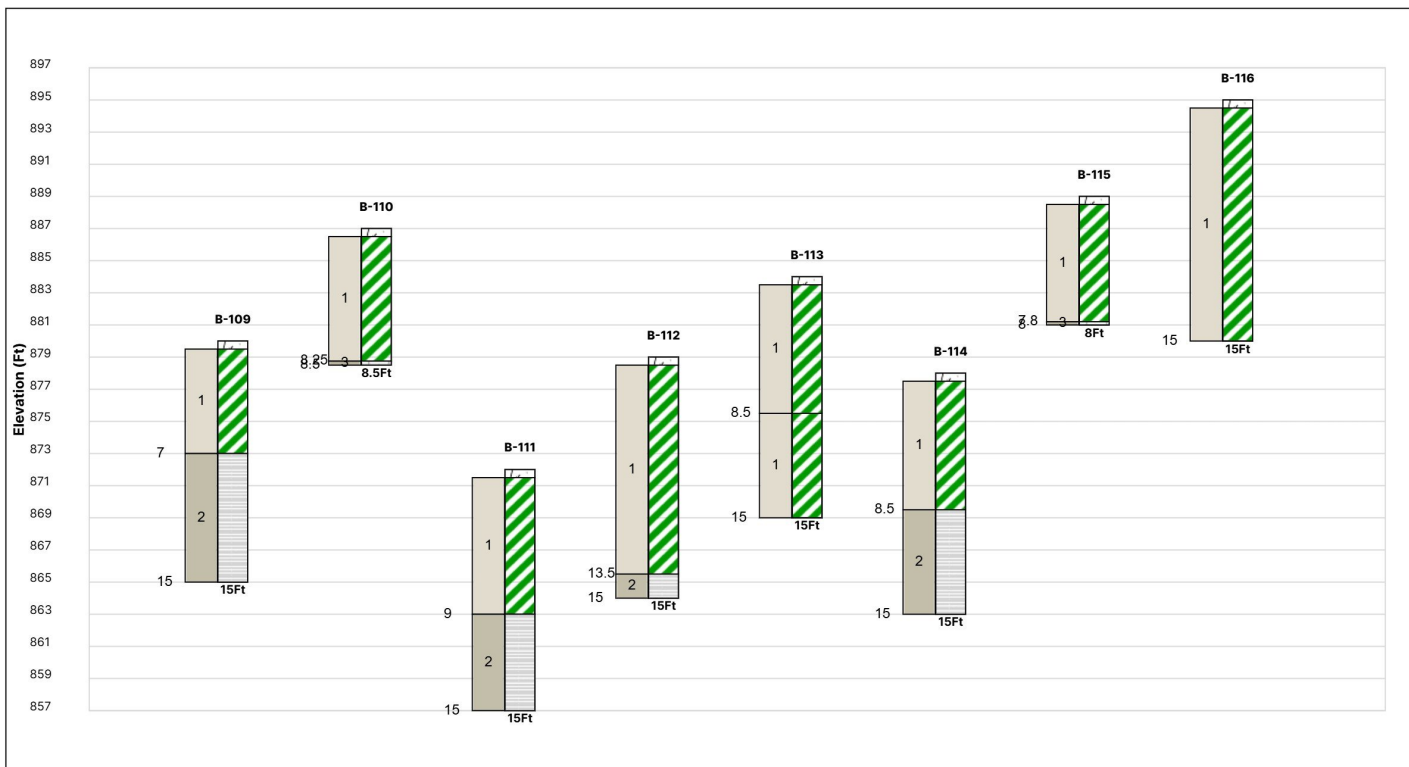
Groundwater levels are temporal. The levels shown are representative of the date and time of our exploration. Significant changes are possible over time.
 Water levels shown are as measured during and/or after drilling. In some cases, boring advancement methods mask the presence/absence of groundwater. See individual logs for details.

Notes:

Layering shown on this figure has been developed by the geotechnical engineer for purposes of modeling the subsurface conditions as required for the subsequent geotechnical engineering for this project.
 Numbers adjacent to soil column indicate depth below ground surface.

- | | |
|--|--------------------------|
| | First Water Observation |
| | Second Water Observation |
| | Third Water Observation |

GeoModel : South Borings



This is not a cross section. This is intended to display the Geotechnical Model only. See individual logs for more detailed conditions

#	Layer Name	General Description
1	Fat Clay	Fat clay (CH), soft to very stiff
2	Shale	Completely to moderately weathered
3	Limestone	Moderately to slightly weathered

Legend	
	TOPSOIL
	Shale
	Fat Clay
	Limestone

Groundwater levels are temporal. The levels shown are representative of the date and time of our exploration. Significant changes are possible over time.

Water levels shown are as measured during and/or after drilling. In some cases, boring advancement methods mask the presence/absence of groundwater. See individual logs for details.

Notes:

Layering shown on this figure has been developed by the geotechnical engineer for purposes of modeling the subsurface conditions as required for the subsequent geotechnical engineering for this project.

Numbers adjacent to soil column indicate depth below ground surface.

- First Water Observation
- Second Water Observation
- Third Water Observation

Attachments

Exploration and Testing Procedures

Field Exploration

Number of Borings	Approximate Boring Depth (feet)	Location
16	15 or auger refusal	Proposed building footprints

Boring Layout and Elevations: Terracon personnel provided the boring layout using handheld GPS equipment (estimated horizontal precision of about ± 10 feet) and referencing existing site features. Approximate ground surface elevations were estimated using Google Earth.

Subsurface Exploration Procedures: We advanced the borings with a track-mounted rotary drill rig using continuous flight augers. Samples were obtained from the borings using thin-walled tube and split-barrel sampling procedures. In the thin-walled tube sampling procedure, a thin-walled, seamless steel tube with a sharp cutting edge was pushed hydraulically into the soil to obtain a relatively undisturbed sample. In the split-barrel sampling procedure, a standard 2-inch outer diameter split-barrel sampling spoon was driven into the ground by a 140-pound automatic hammer falling a distance of 30 inches. The number of blows required to advance the sampling spoon the last 12 inches of a normal 18-inch penetration is recorded as the Standard Penetration Test (SPT) resistance value. The SPT resistance values, also referred to as N-values, are indicated on the boring logs at the test depths. The borings were backfilled with auger cuttings after their completion.

We also observed the boreholes while drilling and at the completion of drilling for the presence of groundwater. The groundwater levels are shown on the attached boring logs.

Our exploration team prepared field boring logs to record the sampling depths, penetration distances, other sampling information, visual classifications of the materials observed during drilling, and our interpretation of the subsurface conditions between samples. The samples were placed in appropriate containers and taken to our laboratory for testing and classification. The final boring logs provided with this report include modifications based on the results of the laboratory tests and observations of the recovered samples.

Laboratory Testing

The project engineer reviewed the field data and assigned laboratory tests. The laboratory testing program included the following tests on selected samples:

- Moisture Content
- Dry Unit Weight
- Unconfined Compression
- Atterberg Limits

Based on the results of our field and laboratory programs, we described and classified the soil samples in general accordance with the Unified Soil Classification System.

Rock classification was conducted using locally accepted practices for engineering purposes; core samples and petrographic analysis may indicate other rock types. The rock classifications on the boring logs were determined using the attached Rock Classification Notes.

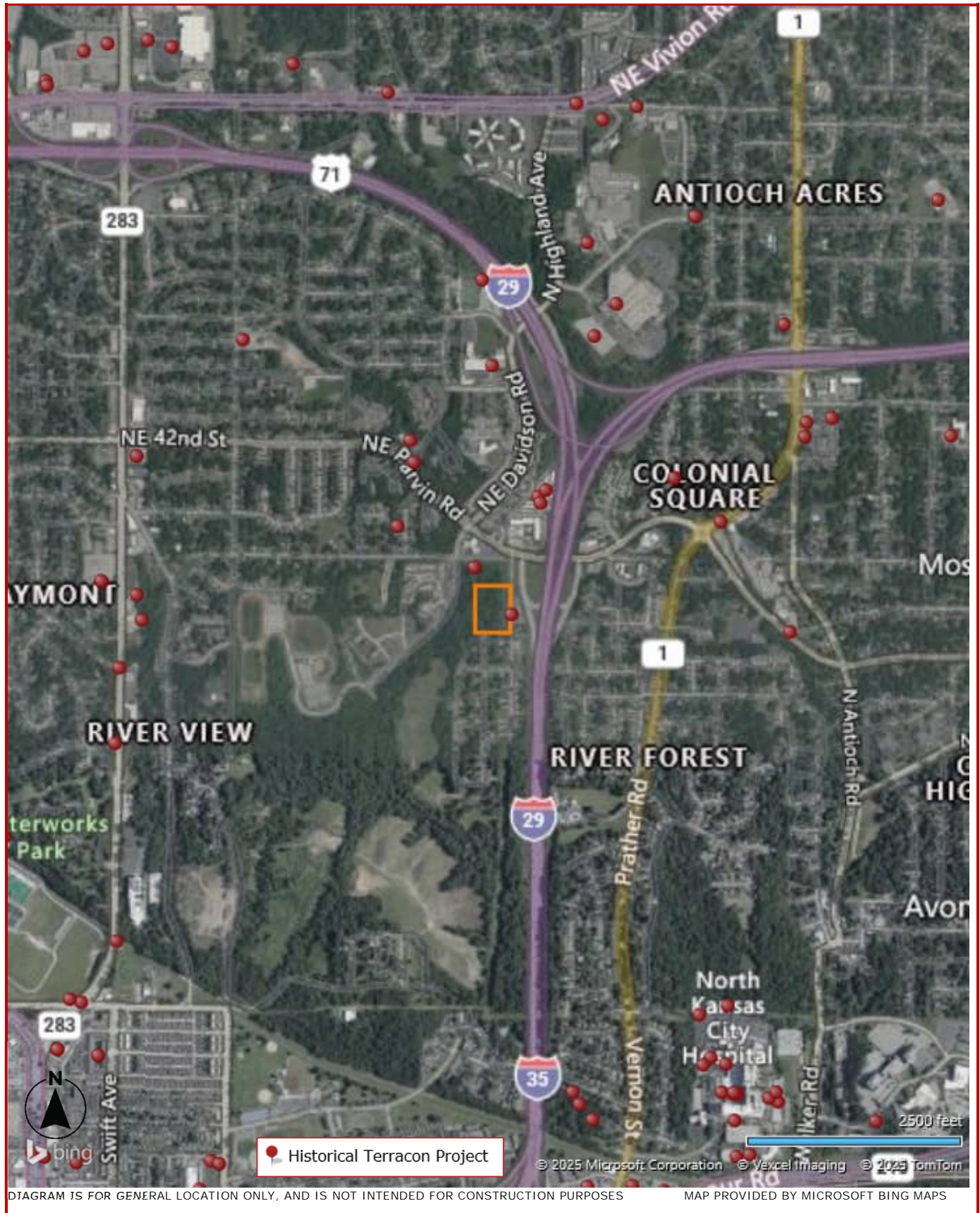
Site Location and Exploration Plans

Contents:

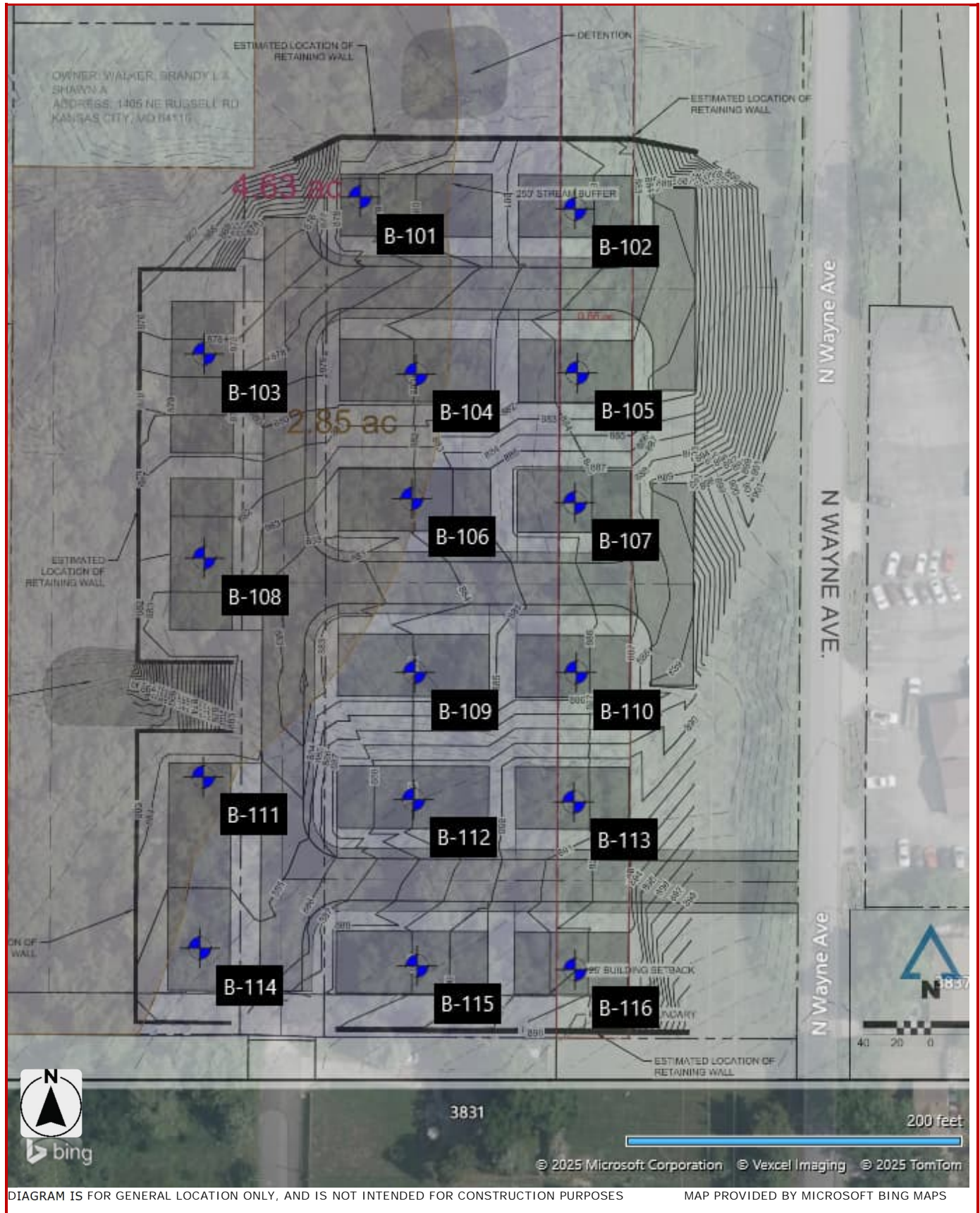
Site Location Plan
Exploration Plan

Note: All attachments are one page unless noted above.

Site Location



Exploration Plan



Exploration and Laboratory Results

Contents:

Boring Logs (B-101 through B-116)

Note: All attachments are one page unless noted above.

BORING LOG NO. B-101

Model Layer	Graphic Log	Lithology Depth (Ft.)	Material Description	Depth (Ft.)	Elevation (Ft.)	Sample Type	Recovery (In.)	Field Test Results	Hand Penetrometer (tsf)	Water Content (%)
1		0.4	TOPSOIL	5	871.6					
			FAT CLAY (CH) , brown, stiff		X	3.99	4-6-8 N = 14	4.5	18	
						8		4.5	19.5	
					X	6	5-7-7 N = 14	4.5	21	
2		8.5	SHALE , brown and gray, highly weathered	10	863.5	X	18	8-13-18 N = 31	4.5	21.2
					X	18	15-19-23 N = 42	4.5	21.4	
		Boring Terminated at 15 Ft								

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).
 See Supporting Information for explanation of symbols and abbreviations.

Notes
 Elevation Reference: Elevation obtained using Google Earth

Water Level Observations
 Groundwater not encountered while drilling
 Groundwater not encountered upon completion

Advancement Method
 0-15 Ft. Solid Stem/Flight Auger

Abandonment Method
 Boring backfilled with auger cuttings upon completion.

Drill Rig
 988/CME-55/300

Hammer Type
 Automatic

Driller
 LN

Logged By
 Stacey Bonderer

Boring Started
 11/18/2025

Boring Completed
 11/18/2025

BORING LOG NO. B-102

Model Layer	Graphic Log	Lithology Depth (Ft.)	Material Description	Depth (Ft.)	Elevation (Ft.)	Sample Type	Recovery (In.)	Water Level Observations	Field Test Results	Hand Penetrometer (tsf)	Strength Test		Water Content (%)	Dry Unit Weight (pcf.)	Atterberg Limits			
											Compressive Strength (tsf)	Strain (%)			LL	PL	PI	
1		0.5	TOPSOIL		884.5													
			FAT CLAY (CH) , light brown, stiff to very stiff															
										6-9-11 N = 20	4.5		14.6					
												1.625	1.8	16.7	102.1	52	20	32
		8.5	FAT CLAY (CH) , light brown, soft		876.5				4-6-6 N = 12	4.5		22.5						
									11-1-2 N = 3	0		55.4						
		13.5	SHALE , gray, moderately weathered		871.5				12-34-50/6"	4.5		19.6						
			Boring Terminated at 15 Ft															

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).
 See Supporting Information for explanation of symbols and abbreviations.

Notes
 Elevation Reference: Elevation obtained using Google Earth

Water Level Observations
 9 Ft. While drilling

Advancement Method
 0-15 Ft. Solid Stem/Flight Auger

Abandonment Method
 Boring backfilled with auger cuttings upon completion.

Drill Rig
 988/CME-55/300
Hammer Type
 Automatic
Driller
 LN

Logged By
 Stacey Bonderer
Boring Started
 11/18/2025
Boring Completed
 11/18/2025

BORING LOG NO. B-104

Model Layer	Graphic Log	Lithology Depth (Ft.)	Material Description	Depth (Ft.)	Elevation (Ft.)	Sample Type	Recovery (In.)	Field Test Results	Hand Penetrometer (tsf)	Water Content (%)
		0.5	TOPSOIL		881.5					
1			FAT CLAY (CH) , brown, stiff to very stiff			X	9	8-7-10 N = 17	4.5	26.7
				5			8		4.5	26.2
3		7.0	LIMESTONE , moderately to slightly weathered		875.0	X	6	5-21-50/2"	4.5	17.3
Boring Refusal at 8 Ft										

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).
 See Supporting Information for explanation of symbols and abbreviations.

Notes
 Elevation Reference: Elevation obtained using Google Earth

Water Level Observations
 Groundwater not encountered while drilling
 Groundwater not encountered upon completion

Advancement Method
 0-8 Ft. Solid Stem/Flight Auger

Abandonment Method
 Boring backfilled with auger cuttings upon completion.

Drill Rig
 988/CME-55/300
Hammer Type
 Automatic
Driller
 LN

Logged By
 Stacey Bonderer
Boring Started
 11/18/2025
Boring Completed
 11/18/2025

BORING LOG NO. B-105

Model Layer	Graphic Log	Lithology Depth (Ft.)	Material Description	Depth (Ft.)	Elevation (Ft.)	Sample Type	Recovery (In.)	Field Test Results	Hand Penetrometer (tsf)	Strength Test		Water Content (%)	Dry Unit Weight (pcf.)	Atterberg Limits				
										Compressive Strength (tsf)	Strain (%)			LL	PL	PI		
1		0.5	TOPSOIL		891.5													
			FAT CLAY (CH) , brown and light brown, stiff to very stiff															
								12	13-14-12 N = 26	4.5			12.8					
						5		24			3.01	1.3	14.6	101.9				
								3	6-6-7 N = 13	4.5			12.5					
						10		18	4-6-8 N = 14	3.75			32.9			88	33	55
		13.5	soft		878.5													
			Boring Terminated at 15 Ft															

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).
 See Supporting Information for explanation of symbols and abbreviations.

Notes
 Elevation Reference: Elevation obtained using Google Earth

Water Level Observations
 Groundwater not encountered while drilling
 Groundwater not encountered upon completion

Advancement Method
 0-15 Ft. Solid Stem/Flight Auger

Abandonment Method
 Boring backfilled with auger cuttings upon completion.

Drill Rig
 988/CME-55/300
Hammer Type
 Automatic
Driller
 LN

Logged By
 Stacey Bonderer
Boring Started
 11/18/2025
Boring Completed
 11/18/2025

BORING LOG NO. B-106

Model Layer	Graphic Log	Lithology Depth (Ft.)	Material Description	Depth (Ft.)	Elevation (Ft.)	Sample Type	Recovery (In.)	Field Test Results	Hand Penetrometer (tsf)	Water Content (%)
		0.5	TOPSOIL		881.5					
1			FAT CLAY (CH) , brown, very stiff			X	9	5-7-10 N = 17	4.5	25
3		3.5	LIMESTONE , brown and gray, moderately weathered		878.5	■	4		4.5	23.4
			Boring Refusal at 4 Ft							

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).
 See Supporting Information for explanation of symbols and abbreviations.

Notes
 Elevation Reference: Elevation obtained using Google Earth

Water Level Observations
 Groundwater not encountered while drilling
 Groundwater not encountered upon completion

Advancement Method
 0-4 Ft. Solid Stem/Flight Auger

Abandonment Method
 Boring backfilled with auger cuttings upon completion.

Drill Rig
 988/CME-55/300
Hammer Type
 Automatic
Driller
 LN

Logged By
 Stacey Bonderer
Boring Started
 11/18/2025
Boring Completed
 11/18/2025

BORING LOG NO. B-107

Model Layer	Graphic Log	Lithology Depth (Ft.)	Material Description	Depth (Ft.)	Elevation (Ft.)	Sample Type	Recovery (In.)	Water Level Observations	Field Test Results	Hand Penetrometer (tsf)	Water Content (%)		
1		0.5	TOPSOIL		892.5								
			FAT CLAY (CH) , brown, stiff				X	7		5-6-6 N = 12	4.5	13.1	
					5						4.5	18.1	
							X	11		3-4-5 N = 9	4.5	20	
						10		X	13		4-7-8 N = 15	4.5	17.9
				13.5	soft, with limestone fragments		879.5						
			Boring Terminated at 15 Ft										

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).
 See Supporting Information for explanation of symbols and abbreviations.

Notes
 Elevation Reference: Elevation obtained using Google Earth

Water Level Observations

13.5 Ft. While drilling

Advancement Method

0-15 Ft. Solid Stem/Flight Auger

Abandonment Method

Boring backfilled with auger cuttings upon completion.

Drill Rig

988/CME-55/300

Hammer Type

Automatic

Driller

LN

Logged By

Stacey Bonderer

Boring Started

11/20/2025

Boring Completed

11/20/2025

BORING LOG NO. B-108

Latitude: 39.1650° Longitude: -94.5620°

15620 W 113th St
 Lenexa, KS 66219-5102

Surface Elevation:
 871(Ft) +/-

Model Layer	Graphic Log	Lithology Depth (Ft.)	Material Description	Depth (Ft.)	Elevation (Ft.)	Sample Type	Recovery (In.)	Field Test Results	Hand Penetrometer (tsf)	Water Content (%)
	▲▲▲▲▲	0.5	TOPSOIL		870.5					
1			FAT CLAY (CH) , dark brown, stiff			X	4	3-3-6 N = 9	4.5	20.7
				5			24			19.7
		7.0	SHALE , brown and gray, completely to highly weathered		864.0	X	7	5-7-8 N = 15	4.5	19.3
2						X	14	10-14-16 N = 30	4.5	20.2
						X	18	10-18-23 N = 41	4.5	21
			Boring Terminated at 15 Ft							

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).
 See Supporting Information for explanation of symbols and abbreviations.

Notes
 Elevation Reference: Elevation obtained using Google Earth

Water Level Observations
 Groundwater not encountered while drilling
 Groundwater not encountered upon completion

Advancement Method
 0-15 Ft. Solid Stem/Flight Auger

Abandonment Method
 Boring backfilled with auger cuttings upon completion.

Drill Rig
 988/CME-55/300

Hammer Type
 Automatic

Driller
 LN

Logged By
 Stacey Bonderer

Boring Started
 11/18/2025

Boring Completed
 11/18/2025

BORING LOG NO. B-109

Model Layer	Graphic Log	Lithology Depth (Ft.)	Material Description	Depth (Ft.)	Elevation (Ft.)	Sample Type	Recovery (In.)	Field Test Results	Hand Penetrometer (tsf)	Water Content (%)
1		0.5	TOPSOIL		879.5					
			FAT CLAY (CH) , brown, stiff				4	5-6-6 N = 12	4.5	16.6
					5		4		4.5	17.3
2		7.0	SHALE , brown and gray, completely to moderately weathered		873.0		17	1-5-9 N = 14	3.0	23
							16	5-9-15 N = 24	4.5	19.5
							11	25-50/5"	4.5	15.8
			Boring Terminated at 15 Ft							

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).
 See Supporting Information for explanation of symbols and abbreviations.

Notes
 Elevation Reference: Elevation obtained using Google Earth

Water Level Observations
 Groundwater not encountered while drilling
 Groundwater not encountered upon completion

Advancement Method
 0-15 Ft. Solid Stem/Flight Auger

Abandonment Method
 Boring backfilled with auger cuttings upon completion.

Drill Rig
 988/CME-55/300

Hammer Type
 Automatic

Driller
 LN

Logged By
 Stacey Bonderer

Boring Started
 11/18/2025

Boring Completed
 11/18/2025

BORING LOG NO. B-111

Model Layer	Graphic Log	Lithology Depth (Ft.)	Material Description	Depth (Ft.)	Elevation (Ft.)	Sample Type	Recovery (In.)	Field Test Results	Hand Penetrometer (tsf)	Water Content (%)	
1		0.5	TOPSOIL	5	871.5						
			FAT CLAY (CH) , brown, very stiff				X	6	8-11-10 N = 21	4.5	15.8
								10		4.5	15.8
							X	6	7-7-8 N = 15	4.5	16.8
2		9.0	SHALE , brown, highly weathered	10	863.0						
							X	12	9-12-13 N = 25	4.5	16.8
							X	18	4-13-14 N = 27	4.5	19.2
			Boring Terminated at 15 Ft								

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).
 See Supporting Information for explanation of symbols and abbreviations.

Notes
 Elevation Reference: Elevation obtained using Google Earth

Water Level Observations
 Groundwater not encountered while drilling
 Groundwater not encountered upon completion

Advancement Method
 0-15 Ft. Solid Stem/Flight Auger

Abandonment Method
 Boring backfilled with auger cuttings upon completion.

Drill Rig
 988/CME-55/300

Hammer Type
 Automatic

Driller
 LN

Logged By
 Stacey Bonderer

Boring Started
 11/20/2025

Boring Completed
 11/20/2025

BORING LOG NO. B-112

Latitude: 39.1646° Longitude: -94.5616°

15620 W 113th St
 Lenexa, KS 66219-5102

Surface Elevation:
 879(Ft) +/-

Model Layer	Graphic Log	Lithology Depth (Ft.)	Material Description	Depth (Ft.)	Elevation (Ft.)	Sample Type	Recovery (In.)	Field Test Results	Hand Penetrometer (tsf)	Water Content (%)
	0.5	TOPSOIL			878.5					
1			FAT CLAY (CH) , brown and brown gray, stiff	5	5	X	7	5-7-8 N = 15	4.5	15.6
							5		4.5	15.7
						X	5	5-5-6 N = 11	4.5	15.4
						X	14	3-3-6 N = 9	4.5	31.6
	13.5	SHALE , brown and gray, highly to moderately weathered			865.5	X	18	12-18-28 N = 46	4.5	18.7
			Boring Terminated at 15 Ft							

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).
 See Supporting Information for explanation of symbols and abbreviations.

Notes
 Elevation Reference: Elevation obtained using Google Earth

Water Level Observations
 Groundwater not encountered while drilling
 Groundwater not encountered upon completion

Advancement Method
 0-15 Ft. Solid Stem/Flight Auger

Abandonment Method
 Boring backfilled with auger cuttings upon completion.

Drill Rig
 988/CME-55/300
Hammer Type
 Automatic
Driller
 LN

Logged By
 Stacey Bonderer
Boring Started
 11/20/2025
Boring Completed
 11/20/2025

BORING LOG NO. B-114

Model Layer	Graphic Log	Lithology Depth (Ft.)	Material Description	Depth (Ft.)	Elevation (Ft.)	Sample Type	Recovery (In.)	Field Test Results	Hand Penetrometer (tsf)	Strength Test		Water Content (%)	Dry Unit Weight (pcf.)	
										Compressive Strength (tsf)	Strain (%)			
1		0.5	TOPSOIL		877.5									
			FAT CLAY (CH) , brown, very stiff				X	7	7-8-9 N = 17	4.5			17.8	
								█	24		1.63	1.2	24	95.2
								X	7	4-7-8 N = 15	4.5			17.9
2		8.5	SHALE , light brown and light gray, highly to moderately weathered		869.5									
							X	18	7-13-17 N = 30	4.5			20.4	
								X	18	12-22-30 N = 52	4.5			18.6
			Boring Terminated at 15 Ft											

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).
 See Supporting Information for explanation of symbols and abbreviations.

Notes
 Elevation Reference: Elevation obtained using Google Earth

Water Level Observations
 Groundwater not encountered while drilling
 Groundwater not encountered upon completion

Advancement Method
 0-15 Ft. Solid Stem/Flight Auger

Abandonment Method
 Boring backfilled with auger cuttings upon completion.

Drill Rig
 988/CME-55/300
Hammer Type
 Automatic
Driller
 LN

Logged By
 Stacey Bonderer
Boring Started
 11/20/2025
Boring Completed
 11/20/2025

BORING LOG NO. B-115

Model Layer	Graphic Log	Lithology Depth (Ft.)	Material Description	Depth (Ft.)	Elevation (Ft.)	Sample Type	Recovery (In.)	Field Test Results	Hand Penetrometer (tsf)	Water Content (%)
	0.5	TOPSOIL			888.5					
1			FAT CLAY (CH) , brown, stiff	5		X	6	4-5-6 N = 11	4.5	19.7
				5			11		4.5	17.7
3		7.8	LIMESTONE , gray, moderately weathered		881.2	X	5	7-6-4 N = 10	4.5	14.6
			Boring Refusal at 8 Ft							

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).
 See Supporting Information for explanation of symbols and abbreviations.

Notes
 Elevation Reference: Elevation obtained using Google Earth

Water Level Observations
 Groundwater not encountered while drilling
 Groundwater not encountered upon completion

Advancement Method
 0-8 Ft. Solid Stem/Flight Auger

Abandonment Method
 Boring backfilled with auger cuttings upon completion.

Drill Rig
 988/CME-55/300
Hammer Type
 Automatic
Driller
 LN

Logged By
 Stacey Bonderer
Boring Started
 11/20/2025
Boring Completed
 11/20/2025

BORING LOG NO. B-116

Model Layer	Graphic Log	Lithology Depth (Ft.)	Material Description	Depth (Ft.)	Elevation (Ft.)	Sample Type	Recovery (In.)	Field Test Results	Hand Penetrometer (tsf)	Water Content (%)
	0.5	0.5	TOPSOIL		894.5					
1			FAT CLAY (CH) , brown and gray, stiff to very stiff			X	12	4-5-6 N = 11	4.5	14.9
				5			7		4.5	18.1
						X	13	6-9-9 N = 18	4.5	18.2
						X	12	5-5-5 N = 10	4.5	20.5
						X	17	4-8-10 N = 18	4.5	18.2
			Boring Terminated at 15 Ft							

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).
 See Supporting Information for explanation of symbols and abbreviations.

Notes
 Elevation Reference: Elevation obtained using Google Earth

Water Level Observations
 Groundwater not encountered while drilling
 Groundwater not encountered upon completion

Advancement Method
 0-15 Ft. Solid Stem/Flight Auger

Abandonment Method
 Boring backfilled with auger cuttings upon completion.

Drill Rig
 988/CME-55/300
Hammer Type
 Automatic
Driller
 LN

Logged By
 Stacey Bonderer
Boring Started
 11/20/2025
Boring Completed
 11/20/2025

Supporting Information

Contents:

General Notes
Unified Soil Classification System
Rock Classification Notes

Note: All attachments are one page unless noted above.

General Notes

Sampling			Water Level		Field Tests	
Auger Cuttings	Modified California Ring Sampler	Rock Core	Water Initially Encountered		N	Standard Penetration Test Resistance (Blows/Ft.)
Dynamic Cone Penetrometer	Modified Dames & Moore Ring Sampler	Dual Sampler SPT	Water Level After a Specified Period of Time		(HP)	Hand Penetrometer
Grab Sample	GeoProbe Macro Core or Large Bore	No Recovery	Water Level After a Specified Period of Time		(T)	Torvane
Ring Sampler	Shelby Tube	Standard Penetration Test	Cave In Encountered		(DCP)	Dynamic Cone Penetrometer
Split Spoon	Texas Cone Penetrometer	Vane Shear	Water levels indicated on the soil boring logs are the levels measured in the borehole at the times indicated. Groundwater level variations will occur over time. In low permeability soils, accurate determination of groundwater levels is not possible with short term water level observations.		UC	Unconfined Compressive Strength
					(PID)	Photo-Ionization Detector
					(OVA)	Organic Vapor Analyzer

Descriptive Soil Classification

Soil classification as noted on the soil boring logs is based Unified Soil Classification System. Where sufficient laboratory data exist to classify the soils consistent with ASTM D2487 "Classification of Soils for Engineering Purposes" this procedure is used. ASTM D2488 "Description and Identification of Soils (Visual-Manual Procedure)" is also used to classify the soils, particularly where insufficient laboratory data exist to classify the soils in accordance with ASTM D2487. In addition to USCS classification, coarse grained soils are classified on the basis of their in-place relative density, and fine-grained soils are classified on the basis of their consistency. See "Strength Terms" table below for details. The ASTM standards noted above are for reference to methodology in general. In some cases, variations to methods are applied as a result of local practice or professional judgment.

Location And Elevation Notes

Exploration point locations as shown on the Exploration Plan and as noted on the soil boring logs in the form of Latitude and Longitude are approximate. See Exploration and Testing Procedures in the report for the methods used to locate the exploration points for this project. Surface elevation data annotated with +/- indicates that no actual topographical survey was conducted to confirm the surface elevation. Instead, the surface elevation was approximately determined from topographic maps of the area.

Strength Terms

Relative Density of Coarse-Grained Soils (More than 50% retained on No. 200 sieve.) Density determined by Standard Penetration Resistance		Consistency of Fine-Grained Soils (50% or more passing the No. 200 sieve.) Consistency determined by laboratory shear strength testing, field visual-manual procedures or standard penetration resistance			Bedrock	
Relative Density	Standard Penetration or N-Value (Blows/Ft.)	Consistency	Unconfined Compressive Strength Q_u (tsf)	Standard Penetration or N-Value (Blows/Ft.)	Standard Penetration or N-Value (Blows/Ft.)	Consistency
Very Loose	0 - 3	Very Soft	less than 0.25	0 - 1	< 20	Weathered
Loose	4 - 9	Soft	0.25 to 0.50	2 - 4	20 - 29	Firm
Medium Dense	10 - 29	Medium Stiff	0.50 to 1.00	4 - 8	30 - 49	Medium Hard
Dense	30 - 50	Stiff	1.00 to 2.00	8 - 15	50 - 79	Hard
Very Dense	> 50	Very Stiff	2.00 to 4.00	15 - 30	>79	Very Hard
		Hard	> 4.00	> 30		

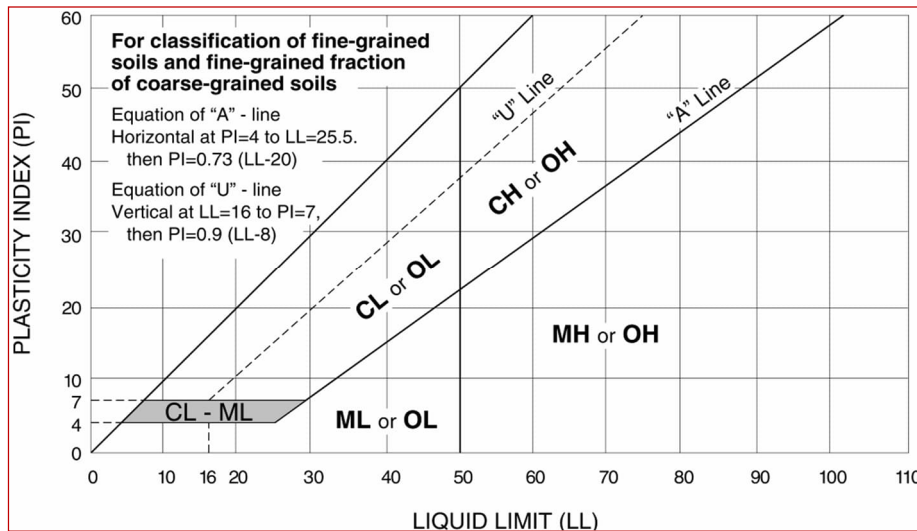
Relevance of Exploration and Laboratory Test Results

Exploration/field results and/or laboratory test data contained within this document are intended for application to the project as described in this document. Use of such exploration/field results and/or laboratory test data should not be used independently of this document.

Unified Soil Classification System

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests ^A				Soil Classification	
				Group Symbol	Group Name ^B
Coarse-Grained Soils: More than 50% retained on No. 200 sieve	Gravels: More than 50% of coarse fraction retained on No. 4 sieve	Clean Gravels: Less than 5% fines ^C	$Cu \geq 4$ and $1 \leq Cc \leq 3$ ^E	GW	Well-graded gravel ^F
		Gravels with Fines: More than 12% fines ^C	$Cu < 4$ and/or $[Cc < 1$ or $Cc > 3.0]$ ^E	GP	Poorly graded gravel ^F
			Fines classify as ML or MH	GM	Silty gravel ^{F, G, H}
		Sands: 50% or more of coarse fraction passes No. 4 sieve	Clean Sands: Less than 5% fines ^D	Fines classify as CL or CH	GC
	$Cu \geq 6$ and $1 \leq Cc \leq 3$ ^E			SW	Well-graded sand ^I
	Sands with Fines: More than 12% fines ^D		$Cu < 6$ and/or $[Cc < 1$ or $Cc > 3.0]$ ^E	SP	Poorly graded sand ^I
			Fines classify as ML or MH	SM	Silty sand ^{G, H, I}
	Fine-Grained Soils: 50% or more passes the No. 200 sieve	Silt and Clays: Liquid limit less than 50	Inorganic:	PI > 7 and plots above "A" line ^J	CL
PI < 4 or plots below "A" line ^J				ML	Silt ^{K, L, M}
Organic:			$\frac{LL \text{ oven dried}}{LL \text{ not dried}} < 0.75$	OL	Organic clay ^{K, L, M, N} Organic silt ^{K, L, M, O}
			Silt and Clays: Liquid limit 50 or more	Inorganic:	PI plots on or above "A" line
PI plots below "A" line		MH			Elastic silt ^{K, L, M}
Organic:		$\frac{LL \text{ oven dried}}{LL \text{ not dried}} < 0.75$		OH	Organic clay ^{K, L, M, P} Organic silt ^{K, L, M, Q}
		Highly organic soils:		Primarily organic matter, dark in color, and organic odor	

- ^A Based on the material passing the 3-inch (75-mm) sieve.
- ^B If field sample contained cobbles or boulders, or both, add "with cobbles or boulders, or both" to group name.
- ^C Gravels with 5 to 12% fines require dual symbols: GW-GM well-graded gravel with silt, GW-GC well-graded gravel with clay, GP-GM poorly graded gravel with silt, GP-GC poorly graded gravel with clay.
- ^D Sands with 5 to 12% fines require dual symbols: SW-SM well-graded sand with silt, SW-SC well-graded sand with clay, SP-SM poorly graded sand with silt, SP-SC poorly graded sand with clay.
- ^E $Cu = D_{60}/D_{10}$ $Cc = \frac{(D_{30})^2}{D_{10} \times D_{60}}$
- ^F If soil contains $\geq 15\%$ sand, add "with sand" to group name.
- ^G If fines classify as CL-ML, use dual symbol GC-GM, or SC-SM.
- ^H If fines are organic, add "with organic fines" to group name.
- ^I If soil contains $\geq 15\%$ gravel, add "with gravel" to group name.
- ^J If Atterberg limits plot in shaded area, soil is a CL-ML, silty clay.
- ^K If soil contains 15 to 29% plus No. 200, add "with sand" or "with gravel," whichever is predominant.
- ^L If soil contains $\geq 30\%$ plus No. 200 predominantly sand, add "sandy" to group name.
- ^M If soil contains $\geq 30\%$ plus No. 200, predominantly gravel, add "gravelly" to group name.
- ^N PI ≥ 4 and plots on or above "A" line.
- ^O PI < 4 or plots below "A" line.
- ^P PI plots on or above "A" line.
- ^Q PI plots below "A" line.



Rock Classification Notes

WEATHERING			
Term	Description		
Fresh	Mineral crystals appear bright; show no discoloration. Features show little or no staining on surfaces. Discoloration does not extend into intact rock.		
Slightly weathered	Rock generally fresh except along fractures. Some fractures stained and discoloration may extend <0.5 inches into rock.		
Moderately weathered	Significant portions of rock are dull and discolored. Rock may be significantly weaker than in fresh state near fractures. Soil zones of limited extent may occur along some fractures.		
Highly weathered	Rock dull and discolored throughout. Majority of rock mass is significantly weaker and has decomposed and/or disintegrated; isolated zones of stronger rock and/or soil may occur throughout.		
Completely weathered	All rock material is decomposed and/or disintegrated to soil. The rock mass or fabric is still evident and largely intact. Isolated zones of stronger rock may occur locally.		
STRENGTH OR HARDNESS			
Description	Field Identification		Uniaxial Compressive Strength, psi
Extremely strong	Can only be chipped with geological hammer. Rock rings on hammer blows. Cannot be scratched with a sharp pick. Hand specimens require several hard hammer blows to break.		>36,000
Very strong	Several blows of a geological hammer to fracture. Cannot be scratched with a 20d common steel nail. Can be scratched with a geologist's pick only with difficulty.		15,000-36,000
Strong	More than one blow of a geological hammer needed to fracture. Can be scratched with a 20d nail or geologist's pick. Gouges or grooves to ¼ inch deep can be excavated by a hard blow of a geologist's pick. Hand specimens can be detached by a moderate blow.		7,500-15,000
Medium strong	One blow of geological hammer needed to fracture. Can be distinctly scratched with 20d nail. Can be grooved or gouged 1/16 in. deep by firm pressure with a geologist's pick point. Can be fractured with single firm blow of geological hammer. Can be excavated in small chips (about 1-in. maximum size) by hard blows of the point of a geologist's pick;		3,500-7,500
Weak	Shallow indent by firm blow with geological hammer point. Can be gouged or grooved readily with geologist's pick point. Can be excavated in pieces several inches in size by moderate blows of a pick point. Small thin pieces can be broken by finger pressure.		700-3,500
Very weak	Crumbles under firm blow with geological hammer point. Can be excavated readily with the point of a geologist's pick. Pieces 1-in. or more in thickness can be broken with finger pressure. Can be scratched readily by fingernail.		150-700
DISCONTINUITY DESCRIPTION			
Fracture Spacing (Joints, Faults, Other Fractures)		Bedding Spacing (May Include Foliation or Banding)	
Description	Spacing	Description	Spacing
Intensely fractured	< 2.5 inches	Laminated	< ½-inch
Highly fractured	2.5 – 8 inches	Very thin	½ – 2 inches
Moderately fractured	8 inches to 2 feet	Thin	2 inches – 1 foot
Slightly fractured	2 to 6.5 feet	Medium	1 – 3 feet
Very slightly fractured	> 6.5 feet	Thick	3 – 10 feet
		Massive	> 10 feet
ROCK QUALITY DESIGNATION (RQD) ¹			
Description	RQD Value (%)		
Very Poor	0 - 25		
Poor	25 – 50		
Fair	50 – 75		
Good	75 – 90		
Excellent	90 - 100		

1. The combined length of all sound and intact core segments equal to or greater than 4 inches in length, expressed as a percentage of the total core run length.