Express Oil Change-Richmond, Kentucky

Geotechnical Engineering Report

Richmond, Kentucky

December 3, 2025 | Terracon Project No. N3255098

Prepared for:

Express Oil Change and Tire Engineers
1880 Southpark Drive
Birmingham, AL 35244

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December 3, 2025

Express Oil Change and Tire Engineers
1880 Southpark Drive
Birmingham, AL 35244

Attn: Tyler Hendon
P: (205) 703-7758
E: Tyler.hendon@expressoil.com

Re: Geotechnical Engineering Report
Express Oil Change- Richmond, Kentucky
Goggins Lane
Richmond, Kentucky
Terracon Project No. N3255098

Dear Mr. Hendon:

We have completed the scope of Geotechnical Engineering services for the above referenced project in general accordance with Terracon Proposal No. PN3255098 dated October 21, 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 proposed 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

STATE OF KENTUCKY
ALAIN J
GALLET
13758
LICENSED
PROFESSIONAL ENGINEER

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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 Terracon 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 Express Oil Change and Tire Engineers store to be located at Goggins Lane in Richmond, Kentucky. The purpose of these services was to provide information and geotechnical engineering recommendations relative to:

- Subsurface soil (and rock) conditions
- Groundwater conditions
- Seismic site classification per IBC
- Site preparation and earthwork
- Foundation design and construction
- Floor slab design and construction
- Lateral earth pressure
- Pavement design and construction

The geotechnical engineering Scope of Services for this project included the advancement of test borings, laboratory testing, engineering analysis, and preparation of this report.

Drawings showing the site and boring locations are shown on the **Site Location** and **Exploration Plan**, respectively. The results of the laboratory testing performed on soil samples obtained from the site during our field exploration are included on the boring logs and as separate graphs in the **Exploration Results** section.

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	Project information was sent by email from Tyler Hendon with Express Oil Change & Tire Engineers on October 12th, 2025. The email included the following attachments containing the site layout and proposed boring location plan: ▪ Site Plan - Goggins Lane KY - Boring Plan.pdf ▪ Development Plan - Goggins Lane KY 3341.pdf

Item	Description
Project Description	A new Express Oil Change & Tire Engineers building with associated parking and drives.
Proposed Structure	Express Oil Change & Tire Engineers building with an approximate footprint of less than 7,000 square feet, supported on shallow foundation systems.
Building Construction	Anticipated to be load-bearing masonry with wood and/or structural steel framing elements, supported on concrete shallow foundation systems with concrete slab-on-grade floor.
Finished Floor Elevation	Not provided. Based on our understanding of the project, we anticipate FFE to be within ± 3 feet of existing grades.
Maximum Loads	The following column and wall loads have been provided for our use in estimating settlement: ▪ Columns: 25 kips ▪ Walls: 2-4 kips per linear foot (klf) ▪ Slabs: 125 pounds per square foot (psf) (assumed – not provided)
Grading/Slopes	Grading plans were not available at the writing of this report. However, we anticipate minimal grading (less than about 3 feet of cut/fill) will be required to develop final grades, excluding remedial grading requirements.
Below-Grade Structures	The proposed building will include an oil change pit on the narrower side of the building. Based on our experience with previous projects, we anticipate the dimensions of the pit will be approximately 30 by 45 feet and 10 feet deep.
Free-Standing Retaining Walls	Not provided.
Pavements	Anticipated pavement traffic information has not been provided. We have assumed both rigid (PCC) and flexible (asphalt) pavement sections will be considered. We anticipate traffic ESALs of less than 30,000. The pavement design period is 20 years. Based on available information, light-duty pavement section thicknesses have been provided for light-duty areas and heavy-duty pavement section thicknesses have been provided for the dumpster pad area, only. If information is available and provided to Terracon for heavy-duty traffic areas outside the dumpster pad area, heavy-duty section design recommendations can be provided, upon request.
Building Code	2018 KBC

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
Parcel Information	The project is located at Goggins Lane in Richmond, Kentucky Approximately 1.4 acres Latitude/Longitude 37.7389209, -84.3327074 (approximate) See **Site Location**
Existing Improvements	This site is within the Richmond Centre shopping and retail district development.
Current Ground Cover	Light vegetation (i.e. grasses)
Existing Topography	Based on review of Google Earth™ and provided information, the site appears to be relatively level with elevations ranging from 962 to 965 feet.

We also collected photographs at the time of our field exploration program. Representative photos are provided in our **Photography Log**.

Geotechnical Characterization

We have developed a general characterization of the subsurface conditions based upon our review of the subsurface exploration, laboratory data, geologic setting and our understanding of the project. This characterization, termed GeoModel, forms the basis of our geotechnical calculations and evaluation of the site. Conditions observed at each exploration point are indicated on the individual logs. The individual logs can be found in the **Exploration Results** and the GeoModel can be found 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	**Surficial**	Topsoil
2	**Existing Fill**	Silty Gravel and Clayey Gravel, with sand, gray to light gray, trace organics
3	**Weathered Bedrock**	Weathered limestone, very weak
4	**Bedrock**	Limestone with interbedded shale, light gray with gray, fresh to slightly weathered, laminated bedding, highly to moderately fractured, strong rock

The borings were advanced in the dry using rotary drilling techniques that allow short term groundwater observations to be made while drilling. Groundwater seepage was not encountered within the maximum drilling depth at the time of our field exploration. Groundwater conditions may be different at the time of construction. Groundwater conditions may change because of seasonal variations in rainfall, runoff, and other conditions not apparent at the time of drilling. Long-term groundwater monitoring was outside the scope of services for this project.

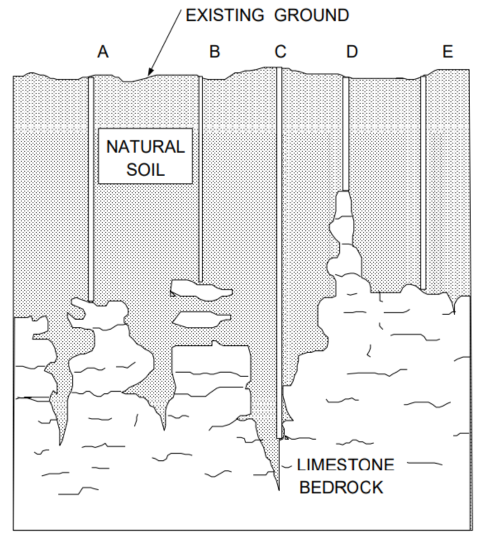
Geologic Hazards

Karst features (including clay seams, caverns, sinkholes, and highly irregular rock surfaces) are common features within carbonate rocks like those encountered in this exploration. The initial limited desktop study performed for this report found that the site is within formations with "prone" karst potential. No sinkholes were mapped within the project boundaries, but six LiDAR sinkholes were mapped within a one-half-mile radius of the project site. Practical refusal (presumed top of rock) was encountered in the building borings at depths ranging from about 2.5 to 7 feet.

The scope of services for this geotechnical evaluation did not include exploration for the presence of underground voids or solution cavities that are known to occur within this type of geology. To determine the likelihood of karst activity at the site, additional studies would need to be undertaken and are recommended prior to beginning construction. Further assessment of specific, unusual features may include additional exploration and/or geophysical analysis (i.e., resistivity study) to better understand the risk and to aid in generating informed decisions. It is possible that documentation exists regarding the extent of existing depressions and sink holes in the surrounding area and the risk these depressions pose a risk to present infrastructure within the vicinity of the project area. If this documentation is available, it should be provided to Terracon so that we may reassess and revise our recommendations, if necessary.

In an area of limestone bedrock, auger refusal (as encountered across the site) can result on slabs of unweathered limestone suspended in the residual soil matrix ("floaters"), on rock "pinnacles" rising above the surrounding bedrock surface, in widened (soil-filled) joints that may extend well below the surrounding bedrock surface, or on the upper surface of continuous bedrock. Several of these possible auger refusal conditions are illustrated in the figure at right.

AUGER REFUSAL ILLUSTRATION



THIS FIGURE IS FOR ILLUSTRATIVE PURPOSES ONLY AND DOES NOT NECESSARILY DEPICT THE SPECIFIC BEDROCK CONDITIONS AT THIS SITE

The Ashlock Formation is known for producing several obstructions that can cause the augers to refuse above sound bedrock. These obstructions can range from floaters to rock pinnacles as illustrated in examples A, B, C, and D in the figure. Depth to competent bedrock in areas of karst geology can vary greatly over short distances. It is possible that the above-mentioned obstructions or sound bedrock will be encountered at depths shallower or deeper than those shown on our boring logs. The possibility of varying depths to bedrock as well as encountering various karst features should be considered when developing the design and construction/excavation plans for this project as well as developing a construction QA/QC plan.

Seismic Site Class

The seismic design requirements for buildings and other structures are based on Seismic Design Category. Site Classification is required to determine the Seismic Design Category for a structure. The Site Classification 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/bedrock properties observed at the site and as described on the exploration logs and results, our professional opinion is for a **Seismic Site Classification of C** be considered for the project. Subsurface explorations at this site were extended to a maximum depth of 17 feet. The site properties below the boring depth to 100 feet were estimated based on our experience and knowledge of geologic conditions of the general area. Additional deeper borings or geophysical testing may be performed to confirm the conditions below the current boring depth.

Geotechnical Overview

The site appears suitable for the proposed construction based upon geotechnical conditions encountered in the test borings, provided that the recommendations provided in this report are implemented in the design and construction phases of this project.

The subsurface materials generally consisted of existing fill comprised mainly of gravel with trace amounts of clay and silt extending to shallow limestone bedrock. Auger refusal was encountered in the borings at depths between 2 and 7 feet below existing grades. Groundwater was not encountered during our exploration.

Terracon provided construction materials testing and observation services during general site development of the Richmond Centre Retail project from July 2007 to December 2008 (Terracon Project No. 57071004). Terracon has documented records of the existing fill to verify it was placed in general accordance with project plans and specifications for the Richmond Centre Development; therefore, the fill is considered controlled and suitable for direct support of the proposed improvements. Additional site preparation recommendations, including subgrade improvement and fill placement, are provided in the **Earthwork** section.

Shallow, strong limestone bedrock was encountered at this site. The top of rock varied in depth from about 2 feet to 7 feet below existing grades. We anticipate that excavation into bedrock will be necessary for the oil change pit and possibly for installation of utilities, below grade structures, and/or foundations. Shallow, completely to highly weathered bedrock (where encountered) can be mechanically ripped; heavy excavation equipment is generally required for deeper excavation. Slightly weathered to unweathered rock may require drilling and blasting. Hoe-rams and/or rock trenchers may be needed in excavations where working space will be limited. Final elevations should be chosen to minimize the amount of potential bedrock excavation required.

Based on the conditions encountered in the borings, we anticipate that at foundation bearing elevation, limestone bedrock will be encountered. The foundations should extend to strong limestone bedrock or a minimum of 1 foot into the weathered limestone layer, whichever is encountered first, with placement of a lean concrete mud mat below foundation bearing elevation to allow for a level, uniform bearing surface. The **Shallow Foundations** section addresses support of the building using conventional spread and continuous concrete footings. The **Floor Slabs** section addresses slab-on-grade support of the building using overexcavation techniques.

The **Pavements** section includes minimum pavement component thickness. Traffic information is currently not available for our review. Pavement designs are provided for the traffic conditions and pavement life conditions as noted in **Project Description** and in the following sections of this report. If anticipated traffic information becomes available, Terracon should be notified so that we may review/revise the recommended pavement section thicknesses provided in this report.

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

Earthwork is anticipated to include clearing and grubbing, excavations, and engineered fill placement. The following sections provide recommendations for use in the preparation of specifications for the work. Recommendations include critical quality criteria, as necessary, to render the site in the state considered in our geotechnical engineering evaluation for foundations, floor slabs, and pavements.

Site Preparation

Prior to placing fill, existing vegetation, topsoil, and root mats should be removed. Complete stripping of the topsoil should be performed in the proposed building and parking/driveway areas.

Where fill is placed on existing slopes steeper than 5H:1V, benches should be cut into the existing slopes prior to fill placement. The benches should have a minimum vertical face height of 1 foot and a maximum vertical face height of 3 feet and should be cut wide enough to accommodate the compaction equipment. This benching will help provide a positive bond between the fill and natural soils and reduce the possibility of failure along the fill/natural soil interface.

Although no evidence of underground facilities (such as septic tanks, cesspools, basements, etc.) was observed during the exploration and site reconnaissance, such features could be encountered during construction. If unexpected underground facilities are encountered, such features should be removed, and the excavation thoroughly cleaned prior to backfill placement and/or construction.

Existing Fill

As noted in **Geotechnical Characterization**, the borings encountered previously placed fill to depths ranging from about 2 to 4.5 feet below existing grades at the time of our field exploration. The placement of the fill was monitored by Terracon during general site grading of the Richmond Centre Development between July 2007 and December 2008.

Terracon has records of the placement and compaction of the fill and consider it controlled and suitable for support of foundations, floor slabs, and pavements.

Support of floor slabs and pavements on or above existing fill soils is discussed in this report. However, even with the recommended construction procedures, inherent risk exists for the owner that compressible fill or unsuitable material, within or buried by the fill will, not be discovered. This risk of unforeseen conditions can be reduced by following the recommendations contained in this report.

For floor slabs and/or pavements once the planned subgrade elevation has been reached, the entire slab and/or pavement area should be proofrolled. Areas of soft or otherwise unsuitable material should be undercut and replaced with either new structural fill or suitable, existing on-site materials.

After proofrolling and prior to placement of additional structural fill in areas below design grade, the subgrade should be scarified, moisture conditioned, and re-compacted to the density recommended in the **Fill Placement and Compaction Requirements** section in this report. This process will further help delineate soft or disturbed areas. Unstable areas identified during scarification and re-compaction should be undercut to expose stable material.

Subgrade Preparation

For the floor slab area, and where bedrock is exposed, we recommend an 18-inch buffer of compacted granular structural fill meeting LVC requirements in the **Fill Material Types** section of this report be provided between floor slab base elevation and exposed bedrock to allow for a more-uniform bearing material beneath the floor slab. The floor slab base layer can be included as part of this buffer.

The subgrade should be proofrolled with an adequately loaded vehicle such as a fully-loaded tandem-axle dump truck. The proofrolling should be performed under the observation of the Geotechnical Engineer or representative. Areas excessively deflecting under the proofroll should be delineated and subsequently addressed by the Geotechnical Engineer. Excessively wet or dry material should either be removed, or moisture conditioned and recompacted. Soft or yielding areas should be undercut or stabilized as necessary to achieve suitable, stable subgrade conditions. Stabilization can include scarification and re-compaction, placement and compaction of coarse, angular stone into the subgrade, utilization of geogrid, and/or partial undercutting and replacing the unstable materials with more stable granular material. If groundwater is encountered during the undercutting process, measures should be implemented to control it during and after construction.

All exposed areas which will receive fill, once properly cleared and benched where necessary, should be scarified to a minimum depth of 10 inches, moisture conditioned as necessary, and compacted per the compaction requirements in this report. Compacted structural fill soils should then be placed to the proposed design grade and the moisture content and compaction of subgrade soils should be maintained until foundation or pavement construction.

Based upon the subsurface conditions determined from the geotechnical exploration, subgrade soils exposed during construction are anticipated to be relatively workable; however, the workability of the subgrade may be affected by precipitation, repetitive construction traffic or other factors. If unworkable conditions develop, workability may be improved by scarifying and drying.

Excavation

Shallow limestone bedrock was encountered across the site at depths between 2 and 7 feet below existing grades. Bedrock competency and hardness typically increase with depth. It is possible that excavation into bedrock will be necessary for installation of utilities and possibly for below grade structures or foundations. If excavation into bedrock is required, shallow, completely to highly weathered bedrock can be mechanically ripped; heavy excavation equipment is generally required for deeper excavation. Slightly weathered to unweathered rock may require drilling and blasting. Hoe-rams and/or rock trenchers may be needed in excavations where working space will be limited. Final elevations should be chosen to minimize the amount of potential bedrock excavation required. It may be advantageous to provide earthwork contractors the opportunity to perform independent rock cores prior to bidding for their own evaluation of rock excavatability across the site.

For shallow grading/excavations (less than about 2 feet below existing grades), we anticipate that the proposed construction can be accomplished with conventional earthmoving equipment. The bottom of excavations should be thoroughly cleaned of loose soils and disturbed materials prior to backfill placement and/or construction.

The descriptions provided below are a guide to conditions generally encountered in the region of the project site. Required excavation techniques will vary based on weathering of the materials to be excavated, and the fracturing, jointing and overall stratigraphy of the feature. Actual field conditions usually display a gradual weathering progression with poorly defined and uneven boundaries between layers of different materials. We recommend that the following definitions for rock in earthwork excavation and drilled-pier construction be included in bid documents:

Excavation Type	Definition
Mass Excavation	Any material occupying an original volume of more than 1 cubic yard which cannot be excavated with a single-toothed ripper drawn by a crawler tractor having a minimum draw bar pull rating of not less than 80,000 pounds usable pull (Caterpillar D-8 or larger).
Trench Excavation	Any material occupying an original volume of more than 1/2 cubic yard which cannot be excavated with a backhoe having a bucket curling rate of not less than 40,000 pounds, using a rock bucket and rock teeth (a John Deere 790 or larger).

Soil Stabilization

Methods of subgrade improvement, as described below, could include scarification, moisture conditioning and recompaction, removal of unstable materials and replacement with granular fill (with or without geosynthetics), and chemical stabilization. The appropriate method of improvement, if required, would be dependent on factors such as schedule, weather, the size of area to be stabilized, and the nature of the instability. More detailed recommendations can be provided during construction as the need for subgrade stabilization occurs. Performing site grading operations during warm seasons and dry periods would help reduce the amount of subgrade stabilization required.

If the exposed subgrade is unstable during proofrolling operations, it could be stabilized using one of the methods outlined below.

- **Scarification and Recompaction** - It may be feasible to scarify, dry, and recompact the exposed soils. The success of this procedure would depend primarily upon favorable weather and sufficient time to dry the soils. Stable subgrades likely would not be achievable if the thickness of the unstable soil is greater than about 1 foot, if the unstable soil is at or near groundwater levels, or if construction is performed during a period of wet or cool weather when drying is difficult.
- **Crushed Stone** - The use of crushed stone or crushed gravel is a common procedure to improve subgrade stability. Typical undercut depths would be expected to range from about 12 to 24 inches below finished subgrade elevation. The use of high modulus geotextiles (i.e., engineering fabric or geogrid) could also be considered after underground work such as utility construction is completed. Prior to placing the fabric or geogrid, we recommend that all below grade construction, such as utility line installation, be completed to avoid damaging the fabric or geogrid. Equipment should not be operated above the fabric or geogrid until one full lift of crushed stone fill is placed above it. The maximum particle size of granular material placed over geotextile fabric or geogrid should not exceed 1-1/2 inches.

- **Chemical Modification** - Improvement of subgrades with portland cement or class C fly ash could be considered for improving unstable soils. Chemical modification should be performed by a pre-qualified contractor having experience with successfully stabilizing subgrades in the project area on similar sized projects with similar soil conditions. Results of chemical analysis of the additive materials should be provided to the geotechnical engineer prior to use. The hazards of chemicals blowing across the site or onto adjacent property should also be considered. Additional testing would be needed to develop specific recommendations to improve subgrade stability by blending chemicals with the site soils. Additional testing could include, but not be limited to, determining the most suitable stabilizing agent, the optimum amounts required, the presence of sulfates in the soil, and freeze-thaw durability of the subgrade.

Further evaluation of the need and recommendations for subgrade stabilization can be provided during construction as the geotechnical conditions are exposed.

Fill Material Types

Fill required to achieve design grade should be classified as structural fill and general fill. Structural fill is material used below, or within 10 feet of structures, pavements or constructed slopes. General fill is material used to achieve grade outside of these areas.

Reuse of On-Site Soil: Excavated on-site soil may be selectively reused as fill. Portions of the on-site soil have an elevated fines content and will be sensitive to moisture conditions (particularly during seasonally wet periods) and may not be suitable for reuse when above optimum moisture content.

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

Property	General Fill	Structural Fill
Composition	Free of deleterious material	Free of deleterious material
Maximum particle size	6 inches (or 2/3 of the lift thickness)	3 inches
Fines content	Not limited	Not limited
Plasticity[2]	Not limited	Liquid Limit less than 40 for fines Plasticity Index less than 22 for fines

Property	General Fill	Structural Fill
GeoModel Layer Expected to be Suitable[1]	2, 3	2, 3[3]

1. Based on subsurface exploration. Actual material suitability should be determined in the field at time of construction.
2. Considered Low Volume Change (LVC) material.
3. Any on-site materials from these layers used as structural fill in within 18 inches of floor slab and pavement subgrades must be free of shale and meet LVC plasticity criteria above.

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

Soil Type [1,2]	USCS Classification	Acceptable Parameters (for Structural Fill)
Low Plasticity Cohesive	CL, CL-ML	Liquid Limit less than 40 Plasticity Index less than 22
Granular	GW, GM, GC, SW, SM, SC	Liquid Limit less than 40 for fines Plasticity Index less than 22 for fines

1. Structural and general fill should consist of approved materials free of organic matter and debris. Frozen material should not be used, and fill should not be placed on a frozen subgrade. A sample of each material type should be submitted to the Geotechnical Engineer for evaluation prior to use on this site. Additional geotechnical consultation should be provided prior to use of uniformly graded gravel on the site.
2. Considered Low Volume Change (LVC) material.

Fill Placement and Compaction Requirements

Structural and general fill should meet the following compaction requirements.

Item	Structural Fill	General Fill
Maximum Lift Thickness	8 inches or less in loose thickness when heavy, self-propelled compaction equipment is used 4 inches in loose thickness when hand-guided equipment (i.e. jumping jack or plate compactor) is used	Same as structural fill

Item	Structural Fill	General Fill
Minimum Compaction Requirements [1,2,3]	98% of max. dry density	92% of max. dry density
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 D 698).
2. High plasticity cohesive fill should not be compacted to more than 100% of standard Proctor maximum dry density.
3. 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 D 4253 and D 4254). 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 structural fill or bedding material in accordance with public works specifications for the utility be 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.

On-site materials are considered suitable for backfill of utility and pipe trenches from 1 foot above the top of the pipe to the final ground surface, provided the material is free of organic matter and deleterious substances.

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 gradation and expansion index requirements of engineered fill discussed in this report. Flooding or jetting for placement and compaction of backfill is not recommended.

For low permeability subgrades, utility trenches are a common source of water infiltration and migration. Utility trenches penetrating beneath the building should be effectively sealed to restrict water intrusion and flow through the trenches, which could migrate below the building. The trench should provide 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 used, the clay trench plug material should be placed and compacted to comply with the water content and compaction recommendations for structural fill stated previously in this report.

Grading and Drainage

All grades must provide effective drainage away from the building during and after construction and should be maintained throughout the life of the structure. Water retained next to the building can 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. The roof should have gutters/drains with downspouts that discharge onto splash blocks at a distance of at least 10 feet from the building.

Exposed ground should be sloped and maintained at a minimum 5% away from the building for at least 10 feet beyond the perimeter of the building. Locally, flatter grades may be necessary to transition ADA access requirements for flatwork. 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

Shallow excavations for the proposed structure are anticipated to be accomplished with conventional construction equipment. For areas where excavation may encounter shallow limestone bedrock, we believe heavy-duty construction equipment, such as a hoe-ram, a heavy dozer equipped with rock excavation equipment, is likely suitable for grading, shallow excavations, and utility trench excavations. Upon completion of filling and grading, care should be taken to maintain the subgrade water content prior to construction of grade-supported improvements such as floor slabs and pavements. Construction traffic over the completed subgrades should be avoided. The site should also be graded to prevent ponding of surface water on the prepared subgrades or in excavations. Water collecting over or adjacent to construction areas should be removed. If the subgrade freezes, desiccates, saturates, or is disturbed, the affected material should be removed, or the materials should be scarified, moisture conditioned, and recompacted prior to floor slab construction.

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 and/or state regulations.

Construction site safety is the sole responsibility of the contractor who controls the means, methods, and sequencing of construction operations. Under no circumstances shall the information provided herein be interpreted to mean Terracon is assuming responsibility for construction site safety or the contractor's activities; such responsibility shall neither be implied nor inferred.

Excavations or other activities resulting in ground disturbance have the potential to affect adjoining properties and structures. Our scope of services does not include review of available final grading information or consider potential temporary grading performed by the contractor for potential effects such as ground movement beyond the project limits. A preconstruction/ precondition survey should be conducted to document nearby property/infrastructure prior to any site development activity. Excavation or ground disturbance activities adjacent or near property lines should be monitored or instrumented for potential ground movements that could negatively affect adjoining property and/or structures.

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

If the site has been prepared in accordance with the requirements noted in **Earthwork**, the following design parameters are applicable for shallow foundations.

Based on the conditions encountered in the borings, we anticipate that at foundation bearing elevation, limestone bedrock will be encountered. As previously discussed, the foundations should extend to strong limestone bedrock or a minimum of 1 foot into the weathered limestone layer, whichever is encountered first. We recommend placement of at least a 2-inch-thick lean concrete mud mat below foundation bearing elevation to allow for a level, uniform bearing surface. It is recommended that the Geotechnical Engineer be retained to observe footing excavations prior to placing concrete.

Design Parameters – Compressive Loads

Item	Description
Maximum Net Allowable Bearing Pressure [1, 2]	6,000 psf
Required Bearing Stratum [3]	Lean concrete overlying strong limestone bedrock or at least 1 foot into the weathered limestone
Minimum Foundation Dimensions	Per IBC 1809.7 or local provision
Ultimate Passive Resistance[4] (equivalent fluid pressures)	240 pcf
Sliding Resistance [5]	0.6 allowable coefficient of friction - bedrock
Minimum Embedment below Finished Grade [6]	See Footnote 7
Estimated Total Settlement from Structural Loads [2]	Less than about 1/2 inch
Estimated Differential Settlement [2, 8]	About 1/2 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. Values assume that exterior grades are no steeper than 20% within 10 feet of structure.

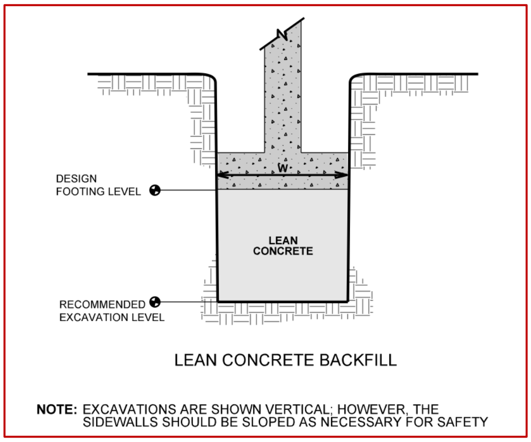
Item	Description

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. Use of passive earth pressures require the sides of the excavation for the spread footing foundation to be nearly vertical and the concrete placed neat against these vertical faces or that the footing forms be removed and compacted structural fill be placed against the vertical footing face. Assumes no hydrostatic pressure.
5. Can be used to compute sliding resistance where foundations are placed on suitable soil/materials. Frictional resistance for granular materials is dependent on the bearing pressure which may vary due to load combinations. For fine-grained materials, lateral resistance using cohesion should not exceed ½ the dead load.
6. Embedment necessary to minimize the effects of frost and/or seasonal water content variations. For sloping ground, maintain depth below the lowest adjacent exterior grade within 5 horizontal feet of the structure.
7. For foundations bearing on intact limestone bedrock (where encountered at proposed foundation bearing elevation), no minimum embedment depth is required for frost protection purposes. For foundations bearing on weathered rock or rock with a residual soil structure (where water can infiltrate and cause the material to be susceptible to frost heave), a minimum 24-inch embedment depth should be implemented for frost protection purposes.
8. Differential settlements are noted for equivalent-loaded foundations and bearing elevation as measured over a span of 50 feet.

Foundation Construction Considerations

As noted in **Earthwork**, the footing excavations should be evaluated under the observation of the Geotechnical Engineer. The base of all foundation excavations should be free of water and soil, prior to placing concrete. Concrete should be placed soon after excavating to reduce bearing material disturbance. Any loose/disturbed material in the bottom of the footing excavations should be removed before foundation concrete is placed. Where weak to medium strong bedrock is encountered, we recommend placement of at least 2-inch-thick mud mat below foundation bearing elevation to allow for a level, uniform bearing surface.

As discussed previously, foundations should bear directly on lean concrete backfill placed in the excavations extending to limestone bedrock. The lean concrete replacement zone is illustrated on the sketch below.



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.

Existing fill materials were observed at the site to depths of 2 to 4.5 feet below existing grade. As previously described, any existing fill present beneath floor slabs should be further evaluated by the Geotechnical Engineer or representative at the time of construction.

If shallow limestone bedrock is encountered at floor slab subgrade elevation, we recommend overexcavation of the bedrock and placing a minimum 18-inch layer of Low Volume Change (LVC) granular structural fill between the base slab elevation and bedrock. The granular base layer can be included as part of this structural fill buffer.

Due to the potential for significant moisture fluctuations of subgrade material beneath floor slabs supported at-grade, the Geotechnical Engineer should evaluate the material within 18 inches of the bottom of the LVC zone immediately prior to placement of additional fill or floor slabs. Soils below the specified water contents within this zone should be moisture conditioned or replaced with structural fill as stated in our **Earthwork** section.

Floor Slab Design Parameters

Item	Description
Floor Slab Support[1]	Minimum 6 inches of free-draining crushed stone aggregate.[3] Overlying minimum 18 inches of low-plasticity granular materials (meeting KYTC specifications).

Item	Description
	Subgrade compacted to recommendations in **Earthwork**
Estimated Modulus of Subgrade Reaction [2]	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. 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.
3. Free-draining granular material should have less than 5% fines (material passing the No. 200 sieve) compacted to at least 95% of ASTM D 698. Other design considerations such as cold temperatures and condensation development could warrant more extensive design provisions.

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.

Saw-cut contraction joints should be placed in the slab to help control the location and extent of cracking. For additional recommendations, refer to the ACI Design Manual. Joints or cracks should be sealed with a waterproof, non-extruding compressible compound specifically recommended for heavy duty concrete pavement and wet environments.

Where 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

Finished subgrade, within and for at least 10 feet beyond the floor slab, should be protected from traffic, rutting, or other disturbance and maintained in a relatively moist condition until floor slabs are constructed. If the subgrade should become damaged or desiccated prior to construction of floor slabs, the affected material should be removed, and structural fill should be added to replace the resulting excavation. Final conditioning of the finished subgrade should be performed immediately prior to placement of the floor slab support course.

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.

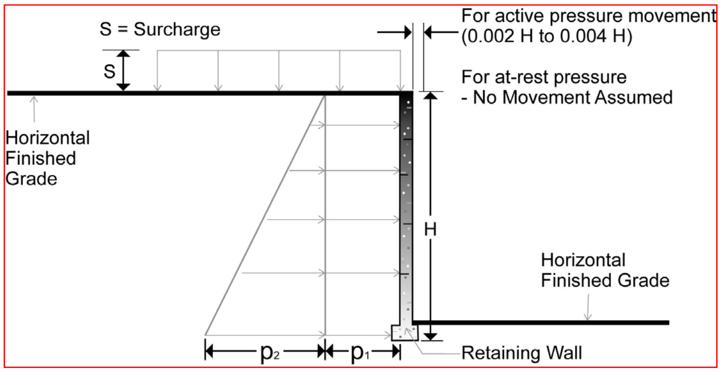
Lateral Earth Pressures

Based on our understanding of the project, the oil change pit will contain below-grade walls which will have lateral earth pressures and potentially hydrostatic forces acting on the walls. It should be noted that limestone bedrock is expected to be exposed as part of the earthwork and excavation of the oil change pit. Significant excavation into the limestone bedrock should be expected to create the working zone behind the walls.

Backfill placed against structures should consist of open-graded granular soils. We recommend at least 3 feet of free-draining crushed stone between the back of the wall footing and the rock cut face. Temporary rock cut slopes for construction of the walls can be near vertical to 1/4H:1V.

Design Parameters

Structures 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, and/or 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 and assumes wall movement. The "at-rest" condition assumes no wall movement and is commonly used for 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 and do not provide for possible hydrostatic pressure on the walls (unless stated).



Lateral Earth Pressure Design Parameters

Earth Pressure Condition [1]	Coefficient for Backfill Type [2]	Surcharge Pressure [3] p_1 (psf)	Equivalent Fluid Pressures (psf) [2]	
			Unsaturated [4]	Submerged [4]
Active (Ka)	Granular - 0.32	(0.32) S	(38)H	(81)H
At-Rest (Ko)	Granular - 0.48	(0.48) S	(58)H	(90)H

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. Fat clay or other expansive soils should not be used as backfill behind the wall.
2. Uniform, horizontal backfill, with a maximum unit weight of 120 pcf. An internal angle of friction of 31 degrees was used for granular soils.
3. Uniform surcharge, where S is surcharge pressure. Loading from heavy compaction equipment is not included.
4. To achieve "Unsaturated" conditions, follow guidelines in **Subsurface Drainage for Below-Grade Walls** below. "Submerged" conditions are recommended when drainage behind walls is not incorporated into the design.

Backfill placed against structures should consist of granular 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 with a minimum 3 feet of granular material from the back of the footing to the near vertical rock cut face for the active case.

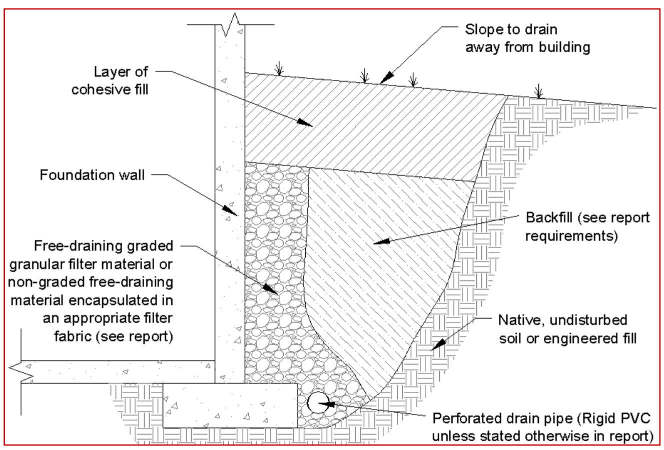
Very little to no lateral earth pressure will be generated by the near vertical cut rock face behind the below-grade wall. We recommend at least 3 feet of free-draining crushed stone between the back of the wall footing and the cut rock face. Wider widths may be required for constructability (to allow a plate compactor and workers between the wall and the cut rock face).

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). Recommendations covering these types of wall systems are beyond the scope of services for this assignment. However, we would be pleased to develop a proposal for evaluation and design of such wall systems upon request.

Subsurface Drainage for Below-Grade Walls

A perforated rigid plastic drain line installed behind the base of walls and extends below adjacent grade 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.

Pavements

General Pavement Comments

Pavement designs are provided for the traffic conditions and pavement life conditions as noted in **Project Description** and in the following sections of this report. A critical aspect of pavement performance is site preparation. Pavement designs noted in this section must be applied to the site which has been prepared as recommended in the **Earthwork** section.

Pavement Section Thicknesses

The following table provides our opinion of minimum thickness for AC and PCC sections:

Minimum Recommended Pavement Section Thickness (inches)

Traffic Area	Pavement Type	Asphalt Concrete Couse		Portland Cement Concrete [1]	Aggregate Base [2]	Total Thickness
		Surface	Base			
Light-Duty	AC	1.5	2.5	--	6.0	10.0
	PCC	--	--	5.0	4.0	9.0
Dumpster Pad [3]	AC	--	--	--	--	--
	PCC	--	--	7.0	4.0	11.0

1. 4,000 psi compressive strength at 28 days, air entrained mix. PCC pavements are recommended for trash container pads and in any other areas subjected to heavy wheel loads and/or turning traffic such as entrance aprons.
2. KYTC crushed limestone dense graded aggregate (DGA). The aggregate base will serve to provide improved drainage beneath the concrete, reduce pumping of fines and reduce frost heave during winter months. Aggregate base course should be compacted to 98 percent of its maximum dry density as determined by ASTM D-698, Standard Proctor Test.
3. The dumpster pad should be large enough to support the container and the tipping axle of the collection truck.

Areas for parking of heavy vehicles, concentrated turn areas, and start/stop maneuvers could require thicker pavement sections. Edge restraints (i.e. concrete curbs or aggregate shoulders) should be planned along curves and areas of maneuvering vehicles.

Although not required for structural support, a minimum 4-inch thick base course layer is recommended to help reduce potential for slab curl, shrinkage cracking, and subgrade pumping through joints. Proper joint spacing will also be required to prevent excessive slab curling and shrinkage cracking. Joints should be sealed to prevent entry of foreign material and doweled where necessary for load transfer. PCC pavement details for joint spacing, joint reinforcement, and joint sealing should be prepared in accordance with ACI 330 and ACI 325.

Where practical, we recommend early-entry cutting of crack-control joints in PCC pavements. Cutting of the concrete in its "green" state typically reduces the potential for micro-cracking of the pavements prior to the crack control joints being formed, compared to cutting the joints after the concrete has fully set. Micro-cracking of pavements may lead to crack formation in locations other than the sawed joints, and/or reduction of fatigue life of the pavement.

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.

Pavement Drainage

Pavements should be sloped to provide rapid drainage of surface water. Water allowed to pond on or adjacent to the pavements could saturate the subgrade and contribute to premature pavement deterioration. In addition, the pavement subgrade should be graded to provide positive drainage within the granular base section. Appropriate sub-drainage or connection to a suitable daylight outlet should be provided to remove water from the granular subbase.

Due to frost-susceptible soils and the possibility of perched groundwater, consideration should be given to installing a pavement subdrain system to control subgrade moisture, improve stability, and improve long-term pavement performance.

We recommend at least 6 inches of free-draining granular material be placed beneath the pavements. The use of a free draining granular base will also reduce the potential for frost action. We recommend pavement subgrades be crowned at least 2% to promote the flow of water towards the subdrains, and to reduce the potential for ponding of water on the subgrade.

The subdrains should be hydraulically connected to the free-draining granular base layer. Subdrains should be sloped to provide positive gravity drainage to reliable discharge points such as the stormwater detention basin. Periodic maintenance of subdrains is required for long-term proper performance.

Pavement Maintenance

The pavement sections represent minimum recommended thicknesses and, as such, periodic upkeep should be anticipated. Preventive maintenance should be planned and provided for through an on-going pavement management program. Maintenance activities are intended to slow the rate of pavement deterioration and to preserve the pavement investment. Pavement care consists of both localized (e.g., crack and joint sealing and patching) and global maintenance (e.g., surface sealing). Additional engineering consultation is recommended to determine the type and extent of a cost-effective program. Even with periodic maintenance, some movements and related cracking may still occur, and repairs may be required.

Pavement performance is affected by its surroundings. In addition to providing preventive maintenance, the civil engineer should consider the following recommendations in the design and layout of pavements:

- Final grade adjacent to paved areas should slope down from the edges at a minimum 2%.
- Subgrade and pavement surfaces should have a minimum 2% slope to promote proper surface drainage.
- Install pavement drainage systems surrounding areas anticipated for frequent wetting.
- Install joint sealant and seal cracks immediately.
- Seal all landscaped areas in or adjacent to pavements to reduce moisture migration to subgrade soils.
- Place compacted, low permeability backfill against the exterior side of curb and gutter.

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 exploration point 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.

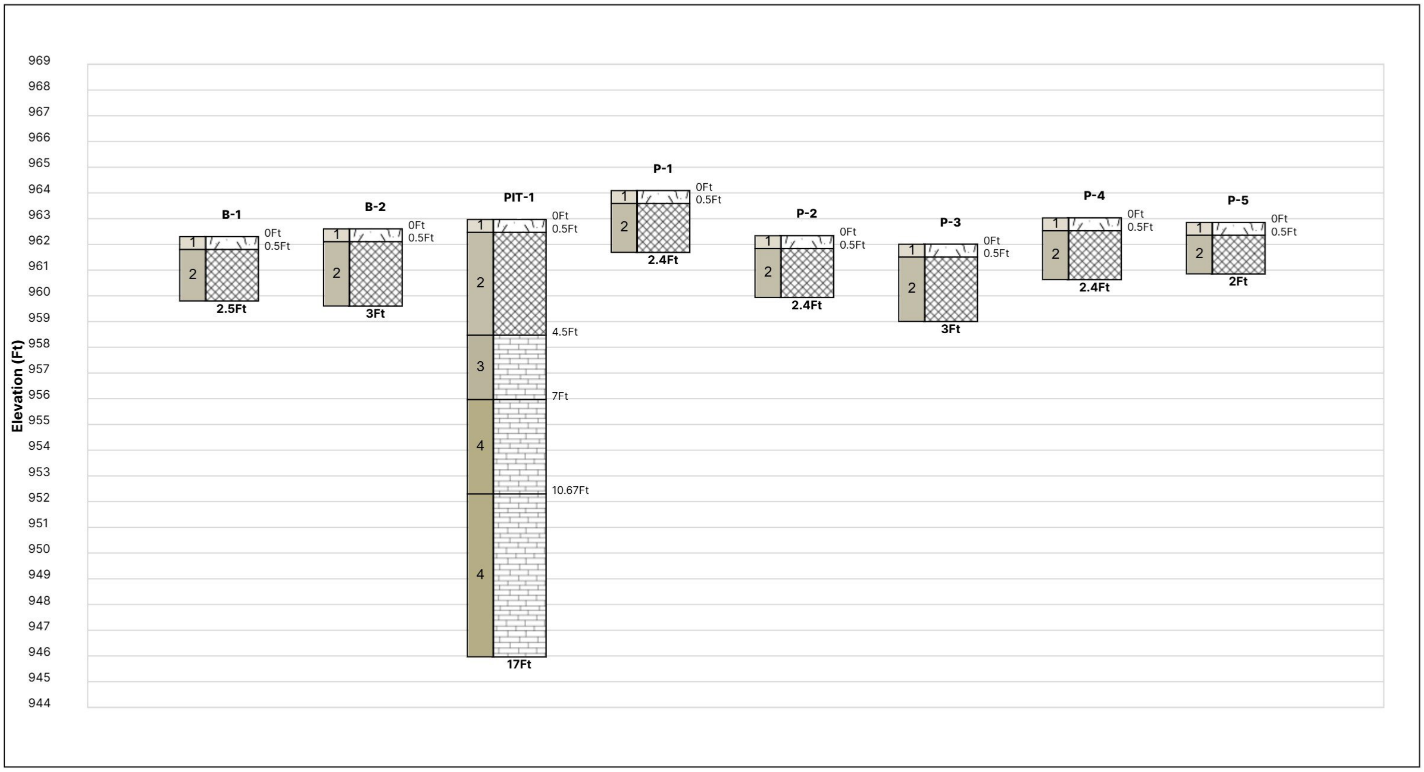
Site characteristics as provided are for design purposes and not to estimate excavation cost. Any use of our report in that regard is done at the sole risk of the excavating cost estimator as there may be variations on the site that are not apparent in the data that could significantly affect excavation 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 and cost estimating including 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



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	**Surficial**	Topsoil
2	**Existing Fill**	Silty Gravel and Clayey Gravel, with sand, gray to light gray, trace organics
3	**Weathered Bedrock**	Weathered limestone, very weak
4	**Bedrock**	Limestone with interbedded shale, light gray with gray, fresh to slightly weathered, laminated bedding, highly to moderately fractured, strong rock

Legend

TOPSOIL

Fill

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.

First Water Observation

Second Water Observation

Third Water Observation

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 groundsurface.

Attachments

Exploration and Testing Procedures

Field Exploration

Number of Borings	Approximate Boring Depth (feet)	Location
2	2.5 to 3	Building area
1	17	Oil change pit
5	2 to 3	Pavement areas

Boring Layout and Elevations: Terracon personnel provided the boring layout using handheld GPS equipment (estimated horizontal accuracy of about ±10 feet) and referencing existing site features. Approximate ground surface elevations were measured in the field by the private utility locator using GNSS equipment. If elevations and a more precise boring layout are desired, we recommend borings be surveyed.

Subsurface Exploration Procedures: We advanced the borings with a track-mounted rotary drill rig using continuous flight solid stem augers. Samples were advanced at 2.5-foot intervals until auger refusal. 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. For safety purposes, all borings were backfilled with auger cuttings after their completion.

Upon encountering auger refusal in Boring PIT-1, we extended into the bedrock with NQ-size double tube-swivel core barrel to retrieve rock core samples. Percent recovery and rock quality designation (RQD) were calculated for the core samples and are noted at their depths of occurrence on the boring logs. RQD is the percent of total length cored consisting only of rock pieces at least 4 inches or more in length and is a measure of the integrity of the rock mass in-situ. The recovered samples were sent to the laboratory for classification.

We also observed the boreholes while drilling and at the completion of drilling for the presence of groundwater. Groundwater was not observed at these times in the boreholes.

The sampling depths, penetration distances, and other sampling information was recorded on the field boring logs. The samples were placed in appropriate containers and taken to our soil laboratory for testing and classification by a Geotechnical Engineer. Our exploration team prepared field boring logs as part of the drilling operations. These field logs included visual classifications of the materials observed during drilling and our interpretation of the subsurface conditions between samples. Final boring logs were prepared from the field logs. The final boring logs represent the Geotechnical Engineer's interpretation of the field logs and include modifications based on observations and tests of the samples in our laboratory.

Laboratory Testing

The project engineer reviewed the field data and assigned laboratory tests. The laboratory testing program included the following types of tests:

- Moisture Content
- Atterberg Limits
- Grain Size Analysis
- Unconfined Compression

The laboratory testing program often included examination of soil samples by an engineer. Based on the results of our field and laboratory programs, we described and classified the soil samples in accordance with the Unified Soil Classification System.

Rock classification was conducted using locally accepted practices for engineering purposes; petrographic analysis may reveal other rock types. Rock core samples typically provide an improved specimen for this classification. Boring log rock classification was determined using the Description of Rock Properties.

Photography Log

Photo 1: Site photograph facing north

Photo 2: Site photograph facing east

Site Location and Exploration Plans

Contents:

Site Location Plan
Exploration Plan

Note: All attachments are one page unless noted above.

Site Location

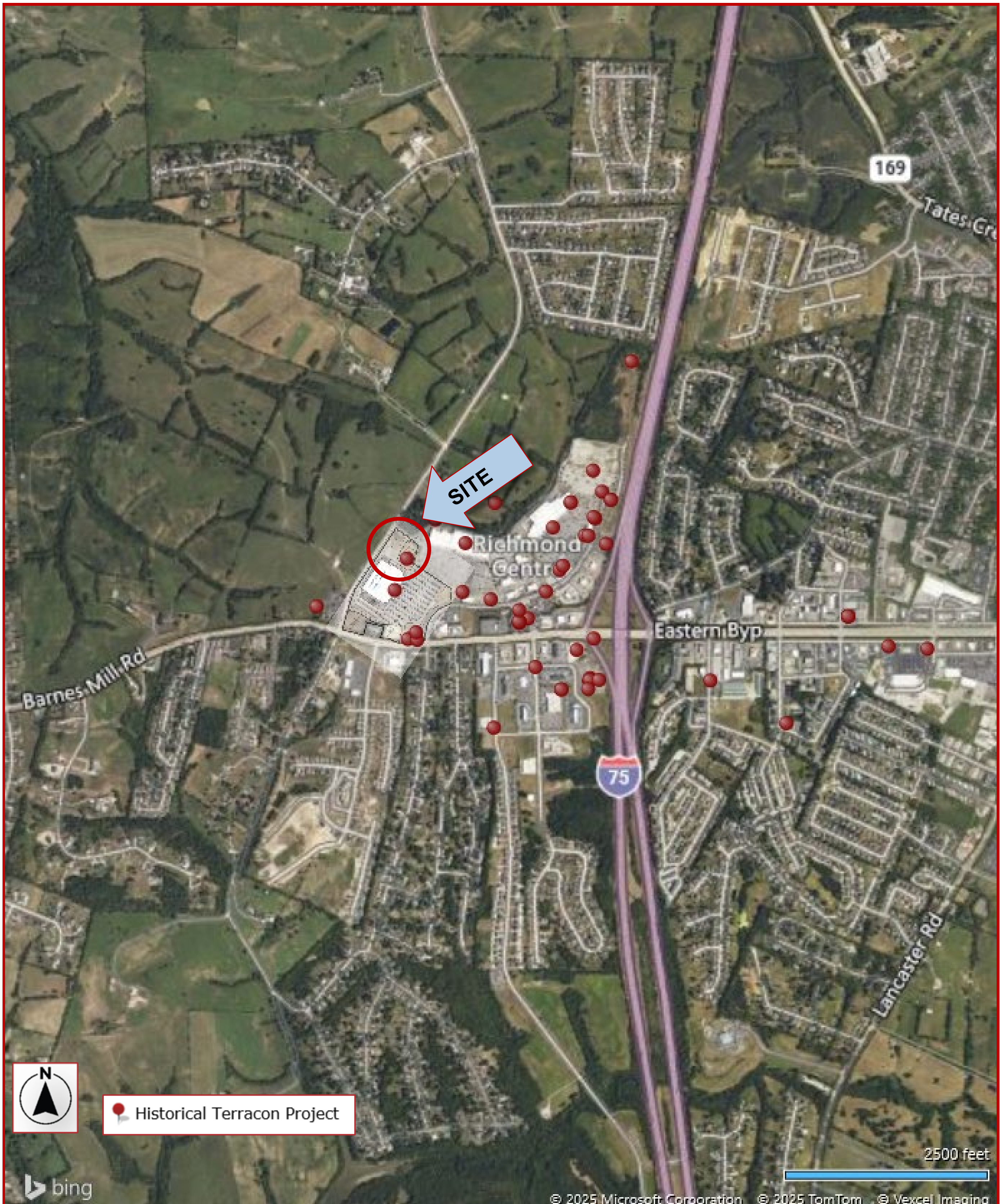


DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES MAP PROVIDED BY MICROSOFT BING MAPS

Exploration Plan

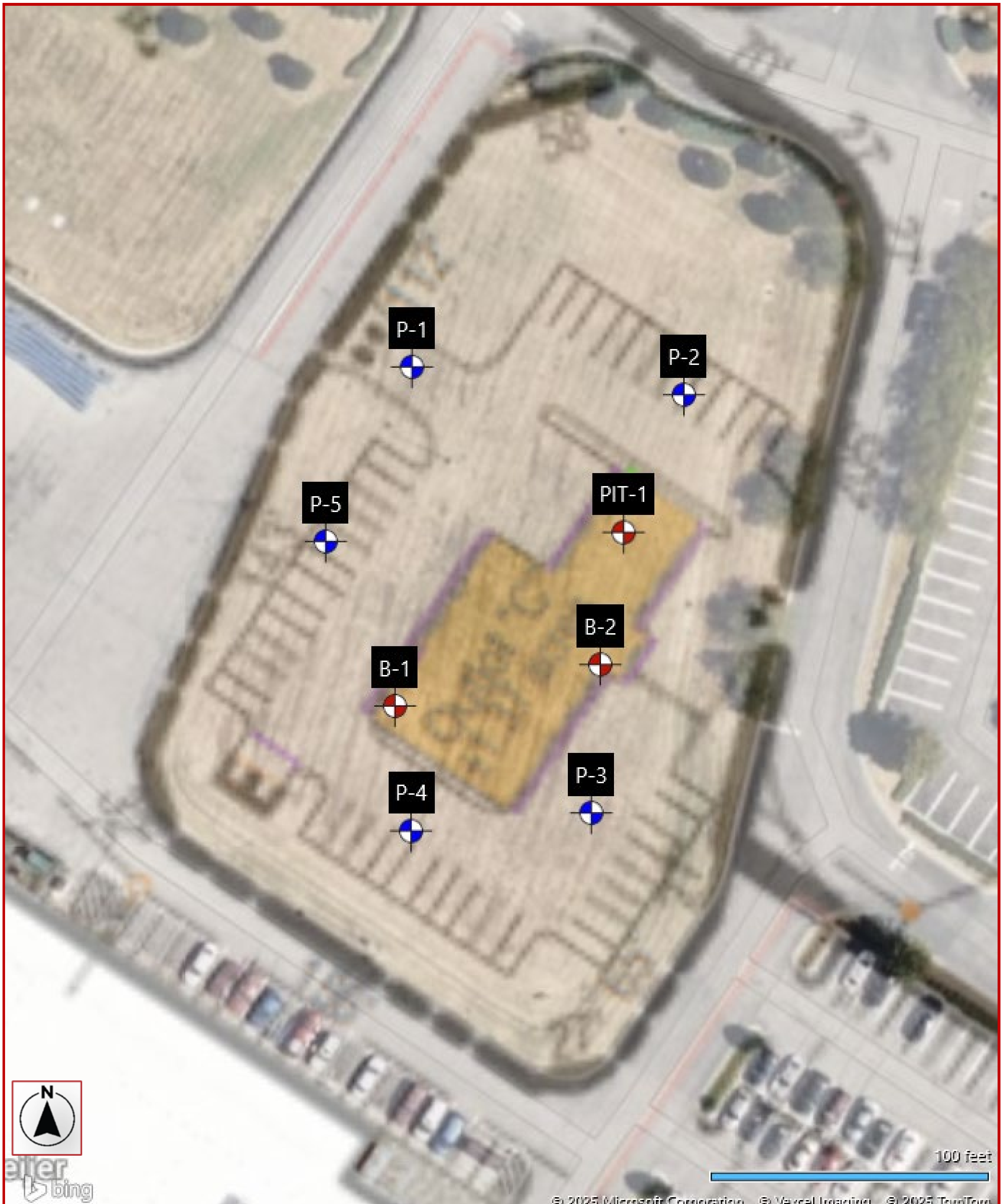


DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES MAP PROVIDED BY MICROSOFT BING MAPS

Exploration and Laboratory Results

Contents:

Boring Logs (B-1, B-2, PIT-1, and P-1 through P-5)
Atterberg Limits
Grain Size Distribution (3 pages)
Unconfined Compressive Strength

Note: All attachments are one page unless noted above.

Express Oil- Richmond, Kentucky
Goggins Lane, Richmond, KY, 40475,USA
Terracon Project No. N3255098

Latitude: 37.7388°   Longitude: -84.3329°

BORING LOG NO. B-1

Terracon
2460 Palumbo Dr
Lexington, KY 40509-1117

Surface Elevation:
963.68(Ft) +/-

Model Layer	Graphic Log	Lithology Depth (Ft.)	Material Description	Depth (Ft.)	Elevation (Ft.)	Sample Type	Recovery (In.)	Field Test Results	Water Content (%)
1		0.5	**TOPSOIL**		963.2	X	13	12-20-50/1"	7.6
2			**FILL** - **SILTY GRAVEL WITH SAND** gray, trace organics			X	0	22-50/2"	

Boring Refusal at 2.5 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: obtained from Google Earth

Advancement Method
0-2.5 Ft. 3.25" Solid Stem/Flight Auger

Abandonment Method
Boring backfilled with auger cuttings upon completion.

Drill Rig
Subcontractor - CME-550X

Hammer Type
Automatic

Driller
E. Anderson; T. White

Logged By
Zachary M. Lloyd, EIT

Boring Started
11/06/2025

Boring Completed
11/06/2025

Facilities | Environmental | Geotechnical | Materials

Express Oil- Richmond, Kentucky
Goggins Lane, Richmond, KY, 40475,USA
Terracon Project No. N3255098

Latitude: 37.7389° Longitude: -84.3326°

BORING LOG NO. B-2

Terracon
2460 Palumbo Dr
Lexington, KY 40509-1117

Surface Elevation:
963.68(Ft) +/-

Model Layer	Graphic Log	Lithology Depth (Ft.)	Material Description	Depth (Ft.)	Elevation (Ft.)	Sample Type	Recovery (In.)	Field Test Results
1		0.5	**TOPSOIL**		963.2		18	21-30-23 N = 53
2			**FILL** - **CLAYEY GRAVEL** gray, trace organics				10	22-50/4"

Boring Refusal at 3 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: obtained from Google Earth

Advancement Method
0-3 Ft. 3.25" Solid Stem/Flight Auger

Drill Rig
Subcontractor - CME-550X

Hammer Type
Automatic

Driller
E. Anderson; T. White

Logged By
Zachary M. Lloyd, EIT

Boring Started
11/06/2025

Boring Completed
11/06/2025

Facilities | Environmental | Geotechnical | Materials

Express Oil- Richmond, Kentucky
Goggins Lane, Richmond, KY, 40475,USA
Terracon Project No. N3255098

Latitude: 37.7392° Longitude: -84.3328°

BORING LOG NO. P-1

Terracon
2460 Palumbo Dr
Lexington, KY 40509-1117

Surface Elevation:
962.2(Ft) +/-

Model Layer	Graphic Log	Lithology Depth (Ft.)	Material Description	Depth (Ft.)	Elevation (Ft.)	Sample Type	Recovery (In.)	Field Test Results	Water Content (%)	Atterberg Limits LL	PL	PI
1		0.5	**TOPSOIL**		961.7		12	6-15-50/4"	9.5	34	17	17
2			**FILL** - **CLAYEY GRAVEL WITH SAND** gray				0	50/2"				

Boring Refusal at 2.4 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: obtained from Google Earth

Advancement Method
0-2.4 Ft. 3.25" Solid Stem/Flight Auger

Drill Rig
Subcontractor - CME-550X

Hammer Type
Automatic

Driller
E. Anderson; T. White

Logged By
Zachary M. Lloyd, EIT

Boring Started
11/06/2025

Boring Completed
11/06/2025

Express Oil- Richmond, Kentucky
Goggins Lane, Richmond, KY, 40475,USA
Terracon Project No. N3255098

Latitude: 37.7391° Longitude: -84.3325°

BORING LOG NO. P-2

Terracon
2460 Palumbo Dr
Lexington, KY 40509-1117

Surface Elevation: 962.34(Ft) +/-

Model Layer	Graphic Log	Lithology Depth (Ft.)	Material Description	Depth (Ft.)	Elevation (Ft.)	Sample Type	Recovery (In.)	Field Test Results	Water Content (%)
1		0.5	**TOPSOIL**		961.8		6	18-50/4"	4.6
2			**FILL** - **SILTY GRAVEL** gray, trace organics				0	50/1"	

Boring Refusal at 2.4 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: obtained from Google Earth

Advancement Method
0-2.4 Ft. 3.25" Solid Stem/Flight Auger

Drill Rig
Subcontractor - CME-550X

Hammer Type
Automatic

Driller
E. Anderson; T. White

Logged By
Zachary M. Lloyd, EIT

Boring Started
11/06/2025

Boring Completed
11/06/2025

Express Oil- Richmond, Kentucky
Goggins Lane, Richmond, KY, 40475,USA
Terracon Project No. N3255098

Latitude: 37.7387° Longitude: -84.3326°

BORING LOG NO. P-3

2460 Palumbo Dr
Lexington, KY 40509-1117

Surface Elevation:
963.71(Ft) +/-

Model Layer	Graphic Log	Lithology Depth (Ft.)	Material Description	Depth (Ft.)	Elevation (Ft.)	Sample Type	Recovery (In.)	Field Test Results	Water Content (%)
1		0.5	**TOPSOIL**		963.2				
2			**FILL** - **CLAYEY GRAVEL** gray, trace organics			X	18	9-30-18 N = 48	12.6
						X	6	20-50/3''	
			Boring Refusal at 3 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: obtained from Google Earth

Advancement Method
0-3 Ft. 3.25" Solid Stem/Flight Auger

Drill Rig
Subcontractor - CME-550X

Hammer Type
Automatic

Driller
E. Anderson; T. White

Logged By
Zachary M. Lloyd, EIT

Boring Started
11/06/2025

Boring Completed
11/06/2025

Facilities | Environmental | Geotechnical | Materials

Express Oil- Richmond, Kentucky
Goggins Lane, Richmond, KY, 40475,USA
Terracon Project No. N3255098

Latitude: 37.7387° Longitude: -84.3328°

BORING LOG NO. P-4

Terracon
2460 Palumbo Dr
Lexington, KY 40509-1117

Surface Elevation:
963.85(Ft) +/-

Model Layer	Graphic Log	Lithology Depth (Ft.)	Material Description	Depth (Ft.)	Elevation (Ft.)	Sample Type	Recovery (In.)	Field Test Results	Water Content (%)
1		0.5	**TOPSOIL**		963.4	X	12	12-50/5"	6.8
2			**FILL** - **SILTY GRAVEL WITH SAND** gray, trace organics						
							0	50/0"	

Boring Refusal at 2.4 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: obtained from Google Earth

Advancement Method
0-3 Ft. 3.25" Solid Stem/Flight Auger

Drill Rig
Subcontractor - CME-550X

Hammer Type
Automatic

Driller
E. Anderson; T. White

Logged By
Zachary M. Lloyd, EIT

Boring Started
11/06/2025

Boring Completed
11/06/2025

Facilities | Environmental | Geotechnical | Materials

Express Oil- Richmond, Kentucky
Goggins Lane, Richmond, KY, 40475,USA
Terracon Project No. N3255098

Latitude: 37.7390° Longitude: -84.3329°

BORING LOG NO. P-5

Terracon
2460 Palumbo Dr
Lexington, KY 40509-1117

Surface Elevation:
963.45(Ft) +/-

Model Layer	Graphic Log	Lithology Depth (Ft.)	Material Description	Depth (Ft.)	Elevation (Ft.)	Sample Type	Recovery (In.)	Field Test Results	Water Content (%)
1		0.5	**TOPSOIL**		963.0		12	12-50/3"	14.6
2			**FILL** - **SILTY GRAVEL** gray, trace organics				0	50/3"	

Boring Refusal at 2 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: obtained from Google Earth

Advancement Method
0-2 Ft. 3.25" Solid Stem/Flight Auger

Drill Rig
Subcontractor - CME-550X

Hammer Type
Automatic

Driller
E. Anderson; T. White

Logged By
Zachary M. Lloyd, EIT

Boring Started
11/06/2025

Boring Completed
11/06/2025

Facilities | Environmental | Geotechnical | Materials

Express Oil- Richmond, Kentucky
Goggins Lane, Richmond, KY, 40475,USA
Terracon Project No. N3255098

Latitude: 37.7390° Longitude: -84.3326°

BORING LOG NO. PIT-1

Terracon
2460 Palumbo Dr
Lexington, KY 40509-1117

Surface Elevation:
963.42(Ft) +/-

Model Layer	Graphic Log	Lithology Depth (Ft.)	Material Description	Depth (Ft.)	Elevation (Ft.)	Sample Type	Recovery (In.)	Field Test Results	Run Length (Ft.)	RQD (%)	Recovery (%)	Unconfined Compressive Strength (psi.)	Water Content (%)
1		0.5	**TOPSOIL**		962.9		8	18-50/2"					
2			**FILL - CLAYEY GRAVEL** gray to light gray				7	26-50/1"					3.7
		4.5			958.9		6	24-50/2"					4.6
3			**WEATHERED LIMESTONE** , very weak	5									
		7.0			956.4		6	7-50/0"					2.4
4			**LIMESTONE** , gray and light gray, slightly weathered, strong, laminated bedding, moderately fractured, With interbedded shale	10			46		5	67	77	9020	
		10.7	**LIMESTONE** , gray to light gray, strong, laminated bedding, highly fractured, With interbedded shale	15	952.8		60		5	100	100	9020	
			Boring Terminated at 17 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: obtained from Google Earth

Advancement Method
0-7 Ft. 3.25" Solid Stem/Flight Auger
7-17 Ft. Rock Coring NQ

Drill Rig
Subcontractor - CME-550X

Hammer Type
Automatic

Driller
E. Anderson; T. White

Logged By
Zachary M. Lloyd, EIT

Boring Started
11/06/2025

Boring Completed
11/06/2025

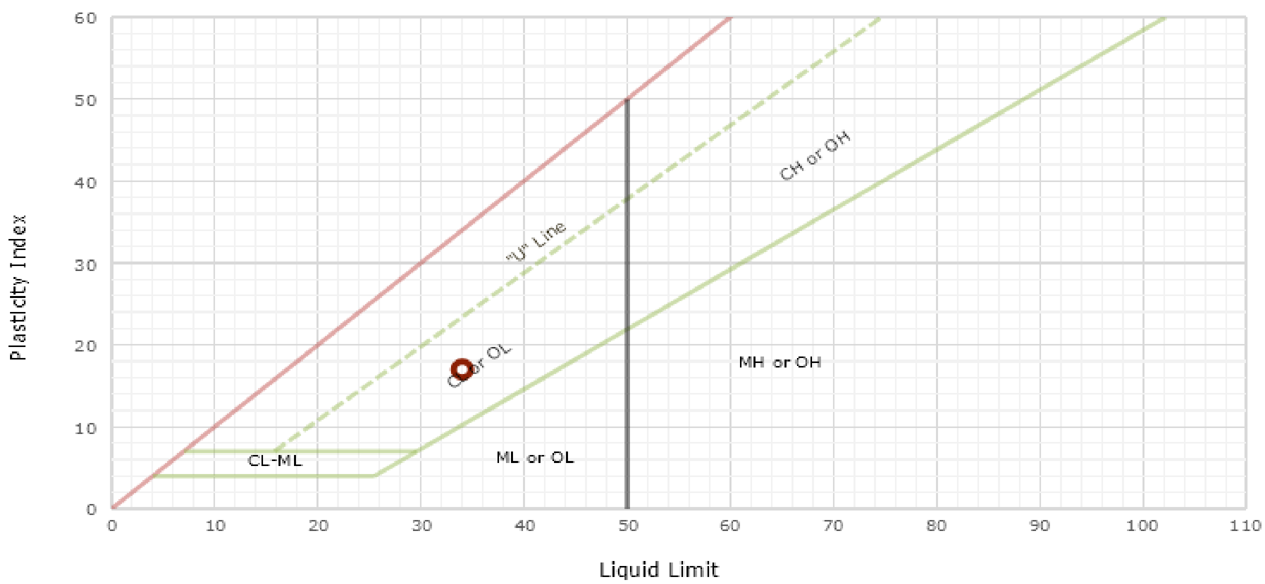
Facilities | Environmental | Geotechnical | Materials

Express Oil- Richmond, Kentucky
Goggins Lane | Richmond, KY 40475
Terracon Project No. N3255098

2460 Palumbo Dr
Lexington, KY 40509-1117

Liquid Limit, Plastic Limit and Plasticity Index of Soils

ASTM D4318



Boring ID	Depth (Ft)	LL	PL	PI	Fines (%)	Description	USCS
P-1	0-1.33	34	17	17	41	Clayey Gravel with Sand	GC

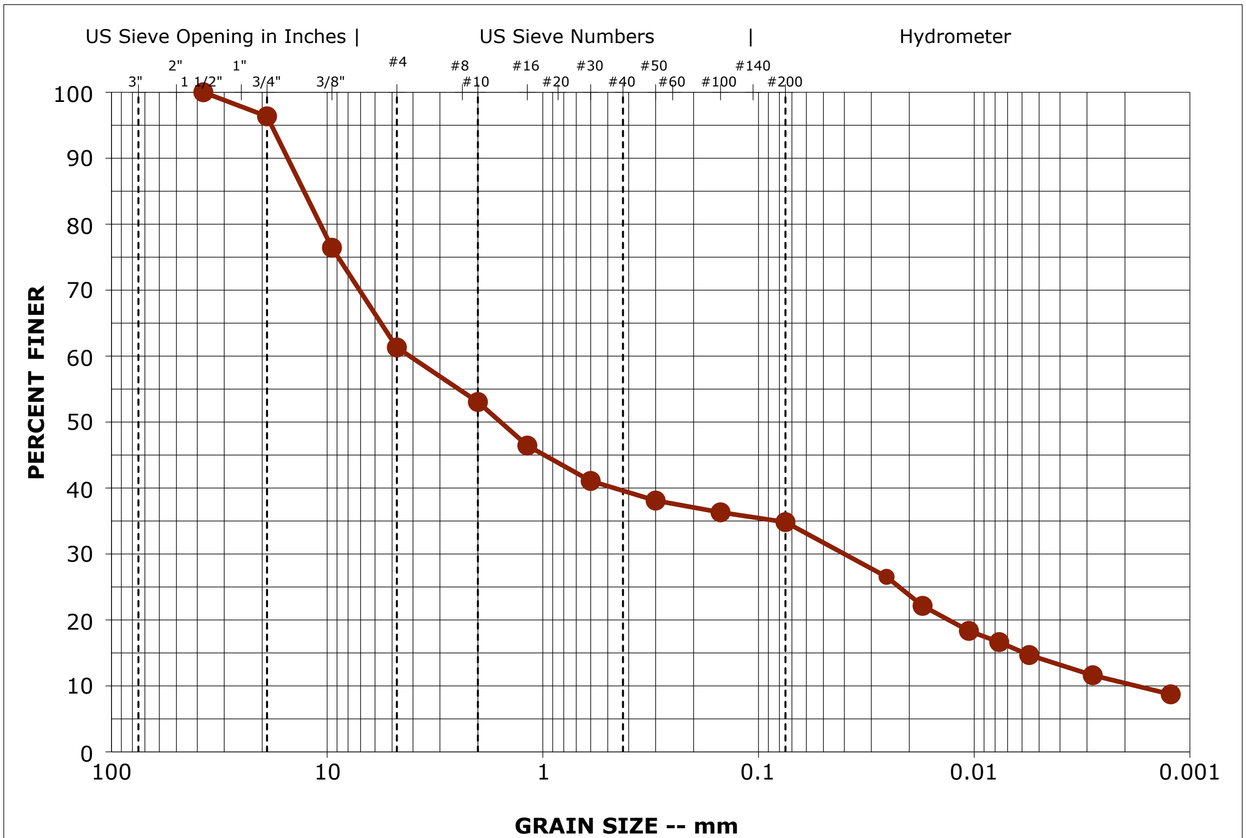
Remarks	

Express Oil- Richmond, Kentucky
Goggins Lane | Richmond, KY 40475
Terracon Project No. N3255098

Terracon
2460 Palumbo Dr
Lexington, KY 40509-1117

Particle-Size Distribution of Soils Using Sieve Analysis

ASTM D422-Method B



Boring ID	Depth (Ft.)	Description	USCS	Assumed Specific Gravity
B-1	0 - 1.08	0	0	2.65

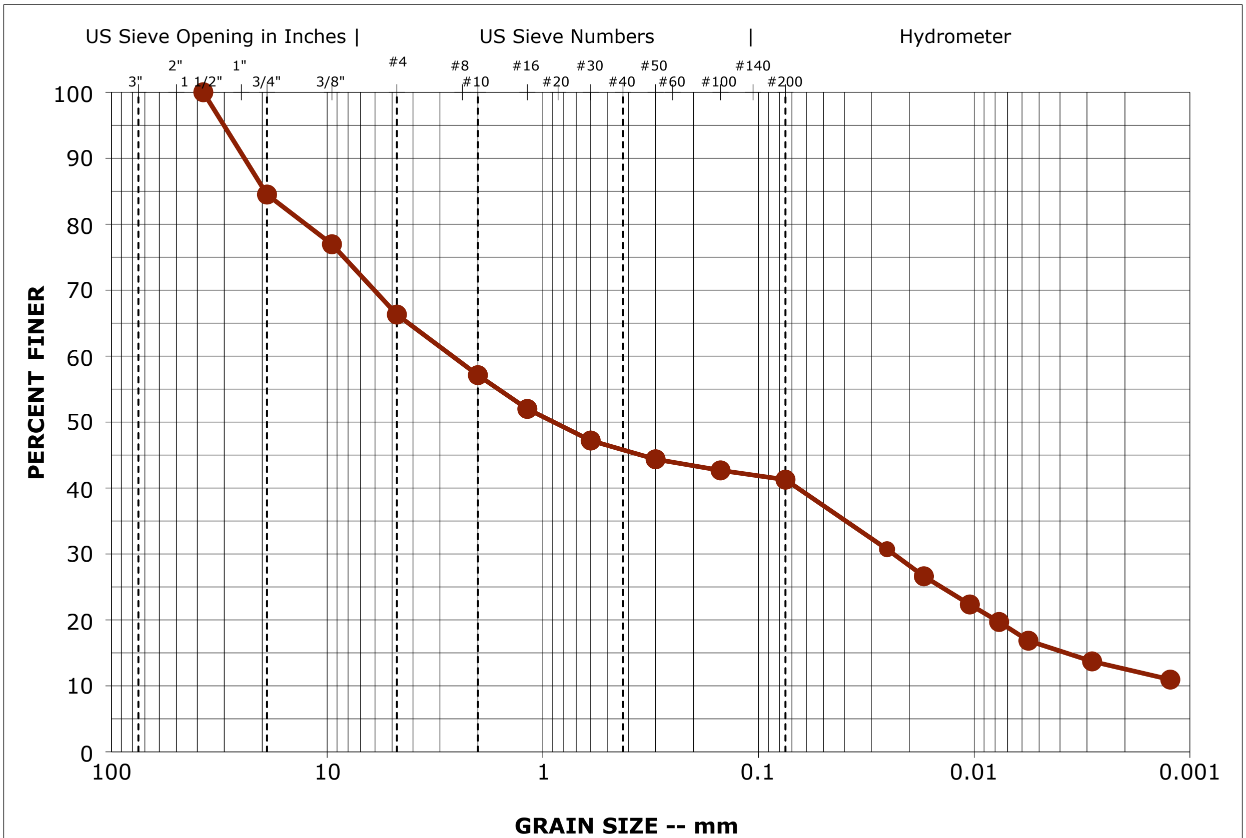
% Cobbles	% Gravel	% Sand	% Fines	% Silt	% Clay
0.0	38.7	26.5	34.8	20.6	14.2

Sieve	% Finer	Sieve	% Finer	Grain Size		Coefficients	
3"	100.0	#50	38.1	D_{100}	37.500	C_C	
1 1/2"	100.0	#100	36.3	D_{60}			
3/4"	96.3	#200	34.8	D_{30}	0.040	C_U	
3/8"	76.4			D_{10}	0.002		
#4	61.3			Remarks			
#8							
#10	53.0						
#16	46.4						
#30	41.1						

Terracon
2460 Palumbo Dr
Lexington, KY 40509-1117

Particle-Size Distribution of Soils Using Sieve Analysis

ASTM D422-Method B



Boring ID	Depth (Ft.)	Description	USCS	Assumed Specific Gravity
P-1	0 - 1.33	0	0	2.65

% Cobbles	% Gravel	% Sand	% Fines	% Silt	% Clay
0.0	33.7	25.0	41.3	25.0	16.3

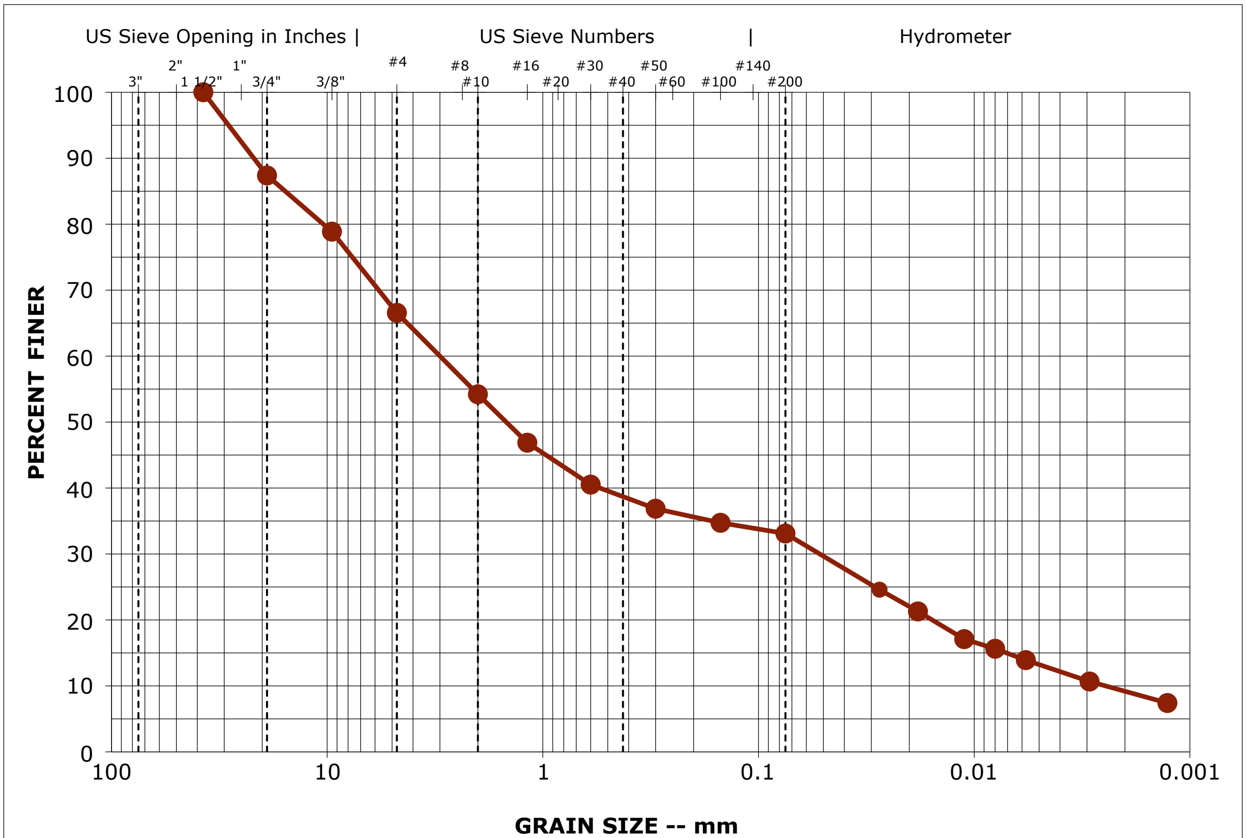
Sieve	% Finer	Sieve	% Finer	Grain Size		Coefficients	
3"	100.0	#50	44.4	D_{100}	37.500	C_C	
1 1/2"	100.0	#100	42.7	D_{60}			
3/4"	84.5	#200	41.3	D_{30}	0.024	C_U	
3/8"	77.0			D_{10}			
#4	66.3			Remarks			
#8							
#10	57.1						
#16	52.0						
#30	47.2						

Express Oil- Richmond, Kentucky
Goggins Lane | Richmond, KY 40475
Terracon Project No. N3255098

Terracon
2460 Palumbo Dr
Lexington, KY 40509-1117

Particle-Size Distribution of Soils Using Sieve Analysis

ASTM D422-Method B



Boring ID	Depth (Ft.)	Description	USCS	Assumed Specific Gravity
P-4	0 - 0.92	0	0	2.65

% Cobbles	% Gravel	% Sand	% Fines	% Silt	% Clay
0.0	33.4	33.5	33.1	19.9	13.2

Sieve	% Finer	Sieve	% Finer	Grain Size		Coefficients	
3"	100.0	#50	36.9	D_{100}	37.500	C_C	
1 1/2"	100.0	#100	34.7	D_{60}			
3/4"	87.4	#200	33.1	D_{30}	0.052	C_U	
3/8"	78.9			D_{10}	0.002		
#4	66.6			Remarks			
#8							
#10	54.2						
#16	46.9						
#30	40.5						

UNIAXIAL COMPRESSIVE STRENGTH OF INTACT ROCK CORE

ASTM D7012 method C

Project Number:	N3255098	Project Name:		Express Oil Change - Richmond			
Boring Number:	PIT-1	Depth:	10.2-10.6				
Height (in.):	3.77	3.77	3.77	3.77	Avg. (in):	3.77	
Diameter (in.):	1.87	1.87	1.87	1.87	Avg. (in):	1.87	
Specimen Weight (gms.):	445.39		Load (lbs.):	24,770	at failure		
Compressive Strength:	9,020		Unit Weight (lbs/ft^3)	163.9			
Boring Number:	PIT-1	Depth:	12-12.4				
Height (in.):	3.75	3.75	3.75	3.75	Avg. (in):	3.75	
Diameter (in.):	1.87	1.87	1.87	1.87	Avg. (in):	1.87	
Specimen Weight (gms.):	447.76		Load (lbs.):	24,770	at failure		
Compressive Strength:	9,020		Unit Weight (lbs/ft^3)	165.6			

Supporting Information

Contents:

General Notes
Unified Soil Classification System
Description of Rock Properties

Note: All attachments are one page unless noted above.

General Notes

Sampling	Water Level	Field Tests
Auger Cuttings; Modified California Ring Sampler; Rock Core; Dynamic Cone Penetrometer; Modified Dames & Moore Ring Sampler; Dual Sampler SPT; Grab Sample; GeoProbe Macro Core or Large Bore; No Recovery; Ring Sampler; Shelby Tube; Standard Penetration Test; Split Spoon; Texas Cone Penetrometer; Vane Shear	Water Initially Encountered Water Level After a Specified Period of Time Water Level After a Specified Period of Time Cave In Encountered 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.	N Standard Penetration Test Resistance (Blows/Ft.) (HP) Hand Penetrometer (T) Torvane (DCP) Dynamic Cone Penetrometer 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		
Relative Density	**Standard Penetration or N-Value (Blows/Ft.)**	**Consistency**	**Unconfined Compressive Strength Qu (tsf)**	**Standard Penetration or N-Value (Blows/Ft.)**
Very Loose	0 - 3	Very Soft	less than 0.25	0 - 1
Loose	4 - 9	Soft	0.25 to 0.50	2 - 4
Medium Dense	10 - 29	Medium Stiff	0.50 to 1.00	5 - 8
Dense	30 - 50	Stiff	1.00 to 2.00	9 - 15
Very Dense	> 50	Very Stiff	2.00 to 4.00	16 - 30
		Hard	> 4.00	> 30

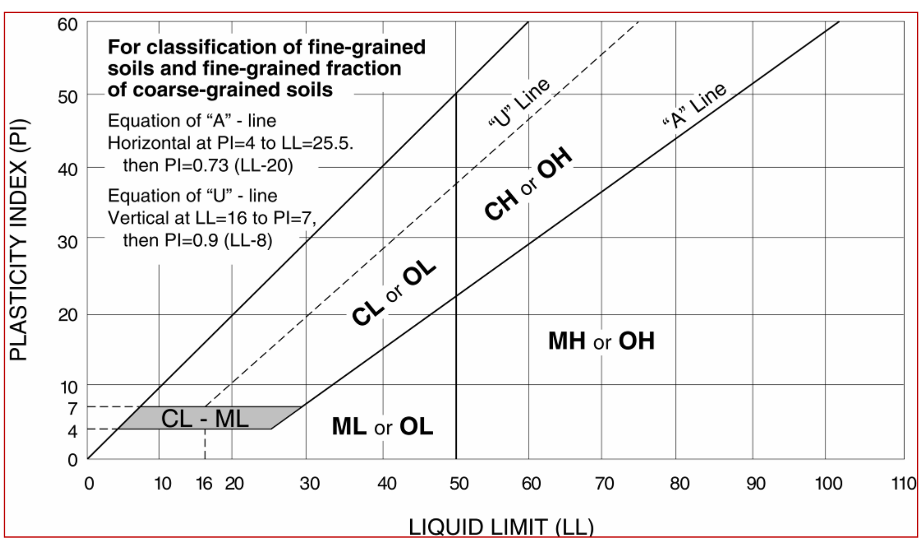
Relevance of Exploration and Laboratory Test Results

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≥4 and 1≤Cc≤3 [E]	GW	Well-graded gravel [F]
			Cu<4 and/or [Cc<1 or Cc>3.0] [E]	GP	Poorly graded gravel [F]
		Gravels with Fines: More than 12% fines [C]	Fines classify as ML or MH	GM	Silty gravel [F, G, H]
			Fines classify as CL or CH	GC	Clayey gravel [F, G, H]
	Sands: 50% or more of coarse fraction passes No. 4 sieve	**Clean Sands:** Less than 5% fines [D]	Cu≥6 and 1≤Cc≤3 [E]	SW	Well-graded sand [I]
			Cu<6 and/or [Cc<1 or Cc>3.0] [E]	SP	Poorly graded sand [I]
		Sands with Fines: More than 12% fines [D]	Fines classify as ML or MH	SM	Silty sand [G, H, I]
			Fines classify as CL or CH	SC	Clayey sand [G, H, I]
Fine-Grained Soils: 50% or more passes the No. 200 sieve	**Silts and Clays:** Liquid limit less than 50	**Inorganic:**	PI > 7 and plots above "A" line [J]	CL	Lean clay [K, L, M]
			PI < 4 or plots below "A" line [J]	ML	Silt [K, L, M]
		Organic:	$\frac{LL\ oven\ dried}{LL\ not\ dried} < 0.75$	OL	Organic clay [K, L, M, N]
					Organic silt [K, L, M, O]
	Silts and Clays: Liquid limit 50 or more	**Inorganic:**	PI plots on or above "A" line	CH	Fat clay [K, L, M]
			PI plots below "A" line	MH	Elastic silt [K, L, M]
		Organic:	$\frac{LL\ oven\ dried}{LL\ not\ dried} < 0.75$	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			PT	Peat

[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 ≥ 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 ≥ 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 ≥ 30% plus No. 200 predominantly sand, add "sandy" to group name.
[M] If soil contains ≥ 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 now 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.