



ECS Midwest, LLC

Geotechnical Engineering Report

Proposed McDonald's 24-1307 - Stockton, MO

West Smith Drive and South Street (37.690000 N, 93.797441 W)
Stockton, Cedar County, MO 65785

ECS Project No. 16:15433 Rev. 1

September 4, 2024

Revised: November 21, 2024





ECS MIDWEST, LLC

Geotechnical • Construction Materials • Environmental • Facilities

Revised: November 21, 2024

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ECS Project No. 16:15433 Rev. 1

Reference: Geotechnical Engineering Report
Proposed McDonald's 24-1307 – Stockton, MO
West Smith Drive and South Street (37.690000 N, 93.797441 W)
Stockton, Cedar County, MO 65785
Purchase Order No. 2780030

Dear Ms. Switzer:

ECS Midwest, LLC (ECS) has completed the geophysical and subsurface exploration, laboratory testing, and geotechnical engineering analyses for the above-referenced project. Our services were performed in general accordance with our agreed upon scope of work. This revised report presents our understanding of the geotechnical aspects of the project along with the results of the field exploration and laboratory testing conducted, and our design and construction recommendations. This report has been revised to incorporate the provided grading plan information.

It has been our pleasure to be of service to McDonald's USA, LLC during the design phase of this project. We would appreciate the opportunity to remain involved during the continuation of the design phase, and we would like to provide our services during construction phase operations as well to verify subsurface conditions anticipated for this report. Should you have any questions concerning the information contained in this report, or if we can be of further assistance to you, please contact us.

Respectfully submitted,

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EXECUTIVE SUMMARY

ECS Midwest, LLC has completed the geophysical and subsurface exploration for the proposed McDonald's restaurant development in Stockton, Missouri. The project information made available to ECS by McDonald's at the time of this report and the results of our geophysical and subsurface exploration, findings, conclusions, and recommendations are summarized below:

PROJECT SUMMARY	
Topic	Overview Statement
Project Description	- Approximately 3,695 square foot restaurant structure. - Structural loads were not available at the time of this report submittal. The report is based on the following structural loads: ➤ Maximum Column Load: 50 kips ➤ Maximum Wall Load: 2 kips per lineal foot - Up to 3 feet of cut/fill will be required to achieve final grade. - Traffic loading was not provided. The pavement design was estimated based on 18-kips ESAL's of 25,000 and 90,000 for the light and heavy-duty traffic with 20 years of design life, respectively.
Geotechnical Characterization	Below the surficial soils, undocumented clayey/silty sand possible fill soils and higher plastic fat clay (CH) soils were observed extending to depths ranging from about 4 to 12 feet below the existing grades. Limestone bedrock was encountered in the test borings at depths ranging from about 3½ to 11½ feet below the existing grades.
Shrink/Swell Potential	Higher plasticity 'fat clays' were encountered within the explored depths of the soil boring. These soils exhibit higher than typical shrink-swell potential and could cause potential heave (PVR - potential vertical rise) in the range of 1 to 3 inches if encountered within 24 inches of lightly loaded proposed building foundations, floor slab, and pavements final subgrade/bearing elevations. Therefore, if observed, ECS recommends removal and replacement of higher plasticity 'fat clays' with low volume change material (LVM).
Earthwork	Existing surficial clayey/silty sand possible fill soils are considered to be suitable for grading operations. However, higher plasticity 'fat clays' are not considered suitable for the grading operations due to high shrink-swell potential.
Geological Hazards	- Apparent active sink holes, cavities or conduits were not observed via the geophysical mapping. Also, no surficial indications of sink hole activity were observed at this site, except some weathered limestone zones. - No documented mines in the site area.
Shallow Foundations	- The proposed structure can be supported on shallow foundations at or below the frost depth of 36 inches, below the final grades bearing on existing lean clays or low volume change material (LVM) for maximum net allowable soil bearing pressure of 2,000 psf. Some undercutting will be required at the foundation bearing elevation in soft/unsuitable soils. - The estimated total and differential settlement will be about 1 inch and 1/2 inch.

PROJECT SUMMARY	
Topic	Overview Statement
Deep Foundations	Deep foundations are not necessary to support the proposed building. However, the proposed pylon sign will either be supported on shallow mat foundation or drilled shaft.
Subgrade Modulus	The proposed floor slab and rigid concrete pavement supported on either existing undocumented possible fill soils or low volume change material (LVM) can be designed using a subgrade modulus of 125 psi/inch.
California Bearing Ratio	The proposed flexible pavement can be designed based on an anticipated California Bearing Ratio of 3, considering upper 24 inches of existing lean clays or low volume change material (LVM).
Below-Grade Structures	None anticipated
Seismic Site Class	Site Class D
Pavements	Given that the subgrade is prepared as noted in Earthwork section of this Report, the estimated pavement sections are as follows: Rigid Concrete Pavement: ➤ Light-Duty: 5 inches of Portland Cement Concrete (PCC) over 6 inches of crushed aggregate. ➤ Heavy-Duty: 6 inches of Portland Cement Concrete (PCC) over 6 inches of crushed aggregate. Flexible Asphalt Pavement: ➤ Light-Duty: 4 inches of Asphalt Concrete over 6 inches of crushed aggregate. ➤ Heavy-Duty: 5 inches of Asphalt Concrete over 8 inches of crushed aggregate.
<i>This Executive Summary is intended as a very brief overview of the primary geotechnical conditions that are expected to affect design and construction. Information gleaned from this Executive Summary should not be utilized in lieu of reading the entire geotechnical report. This summary should not be considered apart from the entire text of the report with the qualifications and considerations mentioned herein. Details of our conclusions and recommendations are discussed in the report text.</i>	

1.0 INTRODUCTION

The purpose of this study was to provide geotechnical information for the design of foundations, pavements and pylon-sign foundation for the proposed McDonald's restaurant development in Stockton, Missouri. The recommendations developed for this report are based on project information supplied by the McDonald's USA, LLC team and Civil and Environmental Consultants, Inc.

ECS provided these services in accordance with the Service Supplier Proposal and authorized by Ms. Amy Switzer through McDonald's Purchase Order No.: 2780030 dated July 31, 2024.

This report contains the procedures and results of our subsurface exploration and laboratory testing programs, review of existing site conditions, engineering analyses, and recommendations for the design and construction of the project. The report includes the following items:

- A brief review and description of our field and laboratory test procedures and the results of the testing conducted.
- A review of surface topographical features and site conditions.
- A review of subsurface soil and bedrock stratigraphy with pertinent physical properties.
- Final soil exploration/test boring logs and subsurface cross section.
- Recommendations for site preparation and construction of compacted engineered fills, including an evaluation of on-site soils for use as compacted engineered fills and identification of potentially unsuitable soils and/or soils exhibiting excessive moisture at the time of sampling.
- Recommended foundation type(s), including allowable soil bearing pressures and anticipated foundation settlements.
- Recommendations for the proposed sign foundation with applicable bearing pressures and estimated settlements.
- Recommendations for the design and construction of retaining walls.
- Geophysical testing to map the karstic formation and sinkholes.
- Seismic Site Classification in accordance with International Building Code 2018 based on the weighted average SPT 'N' blow counts and provide applicable seismic site coefficients (no liquefactions analysis).
- Recommendations for the design and construction of pavements.
- Evaluation and recommendations relative to groundwater control, including recommendations for pavement underdrains.

2.0 PROJECT INFORMATION

2.1 PROJECT LOCATION/CURRENT SITE USE/PAST SITE USE

The project site is located near the southwest corner of West Smith Drive and South Street in Stockton, Missouri. Based on the recent site visit by ECS staff, the subject site is currently developed with a paved parking area on the southern portion of the site with the remaining portions of the site encompassed with grass cover and drive access to Smith Drive. In addition, relatively shallow swales extend nearly colinear with the eastern and northern property lines. The project site is bounded to the north by West Smith Drive, to the east by South Street, and to the south and west by a paved parking lot and a commercial development. Based on the publicly available historical aerial photographs, the site was reportedly used as an agricultural field before 1950. Prior to 1985, the project site was developed with the existing parking area and drive lanes. The site has remained relatively unchanged since that time in its current configuration. The site location is shown below, and in wider scope on the Site Location Diagram in Appendix A:



Site Location Map (bounded in Red)

Based on our review of the client provided recent topographical and grading plan drawings (C300) dated November 15, 2024 and prepared by *Civil & Environmental Consultants, Inc. (Project No. 343-737)*, the existing grade appears to range from about EL. 894 feet to 909 feet MSL.



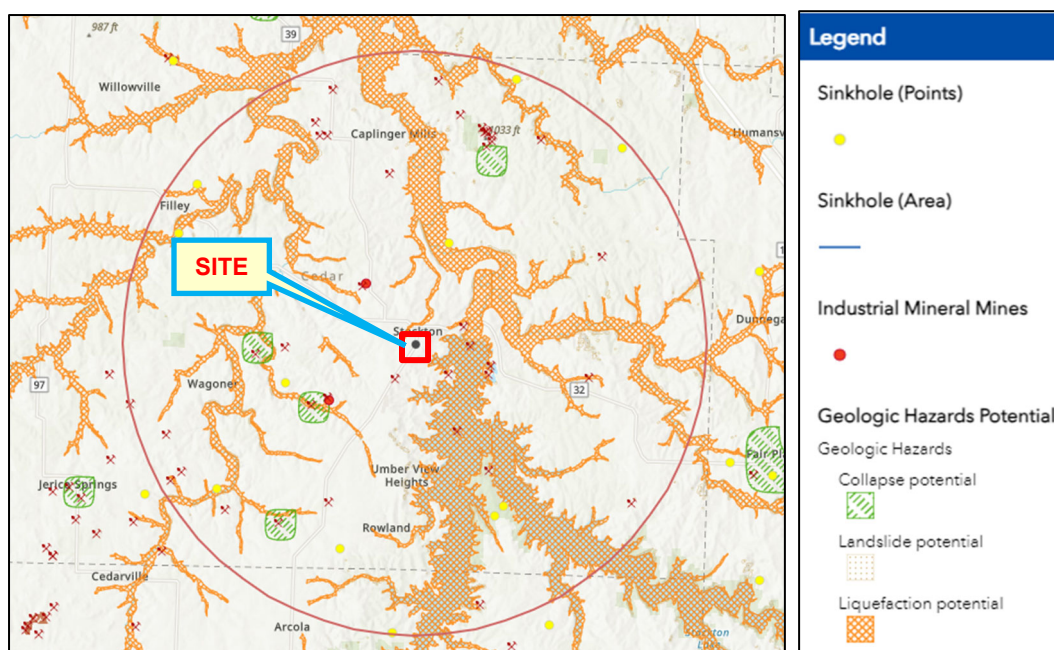
Viewing southwest across the project site



Viewing northwest across the project site

2.1.1 Mineral Mines and Sink Holes

Based on our review of the information available online (i.e., Missouri's Department of Natural Resources Geosciences Technical Resource Assessment Tool, or *GeoSTRAT*), the State of Missouri is known to be home to a wide variety of geological structure and features (including but not limited to fault lines, sinkholes, caves, etc., as well as areas with Karst activity). In particular, the Figure below depicts the geological features and structures within a radius of about 10 miles around the proposed project site:



Geological Features and Structures within 15 miles of the project site

Based on the information included in *GeoSTRAT*, the area of around the project site hosts the following geologic structures and features within a small radius of 10 miles:

GEOLOGICAL FEATURES NEAR THE PROJECT SITE	
Type of Feature	Number of Occurrences
Reported Karstic Sinkholes	6
Industrial Mineral Mines	29
TOTAL	35

2.2 PROPOSED CONSTRUCTION

Based on our review of the provided initial site layout, ECS understands that the project will consist of McDonald's restaurant and associated pavement areas. The following Table summarizes our understanding for the proposed development:

GENERAL DESIGN INFORMATION		
Subject	Design Characteristic	
Proposed Building	One-story, slab-on-grade, building structure encompassing approximately 3,695 square feet in plan area	R
Maximum Column/Wall Loads	50 kips/2 kips per foot	B
Settlement Tolerance	Estimated to be 1-inch total and 1/2-inch differential	B
Grade Supported Slab Loads	120 psf	B
Finished Floor Elevation	EL. 968.93 feet above MSL	R
Pylon Sign	Structure specific details, such as sign height, width, length, and structural loads were not available at this time. ECS estimated maximum compression, uplift and lateral loads of 25 kips, 30 kips and 10 kips, respectively.	B
Retaining Walls	Based on the provided grading plan titled "Grading Exhibit" sheet CP02, a retaining wall will be located along the east portion of the site with a maximum height of about 6 feet above grade.	R
Pavement	Flexible and Rigid concrete pavement based on the 18-kips ESAL's of 25,000 and 90,000 for the light and heavy-duty pavements, respectively, for a design life of 20 years (ESTIMATED)	B

R: Reported by client and/or Design Team

B: Based on ECS estimate in absence of information from Client and/or Design Team

If ECS' understanding of the project is not correct, especially if the structural loads or elevations are different, please contact ECS so that we may review these changes and revise our recommendations, as appropriate.

3.0 FIELD EXPLORATION AND LABORATORY TESTING

Our exploration procedures are explained in greater detail in Appendix B including the insert entitled 'Subsurface Exploration Procedures: SPT'. Our scope of work included drilling thirteen (13) SPT test borings, extending to terminal depths of about 3¼ to 23½ feet below the existing grades. The approximate locations of the completed soil borings are shown on the Boring Location Diagram in Appendix A.

PPI was subcontracted by ECS to perform the drilling services using a truck-mounted drilling rig and utilizing continuous flight hollow stem augers. Prior to drilling, the drilling subcontractor contacted the State of Missouri One-Call System to clear and mark public underground utilities in the vicinity of the project site. In addition, per client's request, PPI engaged a private utility locator to assist in locating underground utilities in the general vicinity of the proposed test borings.

Standard penetration tests (SPTs) were conducted in the borings at regular intervals in general accordance with ASTM D 1586 and D1587. Additionally, ECS performed bedrock coring in boring B-01 from about 11 feet to 21¼ feet below the existing grade and in boring B-05 from about 12½ feet to 23½ feet below the existing grade. The drill crew backfilled the boreholes with cuttings at completion of drilling and grout the bedrock coring. Settlement or expansion of borehole backfill can occur over time resulting in a trip hazard. Monitoring the boreholes after initial drilling activities is not within our scope but should be done by the client or property owner.

3.1 SUBSURFACE CHARACTERIZATION

The subsurface conditions encountered were generally consistent with published geological mapping except the existing undocumented possible fill soils in upper few feet. The following Sections of this text provide generalized characterizations of the soil strata. Please refer to the boring logs in Appendix B.

GENERALIZED SUBSURFACE PROFILE					
Approximate Depth to Bottom of Stratum (feet)	Stratum No.	Material Description	Calibrated Penetrometer Resistance (tsf)	Natural Moisture Content (%)	SPT ⁽¹⁾ N-values (bpf)
Near-Surface Cover	NA	Topsoil: 2 to 6 inches Or Bituminous Pavement: 3 inches Granular Base: 6 inches	NA	NA	NA
1½ to 3½	IA ⁽²⁾	(SC/SM POSSIBLE FILL) Clayey/Silty Sand with Gravel Possible Fill , dark brown, medium dense to very dense	NA	NA	11 to 70
3½ to 4	IB ⁽³⁾	(CL POSSIBLE FILL) Lean Clay with Gravel Possible Fill and (CL/CH POSSIBLE FILL) Lean to Fat Clay Possible Fill , brown, gray, and dark brown, stiff	1½	13 to 30	11 to 26
3 to 11½	II ⁽⁴⁾	(CH) Fat Clay - with chert nodules, reddish-brown, moist, firm to very stiff	½ to 3	34 to 74	3 to 50+
4 to 23½	III ⁽⁵⁾	Limestone/Sandstone, weathered to slightly weathered , tan-gray and light gray, moderately hard to hard	NA	NA	50+

Notes:

- (1) Standard Penetration Testing
- (2) Encountered in borings B-01 through B-05, P-01, P-02, P-03, P-07, and S-01
- (3) Encountered in borings P-04 and P-07
- (4) Encountered in borings B-01 through B-05, P-01, P-02, P-03, P-05, P-06, and S-01
- (5) Bedrock was encountered in borings B-01 through B-05, P-01 through P-07, and S-01

The soil/bedrock stratification shown on the boring logs represents the interpreted soil and bedrock conditions at the actual boring locations. Variations in the stratification can occur between sample intervals and boring locations. The subsurface conditions at other times and locations on the site may differ from those found at the test boring locations. If different site conditions are encountered during construction, ECS should be contacted to review our recommendations relative to the new information.

Because the split-spoon sampler has a 1 $\frac{3}{8}$ -inch inside diameter, the soil classifications noted on the boring logs may not be representative of the entire soil matrix. Material larger than the 1 $\frac{3}{8}$ -inch inside diameter of the split-spoon sampler cannot be collected and observed directly.

The Table below shows observed bedrock depths with respect to existing grades, bedrock recovery, RQD and laboratory determined unconfined compressive strengths in general accordance with ASTM D7012 (*Method C*):

GENERALIZED BEDROCK CHARACTERISTICS					
Soil Boring No.	Apparent Depth to Bedrock Below the Site Grade (feet)	Percent Recovery	RQD, %	Unconfined Compressive Strength (Qu, psi) (ASTM D7012)	Bedrock Types
B-01	10	100	23 to 100	4,520 to 4,770	Sandstone/Limestone - weathered to slightly weathered
B-02	8	NA	NA	NA	Limestone - weathered
B-03	9	NA	NA	NA	Limestone - weathered
B-04	6	NA	NA	NA	Limestone - weathered
B-05	11 $\frac{1}{2}$	100	37 to 86	2,560 to 5,210	Limestone - weathered to slightly weathered
P-01	6 $\frac{1}{2}$	NA	NA	NA	Limestone - weathered
P-02	5 $\frac{1}{2}$	NA	NA	NA	Limestone - weathered
P-03	3 $\frac{1}{2}$	NA	NA	NA	Limestone - weathered
P-04	3 $\frac{1}{2}$	NA	NA	NA	Limestone - weathered
P-05	3 $\frac{1}{4}$	NA	NA	NA	Limestone - weathered
P-06	8	NA	NA	NA	Limestone - weathered
P-07	4	NA	NA	NA	Limestone - weathered
S-01	8 $\frac{1}{2}$	NA	NA	NA	Limestone - weathered

3.2 GROUNDWATER OBSERVATIONS

The drillers observed the boreholes for the presence of measurable free ground water during drilling and at the completion of drilling. Free groundwater was observed at depths of about 3 to 11 feet below the existing grades in borings B-01, B-02, B-03, B-05, P-01, P-04, and P-06 during drilling operations. Free groundwater was not encountered in the remaining borings during drilling operations.

Please note that in predominantly fine-grained soils, groundwater may take several days or weeks to stabilize in the boreholes. The drilling crew backfilled the open boreholes immediately upon completion of drilling. As such, stabilized groundwater readings were not possible. Soils in the Midwest frequently oxidize from gray to brown above the level where the soil remains saturated. This zone of change, which

may be an indication of the long-term groundwater level, is frequently interpreted to be the groundwater table. In general, gray soils were not identified at the soil boring locations.

Estimation of the seasonal high groundwater level based on colors (redoximorphic features) may not be reliable. Also, we often don't know how often or long the soil is saturated at a given depth from color alone. A better estimation of the seasonal high groundwater level would require installation of groundwater observation wells along with observing the wells over a long time period.

Variations in the long-term water table elevation may occur as a result of changes in precipitation, evaporation, surface water runoff, construction activities, and other factors. Perched water conditions may also develop or exist at shallower depths seasonally, particularly within granular soils underlain by clay.

3.3 LABORATORY TESTING

The laboratory testing consisted of selected tests performed on samples obtained during our field exploration operations. Classification and index property tests were performed on representative soil samples. These tests included:

- Calibrated Penetrometer Resistance
- Natural Moisture Content (ASTM D2216)
- Atterberg Limits Test (ASTM D4318)
- Percent Passing US Standard Sieve #200
- Compressive strength tests were performed on selected rock core samples in accordance with ASTM D7012 (*Method C*).

Each sample was visually classified on the basis of texture and plasticity in accordance with ASTM D2488 Standard Practice for Description and Identification of Soils (Visual-Manual Procedures) and including USCS classification symbols. After classification, the samples were grouped in the major zones noted on the boring logs in Appendix B. Testing for Atterberg Limits and unconfined compressive strength was completed and the testing results are included in Appendix C. The group symbols for each soil type are indicated in parentheses along with the soil descriptions. The stratification lines between strata on the logs are approximate; in situ, the transitions may be gradual.

The soil samples will be retained in our laboratory for a period of 60 days, after which, they will be discarded, unless other instructions are received as to their disposal.

3.4 ELECTRICAL RESISTIVITY IMAGING (ERI) - KARST MAPPING

ECS Midwest, LLC performed the geophysical testing at this property and completed a total of four (4) Electrical Resistivity Imaging (ERI) lines at the subject site across the proposed building footprint, and the findings of the report are included in Appendix D. The purpose of an electrical resistivity survey is to estimate the electrical subsurface characteristics through measurements recorded on the ground surface. Based upon the results of the measured electrical properties, estimates of the true resistivities of subsurface features can be made. These estimated values can then be correlated to various geologic parameters including saturated soils, water interfaces, rock, and void spaces.

Resistivity lines were performed with the Dipole-Dipole Testing method. Electrode spacings were at 15-foot lengths for a total resistivity line length of approximately 190 feet. The maximum depth of the resistivity testing was approximately 50 feet near the center of the resistivity lines. Resistivity testing was

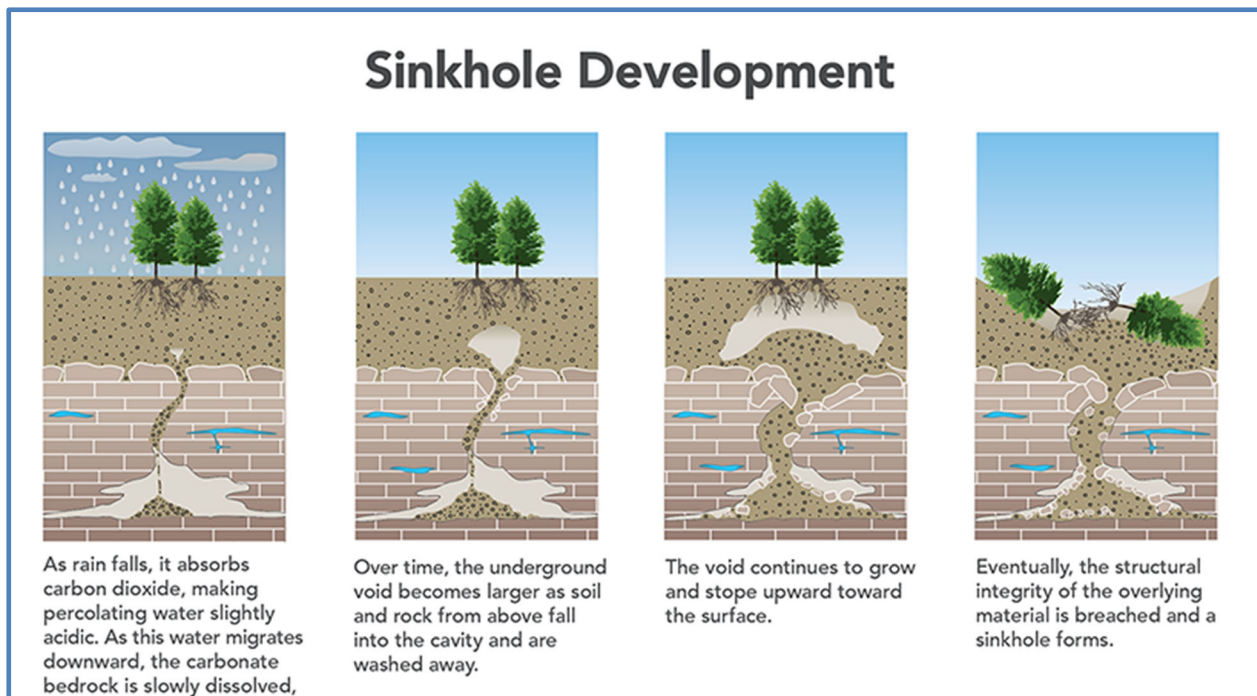
performed with an Abem Terrameter LS2 resistivity meter and the system uses a total of 16 electrode positions.

Areas of active sinkhole formations, caves or conduits were not observed below or in close proximity to the proposed McDonald's building based on the ERI lines performed at the subject site. Also, no surficial indications of sink hole activity were observed at this site, except some weathered limestone zones. Active sinkholes generally show surficial signs of settlement as closed contour depressions at the site, which were not visible during site testing. Potential sources of sinkhole development include areas between bedrock pinnacles, crevices within the bedrock, weathered bedrock zones, and isolated pockets of low resistance clays.

4.0 DESIGN RECOMMENDATIONS

4.1 GEOLOGIC HAZARD

Based on the review of publicly available *Maps from Missouri Geological Survey* in the general vicinity of the proposed project, has identified the potential for this site to be underlain by calcium carbonate and calcium-magnesium carbonate bedrock (i.e., limestone and dolomite). There are numerous sinkholes/points identified in the general vicinity of the proposed site, within 10 miles radius. A Map of the area is shown in **Section 2.1.1** around the proposed site. The presence of carbonate-rich bedrock indicates the potential for sinkhole development at this site. Karst development in this area occurs from the dissolution of the native limestone bedrock material. Over time, groundwater can transport the surrounding soil into bedrock voids causing visible surface features such as circular depressions or areas of drainage. However, some sinkholes may not be visible from surface because they are plugged or capped with a thin layer of rock. The extent of the sinkhole occurrence depends on the particular geologic, hydrogeologic and soil conditions of the site and what disturbances are being created by man-made features. The image below, provided by MDNR, depicts the development of sinkholes over time.



General Sinkhole Development (Source: Missouri Department of Natural Resources)

Based on the geophysical testing using electrical resistivity imaging, (apparent) active sink hole formations, caves or conduits were not observed near the proposed McDonald's facility. However, the present state-of-the-art geotechnical engineering does not permit accurate predictions of where or when sinkholes will occur in the future. Site grading should be established to provide positive drainage both during and after construction, so as to minimize the potential for sinkhole development.

4.2 SHALLOW FOUNDATIONS

Based on the client provided grading drawing titled "Grading Plan" sheet C300 prepared by *Civil & Environmental Consultants, Inc.* dated November 15, 2024, the proposed building will have a finished floor elevation of EL. 968.93 feet above MSL. Settlement and bearing capacity calculations were performed based on the provided finished floor elevation.

Based on the subsurface exploration and knowledge of the local geology, the soils encountered at this site are classified as low and high plasticity 'fat' clays. Fat clay soils have tendency to shrink and swell (exhibit potential vertical rise - PVR) and could cause unacceptable heaving of the proposed lightly loaded grade supported slabs and pavement distress. Also, ECS understands that the proposed structure will be lightly loaded and dead/live loads on the foundations may not counterbalance the swelling pressure of higher plasticity clays.

Based on the limited laboratory testing, the soils encountered within the upper few feet are undocumented clayey/silty sand possible fill soils and undocumented lean clay possible fill soils underlain by high plasticity 'fat clay' soils. Higher plasticity 'fat clays' soils could be present in other areas not explored by ECS. Final grading plans are not available at this time, thus, ECS cannot estimate whether the existing grades will be raised or undercut, to achieve the final grades. If higher plasticity 'fat clays' are encountered within 24 inches of the final grades (foundation bearing elevation and floor slab/pavement final grades), ECS recommends replacing them with low volume change (LVM) material.

Provided subgrades and engineered fills are prepared as recommended in this report, the proposed building structure and pylon sign foundation can be supported by shallow foundations. We recommend the foundation design use the following parameters:

SHALLOW FOUNDATION DESIGN PARAMETERS		
Design Parameter	Column Footing	Wall Footing
Maximum Net Allowable Bearing Pressure ⁽¹⁾	2,000 psf	2,000 psf
Acceptable Bearing Soil Material	Compacted LVM engineered fill or Lean Concrete over Stratum II	Compacted LVM engineered fill or Lean Concrete over Stratum II
Minimum Width	30 inches	18 inches
Minimum Footing Embedment Depth (below slab or finished grade) ⁽²⁾	24 inches	24 inches
Minimum Exterior Frost Depth (below final exterior grade)	36 inches	36 inches
Estimated Total Settlement ⁽³⁾	Less than 1 inch	Less than 1 inch
Estimated Differential Settlement ⁽⁴⁾	Less than ½ inch between columns	Less than ½ inch

Notes:

- (1) Net allowable bearing pressure is the applied pressure in excess of the surrounding overburden soils above the base of the foundation.
- (2) For frost penetration requirements.
- (3) Based on stated structural loads. If final loads are different, ECS must be contacted to update foundation recommendations and settlement calculations.
- (4) Based on maximum column/wall loads and variability in borings. Differential settlement can be re-evaluated once the foundation plans are available.

Suitable Bearing Materials: Footing pads are recommended to be supported on select engineered fill (low volume change material - LVM) or lean concrete overlying competent natural soils. Soils suitable as the subgrade for engineered fill and indirect foundation support should have parameters as noted in the following Table or greater, unless otherwise approved by the geotechnical engineer:

SUITABLE BEARING SOIL CHARACTERISTICS BELOW SELECT FILL		
Maximum Net Allowable Bearing Capacity (psf)	Cohesive Soil (Clays)	
	Consistency	Unconfined Compressive Strength
2,000	Stiff	1 tsf or higher

Potential Undercuts: If soft, unsuitable, and/or fill soils are observed within the building footprint, the unsuitable soils should be undercut and removed. Undercuts should be backfilled with low volume change (LVM) engineered fill or lean concrete up to the original design bottom of footing elevation; the original footing shall be constructed on top of the new engineered fill (LVM) or lean concrete. As discussed in the previous Sections and anticipated footing bearing elevations, 'fat' clays were encountered below this site. Thus, ECS recommends undercutting of these higher plasticity fat clays to a depth of 24 inches below the lightly loaded shallow building foundations and floor slab, if encountered within 24 inches of the bearing elevations.

Cohesive soils encountered at or near the anticipated bearing elevations are sensitive to disturbance when exposed, especially when wet. The contractor should exercise care and minimize traffic and potential disturbance to the soils. If disturbed, the exposed surfaces should be compacted with a plate compactor or jumping jack prior to the placement of reinforcing steel and concrete. Test pits at this site may also be prudent to evaluate the extent and composition of the existing fill.

Uplift Considerations on Shallow Foundations: Where foundations will be subjected to uplift loads, it may be considered that the uplift resistance of the spread foundations be developed from the dead weight of the foundations plus the compression dead load of the columns and the weight of the overlying soil material above the foundations. A unit weight of 120 pounds per cubic foot could be used for compacted on-site soils as backfill around the foundations when determining the weight of the overlying soil prism. In connection with this, the geometry the soil prism for volume computations may be defined by diagonal planes extending up from the top of the perimeter of the foundation to the ground surface by lines drawn outward laterally ½ foot and 1 foot vertically.

Foundation Lateral Loading: The foundations are also expected to be subject to lateral forces. Lateral load resistance will be developed by friction or cohesion acting at the base of foundations, and the passive earth pressure developed by the footings below-grade. Passive pressure and sliding resistance (friction or cohesion) may be used in combination in determining the total resistance to lateral loads. The parameters in the following table are recommended for lateral foundation loading.

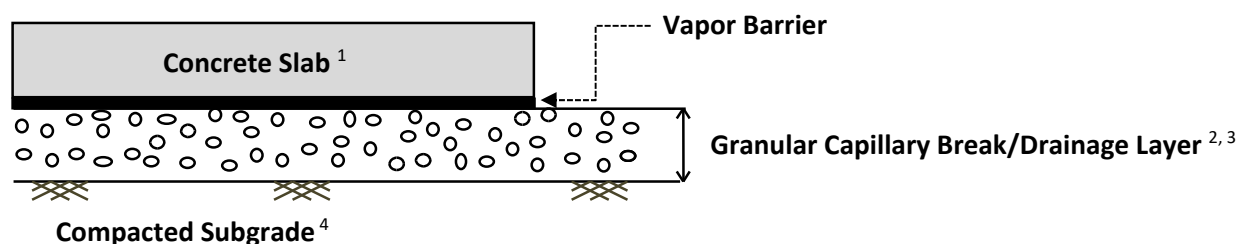
FOUNDATION LATERAL LOADING RESISTANCE PARAMETERS	
Soil Parameter	Estimated value
Coefficient of Passive Earth Pressure (K_p) - engineered fill	2.5
Soil Moist Unit Weight (γ)	120 pcf
Cohesion [<i>Foundations bearing on LVM Material</i>] (C) ⁽¹⁾	1,000
Interface Friction Angle [<i>Poured concrete on engineered fill</i>] (ϕ_i)	18°
Sliding Friction Coefficient [<i>Poured concrete on granular engineered fill</i>] (μ)	0.32
Passive Equivalent Fluid Pressure ⁽²⁾	300H (psf)

1. Cohesion may be used for lateral sliding resistance on the clay soil, but in no case should the lateral sliding resistance exceed half the dead load.
2. Neglect the passive earth pressure within the frost zone due to loss of strength seasonally and strain required to mobilize.

The final design of the foundation for lateral loads should be based on a minimum factor of safety against sliding of 1.5 and overturning of 2. Also, if the resultant force of the maximum vertical force does not act within the middle one-third (kern) of the footing, a smaller effective bearing area will occur and thereby result in a higher effective bearing pressure that must be accounted for in the design. The foundation could also be anchored to help resist overturning.

4.3 SLABS ON GRADE

Based on the client provided grading drawing titled "Grading Plan" sheet C300 prepared by *Civil & Environmental Consultants, Inc.* dated November 15, 2024, the proposed building will have a finished floor elevation of EL. 968.93 feet above MSL, ECS anticipates the floor slab will be supported on either existing undocumented possible fill soils or low volume change material in case higher plasticity 'fat clays' are encountered within 24 inches of the final floor slab subgrade elevation. There will be some inherent risk associated with supporting the grade supported slabs on undocumented possible fill, and the client would need to accept this risk or remove and replace the existing fill with engineered fill. The following graphic depicts our soil-supported slab recommendations.



1. **Concrete Slab:** Minimum 4 inches thick
2. **Drainage Layer:** Minimum 6 inches thick
3. **Drainage Layer Material:** Gravel (GP, GW) having a maximum aggregate size of 1 inch and no more than 5 percent passing the No. 200 sieve.
4. **Compacted Subgrade:** LVC Engineered Fill compacted to at least 95 percent of the maximum dry density per ASTM D1557.

A thicker slab may be needed depending on the actual floor loads. The structural engineer should determine the actual slab thickness and steel reinforcing requirements. Provide adequate construction joints, contraction joints and isolation joints in the slab to reduce the impacts of cracking and shrinkage. Refer to ACI 302.1R04 *Guide for Concrete Floor and Slab Construction* for additional information regarding concrete slab joint design. Reinforce the slab with welded wire fabric or include an appropriate fiber mesh

admixture to help control shrinkage cracking.

ECS recommends slabs-on-grade be underlain by a granular drainage layer placed on a properly prepared subgrade as recommended in the **Site Construction Recommendations** section. The granular material will serve as a capillary break, which if properly designed and installed can assist in more uniform curing of concrete.

Inclusion of a vapor retarder should be considered if the building contains moisture-sensitive floor coverings, equipment or materials. The vapor retarder will help reduce the potential of upward migration of water vapor from the soil into and through the concrete slab, which can contribute to excess humidity and microbial growth in the building. Where a vapor retarder is considered to help provide additional moisture protection, special attention should be given to the surface curing of the slabs to reduce uneven drying of the slabs and associated cracking and/or slab curling. The designer should consider the moisture sensitivity of floor coverings and finishes, and the potential effects of slab curling and cracking when determining if the vapor retarder will be in direct contact with the slab or beneath a layer of granular fill. The use of a blotter or cushion layer above the vapor retarder may be considered for project specific reasons. Refer to ACI 302.1R04 *Guide for Concrete Floor and Slab Construction* and ASTM E 1643 *Standard Practice for Installation of Water Vapor Retarders Used in Contact with Earth or Granular Fill under Concrete Slabs* for additional guidance on these issues.

Positive drainage around the perimeter of the proposed structures should be used to reduce the potential for water accumulation under the floor slab and foundation elements. Slope exterior grades adjacent to the building such that runoff is directed away from the building walls. Direct building downspouts away from the building walls/foundations. Direct slab and pavement surface runoff to appropriate stormwater infrastructure.

Building Slab Isolation: Isolate ground-supported slabs from the foundations and foundation-supported elements of the structure to help reduce shear and bending stresses in the floor caused by differential movement between the foundations and slab. Where the structural configuration prevents the use of a free-floating slab, design the slab with suitable reinforcement and load transfer devices to preclude overstressing of the slab.

Subgrade Modulus: Provided the Subgrade is prepared, and engineered fill and the granular drainage layer are placed as recommended in this report and the final subgrade proofroll is satisfactory and fill is placed as recommended in the subgrade preparation of this report, design the slabs assuming a modulus of subgrade reaction, k of 125 psi/in (pounds per square inch per inch). This modulus of subgrade reaction value assumed is based on the recommended minimum drainage base thickness and correlation of index properties and soil type to historical 1 foot by 1 foot plate load tests. The modulus value used in design should be adjusted for areas larger than 1 foot by 1 foot.

Frost Susceptible Areas: Exterior sidewalks and exterior portions of the floor slab, such as at doorway entrance/exit slab may be susceptible to frost heave movement during colder weather. Additional insulation, installation of subgrade drainage, and/or replacement to the frost depth with non-frost-susceptible backfill should be considered for these areas. Pavement and ground surface grades are recommended to be sloped away from the building and flatwork, to reduce water infiltration and potential frost heave problems. In addition, all slab joints should be sealed to reduce surface water infiltration into the sub-base materials.

4.4 SIGN FOUNDATION - DRILLED SHAFT

Pylon sign structure specific information was not available at this time such as the sign height, length, width, weight and structural loads. A soil boring (S-01) was performed at the proposed sign location extending to a depth of about 8½ feet below the existing grades. In addition, ECS reviewed the bedrock coring data from the two (2) nearby test borings (B-01 and B-05) beyond the termination depth of test boring S-01.

The allowable axial load carrying capacity of a drilled shaft can be computed using the static method of analysis. According to this method, allowable axial capacity, Q_a , at a given penetration is taken as the sum of the skin friction on the side of the shaft, Q_{as} , and the end or point bearing at the shaft tip, Q_{ap} , so that:

$$Q_a = Q_{as} + Q_{ap} = f A_s + q A_p$$

where A_s and A_p represent, respectively, the embedded perimeter surface area and the end area of the shaft; f and q represent, respectively, the allowable unit skin friction and the allowable unit end or point bearing. The total allowable axial capacity in compression will be the summation of the allowable frictional capacity and the allowable end bearing capacity. The total allowable axial capacity in tension (uplift) will be the allowable frictional capacity of the shaft neglecting the end bearing component. Based on the project characteristics, the horizontal (shear) force and overturning moment will govern the design (depth and size) of the shaft. Steel reinforcing steel must be designed by the structural engineer to resist the referenced loads. The Tables below summarize the soil design parameters (based on the soil conditions observed in soil boring S-01) which should be used for uplift and lateral stability analyses based on the LPILE computer programs. Due to the disturbance during shaft installation, frost depth and wetting/drying cycles, ECS recommends that the upper 36 inches be ignored for the design of the foundation system.

ALLOWABLE BEARING CAPACITIES IN COMPRESSION AND UPLIFT				
Soil Type	Approximate Depth below the Existing Grade (ft)	Allowable Unit End Bearing (psf)	Allowable Downward Axial Unit Skin Friction (psf)	Allowable Uplift Unit Skin Friction (psf)
Fill (SC/SM)	0 to 3	NA	NA	NA
CH	3 to 8½	NA	250	150
Weathered ¹ Limestone	>8½	35,000	3,500	2,800

¹ Auger refusal at about 8½ feet. ECS cored the bedrock at test locations B-01 and B-05 and anticipating similar bedrock conditions at the proposed sign location.

LPILE SOIL PARAMETERS FOR LATERAL LOAD ANALYSIS							
Soil Type	Depth Below the Existing Ground Surface (ft)	"p-y" criteria	Effective Unit Weight (pcf)	Insitu Shear Strength Su (psf)	Unconfined Compressive Strength (psi)	Lateral Modulus Ks/Kc (pci)	Strain Factor ϵ_{50}/K_{rm}
Fill (SC/SM)	0 to 3	Neglect ¹					
CH	3 to 8½	Very Stiff	120/58 ²	2,000	NA	Ks=1,000 Kc=400	0.005
Weathered Limestone	>8½	Rock	165/78 ²	NA	2,560 to 5,210	NA	0.0005
Note: Su-Undrained Shear Strength (psf); Ks/kc-modulus of subgrade reaction (pci) for static/cyclic loading condition; and ϵ_{50}/K_{rm} - strain corresponding 50% of the maximum stress. ¹Neglect upper 3 feet of soil for lateral load analyses. ²Buoyant Unit Weight of soil (groundwater is estimated at 3 to 11 feet below the existing grades).							

Expansive Soil Considerations: Drilled shafts extending through potentially expansive soils are subjected to vertical uplift loads when soils become moist or wet and swell against the shafts. For this reason, each the drilled shaft should be designed with sufficient steel reinforcement to resist the tensile stresses caused by the uplift forces of the highly plastic fat soil. The drilled shaft placed within swelling soils at this site should be checked for reinforcement with a preliminary estimated tension load of 35*d kips, where "d" is the diameter of the drilled shaft in feet. A swell test could be performed for site-specific soils to estimate the swelling pressure and tension load on the drilled shaft. The reinforcement of the drilled shaft should be checked for this tension load alone neglecting any dead loads on the drilled shaft.

4.4.1 Drilled Shaft Excavation/Installation Considerations

Relatively shallow groundwater was encountered in most of the test borings during drilling operations. The use of a qualified contractor experienced in dewatering wet soils with shallow groundwater and installing the proposed type of drilled shaft foundations for this project is mandatory in order to reduce the potential for construction problems relative to cave-ins and 'running ground' conditions (ACI 304R, Chapter 8, Concrete Placed Under Water). A temporary steel casing is recommended to control these adverse ground issues. It is also recommended that the geotechnical engineer who has knowledge of the design, and the geologic and subsurface conditions, should observe the drilled shaft excavation/construction and backfilling of concrete.

Weathered limestone interbedded with sandstone was encountered in test borings B-01 and B-05. ECS recommends a minimum of 5 feet of bedrock socket within the weathered limestone interbedded with sandstone to resist uplift, shear and moments. The bearing of the bedrock socket should be measured beginning at the point where continuous bedrock (limestone or limestone interbedded with sandstone) exists along the entire shaft perimeter. The bedrock socket should be observed by the third-part testing firm. The socket should be continuous around the drilled shaft diameter and should be clean. Where the required uplift loads cannot be safely resisted through side friction (i.e. shallow drilled shafts), rock anchors may be required.

Completed drilled shaft excavations should have a planar bottom for axial bearing considerations. Any loose material, disturbed material and water should be removed from the drilled shaft excavation prior to concrete backfilling. Drilled shaft excavations should not be allowed to stand open for any significant

length of time because this may allow water to accumulate. Based on the estimated free groundwater table and expected drilled shaft depths, water will likely be encountered. The maximum depth of water at the bottom of the shaft excavation should not exceed 3 inches prior to concrete placement. Use of drilling mud, downhole dewatering, bentonite or polymer slurry and/or tremie concrete construction methods are expected because shallow groundwater was encountered at the boring location and cannot be managed using temporary casing only. Another alternative may be to use a larger diameter shaft to help reduce drilled shaft embedment depths needed. Sidewalls are recommended to be visually free of cuttings. A clean-out bucket should be provided to permit manual removal of all loose or disturbed soils within the drilled shaft excavation.

The potential for significant caving of shaft sidewalls in granular soils exists and temporary steel casing and/or slurry will be required during drilled shaft excavation. Care must be taken while removing liners or temporary casing during concrete placement so the head of concrete inside the casing is at all times greater than the earth pressure and hydrostatic head outside the casing. The concrete mix for the drilled shaft should be designed and placed to reduce the potential for arching of the concrete during removal of the casing. The temporary steel casing should be extended a minimum 3½ feet above the ground surface for safety and to reduce the potential risk of accidental fall-in of foreign materials and personnel into the excavation hole.

Concrete should consist of a Portland cement mixture properly air-entrained with an appropriate water to cement ratio for proper strength and durability. Because of the presence of water bearing granular soils, placement of concrete by tremie method is expected to be required. ECS recommends a slump of 5 to 7 inches if tremie placement is required. Care must be exercised so the concrete will not contact the reinforcing cages during placement otherwise segregation of the concrete will occur. If the mixture is too stiff, reinforcing cages may be pulled up when liners are withdrawn.

The drilled shaft should have a minimum shaft diameter of 36-inches to help reduce arching and the development of possible voids in placement of the in-situ concrete. The shaft must also contain reinforcing steel (designed by the structural engineer) to resist all combinations of loadings and to satisfy the applicable building codes.

4.4.2 Competent Bedrock Verification Testing

The drilled shaft foundation should be evaluated by a third-party testing firm to determine the adequacy of the bearing material via a down-hole inspection or bedrock coring. The adequacy of the bearing level in bedrock formation will be based upon the absence of voids, highly weathered zones, coal, and seams within the first 4 feet of the test hole. Individual seams, if present below the first 4 feet should not be greater than ¼ inch, and the total of seams within the remainder of the test hole should not exceed 1 inch.

4.5 SITE RETAINING WALLS

ECS understands that the site retaining walls are planned to be constructed along the east portion of the project site. Based on the information provided by the client, the retaining wall height will vary across the site and will range from about 1 to 6 feet above proposed site grades.

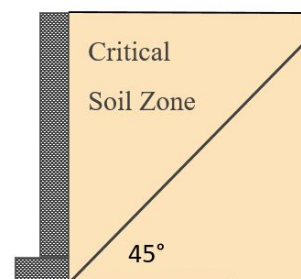
Based on the limited laboratory testing, the soils encountered within the upper few feet are undocumented clayey/silty sand possible fill soils and undocumented lean clay possible fill soils underlain by high plasticity 'fat clay' soils. Higher plasticity 'fat clays' soils could be present in other areas not

explored by ECS. If higher plasticity 'fat clays' are encountered within 24 inches of the final grades (foundation bearing elevation), ECS recommends replacing them with low volume change (LVM) material.

Lateral Earth Pressures: Unlike below grade walls, site retaining walls are free to rotate at the top (not restrained). For these walls, the "Active" (K_a) soil condition should be used along with a triangular distribution of earth pressures. In addition, site retaining walls should be designed to withstand lateral earth pressures exerted by the backfill and any surcharge loads within the "Critical Soil Zone." The Critical Zone is defined as the area between the back of the retaining wall footing and an imaginary line projected upward and rearward at a 45-degree angle (see Figure below). The wall designer is solely responsible for the selection of the earth pressure envelopes depending on the type of wall and surcharges.

The lateral earth pressures developed behind site retaining walls are a function of the backfill soil type, backfill slope angle, and any surcharge loads. For the design of site retaining walls (based on the soil conditions observed in soil boring B-02 and B-05), we recommend the soil parameters provided below:

RETAINING WALL BACKFILL IN THE CRITICAL SOIL ZONE	
Soil Parameter	Estimated Value
Soil Classification	Silty SAND (SM) or more granular
Fines Content	Max. 20% >#200 Sieve
Coefficient of Active Earth Pressure (K_a)	0.31
Retained Soil Moist Unit Weight (γ)	125 pcf
Cohesion (C)	0 psf
Angle of Internal Friction (ϕ)	32°
Active Equivalent Fluid Pressure	39H (psf)



FOUNDATION SOILS	
Soil Parameter	Estimated value
Allowable Soil Bearing Pressure [<i>Foundations bearing on Compacted LVM engineered fill or Lean Concrete over Stratum II</i>]	2,000 psf
Minimum Wall Embedment Below Grade	36 inches
Coefficient of Passive Earth Pressure (K_p)	2.0
Soil Moist Unit Weight (γ)	120 pcf
Interface Friction Angle [<i>Poured concrete on granular soil or granular engineered fill</i>] (ϕ_i)	21°
Sliding Friction Coefficient [<i>Poured concrete on granular soil or granular engineered fill</i>] (μ)	0.38
Passive Equivalent Fluid Pressure	240H (psf)

It is critical that the soil used for backfilling of the retaining walls meet the soil parameters recommended above. If the soils available do not meet those parameters, then ECS should be contacted to provide revised values, and to confirm that only suitable soils will be used for wall backfill.

Care should be used to avoid the operation of heavy equipment to compact the wall backfill since it may overload and damage the wall. In addition, such loads are not typically considered in the design of site retaining walls and are not provided for in our recommendations.

Potential Undercuts: If soft, unsuitable, and/or fill soils are observed within the retaining wall footprint, the unsuitable soils should be undercut and removed. Undercuts should be backfilled with low volume change (LVM) engineered fill or lean concrete up to the original design bottom of footing elevation; the original footing shall be constructed on top of the new engineered fill (LVM) or lean concrete. As discussed in the previous Sections and anticipated footing bearing elevations, 'fat' clays were encountered below this site. Thus, ECS recommends undercutting of these higher plasticity fat clays to a depth of 24 inches below the lightly loaded foundations, if encountered within 24 inches of the bearing elevations.

Cohesive soils encountered at or near the anticipated bearing elevations are sensitive to disturbance when exposed, especially when wet. The contractor should exercise care and minimize traffic and potential disturbance to the soils. If disturbed, the exposed surfaces should be compacted with a plate compactor or jumping jack prior to the placement of reinforcing steel and concrete.

Wall Drainage: Retaining walls should be provided with a wall and foundation drainage system to relieve hydrostatic pressures which may develop behind the walls. This system should consist of weepholes through the wall and/or a 4-inch perforated, closed joint drain line located along the backside of the walls above the top of the footing. The drain line should be surrounded by a minimum of 6 inches of AASHTO #57 Stone wrapped with an approved non-woven geotextile, such as Mirafi 140-N or equivalent. Wall drains can consist of a 12-inch wide zone of free draining gravel, such as AASHTO #57 Stone, employed directly behind the wall and separated from the soils beyond with a non-woven geotextile. Alternatively, the wall drain can consist of a suitable geocomposite drainage board material. The wall drain should be hydraulically connected to the foundation drain.

4.6 SEISMIC DESIGN CONSIDERATIONS

Seismic Site Classification: The International Building Code (IBC) 2018 requires site classification for seismic design based on the upper 100 feet of a soil profile. At least three methods are utilized in classifying sites, namely the shear wave velocity (v_s) method and the Standard Penetration Resistance (N-value) method. The second method (N-value) was used in classifying this site.

SEISMIC SITE CLASSIFICATION			
Site Class	Soil Profile Name	Shear Wave Velocity, V_s , (ft./s)	N value (bpf)
A	Hard Rock	$V_s > 5,000$ fps	N/A
B	Rock	$2,500 < V_s \leq 5,000$ fps	N/A
C	Very dense soil and soft rock	$1,200 < V_s \leq 2,500$ fps	>50
D	Stiff Soil Profile	$600 \leq V_s \leq 1,200$ fps	15 to 50
E	Soft Soil Profile	$V_s < 600$ fps	<15

The maximum explored depth in the present subsurface exploration was about 23½ feet below current site grades. As such, based upon our interpretation of the subsurface conditions and our experience with similar geological settings, the appropriate Seismic Site Classification is "D" as shown in the preceding Table.

Ground Motion Parameters: In addition to the seismic site classification, ECS has determined the design spectral response acceleration parameters following the IBC methodology (ASCE 7-16). The Mapped Responses were estimated from the 'ATC Hazards by Location' website (<https://hazards.atcouncil.org/>) for the address of the project. The design responses for the short period (0.2 sec, S_{DS}) and 1-second period (S_{D1}) are noted in bold at the far-right end of the following Table.

GROUND MOTION PARAMETERS								
Period (sec)	Mapped Spectral Response Accelerations (g)		Values of Site Coefficient for Site Class		Maximum Spectral Response Acceleration Adjusted for Site Class (g)		Design Spectral Response Acceleration (g)	
0.2	S_s	0.141	F_a	1.6	$S_{MS}=F_a S_s$	0.225	$S_{DS}=2/3 S_{MS}$	0.150
1.0	S_1	0.087	F_v	2.4	$S_{M1}=F_v S_1$	0.208	$S_{D1}=2/3 S_{M1}$	0.139

The Site Class definition should not be confused with the Seismic Design Category designation which the Structural Engineer typically assesses. If a higher site classification is beneficial to the project, we can provide additional geophysical testing methods (Refraction Microtremor) that may yield more favorable results.

4.7 PAVEMENT RECOMMENDATIONS

Subgrade Characteristics: Based on the client provided grading drawing titled "Grading Plan" sheet C300 prepared by *Civil & Environmental Consultants, Inc.* dated November 15, 2024, this report is based on cut and fill operations of less than 3 feet to achieve final grades.

Extensive laboratory and field testing were not part of ECS scope for the pavement section design and recommendations. Assuming that the subgrade of the proposed pavements is prepared as recommended in this report, the rigid pavements may be designed for an estimated modulus of subgrade reaction, k_{v1} of 125 psi/in (pounds per square inch per inch) and flexible pavements may be designed using an estimated California Bearing Ratio (CBR) of 3.

As stated in the earlier Sections of this report, the soils encountered at this site are classified as low and higher plasticity clays. The higher plasticity 'fat clay' soil has a tendency to shrink and swell under extreme weather conditions and may shorten the life of pavement. Thus, ECS recommends removing 18 inches of existing fat clay soil below the pavement subgrade elevation, if encountered, and replacing it with low volume change material/low-plasticity soils (LVM).

Pavement Sections: The recommended minimum pavement sections presented in this report were **estimated** based on the anticipated traffic loads. However, the project civil engineer should confirm the traffic loads and if changes are required, please provide ECS the actual 18 kips ESAL loadings so that we can revise our pavement section recommendations. ECS anticipates the following 18-kips ESAL's loads for the flexible and rigid pavement section design:

ESTIMATED 18-KIPS ESAL's	
Pavement Section	Total 18-kip design ESALs
Standard-Duty Auto Areas	25,000
Heavy-Duty Truck Stalls	90,000

The recommended minimum pavement sections listed in the Table below are based on the anticipated usage at the project site with a design life of 20-years. If the anticipated traffic will exceed that assumed, ECS should be contacted for revised pavement design recommendations; otherwise, increased pavement maintenance and a shortened pavement life should be expected. The new flexible and rigid pavement materials and construction should be in accordance with the Guidelines for AASHTO Pavement Design and applicable Missouri Department of Transportation (MoDOT) Standards.

PROPOSED PAVEMENT SECTIONS				
MATERIAL	FLEXIBLE PAVEMENT (CBR=3)		RIGID PAVEMENT (Kv=100 psi/in)	
	Light-Duty	Heavy-Duty	Light-Duty	Heavy-Duty
Portland Cement Concrete ($f'_c = 4000$ psi)	-	-	5 in.	6 in.
Bituminous Surface Course ¹	1½ in	2 in	-	-
Bituminous Binder Course ²	2½ in	3 in	-	-
Crushed Aggregate Base ³	6 in	8 in	6 in	6 in
TOTAL	10 in	13 in	11 in	12 in

1. According to Section 401 of MoDOT Standard Specification for Highway Construction.
2. According to Section 401 of MoDOT Standard Specification for Highway Construction.
3. According to Section 304 of MoDOT Standard Specification for Highway Construction. If crushed gravel or some other material is used in lieu of crushed stone, the material may have a lower structural coefficient, and a thicker base may be required.

Crushed Aggregate Base Course Compaction: The aggregate base course is recommended to be compacted to at least 95 percent of the maximum dry density obtained in accordance with ASTM D 1557, Modified Proctor Method or to at least 98 percent of the maximum dry density obtained in accordance with ASTM D 698, Standard Proctor Method. Prior to placing the granular material, the pavement subgrade soil should be properly compacted, observed to be stable during a final proofroll and free of standing water, mud, and frozen soil.

Hot Mix Asphalt Compaction: The hot mix asphalt should be compacted to a minimum of 93 percent of the maximum theoretical density value.

Rigid Pavements: An air-entrained concrete mix (compressive strength of at least 4,000 pounds per square inch at 28 days) fiber-reinforced concrete is recommended for rigid pavements. Adequate construction joints, contraction joints and isolation joints should be provided in the areas of rigid pavement to reduce the impacts of cracking and shrinkage. Please refer to ACI 330R-92 *Guide for Design of Concrete Parking Lots*. The Guide recommends an appropriate spacing strategy for the anticipated loads and pavement thickness. It has been our experience that joint spacing closer to the minimum values results in a pavement with less cracking and better long-term performance. Control joint spacing should be determined in accordance with the current ACI code. Expansion joints should be provided where pavement abuts fixed objects, such as the buildings and light poles.

Weather Restrictions: Daily temperatures from mid-November to April can often stay below 40°F, limiting the days that asphalt placement can occur. In this region, asphalt plants may close during the months of

December, January, and/or February if particularly cold weather conditions prevail. However, this can change based on year-to-year temperature fluctuations.

Pavement Drainage: An important consideration with the design and construction of pavements is surface and subsurface drainage. Where standing water develops, either on the pavement surface or within the base course layer, softening of the subgrade and other problems related to the deterioration of the pavement can be expected. Based on our estimated groundwater level, ECS considers surface water infiltration to be the main source of water to be considered for pavement design on this project.

Shape or crown the final pavement surface to properly direct surface water to suitable on or off-site stormwater drainage infrastructure. Properly slope the clay pavement subgrade to avoid dips or pockets where water may become trapped. Dips in the clay subgrade could result in a "bathtub" effect, which may trap water and potentially soften the subgrade. The subgrade in areas requiring undercut and backfill with granular soils are recommended to be graded to drain toward a drain tile. The drain tile should be sloped a minimum of ½ to 1 percent to discharge to nearby storm sewers, drainage ditches or other appropriate drainage facilities. Install edge drains where site grades slope toward the pavement edge to reduce the potential for water to enter the base course layer. Slope edge drains to the nearest appropriate drainage facility. Water that ponds on the subgrade surface can lead to deterioration of the subgrade soils, reduction of the base course support characteristics and pavement heave. Good drainage should help reduce the possibility of the subgrade materials being wet over a long period of time.

Water should not be allowed to pond behind curbs and saturate the pavement base stone. In downgrade areas, base stone should extend through the slope face to allow water entering the base stone a path to exit.

Pavement Maintenance: A sound maintenance program should be implemented to help maintain and enhance the performance of pavements and help attain the design service life. A preventative maintenance program should be started early in the pavement life to be effective. The "standard in the industry" supported by research indicates that preventative maintenance should typically begin within 2 to 5 years of the placement of pavement. Failure to perform preventative maintenance will reduce the service life of the pavement and increase the costs for corrective maintenance and full pavement rehabilitation. Seal joints and cracks with elastomeric caulk in a timely manner to help reduce water infiltration through the pavement section into the base course layer, which may result in softening of the subgrade and deterioration of the pavement. Observe pavements for distresses, such as cracks, depressions and poor drainage, at least twice a year, typically once in the spring and once in the fall.

Shrinkage cracking is common with asphalt and occurs with age. Development of cracks should be expected with normal exposure to weather, wear and age. These cracks may become larger when exposed to such things as weather and vegetation growth and should be treated promptly.

5.0 SITE CONSTRUCTION RECOMMENDATIONS

5.1 SUBGRADE PREPARATION

5.1.1 Stripping and Grubbing

The subgrade preparation should consist of stripping all vegetation, existing pavements, and any soft or unsuitable materials from the 5-foot expanded pavement limits and the toe of engineered fills. We understand a third-party testing firm will be retained to verify that unsuitable surficial materials have been removed prior to the placement of engineered fill or construction of structures.

5.1.2 Existing Undocumented Possible Fill

Existing undocumented possible fill was encountered in all test borings (except borings P-05 and P-06) extending to depths of approximately 1½ to 4 feet below the existing ground surface. Possible fill material may extend to deeper depths at other unexplored locations than what was encountered at the boring locations. Information regarding the placement and compaction of the existing possible fill is not known. Test pits at this site may also be prudent to evaluate the extent and composition of the existing possible fill.

Possible Fill in Slab and Pavement Areas: Considering structure slab will be lightly loaded and complete removal and replacement of the existing fill may be cost prohibitive, and the owner may be willing to accept some risk. Below are two (2) alternatives for subgrade preparation in slab and pavement areas with varying anticipated cost and level of risk.

- **Alternative 1 (Partial Removal and Replacement):** Remove at least 18 inches of the existing Fill below the floor slab and pavement (below the design granular base elevation) and replace the undercuts with new engineered fill reinforced with a layer of geogrid (Tensar TX 140 or similar) placed prior to backfilling and compaction of engineered fill. After the undercut and prior to placement of geogrid and compacted backfill, the exposed remaining Fill subgrade must be proofrolled as recommended in the **Proofrolling** section below. Unstable or yielding subgrade materials should be additionally removed and replaced. This alternative carries a low to moderate risk for the proposed floor slab and pavement performance but expected to have moderate construction costs of the alternatives presented.
- **Alternative 2 (Proofroll and Replace as Needed):** After the site has been stripped and the subgrade has been exposed, the subgrade should be proofrolled as recommended in the **Proofrolling** section below. This alternative will only identify near surface soils that are unsuitable for slab support, and unidentified deeper pockets of unsuitable fill could lead to poor performance of the slab. This alternative is expected to have the lowest construction costs of the alternatives presented, but also has a moderate risk of poor slab performance.

5.1.3 Highly Plastic Soils

Based on the visual classification and limited laboratory testing of the retrieved soil samples from the test borings and local knowledge of the area, ECS anticipates the soils at the foundation/slab/pavement subgrade elevation will consist of highly plastic fat clays (CH). Due to the potential for expansive soils in the project site, ECS recommends removing 24 inches of existing 'fat clays' soils below the proposed lightly loaded foundations and floor slab subgrade elevation and 18 inches below the pavement subgrade elevations and replacing it with low volume change material/low-plastic engineered fill (LVM) to reduce the risk for movement due to subgrade soil shrink-swell behavior. If this option is deemed not feasible

from a cost perspective, the project team may choose to leave the existing highly plastic 'fat clay' soils in place, provided they proofroll satisfactorily. However, for this option, an increased risk of pavement/foundation distress and increased maintenance costs should be assumed. Based on FHWA Figure 5-34 (Geotechnical Aspects of Pavements Reference Manual Chapter 5.0), ECS estimated a potential vertical rise (PVR) in the range of 1 to 3 inches.

Alternatively, the existing highly plastic fat clays could be moisture conditioned at and above the optimum moisture content or lime stabilized to lessen the shrink-swell potential.

5.1.4 Proofrolling

After removing all unsuitable surface materials, cutting to the proposed grade, and prior to the placement of any engineered fill or other construction materials, the exposed subgrade should be observed by a third-party testing firm. The exposed subgrade should be thoroughly proofrolled with previously approved construction equipment having a minimum axle load of 10 tons (e.g., fully loaded tandem-axle dump truck). The areas subject to proofrolling should be traversed by the equipment in two perpendicular (orthogonal) directions with overlapping passes of the vehicle under the observation of a third-party testing firm. This procedure is intended to assist in the identification of yielding materials. In the event that unstable or "pumping" subgrade is identified during the proofroll, those areas should be marked for repair prior to the placement of any subsequent engineered fill or other construction materials. Test pits may be excavated to explore the shallow subsurface materials in the area of instability to help determine the appropriate remedial action to stabilize the subgrade.

If construction occurs during wet times of the year (such as during the spring or fall months) or immediately following extended periods of rain, then seasonal reduction of the near surface soil strength will occur. This may cause additional unstable or pumping subgrade areas for constructability concerns. The high moisture content clayey and silty materials, present near surface at several of the boring locations, may not pass a proofroll, and may need to be undercut or repaired. Some undercutting or repair of unstable subgrade soils should be anticipated during slab and pavement subgrade preparation. The actual quantity of the subgrade undercut, or stabilization should be determined at the time of construction.

Undercut or repair of unstable subgrades to establish a suitable support condition may be needed. The improvement method chosen may be influenced by several factors such as weather and schedule, as well as the area, depth and nature of the unstable subgrade soils. Depending on the aforementioned and other factors, subgrade repair methods may include:

Scarification and Compaction: Soils can be scarified, moisture conditioned (i.e., dried or wetted) to within a narrow range of the material's optimum moisture content and compacted. Scarification and compaction are generally most applicable where very shallow unstable conditions are encountered and at times when the soil can be properly dried or wetted to within a narrow range of the material's optimum moisture content.

Undercut and Replacement: ECS recommends soft or yielding soils be evaluated in approximately 6 to 12-inch intervals to help limit the volume of undercuts. If soft or yielding soils are identified, the contractor should remove only 6 to 12 inches of material at a time in the subject area and then proofroll/evaluate the undercut subgrade to determine if additional undercut is needed. This may take more time but could potentially reduce the removal of more soil than necessary.

Chemical Modification: Alternatively, if these soils cannot be stabilized by conventional methods, chemical modification of the subgrade soils, such as with lime, lime kiln dust, cement, cement kiln dust, or other materials, may be utilized to reduce the moisture content and/or provide additional stabilization. An experienced pre-qualified contractor that has successfully chemically modified similar-sized projects with similar soil conditions is recommended to be used. The soil modification procedure, such as determination of the type and quantity of additive, and mixing and curing procedures, should be evaluated before implementation. This evaluation may include testing the soil for pH, resistivity, sulfates, and chloride to check if an adverse chemical reaction could occur. The contractor should be required to minimize dusting or implement dust control measures. For preliminary estimating purposes, the approximate incorporation rate (based on dry weight of soil) is typically in the range of 6 to 7 percent for hydrated lime or lime by-products, and 5 to 7 percent for Portland cement. Typically, the percentage needed is less for hydrated lime than other lime byproducts because the available calcium oxide content of lime byproducts tends to be lower. Alteration of the pavement section to include additional drainage may be needed if a chemically stabilized subgrade is used.

5.1.5 Site Temporary Dewatering

Excavation Dewatering: The excavation/foundation contractor should be prepared to dewater from rainfall and surface runoff during construction. ECS anticipates the removal of accumulated water can be achieved utilizing drainage trenches and a sump and pump system.

The contractor shall make their own assessment of temporary dewatering needs based upon the limited subsurface groundwater information presented in this report. Soil sampling is not continuous, and thus soil and groundwater conditions may vary between sampling intervals (typically 5 feet). If the contractor believes additional subsurface information is needed to assess dewatering needs, they should obtain such information at their own expense. ECS makes no warranties or guarantees regarding the adequacy of the provided information to determine dewatering requirements; such recommendations are beyond our scope of services.

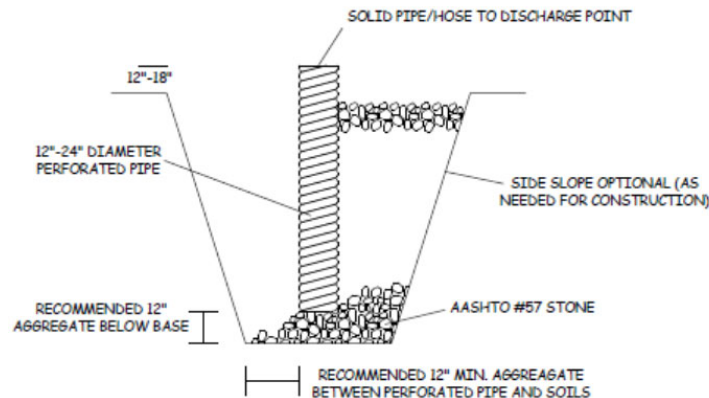
Dewatering systems are a critical component of many construction projects. Dewatering systems must be selected, designed, and maintained by a qualified and experienced (specialty or other) contractor familiar with the geotechnical and other aspects of the project. The failure to properly design and maintain a dewatering system for a given project can result in delayed construction, unnecessary undercuts, detrimental phenomena such as 'running sand' conditions, heaved subgrades, internal erosion (i.e., 'piping'), the migration of 'fines' down-gradient towards the dewatering system, localized settlement of nearby infrastructure, foundations, slabs-on-grade, and pavements, etc. Water discharged from site dewatering systems is recommended to be discharged in accordance with all local, state, and federal requirements.

Surface Water: The surface of the site should be kept properly graded to enhance drainage of the surface water to appropriate discharge or storage areas during construction. We recommend that an attempt be made to enhance the natural drainage without interrupting its pattern.

Subsurface Water: Groundwater observations are described in the **Groundwater Observations** section of this report. Groundwater was observed at depths of about 3 to 11 feet below the existing grades at the time of drilling operations. Excavations for new conventional shallow foundations are not expected to extend below the groundwater level encountered at the boring locations. Based upon the results of the

subsurface exploration and proposed construction, we believe construction dewatering at this site will be mainly to remove accumulated runoff water and perched water.

Strategies for Addressing Perched Groundwater: The typical strategy for addressing perched groundwater seepage into excavations is pumping from trench (or French) drains and sump pits with sump pumps. A typical sump pump drain (found in a sump pit or along a French drain) is depicted below. The inlet of the sump pump is placed at the bottom of the corrugated pipe and the discharge end of the sump pipe is directed to an appropriate stormwater drain.



Sump Pit/Pump Diagram

A typical French drain consists of an 18 to 24-inch wide by 18- to 24-inch-deep bed of AASHTO No. 57 aggregate (or similar open graded aggregate) wrapped in a medium duty, non-woven geotextile and (sometimes) containing a 6-inch diameter, Schedule 40 PVC perforated or slotted pipe. Actual dimensions should be determined during construction. After installation, the geotextile should be wrapped over the top of the aggregate and pipe followed by placement of backfill. The top of the drain should be positioned at least 3½ feet below the design subgrade elevations. Drains should not be routed within the expanded building limits.

Pumping wells or a vacuum system could also be used to address perched groundwater, if encountered. These techniques often are only effective during the initial depletion of the perched water quantity and may quickly be ineffective at addressing accumulation of water from rain, snow, etc.

5.2 EARTHWORK OPERATIONS

5.2.1 Engineered Fill

Product Submittals: Prior to placement of engineered fill, representative bulk samples (typically at least 50 to 100 pounds) of on-site and off-site borrow should be submitted to a third-party testing firm for laboratory testing, which may include natural moisture content, organic content, grain-size distribution, Atterberg limits, and moisture-density relationships for compaction. Imported material should be tested prior to being hauled to the site to determine if it complies with project specifications. Alternatively, Proctor data from other accredited laboratories can be submitted if the test results are within the last 90 days.

Satisfactory Engineered Fill Materials: Engineered fills should consist of materials free of debris with the following engineering properties.

ENGINEERED FILL INDEX PROPERTIES		
Subject		Property
Plasticity	Upper 2 feet in foundation and pavement Areas	LL ≤ 40, PI ≤ 15
	Below 2 feet in foundation and pavement Areas	LL ≤ 45, PI ≤ 20
Max. Particle Size		3 inches
Max. Organic Content		5 percent

Open-graded materials, such as coarser sands, and gravels (SP and GP), which contain increased void space in their mass may need to be encapsulated within a filter geotextile. If the fill is to provide low-frost susceptible characteristics, it must be classified as a clean GW and GP, or coarser SW or SP per Unified Soil Classification System (ASTM D-2487) and must be properly drained.

Unsatisfactory Materials: Unsatisfactory fill materials, which do not satisfy the requirements for suitable materials, include topsoil and organic materials (PT, OH, and OL), frost susceptible silt (ML), and high plasticity soils elastic silt (MH) and fat clay (CH).

Pea gravel is not recommended to be used as engineered fill. Pea gravel has round/smooth characteristics, no fines and does not interlock when compacted, which makes it more susceptible to future movement and instability resulting in excessive and variable settlement.

On-Site Borrow Suitability: On-site soils consisting of fat, highly plastic soils are not recommended to be reused as an engineered fill due to high shrink-swell potential. It may be feasible to reuse the existing base course material as base course or subbase for the new pavement but should be evaluated by a third-party testing firm after the material is exposed and prior to its use. The existing granular base material that is planned to be reused as fill should be stripped clean (e.g., not mixed with bituminous material, subgrade soils and other foreign materials) and stockpiled separately. Prior to its reuse, the material is recommended to be tested, such as with grain-size distribution tests, to further evaluate its suitability. Depending on the base course properties a reduced structural coefficient may be needed for design, which would require additional base course or a thicker hot mix asphalt section.

5.2.2 Compaction

Subgrade Benching: Place fill material in horizontal lifts. Where fill materials will be placed to widen existing embankment fills, or placed up against sloping ground, the soil subgrade should be scarified, and the new fill benched and keyed into the existing material. Place and compact fill on a 3 (H):1 (V) or flatter slope, or step or bench as required to flatten.

Engineered Fill Compaction: Place and compact engineered fill in appropriate thickness loose lifts as recommended below. Beyond these areas, achieve compaction of at least 90 percent. Give as much importance to the moisture content requirements of the material as the density requirements during placement and compaction considering the moisture sensitivity of the soil.

ENGINEERED FILL COMPACTION RECOMMENDATIONS		
Subject		Recommendation
Compaction Standard		Modified Proctor, ASTM D1557
Recommended Compaction		≥ 95 percent of Max. Dry Density
Moisture Content	Fine-grained	-1 to +3 % points of the material's optimum value
	Coarse-grained	-3 to +3 % points of the material's optimum value

Compaction equipment suitable to the material type being compacted should be used. Sheepsfoot compaction equipment is typically suitable for fine-grained soils (clays). A vibratory steel drum roller is typically used for compaction of coarse-grained soils (sands and gravels) as well as to help seal compacted surfaces.

The maximum loose lift thickness depends upon the type of compaction equipment used. For isolated excavations around footing locations or within utility excavations, a hand tamper will likely be required. Listed below are generally recommended maximum loose lift thicknesses for compaction based on the utilized compaction equipment.

RECOMMENDED PRELIMINARY LOOSE LIFT THICKNESSES	
Equipment	Maximum Loose Lift Thickness (inches)
Large/Heavy, Self-Propelled Equipment	8
Small, Self-Propelled, or Remote Controlled (Rammax, etc.)	6 to 8
Hand Operated (Plate Tamps, Jumping Jacks, Wacker-Packers)	4 to 6

- Density testing during fill placement is important to check and document that the specified compaction is being achieved. Thinner lifts and/or more compactive energy may be needed to achieve the required degree of compaction.

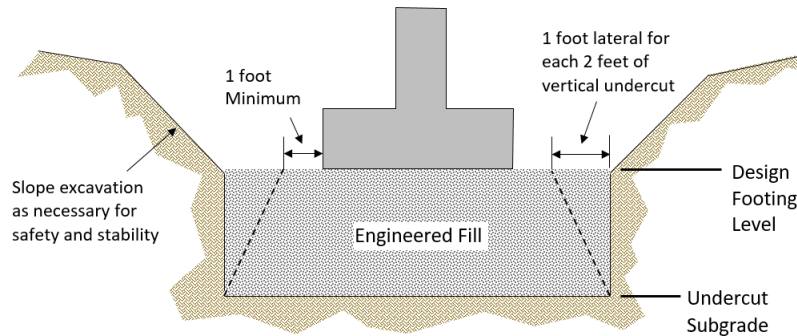
In confined areas such as utility trenches, portable compaction equipment and thin lifts of 4 inches or less may be required to achieve specified degrees of compaction.

Fill Compaction Control: The expanded limits of the proposed construction areas should be well defined, including the limits of the fill zones for pavements, etc., at the time of fill placement. Maintain grade control throughout the filling operations. Filling operations are recommended to be observed on a full-time basis by a third-party testing firm to check and document that the minimum compaction requirements are being achieved. The recommended minimum frequency for field density testing of fills is listed in the Table below but should not be less than three tests per lift.

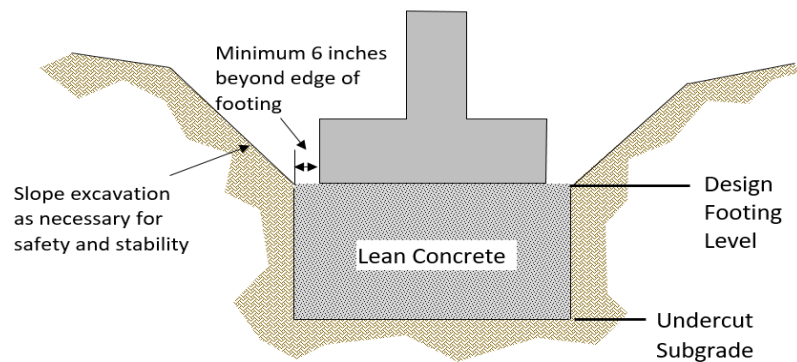
Location	Frequency of Tests
Expanded Building Limits	1 test per 2,500 sq. ft. per lift
Pavement Areas	1 test per 10,000 sq. ft. per lift
Utility Trenches	1 test per 200 linear ft. per lift
Other Non-Critical Areas	1 test per 10,000 sq. ft. per lift

Engineered Fill Below Foundations: Unsuitable bearing soils encountered at the proposed foundation bearing grade or within the foundation influence zone are recommended to be removed to a suitable bearing subgrade and to a lateral extent, as conceptually shown below. The zone of the engineered fill

placed below the foundations is recommended to extend 1 foot beyond the outside edges of the footings and from that point, outward laterally 1 foot for every 2 feet of fill thickness below the footing.



Alternatively, backfill undercuts with lean concrete ($f'_c \geq 1,000$ psi at 28 days) up to the original design bottom of footing elevation. The original footing is recommended to be constructed on top of the hardened lean concrete. If lean concrete is utilized the excavation is recommended to be 1 foot wider than the footing (6 inches on each side), as conceptually shown below, and the lean concrete should be allowed to sufficiently harden prior to placement of the foundation concrete.



Fill Placement Considerations: Do not place fill materials on frozen soils, on frost-heaved soils, on excessively wet soils, or soils that are otherwise unstable. Borrow fill materials should not contain frozen materials at the time of placement, and all frozen or frost-heaved soils should be removed prior to placement of engineered fill or other fill soils and aggregates. Excessively wet soils or aggregates should be scarified, aerated, and moisture conditioned.

5.3 FOUNDATION OBSERVATIONS

Protection of Foundation Excavations: Exposure to the environment may weaken the soils at the footing bearing level if the foundation excavations remain open for too long a time. Therefore, foundation concrete should be placed the same day that excavations are made. If the bearing soils are softened by surface water intrusion or exposure, the softened soils must be removed from the foundation excavation bottom immediately prior to placement of concrete. If the excavation must remain open overnight, or if rainfall becomes imminent while the bearing soils are exposed, a 1 to 3-inch thick "mud mat" of "lean" concrete should be placed on the bearing soils before the placement of reinforcing steel.

Footing Subgrade Observations: It is important to have a third-party testing firm observe the foundation subgrade prior to placing foundation concrete, to confirm the bearing soils are what was anticipated.

5.4 UTILITY INSTALLATIONS

Utility Subgrades: The soil encountered in our exploration are expected to be generally suitable for support of utility pipes. The pipe subgrades should be observed and probed for stability by a third-party testing firm. Any loose or unsuitable materials encountered should be removed and replaced with suitable compacted engineered fill, or pipe stone bedding material.

Utility Backfilling: The granular bedding material (AASHTO No. 57 stone) should be at least 4 inches thick, but not less than that specified by the civil engineer's project drawings and specifications. We recommend that the bedding materials be placed up to the spring line of the pipe. The fill placed for support of the utilities, as well as backfill over the utilities, should satisfy the requirements for engineered fill and Fill Placement.

Excavation Safety: All excavations and slopes should be constructed and maintained in accordance with OSHA excavation safety standards. The contractor is solely responsible for designing, constructing, and maintaining stable temporary excavations and slopes. The contractor's responsible person, as defined in 29 CFR Part 1926, should evaluate the soil exposed in the excavations as part of the contractor's safety procedures. In no case should slope height, slope inclination, or excavation depth, including utility trench excavation depth, exceed those specified in local, state, and federal safety regulations. ECS is providing this information solely as a service to our client. ECS is not assuming responsibility for construction site safety or the contractor's activities; such responsibility is not being implied and should not be inferred.

5.5 GENERAL CONSTRUCTION CONSIDERATIONS

Existing Utilities: Prior to construction, ECS recommends all utilities in the proposed construction areas be positively identified and marked. Active utilities to remain in the construction areas should be exposed and protected during construction to reduce the potential for damage or interruption of service. Abandoned utilities should be removed and backfilled with compacted engineered fill or grouted full of lean concrete if left in-place.

Subgrade Protection: Measures should also be taken to limit site disturbance, especially from rubber-tired heavy construction equipment, and to control and remove surface water from development areas, including structural and pavement areas. It would be advisable to designate a haul road and construction staging area to limit the areas of disturbance and to prevent construction traffic from excessively degrading sensitive subgrade soils and existing pavement areas. Haul roads and construction staging areas could be covered with excess depths of aggregate to protect those subgrades. The aggregate can later be removed and used in pavement areas.

Surface Drainage: Surface drainage conditions should be properly maintained. Surface water should be directed away from the construction area, and the work area should be sloped away from the construction area at a gradient of 1 percent or greater to reduce the potential of ponding water and the subsequent saturation of the surface soils. At the end of each workday, the subgrade soils should be sealed by rolling the surface with a smooth drum roller to minimize infiltration of surface water.

Excavation Safety: All excavations and slopes should be constructed and maintained in accordance with OSHA excavation safety standards. The contractor is solely responsible for designing, constructing, and maintaining stable temporary excavations and slopes. The contractor's responsible person, as defined in 29 CFR Part 1926, should evaluate the soil exposed in the excavations as part of the contractor's safety

procedures. In no case should slope height, slope inclination, or excavation depth, including utility trench excavation depth, exceed those specified in local, state, and federal safety regulations. ECS is providing this information solely as a service to our client. ECS is not assuming responsibility for construction site safety or the contractor's activities; such responsibility is not being implied and should not be inferred.

Bidding/Estimating Considerations: Contractors bidding or undertaking any work at the site should examine the results of the subsurface exploration, satisfy themselves as to the adequacy of the information for bidding and construction, make their own interpretation of the data, and consider the effect it may have on their cost proposal, construction techniques, schedule, and equipment capabilities. Furthermore, contractors should complete any additional fieldwork and investigation they deem necessary to properly prepare a cost proposal for the site work. Soil borings do not provide the same wide-scale view of the subsurface conditions that is obtained during site grading, excavation, or other aspects of earthwork construction. Additional scope may be required to obtain more detailed subsurface information needed for earthwork bid preparation, which could include test pits to better understand the lateral and vertical extents of the subsurface materials of concern such as existing undocumented fill. Even with this additional information, budget contingencies should be carried in construction to help cover potential variations in subsurface conditions.

6.0 CLOSING

ECS has prepared this report to guide the geotechnical-related design and construction aspects of the project. We performed these services in accordance with the standard of care expected of professionals in the industry performing similar services on projects of like size and complexity at this time in the region. No other representation expressed or implied, and no warranty or guarantee is included or intended in this report.

The description of the proposed project is based on information provided to ECS by the Client. If any of this information is inaccurate or changes, either because of our interpretation of the documents provided or site or design changes that may occur later, ECS should be contacted so we can review our recommendations and provide additional or alternate recommendations that reflect the proposed construction.

We recommend that ECS review the project plans and specifications so we can confirm that those plans/specifications are in accordance with the recommendations of this geotechnical report.

Field observations, and quality assurance testing during earthwork and foundation installation are an extension of, and integral to, the geotechnical design. We understand a third-party testing firm will be retained to apply our expertise throughout the geotechnical phases of construction, and to provide consultation and recommendation should issues arise.

ECS is not responsible for the conclusions, opinions, or recommendations of others based on the data in this report.

Appendix A - Drawings and Reports

Site Location Diagram

Boring Location Diagram(s)

Subsurface Cross-Section(s)



SITE LOCATION DIAGRAM

McDonald's 24-1307 - Stockton, MO

West Smith Drive and South Street, Stockton, MO
McDonald's USA, LLC

ENGINEER
JG

SCALE
1" = 200'

PROJECT NO.
16:15433

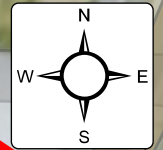
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DATE
8/6/2024

h Dr

W Smith Dr

Smith Dr



Legend



Approximate Building Boring Locations



Approximate Pavement Boring Locations



Approximate Sign Boring Location



BORING LOCATION DIAGRAM

McDonald's 24-1307 - Stockton, MO

West Smith Drive and South Street, Stockton, MO
McDonald's USA, LLC

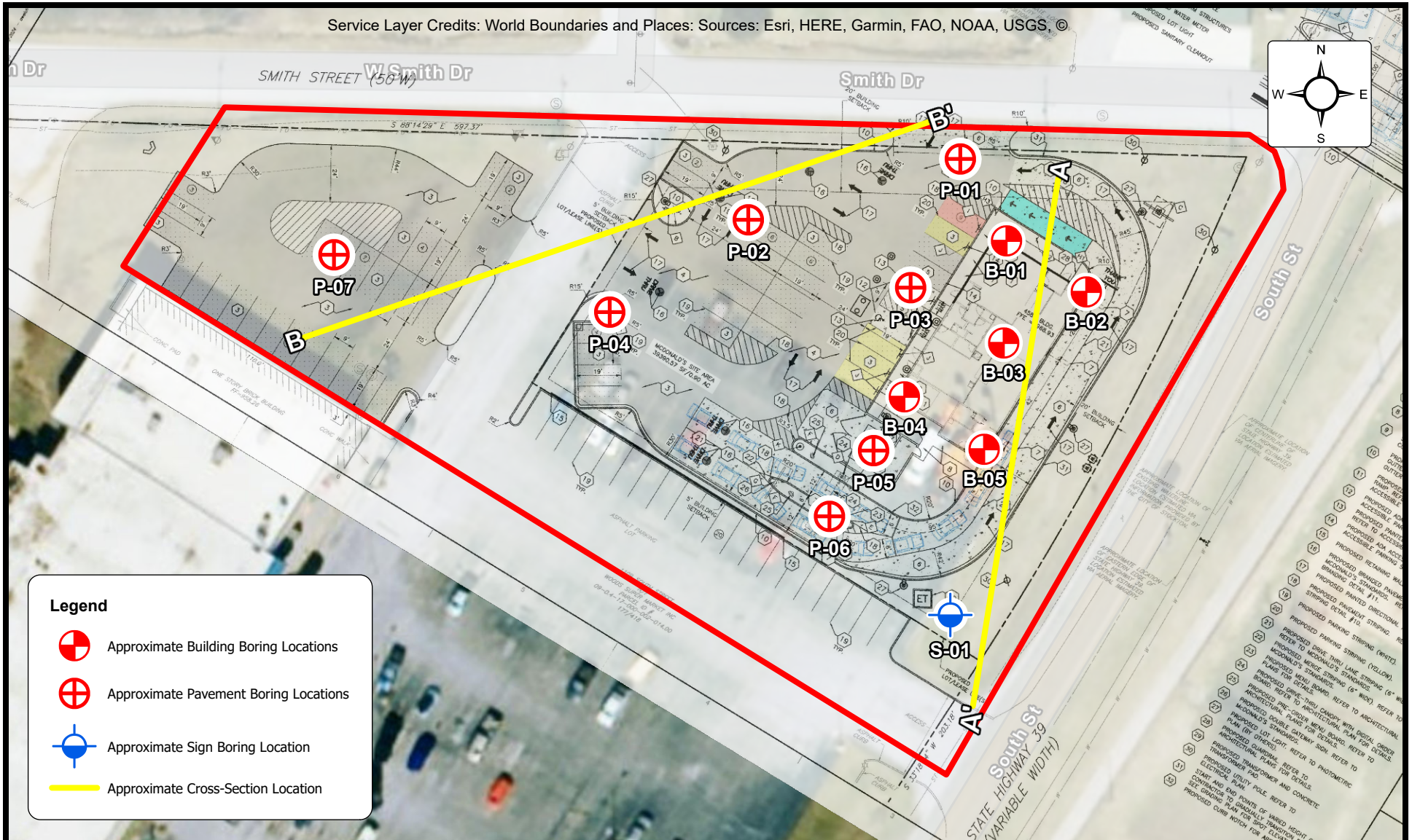
ENGINEER
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SCALE
1" = 60'

PROJECT NO.
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BORING LOCATION DIAGRAM - Overlay

McDonald's 24-1307 - Stockton, MO

West Smith Drive and South Street, Stockton, MO
McDonald's USA, LLC

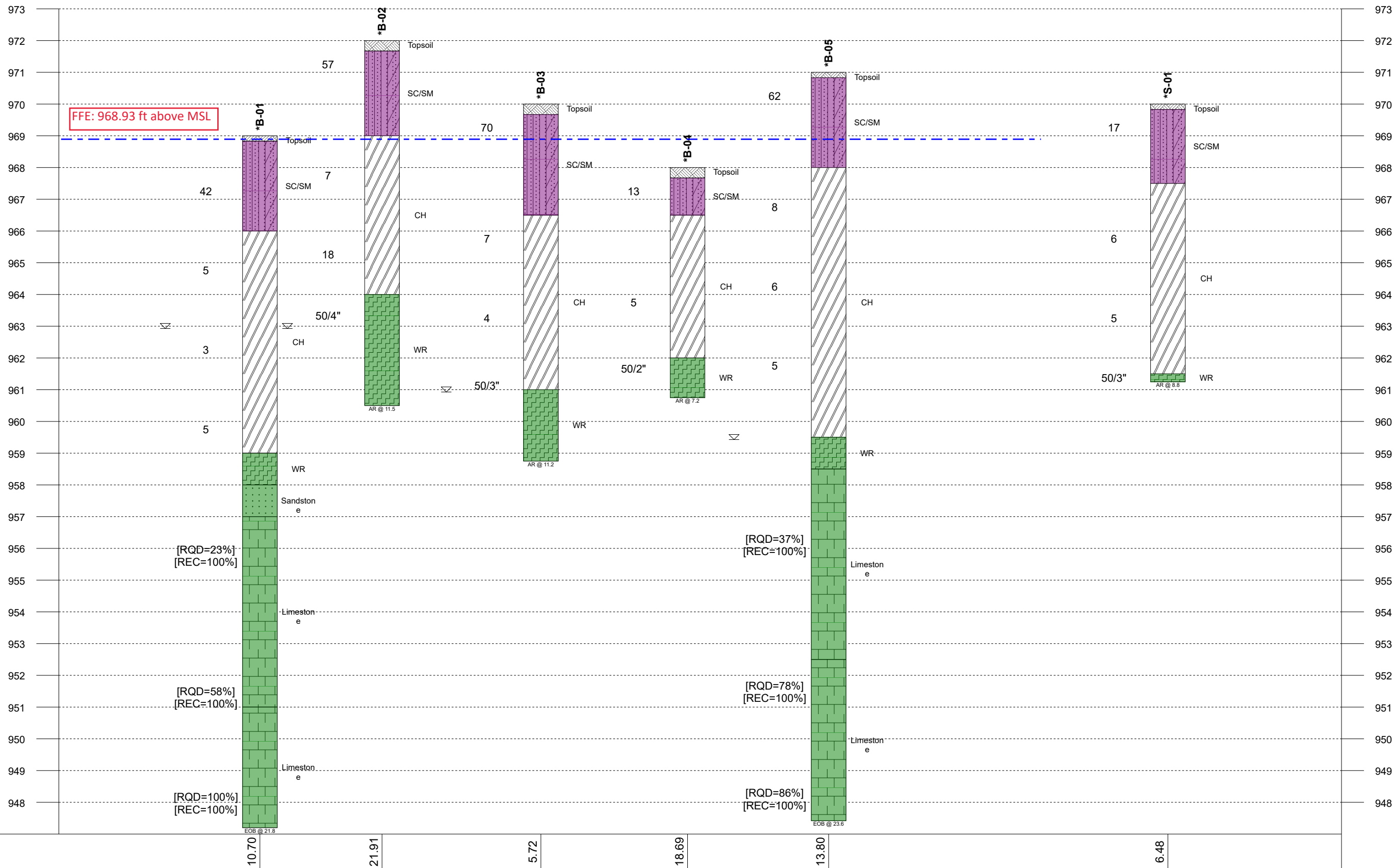
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Legend Key

- Topsoil
- SILT, CLAYEY SAND Fat CLAY
- Weathered Rock
- Limestone
- Sandstone

Notes:

1- EOB: END OF BORING AR: AUGER REFUSAL SR: SAMPLER REFUSAL.
2- THE NUMBER BELOW THE STRIPS IS THE DISTANCE ALONG THE BASELINE.
3- SEE INDIVIDUAL BORING LOG AND GEOTECHNICAL INFORMATION.
4- STANDARD PENETRATION TEST RESISTANCE (LEFT OF BORING) IN BLOWS PER FOOT (ASTM D1586).

Plastic Limit	Water Content	Liquid Limit	WL (First Encountered)	Fill
X	●	△	WL (Completion)	Possible Fill
[FINES CONTENT %]			WL (Seasonal High Water)	Probable Fill
BOTTOM OF CASING			WL (Stabilized)	Rock
LOSS OF CIRCULATION				

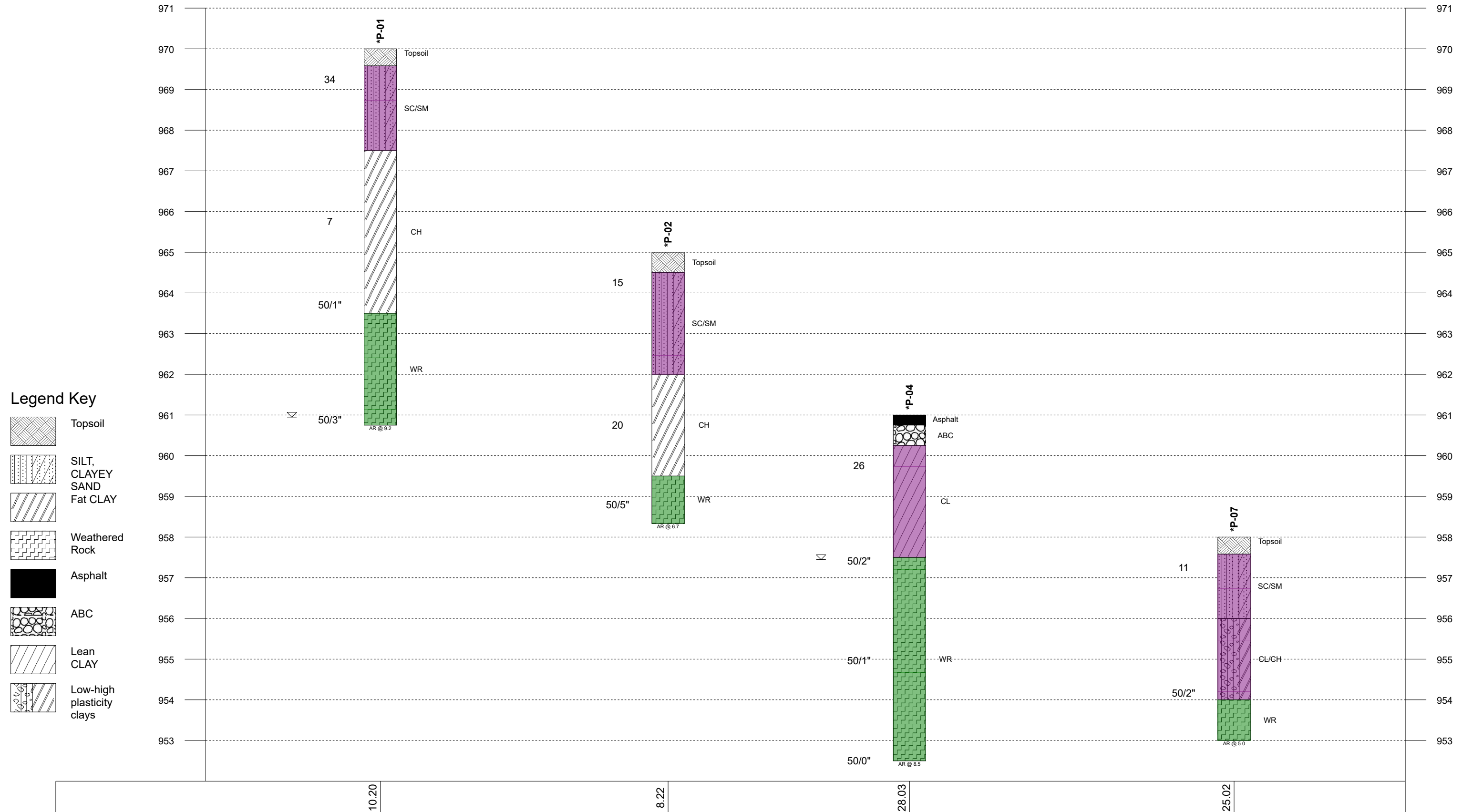
GENERALIZED SUBSURFACE SOIL PROFILE Section line A-A'

McDonald's 24-1307 - Stockton, MO

McDonald's USA, LLC

West Smith Drive and South Street, Stockton, Missouri, 65785

Project No: 16:15433



Notes:

		WL (First Encountered)		Fill
[FINES CONTENT %]		WL (Completion)		Possible Fill
		WL (Seasonal High Water)		Probable Fill
		WL (Stabilized)		Rock



GENERALIZED SUBSURFACE SOIL PROFILE Section line B-B'

Appendix B – Field Operations

Reference Notes

Exploration Procedures

Boring Logs

Rock Cores Photographs



REFERENCE NOTES FOR BORING LOGS

MATERIAL^{1,2}

	ASPHALT
	CONCRETE
	GRAVEL
	TOPSOIL
	VOID
	BRICK
	AGGREGATE BASE COURSE
	GW WELL-GRADED GRAVEL gravel-sand mixtures, little or no fines
	GP POORLY-GRADED GRAVEL gravel-sand mixtures, little or no fines
	GM SILTY GRAVEL gravel-sand-silt mixtures
	GC CLAYEY GRAVEL gravel-sand-clay mixtures
	SW WELL-GRADED SAND gravelly sand, little or no fines
	SP POORLY-GRADED SAND gravelly sand, little or no fines
	SM SILTY SAND sand-silt mixtures
	SC CLAYEY SAND sand-clay mixtures
	ML SILT non-plastic to medium plasticity
	MH ELASTIC SILT high plasticity
	CL LEAN CLAY low to medium plasticity
	CH FAT CLAY high plasticity
	OL ORGANIC SILT or CLAY non-plastic to low plasticity
	OH ORGANIC SILT or CLAY high plasticity
	PT PEAT highly organic soils

DRILLING SAMPLING SYMBOLS & ABBREVIATIONS

SS	Split Spoon Sampler	PM	Pressuremeter Test
ST	Shelby Tube Sampler	RD	Rock Bit Drilling
WS	Wash Sample	RC	Rock Core, NX, BX, AX
BS	Bulk Sample of Cuttings	REC	Rock Sample Recovery %
PA	Power Auger (no sample)	RQD	Rock Quality Designation %
HSA	Hollow Stem Auger		

PARTICLE SIZE IDENTIFICATION

DESIGNATION	PARTICLE SIZES
Boulders	12 inches (300 mm) or larger
Cobbles	3 inches to 12 inches (75 mm to 300 mm)
Gravel: Coarse	¾ inch to 3 inches (19 mm to 75 mm)
Fine	4.75 mm to 19 mm (No. 4 sieve to ¾ inch)
Sand: Coarse	2.00 mm to 4.75 mm (No. 10 to No. 4 sieve)
Medium	0.425 mm to 2.00 mm (No. 40 to No. 10 sieve)
Fine	0.074 mm to 0.425 mm (No. 200 to No. 40 sieve)
Silt & Clay ("Fines")	<0.074 mm (smaller than a No. 200 sieve)

COHESIVE SILTS & CLAYS

UNCONFINED COMPRESSION STRENGTH, QP ⁴	SPT ⁵ (BPF)	CONSISTENCY ⁷ (COHESIVE)
<0.25	<2	Very Soft
0.25 - <0.50	2 - 4	Soft
0.50 - <1.00	5 - 8	Firm
1.00 - <2.00	9 - 15	Stiff
2.00 - <4.00	16 - 30	Very Stiff
4.00 - 8.00	31 - 50	Hard
>8.00	>50	Very Hard

RELATIVE AMOUNT ⁷	COARSE GRAINED (%) ⁸	FINE GRAINED (%) ⁸
Trace	≤5	≤5
With	10 - 20	10 - 25
Adjective (ex: "Silty")	25 - 45	30 - 45

GRAVELS, SANDS & NON-COHESIVE SILTS

SPT ⁵	DENSITY
<5	Very Loose
5 - 10	Loose
11 - 30	Medium Dense
31 - 50	Dense
>50	Very Dense

WATER LEVELS⁶

	WL (First Encountered)
	WL (Completion)
	WL (Seasonal High Water)
	WL (Stabilized)

FILL AND ROCK

FILL	POSSIBLE FILL	PROBABLE FILL	ROCK

¹Classifications and symbols per ASTM D 2488-17 (Visual-Manual Procedure) unless noted otherwise.

²To be consistent with general practice, "POORLY GRADED" has been removed from GP, GP-GM, GP-GC, SP, SP-SM, SP-SC soil types on the boring logs.

³Non-ASTM designations are included in soil descriptions and symbols along with ASTM symbol [Ex: (SM-FILL)].

⁴Typically estimated via pocket penetrometer or Torvane shear test and expressed in tons per square foot (tsf).

⁵Standard Penetration Test (SPT) refers to the number of hammer blows (blow count) of a 140 lb. hammer falling 30 inches on a 2 inch OD split spoon sampler required to drive the sampler 12 inches (ASTM D 1586). "N-value" is another term for "blow count" and is expressed in blows per foot (bpf). SPT correlations per 7.4.2 Method B and need to be corrected if using an auto hammer.

⁶The water levels are those levels actually measured in the borehole at the times indicated by the symbol. The measurements are relatively reliable when augering, without adding fluids, in granular soils. In clay and cohesive silts, the determination of water levels may require several days for the water level to stabilize. In such cases, additional methods of measurement are generally employed.

⁷Minor deviation from ASTM D 2488-17 Note 14.

⁸Percentages are estimated to the nearest 5% per ASTM D 2488-17.



REFERENCE NOTES FOR ROCK CORES

ROCK CLASSIFICATION TYPES		
Igneous	Sedimentary	Metamorphic
Coarse Grained DIABASE DIORITE GABBRO GRANITE PEGMATITE PERIDOTITE SYENITE	Clastic (sediment) SHALE SILTSTONE SANDSTONE CONGLOMERATE LIMESTONE, OOLITIC	Foliated GNEISS PHYLLITE SCHIST SLATE
Fine Grained ANDESITE BASALT RHYOLITE TRACHYTE	Chemically Formed DOLOSTONE GYPSUM HALITE LIMESTONE	Non-Foliated AMPHIBOLITE HORNFELS MARBLE QUARTZITE
Pyroclastic OBSIDIAN PUMICE TUFF	Organic Remains CHALK COAL COQUINA	

HARDNESS	
Very Soft	Deformed by hand
Soft	Scratched with a fingernail
Moderately Hard	Scratched easily with a knife
Hard	Scratched with difficulty with a knife
Very Hard	Cannot be scratched with a knife

JOINT/FRACTURE SPACING	
Fractured/Jointed	Spacing
Very Widely	> 10 feet
Slightly	3 - 10 feet
Moderately	1 - 3 feet
Highly	2 inches - 1 foot
Intensely	< 2 inches

BEDDING	
Thinly	≤ 0.3 ft.
Medium	>0.3 ft. ≤ 1 ft.
Thickly	>1 ft. ≤ 3 ft.
Massive	>3 ft.

JOINT OR FRACTURE CONTINUITY
It shall be noted whether the joints or fractures are continuous or discontinuous. If continuity of joints is not discernable at the scale of the rock core, continuous joints or fractures shall be assumed.

JOINT/FRACTURE ORIENTATION	
The range or average orientation of each joint set or fracture trend shall be measured in degrees from a horizontal plane where possible. If no measurement is possible, the qualitative terms High, Moderate or Low-angle shall be used. Record whether the joints are present in Conjugate sets (i.e. having an opposite sense of dip)	
High	61-90 degree
Moderate	31-60 degree
Low-angle	0-30 degree
Dip-angle	(1-90) _____ degrees (if measured)

Description Sequence	Example Rock Classification Description
ROCK TYPE, [REC=_% ,RQD=_%], Weathering, Hardness, Bedding, Joint/Fracture Spacing, Joint/Fracture Surface Condition, Wall Rock Condition, Joint or Fracture Continuity, Joint/Fracture Orientation, Color, Additional Features	LIMESTONE, [REC=95%,RQD=60%], Highly Weathered, Hard, Thinly Bedded, Slightly Fractured/Jointed, Slightly Rough, Hard Wall Rock, Continuous, Moderate-angle Dip, Gray White

Recovery (REC(%))
$\frac{\text{Total rock recovered from run}}{\text{Total Run Length}}$

Rock Quality Designation (RQD(%))*	
$\frac{\text{Sum of core pieces } \geq 4 \text{ inches long}}{\text{Total Run Length}}$	
RQD%	Description of Rock Quality
0-25%	Very Poor
>25%-50%	Poor
>50%-75%	Fair
>75%-90%	Good
>90%	Excellent

WEATHERING	
Unweathered	No evidence of any chemical or mechanical alteration.
Slightly Weathered	Slight discoloration on surface, slight alteration along discontinuities, less than 10 percent of the rock volume altered.
Moderately Weathered	Discoloring evident, surface pitted and altered with alteration penetrating well below rock surfaces, weathering 'halos' evident. 10 to 50 percent of the rock altered.
Highly Weathered	Entire mass discolored, alteration pervading nearly all of the rock, with some pockets of slightly weathered rock noticeable, some minerals leached away.
Decomposed	Rock reduced to a soil with relict rock structure remaining (i.e. saprolite). Generally molded and crumbled by hand (friable).

JOINT/FRACTURE SURFACE CONDITION			
The following qualitative terms shall be used to describe surface condition of joints and fractures. Multiple terms can be used.			
Very rough	Slightly rough	Slickensided	Gouge

WALL ROCK CONDITION
The qualitative terms 'hard wall rock' or 'soft wall rock' shall be used to describe the condition of the parent rock on either side of the joint or fracture.

*ASTM D6032-17: RQD is performed on cores using BQ to PQ sized bits (1.433 to 3.345 inch diameter cores, respectively)



SUBSURFACE EXPLORATION PROCEDURE: STANDARD PENETRATION TESTING (SPT) ASTM D 1586 Split-Barrel Sampling

Standard Penetration Testing, or **SPT**, is the most frequently used subsurface exploration test performed worldwide. This test provides samples for identification purposes, as well as a measure of penetration resistance, or N-value. The N-Value, or blow counts, when corrected and correlated, can approximate engineering properties of soils used for geotechnical design and engineering purposes.

SPT Procedure:

- Involves driving a hollow tube (split-spoon) into the ground by dropping a 140-lb hammer a height of 30-inches at desired depth
- Recording the number of hammer blows required to drive split-spoon a distance of 18-24 inches (in 3 or 4 Increments of 6 inches each)
- Auger is advanced* and an additional SPT is performed
- One SPT typically performed for every two to five feet. An approximate 1.5 inch diameter soil sample is recovered.



**Drilling Methods May Vary—* The predominant drilling methods used for SPT are open hole fluid rotary drilling and hollow-stem auger drilling.

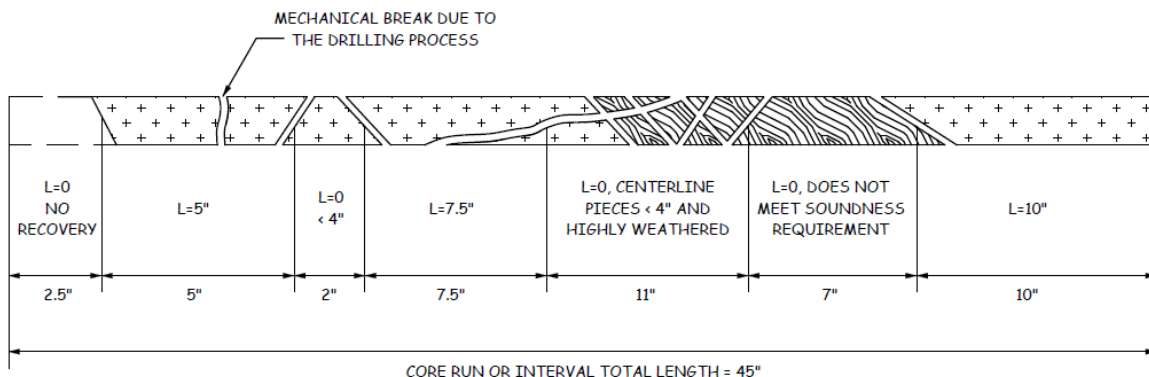


SUBSURFACE EXPLORATION PROCEDURE: ROCK CORE DRILLING AND SAMPLING ASTM D 2113

Rock core drilling is a method to obtain bedrock cores for geological data and to provide information about the engineering properties of rock formations at the drilled locations. Rock coring provides samples for characterization purposes, as well as a measure of the Recovery and Rock Quality Designation, or RQD, and various engineering laboratory tests. The geologic engineering properties determined from rock cores are advantageous in the design of geotechnical elements such as foundations.

Rock Core Procedure:

- Soil test borings are advanced through the soil medium to auger refusal, which is generally considered the top of rock.
- Rock recovery (REC) is the percentage of the total length of rock recovered divided by the length of the core run.
- Rock coring is accomplished with a diamond studded rock core barrel attached to a drill rig and utilized for sampling during the rotation and advancement of the hollow barrel.
- The Rock Quality Designation (RQD) is generally the percentage of the total length of the rock pieces 4-inches in length or greater divided by the length of the rock core run.



$$\begin{aligned} \text{REC}\% &= \frac{\text{TOTAL ROCK RECOVERED}}{\text{CORE RUN TOTAL LENGTH}} \times 100 \\ &= \frac{5" + 2" + 7.5" + 11" + 7" + 10"}{45"} \times 100 \\ &= \frac{42.5"}{45"} \times 100 = 94\% \end{aligned}$$

$$\begin{aligned} \text{RQD}\% &= \frac{\text{TOTAL SOUND CORE PIECES } \geq 4"}{\text{CORE RUN TOTAL LENGTH}} \\ &= \frac{5" + 7.5" + 10"}{45"} \\ &= \frac{22.5"}{45"} \times 100 = 50\% \end{aligned}$$

RQD (ROCK QUALITY DESIGNATION)

CLASSIFICATION OF ROCK QUALITY

0 - 25%	VERY POOR
>25 - 50%	POOR
>50 - 75%	FAIR
>75 - 90%	GOOD
>90 - 100%	EXCELLENT

LEGEND



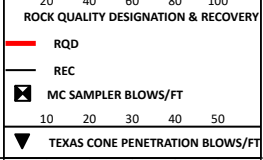
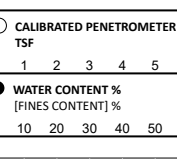
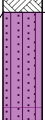
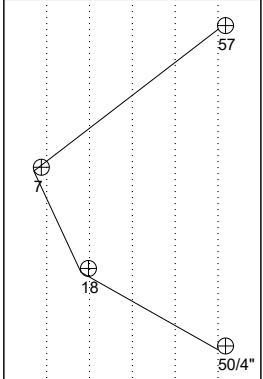
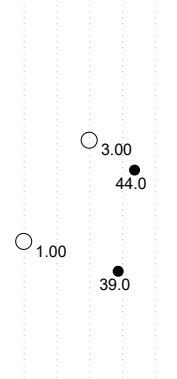
SOUND ROCK



UN SOUND ROCK

NOTE: DIAGRAM ADAPTED FROM ASTM D6032/6032M-17

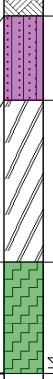
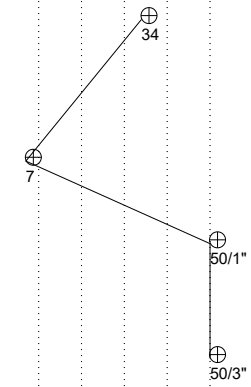
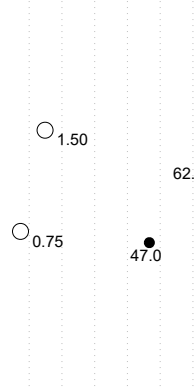
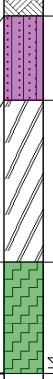
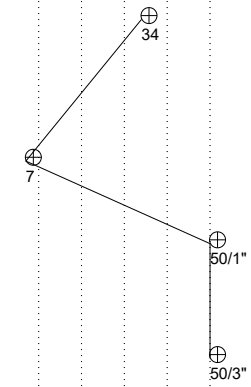
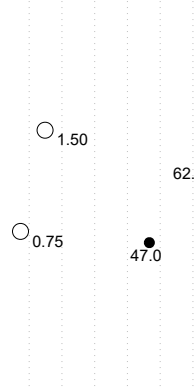
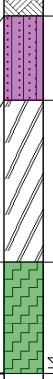
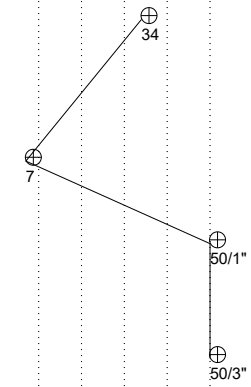
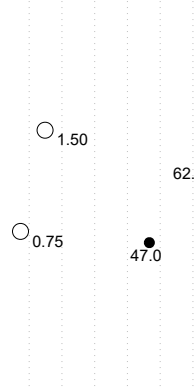
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 WL (First Encountered) 6.00				BORING STARTED: Aug 05 2024				CAVE IN DEPTH:																																																																																																																																																																																																																																																																						
 WL (Completion) Dry				BORING COMPLETED: Aug 05 2024				HAMMER TYPE: Auto																																																																																																																																																																																																																																																																						
 WL (Seasonal High Water)				EQUIPMENT: CME 75				LOGGED BY: JG8																																																																																																																																																																																																																																																																						
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CLIENT: McDonald's USA, LLC				PROJECT NO.: 16:15433		BORING NO.: B-02		SHEET: 1 of 1				
PROJECT NAME: McDonald's 24-1307 - Stockton, MO				DRILLER/CONTRACTOR: Palmerton And Parrish, Inc.								
SITE LOCATION: West Smith Drive and South Street, Stockton, Missouri, 65785								LOSS OF CIRCULATION 				
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DEPTH (FT)	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS	ELEVATION (FT)	BLOWS/6" (TCP/MC/SPT-N value)*	STANDARD PENETRATION BLOWS/FT		LIQUID LIMIT X PLASTIC LIMIT	
									ROCK QUALITY DESIGNATION & RECOVERY		CALIBRATED PENETROMETER TSF	
												
5	S-1	SS	18	18	Topsoil Thickness[4"] (SC/SM POSSIBLE FILL) POSSIBLE FILL, CLAYEY/SILTY SAND WITH GRAVEL, dark brown, moist, very dense			10-36-21 (57)				
					(CH) FAT CLAY, trace chert, reddish- brown, moist, stiff to very stiff		967	3-3-4 (7)				
	S-2	SS	18	18				2-3-15 (18)				
	S-3	SS	18	18				50/4" (50/4")				
10	S-4	SS	4	4	(WR) WEATHERED LIMESTONE SAMPLED AS Sand with Gravel [Weathered LIMESTONE]		962					
15	AUGER REFUSAL AT 11.5 FT											
							957					
							952					
							947					
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THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES. IN-SITU THE TRANSITION MAY BE GRADUAL												
WL (First Encountered)		9.00		BORING STARTED:		Aug 06 2024		CAVE IN DEPTH:				
WL (Completion)		Dry		BORING COMPLETED:		Aug 06 2024		HAMMER TYPE: Auto				
WL (Seasonal High Water)				EQUIPMENT:		CME 75		LOGGED BY:		JG8		
WL (Stabilized)								DRILLING METHOD:		Solid Stem Auger		
GEOTECHNICAL BOREHOLE LOG												

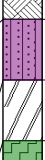
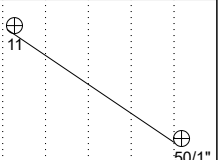
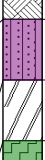
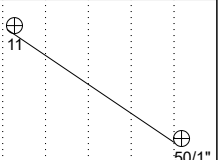
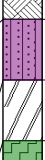
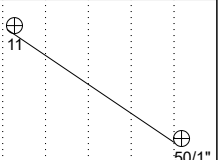
CLIENT: McDonald's USA, LLC				PROJECT NO.: 16:15433		BORING NO.: B-03		SHEET: 1 of 1							
PROJECT NAME: McDonald's 24-1307 - Stockton, MO				DRILLER/CONTRACTOR: Palmerton And Parrish, Inc.											
SITE LOCATION: West Smith Drive and South Street, Stockton, Missouri, 65785								LOSS OF CIRCULATION 							
LATITUDE: 37.689950		LONGITUDE: -93.797339		STATION:		SURFACE ELEVATION: 970.0		BOTTOM OF CASING 							
DEPTH (FT)	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS	ELEVATION (FT)	BLOWS/6" (TCP/MC/SPT-N value) *	STANDARD PENETRATION BLOWS/FT		ROCK QUALITY DESIGNATION & RECOVERY		LIQUID LIMIT X PLASTIC LIMIT		
									10 20 30 40 50		10 20 30 40 50		1 2 3 4 5		
								RQD		REC		MC SAMPLER BLOWS/FT		TEXAS CONE PENETRATION BLOWS/FT	
								10 20 30 40 50		10 20 30 40 50		1 2 3 4 5		WATER CONTENT % [FINES CONTENT] %	
								10 20 30 40 50		10 20 30 40 50		1 2 3 4 5		10 20 30 40 50	
								20-45-25 (70)		3-4-3 (7)		2-2-2 (4)		23-50/3" (50/3")	
								70		7		4		50/3"	
								965							
								20-45-25 (70)		3-4-3 (7)		2-2-2 (4)		23-50/3" (50/3")	
								70		7		4		50/3"	
								965							
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								965							
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								965							
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								965							
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								965							
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								965							
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								965							
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								965							
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								965							
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								965							
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								70		7		4		50/3"	
								965							
								20-45-25 (70)		3-4-3 (7)		2-2-2 (4)		23-50/3" (50/3")	
								70		7		4		50/3"	
								965							
								20-45-25 (70)		3-4-3 (7)		2-2-2 (4)		23-50/3" (50/3")	
								70		7		4		50/3"	
								965							
								20-45-25 (70)		3-4-3 (7)		2-2-2 (4)		23-50/3" (50/3")	
								70		7		4		50/3"	
								965							
								20-45-25 (70)		3-4-3 (7)		2-2-2 (4)		23-50/3" (50/3")	
								70		7		4		50/3"	
								965							
								20-45-25 (70)		3-4-3 (7)		2-2-2 (4)		23-50/3" (50/3")	
								70		7		4		50/3"	
								965							
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								70		7		4		50/3"	
								965							
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								70		7		4		50/3"	
								965							
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								70		7		4		50/3"	
								965							
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								70		7		4		50/3"	
								965							
								20-45-25 (70)		3-4-3 (7)		2-2-2 (4)		23-50/3" (50/3")	
								70		7					

CLIENT: McDonald's USA, LLC				PROJECT NO.: 16:15433		BORING NO.: B-04		SHEET: 1 of 1				
PROJECT NAME: McDonald's 24-1307 - Stockton, MO				DRILLER/CONTRACTOR: Palmerton And Parrish, Inc.								
SITE LOCATION: West Smith Drive and South Street, Stockton, Missouri, 65785								LOSS OF CIRCULATION 				
LATITUDE: 37.689889		LONGITUDE: -93.797478		STATION:		SURFACE ELEVATION: 968.0		BOTTOM OF CASING 				
DEPTH (FT)	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS	ELEVATION (FT)	BLOWS/6" (TCP/MC/SPT-N value) *	STANDARD PENETRATION BLOWS/FT		LIQUID LIMIT X PLASTIC LIMIT	
									ROCK QUALITY DESIGNATION & RECOVERY		CALIBRATED PENETROMETER TSF	
									MC SAMPLER BLOWS/FT		WATER CONTENT % [FINES CONTENT] %	
									TEXAS CONE PENETRATION BLOWS/FT			
	S-1	SS	18	18	Topsoil Thickness[4"] (SC/SM POSSIBLE FILL) POSSIBLE FILL, CLAYEY/SILTY SAND WITH GRAVEL, dark brown, moist, medium dense (CH) FAT CLAY WITH CHERT, reddish- brown, moist, firm			8-6-7 (13)	13			
5	S-2	SS	18	18			963	10-3-2 (5)	5	0.75	55.0	
	S-3	SS	8	8	(WR) WEATHERED LIMESTONE SAMPLED AS Sand with Gravel [Weathered LIMESTONE] AUGER REFUSAL AT 7.2 FT			46-50/2" (50/2")	50/2"			
10							958					
15							953					
20							948					
25							943					
30							938					
THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES. IN-SITU THE TRANSITION MAY BE GRADUAL												
☒ WL (First Encountered) Dry				BORING STARTED: Aug 06 2024				CAVE IN DEPTH:				
☒ WL (Completion) Dry				BORING COMPLETED: Aug 06 2024				HAMMER TYPE: Auto				
☒ WL (Seasonal High Water)				EQUIPMENT: CME 75		LOGGED BY: JG8		DRILLING METHOD: Solid Stem Auger				
GEOTECHNICAL BOREHOLE LOG												

CLIENT: McDonald's USA, LLC				PROJECT NO.: 16:15433		BORING NO.: B-05		SHEET: 1 of 1										
PROJECT NAME: McDonald's 24-1307 - Stockton, MO				DRILLER/CONTRACTOR: Palmerton And Parrish, Inc.														
SITE LOCATION: West Smith Drive and South Street, Stockton, Missouri, 65785								LOSS OF CIRCULATION 										
LATITUDE: 37.689819		LONGITUDE: -93.797358		STATION:		SURFACE ELEVATION: 971.0		BOTTOM OF CASING 										
DEPTH (FT)	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS	ELEVATION (FT)	BLOWS/6" (TCP/MC/SPT-N value) *	STANDARD PENETRATION BLOWS/FT		ROCK QUALITY DESIGNATION & RECOVERY		LIQUID LIMIT PLASTIC LIMIT		CALIBRATED PENETROMETER TSF		WATER CONTENT % [FINES CONTENT] %	
									10 20 30 40 50		10 20 30 40 50		1 2 3 4 5		10 20 30 40 50			
									RQD		REC		MC SAMPLER BLOWS/FT		TEXAS CONE PENETRATION BLOWS/FT			
									10 20 30 40 50		10 20 30 40 50		1 2 3 4 5		10 20 30 40 50			
									6-36-26 (62)		2-4-4 (8)		2-3-3 (6)		2-2-3 (5)			
5	S-1	SS	18	18	Topsoil Thickness[2"] (SC/SM POSSIBLE FILL) POSSIBLE FILL, CLAYEY/SILTY SAND WITH GRAVEL, dark brown, moist, very dense													
	S-2	SS	18	18	(CH) FAT CLAY WITH CHERT, reddish-brown, moist, very stiff		966											
	S-3	SS	18	18														
10	S-4	SS	18	18			961											
					(WR) WEATHERED LIMESTONE SAMPLED AS Sand with Gravel [Weathered LIMESTONE]													
15	1	RC	51	51	LIMESTONE, interbedded with sandstone layers, slightly to moderately weathered, slightly fractured, moderately pitted, moderately hard, tan-gray		956											
20	2	RC	60	60	LIMESTONE, slightly weathered, slightly pitted, hard, tan-gray to light gray		951											
	3	RC	21	21														
25					END OF BORING AT 23.6 FT		946											
30							941											
THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES. IN-SITU THE TRANSITION MAY BE GRADUAL																		
WL (First Encountered) 11.50				BORING STARTED: Aug 05 2024				CAVE IN DEPTH:										
WL (Completion) Dry				BORING COMPLETED: Aug 05 2024				HAMMER TYPE: Auto										
WL (Seasonal High Water)				EQUIPMENT: CME 75				LOGGED BY: JG8				DRILLING METHOD: Solid Stem Auger						
WL (Stabilized)																		
GEOTECHNICAL BOREHOLE LOG																		

CLIENT: McDonald's USA, LLC				PROJECT NO.: 16:15433		BORING NO.: P-01		SHEET: 1 of 1																																																																																								
PROJECT NAME: McDonald's 24-1307 - Stockton, MO				DRILLER/CONTRACTOR: Palmerton And Parrish, Inc.																																																																																												
SITE LOCATION: West Smith Drive and South Street, Stockton, Missouri, 65785								LOSS OF CIRCULATION																																																																																								
LATITUDE: 37.690172		LONGITUDE: -93.797411		STATION:		SURFACE ELEVATION: 970.0		BOTTOM OF CASING																																																																																								
<table><thead><tr><th rowspan="4">DEPTH (FT)</th><th rowspan="4">SAMPLE NUMBER</th><th rowspan="4">SAMPLE TYPE</th><th rowspan="4">SAMPLE DIST. (IN)</th><th rowspan="4">RECOVERY (IN)</th><th rowspan="4">DESCRIPTION OF MATERIAL</th><th rowspan="4">WATER LEVELS</th><th rowspan="4">ELEVATION (FT)</th><th rowspan="4">BLOWS/6" (TCP/MC/SPT-N value)*</th><th colspan="2">STANDARD PENETRATION BLOWS/FT</th><th colspan="2">ROCK QUALITY DESIGNATION & RECOVERY</th><th colspan="2">LIQUID LIMIT PLASTIC LIMIT</th><th colspan="2">CALIBRATED PENETROMETER TSF</th><th colspan="2">WATER CONTENT % [FINES CONTENT] %</th></tr><tr><th colspan="2">10 20 30 40 50</th><th colspan="2">20 40 60 80 100</th><th colspan="2">1 2 3 4 5</th><th colspan="2">10 20 30 40 50</th></tr><tr><th colspan="2">RQD</th><th colspan="2">REC</th><th colspan="2">MC SAMPLER BLOWS/FT</th><th colspan="2">TEXAS CONE PENETRATION BLOWS/FT</th></tr><tr><th colspan="2">10 20 30 40 50</th><th colspan="2">10 20 30 40 50</th><th colspan="2">10 20 30 40 50</th></tr></thead><tbody><tr><td rowspan="4">5</td><td>S-1</td><td>SS</td><td>18</td><td>18</td><td>Topsoil Thickness[5"] (SC/SM POSSIBLE FILL) POSSIBLE FILL, CLAYEY/SILTY SAND WITH GRAVEL, dark brown, moist, dense (CH) FAT CLAY, trace chert, reddish- brown, moist, firm to stiff</td><td></td><td>965</td><td>13-20-14 (34) 2-3-4 (7) 8-50/1" (50/1") 50/3" (50/3")</td><td></td><td></td></tr><tr><td>S-2</td><td>SS</td><td>18</td><td>18</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>S-3</td><td>SS</td><td>7</td><td>7</td><td>(WR) WEATHERED LIMESTONE SAMPLED AS Sand with Gravel [Weathered LIMESTONE]</td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>S-4</td><td>SS</td><td>3</td><td>3</td><td>AUGER REFUSAL AT 9.2 FT</td><td></td><td></td><td></td><td></td><td></td><td></td></tr></tbody></table>												DEPTH (FT)	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS	ELEVATION (FT)	BLOWS/6" (TCP/MC/SPT-N value)*	STANDARD PENETRATION BLOWS/FT		ROCK QUALITY DESIGNATION & RECOVERY		LIQUID LIMIT PLASTIC LIMIT		CALIBRATED PENETROMETER TSF		WATER CONTENT % [FINES CONTENT] %		10 20 30 40 50		20 40 60 80 100		1 2 3 4 5		10 20 30 40 50		RQD		REC		MC SAMPLER BLOWS/FT		TEXAS CONE PENETRATION BLOWS/FT		10 20 30 40 50		10 20 30 40 50		10 20 30 40 50		5	S-1	SS	18	18	Topsoil Thickness[5"] (SC/SM POSSIBLE FILL) POSSIBLE FILL, CLAYEY/SILTY SAND WITH GRAVEL, dark brown, moist, dense (CH) FAT CLAY, trace chert, reddish- brown, moist, firm to stiff		965	13-20-14 (34) 2-3-4 (7) 8-50/1" (50/1") 50/3" (50/3")			S-2	SS	18	18								S-3	SS	7	7	(WR) WEATHERED LIMESTONE SAMPLED AS Sand with Gravel [Weathered LIMESTONE]							S-4	SS	3	3	AUGER REFUSAL AT 9.2 FT						
DEPTH (FT)	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS	ELEVATION (FT)	BLOWS/6" (TCP/MC/SPT-N value)*	STANDARD PENETRATION BLOWS/FT		ROCK QUALITY DESIGNATION & RECOVERY										LIQUID LIMIT PLASTIC LIMIT		CALIBRATED PENETROMETER TSF		WATER CONTENT % [FINES CONTENT] %																																																																							
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 WL (First Encountered) 9.00				BORING STARTED: Aug 06 2024				CAVE IN DEPTH:																																																																																								
 WL (Completion) Dry				BORING COMPLETED: Aug 06 2024				HAMMER TYPE: Auto																																																																																								
 WL (Seasonal High Water)				EQUIPMENT: CME 75		LOGGED BY: JG8		DRILLING METHOD: Solid Stem Auger																																																																																								
 WL (Stabilized)																																																																																																
GEOTECHNICAL BOREHOLE LOG																																																																																																

CLIENT: McDonald's USA, LLC				PROJECT NO.: 16:15433		BORING NO.: P-02		SHEET: 1 of 1				
PROJECT NAME: McDonald's 24-1307 - Stockton, MO				DRILLER/CONTRACTOR: Palmerton And Parrish, Inc.								
SITE LOCATION: West Smith Drive and South Street, Stockton, Missouri, 65785								LOSS OF CIRCULATION 				
LATITUDE: 37.690103		LONGITUDE: -93.797706		STATION:		SURFACE ELEVATION: 965.0		BOTTOM OF CASING 				
DEPTH (FT)	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS	ELEVATION (FT)	BLOWS/6" (TCP/MC/SPT-N value) *	STANDARD PENETRATION BLOWS/FT		LIQUID LIMIT X PLASTIC LIMIT	
									ROCK QUALITY DESIGNATION & RECOVERY		CALIBRATED PENETROMETER TSF	
									MC SAMPLER BLOWS/FT		WATER CONTENT % [FINES CONTENT] %	
									TEXAS CONE PENETRATION BLOWS/FT			
	S-1	SS	18	18	Topsoil Thickness[6"] (SC/SM POSSIBLE FILL) POSSIBLE FILL, CLAYEY/SILTY SAND WITH GRAVEL, dark brown, moist, medium dense			9-9-6 (15)				
5	S-2	SS	18	18	(CH) FAT CLAY, trace chert, reddish-brown, moist, firm		960	1-3-17 (20)		0.50	72.0	
	S-3	SS	5	5	(WR) WEATHERED LIMESTONE SAMPLED AS Sand with Gravel [Weathered LIMESTONE]			50/5" (50/5")				
10					AUGER REFUSAL AT 6.7 FT		955					
15							950					
20							945					
25							940					
30							935					
THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES. IN-SITU THE TRANSITION MAY BE GRADUAL												
☒ WL (First Encountered) Dry				BORING STARTED: Aug 06 2024				CAVE IN DEPTH:				
☒ WL (Completion) Dry				BORING COMPLETED: Aug 06 2024				HAMMER TYPE: Auto				
☒ WL (Seasonal High Water)				EQUIPMENT: CME 75		LOGGED BY: JG8		DRILLING METHOD: Solid Stem Auger				
GEOTECHNICAL BOREHOLE LOG												

CLIENT: McDonald's USA, LLC				PROJECT NO.: 16:15433		BORING NO.: P-03		SHEET: 1 of 1																																																																																											
PROJECT NAME: McDonald's 24-1307 - Stockton, MO				DRILLER/CONTRACTOR: Palmerton And Parrish, Inc.																																																																																															
SITE LOCATION: West Smith Drive and South Street, Stockton, Missouri, 65785								LOSS OF CIRCULATION 																																																																																											
LATITUDE: 37.690019		LONGITUDE: -93.797489		STATION:		SURFACE ELEVATION: 967.0		BOTTOM OF CASING 																																																																																											
<table><thead><tr><th>DEPTH (FT)</th><th>SAMPLE NUMBER</th><th>SAMPLE TYPE</th><th>SAMPLE DIST. (IN)</th><th>RECOVERY (IN)</th><th>DESCRIPTION OF MATERIAL</th><th>WATER LEVELS</th><th>ELEVATION (FT)</th><th>BLOWS/6" (TCP/MC/SPT-N value)*</th><th>STANDARD PENETRATION BLOWS/FT 10 20 30 40 50 ROCK QUALITY DESIGNATION & RECOVERY RQD REC MC SAMPLER BLOWS/FT 10 20 30 40 50 TEXAS CONE PENETRATION BLOWS/FT</th><th>LIQUID LIMIT X PLASTIC LIMIT CALIBRATED PENETROMETER TSF 1 2 3 4 5 WATER CONTENT % [FINES CONTENT] % 10 20 30 40 50</th></tr></thead><tbody><tr><td></td><td>S-1</td><td>SS</td><td>18</td><td>18</td><td>Topsoil Thickness[6"] (SC/SM POSSIBLE FILL) POSSIBLE FILL, CLAYEY/SILTY SAND WITH GRAVEL, dark brown, moist, medium dense (CH) FAT CLAY WITH CHERT, reddish- brown, moist (WR) WEATHERED LIMESTONE SAMPLED AS Sand with Gravel [Weathered LIMESTONE] AUGER REFUSAL AT 4.0 FT</td><td></td><td></td><td>4-6-5 (11) 50/1" (50/1")</td><td></td><td></td></tr><tr><td>5</td><td>S-2</td><td>SS</td><td>1</td><td>1</td><td></td><td></td><td>962</td><td></td><td></td><td></td></tr><tr><td>10</td><td></td><td></td><td></td><td></td><td></td><td></td><td>957</td><td></td><td></td><td></td></tr><tr><td>15</td><td></td><td></td><td></td><td></td><td></td><td></td><td>952</td><td></td><td></td><td></td></tr><tr><td>20</td><td></td><td></td><td></td><td></td><td></td><td></td><td>947</td><td></td><td></td><td></td></tr><tr><td>25</td><td></td><td></td><td></td><td></td><td></td><td></td><td>942</td><td></td><td></td><td></td></tr><tr><td>30</td><td></td><td></td><td></td><td></td><td></td><td></td><td>937</td><td></td><td></td><td></td></tr></tbody></table>												DEPTH (FT)	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS	ELEVATION (FT)	BLOWS/6" (TCP/MC/SPT-N value)*	STANDARD PENETRATION BLOWS/FT 10 20 30 40 50 ROCK QUALITY DESIGNATION & RECOVERY RQD REC MC SAMPLER BLOWS/FT 10 20 30 40 50 TEXAS CONE PENETRATION BLOWS/FT	LIQUID LIMIT X PLASTIC LIMIT CALIBRATED PENETROMETER TSF 1 2 3 4 5 WATER CONTENT % [FINES CONTENT] % 10 20 30 40 50		S-1	SS	18	18	Topsoil Thickness[6"] (SC/SM POSSIBLE FILL) POSSIBLE FILL, CLAYEY/SILTY SAND WITH GRAVEL, dark brown, moist, medium dense (CH) FAT CLAY WITH CHERT, reddish- brown, moist (WR) WEATHERED LIMESTONE SAMPLED AS Sand with Gravel [Weathered LIMESTONE] AUGER REFUSAL AT 4.0 FT			4-6-5 (11) 50/1" (50/1")			5	S-2	SS	1	1			962				10							957				15							952				20							947				25							942				30							937			
DEPTH (FT)	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS	ELEVATION (FT)	BLOWS/6" (TCP/MC/SPT-N value)*	STANDARD PENETRATION BLOWS/FT 10 20 30 40 50 ROCK QUALITY DESIGNATION & RECOVERY RQD REC MC SAMPLER BLOWS/FT 10 20 30 40 50 TEXAS CONE PENETRATION BLOWS/FT	LIQUID LIMIT X PLASTIC LIMIT CALIBRATED PENETROMETER TSF 1 2 3 4 5 WATER CONTENT % [FINES CONTENT] % 10 20 30 40 50																																																																																									
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5	S-2	SS	1	1			962																																																																																												
10							957																																																																																												
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30							937																																																																																												
THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES. IN-SITU THE TRANSITION MAY BE GRADUAL																																																																																																			
☐ WL (First Encountered) Dry					BORING STARTED: Aug 06 2024			CAVE IN DEPTH:																																																																																											
☒ WL (Completion) Dry					BORING COMPLETED: Aug 06 2024			HAMMER TYPE: Auto																																																																																											
☒ WL (Seasonal High Water)					EQUIPMENT: CME 75		LOGGED BY: JG8		DRILLING METHOD: Solid Stem Auger																																																																																										
☐ WL (Stabilized)																																																																																																			

GEOTECHNICAL BOREHOLE LOG

CLIENT: McDonald's USA, LLC				PROJECT NO.: 16:15433		BORING NO.: P-04		SHEET: 1 of 1											
PROJECT NAME: McDonald's 24-1307 - Stockton, MO				DRILLER/CONTRACTOR: Palmerton And Parrish, Inc.															
SITE LOCATION: West Smith Drive and South Street, Stockton, Missouri, 65785								LOSS OF CIRCULATION 											
LATITUDE: 37.689989		LONGITUDE: -93.797931		STATION:		SURFACE ELEVATION: 961.0		BOTTOM OF CASING 											
DEPTH (FT)	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS	ELEVATION (FT)	BLOWS/6" (TCP/MC/SPT-N value) *	STANDARD PENETRATION BLOWS/FT		ROCK QUALITY DESIGNATION & RECOVERY		LIQUID LIMIT PLASTIC LIMIT		CALIBRATED PENETROMETER TSF		WATER CONTENT % [FINES CONTENT] %		
									10 20 30 40 50		10 20 30 40 50		1 2 3 4 5		10 20 30 40 50				
	S-1	SS	18	18	Asphalt Thickness[3"] Aggregate Base Course Thickness[6"] (CL POSSIBLE FILL) POSSIBLE FILL, LEAN CLAY WITH GRAVEL, brown and gray, moist, stiff (WR) WEATHERED LIMESTONE SAMPLED AS Sand with Gravel [Weathered LIMESTONE]			3-2-24 (26)											
5	S-2	SS	2	2				50/2" (50/2")											
	S-3	SS	1	1				50/1" (50/1")											
10	S-4	SS	0	0	AUGER REFUSAL AT 8.5 FT			50/0" (50/0")											
15																			
20																			
25																			
30																			
THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES. IN-SITU THE TRANSITION MAY BE GRADUAL																			
WL (First Encountered) 3.50				BORING STARTED: Aug 06 2024				CAVE IN DEPTH:											
WL (Completion) Dry				BORING COMPLETED: Aug 06 2024				HAMMER TYPE: Auto											
WL (Seasonal High Water)				EQUIPMENT: CME 75				LOGGED BY: JG8				DRILLING METHOD: Solid Stem Auger							
WL (Stabilized)																			
GEOTECHNICAL BOREHOLE LOG																			

CLIENT: McDonald's USA, LLC				PROJECT NO.: 16:15433		BORING NO.: P-05		SHEET: 1 of 1				
PROJECT NAME: McDonald's 24-1307 - Stockton, MO				DRILLER/CONTRACTOR: Palmerton And Parrish, Inc.								
SITE LOCATION: West Smith Drive and South Street, Stockton, Missouri, 65785								LOSS OF CIRCULATION 				
LATITUDE: 37.689825		LONGITUDE: -93.797528		STATION:		SURFACE ELEVATION: 967.0		BOTTOM OF CASING 				
DEPTH (FT)	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS	ELEVATION (FT)	BLOWS/6" (TCP/MC/SPT-N value) *	STANDARD PENETRATION BLOWS/FT		LIQUID LIMIT X PLASTIC LIMIT	
									ROCK QUALITY DESIGNATION & RECOVERY		CALIBRATED PENETROMETER TSF	
								10 20 30 40 50		1 2 3 4 5		
								20 40 60 80 100		WATER CONTENT % [FINES CONTENT] %		
								RQD		10 20 30 40 50		
								REC		10 20 30 40 50		
								MC SAMPLER BLOWS/FT		TEXAS CONE PENETRATION BLOWS/FT		
								10 20 30 40 50				
								6		1.75 56.0		
								3-2-4 (6)				
								962				
								957				
								952				
								947				
								942				
								937				
THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES. IN-SITU THE TRANSITION MAY BE GRADUAL												
☒ WL (First Encountered) Dry				BORING STARTED: Aug 06 2024				CAVE IN DEPTH:				
☒ WL (Completion) Dry				BORING COMPLETED: Aug 06 2024				HAMMER TYPE: Auto				
☒ WL (Seasonal High Water)				EQUIPMENT: CME 75		LOGGED BY: JG8		DRILLING METHOD: Solid Stem Auger				
☒ WL (Stabilized)												
GEOTECHNICAL BOREHOLE LOG												

CLIENT: McDonald's USA, LLC				PROJECT NO.: 16:15433		BORING NO.: P-06		SHEET: 1 of 1				
PROJECT NAME: McDonald's 24-1307 - Stockton, MO				DRILLER/CONTRACTOR: Palmerton And Parrish, Inc.								
SITE LOCATION: West Smith Drive and South Street, Stockton, Missouri, 65785								LOSS OF CIRCULATION 				
LATITUDE: 37.689744		LONGITUDE: -93.797589		STATION:		SURFACE ELEVATION: 967.0		BOTTOM OF CASING 				
DEPTH (FT)	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS	ELEVATION (FT)	BLOWS/6" (TCP/MC/SPT-N value) *	STANDARD PENETRATION BLOWS/FT		LIQUID LIMIT X PLASTIC LIMIT	
									ROCK QUALITY DESIGNATION & RECOVERY		CALIBRATED PENETROMETER TSF	
								10 20 30 40 50		1 2 3 4 5		
								20 40 60 80 100				
								RQD				
								REC				
								MC SAMPLER BLOWS/FT		WATER CONTENT % [FINES CONTENT] %		
								10 20 30 40 50		10 20 30 40 50		
								TEXAS CONE PENETRATION BLOWS/FT				
5	S-1	SS	18	18	Asphalt Thickness[3"] Aggregate Base Course Thickness[6"] (CH) FAT CLAY, trace chert, reddish-brown, moist, firm to stiff		962	3-2-3 (5)		5	1.50	34.0
								2-3-3 (6)		6	1.50	59.0
	S-2	SS	18	18				1-1-2 (3)		3	0.50	74.0
	S-3	SS	18	18				50/5" (50/5")		50/5"		
10	S-4	SS	5	5	(WR) WEATHERED LIMESTONE SAMPLED AS Sand with Gravel [Weathered LIMESTONE] AUGER REFUSAL AT 9.5 FT		957					
15							952					
20							947					
25							942					
30							937					
THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES. IN-SITU THE TRANSITION MAY BE GRADUAL												
WL (First Encountered)		6.00		BORING STARTED:		Aug 06 2024		CAVE IN DEPTH:				
WL (Completion)		Dry		BORING COMPLETED:		Aug 06 2024		HAMMER TYPE: Auto				
WL (Seasonal High Water)				EQUIPMENT:		CME 75		LOGGED BY:		JG8		
WL (Stabilized)										DRILLING METHOD: Solid Stem Auger		
GEOTECHNICAL BOREHOLE LOG												

CLIENT: McDonald's USA, LLC						PROJECT NO.: 16:15433		BORING NO.: P-07		SHEET: 1 of 1																																																																																																																																																																																											
PROJECT NAME: McDonald's 24-1307 - Stockton, MO						DRILLER/CONTRACTOR: Palmerton And Parrish, Inc.																																																																																																																																																																																															
SITE LOCATION: West Smith Drive and South Street, Stockton, Missouri, 65785								LOSS OF CIRCULATION >100<																																																																																																																																																																																													
LATITUDE: 37.690044		LONGITUDE: -93.798317		STATION:		SURFACE ELEVATION: 958.0		BOTTOM OF CASING 																																																																																																																																																																																													
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GEOTECHNICAL BOREHOLE LOG

CLIENT: McDonald's USA, LLC				PROJECT NO.: 16:15433		BORING NO.: S-01		SHEET: 1 of 1				
PROJECT NAME: McDonald's 24-1307 - Stockton, MO				DRILLER/CONTRACTOR: Palmerton And Parrish, Inc.								
SITE LOCATION: West Smith Drive and South Street, Stockton, Missouri, 65785								LOSS OF CIRCULATION				
LATITUDE: 37.689628		LONGITUDE: -93.797408		STATION:		SURFACE ELEVATION: 970.0		BOTTOM OF CASING				
DEPTH (FT)	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS	ELEVATION (FT)	BLOWS/6" (TCP/MC/SPT-N value) *	STANDARD PENETRATION BLOWS/FT		LIQUID LIMIT PLASTIC LIMIT	
									ROCK QUALITY DESIGNATION & RECOVERY		CALIBRATED PENETROMETER TSF	
								10 20 30 40 50		1 2 3 4 5		
								20 40 60 80 100		10 20 30 40 50		
								RQD		WATER CONTENT % [FINES CONTENT] %		
								REC		10 20 30 40 50		
								MC SAMPLER BLOWS/FT		10 20 30 40 50		
								10 20 30 40 50		10 20 30 40 50		
								TEXAS CONE PENETRATION BLOWS/FT				
	S-1	SS	18	18	Topsoil Thickness[2"] (SC/SM POSSIBLE FILL) POSSIBLE FILL, CLAYEY/SILTY SAND WITH GRAVEL, dark brown, moist, medium dense (CH) FAT CLAY, trace chert, reddish- brown, moist, very stiff			3-6-11 (17)				
5	S-2	SS	18	18			965	3-2-4 (6)			3.00	
											49.0	
	S-3	SS	18	18				2-2-3 (5)			2.00	
10	S-4	SS	3	3	(WR) WEATHERED LIMESTONE SAMPLED AS Sand with Gravel [Weathered LIMESTONE] AUGER REFUSAL AT 8.8 FT		960	50/3" (50/3")			59.0	
15							955					
20							950					
25							945					
30							940					
THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES. IN-SITU THE TRANSITION MAY BE GRADUAL												
WL (First Encountered) Dry				BORING STARTED: Aug 06 2024				CAVE IN DEPTH:				
WL (Completion) Dry				BORING COMPLETED: Aug 06 2024				HAMMER TYPE: Auto				
WL (Seasonal High Water)				EQUIPMENT: CME 75		LOGGED BY: JG8		DRILLING METHOD: Solid Stem Auger				
WL (Stabilized)												
GEOTECHNICAL BOREHOLE LOG												



Rock Core B-01

Run 1: From 11'-1" to 15' Below Existing Grade

Recovery = 100%, RQD = 23%

Run 2: From 15' to 20' Below Existing Grade

Recovery = 100%, RQD = 58%

Run 3: From 20' to 21'-8" Below Existing Grade

Recovery = 100%, RQD = 100%



Rock Core B-05

Run 1: From 12'-7" to 16'-10" Below Existing Grade

Recovery = 100%, RQD = 37%

Run 2: From 16'-10" to 21'-10" Below Existing Grade

Recovery = 100%, RQD = 78%

Run 3: From 21'-10" to 23'-7" Below Existing Grade

Recovery = 100%, RQD = 86%

Appendix C – Laboratory Testing

Laboratory Testing Summary

Other Laboratory Test Results



LABORATORY TESTING PROCEDURES:

Index Testing

Moisture content determination was performed on select fine-grained soil samples in accordance with ASTM D 2216.

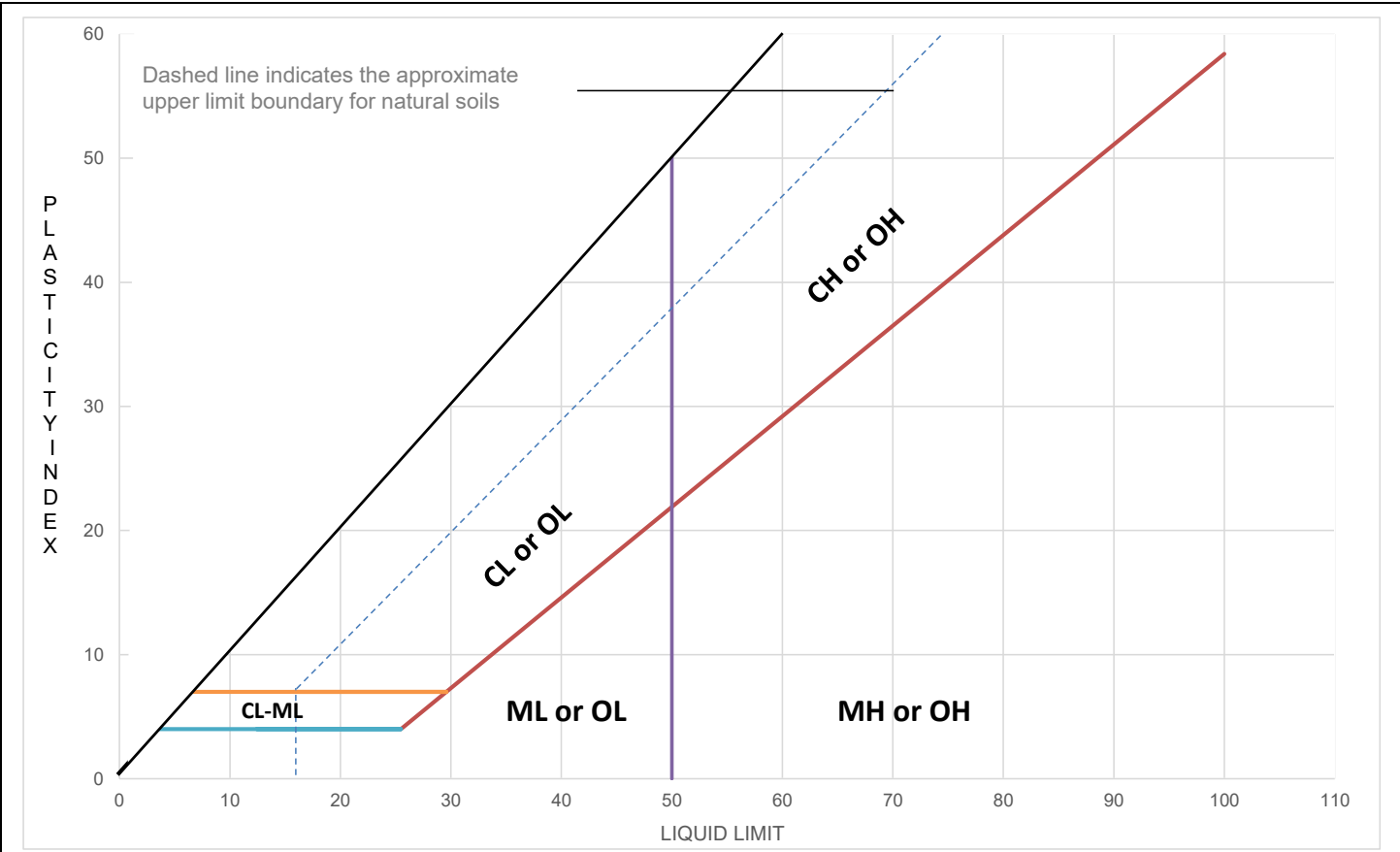
Calibrated hand penetrometer tests (Qp) were performed on select cohesive soil samples. In the hand penetrometer test, the unconfined compressive strength of a soil sample is estimated, to a maximum of 4.5 or 6 tons per square foot (tsf), depending on the penetrometer model, by measuring the resistance of a soil sample to penetration by a small, calibrated, spring-loaded cylinder.

Atterberg limits determination was performed on select fine-grained soil samples in accordance with ASTM D 4319. The Atterberg limits are a basic measure of the critical water contents of a fine-grained soil: its **liquid limit**, **plastic limit**, and **shrinkage limit**. Depending on its water content, a soil may appear in one of four states: solid, semi-solid, plastic and liquid. In each state, the consistency and behavior of a soil is different and consequently so are its engineering properties. Atterberg limits can also be used to help distinguish between silt and clay, and to distinguish between different types of silts and clays.

Particle size distribution, also referred to as gradation or sieve analysis, refers to the proportions by dry mass of a soil particles distributed over specified particle-size ranges. The particle size distribution is used to help classify soils for engineering purposes. Particle size distribution determination was performed on select fine-grained soil samples in accordance with ASTM D 421, D 422 and/or D 1140.

A **loss on ignition (LOI)** test is used to estimate the organic content of the soil. In the LOI test a dry sample is heated to 440° C to burn off organic matter within the sample. The lost weight is compared to the initial dry weight to estimate the percentage of organics in the material. LOI determination was performed in accordance with ASTM D 2974.

LIQUID AND PLASTIC LIMITS TEST REPORT



TEST RESULTS (ASTM D4318-10 (MULTIPOINT TEST))

	Sample Location	Sample Number	Sample Depth (ft)	LL	PL	PI	%<#40	%<#200	AASHTO	USCS	Material Description
■	B-01	D3S-50	3.00-5.00	106	33	73	97.0	88.9	A-7-5	CH	CH
◆	B-05	D3S-51	6.00-8.00	126	37	89	96.8	95.2	A-7-5	CH	CH

Project: 24-1307 McDonald's - Stockton, MO
Client: McDonald's USA, LLC

Project No.: 16:15433
Date Reported: 8/27/2024



Office / Lab
ECS Midwest LLC - Chicago

Address
1575 Barclay Boulevard
Buffalo Grove, IL 60089

Office Number / Fax
(847)279-0366
(847)279-0369

Tested by	Checked by	Approved by	Date Received
PGold	JSutton	JSutton	

Unconfined Compressive Strength Test Report

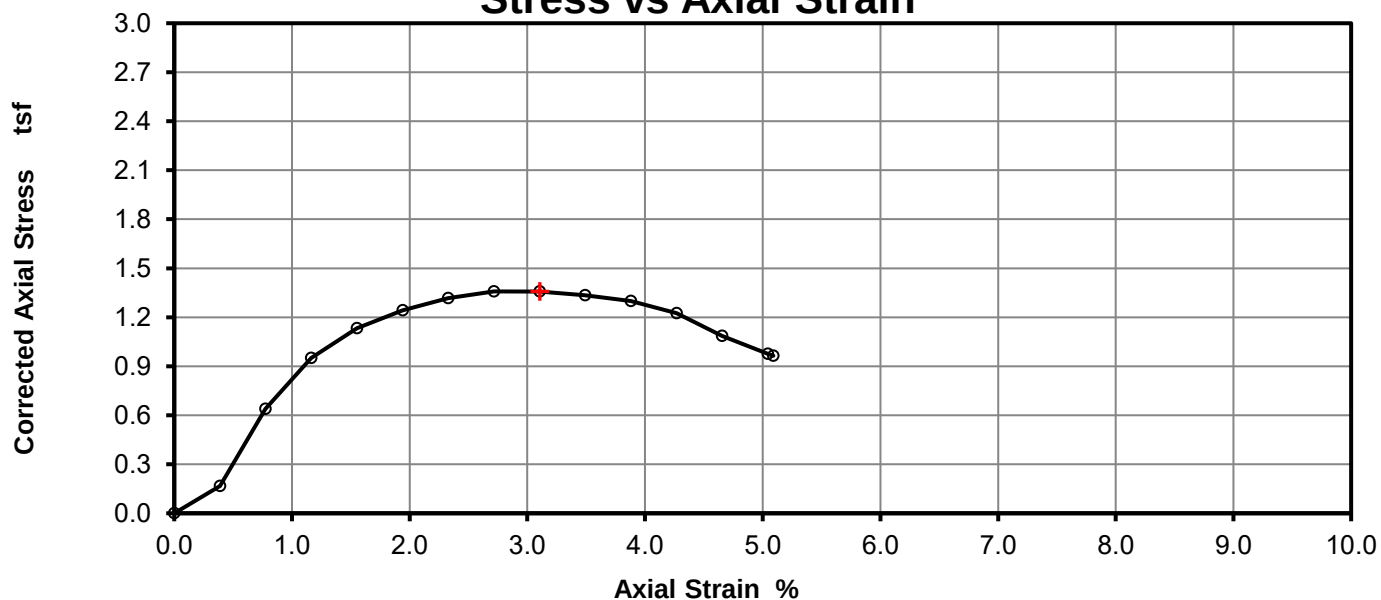
ASTM D2166

Initial Conditions

Height	in	6.44	
Diameter	in	2.85	
Bulk Density	pcf	113.78	
Water Content	%	39.2	
Dry Density	pcf	81.72	
Voids Ratio		1.062	
(Specific gravity assumed 2.70)			
Degree of Saturation	%	100	
Rate of Strain applied	%/min	1.55	
At failure	Axial Strain	%	3.1
	Maximum Stress	tsf	1.4
	Shear Strength	tsf	0.7



Stress vs Axial Strain



Project: 24-1307 McDonald's - Stockton, MO

Client: McDonald's USA, LLC

Sample Source: B-01

Project No.: 16:15433

Depth (ft): 3 - 5

Sample No.: D3S-50

Date Reported: 8/27/2024



Office / Lab

Address

Office Number / Fax

ECS Midwest LLC - Chicago

1575 Barclay Boulevard
Buffalo Grove, IL 60089

(847)279-0366

(847)279-0369

Tested by	Checked by	Approved by	Date Received	Remarks
JSutton	JSutton	JSutton		

Unconfined Compressive Strength Test Report

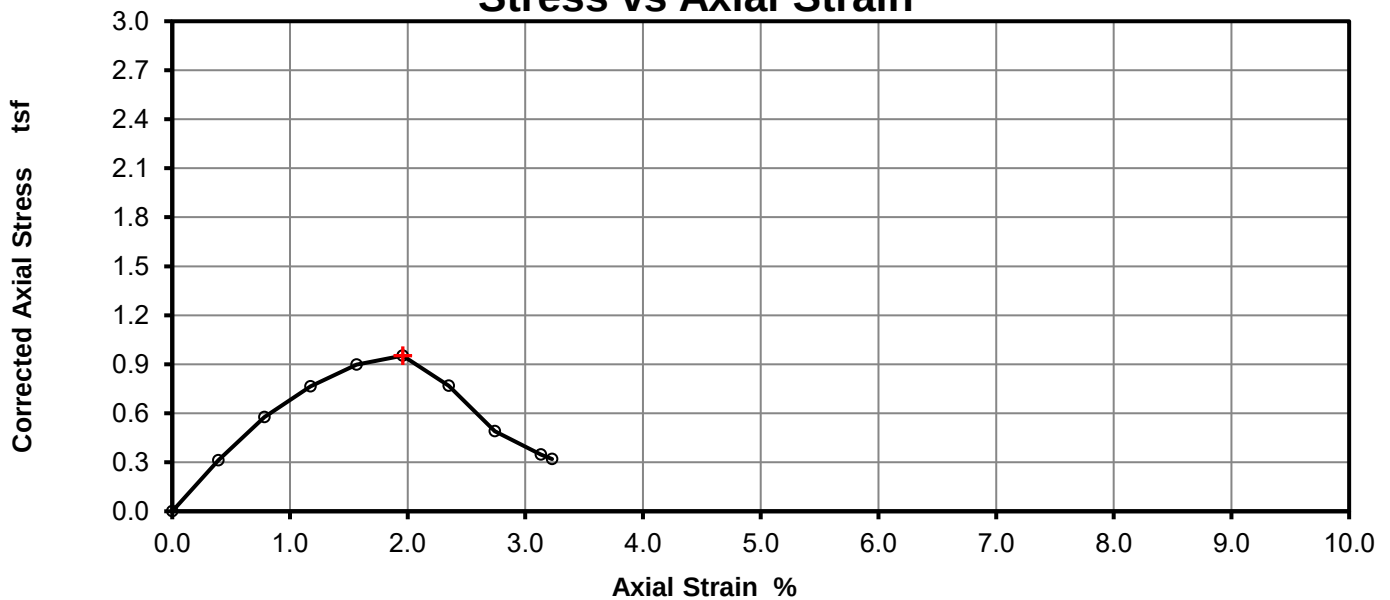
ASTM D2166

Initial Conditions

Height	in	6.38	
Diameter	in	2.86	
Bulk Density	pcf	106.24	
Water Content	%	51.6	
Dry Density	pcf	70.09	
Voids Ratio		1.404	
(Specific gravity assumed 2.70)			
Degree of Saturation	%	99	
Rate of Strain applied	%/min	1.57	
At failure	Axial Strain	%	2.0
	Maximum Stress	tsf	1.0
	Shear Strength	tsf	0.5



Stress vs Axial Strain



Project: 24-1307 McDonald's - Stockton, MO
 Client: McDonald's USA, LLC
 Sample Source: B-05

Project No.: 16:15433
 Depth (ft): 6 - 8
 Sample No.: D3S-51
 Date Reported: 8/27/2024



Office / Lab	Address	Office Number / Fax
ECS Midwest LLC - Chicago	1575 Barclay Boulevard Buffalo Grove, IL 60089	(847)279-0366 (847)279-0369

Tested by	Checked by	Approved by	Date Received	Remarks
JSutton	JSutton	JSutton		

Appendix D – Supplemental Documents

Geophysical Testing/Mapping

Important Information About This Geotechnical Report



August 22, 2024

Ms. Brenda Barber-Hoch
McDonald's USA, LLC
110 North Carpenter Street
Chicago, IL 60607

Reference: Summary of Geophysical Survey
Proposed McDonald's 24-1307
Stockton, Missouri

ECS Project Number: 26:6968

Dear Ms. Barber-Hoch:

As authorized by your acceptance in accordance with the Service Supplier Proposal and authorized by Ms. Amy Switzer through McDonald's Purchase Order No.: 2780030 dated July 31, 2024, ECS Southeast, LLC (ECS) has completed the limited Geophysical Survey a proposed McDonald's in Stockton, Missouri.

PROJECT INFORMATION

The proposed development will consist of a new McDonald's restaurant located in the southwestern quadrant of the intersection of South Street and West Smith Drive in Stockton, Missouri. This geophysical survey has been conducted consecutively to the Geotechnical Exploration Project (please referenced ECS Geotechnical Report No. 16:15433) for the subject property and should be considered an addendum to the geotechnical report.

GEOPHYSICAL TESTING METHODS

Electrical Resistivity Imaging (ERI)

To better characterize subsurface condition, a geophysical Electrical Resistivity Imaging (ERI) survey was performed generally centered near the existing depression. An ERI survey is a non-invasive exploration method that can aid in the characterization of subsurface soil and rock conditions. During the subject ERI survey, stakes were driven into the ground, electrical current was applied to the ground at two locations, and a resulting voltage was recorded at two other locations. This allowed calculation of the apparent resistivity at a point centered between the four stakes and at a depth related to the spacing of the stakes. By moving the stakes laterally, and by changing the spacing between the stakes, a profile showing the apparent resistivity values at various depths along a line was produced. To aid in data collection, an array of multiple stakes was laid out and connected to a single cable. This cable was then connected to an electrical resistivity meter which automatically selects various stake combinations to measure the apparent resistivity values across the line.

Once the apparent resistivity data were recorded, the data was modeled to estimate the electrical resistivity profile. This modeled resistivity profile was then correlated to soils, voids, fracture zones, rock

surfaces, and other geologic features. ECS conducted the ERI survey utilizing an ABEM 32-probe automatic switching resistivity meter. Probe spacing was determined in the field and was designed to provide a maximum exploration depth of approximately 50 feet below the ground surface. A total of four (4) ERI survey lines were performed as shown in the attached ERI location diagram.

GEOPHYSICAL SURVEY RESULTS

Generally, the ERI obtained results correlated well with the on-going geotechnical exploration, indicating low resistivity zones (sub 100 ohm-m) overlying higher resistivity features (300+ ohm-m). It is our opinion this represents saturated clays overlying mass limestone bedrock.

When reviewing ERI geophysical data for possible sinkhole formation, we anticipate a typical formation geometry would be represented as saturated fine-grained materials migrating down, past and through higher resistivity features, interpolated as bedrock. When reviewing ERI data indicating possible sinkhole formation, ECS expects to see a clear contrast between low resistivity and high resistivity areas, which could indicate the presence of active karst solution in the form of a "couplet" zone. These possible couplets would be an indication of soil migration into an underlying feature. We do not observe any obvious features that would be indicative of on-going karst solutioning or sinkhole formation.

However, it should be noted that an anomalous high resistance zone of data was observed near stationing 100 feet on ERI array #1. We are unsure what this feature may indicate, however it appears likely this zone was influenced by the close proximity soil test boring B-02. In effect, we anticipate the drilling for boring B-02 resulted in a zone of disturbed soils with slightly higher resistivity values representing more open pore space and/or less compacted soil backfill.

CONCLUSIONS AND RECOMMENDATIONS

Based on the conditions encountered during our field exploration, it is our opinion that the karst risk underlying this site is relatively low. However, given the underlying carbonate geology and abundance of mapped sinkholes in the general area, we recommend the owner follow a limited program of general sinkhole risk reduction and corrective actions.

General Sinkhole Risk Reduction

Based on our experience, corrective actions can be performed to reduce the potential for sinkhole development at this site. These corrective actions would reduce but not eliminate the potential for sinkhole development. Much can be accomplished to decrease the potential of future sinkhole activity by proper grade selection and through the establishment of positive site drainage.

In general, the portions of a site that are excavated to achieve the desired grades will have a higher risk of sinkhole development than the areas that are filled, because of the exposure of relic fractures in the soil to rainfall and runoff. On the other hand, those portions of a site that receive a modest amount of fill

(or that have been filled in the past) will have a decreased risk of sinkhole development caused by rainfall or runoff because the placement of a cohesive soil fill over these areas effectively caps the area with a relatively impervious "blanket" of remolded soil. Therefore, the recommendations that follow incorporate a modest remedial treatment program designed to make the surface of the soil in excavated areas less permeable.

Although it is our opinion that the risk of ground subsidence associated with sinkhole formation cannot be eliminated, we have found that several measures are useful in site design and development to reduce this potential risk. These measures include:

- Maintaining positive site drainage to route surface waters well away from structural areas both during construction and for the life of the structure.
- The scarification and re-compaction of the upper 10 to 12 inches of soil in earthwork cut areas.
- Verifying that subsurface utility piping beneath structures is carefully constructed and pressure tested prior to its placement in service.
- The use of pavement or geosynthetic clay lined ditches, particularly in cut areas, to collect and transport surface water to areas away from structures.

Considerations when building within a sinkhole prone area are to provide positive surface drainage away from proposed building or parking areas both during and after construction. Backfill in utility trenches or other excavations should consist of compacted, well-graded material such as dense graded aggregate or compacted on site soils. The use of an open graded stone (such as No. 57 stone) is not recommended unless the stone backfill is provided an exit path and not allowed to pond. If sinkhole conditions are observed, the type of corrective action is most appropriately determined by a geotechnical engineer on a case-by-case basis.

GENERAL COMMENTS AND CLOSURE

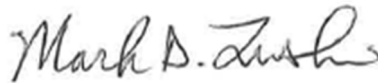
The conclusions and recommendations provided in this report are based upon the information provided to us at the time of the report and our experience with similar projects. If the information or assumptions presented in this report are not accurate, ECS should be notified to review our recommendations and address the discrepancy.

We appreciate the opportunity to be of continued service to you on this project. If you have any questions concerning the information presented in this report, or if we can be of further assistance, please contact us at (615)885-4983.

Respectfully,
ECS SOUTHEAST, LLC



Matt T. Bible, E.I.
Project Manager
MBible@ecslimited.com



Mark D. Luskin
Vice President
MLuskin@ecslimited.com

Attachments: Site Location Diagram
Exploration Location Diagram
Geophysical Survey Data
Important Information



McDonald's - Stockton
US RT 39 & Smith Road
Stockton, Missouri

ECS Project No. 24:1307



Figure 1- Site Location Diagram

Approximate Site Location Outlined in Red



McDonald's - Stockton
US RT 39 & Smith Road
Stockton, Missouri

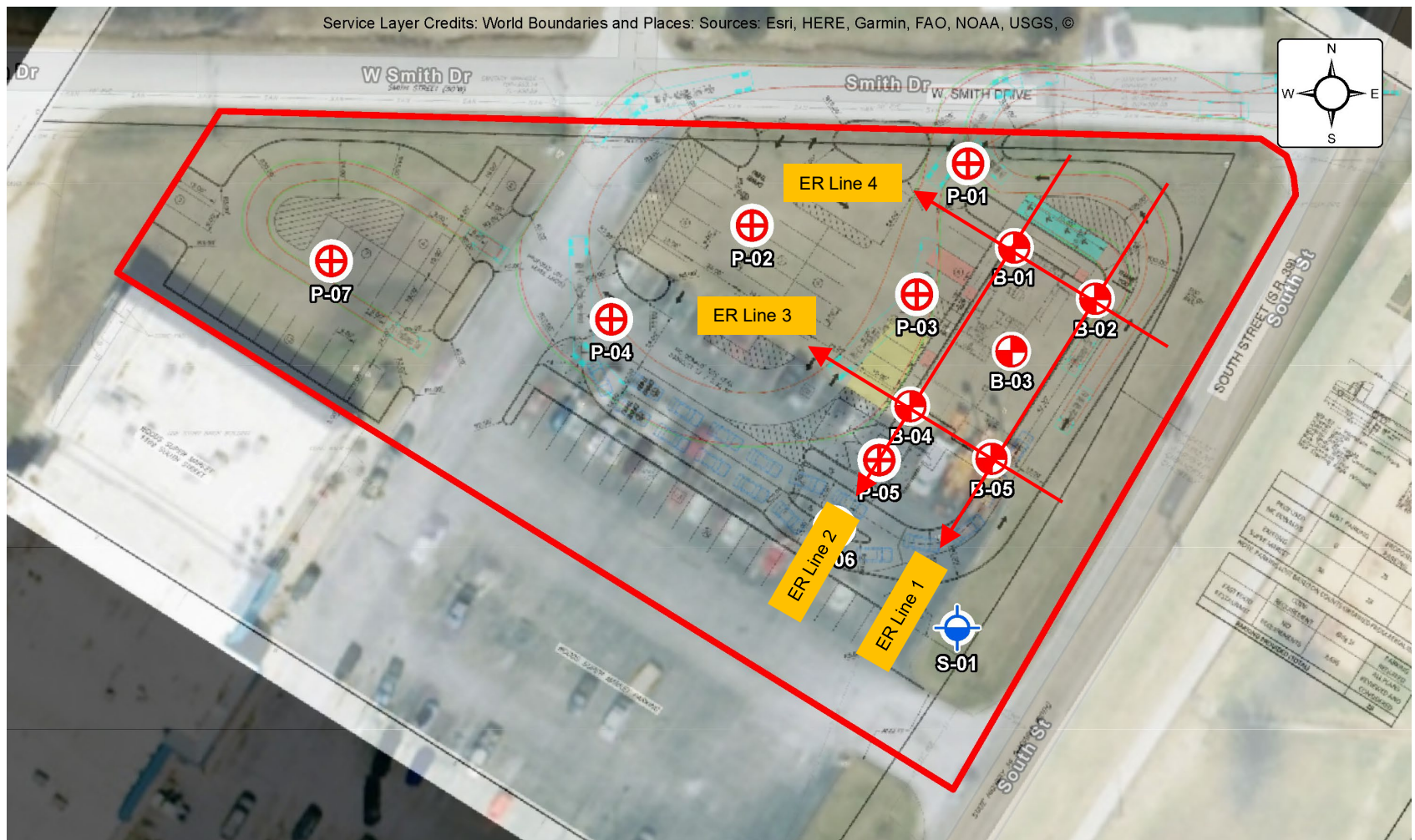
ECS Project No. 24:1307



Figure 2 - Exploration Location Diagram



Approximate ERI Array Locations
and Orientation



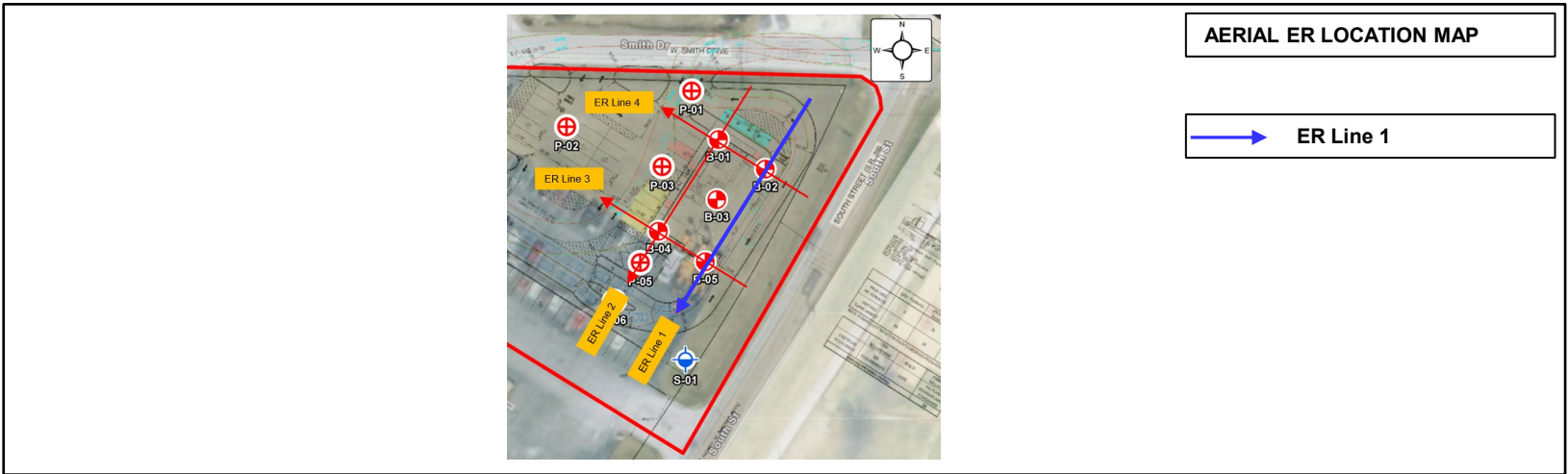
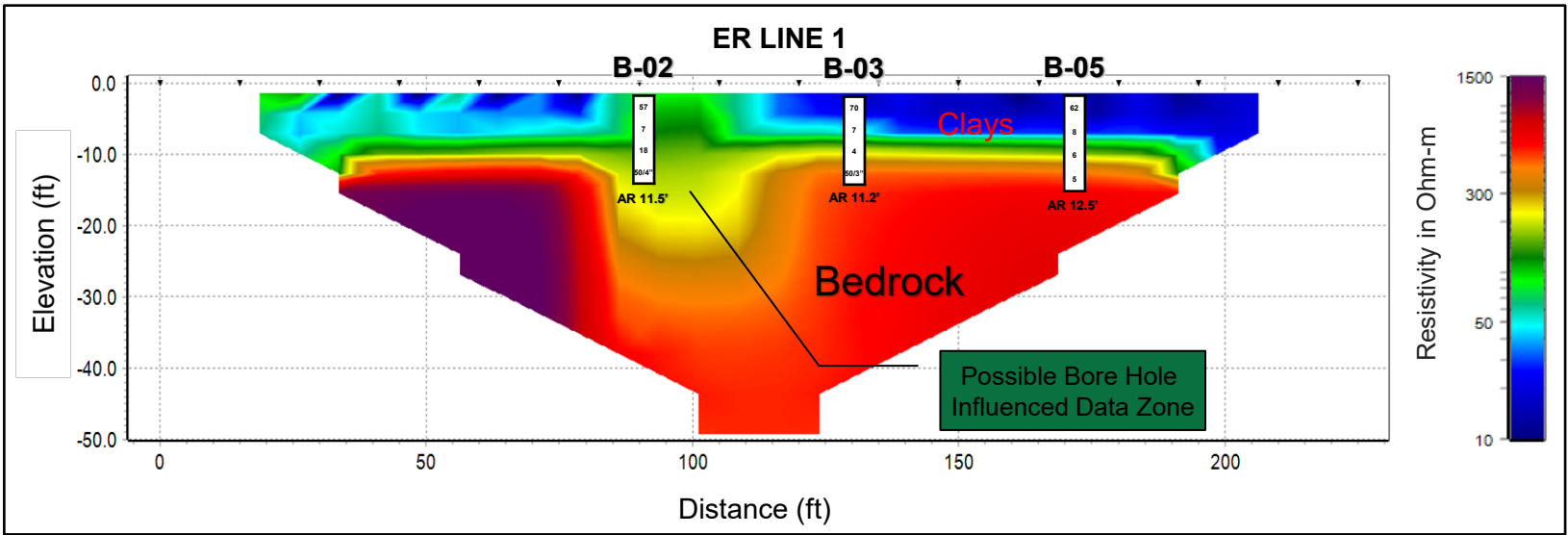
McDonald's - Stockton
US RT 39 & Smith Road
Stockton, Missouri

ECS Project No. 24:1307



Figure 3 - Exploration Location Diagram

→ Approximate ERI Array Locations
and Orientation



Project No.: 24:1307

Date: 08/10/2024

Scale: NTS

Line 1

McDonald's-Stockton

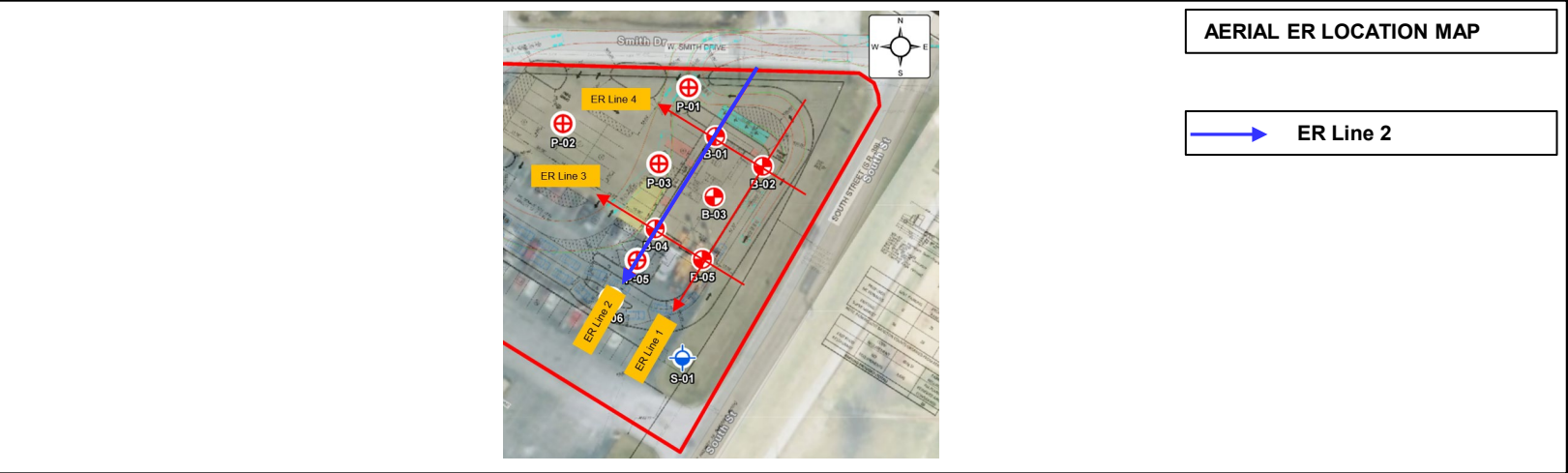
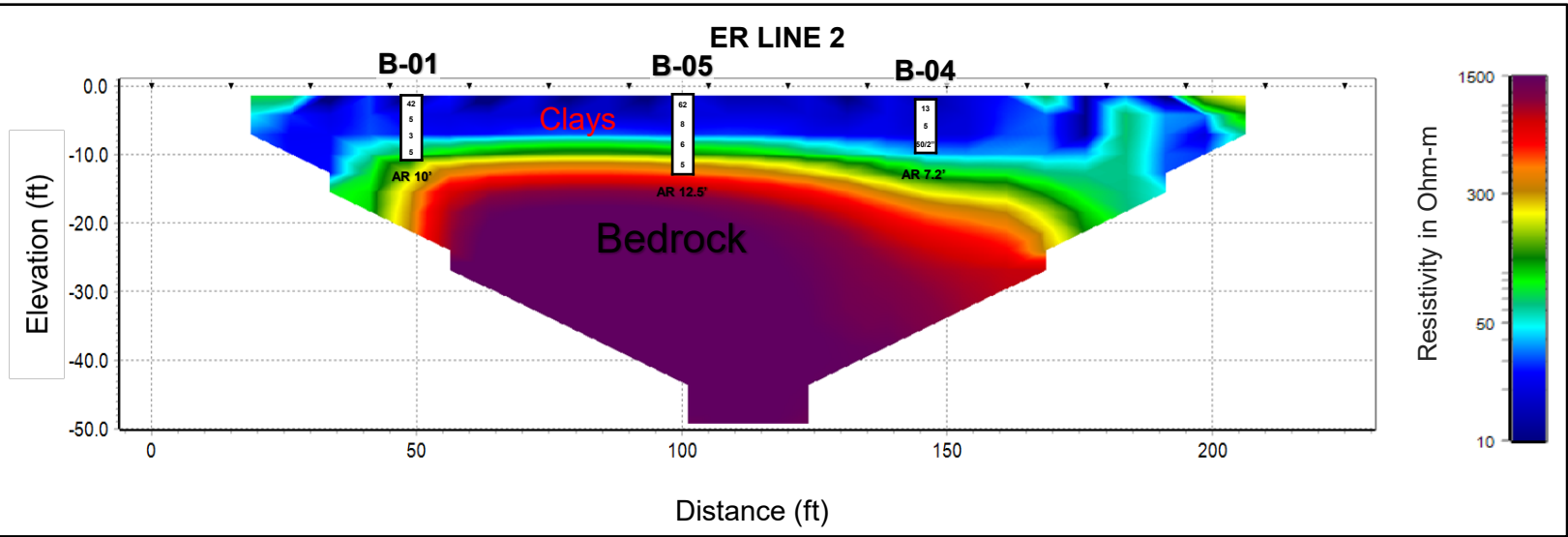
Stockton, Missouri



Figure 4 – ERI Profile

NOTES

- Data Acquisition
- ABEM Terrameter LS 2
- 16 nodes
- 15 ft spacing
- Line runs Top to Bottom



Project No.: 24:1307

Date: 08/10/2024

Scale: NTS

Line 2

McDonald's-Stockton

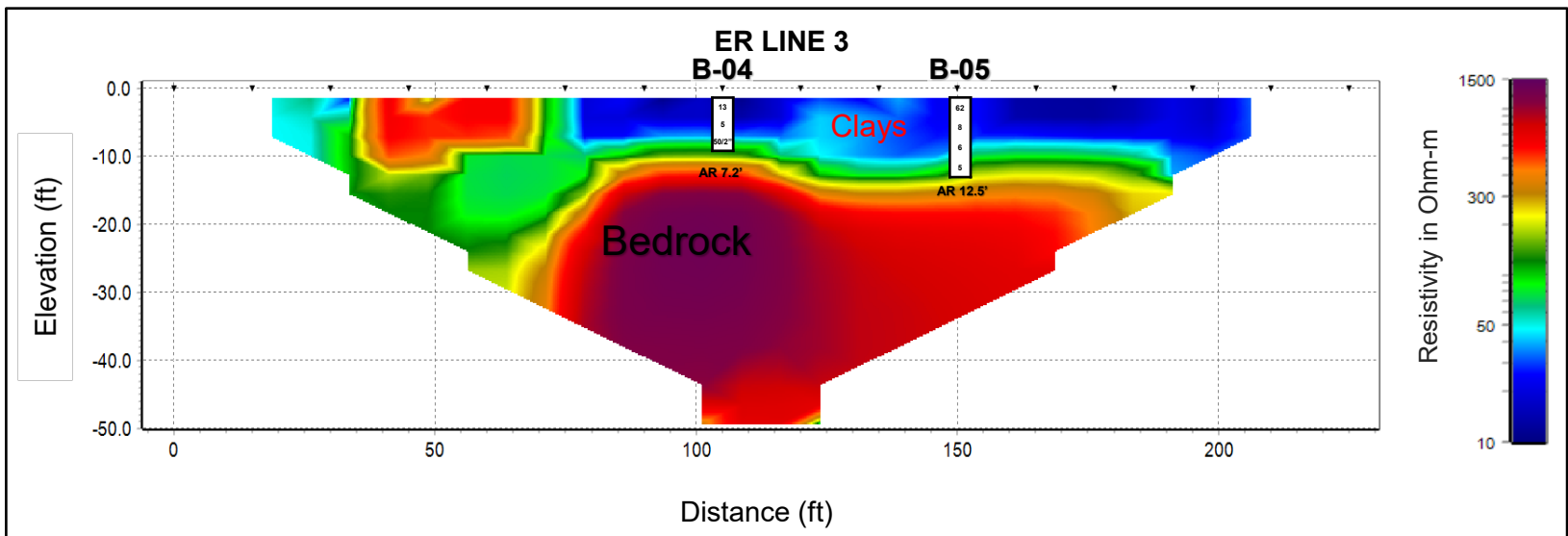
Stockton, Missouri



Figure 5 – ERI Profile

NOTES

- Data Acquisition
- ABEM Terrameter LS 2
 - 16 nodes
 - 15 ft spacing
 - Line runs Top to Bottom



Project No.: 24:1307

Date: 08/10/2024

Scale: NTS

Line 3

McDonald's-Stockton

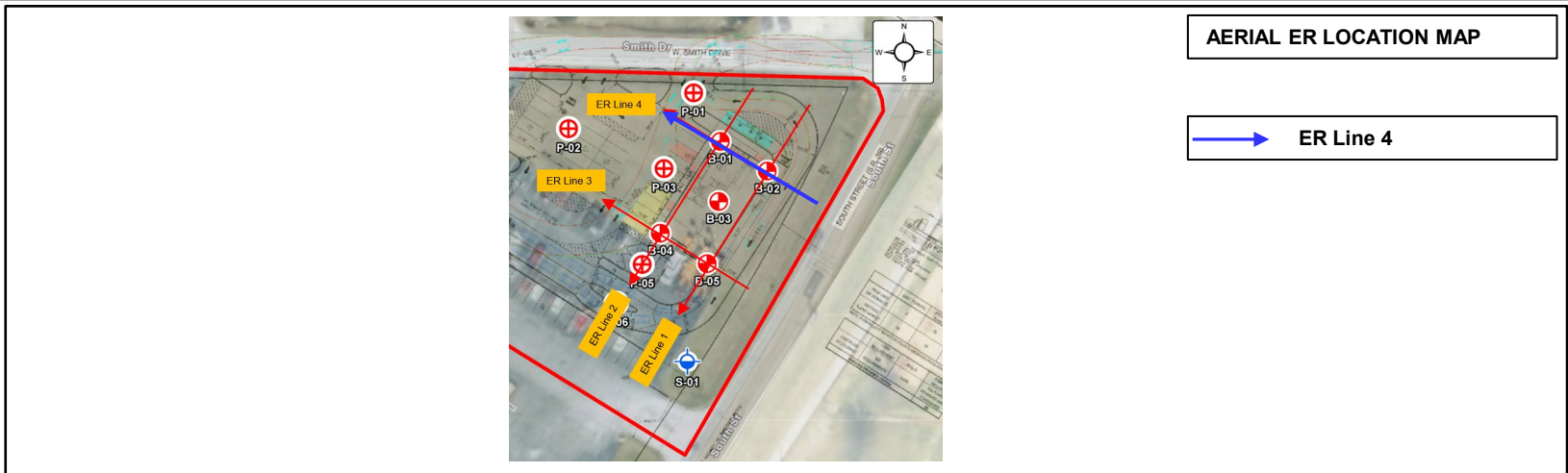
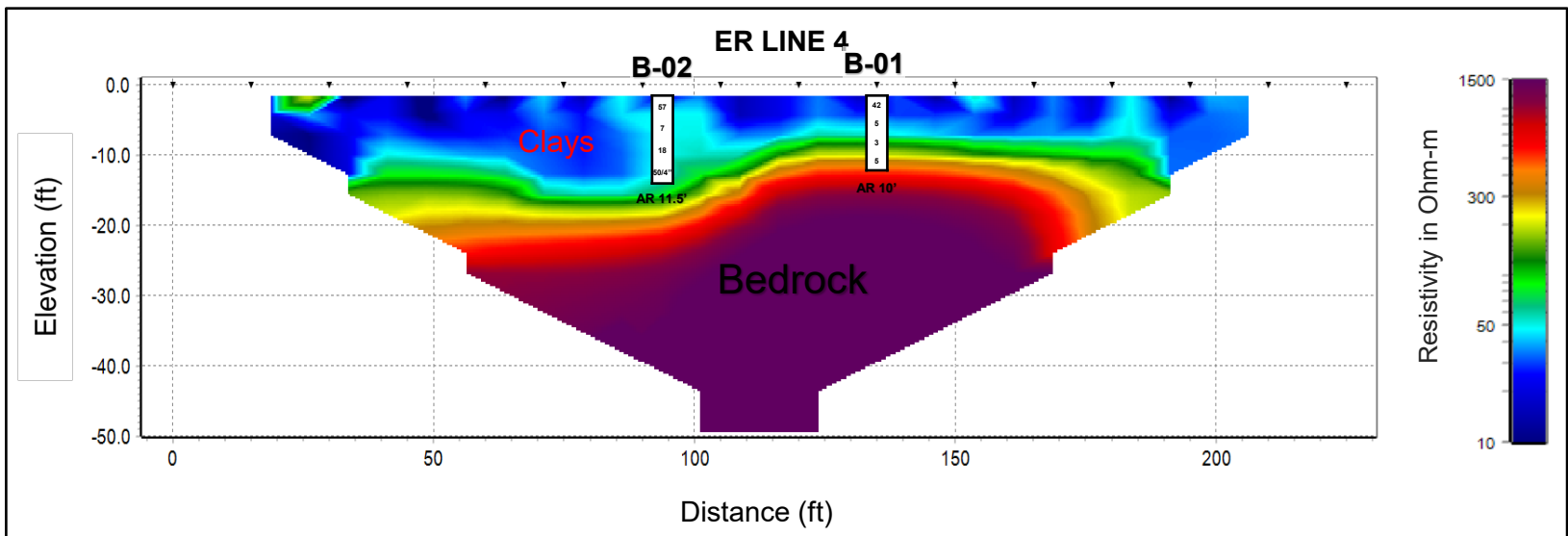
Stockton, Missouri



Figure 6 – ERI Profile

NOTES

Data Acquisition
 - ABEM Terrameter LS 2
 - 16 nodes
 - 15 ft spacing
 - Line runs Right to Left



Project No.: 24:1307

Date: 08/10/2024

Scale: NTS

Line 4

McDonald's-Stockton

Stockton, Missouri



Figure 7 – ERI Profile

NOTES

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- ABEM Terrameter LS 2
- 16 nodes
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Important Information about This Geotechnical-Engineering Report

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

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

The Geoprofessional Business Association (GBA) has prepared this advisory to help you – assumedly a client representative – interpret and apply this geotechnical-engineering report as effectively as possible. In that way, you can benefit from a lowered exposure to problems associated with subsurface conditions at project sites and development of them that, for decades, have been a principal cause of construction delays, cost overruns, claims, and disputes. If you have questions or want more information about any of the issues discussed herein, contact your GBA-member geotechnical engineer. Active engagement in GBA exposes geotechnical engineers to a wide array of risk-confrontation techniques that can be of genuine benefit for everyone involved with a construction project.

Understand the Geotechnical-Engineering Services Provided for this Report

Geotechnical-engineering services typically include the planning, collection, interpretation, and analysis of exploratory data from widely spaced borings and/or test pits. Field data are combined with results from laboratory tests of soil and rock samples obtained from field exploration (if applicable), observations made during site reconnaissance, and historical information to form one or more models of the expected subsurface conditions beneath the site. Local geology and alterations of the site surface and subsurface by previous and proposed construction are also important considerations. Geotechnical engineers apply their engineering training, experience, and judgment to adapt the requirements of the prospective project to the subsurface model(s). Estimates are made of the subsurface conditions that will likely be exposed during construction as well as the expected performance of foundations and other structures being planned and/or affected by construction activities.

The culmination of these geotechnical-engineering services is typically a geotechnical-engineering report providing the data obtained, a discussion of the subsurface model(s), the engineering and geologic engineering assessments and analyses made, and the recommendations developed to satisfy the given requirements of the project. These reports may be titled investigations, explorations, studies, assessments, or evaluations. Regardless of the title used, the geotechnical-engineering report is an engineering interpretation of the subsurface conditions within the context of the project and does not represent a close examination, systematic inquiry, or thorough investigation of all site and subsurface conditions.

Geotechnical-Engineering Services are Performed for Specific Purposes, Persons, and Projects, and At Specific Times

Geotechnical engineers structure their services to meet the specific needs, goals, and risk management preferences of their clients. A geotechnical-engineering study conducted for a given civil engineer

will not likely meet the needs of a civil-works constructor or even a different civil engineer. Because each geotechnical-engineering study is unique, each geotechnical-engineering report is unique, prepared *solely* for the client.

Likewise, geotechnical-engineering services are performed for a specific project and purpose. For example, it is unlikely that a geotechnical-engineering study for a refrigerated warehouse will be the same as one prepared for a parking garage; and a few borings drilled during a preliminary study to evaluate site feasibility will not be adequate to develop geotechnical design recommendations for the project.

Do not rely on this report if your geotechnical engineer prepared it:

- for a different client;
- for a different project or purpose;
- for a different site (that may or may not include all or a portion of the original site); or
- before important events occurred at the site or adjacent to it; e.g., man-made events like construction or environmental remediation, or natural events like floods, droughts, earthquakes, or groundwater fluctuations.

Note, too, the reliability of a geotechnical-engineering report can be affected by the passage of time, because of factors like changed subsurface conditions; new or modified codes, standards, or regulations; or new techniques or tools. *If you are the least bit uncertain about the continued reliability of this report, contact your geotechnical engineer before applying the recommendations in it. A minor amount of additional testing or analysis after the passage of time – if any is required at all – could prevent major problems.*

Read this Report in Full

Costly problems have occurred because those relying on a geotechnical-engineering report did not read the report in its entirety. Do not rely on an executive summary. Do not read selective elements only. *Read and refer to the report in full.*

You Need to Inform Your Geotechnical Engineer About Change

Your geotechnical engineer considered unique, project-specific factors when developing the scope of study behind this report and developing the confirmation-dependent recommendations the report conveys. Typical changes that could erode the reliability of this report include those that affect:

- the site's size or shape;
- the elevation, configuration, location, orientation, function or weight of the proposed structure and the desired performance criteria;
- the composition of the design team; or
- project ownership.

As a general rule, *always* inform your geotechnical engineer of project or site changes – even minor ones – and request an assessment of their impact. *The geotechnical engineer who prepared this report cannot accept*

responsibility or liability for problems that arise because the geotechnical engineer was not informed about developments the engineer otherwise would have considered.

Most of the “Findings” Related in This Report Are Professional Opinions

Before construction begins, geotechnical engineers explore a site’s subsurface using various sampling and testing procedures. *Geotechnical engineers can observe actual subsurface conditions only at those specific locations where sampling and testing is performed.* The data derived from that sampling and testing were reviewed by your geotechnical engineer, who then applied professional judgement to form opinions about subsurface conditions throughout the site. Actual site-wide subsurface conditions may differ – maybe significantly – from those indicated in this report. Confront that risk by retaining your geotechnical engineer to serve on the design team through project completion to obtain informed guidance quickly, whenever needed.

This Report’s Recommendations Are Confirmation-Dependent

The recommendations included in this report – including any options or alternatives – are confirmation-dependent. In other words, they are not final, because the geotechnical engineer who developed them relied heavily on judgement and opinion to do so. Your geotechnical engineer can finalize the recommendations *only after observing actual subsurface conditions* exposed during construction. If through observation your geotechnical engineer confirms that the conditions assumed to exist actually do exist, the recommendations can be relied upon, assuming no other changes have occurred. *The geotechnical engineer who prepared this report cannot assume responsibility or liability for confirmation-dependent recommendations if you fail to retain that engineer to perform construction observation.*

This Report Could Be Misinterpreted

Other design professionals’ misinterpretation of geotechnical-engineering reports has resulted in costly problems. Confront that risk by having your geotechnical engineer serve as a continuing member of the design team, to:

- confer with other design-team members;
- help develop specifications;
- review pertinent elements of other design professionals’ plans and specifications; and
- be available whenever geotechnical-engineering guidance is needed.

You should also confront the risk of constructors misinterpreting this report. Do so by retaining your geotechnical engineer to participate in prebid and preconstruction conferences and to perform construction-phase observations.

Give Constructors a Complete Report and Guidance

Some owners and design professionals mistakenly believe they can shift unanticipated-subsurface-conditions liability to constructors by limiting the information they provide for bid preparation. To help prevent the costly, contentious problems this practice has caused, include the complete geotechnical-engineering report, along with any attachments or appendices, with your contract documents, *but be certain to note*

conspicuously that you’ve included the material for information purposes only. To avoid misunderstanding, you may also want to note that “informational purposes” means constructors have no right to rely on the interpretations, opinions, conclusions, or recommendations in the report. Be certain that constructors know they may learn about specific project requirements, including options selected from the report, *only* from the design drawings and specifications. Remind constructors that they may perform their own studies if they want to, and *be sure to allow enough time* to permit them to do so. Only then might you be in a position to give constructors the information available to you, while requiring them to at least share some of the financial responsibilities stemming from unanticipated conditions. Conducting prebid and preconstruction conferences can also be valuable in this respect.

Read Responsibility Provisions Closely

Some client representatives, design professionals, and constructors do not realize that geotechnical engineering is far less exact than other engineering disciplines. This happens in part because soil and rock on project sites are typically heterogeneous and not manufactured materials with well-defined engineering properties like steel and concrete. That lack of understanding has nurtured unrealistic expectations that have resulted in disappointments, delays, cost overruns, claims, and disputes. To confront that risk, geotechnical engineers commonly include explanatory provisions in their reports. Sometimes labeled “limitations,” many of these provisions indicate where geotechnical engineers’ responsibilities begin and end, to help others recognize their own responsibilities and risks. *Read these provisions closely.* Ask questions. Your geotechnical engineer should respond fully and frankly.

Geoenvironmental Concerns Are Not Covered

The personnel, equipment, and techniques used to perform an environmental study – e.g., a “phase-one” or “phase-two” environmental site assessment – differ significantly from those used to perform a geotechnical-engineering study. For that reason, a geotechnical-engineering report does not usually provide environmental findings, conclusions, or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. *Unanticipated subsurface environmental problems have led to project failures.* If you have not obtained your own environmental information about the project site, ask your geotechnical consultant for a recommendation on how to find environmental risk-management guidance.

Obtain Professional Assistance to Deal with Moisture Infiltration and Mold

While your geotechnical engineer may have addressed groundwater, water infiltration, or similar issues in this report, the engineer’s services were not designed, conducted, or intended to prevent migration of moisture – including water vapor – from the soil through building slabs and walls and into the building interior, where it can cause mold growth and material-performance deficiencies. Accordingly, *proper implementation of the geotechnical engineer’s recommendations will not of itself be sufficient to prevent moisture infiltration.* Confront the risk of moisture infiltration by including building-envelope or mold specialists on the design team. *Geotechnical engineers are not building-envelope or mold specialists.*



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