Intertek-PSI
11826 Borman Drive
Saint Louis, Missouri 63146

Tel +1 314 432 8073
Fax +1 314 432 5119
**intertek.com/building**

September 8, 2022

McDonald's USA, LLC
110 N. Carpenter Street
Chicago, Illinois 60607

Attn: Amy Switzer

**Subject: Report of Geotechnical Exploration**
Proposed McDonald's (#40762)
3720 W. Sunshine Street
Springfield, Missouri 65807
PSI Project Number: 0040447-1

Amy Switzer:

Professional Service Industries, Inc. (PSI), an Intertek company, performed the geotechnical exploration requested for the proposed McDonald's (#40762) located in Springfield, Missouri. PSI provided its services in general accordance with our agreement dated Jul 15, 2022. As requested, PSI is transmitting an electronic copy of the report documents with this letter.

PSI thanks you for choosing us as your consultant for this project. Please contact us at (314) 432-8073 if you have any questions or if we may be of further service.

Respectfully Submitted,
**PROFESSIONAL SERVICE INDUSTRIES, INC.**

Daniel. D. Iffrig, PE
Project Manager
Geotechnical Services

Matthew Satterfield, PE
Principal Consultant
Regional Director

REPORT OF GEOTECHNICAL EXPLORATION

Proposed McDonald's (#40762)
3720 W. Sunshine Street
Springfield, Missouri

Prepared for

McDonald's USA, LLC
110 N. Carpenter Street
Chicago, Illinois 60607

Prepared by

Professional Service Industries, Inc.
11826 Borman Drive
Saint Louis, Missouri 63146

September 8, 2022

PSI Project Number 0040447-1


Daniel D. Iffrig, PE
Project Manager
PE: 2018000217 EXP. 12/31/2022

Matthew Satterfield, PE
Principal Consultant
Regional Director

## TABLE OF CONTENTS

# 1. PROJECT INFORMATION

## 1.1 PROJECT AUTHORIZATION

The following table summarizes, in chronological order, the project authorization history for the services performed and represented in this report by Professional Service Industries, Inc. (PSI).

| **PROJECT TITLE:** PROPOSED MCDONALD’S (#40762) - SPRINGFIELD, MISSOURI | | |
|---|---|---|
| **Document and Reference Number** | **Date** | **Requested/Provided By** |
| Request for Proposal | 7/12/2022 | Erica Lewis of McDonald’s USA, LLC |
| PSI Proposal Number: 0040-378172 | 7/15/2022 | Luke Lance and Matthew Satterfield of PSI |
| Notice to Proceed | 7/19/2022 | Amy Switzer of McDonald’s USA, LLC (PO# 2537497) |

## 1.2 PROJECT DESCRIPTION

PSI understands the proposed construction will consist of a single-story McDonald’s restaurant measuring approximately 4,500 square feet in footprint area, with ancillary parking, drive through, drive lanes, and a dumpster pad. The proposed structure will be constructed with a steel frame and masonry veneer. Pavements are going to be designed by the design team to resist heavy duty and standard duty loads, however, the Client has not provided PSI with the design parameters for the pavements at this time.

The proposed development will not feature slopes, retaining walls, basements, or other below-grade structures that would require geotechnical exploration, laboratory testing, or engineering.

The following table lists the material and information provided for this project:

| FILE NAME | DESCRIPTION OF MATERIAL | PROVIDER/SOURCE | DATE PROVIDED | USED AS A BASIS FOR THIS REPORT |
|---|---|---|---|---|
| “mcd w sunshine concepts-conc Core Drill Plan.pdf” | Site Plan With Boring Locations | McDonald’s USA, LLC | 7/8/2022 | Yes |
| “2421290 Springfield, MO conc 3 WITH TRUCK TURN.pdf” | Site Plan | McDonald’s USA, LLC | 7/8/2022 | No |
| “Updated APN Map.pdf” | Parcel Map | McDonald’s USA, LLC | 7/8/2022 | Yes |

The following table lists the structural loads and site features that are required for or are the design basis for the conclusions contained in this report:

| **STRUCTURAL LOAD/PROPERTY** | **REQUIREMENT/DESIGN BASIS** | |
|---|---|---|
| **BUILDING** | | |
| Maximum Column Loads | 150 kips | B |
| Maximum Wall Loads | 5 kips per lineal foot | B |
| Finish Floor Elevation and Type | 1,262 feet, slab-on-grade | B |
| Maximum Floor Loads and Size | 125 psf, 4,500 SF | B\|R |

| STRUCTURAL LOAD/PROPERTY | REQUIREMENT/DESIGN BASIS | |
|---|---|---|
| Settlement Tolerances | 1-inch total; ¾-inch differential between adjacent columns | B |
| **PAVEMENTS** | | |
| Pavement 18-kip ESAL (Cycle & Duration) | Light – 30,000 ESAL Heavy – 60,000 ESAL; with a life expectancy of 20 years | B |
| **GRADING** | | |
| Planned Grade Variations at Site | +/- 2 feet of existing grades | B |

R = Reported to PSI by the Client and/or the design team
B = Report has been prepared based on this parameter or loading in the absence of client supplied information at the time of this report

The geotechnical recommendations presented in this report are based on the available project information and the subsurface materials described in this report. If the noted information is incorrect, please inform PSI in writing so that we may amend the recommendations presented in this report if appropriate and if desired by the client. PSI will not be responsible for the implementation of its recommendations when it is not notified of changes in the project.

### 1.3 PURPOSE AND SCOPE OF SERVICES

The purpose of this study was to explore the subsurface conditions at the site to prepare recommendations for foundation systems and pavement sections for the proposed construction. PSI's scope of services included drilling 11 soil test borings at the site, to depths of about 5 feet to 20 feet below the ground surface, select laboratory testing, and preparation of this geotechnical report. This report briefly outlines the project description, presents available project information, testing procedures, describes the site and subsurface conditions, and presents recommendations regarding the following:

- A discussion of subsurface conditions encountered including recommended soil properties including, site location plan, boring location plan, boring logs, site profiles, and laboratory data;
- An evaluation of the data as it pertains to foundations, slabs, and pavements for the proposed site development;
- Recommendations for site preparation, including placement and compaction of fill soils;
- Geotechnical recommendations for foundation types, depths, allowable bearing capacities, and an estimate of potential settlement;
- Geotechnical recommendations regarding floor and/or other at-grade slabs;
- Seismic site class and coefficients for use in seismic design (IBC 2018);
- Pavement section design and pavement subgrade preparation; and
- Comments regarding factors that will impact construction and performance of the proposed construction.

The scope of services did not include an environmental assessment for determining the presence or absence of wetlands, or hazardous or toxic materials in the soil, bedrock, surface water, groundwater, or air, on, or below, or around this site. Any statement in this report or on the boring logs regarding odors, colors, and unusual or suspicious items or conditions are strictly for informational purposes.

PSI did not provide any service to investigate or detect the presence of moisture, mold or other biological contaminants in or around any structure, or any service that was designed or intended to prevent or lower the risk of the occurrence of the amplification of the same. Client acknowledges that mold is ubiquitous to the environment with mold amplification occurring when building materials are impacted by moisture. Client further acknowledges that site conditions are outside of PSI's control, and that mold amplification will likely occur, or continue to occur, in the presence of moisture. As such, PSI cannot and shall not be held responsible for the occurrence or recurrence of mold amplification.

## 2. SITE HISTORY AND CONDITIONS

### 2.1 SITE LOCATION AND DESCRIPTION

The approximate 1.1 acre site for the proposed McDonald's is located within the western half of the existing 2.5 acre parcel at the address of 3720 W. Sunshine Street in Springfield, Missouri. The site is located approximately 400 feet southwest of the intersection of S. Zimmer Avenue and W. Sunshine Street. The site latitude and longitude is approximately N 37° 10' 56" and W 93° 21' 20", respectively. The property is bordered by W. Sunshine Street to the north, the existing Central Bank to the east, and 3800 W. Sunshine Street to the west. At the time of drilling, the site was covered with grass. Based on publicly available topographic information obtained from Google Earth Pro, surface runoff could generally flow from northeast to southwest.

Existing structures were present at the time of drilling activities along the eastern and western borders of the proposed site, which appeared to be single-story structures. Based on visual observations of these adjacent structures, and PSI's experience with the local geology and structures of similar type and size, the structures may be supported on a foundation system consisting of spread footings. However, this information has not been confirmed. Based on cursory observations of the perimeter of these structures, no visually obvious indications of settlement-related distress were apparent. In addition, PSI was not informed of any settlement-related distress.

### 2.2 SITE HISTORY (TIMELINE)

Based on historical aerial images and data obtained from the "Interactive Maps" database maintained by the City of Springfield, Missouri, PSI understands the following item to comprise the site history at the project site:

- In 1936, the aerial imagery appears to show the site may have been used as agricultural land;
- In 1954, development of W. Sunshine Street appears to have began, along with a U-shaped gravel drive south of W. Sunshine Street. The aerial image also shows two apparent residential structures at the proposed McDonald's site, with one located close to W. Sunshine Street and another located further south along the apparent southern property line.
- In 1960, W. Sunshine Street became a divided road with a median, and the previous U-shaped gravel drive appears to have been removed and replaced with a trapezoidal-shaped paved area. The two structures present in the 1954 aerial image appear to have been removed by 1960, and a new apparent single-story structure appears to have been developed between those two previous structure locations. The property west of the proposed McDonald's site appears to have been partially paved with possible gravel in 1960.
- Between 1960 and 2001, the site of the proposed McDonald's generally appears to have remained the same, with the only apparent changes being made to the paved surface of the property toward the west. In the 1985 aerial image, an oval track is apparent east of the proposed McDonald's location.

- In 2008, the structures and portions of the pavement present in earlier imagery appears to have been removed as indicated by what appears to be ground disturbance in the aerials.
- Between 2008 and 2018, the available aerial imagery shows several changes adjacent to the proposed McDonald's site. To the east of the site in 2014, an apparent drive through banking kiosk appears to have been developed. Between 2016 and 2018, the existing "Plaza Tire Service" store west of the proposed McDonald's site appears to have been developed. Also between 2016 and 2018, the drive through banking kiosk appears to have been removed, and construction activities for the existing "Central Bank" located east of the site also appear to have begun. Based on the apparent ground disturbance in the 2018 aerial image, some of the grading activities for the existing Central Bank extended within the eastern limits of the proposed McDonald's location.
- There do not appear to be major changes to the site between the aerial images dated 2020 and 2022.

In summary of the above interpretations of the available aerial imagery and data, the site appears to have had several different structures present on site at various periods of time. Based on possible grade changes associated with the removal of these structures and recent adjacent construction activities near the proposed McDonald's site, it is possible that the ground surface at the proposed McDonald's site is underlain by some undocumented fill. Depending on the construction practices at the time the previous structures were removed at this site, some of the possible undocumented fill may contained buried structural elements from the previous structures. At current, there has been no information made available to PSI indicating the previous buildings at this site contained below-grade structures.

## 2.3 GENERAL AREA GEOLOGY

A review of the United States Geological Survey geologic units of Missouri indicates that the bedrock in this region is part of the Osagean Series of Carboniferous Mississippian age, which consist primarily of limestone containing nodules and beds of chert, with minor shale units. The underlying bedrock units may potentially be comprised of the Lower Warsaw, Keokuk Limestone, or the Burlington Limestone/Grand Falls Chert formations.

Additionally, the Missouri Department of Natural Resources (MODNR) "Surficial Materials Map of the Springfield 1° x 2° Quadrangle, Missouri" published in 1984 shows that the surficial geology mapped in this area is comprised of Springfield Residuum. In general, residuum is typically comprised of weathered bedrock fragments suspended within a clay matrix. According to the MODNR surficial materials map, the Springfield Residuum is generally described as a dark red to reddish brown cherty clay interbedded with chert nodules and layers which typically contain 10 to 50 percent chert fragments, with up to 100 percent chert fragments in some areas. On gently rolling uplands, the MODNR map also indicates the Springfield Residuum is covered with dense lag gravels that are typically 6 to 24 inches in thickness. Lag gravels are typically characterized as heterogenous accumulations of gravels, cobbles, and boulders ranging from subangular to angular, with interstitial voids containing slit or small rock fragments that generally undulate with depth beneath the ground surface. Typically, the upper 2 to 3 feet of Springfield Residuum beneath the lag gravels are almost "stone-free". These lag gravels are occasionally overlain with a 1 to 3-foot thick "windblown" silty clay (loess).

The Springfield Residuum materials are also noted to contain numerous karst features including sinkholes, caves, and pinnacled bedrock, as well as losing streams within this residuum. Large clusters of sinkholes have been reported within this residuum near the Missouri towns of Nixa, Republic, Wheatland, Ash Grove, and Springfield.

### 2.4 LOCAL KARST FEATURES

A review of sinkhole locations was performed for this project using the MODNR GEOSTRAT map layers, as well as the "Interactive Maps" database maintained by the City of Springfield, Missouri. The MODNR sinkhole map layer is based on MODNR interpretations of USGS topographic maps, with potential sinkhole locations being field verified in some instances. No information is available for the process or methods used to map sinkhole locations for the "Interactive Maps" database for Springfield, Missouri, however, significantly more sinkholes are mapped in this database in comparison to the MODNR GEOSTRAT MAP layers.

Based on PSI's review of the mapped sinkholes, there are no mapped sinkholes specifically located within the project site, however, several sinkhole locations are mapped outside of a 1,300 foot distance from the property limits of 3720 W. Sunshine Street (See Appendix C). It is important to note that these sinkhole databases do not provide the date of the topographic information used when performing their sinkhole interpretations, therefore, it is not clear when the sinkholes may have formed. A site-specific karst investigation was not included in this scope of work. The presence of karst features underlying a project site can only be identified with a more extensive and rigorous field exploration than specified in the client's RFP, and therefore is beyond PSI's scope of work.

Karst is a type of topography that is formed from the dissolution of soluble bedrock formations such as limestone, dolomite, and gypsum but can extend to somewhat weathering-resistant bedrock formations containing quartzite given the right conditions. Karst features are generally characterized by underground drainage networks with sinkholes and caves within the bedrock mass. Karst features can have a substantial impact on site development and building performance depending on the depth, size, and nature of the karst feature and the proposed development. Karst related impacts to structures can range from minor to severe karst induced settlements with major settlements leading to severe structural distress and other potential resulting hazards such as ruptured utility lines, racked doors and windows, cracking in walls, and potentially collapse of structures depending on the magnitude of movements.

The exacerbation of existing karst features and formation of new karst features can occur due to changes in grading, drainage, sources of water, and changes in water chemistry at sites within karst terrain. Therefore, it will be critical that the proposed site development features incorporate adequate drainage so as not to worsen features at this site.

## 3. EXPLORATION PROCEDURES AND SUBSURFACE CONDITIONS

The soil borings were performed with an ATV-mounted drill rig and were advanced using 3¼-inch inside diameter hollow-stem augers. Representative samples were obtained employing split-spoon and thin-wall tube sampling procedures in general accordance with ASTM procedures. The laboratory testing program was conducted in general accordance with applicable ASTM specifications. The results of these tests are to be found on the accompanying boring logs located in the Appendix.

### 3.1 SUBSURFACE CONDITIONS

The site subsurface conditions were explored with 11 soil test borings, 5 borings within the proposed building area and 6 borings within parking and drive areas. Building boring depths were approximately 20 feet and pavement boring depths ranged from approximately 5 feet to 15 feet.

The boring locations were selected by the Client, and the boring depths were suggested by PSI and reviewed with the client prior to drilling. The borings were staked in the field by measuring distances from available surface features using a handheld GPS. The locations should be considered accurate only to the degree implied by the means and methods used to define them.

Approximately 4 to 6 inches of topsoil-like materials were present below the existing ground surface of borings B-02 through B-04, and B-06 through B-10. The soils encountered beneath the topsoil-like materials at boring B-04, and beneath the existing ground surface at boring B-11 primarily included coarse-grained undocumented fill soils that extended to depths ranging from 1⅓ to 4⅓ feet below the existing ground surface. Based on the results of visual classification, these soils were classified as poorly graded gravel (GP), and nearly equal parts of poorly graded sand and poorly graded gravel (SP/GP) in accordance with the Unified Soil Classification System (USCS). The standard penetration N-value recorded within the coarse-grained undocumented fill soils generally indicated a relative density of medium-dense. A moisture content test performed within these soils indicated a moisture content of approximately 4 percent.

The soils encountered beneath the coarse-grained undocumented fill soils at borings B-04 and B-11, beneath the topsoil-like materials at borings B-02, -03, -07, -08, -09, and -10, and beneath the existing ground surface at borings B-01 and B-05 primarily included fine-grained undocumented fill soils that extended to depths ranging from 1¼ to 8 feet below the existing ground surface. Based on the results of Atterberg limits and visual classification, these soils were classified as silt (ML), low plasticity clay (CL), and high plasticity clay (CH) in accordance with the USCS. The standard penetration N-values within the fine-grained undocumented fill soils indicated consistencies ranging from medium-stiff to very-hard, however, typical consistencies generally ranged from stiff to very-stiff. Overall, the moisture contents of the fine-grained undocumented fill soils ranged from 8 to 39 percent, with an average of 17 percent.

The soils encountered beneath the topsoil-like materials at boring B-06, and beneath the fine-grained undocumented fill soils encountered at borings B-02 through B-05, B-07, and B-10 primarily included lag gravels that extended to depths ranging from 3 to 8 feet below the existing ground surface. Based on the results of visual classification, these soils were classified as poorly graded gravel (GP) in accordance with the USCS. The lag gravels generally contained weathered limestone and/or chert, with variable secondary contents of smaller coarse-grained fragments, in addition to fine-grained soil. The standard penetration N-values within these lag gravels indicate relative densities of medium-dense to very-dense. <u>Based on the available geologic maps and associated descriptions for lag gravel within this region, these medium-dense to very-dense lag gravels may be challenging to excavate.</u> Overall, the moisture contents of the lag gravels ranged from 6 to 25 percent, with an average of 13 percent. In general, moisture contents above 17 percent could be indicative of a higher secondary clay content within the lag gravels.

The soils encountered beneath the fine-grained undocumented fill at borings B-01 and B-08, and beneath the lag gravels at borings B-02 through B-07 primarily included residual soils that extended to depths ranging from 15 to 20 feet below the existing ground surface. Based on the results of Atterberg limits and visual classification, these soils were classified as low plasticity clay (CL), and high plasticity clay (CH) in accordance with the USCS. The standard penetration N-values within these residual soils indicate consistencies of medium-stiff to very-hard, however, typically consistencies generally ranged from medium-stiff to very-stiff. The moisture contents of the residual soils within the upper 5 feet ranged from 17 to 23 percent, with an average of 20 percent. Overall, the moisture contents of the residual soils ranged from 12 to 96 percent, with a typical range of 17 to 64 percent, and an overall average of 40 percent. <u>Based on an average moisture content within the upper 5 feet of the residual soils of 20 percent,</u>

plastic limits in the range of 31 to 33 percent, and liquid limits in the range of 68 to 95 percent, PSI believes these relatively dry residual soils to have a significant potential for volume change with changes in moisture content.

The intermediate geomaterials encountered beneath the residual soils at boring B-01 primarily included weathered chert, which extended to the terminal depth of the boring. Based on the results of visual classification, this intermediate geomaterial was classified as a poorly graded gravel (GP) in accordance with the USCS. The standard penetration N-value recorded within the weathered chert indicated a relative density of medium-dense. Due to the relatively freely draining nature and limited engineering significance of moisture content testing of poorly graded gravels, moisture content testing was not performed on the weathered chert.

The following table briefly summarizes the range of results from the field and laboratory testing programs. Please refer to the attached boring logs and laboratory data sheets for more specific information:

| PROPERTY DESCRIPTION / SOIL STRATA TYPE | Approximate Layer Depths (ft.) | RANGE OF PROPERTY VALUES | | | | | |
|---|---|---|---|---|---|---|---|
| | | Standard Penetration, N | Moisture Content, % | Dry Unit Weight, pcf | Unconfined Compressive Strength, Qu (tsf) | Liquid Limit, % | Plastic Limit, % |
| Coarse-grained Undocumented FILL | 0 - 4⅓ | 14 | 4 | --- | --- | --- | --- |
| Fine-grained Undocumented FILL | 0 - 8 | 4 - SSR | 9 - 39 | --- | --- | 32 | 16 |
| Lag Gravels | 0 - 8 | 27 - 58 | 6 – 25 | --- | --- | --- | --- |
| Residual Soils | 1⅓ - 20 | 6 - SSR | 12 - 96 | --- | --- | 68 - 95 | 31 - 33 |
| Weathered Chert | 19¾-20 | 26 | --- | --- | --- | --- | --- |

SSR = Split Spoon Refusal (greater than 50 blows for one, 6-inch increment)

Auger refusal materials were not encountered within the borings. Auger refusal is a designation applied to materials that cannot be further penetrated by the power of the auger with ordinary effort and is normally indicative of a very hard or very dense material, such as boulders or gravel lenses or the upper surface of bedrock. Weathered rock was encountered at boring B-01 at a depth of approximately 19¾ feet below the existing ground surface. Rock exploration and coring was beyond the scope of this exploration.

Split spoon refusal materials were encountered within some of the borings. Split spoon refusal materials are defined as materials that cannot be penetrated with a standard split spoon using ordinary effort (greater than 50 blows per 6 inches). These materials were encountered in boring B-02 at a depth of approximately 19 ½ feet on what could be the weathered bedrock surface, and at boring B-04 at a depth of approximately 2 ½ feet within the predominantly fine-grained undocumented fill. Based on PSI's interpretation of the field data, the sampler refusal encountered at boring B-04 may be due to rock fragments too large to enter the split spoon sampler.

The above subsurface description is of a generalized nature to highlight the major subsurface stratification features and material characteristics. The boring logs included in the Appendix should be reviewed for specific information at individual boring locations. These records include soil/rock descriptions, stratifications, penetration resistances, and locations of the samples and laboratory test data. The stratifications shown on the boring logs represent the conditions only at the actual boring locations. Variations may occur and should be expected between boring locations. The stratifications represent the approximate boundary between subsurface materials and the actual transition may be gradual. Water level information obtained during field operations is also shown on these boring logs. The samples that were not altered by laboratory testing will be retained for 60 days from the date of this report and then will be discarded.

### 3.2 WATER LEVEL MEASUREMENTS

Free water was observed in boring B-03 at a depth of approximately 19 feet below the existing ground surface. Free groundwater was not observed in the other borings upon completion, indicating that groundwater within the vicinity of those borings at the time of the exploration was either below the terminated depths of the borings, or that the soils encountered in those borings are relatively impermeable. Based on PSI's experience and laboratory moisture content measurements, the groundwater table at the time of the field exploration was estimated to be approximately 6 to 13 ½ feet below the existing ground surface. Although free water was not encountered at some of the borings this time, water can be present within the depths explored during other times of the year depending upon climatic and rainfall conditions.

In fine-grained soils such as the silty clay at this site, the water levels in the boreholes are often not representative of the actual groundwater level, because the boreholes remain open for a relatively short time. If it is desirable to obtain longer-term measurements, it will necessary to install water level observation wells or piezometers.

The groundwater level at the site, as well as perched water levels and volumes, will fluctuate based on variations in rainfall, snowmelt, evaporation, surface run-off and other related hydro-geologic factors. The water level measurements presented in this report are the levels that were measured at the time of PSI's field activities.

A summary of the observed groundwater conditions is presented on the following table. These observations are based upon measurements during PSI's field operation on August 15 and 16 of 2022, and were measured using a conventional measuring tape.

| **GROUNDWATER OBSERVATIONS** (FEET BELOW THE EXISTING GROUND SURFACE) | | | | |
|---|---|---|---|---|
| Boring No. | Ground Surface Elevations | Groundwater During Drilling | Groundwater Upon Auger Removal | Groundwater Delayed Readings |
| B-01 | Not Surveyed | Not Encountered | None Observed | N/A |
| B-02 | Not Surveyed | Not Encountered | None Observed | N/A |
| B-03 | Not Surveyed | 19 | None Observed | N/A |
| B-04 | Not Surveyed | Not Encountered | None Observed | N/A |
| B-05 | Not Surveyed | Not Encountered | None Observed | N/A |

| GROUNDWATER OBSERVATIONS (FEET BELOW THE EXISTING GROUND SURFACE) | | | | |
|---|---|---|---|---|
| Boring No. | Ground Surface Elevations | Groundwater During Drilling | Groundwater Upon Auger Removal | Groundwater Delayed Readings |
| B-06 | Not Surveyed | Not Encountered | None Observed | N/A |
| B-07 | Not Surveyed | Not Encountered | None Observed | N/A |
| B-08 | Not Surveyed | Not Encountered | None Observed | N/A |
| B-09 | Not Surveyed | Not Encountered | None Observed | N/A |
| B-10 | Not Surveyed | Not Encountered | None Observed | N/A |
| B-11 | Not Surveyed | Not Encountered | None Observed | N/A |

## 4. GEOTECHNICAL EVALUATION

The following geotechnical related recommendations have been developed on the basis of the subsurface conditions encountered and PSI's understanding of the proposed development. Should changes in the project criteria occur, a review must be made by PSI to determine if modifications to our recommendations will be required.

There are 6 primary geotechnical related concerns at this site, which will affect the performance of the foundations for this structure. The following summarizes those concerns:

1. The shear strength and compressibility of the upper soils will control the behavior of the proposed structure.
2. Existing undocumented fill materials of variable consistency were encountered in relatively isolated areas within the building area.
3. The medium-dense to very-dense lag gravels may be challenging to excavate in some areas, and may require care during excavation.
4. High Plasticity clays were encountered in the exploration that will require remediation.
5. Relatively sensitive soils were encountered in the upper parts of the borings. Equipment mobility difficulty may be anticipated where these sensitive soils have relatively high moisture contents, or if these soils are exposed to wet weather conditions.
6. Drying of some of the on-site soils may be required to achieve proper compaction during grading.
7. Geologic Hazards

### 4.1 SHEAR STRENGTH AND COMPRESSIBILITY OF SOIL

The primary geotechnical property controlling the bearing capacity and compressibility of the soils bearing the applied loads is the shear strength of the soil. Based on 2 feet of cut or fill and a shallow foundation bearing at a depth of 2 ½ feet below exterior or adjacent grades, the applied foundation load on a shallow foundation up to 7 feet wide will be distributed through the 14 to 21 feet of soil generally beneath the footing. PSI believes the fine-grained soils to comprise the majority of this zone, and that the shear strength of the soils in this zone ranges from 1,300 pounds per square foot (psf) to 2,600 psf. This shear strength is considered "undrained" or a "total stress" parameter and will be used in conjunction with other physical and geometric parameters to calculate an allowable bearing capacity.

## 4.2 EXISTING UNDOCUMENTED FILL

Based on PSI's soil borings, the site is underlain by up to 8 feet of undocumented fill in isolated areas of the site. Boring B-01 encountered approximately 8 feet of undocumented fill materials within the building area, while other borings encountered 1 ¼ to 4 ½ feet of undocumented fill within the building area. The presence of the undocumented fill introduces a construction risk due to the potential for excessive and/or non-uniform settlement. The amount of risk is based on consistency of the fill and variations in the material property. For purposes of this report, PSI is providing the following definition of fill and the different classifications:

**Fill** – Man-placed soil is called "fill", and the process of placing it is termed "filling". One of the most common problems of earth construction is the wide variability of the source soil, termed "borrow". An essential part of the geotechnical engineering report is to provide guidance for the placement of fill from a borrow source in a manner that achieves the design parameters for the project being constructed. Fill is further classified by the placement process. The following lists various terms applied to fill placement practices:

a. **Uncontrolled Fill** - Fill material that consists of soil and/or non-soil materials that has been placed in a manner that does not produce consistent density, uniform moisture content at time of placement, and in general materials of durable physical characteristics is termed an uncontrolled fill.

b. **Undocumented Fill** - Fill material composed of soil that has **not** been observed by a geotechnical engineer or qualified technician under the direction of a geotechnical engineer during the actual fill placement process with physical measurements of lift thickness, dry density, moisture content at time of placement, location of tests and fill soils placed, and the methodology of placement with types of placement equipment is termed undocumented fill.

c. **Engineered Fill** - Fill material that is placed to have specific shear strength, permeability, consolidation, or other physical parameter(s) specific to the end use of the man placed soil material. Applications include, but are not limited to, retaining wall backfill, pond and landfill liners, embankments, dams, and bridge abutments.

The presence of undocumented fill introduces a construction risk and precludes typical site development and construction. Based on the variability in the SPT N-values and moisture contents within the undocumented fill materials at this site, the undocumented fill materials do not appear to have been placed with engineering control, and generally appear to be variable in consistency/relative density. As such, the fill appears to contain softer zones than other portions of the undocumented fill, which can cause total and differential settlement between columns that may not be tolerated by the proposed structure. Although soft undocumented fill soils were not encountered in the upper 5 to 8-feet of the soil profile at the boring locations, this does not eliminate the possibility that soft or loose pockets or layers are present between the borings.

Although it may be possible to utilize conventional spread footing foundations after completing the recommended grading and foundation preparation, the owner must accept a risk that excessive and/or non-uniform settlement may occur. The risk of settlement of the fill can be reduced if the existing fill is removed and replaced with a controlled compacted fill, but this option could be costly. To reduce the differential settlement between columns, PSI recommends that the up to 8 feet of fill be removed and replaced in a controlled manner, which should be observed and documented by a representative of the geotechnical engineer.

Due to the demolition of the previous buildings at this site, there may be buried structural elements or previous foundations buried in the subsurface profile. These materials, if encountered, should be removed from the site to limit the amount of differential/non-uniform movement. If it is desirable to reduce the amount of risk associated with excessive/non-uniform settlement at the site in the foundation, floor slab, and pavement areas, it would be necessary, at a minimum, to proof roll in the building footprint and pavement areas and perform proof compaction for the foundation bearing surfaces as outlined in the "Site Preparation" and "Foundation Recommendation" sections of this report.

### 4.3 LAG GRAVEL EXCAVATION

PSI's borings encountered medium-dense to very-dense poorly graded gravels in select areas of the site, which are understood to be naturally deposited "lag gravel" materials. Based on these materials being relatively dense, encountered in PSI's borings in thicknesses of approximately 2 to 3 feet, and reported in this area to be additionally comprised of boulders and cobbles, PSI anticipates there may be some difficulty experienced when excavating through these materials. It may be possible that particles greater than 3 inches in diameter may be encountered when excavating through these lag gravel materials. An experienced contractor should determine the appropriate excavating equipment for excavation or ripping of these lag gravel materials.

During excavation for the footings and floor slabs, and depending on the requirements for high plasticity clay remediation presented in this report, no more than 2 inches of natural lag gravels should be exposed above the base of the excavation. Additionally, cavities formed as a result of excavating particle sizes greater than 3 inches should be backfilled with a compacted engineered fill as discussed later in this report.

### 4.4 HIGH PLASTICITY CLAY

Potentially expansive high plasticity "fat" clays are present in the project area and will have a significant impact on the proposed construction. Where these soils are within about 3 feet of lightly loaded structural features, remediation should be considered. High plasticity clays have the potential for volume change with changes in the soil moisture content. Based on the relatively low moisture contents of the high plasticity clays encountered in PSI's borings, and the relatively high liquid and plastic limits, these high plasticity clay soils are anticipated to have a relatively high potential for volume change with changes in the moisture content. In severe cases, movement and distress to footings and foundation walls can occur. Remedial measures are recommended in select areas of the site to reduce the swell potential.

Remediation should include replacing the high plasticity clay soils where they occur within a depth of 3 feet beneath proposed slabs and 2 ½ feet below lightly loaded footings and replacing this material with a low plasticity compacted soil or a dense graded crushed stone. If a crushed stone is used, the subgrade should be graded as to drain to either a submersible pump or to daylight as to limit the amount of free water available, which promotes swelling of the soils. Alternatively, lime-treatment of the high plastic clay can be accomplished to reduce the plasticity index, improve workability, promote drying, and reduce swell potential.

Based on the depths of the lag gravels encountered in PSI's borings, it could be possible that these lag gravels are present near footing and floor slab depths for the proposed McDonalds. Depending on the consistency and composition of the lag gravels, and elevations of the proposed floor slabs and footings relative to the elevations of the existing lag gravels, it is possible that a portion of the existing lag gravels could potentially be utilized as a portion of the remedial thicknesses recommended by PSI for high plasticity clay remediation. It is important to note that the lag gravels were encountered in relatively isolated areas of the site. Surveying of the boring locations likely will be needed to determine if the lag gravels are present near elevations of footings and floor slabs. Provided that these lag gravels exist in thicknesses with less than 50 percent clay content, and are comprised of predominantly dense graded stone meeting the maximum particle size criteria in Section 5.1.1 of this report, it may be possible to keep the lag gravels in place in select areas of the site to comprise the recommended remedial thickness for high plasticity clays. If the lag gravels are excavated above the foundation and floor slab bearing elevations, it is possible that a some of the lag gravels could be reused on site provided they conform to the "Soil and Aggregate Fill Placement Criteria" section of this report. A representative of the geotechnical engineer of record should observe and document the composition, consistency, and thickness of encountered lag gravels during construction to determine if these materials can be left in place beneath the structure. Additional laboratory testing may be necessary during construction to determine the suitability of the lag gravels for support of the structure and/or reuse in compacted engineered fill.

## 4.5 EQUIPMENT MOBILITY

The upper fine-grained soils can potentially be sensitive to increases in moisture content during construction activities. PSI has been involved with several projects in this region where these otherwise competent soils can undergo a significant loss of stability while construction activities take place during wetter portions of the year. Thus during wetter portions of the year, there may be an increased difficulty with site grading. Soils that become disturbed would need to be excavated and replaced; however, this remedial excavation may expose progressively wetter soils with depth, thus compounding the problem condition. Thus, a normal approach to subgrade preparation may not be possible.

Depending on weather and soil conditions at the time of construction, methods for accomplishing grading may include the use of wide-track, low-contact-pressure type equipment to perform the recommended site grading. The determination of the proper equipment for use in excavation would be dependent on the condition of the soils at the time of construction and the prevailing weather conditions. Narrow track equipment and rubber tired vehicles may experience difficulty moving about the site and may deteriorate otherwise suitable soils.

## 4.6 SITE COMPACTION

Since this site predominantly consists of silts and clays, it may become difficult to properly compact the soils because of high moisture contents. The soils may need to be scarified and dried to a moisture content that will facilitate compaction in accordance with the structural fill requirements of this report.

PSI understands that high plasticity clay soils, similar to those encountered in PSI's borings, may be considered for use as new structural fill placed for the development of the proposed McDonald's. These high plasticity clay soils could be used for new structural fills with caution. If these high plasticity clay soils are used as new structural fill, the new structural fill should also contain a sufficient content of granular materials that are thoroughly integrated and well-distributed throughout the high plasticity clay fill, in addition to passing the placement and compaction requirements for the materials presented in later sections of this report.

### 4.7 GEOLOGIC HAZARDS

As part of PSI's fulfilment of our scope of services dated July 15, 2022, PSI performed a review of potential geologic hazards at the proposed site of the proposed McDonald's. A cursory review of the geologic maps and map layers for the proposed location of the proposed McDonald's has identified the potential for this site to be underlain by carbonate rock. The presence of carbonate rock indicates the potential for sinkhole development at this site.

The cursory site reconnaissance performed at this project site did not reveal visual indications of active sinkholes. Based on PSI's review of the available topographical and map layer information, such as the USGS 7 ½-minute quadrangle topographical sections, MoDNR analysis of those maps, and the previously referenced "Interactive Maps" database, the available information does not appear to indicate sinkhole activity at the proposed site (see Appendix C). However, given the close proximity of adjacent karst features (reported sinkholes), the proposed McDonald's site could be considered as being within a "karst landscape".

In general, karst landscapes have a higher potential risk of sinkhole formations manifesting at the ground surface when the overburden soils are relatively thin and comprised of collapsible materials. Based on the information obtained from the borings, the overburden soils generally appear to be at least 20 feet thick and predominantly comprised of non-aeolian deposits such as residual soils. Cohesive residual soils can generally be considered to have a lower risk to collapse if underlain by a sinkhole based on the index and shear strength properties of these soils. In karst terrains where several sinkholes are mapped, it is typical for multiple karst features to be present at similar elevation ranges and for those sinkholes to be connected. While MODNR and the "Interactive Maps" database have mapped several sinkholes near the site, the publicly available topographic information at the approximate locations of mapped sinkholes near the site do not clearly indicate that the mapped sinkholes are connected at similar elevation ranges. Therefore, the risk associated with connected karst features underlying the site is unknown at this time. Based on the available information, the potential for overburden collapse due to underlying sinkhole formations appears to be low, however, the risk is not "zero". An elevated risk of potential overburden collapse should be anticipated for this site in the absence of further geophysical testing and a site-specific karst study. It is important to note that the present standard-of-practice of geotechnical engineering does not permit accurate predictions of where or when sinkholes will occur, therefore the owner must be willing to accept the risks associated with developing in karst landscapes.

The proposed McDonald's should be designed to limit the infiltration of water into the potentially collapsible soils underlying the proposed structure. This may include special measures to seal utilities and roofs drains or make them flexible at critical locations to reduce the potential for the introduction of water into the subgrade materials. Perimeter drains should also be installed to minimize the inflow of surface water percolation into the potentially collapsible soils under the proposed structure. Perimeter drains should be designed and constructed with care and specific features to limit the drain's potential to collect, pool, or concentrate water along its alignment.

Site grading should be established to provide positive drainage both during and after construction so as to minimize the potential for sinkhole development as a result of this project. During construction the grading contractor should be alert to indications of possible sinkhole features encountered. Sink features encountered during construction should be reviewed and remediation measures undertaken under the direction of the geotechnical engineer. Placement of any structure overlying sinkholes should be avoided, unless the owner is willing to accept the risk.

The following general comments are provided for consideration in developing plans for the proposed McDonald's. The depressions and sinkholes commonly associated with carbonate rock formations are the result of the continuous process of erosion of the limestone bedrock by solution activity within this formation.

Ultimately, this process can cause a collapse of the overlying limestone or soil overburden, resulting in a sinkhole. The sinkhole can then allow surface water runoff to enter the subsurface passage, further enlarging the sinkhole. 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.

Published information indicate that modification of natural surface drainage patterns is one of the major factors in man induced sinkhole collapses. Factors such as the ponding of surface water or concentrated flow of storm water runoff, leaking underground pipes and faulty drainage features have provided the mechanism for erosion of soil through solution channels in the bedrock. The resulting void eventually collapses depending upon the amount of water entering the system and the soils involved.

# 5. GEOTECHNICAL RECOMMENDATIONS

## 5.1 SITE PREPARATION

PSI recommends that vegetation, roots, soft, organic, frozen, and unsuitable soils in the construction areas be stripped from the site and either wasted or stockpiled for later use in non-load bearing areas. A representative of the geotechnical engineer should determine the depth of removal at the time of construction.

In this region, these otherwise competent silts and lean clays can undergo a significant loss of stability when construction activities take place during wetter portions of the year. PSI anticipates that the soils in the project area can become easily disturbed if subjected to conventional rubber tire or narrow track-type equipment. Soils that become disturbed would need to be excavated and replaced; however, this remedial excavation may expose progressively wetter soils with depth, thus compounding the problem condition. Thus, a normal approach to subgrade preparation may not be possible. Appropriate wide-track equipment selection should aid in minimizing potential disturbance.

It is likely that stripping and excavating to the proposed subgrade level will require the use of wide-track or other equipment that has a low contact pressure on the subgrade. Otherwise, the soils at the excavation bottom may become disturbed and additional excavation would be recommended.

After stripping and excavating to the proposed subgrade level, as required, the building and parking areas should be proof-rolled with a loaded tandem axle dump truck or similar piece of heavy rubber tired vehicle (typically with an axle load greater than 9 tons). Soils that are observed to rut or deflect excessively (typically greater than 1-inch) under the moving load should be undercut and replaced with properly compacted fill. The proofrolling and undercutting activities should be observed and documented by a representative of the geotechnical engineer and should be performed during a period of dry weather. The subgrade soils should be scarified and compacted to at least 90% of the materials' modified Proctor maximum dry density, in general accordance with ASTM procedures, to a depth of at least 6 inches below the surface.

Based on using a system of shallow foundations, PSI recommends that undocumented fill be excavated in the proposed building area. The base of the excavation should extend 5 feet beyond the edge of the building area and slope back to provide a stable slope. It is likely that saturated, soft soils will be encountered as the excavation approaches the bottom of the undocumented fill. Once undocumented fill has been removed, clean, over-sized rock (2"-5") may be rolled into the base of the excavation to allow for a working surface to allow for proper compaction. No more than 2 inches of clean rock should be exposed above the base of the excavation to reduce the amount of fine migration which can lead to undesirable amounts of settlement. A representative of the geotechnical engineer should be present to observe the placement of the stone.

Highly plasticity clays should be remediated prior to placement of new fill. The high plasticity clays can be remediated or replaced as discussed earlier. A representative of PSI's geotechnical engineer should observe the subgrade soils, perform plasticity index tests, and estimate the approximate extent of the exposed high plasticity clays. If it is desirable to modify the high plasticity clays with a lime product, such as Code L, PSI recommends that concentration levels be estimated by conducting a lime series test with the actual soils and additives that will be used. The geotechnical engineer's representative should observe the remediation procedures for compliance with the project plans and specifications.

Moisture content changes in the high plasticity soils should not be permitted during or after construction. Increases in moisture content can cause swelling of the high plasticity soils. If the exposed high plasticity clays become inundated or desiccated, PSI recommends they be removed prior to new fill placement. Ideally, excavation should be performed during a period of dry weather.

After subgrade preparation and observation have been completed, fill placement required to establish grade may begin. Fill materials should be free of organic or other deleterious materials, have a maximum particle size less than 3 inches, and have a liquid limit less than 45 and plasticity index less than 25. Fill materials should have a Proctor maximum dry density greater than 100 pcf. Soils classified as CL, ML, CL-ML, SM, SC-SM, SW, and GW will generally be suitable for use as structural fill. Soils classified as MH, CH, GP and SP could be made suitable for use as structural fill with caution. The application of these materials should be reviewed by the geotechnical engineer prior to implementation. The on-site CL and ML soils are suitable for use as structural fill, but some moisture conditioning, such as scarifying and drying, may be needed to achieve compaction. If the fill is too dry, water should be uniformly applied and thoroughly mixed into the soil by disking or scarifying. Close moisture content control will be required to achieve the recommended degree of compaction.

High plasticity clays could be made suitable for use as structural fill with caution, provided that each of the following additional items are also satisfied for the new fill:

1) New fill materials containing high plasticity clay soils should also have granular material contents of greater than or equal to 50 percent by weight. The granular material content (i.e. rock fragments) should be determined by gradation testing of the materials.
2) The presence of granular materials within these new structural fills are evenly distributed with no permeable granular pockets, lenses, or layers.
3) The new structural fill can be tested with nuclear density gauge test methods, or similar field moisture-density tests. Where rock fragments are comprised predominantly of chert, and where the chert is used to obtain a sufficient granular content for the new high plasticity clay structural fill, a Proctor maximum dry density of greater than 95 pcf could be used.

Permeable fill such as sand or clean stone used on this site should be given careful consideration. These permeable materials should not be placed within 3 feet of high plasticity clays. Even though the excavation may be essentially dry during construction, and no groundwater is anticipated over time, these permeable pockets will eventually collect water through condensation and therefore promote soil swelling and heaving. If moderately permeable fill is used, it is strongly recommended that it be drained through the use of draintile or other appropriate means.

Structural fill to establish construction grades should be placed in maximum loose lifts of 8 inches and compacted as defined in the fill placement portion of this report. Each lift of compacted-engineered fill should be observed, tested and documented by a representative of the geotechnical engineer prior to placement of subsequent lifts. The edges of compacted fill should extend 5 feet beyond the edges of buildings prior to sloping. In addition to structural fills, utility trenches within the building and parking area should be compacted as outlined above.

### 5.1.1 SOIL AND AGGREGATE FILL PLACEMENT CRITERIA

The fill placed shall be tested and documented by a geotechnical technician and directed by a geotechnical engineer to evaluate the placement of fill material. In general, a separate modified Proctor test should be performed for every change in material. The geotechnical engineer of record can only review the testing that is performed under the geotechnical engineer of record's direct supervision. The following table summarizes the recommended compactive effort for various types of engineered fills.

| MATERIAL TESTED | PROCTOR TYPE | MIN % DRY DENSITY | MOISTURE CONTENT RANGE | FREQUENCY OF TESTING* |
|---|---|---|---|---|
| Structural Fill (Cohesive) – CL or ML | Modified | 90% | -2 to +2 % | 3 per 1,000 cy of fill placed |
| Structural Fill (Cohesive) – GC** | Modified | 90% | 0 to +3 % | 3 per 1,000 cy of fill placed |
| Structural Fill (Granular) | Modified | 90% | -2 to +2 % | 3 per 1,000 cy of fill placed |
| Random Fill (non-load bearing) | Modified | 88% | -3 to +3 % | 3 per 3,000 cy of fill placed |
| Utility Trench Backfill / Wall Backfill | Modified | 90% | -2 to +2 % | 3 per 200 cy of fill placed |

*Minimum of 3 tests per lift

**This specification should be used where high plasticity clay soils are combined with sufficient contents of granular materials for use as new structural fill.

The test frequency for the laboratory reference should be one laboratory Proctor test for every 5 field density tests for the first 25 field tests and for every 10 field density tests thereafter for each material used on the site. If the borrow or source of fill material changes, a new reference moisture/density test should be performed.

After the first 5 reference moisture/density tests have been performed for the same material, a 1-point proctor test can be used at an interval of one for every 10 field density tests to extend the full reference test cycle to one for every 25 field density tests. One-point proctor tests must be compacted within -2 and 0 % dry of the calculated optimum moisture content as based on the family of optimum determined from the first 5 reference moisture density tests.

Tested fill materials that do not achieve either the required dry density or moisture content range shall be recorded, the location noted, and reported to the Contractor and Owner. A re-test of that area should be performed after the Contractor performs remedial measures.

### 5.1.2 HIGH PLASTICITY CLAY CONSIDERATIONS

Due to the presence of high plasticity clays, consideration should be given to measures that can reduce the long term shrink/swell potential of the clay soils. High plasticity clays expand or shrink by absorbing or losing moisture; therefore, reducing the moisture content variation of a soil will reduce its volume change. Although it is not possible to prevent soil moisture changes, a number of steps may be taken to aid in the reduction of subsoil moisture content variations. These steps are intended to help reduce the shrink/swell potential, not eliminate it. Some of these measures are:

1. During construction, a positive drainage scheme should be implemented and maintained to prevent ponding of water on subgrades.
2. The building subgrade should not be allowed to dry out; backfill should proceed as soon as possible to minimize changes in the natural moisture regime.
3. Permanent positive drainage should be maintained around the building through a roof/gutter system connected to drainage piping or discharging upon paved surfaces, thereby transmitting water away from the foundation perimeter. In addition, site grading should provide rapid drainage of surface water away from foundation areas.
4. Utility trenches should be backfilled with low plasticity clays to reduce the potential of the trenches to act as aqueducts transmitting water beneath the structures due to excess surface water infiltration.
5. Shrubbery, flower beds and sprinkler systems surrounding the structures should be eliminated or at least limited, and should be designed so that the bedding soils drain away from the building areas. The planters should have impermeable bases with weep holes discharging into drainage pipes or onto paved surfaces.
6. Trees and/or large bushes should not be planted adjacent to the structures.
7. Since plumbing and other water leaks can cause excessive heaving of high plasticity soils, every effort should be made to maintain the plumbing in good working order and prevent or minimize water leaks and discharges. It is recommended that all water supply lines and waste water lines be tested for leaks prior to backfilling the utility trenches.

Moisture content changes, typically either higher than 5% above the plastic limit or lower than the plastic limit, in the highly plastic soils should not be permitted during or after construction. Increases in moisture content can cause swelling of the high plasticity soils during construction and increase shrinkage potentials due to drying after construction. If the exposed fat clays become inundated or desiccated, PSI recommends they be removed prior to new fill placement. Ideally, excavation should be performed during a period of dry weather.

## 5.2 FOUNDATION RECOMMENDATIONS

### 5.2.1 SPREAD FOOTING RECOMMENDATIONS

The planned construction can be supported on conventional spread-type footing foundations bearing on either competent naturally deposited soils or compacted-engineered fill. Spread footings for building columns and continuous footings for bearing walls can be designed for allowable soil bearing pressures of 3,100 psf and 2,900 psf, respectively, based on dead load plus design live load. These allowable soil bearing pressures are based on the loads and finished floor elevations provided in Section 1.2 of this report, foundations bearing at a depth of 2 ½ feet below exterior or adjacent grades, and are based on foundation widths of 7 feet and 2 feet for spread footings and continuous footings, respectively. PSI recommends a minimum dimension of 24 inches for square footings and 18 inches for continuous footings to reduce the possibility of a local bearing capacity failure.

After stripping and excavating to the proposed subgrade level, as required, the foundation bearing surface should be proof compacted with a hydraulic vibratory compactor plate that exerts at least 16,000 pounds of impulse force at 2,100 cycles per minute on a plate no larger than 29 inches by 32 inches. If the ground becomes unstable or compresses more than 1-inch, the foundation soils shall be over excavated and replaced until either the subgrade passes the proof compaction or a thickness of 2 times the minimum base width of the foundation below the foundation is replaced with documented structural fill. It should be noted that there will be some elevated potential for higher settlements with this approach oppose to traditional proof-rolling methods. Proof compaction should be observed and documented by the engineer of record or their direct representative during the foundation preparation work.

Exterior footings and footings in unheated areas should be located at a depth of 30 inches or deeper below the final exterior grade to provide adequate frost protection. If the building is to be constructed during the winter months or if footings will likely be subjected to freezing temperatures after foundation construction, then interior and exterior footings should be protected from freezing. Otherwise, interior footings can be located at nominal depths compatible with architectural and structural considerations.

Laboratory consolidation testing was beyond the scope of this exploration. Based on the explored subsurface conditions and site geology, laboratory testing and past experience, PSI anticipates that properly designed and constructed footings supported on the recommended materials should experience total and differential settlements between adjacent columns of less than 1 ¼-inch and ¾-inch, respectively. **It is important to note, that this site is sensitive to settlement. Increases in loading or changes in floor or foundation grade may result in undesired amounts of settlement. The geotechnical engineer should be consulted prior to loading changes. The calculated settlements in this report were prepared using empirical consolidation parameters correlated with moisture contents, and the allowable soil bearing pressures and foundation dimensions presented in this section of the report. These calculated settlements should be considered approximate.**

### 5.2.2 SHALLOW FOUNDATION CONSTRUCTION CONSIDERATIONS

The foundation excavations should be observed by a representative of PSI prior to steel or concrete placement to assess that the foundation materials are consistent with the materials discussed in this report. Soft or loose soil zones encountered at the bottom of the footing excavations should be removed to the level of competent naturally deposited soils or properly compacted structural fill as directed by the geotechnical engineer. Cavities formed as a result of excavation of soft or loose soil zones should be backfilled with lean concrete or dense graded compacted crushed stone.

After opening, footing excavations should be observed and concrete placed as quickly as possible to avoid exposure of the footing bottoms to wetting and drying. Surface runoff water should be drained away from the excavations and not be allowed to pond. If possible, the foundation concrete should be placed during the same day the excavation is made. If it is required that footing excavations be left open for more than one day, the soils in the excavation should be protected to reduce evaporation or entry of moisture.

Since there is the possibility of constructing below ground water table at certain times of the year, PSI recommends dewatering the site prior to excavating be considered. Dewatering should be able to be accomplished by excavating a perimeter trench around the site and backfilling with a filter fabric protected clean gravel and a submersible pump to excavate the water. The water table, if encountered, should be lower at least 2 feet below the bottom of the excavation.

## 5.3 EARTHQUAKE AND SEISMIC DESIGN CONSIDERATION

The 2018 International Building Code (IBC) requires that a site class be determined for the calculation of earthquake design forces in structures. The site class designation is a function of soil type (i.e., depth of soil and strata types). Auger refusal on bedrock was not encountered during this exploration. Based on PSI's borings and experience in this area, PSI is basing this site class designation on encountering rock at approximately 25 feet below the ground surface and that the consistency of the soils below the depth of the boring are consistent or stiffer than the 20 feet of depth explored. Additional drilling or shear wave velocity testing is needed to define the depth to rock. Based on the estimated depth to rock and the estimated shear strength of the soil at the boring locations, Site Class "C" is recommended. The USGS-NEHRP probabilistic ground motion values interpolated between the nearest four grid points from latitude 37.1822° and longitude –93.3555° are as follows:

| Period (seconds) | 2% Probability of Event in 50 Years (%g) | Site Coefficients | Max. Spectral Acceleration Parameters | Design Spectral Acceleration Parameters | |
|---|---|---|---|---|---|
| 0.2 ($S_s$) | 18.5 | $F_a = 1.3$ | $S_{ms} = 0.24$ | $S_{Ds} = 0.16$ | $T_0 = 0.129$ |
| 1.0 ($S_1$) | 10.3 | $F_v = 1.5$ | $S_{m1} = 0.155$ | $S_{D1} = 0.103$ | $T_s = 0.644$ |
| | | | $S_{ms} = F_a S_s$ | $S_{Ds} = ⅔*S_{ms}$ | $T_0 = 0.2*S_{D1}/S_{Ds}$ |
| | | | $S_{m1} = F_v S_1$ | $S_{D1} = ⅔*S_{m1}$ | $T_s = S_{D1}/S_{Ds}$ |

The Site Coefficients, $F_a$ and $F_v$ were interpolated for IBC 2018 Tables 1613.2.3(1) and 1613.2.3(2) as a function of the site classifications and the mapped spectral response acceleration at the short ($S_s$) and 1-second ($S_1$) periods.

Based on the Spectral Acceleration values for this site, structures with a Risk Category of I, II, and III (Table 1604.5) could be designed as a Seismic Design Category B as defined in Tables 1613.2.5(1) and 1613.2.5(2). Structures with a Risk Category IV could be designed as a Seismic Design Category C. The Risk Category is based on the nature of the occupancy of the structure and is typically determined by the design team (Architect/Structural Engineer) or building official. The determination of the Risk Category is beyond PSI's scope of service.

According to IBC 2018, Section 1803.5.11 requires that sites with a Seismic Design Categories C through F be evaluated for slope instabilities, liquefaction, surface rupture due to faulting or lateral spreading and estimates on the differential settlement. A detailed study of these effects was beyond PSI's scope of services. However, the following table presents a qualitative assessment of these issues considering the site class, the subsurface soil properties, the groundwater elevation, and probabilistic ground motions:

| HAZARD | RELATIVE RISK | COMMENTS |
|---|---|---|
| Slope Stability | Low | The site is relatively flat and does not/will not incorporate significant cut or fill slopes |
| Liquefaction | Low | The soil within the upper 20 feet of the subsurface profile is a relatively dense and/or cohesive soil |
| Settlements | Low | Based on the relatively dense/cohesive nature of the soils, the excess pore pressures generated by a seismic event should not induce a significant amount of settlement |
| Surface Rupture | Low | The site is not underlain by a mapped Holocene-aged fault |

### 5.4 FLOOR SLAB RECOMMENDATIONS

The floor slab can be grade supported on naturally occurring CL or ML soils, or properly compacted/engineered fill. It is PSI's understanding that the floor slab for the proposed McDonald's will ***not*** support loads greater than "typical" floor slab loads (<125 psf). If sections of the floor slab will support loads greater than "typical" floor slab loads, underlying subgrade soils below these sections may need to be removed and replaced with compacted/engineered fill. PSI recommends that if the proposed building will include heavily loaded floor slab sections, PSI should be provided the opportunity to review the final design plans and specifications to determine if the underlying subsurface soils can adequately support the heavily loaded floor slab sections. Proofrolling, as discussed earlier in this report, should be accomplished to identify soft or unstable soils that should be removed from the floor slab area prior to fill placement and/or floor slab construction. High plasticity clays below floor slabs should be remediated, as discussed earlier. The following recommendations are based on "typical" floor slab loads.

It is recommended that the floor slab be grade supported on crushed limestone or sand/gravel mix of MODOT Type 5 or similar. Where additional drainage capabilities are desired, a more open-graded material may be used. Crushed limestone of MODOT Type 5 containing 6% fines or less would be suitable for this use. If the floor slab is to be supported on MODOT Type 5 crushed limestone or other open-graded material, PSI recommends utilizing a geo-textile fabric between the subgrade soils and this base material to prevent the migration of the subgrade soil into the voids of the open graded "clean" crushed limestone.

PSI recommends that a minimum 4-inch thick free draining granular mat be placed beneath the floor slab to enhance drainage. The soil surface shall be graded to drain away from the building without low spots that can trap water prior to placing the granular drainage layer. Polyethylene sheeting should be placed to act as a vapor retarder where the floor will be in contact with moisture sensitive equipment or product such as tile, wood, carpet, etc., as directed by the design engineer. The decision to locate the vapor retarder in direct contact with the slab or beneath the layer of granular fill should be made by the design engineer after considering the moisture sensitivity of subsequent floor finishes, anticipated project conditions and the potential effects of slab curling and cracking. The floor slabs should have an adequate number of joints to reduce cracking resulting from differential movement and shrinkage.

For subgrade prepared as recommended and properly compacted fill, a modulus of subgrade reaction, *k* value, of 140 pounds per cubic inch (pci) may be used in the grade slab design based on values typically obtained from 1-foot x 1-foot plate load tests. However, depending on how the slab load is applied, the value will have to be geometrically modified. The value should be adjusted for larger areas using the following expression for cohesive and cohesionless soil:

Modulus of Subgrade Reaction, $k_s = \left(\frac{k}{B}\right)$ for cohesive soil and

$k_s = k\left(\frac{B+1}{2B}\right)^2$ for cohesionless soil

where:

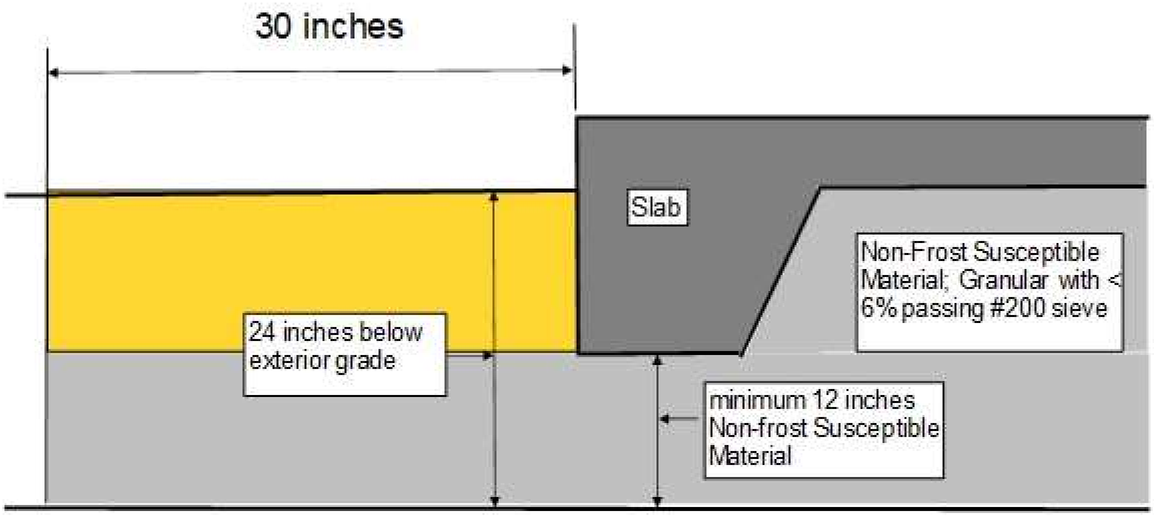
$k_s$ = coefficient of vertical subgrade reaction for loaded area,

$k$ = coefficient of vertical subgrade reaction for 1x1 square foot area, and

$B$ = width of area loaded, in feet

### 5.4.1 UNHEATED SLAB RECOMMENDATIONS

Grade supported slab structures in unheated areas shall have a minimum of 12 inches of non-frost susceptible materials to a depth of 24 inches below the exterior grade with at least 12 inches below the bottom of the slab or perimeter footings. These materials shall extend at least 30 inches from the outside limits of the grade supported slab. The 30-inch dimension can be reduced by 1.25 inches for every additional inch below 24 inches that the non-frost susceptible material is extended below grade. Non-frost susceptible soil is defined as drained, granular material with less than 6% passing the #200 sieve. The non-frost susceptible soils shall be graded and gravity drained such that it will not impound or trap water within the frost protected area.




### 5.5 PAVEMENT SECTION RECOMMENDATIONS

PSI's scope of services did not include extensive sampling and CBR testing of existing subgrade or potential sources of imported fill for the specific purpose of detailed pavement section analysis. Instead, PSI has based this report on pavement-related design parameters that are considered to be typical for the area soil types.

In large areas of pavement, or where pavements are subject to significant traffic, a more detailed analysis of the subgrade and traffic conditions should be made. The results of such a study will provide information necessary to design an economical and serviceable pavement.

The recommended thicknesses presented below are considered typical and minimum for the parameters used in this report. PSI understands that given budgetary considerations, it is desirable to place thinner pavement sections than those presented. However, the client, the owner, and the project principals should be aware that thinner pavement sections might result in increased maintenance costs and lower than anticipated pavement life. The pavement subgrade should be prepared as discussed in the "Site Preparation" section of this report.

PSI has estimated the subgrade soils will be prepared to achieve a CBR of at least 3. Based on this value, it is possible to use a locally typical "standard" pavement section consisting of the following:

| Recommended Thicknesses (Inches)* | | |
|---|---|---|
| **Pavement Materials **** | **Car Parking** | **Driveways** |
| Asphaltic Surface Course | 1½ | 1½ |
| Asphaltic Binder Course | 2½ | 3½ |
| Base Rock | 6 | 6 |
| Or | | |
| Portland Cement Concrete | 5 | 6 |
| Base Rock | 4 | 4 |

* Pavement sections were evaluated using Pavement Assessment Software (PAS) which is based on the 1986 AASHTO Design equations; a reliability of 80%; and a 20-year 18-kip single axle load (ESAL) of 30,000 for light duty and 60,000 for drive areas. Flexible Pavements were evaluated based on an initial serviceability of 4.2 and a terminal service of 2.0. Rigid Pavements were evaluated based on an initial serviceability of 4.5 and a terminal service of 2.0; an unreinforced concrete mix with a 28-day modulus of rupture of 550 psi (approx. 4,000 psi compressive strength)

** Pavement materials should conform to local and state guidelines, if applicable.

Rigid concrete pavement is recommended where trash dumpsters or semi-trailers are to be parked on the pavement or where a considerable load is transferred from relatively small steel wheels. This should provide better distribution of surface loads to the subgrade without causing deformation of the surface. Trash dumpster pads should be at least 8 inches thick and properly reinforced.

Pavement may be placed after the subgrade has been properly compacted, fine graded and proofrolled. The work should be done in accordance with State Department of Transportation guidelines.

<u>Asphalt Pavement Section</u>

The granular base course should be built at least 2 feet wider than the pavement on each side to support the tracks of the slipform paver. This extra width is structurally beneficial for wheel loads applied at pavement edges. The asphalt base course should be compacted to a minimum of 95% Marshall density according to ASTM D1559.

Asphaltic surface mixture should have a minimum stability of 1,800 pounds and the surface course should be compacted to a minimum of 97% Marshall density according to ASTM D1559. To reduce the potential thermal cracking in this region, asphalt binder grade of PG 64-28 is recommended. However, for base mixes to be placed 4 inches below the surface, PG 64-22 is sufficient.

Asphaltic concrete mix designs and Marshall characteristics should be reviewed by PSI to determine if they are consistent with the recommendations given in this report.

<u>Concrete Pavement Section</u>

Because the pavement at this site will be subjected to freeze-thaw cycles, PSI recommends that an air entrainment admixture be added to the concrete mix to achieve an air content in the range of 5% to 7% to provide freeze-thaw durability in the concrete. Concrete with a 28-day specified compressive strength of 4,000 psi should be adequate in this area. A mixture with a maximum slump of 4 inches is acceptable. If a water reducing admixture is specified, the slump can be higher. It is recommended that admixtures are submitted in advance of use in the concrete.

Pavement for the dumpster area should be constructed of Portland cement concrete with a load transfer device installed where construction joints are required. A thickened edge is recommended on the outside of slabs subjected to wheel loads. This thickened edge usually takes the form of an integral curb. Fill material should be compacted behind the curb or thickened edge of the outside slabs. The following are recommended to enhance the quality of the pavement.

- Moisten subgrade just prior to placement of concrete.
- Cure fresh concrete with a liquid membrane-forming curing compound.
- Keep automobile traffic off the slab for 3 days and truck traffic off the slab for 7 days, unless tests are made to determine that the concrete has gained adequate strength (i.e., usually 4,000 psi)

Base Rock Section

PSI recommends that a MODOT Type 5 aggregate base rock (MODOT Specifications Handbook, Sec. 1007.3.2) be used under the asphalt or concrete pavements. The material should be placed and compacted as discussed in the "Soil and Aggregate Fill" section of this report. The following recommended gradations are based on the specifications of MODOT for a Type 5 aggregate base rock.

| **Sieve Size** | **Percent Passing by Weight (Mass)** |
|---|---|
| 1-inch (25.0 mm) | 100 |
| 1/2-inch (12.5 mm) | 60-90 |
| No. 4 (4.75 mm) | 35-60 |
| No. 30 (600 µm) | 10-35 |
| No. 200 (75 µm) | 0-15 |

Pavement Subgrade Preparation

Prior to paving, the prepared subgrade should be proofrolled using a loaded tandem axle dump truck or similar type of pneumatic tired equipment with a minimum gross weight of 9 tons per single axle. Localized soft areas identified should be repaired prior to paving. Moisture content of the subgrade be maintained between -2% and +3% of the optimum at the time of paving. It may require rework when the subgrade is either desiccated or wet.

Construction traffic should be minimized to prevent unnecessary disturbance of the pavement subgrade. Disturbed areas, as verified by PSI, should be removed and replaced with properly compacted material.

Pavement Drainage & Maintenance

PSI recommends pavements be sloped to provide rapid surface drainage. Water allowed to pond on or adjacent to the pavement could saturate the subgrade and cause premature deterioration of pavements, and removal and replacement may be required. Consideration should be given to the use of an interceptor drain to collect and remove water collecting in the granular base. The interceptor drains could be incorporated with the storm drains of other utilities located in the pavement areas.

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

## 6. CONSTRUCTION CONSIDERATIONS

PSI should be retained to provide observation and testing of construction activities involved in the foundation, earthwork, and related activities of this project. PSI cannot accept responsibility for conditions that deviate from those described in this report, nor for the performance of the foundation system if not engaged to also provide construction observation and testing for this project.

### 6.1 MOISTURE SENSITIVE SOILS/WEATHER RELATED CONCERNS

The upper fine-grained soils encountered at this site are expected to be sensitive to disturbances caused by construction traffic and to changes in moisture content. During wet weather periods, increases in the moisture content of the soil can cause significant reduction in the soil strength and support capabilities. In addition, soils that become wet may be slow to dry and thus significantly retard the progress of grading and compaction activities. It will, therefore, be advantageous to perform earthwork and foundation construction activities during dry weather.

### 6.2 DRAINAGE AND GROUNDWATER CONSIDERATIONS

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

While groundwater was not encountered at the time the field exploration was conducted, it is possible that seasonal variations will cause fluctuations or a water table to be present in the upper soils. Additionally, perched water may be encountered in discontinuous zones within the overburden or near the contact with bedrock. Water should be removed from excavations by pumping. The Geotechnical engineer should be consulted if excessive and uncontrolled amounts of seepage occur.

### 6.3 RECOMMENDED CONSTRUCTION SERVICES

The information provided in this report may be based on interpretation of client supplied information, publicly available data bases, exploration data, and PSI's experience and knowledge. The client must recognize that some geological variations are expected occur between boring locations and physical characteristics are expected to vary with time; therefore, it is important to retain the geotechnical engineer throughout the construction period. Though the geotechnical engineer may be needed during other phases of the project, PSI recommends the geotechnical engineer, or their representative, be present during the following at a minimum to confirm the materials are consistent with our design recommendations:

- Stripping of the subgrade
- Proof-rolling of the subgrade prior to fill placement, slab construction and pavement placement
- Fill placement to establish grade
- Foundation excavations prior to concrete placement

- Slab subgrade prior to concrete placement

If conditions are observed that vary from those stated in this report, PSI can provide updated recommendations based on the site conditions at the time of construction.

### 6.4 RECOMMENDED ADDITIONAL GEOTECHNICAL SERVICES

Due to the proposed McDonald's being located within a karst terrain, and the potential risk to developments overlying possible karst features, the following additional geotechnical services should be considered prior to design and construction:

- Electrical Resistivity Tomography (ERT) Testing: ERT is a geophysical method that can be used to interpret changes in material densities within the subsurface profile based on an evaluation of the electrical resistivity of those subsurface materials. This geophysical method can be useful in karst terrain to aid in identification of potential karst features, or to evaluate the site for potential pinnacled rock. While there were no obvious signs of pinnacled rock encountered in PSI's borings, documentation of the local geology at this site indicates their potential presence within the vicinity of the site.
- Refraction Micro-Tremor (ReMi) Testing: ReMi is a geophysical method that can be used to interpret changes in material densities within the subsurface profile based on an evaluation of the shear wave component of ambient surface waves at the site. This geophysical method is typically applied to determine the shear wave velocity profile of a site for use in Seismic Site Class classifications per the IBC. In addition, when this testing is performed at sites underlain by karst features, such as sinkholes, it is possible that relatively large karst features underlying a significant portion the ReMi arrays could be detected by a significant drop in shear wave velocity near the karst feature depth range. While there is no conclusive information indicating significant karst features underly the site, and while there is limited information on the depth to bedrock at this site, the ReMi testing could aid in evaluating each of these potential conditions within the upper 100 feet of the subsurface profile.

### 6.5 EXCAVATIONS

In Federal Register, Volume 54, No. 209 (October 1989), the United States Department of Labor, Occupational Safety and Health Administration (OSHA) amended its "Construction Standards for Excavations, 29 CFR, part 1926, Subpart P". This document was issued to better enhance the safety of workers entering trenches or excavations. It is mandated by this federal regulation that excavations, whether they be utility trenches, basement excavation or footing excavations, be constructed in accordance with the new OSHA guidelines. It is PSI's understanding that these regulations are being strictly enforced and if they are not closely followed, the owner and the contractor could be liable for substantial penalties.

The contractor is solely responsible for designing and constructing stable, temporary excavations and should shore, slope, or bench the sides of the excavations as required to maintain stability of both the excavation sides and bottom. 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.

PSI is providing this information solely as a service to our client. PSI does not assume responsibility for construction site safety or the contractor's or other party's compliance with local, state, and federal safety or other regulations.

## 7. GEOTECHNICAL RISK

The concept of risk is an important aspect of the geotechnical evaluation. The primary reason for this is that the analytical methods used to develop geotechnical recommendations do not comprise an exact science. The analytical tools which geotechnical engineers use are generally empirical and must be used in conjunction with engineering judgment and experience. Therefore, the solutions and recommendations presented in the geotechnical evaluation should not be considered risk-free and, more importantly, are not a guarantee that the interaction between the soils and the proposed structure will perform as planned. The engineering recommendations presented in the preceding section constitutes PSI’s professional estimate of those measures that are necessary for the proposed structure to perform according to the proposed design based on the information generated and reference during this evaluation, and PSI’s experience in working with these conditions.

## 8. REPORT LIMITATIONS

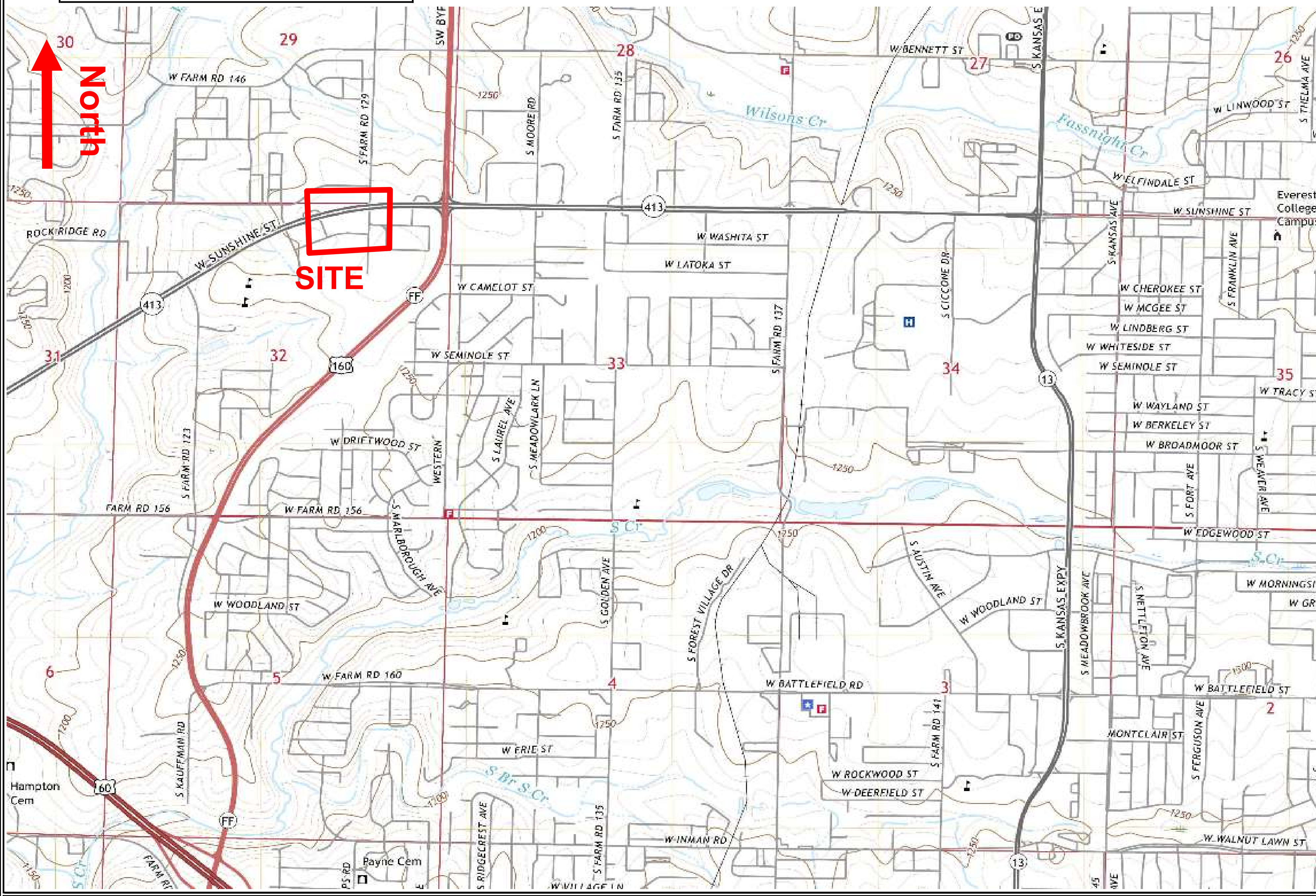
The recommendations submitted are based on the available subsurface information obtained by PSI and design details furnished by the Client and the design team. If there are revisions to the plans for this project or if deviations from the subsurface conditions noted in this report are encountered during construction, PSI should be notified immediately to determine if changes in the foundation recommendations are required. If PSI is not retained to perform these functions, PSI will not be responsible for the impact of those conditions on the project.

The geotechnical engineer warrants that the findings, recommendations, specifications, or professional advice contained herein have been made in accordance with generally accepted professional geotechnical engineering practices in the local area. No other warranties are implied or expressed.

After the plans and specifications are more complete, the geotechnical engineer should be retained and provided the opportunity to review the final design plans and specifications to check that our engineering recommendations have been properly incorporated into the design documents. At that time, it may be necessary to submit supplementary recommendations. This report has been prepared for the exclusive use of McDonald’s USA, LLC for the specific application to the proposed McDonald’s in Springfield, Missouri.

**APPENDIX A - VICINTY MAP**

**Professional Service Industries, Inc.**




| | | | | |
|---|---|---|---|---|
| **Topographic Map**<br><br>**Provided by the USGS** | **Proposed McDonald's**<br>**3720 W. Sunshine Street**<br>**Springfield, Missouri** | PSI Project Number<br>Map Date<br>Contour Elevation (ft) | 0040447-1<br>2021<br>10 | Drawn By: DI<br>Date: 8/31/2022<br>Map Name: Springfield, MO |

## APPENDIX B – AERIAL PHOTOGRAPH

**Professional Service Industries, Inc.**

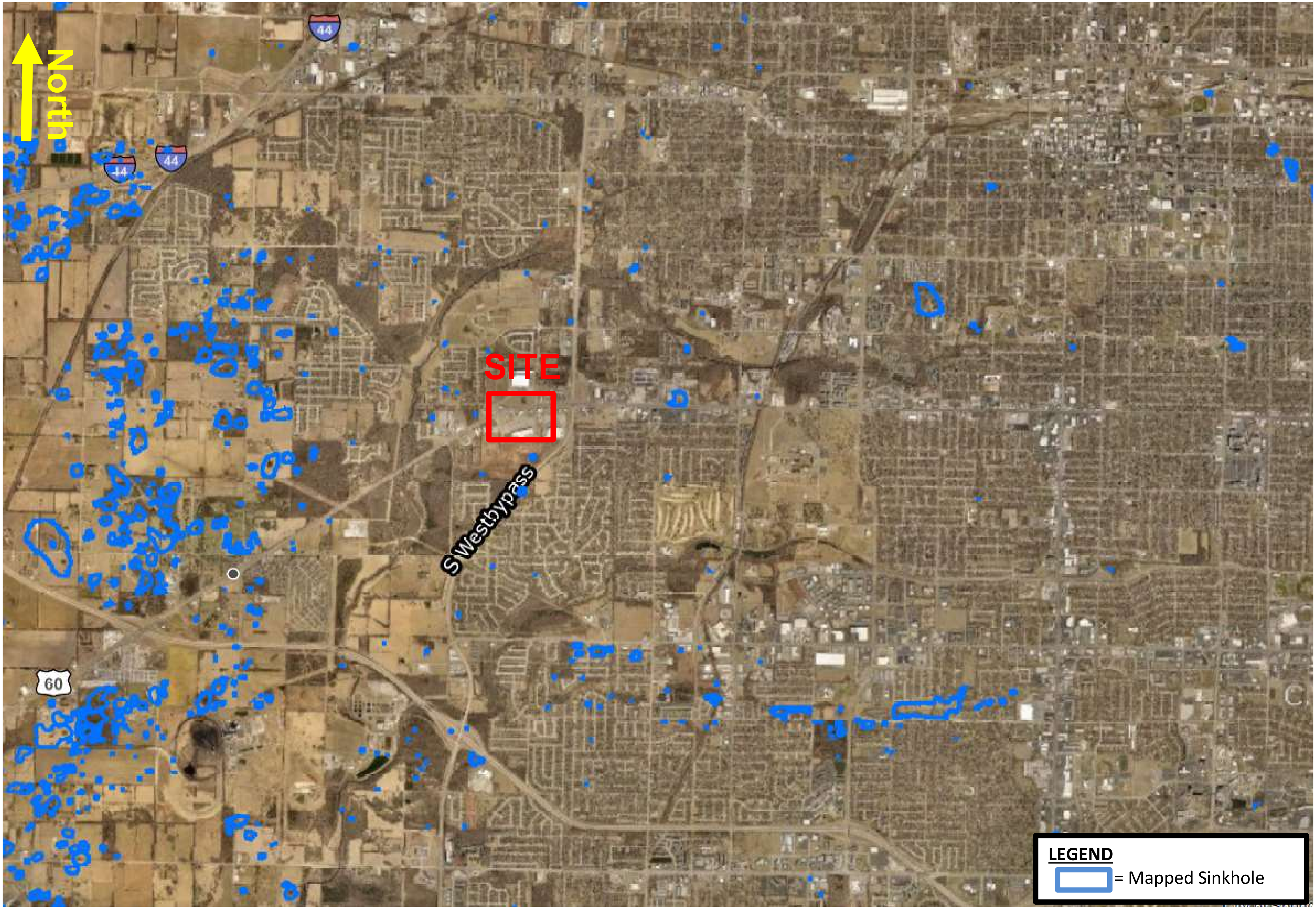

| | | | | | |
|---|---|---|---|---|---|
| **Aerial Photograph Provided by Google Earth™** | **Proposed McDonald's Springfield, Missouri** | PSI Project Number | 0040447-1 | Drawn By: | DI |
| | | Photograph Date | Nov. 2021 | Date: | 8/31/2022 |

## APPENDIX C – MAPPED SINKHOLE LOCATIONS

Professional Service Industries, Inc.


| Mapped Sinkholes (Zoomed In)<br>Provided by City of Springfield, MO GIS | Proposed McDonald's<br>Springfield, Missouri | PSI Project Number<br>Date Obtained | 0040447-1<br>8/30/2022 | Drawn By:<br>Date: | DI<br>8/31/2022 |
|---|---|---|---|---|---|

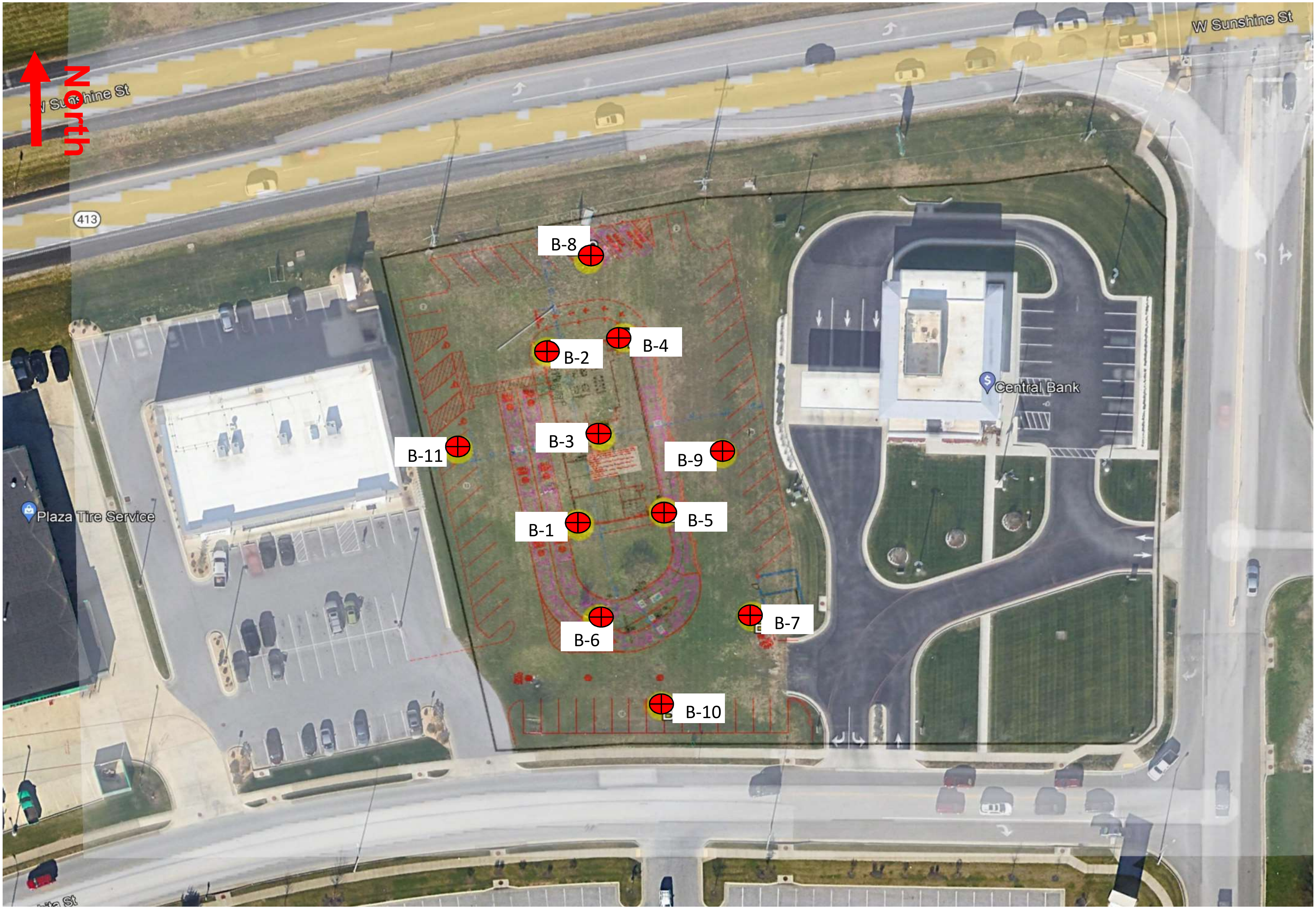
Professional Service Industries, Inc.




| Mapped Sinkholes (Zoomed Out) Provided by City of Springfield, MO GIS | Proposed McDonald's Springfield, Missouri | PSI Project Number | 0040447-1 | Drawn By: | DI |
|---|---|---|---|---|---|
| | | Date Obtained | 8/30/2022 | Date: | 8/31/2022 |

## APPENDIX D - BORING LOCATION PLANS

Professional Service Industries, Inc.




| Boring Location Plan with Client Site Plan | Proposed McDonald's Springfield, Missouri | PSI Project Number 0040447-1 | Drawn By: DI<br>Date: 8/31/2022 |
|---|---|---|---|

**Professional Service Industries, Inc.**


| | | | | | |
|---|---|---|---|---|---|
| **Boring Location Plan with Client Site Plan** | **Proposed McDonald's Springfield, Missouri** | PSI Project Number | 0040447-1 | Drawn By: | DI |
| | | | | Date: | 8/31/2022 |

## APPENDIX E – BORING LOGS AND LABORATORY TEST REPORTS

# BORING B-01

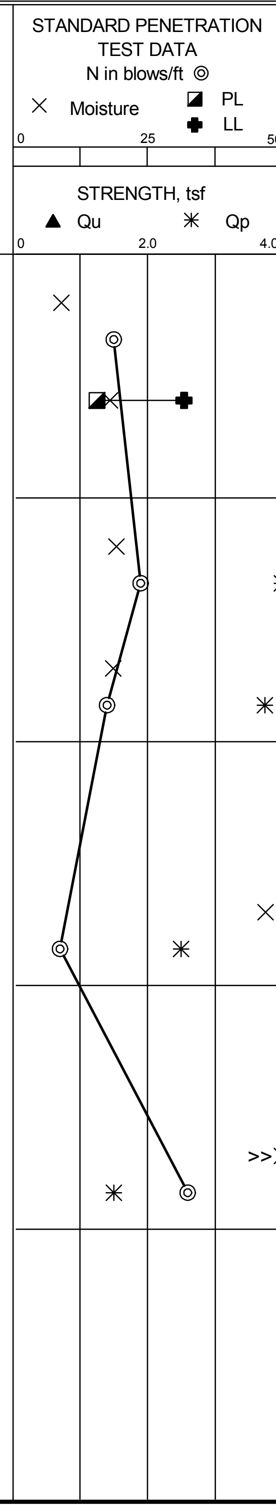
| | | | |
|---|---|---|---|
| **DATE STARTED:** | 8/16/22 | **DRILL COMPANY:** | REDI |
| **DATE COMPLETED:** | 8/16/22 | **DRILLER:** Eric | **LOGGED BY:** Corey |
| **COMPLETION DEPTH** | 20.0 ft | **DRILL RIG:** | CME 750 |
| **BENCHMARK:** | N/A | **DRILLING METHOD:** | Hollow Stem Auger |
| **ELEVATION:** | 1261 ft | **SAMPLING METHOD:** | SS/ ST |
| **LATITUDE:** | 37.1821° | **HAMMER TYPE:** | Automatic |
| **LONGITUDE:** | -93.3556° | **EFFICIENCY** | 75% |
| **STATION:** N/A | **OFFSET:** N/A | **REVIEWED BY:** | DI |

**REMARKS:** $N_{60}$ denotes the normalization to 60% efficiency as described in ASTM D4633.

| **Water** | | |
|---|---|---|
| While Drilling | | Not Encountered |
| Upon Completion | | Not Encountered |
| Delay | | N/A |

**BORING LOCATION:**
Proposed Building

| Elevation (feet) | Depth, (feet) | Sample Type | Sample No. | Recovery (inches) | MATERIAL DESCRIPTION | USCS Classification | SPT Blows per 6-inch (SS) Push Pressure (ST) | Moisture, % | Additional Remarks |
|---|---|---|---|---|---|---|---|---|---|
| | 0 | | | | Orangish-brown, SILT (ML) (FILL) | ML | | | |
| 1260 | | SS | 1 | 8 | | | 4,7,8 $N_{60}$=19 | 9 | |
| | | ST | 2 | | Brown and gray, lean CLAY (CL), with gravel (FILL) | CL | 500 psi | 18 | LL = 32 PL = 16 |
| 1255 | 5 | SS | 3 | 18 | Brown and gray, lean CLAY (CL), trace silt (Possible FILL) | CL | 6,8,11 $N_{60}$=24 | 19 | |
| | | SS | 4 | 18 | Brown, lean CLAY (CL) | CL | 5,6,8 $N_{60}$=18 | 19 | |
| 1250 | 10 | | | | | | | | |
| | | SS | 5 | 18 | Brown and red, fat CLAY (CH), trace gravel (possible CL) | CH | 3,3,4 $N_{60}$=9 | 47 | |
| 1245 | 15 | | | | | | | | |
| | | SS | 6 | 18 | | | 3,6,20 $N_{60}$=33 | 61 | |
| | 20 | | | | Gray, weathered CHERT fragments | GP | | | |
| | | | | | Boring terminated at 20.0 ft. | | | | |




Professional Service Industries, Inc.
11826 Borman Drive
Saint Louis, MO 63146
Telephone: (314) 432-8073

**PROJECT NO.:** 0040447-1
**PROJECT:** Proposed McDonald's (#40762)
**LOCATION:** 3720 W. Sunshine Street
Springfield, Missouri

The stratification lines represent approximate boundaries. The transition may be gradual.

# BORING B-02

| | | | |
|---|---|---|---|
| **DATE STARTED:** | 8/15/22 | **DRILL COMPANY:** | REDI |
| **DATE COMPLETED:** | 8/15/22 | **DRILLER:** Eric **LOGGED BY:** | Corey |
| **COMPLETION DEPTH** | 19.5 ft | **DRILL RIG:** | CME 750 |
| **BENCHMARK:** | N/A | **DRILLING METHOD:** | Hollow Stem Auger |
| **ELEVATION:** | 1265 ft | **SAMPLING METHOD:** | SS |
| **LATITUDE:** | 37.1823° | **HAMMER TYPE:** | Automatic |
| **LONGITUDE:** | -93.3556° | **EFFICIENCY** | 75% |
| **STATION:** N/A | **OFFSET:** N/A | **REVIEWED BY:** | DI |

**Water**

| | | |
|---|---|---|
| ▽ | While Drilling | Not Encountered |
| ▼ | Upon Completion | Not Encountered |
| ▽ | Delay | N/A |

**BORING LOCATION:**
Proposed Building

**REMARKS:** $N_{60}$ denotes the normalization to 60% efficiency as described in ASTM D4633.

| Elevation (feet) | Depth, (feet) | Graphic Log | Sample Type | Sample No. | Recovery (inches) | MATERIAL DESCRIPTION | USCS Classification | SPT Blows per 6-inch (SS) | Moisture, % | STANDARD PENETRATION TEST DATA (N in blows/ft ◎; × Moisture; ◪ PL; ✚ LL; STRENGTH, tsf ▲ Qu ✳ Qp) | Additional Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0 | | | | | 4" Topsoil-like materials | | | | | |
| | | | | | | Brown, lean CLAY (CL) (FILL) | CL | | 15 | | |
| | | | | 1 | 10 | White and yellow, weathered LIMESTONE and CHERT fragments (Lag gravels) | GP | 6,13,24 $N_{60}$=46 | | | |
| | | | | | | Brown and red, fat CLAY (CH) - with weathered limestone pieces from 3.5 to 5.0 ft. | CH | | 17 | | |
| | | | | 2 | 16 | | | 8,14,16 $N_{60}$=38 | | | |
| 1260 | 5 | | | | | | | | | | |
| | | | | | | - trace weathered limestone pieces from 6.0 to 10.0 ft. | | | 34 | LL = 68 PL = 31 | |
| | | | | 3 | 10 | | | 10,11,16 $N_{60}$=34 | | | |
| | | | | | | | | | 45 | | |
| | | | | 4 | 18 | | | 6,6,10 $N_{60}$=20 | | | |
| 1255 | 10 | | | | | | | | | | |
| | | | | | | | | | 45 | | |
| | | | | 5 | 15 | | | 5,6,7 $N_{60}$=16 | | | |
| 1250 | 15 | | | | | | | | | | |
| | | | | | | | | | 48 | | |
| | | | | 6 | 4 | - dark brown and red, with gravel, wet, below 18.5 ft. | | 3,1,50/0" | | | |
| | | | | | | Sampler refusal encountered at 19.5 ft. Boring terminated at 19.5 ft. | | | | | |

intertek psi

Professional Service Industries, Inc.
11826 Borman Drive
Saint Louis, MO 63146
Telephone: (314) 432-8073

**PROJECT NO.:** 0040447-1
**PROJECT:** Proposed McDonald's (#40762)
**LOCATION:** 3720 W. Sunshine Street
Springfield, Missouri

The stratification lines represent approximate boundaries. The transition may be gradual.

# BORING B-03

| | | | |
|---|---|---|---|
| **DATE STARTED:** | 8/15/22 | **DRILL COMPANY:** | REDI |
| **DATE COMPLETED:** | 8/15/22 | **DRILLER:** Eric | **LOGGED BY:** Corey |
| **COMPLETION DEPTH** | 20.0 ft | **DRILL RIG:** | CME 750 |
| **BENCHMARK:** | N/A | **DRILLING METHOD:** | Hollow Stem Auger |
| **ELEVATION:** | 1264 ft | **SAMPLING METHOD:** | |
| **LATITUDE:** | 37.1822° | **HAMMER TYPE:** | Automatic |
| **LONGITUDE:** | -93.3555° | **EFFICIENCY** | 75% |
| **STATION:** N/A | **OFFSET:** N/A | **REVIEWED BY:** | DI |

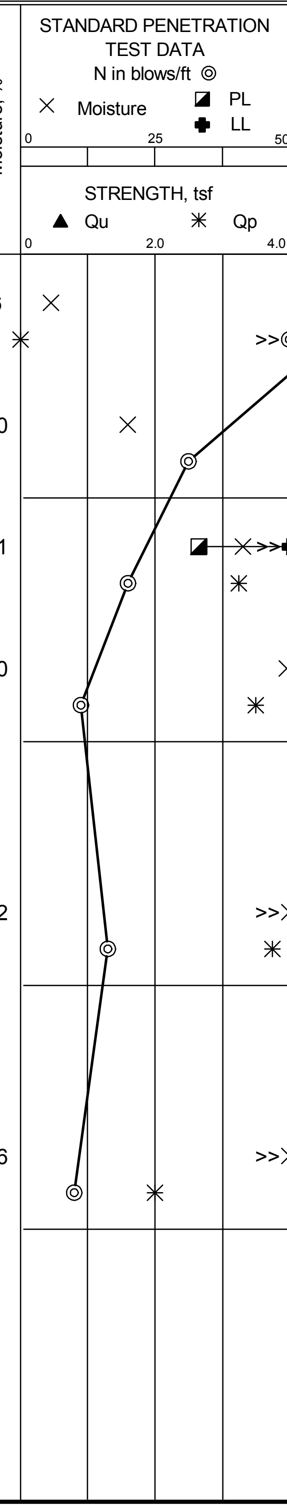
**Water**

| | | |
|---|---|---|
| ▽ | While Drilling | Not Encountered |
| ▼ | Upon Completion | 19 feet |
| ▽ | Delay | N/A |

**BORING LOCATION:**
Proposed Building

**REMARKS:** $N_{60}$ denotes the normalization to 60% efficiency as described in ASTM D4633.

| Elevation (feet) | Depth, (feet) | Sample No. | Recovery (inches) | MATERIAL DESCRIPTION | USCS Classification | SPT blows | Moisture, % |
|---|---|---|---|---|---|---|---|
| 1264 | 0 | | | 6" Topsoil-like materials | | | |
| | | | | Brown, lean CLAY (CL) (FILL) | CL | | 6 |
| | | 1 | 10 | Gray, weathered CHERT fragments, with sand (Lag gravels) | GP | 13,27,19 $N_{60}$=58 | |
| | | | | Brown and red, fat CLAY (CH) - with chert fragments from 3.5 to 5.0 ft. | CH | | 20 |
| 1260 | 5 | 2 | 12 | | | 8,15,10 $N_{60}$=31 | |
| | | | | - trace chert fragments below 6.0 ft. | | | 41 |
| | | 3 | 18 | | | 9,9,7 $N_{60}$=20 | |
| 1255 | 10 | 4 | 16 | | | 3,4,5 $N_{60}$=11 | 50 |
| 1250 | 15 | 5 | 18 | | | 3,5,8 $N_{60}$=16 | 52 |
| | | | | - driller notes rocky drilling below 17.0 ft. | | | |
| 1245 | | 6 | 14 | ▼ - dark brown, wet, below 18.5 ft. | | 3,3,5 $N_{60}$=10 | 96 |
| | 20 | | | Boring terminated at 20.0 ft. | | | |




Additional Remarks

**Professional Service Industries, Inc.**
11826 Borman Drive
Saint Louis, MO 63146
Telephone: (314) 432-8073

**PROJECT NO.:** 0040447-1
**PROJECT:** Proposed McDonald's (#40762)
**LOCATION:** 3720 W. Sunshine Street
Springfield, Missouri

The stratification lines represent approximate boundaries. The transition may be gradual.

# BORING B-04

| | | | |
|---|---|---|---|
| **DATE STARTED:** | 8/15/22 | **DRILL COMPANY:** | REDI |
| **DATE COMPLETED:** | 8/15/22 | **DRILLER:** Eric | **LOGGED BY:** Corey |
| **COMPLETION DEPTH** | 20.0 ft | **DRILL RIG:** | CME 750 |
| **BENCHMARK:** | N/A | **DRILLING METHOD:** | Hollow Stem Auger |
| **ELEVATION:** | 1264 ft | **SAMPLING METHOD:** | SS/ ST |
| **LATITUDE:** | 37.1824° | **HAMMER TYPE:** | Automatic |
| **LONGITUDE:** | -93.3555° | **EFFICIENCY** | 75% |
| **STATION:** N/A | **OFFSET:** N/A | **REVIEWED BY:** | DI |

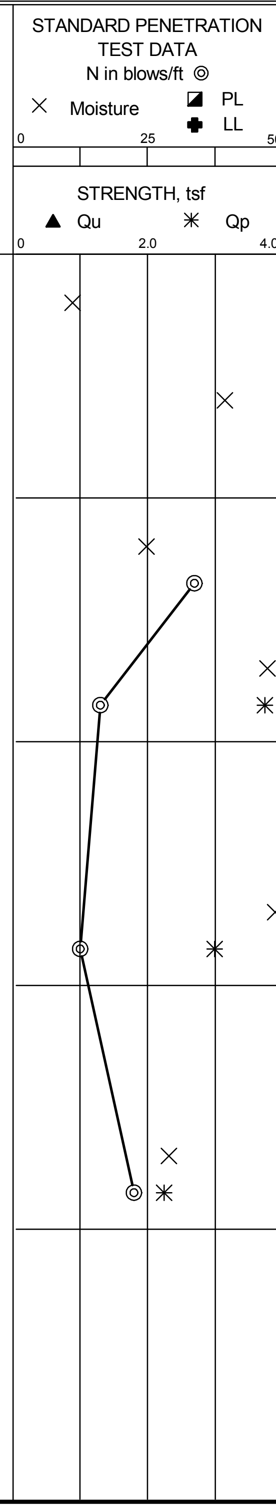
**Water**

| | |
|---|---|
| While Drilling | Not Encountered |
| Upon Completion | Not Encountered |
| Delay | N/A |

**BORING LOCATION:**
Proposed Building

**REMARKS:** $N_{60}$ denotes the normalization to 60% efficiency as described in ASTM D4633.

| Elevation (feet) | Depth, (feet) | Sample No. | Recovery (inches) | MATERIAL DESCRIPTION | USCS Classification | SPT Blows per 6-inch (SS) Push Pressure (ST) | Moisture, % | Additional Remarks |
|---|---|---|---|---|---|---|---|---|
| | 0 | | | 4" Topsoil-like materials | | | | |
| | | | | White, crushed LIMESTONE pieces, with clay (FILL) | GP | | 11 | |
| | | 1 | 13 | Red and gray, lean CLAY (CL), with gravel (FILL)<br>- sampler refusal at approximately 2.5 ft.<br>- driller notes hard drilling from 3.0 to 5.0 ft.<br>- trace roots from 3.0 to 4.5 ft. | CL | 8,18,50/5" | 39 | |
| 1260 | | 2 | | | | | | |
| | 5 | | | White and gray, weathered CHERT fragments, with red/brown fat clay (Lag gravels) | GP | | 25 | |
| | | 3 | 11 | | | 6,9,18 $N_{60}$=34 | | |
| | | | | Red and brown, fat CLAY (CH)<br>- trace chert from 8.5 to 10.0 ft. | | | 47 | |
| 1255 | | 4 | 18 | | | 4,6,7 $N_{60}$=16 | | |
| | 10 | | | | | | | |
| 1250 | | 5 | 18 | - moist below 13.5 ft. | CH | 3,4,6 $N_{60}$=13 | 49 | |
| | 15 | | | | | | | |
| 1245 | | 6 | 14 | - with chert fragments below 18.5 ft. | | 4,5,13 $N_{60}$=23 | 29 | |
| | 20 | | | Boring terminated at 20.0 ft. | | | | |




The stratification lines represent approximate boundaries. The transition may be gradual.


Professional Service Industries, Inc.
11826 Borman Drive
Saint Louis, MO 63146
Telephone: (314) 432-8073


**PROJECT NO.:** 0040447-1
**PROJECT:** Proposed McDonald's (#40762)
**LOCATION:** 3720 W. Sunshine Street
Springfield, Missouri

# BORING B-05

| | | | |
|---|---|---|---|
| **DATE STARTED:** | 8/16/22 | **DRILL COMPANY:** | REDI |
| **DATE COMPLETED:** | 8/16/22 | **DRILLER:** Eric | **LOGGED BY:** Corey |
| **COMPLETION DEPTH** | 20.0 ft | **DRILL RIG:** | CME 750 |
| **BENCHMARK:** | N/A | **DRILLING METHOD:** | Hollow Stem Auger |
| **ELEVATION:** | 1261 ft | **SAMPLING METHOD:** | SS |
| **LATITUDE:** | 37.1821° | **HAMMER TYPE:** | Automatic |
| **LONGITUDE:** | -93.3554° | **EFFICIENCY** | 75% |
| **STATION:** N/A | **OFFSET:** N/A | **REVIEWED BY:** | DI |

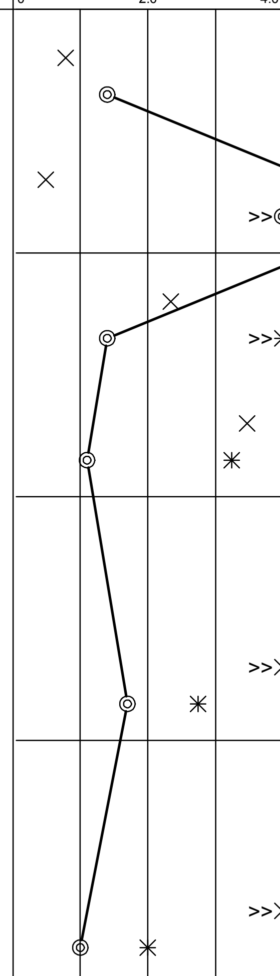
**REMARKS:** $N_{60}$ denotes the normalization to 60% efficiency as described in ASTM D4633.

| Water | | |
|---|---|---|
| While Drilling | Not Encountered | |
| Upon Completion | Not Encountered | |
| Delay | N/A | |

**BORING LOCATION:**
Proposed Building

| Elevation (feet) | Depth, (feet) | Sample Type | Sample No. | Recovery (inches) | MATERIAL DESCRIPTION | USCS Classification | SPT Blows per 6-inch (SS) | Moisture, % | Additional Remarks |
|---|---|---|---|---|---|---|---|---|---|
| 1261 | 0 | | | | Brown, SILT (ML), trace roots (FILL) | ML | | | |
| 1260 | | SS | 1 | 10 | | | 5,7,7 $N_{60}$=18 | 10 | |
| | 2.75 | | | | Gray, weathered CHERT fragments with sand (Lag gravels) | GP | | | |
| | | SS | 2 | 6 | | | 22,33,25 $N_{60}$=73 | 6 | |
| 1255 | 5.5 | | | | Red and brown, fat CLAY (CH) - with chert fragments from 6.0 to 7.5 ft. | CH | | 29 | |
| | | SS | 3 | 11 | | | 6,8,6 $N_{60}$=18 | | |
| | | SS | 4 | 10 | | | 6,5,6 $N_{60}$=14 | 43 | |
| 1250 | 10 | | | | | | | | |
| | | SS | 5 | 18 | | | 4,5,12 $N_{60}$=21 | 52 | |
| 1245 | 15 | | | | | | | | |
| | | SS | 6 | 18 | - dark brown and red, moist, below 18.5 ft. | | 3,3,7 $N_{60}$=13 | 64 | |
| | 20 | | | | Boring terminated at 20.0 ft. | | | | |

STANDARD PENETRATION TEST DATA
N in blows/ft ◎
× Moisture ◪ PL ✚ LL
0 25 50
STRENGTH, tsf
▲ Qu ✳ Qp
0 2.0 4.0





intertek psi
Professional Service Industries, Inc.
11826 Borman Drive
Saint Louis, MO 63146
Telephone: (314) 432-8073


**PROJECT NO.:** 0040447-1
**PROJECT:** Proposed McDonald's (#40762)
**LOCATION:** 3720 W. Sunshine Street
Springfield, Missouri

The stratification lines represent approximate boundaries. The transition may be gradual.

| | | | |
|---|---|---|---|
| **DATE STARTED:** | 8/16/22 | **DRILL COMPANY:** | REDI |
| **DATE COMPLETED:** | 8/16/22 | **DRILLER:** Eric **LOGGED BY:** | Corey |
| **COMPLETION DEPTH** | 15.0 ft | **DRILL RIG:** | CME 750 |
| **BENCHMARK:** | N/A | **DRILLING METHOD:** | Hollow Stem Auger |
| **ELEVATION:** | 1259 ft | **SAMPLING METHOD:** | SS |
| **LATITUDE:** | 37.1819° | **HAMMER TYPE:** | Automatic |
| **LONGITUDE:** | -93.3556° | **EFFICIENCY** | 75% |
| **STATION:** N/A | **OFFSET:** N/A | **REVIEWED BY:** | DI |

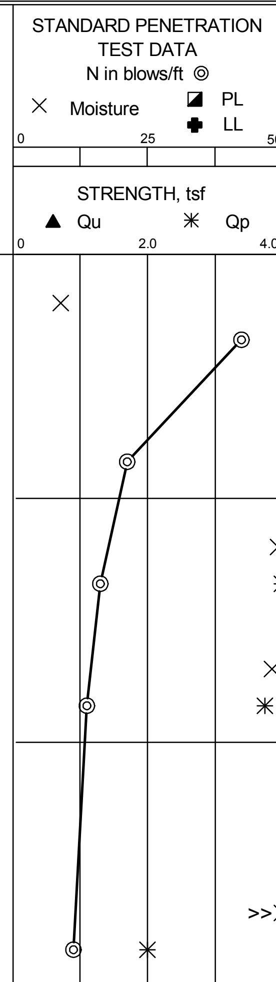
**REMARKS:** $N_{60}$ denotes the normalization to 60% efficiency as described in ASTM D4633.

# BORING B-06

| Water | | |
|---|---|---|
| While Drilling | | Not Encountered |
| Upon Completion | | Not Encountered |
| Delay | | N/A |

**BORING LOCATION:**
Proposed Drive-Thru Lane

| Elevation (feet) | Depth, (feet) | Sample No. | Recovery (inches) | MATERIAL DESCRIPTION | USCS Classification | SPT Blows per 6-inch (SS) | Moisture, % | Additional Remarks |
|---|---|---|---|---|---|---|---|---|
| | 0 | | | 6" Topsoil-like materials | | | | |
| | | 1 | 6 | Gray, weathered CHERTfragments, with clay and sand (Lag gravels)<br>- driller notes rough drilling from 1.0 to 3.5 ft. | GP | 15,16,18 $N_{60}$=43 | 9 | |
| 1255 | | 2 | 0 | No recovery from 3.5 to 5.0 ft., possible chert fragment blocking sampler.<br>- driller notes rocky drilling from 3.5 to 5.0 ft. | CH | 7,9,8 $N_{60}$=21 | | |
| | 5 | | | Red and brown, fat CLAY (CH) | | | | |
| | | 3 | 18 | | | 4,6,7 $N_{60}$=16 | 49 | |
| 1250 | | 4 | 18 | | CH | 4,5,6 $N_{60}$=14 | 48 | |
| | 10 | | | | | | | |
| 1245 | | 5 | 15 | - dark brown and red, moist, with gravel, from 13.5 to 15.0 ft. | | 3,5,4 $N_{60}$=11 | 54 | |
| | 15 | | | Boring terminated at 15.0 ft. | | | | |





intertek psi

Professional Service Industries, Inc.
11826 Borman Drive
Saint Louis, MO 63146
Telephone: (314) 432-8073


**PROJECT NO.:** 0040447-1
**PROJECT:** Proposed McDonald's (#40762)
**LOCATION:** 3720 W. Sunshine Street
Springfield, Missouri

The stratification lines represent approximate boundaries. The transition may be gradual.

# BORING B-07

| | | | |
|---|---|---|---|
| **DATE STARTED:** | 8/15/22 | **DRILL COMPANY:** | REDI |
| **DATE COMPLETED:** | 8/15/22 | **DRILLER:** Eric | **LOGGED BY:** Corey |
| **COMPLETION DEPTH** | 15.0 ft | **DRILL RIG:** | CME 750 |
| **BENCHMARK:** | N/A | **DRILLING METHOD:** | Hollow Stem Auger |
| **ELEVATION:** | 1260 ft | **SAMPLING METHOD:** | SS |
| **LATITUDE:** | 37.1819° | **HAMMER TYPE:** | Automatic |
| **LONGITUDE:** | -93.3553° | **EFFICIENCY** | 75% |
| **STATION:** N/A | **OFFSET:** N/A | **REVIEWED BY:** | DI |

**Water**

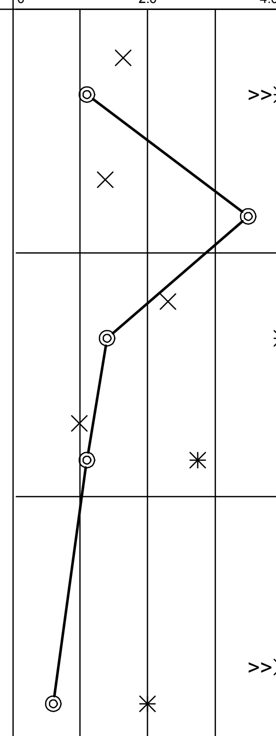
| | |
|---|---|
| While Drilling | Not Encountered |
| Upon Completion | Not Encountered |
| Delay | N/A |

**BORING LOCATION:**
Proposed Dumpster Pad

**REMARKS:** $N_{60}$ denotes the normalization to 60% efficiency as described in ASTM D4633.

| Elevation (feet) | Depth, (feet) | Sample No. | Recovery (inches) | MATERIAL DESCRIPTION | USCS Classification | SPT Blows per 6-inch (SS) | Moisture, % | Additional Remarks |
|---|---|---|---|---|---|---|---|---|
| 1260 | 0 | | | 6" Topsoil-like materials | | | | |
| | | 1 | 10 | Dark brown, SILT (ML), trace gravel (FILL) | ML | 4,5,6 $N_{60}$=14 | 20 | |
| 1255 | 5 | 2 | 13 | Gray, weathered CHERT pieces, with clay, trace sand (Lag gravels) | GP | 7,12,23 $N_{60}$=44 | 17 | |
| | | 3 | 12 | Brown, red, and tan, fat CLAY (CH) - trace chert fragments from 6.0 to 10.0 ft. | CH | 4,7,7 $N_{60}$=18 | 29 | |
| 1250 | 10 | 4 | 18 | - brown and red from 8.5 to 10.0 ft. | CH | 4,6,5 $N_{60}$=14 | 12 | |
| 1245 | 15 | 5 | 18 | - dark brown and red, moist, below 13.5 ft. | CH | 3,3,3 $N_{60}$=8 | 55 | |
| | | | | Boring terminated at 15.0 ft. | | | | |

STANDARD PENETRATION TEST DATA
N in blows/ft ◎
× Moisture ◪ PL ✚ LL
0 25 50
STRENGTH, tsf
▲ Qu ✳ Qp
0 2.0 4.0





Professional Service Industries, Inc.
11826 Borman Drive
Saint Louis, MO 63146
Telephone: (314) 432-8073


**PROJECT NO.:** 0040447-1
**PROJECT:** Proposed McDonald's (#40762)
**LOCATION:** 3720 W. Sunshine Street
Springfield, Missouri

The stratification lines represent approximate boundaries. The transition may be gradual.

| | | | |
|---|---|---|---|
| **DATE STARTED:** 8/15/22 | **DRILL COMPANY:** REDI | | |
| **DATE COMPLETED:** 8/15/22 | **DRILLER:** Eric | **LOGGED BY:** Corey | |
| **COMPLETION DEPTH** 15.0 ft | **DRILL RIG:** CME 750 | | |
| **BENCHMARK:** N/A | **DRILLING METHOD:** Hollow Stem Auger | | |
| **ELEVATION:** 1265 ft | **SAMPLING METHOD:** SS | | |
| **LATITUDE:** 37.1825° | **HAMMER TYPE:** Automatic | | |
| **LONGITUDE:** -93.3556° | **EFFICIENCY** 75% | | |
| **STATION:** N/A **OFFSET:** N/A | **REVIEWED BY:** DI | | |

# BORING B-08

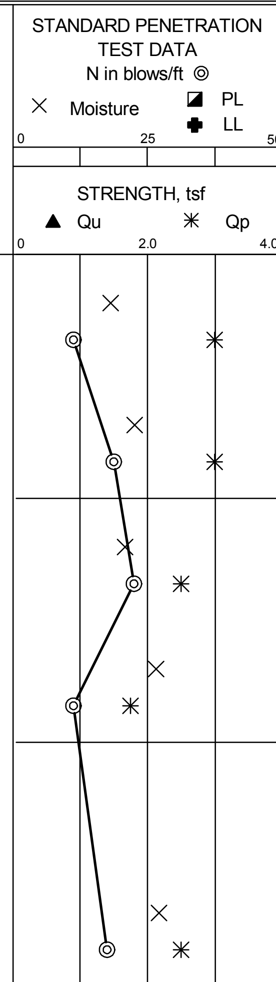
**Water**

| | | |
|---|---|---|
| ▽ | While Drilling | Not Encountered |
| ▼ | Upon Completion | Not Encountered |
| ▽ | Delay | N/A |

**BORING LOCATION:**
Proposed Parking/Drive Lane

**REMARKS:** $N_{60}$ denotes the normalization to 60% efficiency as described in ASTM D4633.

| Elevation (feet) | Depth, (feet) | Sample Type | Sample No. | Recovery (inches) | MATERIAL DESCRIPTION | USCS Classification | SPT Blows per 6-inch (SS) | Moisture, % | Additional Remarks |
|---|---|---|---|---|---|---|---|---|---|
| | 0 | | | | 4" Topsoil-like materials | | | | |
| | | | | | Brown and dark brown, lean CLAY (CL) (FILL) | CL | | 18 | |
| | | SS | 1 | 12 | Red and brown, lean CLAY (CL), possible CH | | 4,4,5 $N_{60}$=11 | | |
| | | SS | 2 | 18 | | | 5,6,9 $N_{60}$=19 | 23 | |
| 1260 | 5 | | | | | | | | |
| | | SS | 3 | 13 | - trace gravel below 6.0 ft.<br>- with sand from 6.0 to 7.5 ft. | CL | 7,7,11 $N_{60}$=23 | 21 | |
| | | SS | 4 | 18 | - red, brown, and tan, below 8.5 ft. | | 3,4,5 $N_{60}$=11 | 27 | |
| 1255 | 10 | | | | | | | | |
| | | | | | Red and brown, fat CLAY (CH), with chert fragments | CH | | 27 | |
| | | SS | 5 | 18 | | | 4,6,8 $N_{60}$=18 | | |
| 1250 | 15 | | | | Boring terminated at 15.0 ft. | | | | |





intertek psi

Professional Service Industries, Inc.
11826 Borman Drive
Saint Louis, MO 63146
Telephone: (314) 432-8073


**PROJECT NO.:** 0040447-1
**PROJECT:** Proposed McDonald's (#40762)
**LOCATION:** 3720 W. Sunshine Street
Springfield, Missouri

The stratification lines represent approximate boundaries. The transition may be gradual.

| | | | |
|---|---|---|---|
| **DATE STARTED:** | 8/15/22 | **DRILL COMPANY:** | REDI |
| **DATE COMPLETED:** | 8/15/22 | **DRILLER:** Eric | **LOGGED BY:** Corey |
| **COMPLETION DEPTH** | 5.0 ft | **DRILL RIG:** | CME 750 |
| **BENCHMARK:** | N/A | **DRILLING METHOD:** | Hollow Stem Auger |
| **ELEVATION:** | 1262 ft | **SAMPLING METHOD:** | SS |
| **LATITUDE:** | 37.1822° | **HAMMER TYPE:** | Automatic |
| **LONGITUDE:** | -93.3553° | **EFFICIENCY** | 75% |
| **STATION:** N/A | **OFFSET:** N/A | **REVIEWED BY:** | DI |

**REMARKS:** $N_{60}$ denotes the normalization to 60% efficiency as described in ASTM D4633.

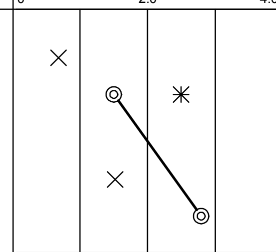
# BORING B-09

| Water | | |
|---|---|---|
| ▽ | While Drilling | Not Encountered |
| ▼ | Upon Completion | Not Encountered |
| ▽ | Delay | N/A |

**BORING LOCATION:**
Proposed Parking/Drive Lane

| Elevation (feet) | Depth, (feet) | Graphic Log | Sample Type | Sample No. | Recovery (inches) | MATERIAL DESCRIPTION | USCS Classification | SPT Blows per 6-inch (SS) | Moisture, % | Additional Remarks |
|---|---|---|---|---|---|---|---|---|---|---|
| | 0 | | | | | 4" Topsoil-like materials | | | | |
| | | | | | | Brown, SILT (ML), trace chert and limestone pieces (FILL) | ML | | 8 | |
| 1260 | | | SS | 1 | 13 | | | 6,7,8 $N_{60}$=19 | | |
| | | | | | | Brown and red, fat CLAY (CH), trace gravel (possible FILL) | CH | | 19 | |
| | | | SS | 2 | 14 | | | 8,11,17 $N_{60}$=35 | | |
| | 5 | | | | | Boring terminated at 5.0 ft. | | | | |

STANDARD PENETRATION TEST DATA
N in blows/ft ◎
× Moisture ◪ PL ✚ LL
0 25 50
STRENGTH, tsf
▲ Qu ✳ Qp
0 2.0 4.0



Professional Service Industries, Inc.
11826 Borman Drive
Saint Louis, MO 63146
Telephone: (314) 432-8073

**PROJECT NO.:** 0040447-1
**PROJECT:** Proposed McDonald's (#40762)
**LOCATION:** 3720 W. Sunshine Street
Springfield, Missouri

The stratification lines represent approximate boundaries. The transition may be gradual.

| | | | |
|---|---|---|---|
| **DATE STARTED:** 8/16/22 | **DRILL COMPANY:** REDI | | |
| **DATE COMPLETED:** 8/16/22 | **DRILLER:** Eric | **LOGGED BY:** Corey | |
| **COMPLETION DEPTH** 5.0 ft | **DRILL RIG:** CME 750 | | |
| **BENCHMARK:** N/A | **DRILLING METHOD:** Hollow Stem Auger | | |
| **ELEVATION:** 1259 ft | **SAMPLING METHOD:** SS | | |
| **LATITUDE:** 37.1818° | **HAMMER TYPE:** Automatic | | |
| **LONGITUDE:** -93.3554° | **EFFICIENCY:** 75% | | |
| **STATION:** N/A | **OFFSET:** N/A | **REVIEWED BY:** DI | |

# BORING B-10

**Water**

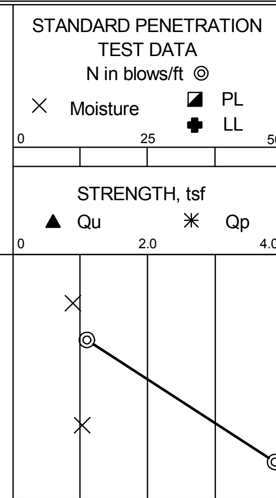
| | | |
|---|---|---|
| ▽ | While Drilling | Not Encountered |
| ▼ | Upon Completion | Not Encountered |
| ▽ | Delay | N/A |

**BORING LOCATION:** Proposed Parking/Drive Lane

**REMARKS:** $N_{60}$ denotes the normalization to 60% efficiency as described in ASTM D4633.

| Elevation (feet) | Depth, (feet) | Graphic Log | Sample Type | Sample No. | Recovery (inches) | MATERIAL DESCRIPTION | USCS Classification | SPT Blows per 6-inch (SS) | Moisture, % | Additional Remarks |
|---|---|---|---|---|---|---|---|---|---|---|
| | 0 | | | | | 4" Topsoil-like materials | | | | |
| | | | | 1 | 6 | Brown, SILT (ML) (FILL) | ML | 4,6,5 $N_{60}$=14 | 11 | |
| 1255 | | | | 2 | 10 | Gray, crushed CHERT pieces with sand, trace clay (Lag gravels) | GP | 10,13,26 $N_{60}$=49 | 13 | |
| | 5 | | | | | Boring terminated at 5.0 ft. | | | | |

STANDARD PENETRATION TEST DATA




Professional Service Industries, Inc.
11826 Borman Drive
Saint Louis, MO 63146
Telephone: (314) 432-8073

**PROJECT NO.:** 0040447-1
**PROJECT:** Proposed McDonald's (#40762)
**LOCATION:** 3720 W. Sunshine Street
Springfield, Missouri

The stratification lines represent approximate boundaries. The transition may be gradual.

# BORING B-11

| | | | |
|---|---|---|---|
| **DATE STARTED:** | 8/15/22 | **DRILL COMPANY:** | REDI |
| **DATE COMPLETED:** | 8/15/22 | **DRILLER:** Eric | **LOGGED BY:** Corey |
| **COMPLETION DEPTH** | 5.0 ft | **DRILL RIG:** | CME 750 |
| **BENCHMARK:** | N/A | **DRILLING METHOD:** | Hollow Stem Auger |
| **ELEVATION:** | 1263 ft | **SAMPLING METHOD:** | SS |
| **LATITUDE:** | 37.1822° | **HAMMER TYPE:** | Automatic |
| **LONGITUDE:** | -93.3558° | **EFFICIENCY** | 75% |
| **STATION:** N/A | **OFFSET:** N/A | **REVIEWED BY:** | DI |

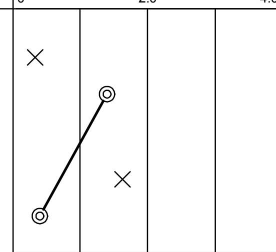
**Water**

| | |
|---|---|
| While Drilling | Not Encountered |
| Upon Completion | Not Encountered |
| Delay | N/A |

**BORING LOCATION:**
Proposed Parking/Drive Lane

**REMARKS:** $N_{60}$ denotes the normalization to 60% efficiency as described in ASTM D4633.

| Elevation (feet) | Depth, (feet) | Graphic Log | Sample Type | Sample No. | Recovery (inches) | MATERIAL DESCRIPTION | USCS Classification | SPT Blows per 6-inch (SS) | Moisture, % | STANDARD PENETRATION TEST DATA (N in blows/ft; Moisture; PL; LL; STRENGTH, tsf: Qu, Qp) | Additional Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0 | | | | | Gray, crushed CHERT pieces, AND, gray, fine to medium SAND (SP) (FILL) | GP/SP | | 4 | | |
| | | | | 1 | 8 | | | 4,8,6 $N_{60}$=18 | | | |
| 1260 | | | | 2 | 4 | | | 3,2,2 $N_{60}$=5 | 20 | | |
| | 5 | | | | | Dark brown, SILT (ML), with sand and chert pieces (FILL) | ML | | | | |
| | | | | | | Boring terminated at 5.0 ft. | | | | | |



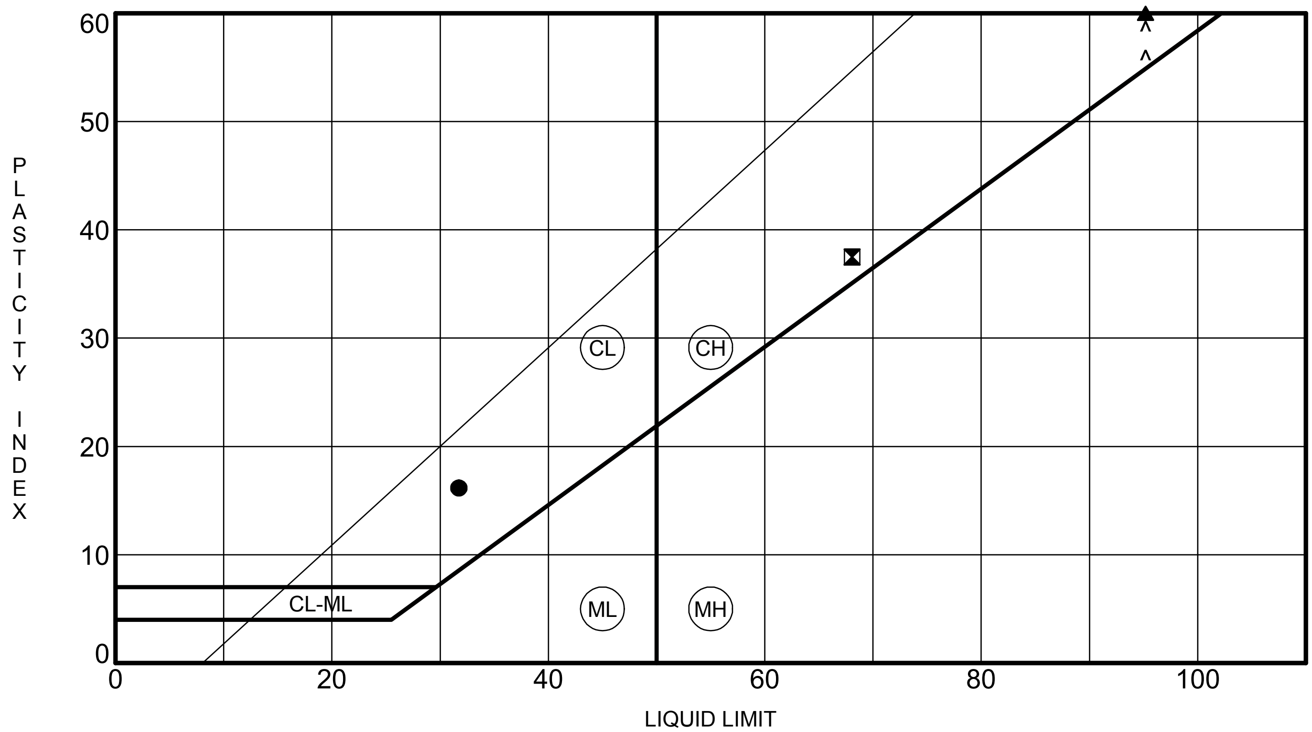


intertek psi

Professional Service Industries, Inc.
11826 Borman Drive
Saint Louis, MO 63146
Telephone: (314) 432-8073


**PROJECT NO.:** 0040447-1
**PROJECT:** Proposed McDonald's (#40762)
**LOCATION:** 3720 W. Sunshine Street
Springfield, Missouri

The stratification lines represent approximate boundaries. The transition may be gradual.




| | Boring | Depth (ft) | LL | PL | PI | Fines | Classification (*Visual) |
|---|---|---|---|---|---|---|---|
| ● | **B-01** | **3.0** | **32** | **16** | **16** | | |
| ⧗ | **B-02** | **6.0** | **68** | **31** | **37** | | |
| ▲ | **B-03** | **6.0** | **95** | **33** | **62** | | |

intertek psi

**Professional Service Industries, Inc.**
**11826 Borman Drive**
**Saint Louis, MO 63146**
**Telephone: (314) 432-8073**
**Fax: (314) 432-5119**

## ATTERBERG LIMIT RESULTS

PSI Job No.: 0040447-1
Project: Proposed McDonald's (#40762)
Location: 3720 W. Sunshine Street
Springfield, Missouri

# APPENDIX F – DRILLING, FIELD, AND LAB TESTING PROCEDURES

## FIELD TESTS AND MEASUREMENTS

### *Penetration Tests and Split-Barrel Sampling of Soils*

During the sampling procedures, Standard Penetration Tests (SPT) were performed at regular intervals (2½-foot intervals to 10 feet and 5-foot intervals thereafter) to obtain the standard penetration (N) values of the soil. The results of the standard penetration test indicate the relative density and comparative consistency of the soils, and thereby provide a basis for estimating the relative strength and compressibility of the soil profile components. The split-barrel sampler provides a soil sample for identification purposes and for laboratory tests appropriate for soil obtained from a sampler that may produce large shear strain while obtaining the sample.

### *Thin-Walled (Shelby) Tube Geotechnical Sampling of Soils*

Thin-walled tube samples are utilized to obtain a relatively undisturbed specimen suitable for laboratory tests of structural properties or other tests that might be influenced by soil properties. A relatively undisturbed sample is obtained by pressing a thin-walled metal tube (typically an outside diameter 3 inches) into the in-situ soil, removing the soil-filled tube, and sealing the ends to reduce the soil disturbance or moisture loss. These samples may be utilized in the laboratory to obtain the following information or perform the following tests: Unconfined Compressive Strength ($q_u$), Laboratory Determination of Water Content, Wet and Dry Density, Void Ratio, Percent Saturation, Grain Size, and Atterberg Limits.

### *Water Level Measurements*

Water level observations were attempted during and upon completion of the drilling operation using a 100-foot tape measure. The depths of observed water levels in the boreholes are noted on the boring logs presented in the Appendix of this report. In the borings where water is unable to be observed during the field activities, in relatively impervious soils, the accurate determination of the groundwater elevation may not be possible even after several days of observation. Seasonal variations, temperature and recent rainfall conditions may influence the levels of the groundwater table and volumes of water will depend on the permeability of the soils.

### *Ground Surface Elevations*

The approximate elevations at the ground surface of the borings were estimated based on publicly available topographic information obtained from Google Earth Pro. These approximate elevations are indicated on the attached boring logs that are located in the Appendix of this report. Surveying of the borings was outside of this scope of services. Approximate elevations for site range from 1,255 to 1,264 feet above mean sea level.

## LABORATORY TESTING PROGRAM

In addition to the field investigation, a supplemental laboratory-testing program was conducted to determine additional engineering characteristics of the foundation materials necessary in analyzing the behavior of the soils as it relates to the construction of the proposed McDonald's. Laboratory results may be found on the boring logs and individual test results are included in the Appendix.  The laboratory testing program is as follows:

### *Laboratory Determination of Water (Moisture) Content of Soil by Mass*

The water content is a significant index property used in establishing a correlation between soil behavior and its index properties.  The water content is used in expressing the phase relationship of air, water, and solids in a given volume of material.  In fine grained cohesive soils, the behavior of a given soil type often depends on its water content.  The water content of a soil, along with its liquid and plastic limits as determined by Atterberg Limit testing, is used to express its relative consistency or liquidity index.

### *Atterberg Limits*

The Atterberg Limits are defined by the liquid limit (LL) and plastic limit (PL) states of a given soil.  These limits are used to determine the moisture content limits where the soil characteristics changes from behaving more like a fluid on the liquid limit end to where the soil behaves more like individual soil particles on the plastic limit end.  The liquid limit is often used to indicate if a soil is a low or high plasticity soil.  The plasticity index (PI) is the difference between the liquid limit and the plastic limit.  The plasticity index is used in conjunction with the liquid limit to assess if the material will behave like a silt or clay.  The material can also be classified as an organic material by comparing the liquid limit of the natural material to the liquid limit of the sample after being oven-dried.

## APPENDIX G – GENERAL NOTES/SOIL CLASSIFICATION CHART

# GENERAL NOTES

## SAMPLE IDENTIFICATION

The Unified Soil Classification System (USCS), AASHTO 1988 and ASTM designations D2487 and D-2488 are used to identify the encountered materials unless otherwise noted. Coarse-grained soils are defined as having more than 50% of their dry weight retained on a #200 sieve (0.075mm); they are described as: boulders, cobbles, gravel or sand. Fine-grained soils have less than 50% of their dry weight retained on a #200 sieve; they are defined as silts or clay depending on their Atterberg Limit attributes. Major constituents may be added as modifiers and minor constituents may be added according to the relative proportions based on grain size.

## DRILLING AND SAMPLING SYMBOLS

SFA: Solid Flight Auger - typically 4" diameter flights, except where noted.
HSA: Hollow Stem Auger - typically 3¼" or 4¼ I.D. openings, except where noted.
M.R.: Mud Rotary - Uses a rotary head with Bentonite or Polymer Slurry
R.C.: Diamond Bit Core Sampler
H.A.: Hand Auger
P.A.: Power Auger - Handheld motorized auger

SS: Split-Spoon - 1 3/8" I.D., 2" O.D., except where noted.
ST: Shelby Tube - 3" O.D., except where noted.
RC: Rock Core
TC: Texas Cone
BS: Bulk Sample
PM: Pressuremeter
CPT-U: Cone Penetrometer Testing with Pore-Pressure Readings

## SOIL PROPERTY SYMBOLS

N: Standard "N" penetration: Blows per foot of a 140 pound hammer falling 30 inches on a 2-inch O.D. Split-Spoon.
$N_{60}$: A "N" penetration value corrected to an equivalent 60% hammer energy transfer efficiency (ETR)
$Q_u$: Unconfined compressive strength, TSF
$Q_p$: Pocket penetrometer value, unconfined compressive strength, TSF
w%: Moisture/water content, %
LL: Liquid Limit, %
PL: Plastic Limit, %
PI: Plasticity Index = (LL-PL),%
DD: Dry unit weight, pcf
▼,▽,▼: Apparent groundwater level at time noted

## RELATIVE DENSITY OF COARSE-GRAINED SOILS

| Relative Density | N - Blows/foot |
|---|---|
| Very Loose | 0 - 4 |
| Loose | 4 - 10 |
| Medium Dense | 10 - 30 |
| Dense | 30 - 50 |
| Very Dense | 50 - 80 |
| Extremely Dense | 80+ |

## ANGULARITY OF COARSE-GRAINED PARTICLES

| Description | Criteria |
|---|---|
| Angular: | Particles have sharp edges and relatively plane sides with unpolished surfaces |
| Subangular: | Particles are similar to angular description, but have rounded edges |
| Subrounded: | Particles have nearly plane sides, but have well-rounded corners and edges |
| Rounded: | Particles have smoothly curved sides and no edges |

## GRAIN-SIZE TERMINOLOGY

| Component | Size Range |
|---|---|
| Boulders: | Over 300 mm (>12 in.) |
| Cobbles: | 75 mm to 300 mm (3 in. to 12 in.) |
| Coarse-Grained Gravel: | 19 mm to 75 mm (¾ in. to 3 in.) |
| Fine-Grained Gravel: | 4.75 mm to 19 mm (No.4 to ¾ in.) |
| Coarse-Grained Sand: | 2 mm to 4.75 mm (No.10 to No.4) |
| Medium-Grained Sand: | 0.42 mm to 2 mm (No.40 to No.10) |
| Fine-Grained Sand: | 0.075 mm to 0.42 mm (No. 200 to No.40) |
| Silt: | 0.005 mm to 0.075 mm |
| Clay: | <0.005 mm |

## PARTICLE SHAPE

| Description | Criteria |
|---|---|
| Flat: | Particles with width/thickness ratio > 3 |
| Elongated: | Particles with length/width ratio > 3 |
| Flat & Elongated: | Particles meet criteria for both flat and elongated |

## RELATIVE PROPORTIONS OF FINES

| Descriptive Term | % Dry Weight |
|---|---|
| Trace: | < 5% |
| With: | 5% to 12% |
| Modifier: | >12% |

# GENERAL NOTES

(Continued)

## CONSISTENCY OF FINE-GRAINED SOILS

| $Q_U$ - TSF | N - Blows/foot | Consistency |
|---|---|---|
| 0 - 0.25 | 0 - 2 | Very Soft |
| 0.25 - 0.50 | 2 - 4 | Soft |
| 0.50 - 1.00 | 4 - 8 | Firm (Medium Stiff) |
| 1.00 - 2.00 | 8 - 15 | Stiff |
| 2.00 - 4.00 | 15 - 30 | Very Stiff |
| 4.00 - 8.00 | 30 - 50 | Hard |
| 8.00+ | 50+ | Very Hard |

## MOISTURE CONDITION DESCRIPTION

| Description | Criteria |
|---|---|
| Dry: | Absence of moisture, dusty, dry to the touch |
| Moist: | Damp but no visible water |
| Wet: | Visible free water, usually soil is below water table |

## RELATIVE PROPORTIONS OF SAND AND GRAVEL

| Descriptive Term | % Dry Weight |
|---|---|
| Trace: | < 15% |
| With: | 15% to 30% |
| Modifier: | >30% |

## STRUCTURE DESCRIPTION

| Description | Criteria |
|---|---|
| Stratified: | Alternating layers of varying material or color with layers at least ¼-inch (6 mm) thick |
| Laminated: | Alternating layers of varying material or color with layers less than ¼-inch (6 mm) thick |
| Fissured: | Breaks along definite planes of fracture with little resistance to fracturing |
| Slickensided: | Fracture planes appear polished or glossy, sometimes striated |
| Blocky: | Cohesive soil that can be broken down into small angular lumps which resist further breakdown |
| Lensed: | Inclusion of small pockets of different soils |
| Layer: | Inclusion greater than 3 inches thick (75 mm) |
| Seam: | Inclusion 1/8-inch to 3 inches (3 to 75 mm) thick extending through the sample |
| Parting: | Inclusion less than 1/8-inch (3 mm) thick |

## SCALE OF RELATIVE ROCK HARDNESS

| $Q_U$ - TSF | Consistency |
|---|---|
| 2.5 - 10 | Extremely Soft |
| 10 - 50 | Very Soft |
| 50 - 250 | Soft |
| 250 - 525 | Medium Hard |
| 525 - 1,050 | Moderately Hard |
| 1,050 - 2,600 | Hard |
| >2,600 | Very Hard |

## ROCK BEDDING THICKNESSES

| Description | Criteria |
|---|---|
| Very Thick Bedded | Greater than 3-foot (>1.0 m) |
| Thick Bedded | 1-foot to 3-foot (0.3 m to 1.0 m) |
| Medium Bedded | 4-inch to 1-foot (0.1 m to 0.3 m) |
| Thin Bedded | 1¼-inch to 4-inch (30 mm to 100 mm) |
| Very Thin Bedded | ½-inch to 1¼-inch (10 mm to 30 mm) |
| Thickly Laminated | 1/8-inch to ½-inch (3 mm to 10 mm) |
| Thinly Laminated | 1/8-inch or less "paper thin" (<3 mm) |

## ROCK VOIDS

| Voids | Void Diameter |
|---|---|
| Pit | <6 mm (<0.25 in) |
| Vug | 6 mm to 50 mm (0.25 in to 2 in) |
| Cavity | 50 mm to 600 mm (2 in to 24 in) |
| Cave | >600 mm (>24 in) |

## GRAIN-SIZED TERMINOLOGY

(Typically Sedimentary Rock)

| Component | Size Range |
|---|---|
| Very Coarse Grained | >4.76 mm |
| Coarse Grained | 2.0 mm - 4.76 mm |
| Medium Grained | 0.42 mm - 2.0 mm |
| Fine Grained | 0.075 mm - 0.42 mm |
| Very Fine Grained | <0.075 mm |

## ROCK QUALITY DESCRIPTION

| Rock Mass Description | RQD Value |
|---|---|
| Excellent | 90 -100 |
| Good | 75 - 90 |
| Fair | 50 - 75 |
| Poor | 25 -50 |
| Very Poor | Less than 25 |

## DEGREE OF WEATHERING

| | |
|---|---|
| Slightly Weathered: | Rock generally fresh, joints stained and discoloration extends into rock up to 25 mm (1 in), open joints may contain clay, core rings under hammer impact. |
| Weathered: | Rock mass is decomposed 50% or less, significant portions of the rock show discoloration and weathering effects, cores cannot be broken by hand or scraped by knife. |
| Highly Weathered: | Rock mass is more than 50% decomposed, complete discoloration of rock fabric, core may be extremely broken and gives clunk sound when struck by hammer, may be shaved with a knife. |

# SOIL CLASSIFICATION CHART

NOTE: DUAL SYMBOLS ARE USED TO INDICATE BORDERLINE SOIL CLASSIFICATIONS

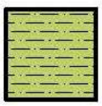
| MAJOR DIVISIONS | | | SYMBOLS | | TYPICAL DESCRIPTIONS |
|---|---|---|---|---|---|
| | | | GRAPH | LETTER | |
| COARSE GRAINED SOILS | GRAVEL AND GRAVELLY SOILS | CLEAN GRAVELS | | GW | WELL-GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES |
| | | (LITTLE OR NO FINES) | | GP | POORLY-GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES |
| | MORE THAN 50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE | GRAVELS WITH FINES | | GM | SILTY GRAVELS, GRAVEL - SAND - SILT MIXTURES |
| | | (APPRECIABLE AMOUNT OF FINES) | | GC | CLAYEY GRAVELS, GRAVEL - SAND - CLAY MIXTURES |
| MORE THAN 50% OF MATERIAL IS LARGER THAN NO. 200 SIEVE SIZE | SAND AND SANDY SOILS | CLEAN SANDS | | SW | WELL-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES |
| | | (LITTLE OR NO FINES) | | SP | POORLY-GRADED SANDS, GRAVELLY SAND, LITTLE OR NO FINES |
| | MORE THAN 50% OF COARSE FRACTION PASSING ON NO. 4 SIEVE | SANDS WITH FINES | | SM | SILTY SANDS, SAND - SILT MIXTURES |
| | | (APPRECIABLE AMOUNT OF FINES) | | SC | CLAYEY SANDS, SAND - CLAY MIXTURES |
| FINE GRAINED SOILS | SILTS AND CLAYS | LIQUID LIMIT LESS THAN 50 | | ML | INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS OR CLAYEY SILTS WITH SLIGHT PLASTICITY |
| | | | | CL | INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS |
| | | | | OL | ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY |
| MORE THAN 50% OF MATERIAL IS SMALLER THAN NO. 200 SIEVE SIZE | SILTS AND CLAYS | LIQUID LIMIT GREATER THAN 50 | | MH | INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SAND OR SILTY SOILS |
| | | | | CH | INORGANIC CLAYS OF HIGH PLASTICITY |
| | | | | OH | ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS |
| HIGHLY ORGANIC SOILS | | | | PT | PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENTS |

intertek psi

# Graphic Symbols for Materials and Rock Deposits

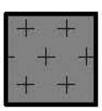

CONCRETE
Portland Cement Concrete

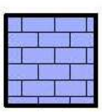

BITUMINOUS CONCRETE

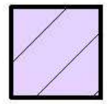

CLAYSTONE

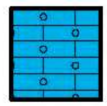

COAL
Coal, Anthracite Coal

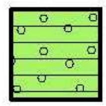

CONGLOMERATE/BRECCIA
Conglomerate, Breccia

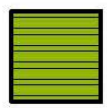

IGNEOUS ROCK
Anorthsite, Basalt, Metabasalt, Diabase (Gabbro), Gabbro, Granite/Granodionite, Homfels, Pegmatite, Rhyolite/Metarhyolite

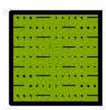

LIMESTONE
Limestone, Dolomite

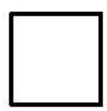

METAMORPHIC ROCK
Amphibolite, Gneiss, Marble, Phyllite, Quartzite, Schist, Serpentinite, Slate

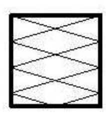

CHERT


SANDSTONE
Sandstone, Orthoquarzite (Sandstone)


SHALE


SILTSTONE


NO RECOVERY


VOID