Subgrade Exploration – Final Report
LAW-93-1.99 (PID 119504) Left Turn Lane Addition
Ironton, Ohio
S&ME Project No. 22-780161A

PREPARED FOR:

Crawford, Murphy & Tilly
8101 North High Street
Suite 150
Columbus, Ohio 43235

PREPARED BY:

S&ME, Inc.
862 East Crescentville Road
Cincinnati, OH 45246

June 24, 2024

June 24, 2024

Crawford, Murphy & Tilly, Inc.
8101 North High Street, Suite 150
Columbus, Ohio 43235

Attention: Mr. Joshua Lockhart, P.E.
E: jlockhart@cmtengr.com

Reference: **Subgrade Exploration – Final Report**
LAW-93-1.99 (PID 119504) Left Turn Lane Addition
Ironton, Ohio
S&ME Project No. 22-780161A

Dear Mr. Lockhart:

In accordance with our revised proposal dated January 22, 2024, which was authorized with a Notice to Proceed (NTP) on February 27, 2024, S&ME, Inc. (S&ME) has completed a Subgrade Exploration for the proposed LAW-93-1.99 Left Turn Lane Addition project in Lawrence County, Ohio (see Vicinity Map, Figure 1 in Appendix A).

In accordance with Section 701 of the current ODOT Specifications for Geotechnical Explorations (SGE), S&ME is herewith submitting a "final" version of this report. This report contains the information obtained from the borings, laboratory test results, as well as analyses and recommendations for the design and construction of this project. ODOT Soil Profile plan sheets will be submitted under separate cover.

We appreciate having been given the opportunity to be of service. Please do not hesitate to contact us if you have any questions regarding this submission.

Sincerely,

S&ME, Inc.

BENJAMIN C
DUSINA
71785

Sudip B. Khadka, P.E.
Project Engineer

Benjamin C. Dusina, P.E.
Principal Engineer

Submitted: Electronic Copy

Table of Contents

List of Tables

Appendices

1.0 Executive Summary

S&ME understands this project consists of the addition of a left turn lane to eastbound SR 93 at the intersection with Porter Gap Road (CR 21). No additional embankment construction is planned at this time. The project begins west of the intersection and extends east for approximately 850 linear feet along SR 93.

S&ME performed three (3) subgrade borings with adjoining pavement cores and one (1) standalone pavement core through the existing pavement and shoulders of SR 93. The borings encountered 5 to 12 inches of asphalt, with one (1) pavement core encountering 7.5 inches of concrete below the asphalt.

Beneath the pavement, borings B-001-0-23 and B-002-0-23 encountered 4.5 to 5.0 feet of medium dense to very dense light brown to brown with gray GRAVEL WITH SAND AND SILT (A-2-4) over stiff to very stiff brown SILT AND CLAY (A-6a), with weathered sandstone fragments throughout the layers. Beneath the pavement, Boring B-003-0-23 encountered a layer of hard light brown to gray SILT AND CLAY (A-6a) over weathered shale bedrock at 5.5 feet below the existing ground surface.

Groundwater seepage was encountered in Boring B-001-0-23 at 3.5 feet during drilling. The remaining borings did not encounter groundwater during the current exploration.

Based on conditions encountered in the borings, a brief summary, of recommendations included in this report with respect to the subgrade conditions/remediation and new pavement design is:

- The ODOT Subgrade Analysis spreadsheet indicates none near surface subgrade soils encountered in the borings are unstable or unsuitable. Based on the Subgrade Analysis spreadsheet and the preliminary plans, global subgrade stabilization is not required.
- Using the ODOT Subgrade Analysis spreadsheet (Ver. 14.7), the average California Bearing Ratio (CBR) of the existing subgrade soils encountered in the borings over the entire project length is 9%.

2.0 Introduction

S&ME understands this project consists of the addition of a left turn lane on eastbound SR 93 at the intersection with Porter Gap Road (CR 21) in Ironton, Ohio. The improvements begin at SLM 1.99 on SR 93. Crawford, Murphy & Tilly (CMT) has requested that S&ME perform the subgrade borings, pavement cores, and laboratory testing for this project, and prepare a Subgrade Exploration report and Soil Profile Sheets.

S&ME understands that this exploration program is to be performed for this project in accordance with the January 2024 update to the ODOT Specifications for Geotechnical Explorations (SGE).

3.0 Geology and Observations of the Project

3.1 Geology

Geologic references indicate that this project site is located within the Ironton Plateau of the Allegheny Plateaus physiographic region. Surficial geology mapping indicates Holocene-aged alluvium and Wisconsinan-aged sands and gravels are present in the area. Geologic bedrock mapping (Bedrock Geology of the Ironton, Ohio Quadrangle, Ohio Division of Geological Survey) indicates the uppermost bedrock consists of the Breathitt Group of the Pennsylvanian system, which is sedimentary bedrock composed of sandy shale and coarse sandstone with occasional coal seams and the Pittsburg coal seam at its base. Surficial geology mapping indicates bedrock ranges from above the existing roadway surface to roughly 30 feet below existing grade. Bedrock was encountered in Boring B-003-0-23 at a depth of 5.5 feet below existing grade. Bedrock was not encountered in Borings B-001-0-23 or B-002-0-23 to termination depth of 7.4 to 8.0 feet.

3.2 Available Information

Based on review of the ODOT Transportation Information Management System (TIMS) webpage, the historic borings for the initial construction of SR 75 were available (LAW-75-0.65), which was later renamed SR 93. These historic logs do not meet current SGE requirements for subgrade analyses.

A review of the ODNR "Ohio Karst Areas" map indicates the site lies in an area not known to contain karst features. A review of the ODNR "Landslides in Ohio" map reveals the site is in an area susceptible to landslides, and the ODNR "Ohio Mine Locator" map indicates the project site does not pass through any mapped abandoned or active mines, although there are several abandoned mines south of SR 93.

3.3 Reconnaissance

On February 20, 2024 S&ME performed a site reconnaissance visit to the project site to observe current conditions, potential utility conflicts, and traffic control requirements, in addition to staking the borings. Minor pavement distress was observed throughout the project limits.

4.0 Exploration

4.1 Field Investigation

On February 26, 2024, three (3) borings (designated as borings B-001-0-23 through B-003-0-23), and four (4) pavement cores were performed for this Subgrade Exploration. The locations of the borings and cores are shown on the Plan of Borings included in Figure 2 of Appendix A. The subgrade borings were generally spaced at 400-foot intervals. The borings were located where they could be safely drilled away from overhead or underground utilities. Location coordinates and ground surface elevations at the completed boring locations were provided by CMT.

The borings were performed by a track-mounted drilling rig using 4½-inch O.D. continuous flight auger to advance the borings between sampling attempts. Disturbed but representative soil samples were obtained by lowering a 2-inch O.D. split-barrel sampler to the bottom of the boring and then driving the sampler into the soil with blows from a 140-pound hammer freely falling 30 inches (ASTM D1586 - Standard Penetration Test). Six (6) feet of continuous SPT sampling were attempted beginning at the approximate proposed subgrade level. SPT samples were examined immediately after recovery and representative portions were preserved in airtight glass jars. In each of the borings the existing pavement was cored using a diamond-impregnated core barrel using water as the cooling fluid prior to sampling the subgrade materials. A separate pavement core was also performed (X-001-0-23) near the center of SR 93. Photographs of the recovered pavement cores are included in Appendix B of this report.

In accordance with the current ODOT SGE, the hammer system on the drill rigs had been calibrated in accordance with ASTM D 4633 to determine the drill rod energy ratio (78.7%). At the completion of drilling, the borings were backfilled with cuttings and cold patch asphalt was placed at an equivalent thickness of the asphalt pavement.

In the field, experienced S&ME personnel performed the following: 1) examined all samples recovered from the borings; 2) preserved representative portions of all samples in airtight glass jars; 3) prepared a log of each boring; 4) made seepage and groundwater observations; 5) made hand-penetrometer measurements in soil specimens exhibiting cohesion; and, 6) provided liaison between the field work and the Project Engineer so the exploration program could be modified in the event unusual or unexpected subsurface conditions were encountered. All recovered samples were transported to the soil laboratory of S&ME for further examination and testing.

4.2 Laboratory Testing

In the laboratory, all soil samples were visually identified and tested for natural moisture content. Classification testing (liquid/plastic limit determinations and grain-size analyses) was performed on a minimum of two (2) soil samples recovered from the continuously sampled subgrade zone in each boring. Sulfate testing was not performed based on discussions with ODOT District 9 prior to field exploration activities. The results of the laboratory tests are recorded numerically on individual boring logs and are also included in Appendix B of this report.

Based upon the results of the laboratory testing program, the field logs were modified, if necessary, and copies of the laboratory corrected boring logs are submitted in Appendix B of this report. Shown on these logs are:

descriptions of the soil stratigraphy encountered; depths from which samples were preserved; sampling efforts (blow-counts) required to obtain the specimens in the borings; calculated N_{60} values; laboratory testing results; seepage and groundwater observations made at the time of drilling; and, values of hand-penetrometer measurements made in soil samples exhibiting cohesion. For your reference, hand-penetrometer values are roughly equivalent to the unconfined compressive strength of the cohesive fraction of the soil sample.

Soils have been classified in accordance with Section 603 of the ODOT SGE and described in general accordance with Section 602. An explanation of the symbols and terms used on the boring logs, definitions of the special adjectives used to denote the minor soil components, rock descriptions, and information pertaining to sampling and identification are presented in Appendix B. Group Indices determined from the results of the laboratory testing program are also provided on the boring logs.

5.0 Findings

5.1 Existing Pavement and Surficial Materials

Each of the borings performed as part of this exploration were advanced through the existing pavement. Table 5-1 summarizes the pavement thicknesses encountered and pavement core photograph logs are included in Appendix B.

Table 5-1: Summary of Surficial Materials

Boring No.	General Core Location	Asphalt (in.)	Concrete (in.)	Aggregate Base (in.)
B-001-0-23	EB Shoulder	12	--	--
B-002-0-23	Median	5	--	13
B-003-0-23	WB Shoulder	6	--	18
X-001-0-23	Median	6	7.5	Not Measured

5.2 Subsurface Stratigraphy

Beneath the pavement, borings B-001-0-23 and B-002-0-23 encountered 4.5 to 5.0 feet of medium dense to very dense light brown to brown with gray GRAVEL WITH SAND AND SILT (A-2-4) over stiff to very stiff brown SILT AND CLAY (A-6a), with weathered sandstone fragments throughout the layers. Beneath the pavement , Boring B-003-0-23 encountered a layer of hard light brown to gray SILT AND CLAY (A-6a) over weathered shale bedrock at 5.5 feet below the existing ground surface.

5.3 Groundwater Observations

Groundwater seepage was encountered in Boring B-001-0-23 at 3.5 feet during drilling. The remaining borings did not encounter groundwater during the current exploration. The borings were backfilled immediately after drilling, therefore long-term groundwater level readings were not obtained.

6.0 Analyses and Recommendations

6.1 General Discussion

S&ME understands this project consists of the addition of a left turn lane to eastbound SR 93 at the intersection with Porter Gap Road (CR 21). No additional embankment construction is planned at this time. The project begins west of the intersection and extends east for approximately 850 linear feet along SR 93.

6.2 Subgrade Support Parameters

Appendix D includes the ODOT Subgrade Analysis spreadsheet (Ver. 14.7) created by the ODOT Office of Geotechnical Engineering (OGE) to summarize the soil type (by ODOT/HRB classification), group indices, depth, blow-counts, and Atterberg Limit values of the proposed subgrade soils encountered in the borings drilled for this project. This table also computes an average of the estimated values of the California Bearing Ratio (CBR) for the soils encountered at or below the anticipated subgrade level of the proposed roadway profile.

Based on the plan and profile information available at the time of this report, the following average California Bearing Ratio (CBR) is computed by the ODOT Subgrade Analysis spreadsheet for the anticipated subgrade soils encountered in the borings performed for this project:

CBR = 9%

Based on this average value and Section 203.1 of the current ODOT Pavement Design Manual, the following value of Resilient Modulus (M_R) correlates to this average CBR value.

M_R = 10,800 psi

These subgrade support values may be used during pavement design for this project provided that the entire proposed subgrade in the pavement reconstruction area is prepared in strict accordance with Item 204 of the current ODOT *Construction and Materials Specifications* (*CMS*). Additionally, all borrow soil placed within 3 feet of the final subgrade level of a new fill embankment shall be capable of providing average subgrade support parameters which meet or exceed the above values. This subgrade evaluation also assumes that the subgrade for the new roadways is composed of the materials encountered in the borings. If, at the time of construction, it is determined that the subgrade consists of materials different than those encountered in the borings, the pavement design subgrade criteria should be reviewed and, if necessary, modified.

6.3 Unsuitable Subgrade Materials

None of the borings drilled during this exploration encountered soil considered unsuitable by classification (A-2-5, A-4b, A-5, A-7-5, and A-8), or if the liquid limit is above 65%. Bedrock was encountered in Boring B-003-0-23 but was not within 6 inches of the proposed subgrade.

Existing underground utility lines are likely present beneath and adjacent to the existing roadway, and the type of material used and the relative compactness of backfill within any such utility trenches are unknown. S&ME

recommends any planned utility relocation be performed prior to proofrolling. Some instability of utility trench backfill may occur during earthwork operations and/or proofrolling, and some recompaction of granular utility trench backfill may become necessary. Additionally, if water has accumulated within the utility backfill, the subgrade soil in the vicinity of any saturated utility trenches may have become sufficiently weak, soft, and/or wet that proofrolling may identify these additional areas as requiring overexcavation and replacement. In any case, care should be taken not to disturb any shallow utilities during proofrolling, overexcavation, or chemical stabilization activities.

Because of the variable nature of the wide spacing of the explorations, it is possible that areas of unsuitable organic, elastic, or silt materials that were not encountered in any of the borings may be encountered during earthwork operations. Visual observation of the earthwork/grading procedures by the Geotechnical Engineer of Record may potentially result in a reduction of overexcavation of any unsuitable soils not encountered in the borings. Additionally, S&ME recommends that construction traffic be minimized or restricted once the planned soil subgrade level has been exposed or attained.

6.4 ODOT Subgrade Analysis

ODOT Subgrade Analyses (Section 600 of the ODOT Geotechnical Design Manual) indicates that a comparison of the laboratory-measured moisture content to the estimated optimum moisture content of the subgrade soil, along with the normalized blow-count (N_{60}) from SPT sampling, may be used as an indicator of the potential need for subgrade treatment or remediation of unstable subgrade soil. The acceptable options presented by Subgrade Analysis to remediate and establish a stable soil subgrade are either to “excavate and replace” or chemical stabilization.

Appendix D summarizes the laboratory-measured moisture content of the samples obtained from each boring with respect to their estimated optimum moisture contents, along with the lowest N value (N_{60L}) obtained from the Standard Penetration Tests performed in each boring. This table also indicates the recommended *CMS* Item 204 “excavate and replace” depths for problematic soil at each boring location, if encountered.

Appendix D indicates that none of subgrade borings performed as part of this exploration encountered soil at or just below the proposed subgrade level with characteristics defined as problematic (excessive soil moisture content, a low N_{60} value, and/or a low hand penetrometer value), thus global stabilization is not required.

6.4.1 Additional Subgrade Remediation Considerations

S&ME recommends that construction traffic be minimized once the required subgrade level has been attained. Construction traffic resulting from cyclical haul routes or limited access points may increase the quantity of soil identified by proof rolling as requiring removal, particularly during periods of moist weather.

It is also recommended that overexcavated subgrade areas backfilled with granular soil be drained to an underdrain, catch basin, or pipe.

6.5 Construction and Groundwater Considerations

Groundwater seepage was encountered in one (1) of the borings performed for this exploration, Boring B-001-0-23 at 3.5 feet during drilling. Some groundwater seepage may emanate from granular seams or zones that are encountered in excavations; however, the quantity of water is anticipated to be limited and may likely be controlled by bailing or with portable pumps.

Surface water runoff and groundwater should be controlled during construction, as cohesive soils (A-4b, A-6a, and A-6b,) that may be present in sidewalls of excavations will likely exhibit instability in the presence of water and/or construction vibrations. S&ME recommends that the sides and bottoms of all excavations be closely monitored by the Geotechnical Engineer of Record or the designated representative during the construction of the structure. Additionally, all excavations should be either sloped back or braced in accordance with the most recent OSHA excavation guidelines.

7.0 Final Considerations

This report has been prepared in accordance with generally accepted geotechnical engineering practice for specific application to this project. The conclusions and recommendations contained in this report are based upon applicable standards of our practice in this geographic area at the time this report was prepared. No other representation or warranty either express or implied, is made.

We relied on project information given to us to develop our conclusions and recommendations. If project information described in this report is not accurate, or if it changes during project development, we should be notified of the changes so that we can modify our recommendations based on this additional information if necessary.

Our conclusions and recommendations are based on limited data from a field exploration program. Subsurface conditions can vary widely between explored areas. Some variations may not become evident until construction. If conditions are encountered which appear different than those described in our report, we should be notified. This report should not be construed to represent subsurface conditions for the entire site.

Unless specifically noted otherwise, our field exploration program did not include an assessment of regulatory compliance, environmental conditions or pollutants or presence of any biological materials (mold, fungi, bacteria). If there is a concern about these items, other studies should be performed. S&ME can provide a proposal and perform these services if requested.

S&ME should review the Stage 2 and Final plans and specifications to confirm our recommendations are properly interpreted and implemented. The recommendations in this report are contingent on S&ME’s review of plans and specifications.

Appendices

Appendix A – Additional Figures

Important Information About Your

Geotechnical Engineering Report

Variations in subsurface conditions can be a principal cause of construction delays, cost overruns and claims. The following information is provided to assist you in understanding and managing the risk of these variations.

Geotechnical Findings Are Professional Opinions

Geotechnical engineers cannot specify material properties as other design engineers do. Geotechnical material properties have a far broader range on a given site than any manufactured construction material, and some geotechnical material properties may change over time because of exposure to air and water, or human activity.

Site exploration identifies subsurface conditions at the time of exploration and only at the points where subsurface tests are performed or samples obtained. Geotechnical engineers review field and laboratory data and then apply their judgment to render professional opinions about site subsurface conditions. Their recommendations rely upon these professional opinions. Variations in the vertical and lateral extent of subsurface materials may be encountered during construction that significantly impact construction schedules, methods and material volumes. While higher levels of subsurface exploration can mitigate the risk of encountering unanticipated subsurface conditions, no level of subsurface exploration can eliminate this risk.

Scope of Geotechnical Services

Professional geotechnical engineering judgment is required to develop a geotechnical exploration scope to obtain information necessary to support design and construction. A number of unique project factors are considered in developing the scope of geotechnical services, such as the exploration objective; the location, type, size and weight of the proposed structure; proposed site grades and improvements; the construction schedule and sequence; and the site geology.

Geotechnical engineers apply their experience with construction methods, subsurface conditions and exploration methods to develop the exploration scope. The scope of each exploration is unique based on available project and site information. Incomplete project information or constraints on the scope of exploration increases the risk of variations in subsurface conditions not being identified and addressed in the geotechnical report.

Services Are Performed for Specific Projects

Because the scope of each geotechnical exploration is unique, each geotechnical report is unique. Subsurface conditions are explored and recommendations are made for a specific project.

Subsurface information and recommendations may not be adequate for other uses. Changes in a proposed structure location, foundation loads, grades, schedule, etc. may require additional geotechnical exploration, analyses, and consultation. The geotechnical engineer should be consulted to determine if additional services are required in response to changes in proposed construction, location, loads, grades, schedule, etc.

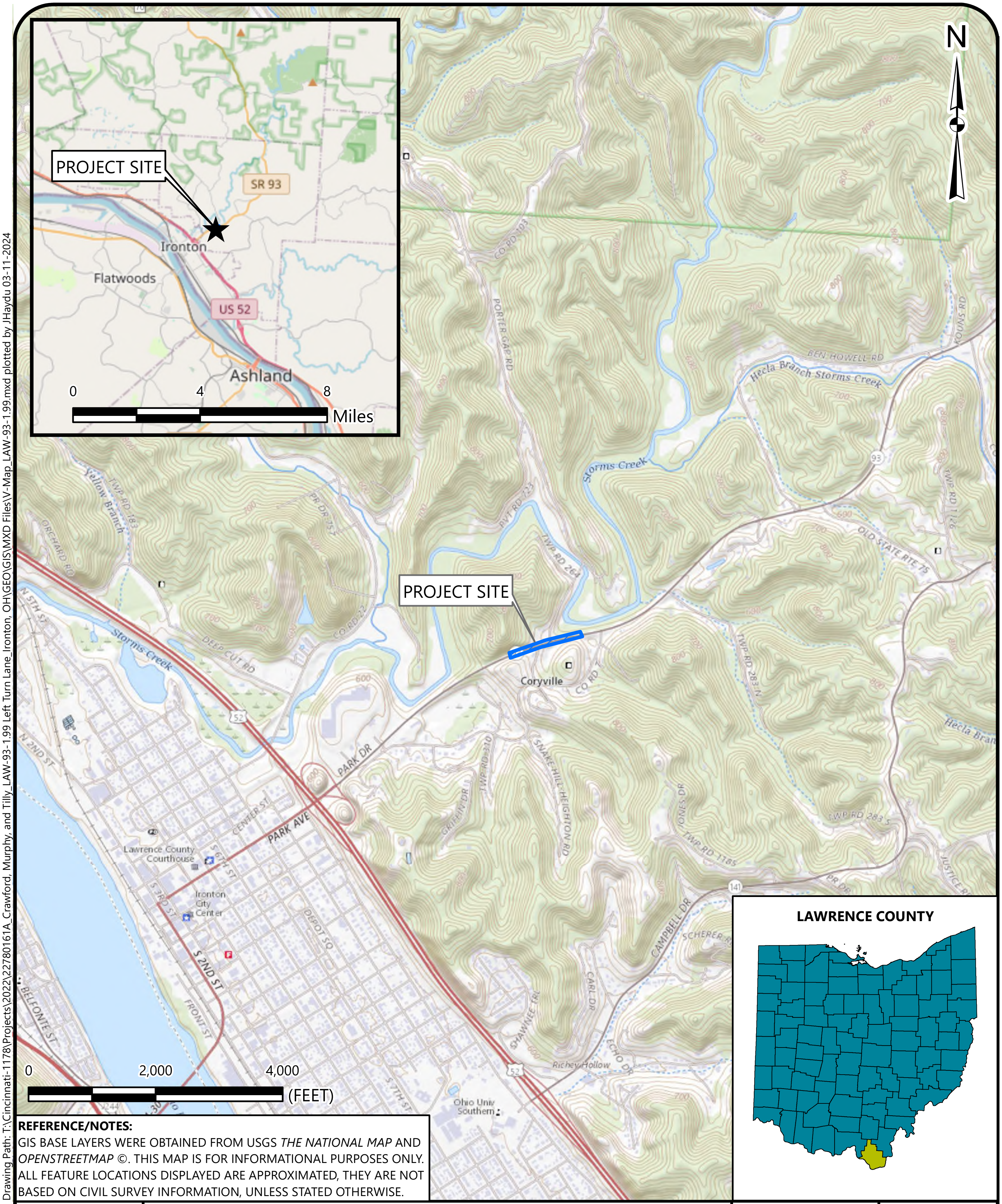
Geo-Environmental Issues

The equipment, techniques, and personnel used to perform a geo-environmental study differ significantly from those used for a geotechnical exploration. Indications of environmental contamination may be encountered incidental to performance of a geotechnical exploration but go unrecognized. Determination of the presence, type or extent of environmental contamination is beyond the scope of a geotechnical exploration.

Geotechnical Recommendations Are Not Final

Recommendations are developed based on the geotechnical engineer's understanding of the proposed construction and professional opinion of site subsurface conditions. Observations and tests must be performed during construction to confirm subsurface conditions exposed by construction excavations are consistent with those assumed in development of recommendations. It is advisable to retain the geotechnical engineer that performed the exploration and developed the geotechnical recommendations to conduct tests and observations during construction. This may reduce the risk that variations in subsurface conditions will not be addressed as recommended in the geotechnical report.

Portion obtained with permission from "Important Information About Your Geotechnical Engineering Report", ASFE, 2004



REFERENCE/NOTES:
GIS BASE LAYERS WERE OBTAINED FROM USGS *THE NATIONAL MAP* AND *OPENSTREETMAP* ©. THIS MAP IS FOR INFORMATIONAL PURPOSES ONLY. ALL FEATURE LOCATIONS DISPLAYED ARE APPROXIMATED, THEY ARE NOT BASED ON CIVIL SURVEY INFORMATION, UNLESS STATED OTHERWISE.

Drawing Path: T:\Cincinnati-1178\Projects\2022\22780161A_Crawford, Murphy, and Tilly_LAW-93-1.99 Left Turn Lane_Ironton, OH\GEO\GIS\MXD Files\V-Map_LAW-93-1.99.mxd plotted by JHaydu 03-11-2024

VICINITY MAP

LAW-93-1.99 | PID 119504
IRONTON, LAWRENCE COUNTY, OHIO

SCALE:
1 " = 2,000 '

DATE:
3-11-24

PROJECT NUMBER
22780161A

FIGURE No.
1

Drawing Path: T:\Cincinnati-1178\Projects\2022\22780161A_Crawford, Murphy, and Tilly_LAW-93-1.99 Left Turn Lane_Ironton, OH\GEO\GIS\MXD Files\POB_LAW-93-1.99.mxd plotted by JHaydu 03-11-2024

REFERENCE:
GIS BASE LAYERS WERE OBTAINED FROM ESRI. THIS MAP IS FOR INFORMATIONAL PURPOSES ONLY. ALL FEATURE LOCATIONS DISPLAYED ARE APPROXIMATED. THEY ARE NOT BASED ON CIVIL SURVEY INFORMATION, UNLESS STATED OTHERWISE.

PLAN OF BORINGS

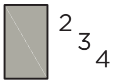
LAW-93-1.99 | PID 119504
IRONTON, LAWRENCE COUNTY, OHIO

SCALE:
1 " = 200 '
DATE:
3-11-24
PROJECT NUMBER
22780161A

FIGURE NO.
2

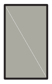
Appendix B – Field Procedures

ODOT SOIL LOG LEGEND



The STANDARD PENETRATION TEST (SPT) as defined by AASHTO T206 (or ASTM D1586) is a method to obtain a disturbed soil sample for examination and testing and to obtain relative density and consistency information. A standard 1.4-inch I.D./2-inch O.D. split-barrel sampler is driven three 6-inch increments (see graphic at right) with a 140 lb. hammer freely falling 30 inches. The hammer can either be of a trip, free-fall design, or actuated by a rope and cathead. The SPT N Value is determined by adding the number of blows from the 2nd and 3rd 6-inch increments.

SPT BLOWCOUNT CORRECTION FOR HAMMER EFFICIENCY (N_{60}) is determined by the following equation: N_{60} = N * [Drill Rod Energy Ratio (%) / 60], and where the drill rod energy ratio is determined in accordance with ASTM D4633. If the drill rod energy ratio exceeds 90%, it is limited to 90% to determine the N_{60} value and is shown on the log as 90*.



SHELBY TUBE (ST) samples are obtained by hydraulically pushing a thin-walled tube (typically 3-inches in diameter) to obtain a relatively undisturbed sample for testing of fine-grained soils to determine engineering properties such as strength, compressibility, permeability, and density. Shelby tubes are sampled in general accordance with ASTM D1587 (AASHTO T207).

DESCRIPTIVE ORDER OF SOIL STRATA: Consistency/Density, color, ODOT soil classification description, minor soil constituents with percentage modifiers, organic content, miscellaneous constituents or descriptions, relative moisture condition.

ODOT SOIL CLASSIFICATION DESCRIPTION AND SYMBOL

⁘	**GRAVEL** **(A-1-a)**	⁛	**SILT** **(A-4b)**	▦	**ORGANIC CLAY** **(A-8b)**
⁘	**GRAVEL WITH SAND** **(A-1-B)**	▤	**ELASTIC SILT AND CLAY** **(A-5)**	P	**PEAT**
FS	**FINE SAND** **(A-3)**	▨	**SILT AND CLAY** **(A-6a)**	⁂	**UNCONTROLLED FILL**
⁙	**COARSE AND FINE SAND** **(A-3a)**	▤	**SILTY CLAY** **(A-6b)**	▩	**BOULDERY ZONE**
⁘	**GRAVEL WITH SAND AND SILT** **(A-2-4 OR A-2-5)**	▥	**ELASTIC CLAY** **(A-7-5)**	▧	**SOD/ROOTMAT/ TOPSOIL**
⁘	**GRAVEL WITH SAND, SILT AND CLAY** **(A-2-6 OR A-2-7)**	▦	**CLAY** **(A-7-6)**	▩	**PAVEMENT OR BASE**
▥	**SANDY SILT** **(A-4a)**	⁛	**ORGANIC SILT** **(A-8a)**	⁖	**CONCRETE**

SOIL LOG SYMBOLS

SS - Split-Spoon Sample
ST - Shelby Tube Sample
TR - Top of Rock
REC - Sample Recovery, %
HP - Hand Penetrometer Value, tsf
LOI - Loss on Ignition Test, %

Qu - Unconfined Compressive Strength
γd - Dry Unit Weight, pcf
γm - Moist Unit Weight, pcf
GR - Gravel Content, %
CS - Coarse Sand Content, %

FS - Fine Sand Content, %
SI - Silt Content, %
CL - Clay Content, %
LL - Liquid Limit
PL - Plastic Limit
PI - Plasticity Index
WC - Natural Water Content, %

NOTE: Particle size contents are expressed % by weight.

PARTICLE SIZE

Particle	Size	US Sieve Size
Boulder	>300 mm (12 in.)	12 in.
Cobble	75 - 300 mm (3 - 12 in.)	3 - 12 in.
Coarse gravel	19 - 75 mm (3/4 - 3 in.)	3/4 - 3 in.
Fine gravel	2 - 19 mm (0.08 - 3/4 in.)	#10 - 3/4 in.
Coarse sand	0.42 - 2.0 mm	#40 - #10
Fine sand	0.074 - 0.42 mm	#200 - #40
Silt	0.005 - 0.074 mm	NA
Clay	< 0.005 mm	NA

FINE-GRAINED SOIL
(Relative Consistency)

	N_{60}	HP
Very soft	< 2 bpf	< 0.25 tsf
Soft	2 - 4 bpf	> 0.25 - 0.5 tsf
Medium stiff	5 - 8 bpf	> 0.5 - 1.0 tsf
Stiff	9 - 15 bpf	> 1.0 - 2.0 tsf
Very stiff	16 - 30 bpf	> 2.0 - 4.0 tsf
Hard	> 30 bpf	> 4.0 tsf

COARSE-GRAINED SOIL
(Relative Density)

	N_{60}
Very loose	< 5 bpf
Loose	5 - 10 bpf
Medium dense	11 - 30 bpf
Dense	31 - 50 bpf
Very dense	> 50 bpf

MINOR CONSTITUENTS
(% By Weight)

	Percentage
Trace	0% - 10%
Little	>10% - 20%
Some	>20% - 35%
"And"	≥ 35%

ORGANIC CONTENT OF SOIL
(Determined by ASTM D2974 or AASHTO T267)

Classification	Percentage
Slightly organic	2% - 4%
Moderately organic	>4% - 10%
Highly organic	> 10%

RELATIVE MOISTURE CONDITION

Dry	Cohesive - Powdery, WC well below PL Granular - No moisture present
Damp	Cohesive - Leaves very little moisture when pressed, WC < PL Granular - Internal moisture, little to no surface moisture
Moist	Cohesive - Leaves moisture when pressed, PL < WC < LL - 3 Granular - Free water on surface, shiny appearance
Wet	Cohesive - Mushy, WC near or above LL Granular - Voids filled with free water

—W	**At Time of Drilling**	Free water (seepage or groundwater) observation made anytime during the drilling process. Depending on time of reading and drilling methodologies, this value may be influenced by the drilling process.
▽	**At end of Drilling**	Free water measurement soon after the drilling processes are complete, and the borehole is at final depth. Drilling fluids, if introduced during drilling, may influence this measurement.
▼	**24 hrs After Drilling**	Free water measurements made in a borehole hours to days after drilling is complete including the time elapsed (i.e., "24 hrs" as shown at left). Depending on subsurface conditions, elapsed time, drilling process, etc. this observation may reflect a stabilized level.

REFERENCES:
Ohio Department of Transportation (ODOT), Specifications for Geotechnical Explorations (SGE)

ODOT ROCK CORE LOG LEGEND

DESCRIPTIVE ORDER FOR ROCK STRATA

Bedrock type, color, weathering, strength, texture, bedding, other descriptors, type and condition of discontinuities, unit RQD, unit recovery.

When alternating layers occur between two distinct rock types, describe the material as “Interbedded” with the major rock type first, with estimated percentage, and the secondary rock type second, with estimated percentage. Provide the unit RQD and unit recovery, then describe each rock type in detail.

For spread footings founded on or into bedrock, describe discontinuities using the modified Rock Mass Rating (RMR) system (degree of fracturing, aperture width and surface roughness). For drilled shafts extending into bedrock, describe discontinuities using the Geologic Strength Index (GSI) system (discontinuity structure and surface condition). For rock cut slopes, describe discontinuities using both the modified RMR and GSI systems.

COMMON OHIO BEDROCK TYPES AND SYMBOLS

▤	SHALE	▒	SILTSTONE	▦	LIMESTONE	C	COAL
▨	CLAYSTONE/ MUDSTONE	⁘	SANDSTONE	▧	DOLOMITE	▩	UNDERCLAY/ FIRECLAY

WEATHERING

Unweathered	No evidence of chemical or mechanical alternation of the rock mass. Mineral crystals have a bright appearance with no discoloration. Fractures show little or no staining on surfaces.
Slightly Weathered	Slight discoloration of the rock surface with minor alterations along discontinuities. Less than 10% of the rock volume presents alteration.
Moderately Weathered	Portions of the rock mass are discolored with a dull appearance. Surfaces may have a pitted appearance with weathering “halos”. Isolated zones of varying rock strengths.
Highly Weathered	Entire rock mass appears discolored and dull. Some pockets of slightly to moderately weathered rock and some areas of severely weathered materials may be present.
Severely Weathered	Majority of the rock mass reduced to a soil-like state. Zones of more resistant rock may be present, but the material can generally be molded and crumbled by hand pressures.

STRENGTH

		APPROX. UNCONFINED COMPRESSIVE STRENGTH (PSI)
Extremely Strong	Cannot be scratched by a knife or sharp pick. Chipping off hand specimens requires hard repeated blows of a geologist’s hammer.	> 30,000
Very Strong	Cannot be scratched by a knife or sharp pick. Breaking off hand specimens requires hard repeated blows of a geologist’s hammer.	30,000 - 15,000
Strong	Can be scratched with a knife or pick with difficulty. Requires hard hammer blows to detach hand specimen.	15,000 - 7,500
Moderately Strong	Can be scratched with a knife or pick. Gouges ¼” deep can be excavated by a pick. Requires moderate hammer blows to detach specimen.	7,500 - 3,600
Slightly Strong	Can be gouged 0.05 inch deep by firm pressure with a knife or pick point. Can excavate small pieces (1-inch) by hard blows with a pick.	3,600 - 1,500
Weak	Can be gouged readily by a knife or pick or excavated in small fragments by moderate blows of a pick. Small, thin pieces can be broken by hand.	1,500 - 750
Very Weak	Can be carved with a knife and excavated readily with a pick. Pieces 1 inch or more thick can be broken by hand. Can be scratched by fingernail.	750 - 40

TEXTURE

Boulder	> 12 in.
Cobble	12 - 3 in.
Gravel	3 - 0.08 in.
Coarse Sand	0.08 - 0.02 in.
Medium Sand	0.02 - 0.01 in.
Fine Sand	0.01 - 0.005 in.
Very Fine Sand	0.005 - 0.003 in.

BEDDING

Very Thick Bedded	> 36 in.
Thick Bedded	36 in. - 18 in.
Medium Bedded	18 in. - 10 in.
Thin Bedded	10 in. - 2 in.
Very Thin Bedded	2 in. - 0.4 in.
Laminated	0.4 in. - 0.1 in.
Thinly Laminated	< 0.1 in.

REFERENCES: OHIO DEPARTMENT OF TRANSPORTATION (ODOT), SPECIFICATIONS FOR GEOTECHNICAL EXPLORATIONS (SGE).

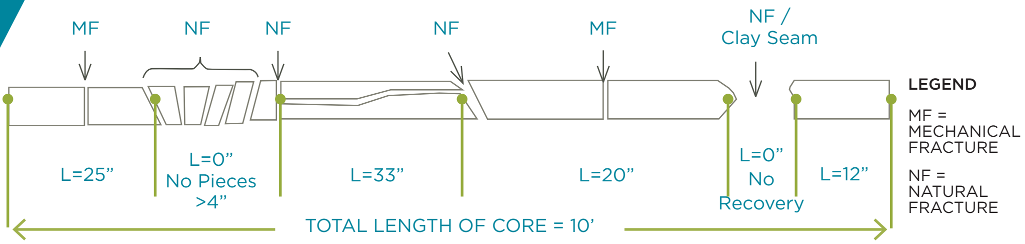
ODOT ROCK CORE LOG LEGEND

ROCK CORE RECOVERY

Recovery to be determined by core run and by rock unit (layer).

$$\text{REC= (Recovery)} \; \frac{\text{Length of Rock Core Recovered}}{\text{Length of Core Run}} \; \text{x100}$$

ROCK QUALITY DESIGNATION (RQD)



$$\text{RQD= (Equation)} \left(\frac{\Sigma \text{ Core with Length (L)} \geq 4\text{”}}{\text{Core Run or Interval Total Length}} \right) \text{x 100}$$

$$\text{RQD= (Example)} \left(\frac{25\text{”} + 33\text{”} + 20\text{”} + 12\text{”}}{120\text{”}} \right) \text{x 100 = 75\%}$$

DESCRIPTORS

Arenaceous - Sandy

Argillaceous - Clayey

Brecciated - Contains angular gravel

Calcareous - Contains calcium carbonate

Carbonaceous - Contains carbon

Cherty - Contains chert

Conglomeritic - Contains rounded gravel

Crystalline - Contains crystalline structure

Dolomitic - Contains Ca/Mg carbonate

Ferriferous - Contains iron

Fissile - Thin planar partings

Fossiliferous - Contains fossils

Friable - Easily broken down

Micaceous - Contains mica

Pyritic - Contains pyrite

Siliceous - Contains silica

Stylolitic - Contains stylotites

Vuggy - Contains openings

DISCONTINUITIES IN BEDROCK

Fault	Fracture which expresses displacement parallel to the surface that does not result in a polished surface.
Joint	Planar fracture that does not express displacement. Generally occurs at regularly spaced intervals.
Shear	Fracture which expresses displacement parallel to the surface that results in polished surfaces or slickensides.
Bedding	A surface produced along a bedding plane.
Contact	A surface produced along a contact plane. (generally not seen in Ohio)

MODIFIED RMR DISCONTINUITY TERMS

DEGREE OF FRACTURING

Unfractured	>10 ft.
Intact	10 ft. – 3 ft.
Slightly Fractured	3 ft. – 1 ft.
Moderately Fractured	12 in. – 4 in.
Fractured	4 in. – 2 in.
Highly Fractured	< 2 in.

APERTURE WIDTH

Open	> 0.2 in.
Narrow	0.2 in. - 0.05 in.
Tight	< 0.05 in.

SURFACE ROUGHNESS

Very Rough	Near vertical steps and ridges occur on the discontinuity surface.
Slightly Rough	Asperities on the discontinuity surface are distinguishable and can be felt.
Slickensided	Surface has a smooth, glassy finish with visual evidence of striation.

GSI DISCONTINUITY TERMS

ROCK MASS STRUCTURE

Intact or Massive	Intact rock with few widely spaced discontinuities
Blocky	Well interlocked undisturbed rock mass, formed by 3 intersecting discontinuity sets
Very Blocky	Interlocked, partially disturbed mass formed by 4 or more joint sets
Blocky/ Disturbed/Seamy	Angular blocks formed by many intersecting discontinuity sets, bedding planes
Disintegrated	Poorly interlocked, heavily broken rock mass
Laminated/ Sheared	Lack of blockiness due to close spacing of weak shear planes

SURFACE CONDITION

Very Good	Very rough, fresh unweathered surfaces
Good	Rough, slightly weathered, iron stained surfaces
Fair	Smooth, moderately weathered and altered surfaces
Poor	Slickensided, high weathered surface with compact coatings
Very Poor	Slickensided, highly weathered surface with soft clay coatings

REFERENCES: OHIO DEPARTMENT OF TRANSPORTATION (ODOT), SPECIFICATIONS FOR GEOTECHNICAL EXPLORATIONS (SGE).

PROJECT: LAW-93-1.99 Left Turn Lane Addition	DRILLING FIRM/OPERATOR: S&ME Inc./Brandon Kenyon	DRILL RIG: R-43 CME 550X	STATION/OFFSET:	EXPLORATION ID B-001-0-23
TYPE: Subgrade	SAMPLING FIRM/LOGGER: S&ME Inc./Rebecca Scherzinger	HAMMER: Auto Hammer (140 lb)	ALIGNMENT:	
PID: 119504 SFN: N/A	DRILLING METHOD: CFA	CALIBRATION DATE: 03/04/2021	ELEVATION: 568.10 EOB: 7.4	PAGE
START: 02/26/2024 END: 02/26/2024	SAMPLING METHOD: SS	ENERGY RATIO (%): 78.70	LAT/LONG: 38.545209, -82.666103	1 OF 1

MATERIAL DESCRIPTION AND NOTES	ELEV. 568.1	DEPTHS	SPT/RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	SO4 ppm	BACK FILL
ASPHALT (12 INCHES)	567.1																		■
MEDIUM DENSE TO VERY DENSE, LIGHT BROWN GRAVEL WITH SAND AND SILT, TRACE CLAY, MOIST, CONTAINS GRAY WEATHERED SANDSTONE FRAGMENTS			14 10 12	29	100	SS-1		9	8	39	12	5	16	15	1	12	A-2-4 (0)		▨
	564.1	▽	4 14 64	84	100	SS-2										9	A-2-4 (v)		▨
VERY DENSE, BROWN WITH GRAY GRAVEL WITH SAND AND SILT, TRACE CLAY, DAMP, CONTAINS GRAY WEATHERED SANDSTONE FRAGMENTS	562.1		15 50/2"	-	100	SS-3		6	11	43	13	8	18	13	5	10	A-2-4 (0)		▨
STIFF TO VERY STIFF, BROWN SILT AND CLAY, LITTLE FINE TO COARSE SAND, TRACE GRAVEL, DAMP TO MOIST, CONTAINS DECAYED WOOD FRAGMENTS, CONTAINS GRAY WEATHERED SANDSTONE FRAGMENTS, RESIDUUM			18 45 50/3"	-	100	SS-4	3.00 1.25									8	A-6a (v)		▨
	560.7	EOB	50/5"	-	99	SS-5										20	A-6a (v)		▨

NOTES: Groundwater seepage encountered at 3.5-ft while drilling.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: ASPHALT PATCH, SOIL CUTTINGS

PROJECT: LAW-93-1.99 Left Turn Lane Addition
TYPE: Subgrade
PID: 119504 SFN: N/A
START: 02/26/2024 END: 02/26/2024

DRILLING FIRM/OPERATOR: S&ME Inc./Brandon Kenyon
SAMPLING FIRM/LOGGER: S&ME Inc./Rebecca Scherzinger
DRILLING METHOD: CFA
SAMPLING METHOD: SS

DRILL RIG: R-43 CME 550X
HAMMER: Auto Hammer (140 lb)
CALIBRATION DATE: 03/04/2021
ENERGY RATIO (%): 78.70

STATION/OFFSET:
ALIGNMENT:
ELEVATION: 592.40 EOB: 8.0
LAT/LONG: 38.545521, -82.664683

EXPLORATION ID
B-002-0-23

PAGE
1 OF 1

MATERIAL DESCRIPTION AND NOTES	ELEV. 592.4	DEPTHS	SPT/RQD	N60	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	SO4 ppm	BACK FILL
ASPHALT (5 INCHES)	592.0																		
AGGREGATE SUBBASE (13 INCHES)	590.9																		
MEDIUM DENSE, LIGHT BROWN GRAVEL WITH SAND AND SILT, LITTLE CLAY, DAMP TO MOIST	589.4		7 8 9	22	100	SS-1		10	4	47	17	12	21	13	8	10	A-2-4 (0)		
MEDIUM DENSE, LIGHT BROWN GRAVEL WITH SAND AND SILT, TRACE CLAY, DAMP, CONTAINS GRAY WEATHERED SANDSTONE FRAGMENTS	586.4		8 8 12	26	100	SS-2		10	3	58	10	8	17	15	2	10	A-2-4 (0)		
			21 8 8	21	100	SS-3										8	A-2-4 (v)		
VERY STIFF, BROWN SILT AND CLAY, SOME FINE TO COARSE SAND, TRACE GRAVEL, DAMP, CONTAINS GRAY WEATHERED SANDSTONE FRAGMENTS, RESIDUUM	584.4		5 5 5	13	25	SS-4	2.00 2.50									13	A-6a (v)		
		EOB																	

NOTES: Groundwater not encountered while drilling.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: ASPHALT PATCH, SOIL CUTTINGS

PROJECT:	LAW-93-1.99 Left Turn Lane Addition	DRILLING FIRM/OPERATOR:	S&ME Inc./Brandon Kenyon	DRILL RIG:	R-43 CME 550X	STATION/OFFSET:	
TYPE:	Subgrade	SAMPLING FIRM/LOGGER:	S&ME Inc./Rebecca Scherzinger	HAMMER:	Auto Hammer (140 lb)	ALIGNMENT:	
PID: 119504	SFN: N/A	DRILLING METHOD:	CFA	CALIBRATION DATE:	03/04/2021	ELEVATION: 568.10	EOB: 8.5
START: 02/26/2024	END: 02/26/2024	SAMPLING METHOD:	SS	ENERGY RATIO (%):	78.70	LAT/LONG:	38.545745, -82.663254

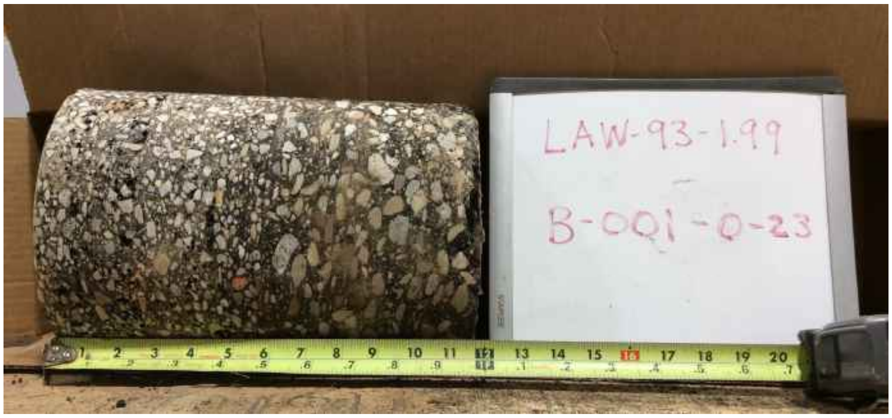
EXPLORATION ID
B-003-0-23

PAGE
1 OF 1

MATERIAL DESCRIPTION AND NOTES		ELEV. 568.1	DEPTHS	SPT/RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%)					ATTERBERG			WC	ODOT CLASS (GI)	SO4 ppm	BACK FILL
									GR	CS	FS	SI	CL	LL	PL	PI				
ASPHALT (6 INCHES)	▩	567.6																		■
AGGREGATE SUBBASE (18 INCHES)	▩	565.6		4 2 4	8	100	SS-1										9			▨
HARD, LIGHT BROWN TO GRAY SILT AND CLAY, LITTLE FINE TO COARSE SAND, LITTLE GRAVEL, DAMP, IRON OXIDE STAINING, RESIDUUM	▨			6 7 20	35	100	SS-2		17	9	10	39	17	34	20	14	10	A-6a (6)		▨
	▨	562.6		3 25 30	72	100	SS-3		3	5	8	43	27	38	23	15	10	A-6a (9)		▨
SHALE, GRAY, VERY THIN LAMINATED, SEVERELY WEATHERED, VERY WEAK	☰		TR	10 34 50/5"	-	94	SS-4										7	Rock (v)		▨
	☰	559.6		9 28 35	83	100	SS-5										7	Rock (v)		▨
			EOB																	

NOTES: Groundwater not encountered while drilling.

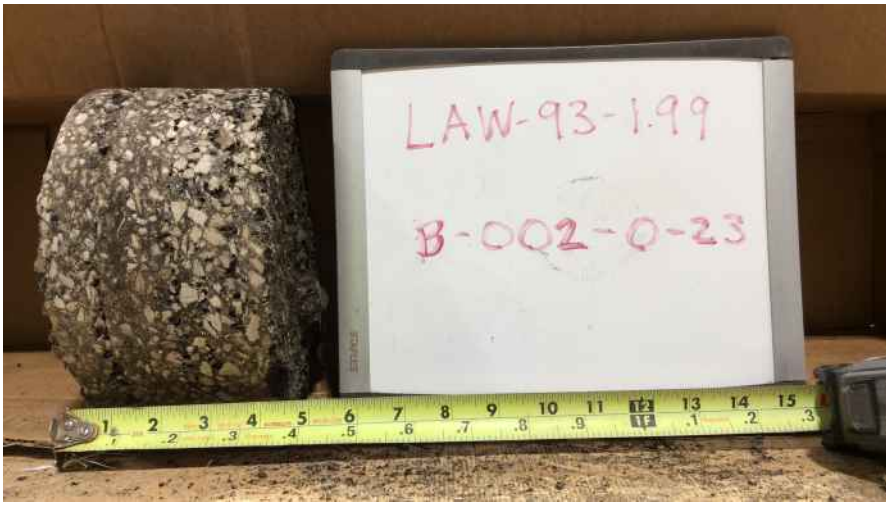
ABANDONMENT METHODS, MATERIALS, QUANTITIES: ASPHALT PATCH, SOIL CUTTINGS



Date: 3/15/2024

Photographer: R. Scherzinger

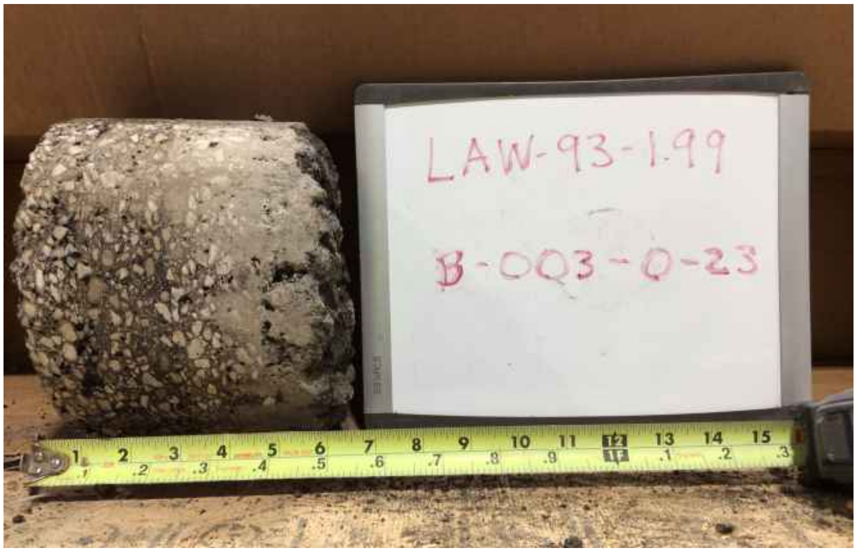
1	**Core No. / Location**	B-001-0-23 / WB Shoulder
	Thickness	Asphalt = 12 inches



Date: 3/15/2024

Photographer: R. Scherzinger

2	**Core No. / Location**	B-002-0-23 / Median
	Thickness	Asphalt = 5 inches



Date: 3/15/2024

Photographer: R. Scherzinger

3	**Core No. / Location**	B-003-0-23 / EB Shoulder
	Thickness	Asphalt = 6 inches


Difficulty removing the material after coring.

Date: 3/15/2024

Photographer: R. Scherzinger

4	**Core No. / Location**	X-001-0-23 / Median
	Thickness	Asphalt = 6 inches / Concrete = 7.5 inches

Summary of Field Procedures

♦ Boring and Sampling

Surface Coring of Concrete Pavement

Coring of concrete slabs or concrete pavement was performed in general accordance with ASTM C42, *Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete*. Samples were obtained for measuring approximate thickness only. Cores were drilled in the vertical orientation and, were used for thickness measurement, at least one foot from formed joints or obvious edges. Moisture conditioning and end surface preparation of recovered cores described in Section 7 of ASTM C42 was not performed.

Soil Test Boring with Flight Auger

Soil sampling and penetration testing were performed in general accordance with ASTM D1586, *Standard Test Method for Penetration Test and Split Barrel Sampling of Soils*. Borings were made by mechanically twisting a continuous steel flight auger into the soil. At regular intervals, soil samples were obtained with a standard 1.4-inch I. D., 2-inch O. D., split barrel sampler. The sampler was first seated six inches to penetrate any loose cuttings, then driven an additional 12 inches with blows of a 140-pound hammer falling 30 inches. The number of hammer blows required to drive the sampler through the two final six inch increments was recorded as the penetration resistance (SPT N) value. The N-value, when properly interpreted by qualified professional staff, is an index of the soil strength and foundation support capability.

Auger Borings

Auger borings were advanced mechanically by a drill rig using a flight auger or hollow stem auger in general accordance with ASTM D1452, *Standard Practice for Soil Investigation and Sampling by Auger Borings*. The soils encountered were identified in the field by examining the cuttings brought to the surface. Soil consistency was qualitatively estimated by the relative difficulty of advancing the augers.

Refusal to Drilling

Refusal to the soil drilling methods used at this site may result from encountering hard cemented soil, soft weathered rock, coarse gravel, cobbles or boulders, thin rock seams, or the upper surface of sound continuous rock. Core drilling would be required to determine the character and continuity of materials below refusal of the soil auger in natural soils. Where fills are present, refusal to drilling may also result from encountering buried debris, building materials, or objects. Backhoe test pits would be required to expose and identify buried materials below refusal levels in filled areas.

Borehole Closure

Following collection of relevant geotechnical data, boreholes were filled by slowly pouring auger cuttings into the open hole such that minimal “bridging” of the material occurred in the hole. Backfilling of the upper two feet of each hole was tamped as heavily as possible with a shovel handle or other hand held equipment, and the backfill crowned to direct rainfall away on the surface. Where boreholes exceeded five feet in depth, a plastic hole plug was firmly tamped into place within the backfill at a depth of about two feet.

Patching of Asphalt Surface

Penetrations of asphalt surfaces made during the drilling process were patched using compacted asphalt cold patch material. Cold patch asphalt was placed to provide a surface flush with existing pavement adjacent to the boring. Cold patch asphalt was compacted by tamping it into the boring with a shovel handle or similar hand held equipment.

Preservation and Transporting of Soil Samples with Control of Field Moisture

Procedures for preserving soil samples obtained in the field and transportation of samples to the laboratory generally followed those given in ASTM D4220, *Standard Practice for Preserving and Transporting Soil Samples* for Group B samples as defined in Section 4. Group B samples are those samples not suspected of being contaminated and for which only water content and classification, proctor, relative density, or profile logging will be performed. Group B samples also include bulk samples that are intended to be remolded in the laboratory for compaction, swell pressure, percent swell, consolidation, permeability, CBR, or shear testing. Representative samples of the cuttings or split spoon samples, or representative bulk samples, were placed in suitably identified, sealed glass jars or plastic containers and transported to the laboratory. Sample identification numbers on the containers corresponded to sample numbers recorded on field boring records or test pit records. Thin-walled tube samples were sealed at the ends with paraffin and capped with plastic end caps.

♦ Field Tests of Earth Materials

The subsurface conditions encountered during drilling were reported on a field test boring record by the chief driller. The record contains information about the drilling method, samples attempted and sample recovery, indications of materials in the borings such as coarse gravel, cobbles, etc., and indications of materials encountered between sample intervals. Representative soil samples were placed in glass jars and transported to the laboratory along with the field boring records. Recovered samples not expended in laboratory tests are commonly retained in our laboratory for 60 days following completion of drilling. Field boring records are retained at our office.

Measurement of Static Water Levels

Water level readings were made in the open boreholes immediately after completing drilling and withdrawal of the tools. Where feasible, measurements were repeated after an elapsed period of 24 hours to gauge the stabilized water level. Procedures for measurement of liquid levels in open boreholes are described in ASTM D4750, *Standard Test Method for Determining Subsurface Liquid Levels in a Borehole or Monitoring Well (Observation Well)*. A weighted measuring tape was slowly lowered into each borehole until the liquid surface was penetrated by the weighted end. The reading on the tape was recorded at a reference point on the surface and compared to the reading at the demarcation of the wetted and unwetted portions of the tape. The difference between the two readings was recorded as the depth of the liquid surface below the reference point. Measurements made by this method were then repeated until approximately consistent values were obtained.

Appendix C – Laboratory Procedures

Laboratory Test Results Summary
Summary of Laboratory Procedures

Lab Summary

Project No. : **22780161A**

Project Name: **LAW-93-1.99 Left Turn Lane Addition**

Client Name: CM&T

Summary of Laboratory Test Results (ODOT)

Boring No.	Sample Reference	Sample Depth Top (ft)	Sample Depth Bottom (ft)	Natural Moisture Content (%)	ATT. Limits			Gravel (%)	Coarse Sand (%)	Fine Sand (%)	Silt (%)	Clay (%)	Silt / Clay (%)	D / 50 (mm)	D / 95 (mm)	ODOT Classification (GI)
					L.L	P.L	P.I									
B-001-0-23	SS-1	1	2.5	12.4	16	15	1	8.6	7.6	39	11.6	5	17	5.140	7.648	A-2-4 (0)
B-001-0-23	SS-2	2.5	4	8.7												
B-001-0-23	SS-3	4	4.67	9.7	18	13	5	6.0	11	42.9	12.7	8	21	1.129	8.985	A-2-4 (0)
B-001-0-23	SS-4	5.5	6.75	7.9												
B-001-0-23	SS-5	7	7.42	20.1												
B-002-0-23	SS-1	1.5	3	9.7	21	13	8	10.1	3.6	46.9	17.2	12	29	0.226	10.015	A-2-4 (0)
B-002-0-23	SS-2	3	4.5	10.2	17	15	2	10.1	2.8	58.3	9.6	8	17	0.264	12.159	A-2-4 (0)
B-002-0-23	SS-3	4.5	6	7.6												
B-002-0-23	SS-4	6	7.5	13.2												
B-003-0-23	SS-1	1	2.5	8.5												
B-003-0-23	SS-2	2.5	4	9.8	34	20	14	17.2	8.8	10.2	38.5	17	56	0.293		A-6a (10)
B-003-0-23	SS-3	4	5.5	9.8	38	23	15	2.6	5.4	8.2	42.7	27	70	0.129	7.818	A-6a (10)
B-003-0-23	SS-4	5.5	6.92	7.4												
B-003-0-23	SS-5	7	8.5	6.9												

Summary of Laboratory Procedures

Recovered disturbed and undisturbed samples and the drillers' field logs were transported to the laboratory where they were examined by the geotechnical engineer. Selected samples representative of certain groups of soils were subjected to simple classification tests by hand or other simple means.

Recovered disturbed and undisturbed samples and the drillers' field logs were transported to the laboratory where they were examined by the geotechnical engineer. Selected samples representative of certain groups of soils were subjected to simple classification tests by hand or other simple means. Other samples were tested in the laboratory to determine their strength or consolidation properties.

Laboratory Tests of Soil

Examination of Split Spoon Soil Samples

Soil and rock samples and field boring records were reviewed in the laboratory by the geotechnical engineer. Soils were classified in general accordance with the visual-manual method described in ASTM D 2488, *Standard Practice for Description and Identification of Soils (Visual-Manual Method)*. The geotechnical engineer also prepared the final boring records enclosed with this report.

Examination of Split Spoon Soil Samples

Soil and rock samples and field boring records were reviewed in the laboratory by the geotechnical engineer. Representative soil samples were selected for classification testing to provide grain size and plasticity data to allow classification of the samples in general accordance with the AASHTO Classification method described in ASTM D3282, *Standard Practice for Classification of Soils and Soil Aggregate Mixtures for Highway Construction Purposes*. The geotechnical engineer also prepared the final boring records enclosed with this report.

Moisture Content Testing of Soil Samples by Oven Drying

Moisture content was determined in general conformance with the methods outlined in ASTM D2216, "Standard Test Method for Laboratory Determination of Water (Moisture) Content of Soil or Rock by Mass." This method is limited in scope to Group B, C, or D samples of earth materials which do not contain appreciable amounts of organic material, soluble solids such as salt or reactive solids such as cement. This method is also limited to samples which do not contain contamination.

A representative portion of the soil was divided from the sample using one of the methods described in Section 9 of ASTM D2216. The split portion was then placed in a drying oven and heated to approximately 110 degrees C overnight or until a constant mass was achieved after repetitive weighing. The moisture content of the soil was then computed as the mass of water removed from the sample by drying, divided by the mass of the sample dry, times 100 percent. No attempt was made to exclude any particular particle size from the portion split from the sample.

Liquid and Plastic Limits Testing

Atterberg limits of the soils was determined generally following the methods described by ASTM D4318, *Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils*. Albert Atterberg originally defined "limits of consistency" of fine grained soils in terms of their relative ease of deformation at various moisture contents. In current engineering usage, the liquid limit of a soil is defined as the moisture content, in percent, marking the upper limit of viscous flow and the boundary with a semi-liquid state. The plastic limit defines the lower limit of plastic behavior, above which a soil behaves plastically below which it retains its shape upon drying. The plasticity index (PI) is the range of water content over which a soil behaves plastically. Numerically, the PI is the difference between liquid limit and plastic limit values.

Representative portions of fine grained Group A, B, C, or D samples were prepared using the wet method described in Section 10.1 of ASTM D4318. The liquid limit of each sample was determined using the multipoint method (Method A) described in Section 11. The liquid limit is by definition the moisture content where 25 drops of a hand operated liquid limit device are required to close a standard width groove cut in a soil sample placed in the device. After each test, the moisture content of the sample was adjusted and the sample replaced in the device. The test was repeated to provide a minimum of three widely spaced combinations of N versus moisture content. When plotted on semilog paper, the liquid limit moisture content was determined by straight line interpolation between the data points at N equals 25 blows.

The plastic limit was determined using the procedure described in Section 17 of ASTM D4318. A selected portion of the soil used in the liquid limit test was kneaded and rolled by hand until it could no longer be rolled to a 3.2 mm thread on a glass plate. This procedure was repeated until at least 6 grams of material was accumulated, at which point the moisture content was determined using the methods described in ASTM D2216.

Grain Size Analysis of Samples

The distribution of particle sizes greater than 75 µm was determined in general accordance with the procedures described by ASTM D421, *Standard Practice for Dry Preparation of Soil Samples for Particle-Size Analysis and Determination of Soil Constants*, and D422, *Standard Test Method for Particle Size Analysis of Soils*. During preparation samples were divided into two portions. The material coarser than the No. 30 U.S. sieve size fraction was dry sieved through a nest of standard sieves as described in Article 6. Material passing the No. 30 sieve was independently passed through a nest of sieves down to the No. 200 size.

Grain Size Analysis of Samples with Hydrometer

The distribution of particle sizes was determined in general accordance with the procedures described by ASTM D421, *Standard Practice for Dry Preparation of Soil Samples for Particle-Size Analysis and Determination of Soil Constants*, and D422, *Standard Test Method for Particle Size Analysis of Soils*. During preparation samples were divided into two portions. The material coarser than the No. 10 U.S. sieve size fraction was dry sieved through a nest of standard sieves as described in Article 6. Material passing the No. 10 sieve was soaked in demineralized water and a dispersing agent, then the soil-water slurry placed in a glass sedimentation chamber and the specific gravity of the slurry recorded at various time intervals. The grain size distribution was calculated from the time rate of sedimentation of the various size particles. After the final hydrometer reading was obtained, the suspension was washed through the No. 200 sieve. The remaining material retained on the No. 200 sieve was oven dried, and then passed through a standard nest of sieves.

Percent Fines Determination of Samples

A selected specimen of soils was washed over a No. 200 sieve after being thoroughly mixed and dried. This test was conducted in general accordance with ASTM D1140, *Standard Test Method for Amount of Material Finer Than the No. 200 Sieve*. Method A, using water to wash the sample through the sieve without soaking the sample for a prescribed period of time, was used and the percentage by weight of material washing through the sieve was deemed the “percent fines” or percent clay and silt fraction.

Appendix D – Subgrade Analysis

OHIO DEPARTMENT OF TRANSPORTATION

OFFICE OF GEOTECHNICAL ENGINEERING

PLAN SUBGRADES
Geotechnical Design Manual Section 600

LAW-93-1.99
PID 119504

PROJECT DESCRIPTION - Left turn lane addition at Porter Gap Road (CR 21).

S&ME, Inc.

Prepared By: Rebecca E. Scherzinger, PE
Date prepared: Monday, March 11, 2024

S&ME, Inc.
862 E. Crescentville Road
Cincinnati, Ohio 45246

513-771-8471
rscherzinger@smeinc.com

NO. OF BORINGS: 3

#	Boring ID	Alignment	Station	Offset	Dir	Drill Rig	ER	Boring EL.	Proposed Subgrade EL	Cut Fill
1	B-001-0-23	LAW-93	9999	999	Lt	S&ME CME 550X (R-43)	79	609.4	608.4	1.0 C
2	B-002-0-23	LAW-93	9999	999	CL	S&ME CME 550X (R-43)	79	592.4	590.9	1.5 C
3	B-003-0-23	LAW-93	9999	999	Rt	S&ME CME 550X (R-43)	79	592.6	590.1	2.5 C

OHIO DEPARTMENT OF TRANSPORTATION

Subgrade Analysis

V. 14.7 2/16/2024

#	Boring	Sample	Sample Depth		Subgrade Depth		Standard Penetration		HP (tsf)	Physical Characteristics						Moisture		Ohio DOT		Sulfate Content (ppm)	Problem		Excavate and Replace (Item 204)		Recommendation (Enter depth in inches)
			From	To	From	To	N_{60}	N_{60L}		LL	PL	PI	% Silt	% Clay	P200	M_C	M_{OPT}	Class	GI		Unsuitable	Unstable	Unsuitable	Unstable	
1	B 001-023	SS-1	1.0	2.5	0.0	1.5	29	29		16	15	1	12	5	17	12	10	A-2-4	0						
		SS-2	2.5	4.0	1.5	3.0	84									9	10	A-2-4	0						
		SS-3	4.0	4.7	3.0	3.7	100			18	13	5	13	8	21	10	10	A-2-4	0						
		SS-4	5.5	6.8	4.5	5.8	100		1.25							8	14	A-6a	10						
2	B 002-023	SS-1	1.5	3.0	0.0	1.5	22	13		21	13	8	17	12	29	10	10	A-2-4	0						
		SS-2	3.0	4.5	1.5	3.0	26			17	15	2	10	8	18	10	10	A-2-4	0						
		SS-3	4.5	6.0	3.0	4.5	21									8	10	A-2-4	0						
		SS-4	6.0	7.5	4.5	6.0	13		2							13	14	A-6a	10						
3	B 003-023	SS-2	2.5	4.0	0.0	1.5	35	30		34	20	14	39	17	56	10	15	A-6a	6						
		SS-3	4.0	5.5	1.5	3.0	72			38	23	15	43	27	70	10	18	A-6a	9						
		SS-4	5.5	6.9	3.0	4.4	100									7	0	Rock	0						
		S-5	7.0	8.5	4.5	6.0	83									7	0	Rock	0						

OHIO DEPARTMENT OF TRANSPORTATION

Subgrade Analysis

V. 14.7 2/16/2024

PID: PID 119504

County-Route-Section: LAW-93-1.99
No. of Borings: 3

Geotechnical Consultant: S&ME, Inc.
Prepared By: Rebecca E. Scherzinger, PE
Date prepared: 3/11/2024

Chemical Stabilization Options		
320	Rubblize & Roll	Option
206	Cement Stabilization	Option
	Lime Stabilization	No
206	Depth	NA

Excavate and Replace Stabilization Options	
Global Geotextile Average(N60L): Average(HP):	 0" 12"
Global Geogrid Average(N60L): Average(HP):	 0" 0"

Design CBR	9

% Samples within 3 feet of subgrade			
$N_{60} \leq 5$	0%	HP ≤ 0.5	0%
$N_{60} < 12$	0%	0.5 < HP ≤ 1	0%
$12 \leq N_{60} < 15$	0%	1 < HP ≤ 2	0%
$N_{60} \geq 20$	75%	HP > 2	0%
M+	0%		
Rock	0%		
Unsuitable Soil	0%		

Excavate and Replace at Surface	
Average	0"
Maximum	0"
Minimum	0"

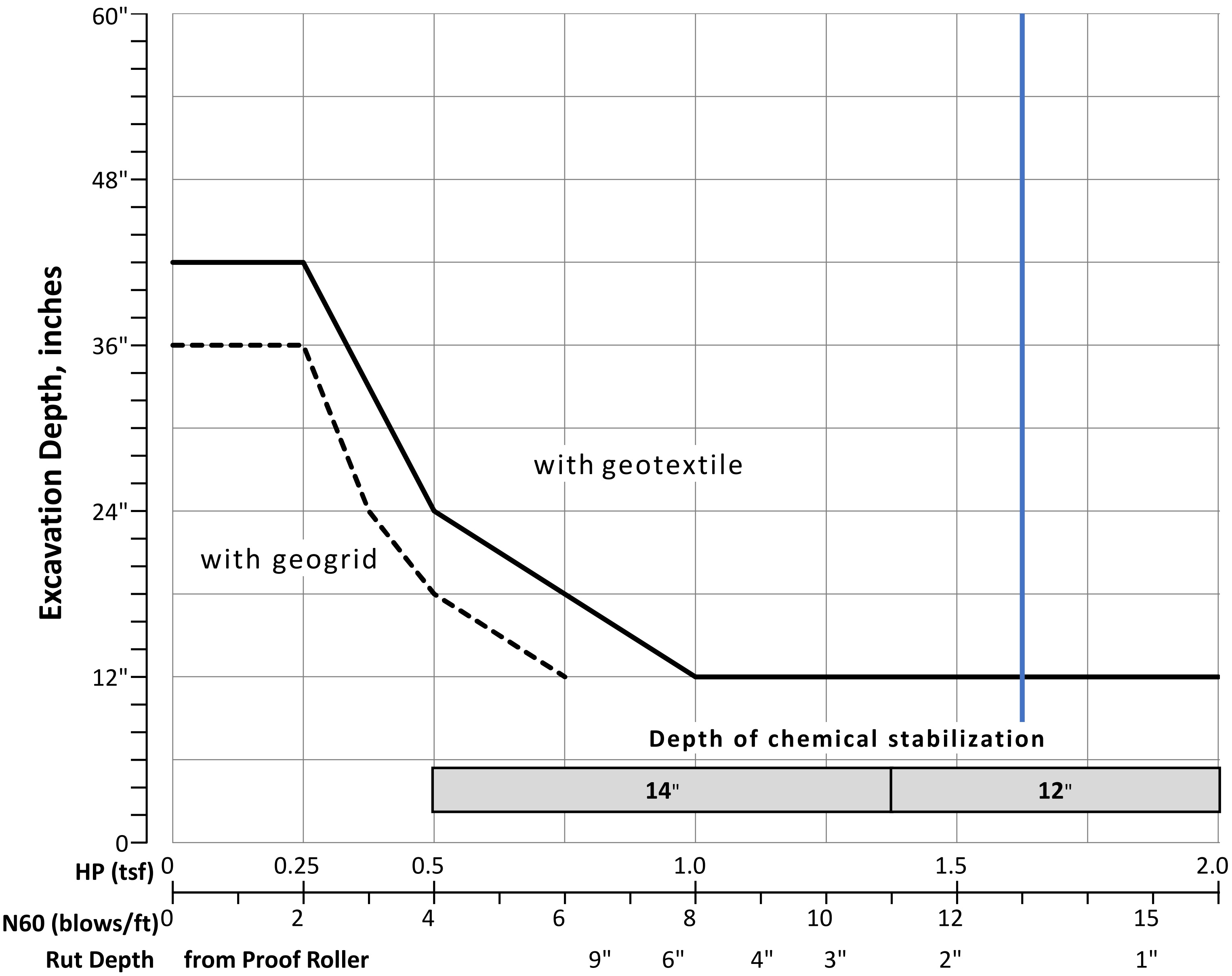
% Proposed Subgrade Surface	
Unstable & Unsuitable	0%
Unstable	0%
Unsuitable (Soil & Rock)	0%

	N_{60}	N_{60L}	HP	LL	PL	PI	Silt	Clay	P 200	M_C	M_{OPT}	GI
Average	57	24	1.63	24	17	8	22	13	35	10	10	3
Maximum	100	30	2.00	38	23	15	43	27	70	13	18	10
Minimum	13	13	1.25	16	13	1	10	5	17	7	0	0

Classification Counts by Sample

ODOT Class	UCF	Rock	A-1-a	A-1-b	A-2-4	A-2-5	A-2-6	A-2-7	A-3	A-3a	A-4a	A-4b	A-5	A-6a	A-6b	A-7-5	A-7-6	A-8a	A-8b	Totals
Count	0	2	0	0	6	0	0	0	0	0	0	0	0	4	0	0	0	0	0	12
Percent	0%	17%	0%	0%	50%	0%	0%	0%	0%	0%	0%	0%	0%	33%	0%	0%	0%	0%	0%	100%
% Rock|Granular|Cohesive	0%	17%	50%									33%								100%
Surface Class Count	0	0	0	0	4	0	0	0	0	0	0	0	0	2	0	0	0	0	0	6
Surface Class Percent	0%	0%	0%	0%	67%	0%	0%	0%	0%	0%	0%	0%	0%	33%	0%	0%	0%	0%	0%	100%

Fig. 600-1 – Subgrade Stabilization



OVERRIDE TABLE

Calculated Average	New Values	Check to Override
1.63		☐ HP
24.00		☐ N60L

Average HP ▬

Average N_{60L} ▬

Appendix E – Geotechnical Design Checklists

I. Geotechnical Design Checklists

Project: LAW-93-1.99 **PDP Path:**

PID: 119504 **Review Stage:** 1

Checklist	Included in This Submission
II. Reconnaissance and Planning	✓
III. A. Centerline Cuts	
III. B. Embankments	
III. C. Subgrade	✓
IV. A. Foundations of Structures	
IV. B. Retaining Wall	
V. A. Landslide Remediation	
V. B. Rockfall Remediation	
V. C. Wetland or Peat Remediation	
V. D. Underground Mine Remediation	
V. E. Surface Mine Remediation	
V. F. Karst Remediation	
VI. A. Geotechnical Profile	
VI. D. Geotechnical Reports	✓

II. Reconnaissance and Planning Checklist

C-R-S:	LAW-93-1.99	**PID:**	119504	**Reviewer:**	RES	**Date:**	3/27/2024

Reconnaissance		(Y/N/X)	Notes:
1	Based on Section 302.1 in the SGE, have the necessary plans been developed in the following areas prior to the commencement of the subsurface exploration reconnaissance:		
	Roadway plans	✓	
	Structures plans		
	Geohazards plans		
2	Have the resources listed in Section 302.2.1 of the SGE been reviewed as part of the office reconnaissance?	Y	
3	Have all the features listed in Section 302.3 of the SGE been observed and evaluated during the field reconnaissance?	Y	
4	If notable features were discovered in the field reconnaissance, were the GPS coordinates of these features recorded?	X	

Planning - General		(Y/N/X)	Notes:
5	In planning the geotechnical exploration program for the project, have the specific geologic conditions, the proposed work, and historic subsurface exploration work been considered?	Y	
6	Has the ODOT Transportation Information Mapping System (TIMS) been accessed to find all available historic boring information and inventoried geohazards?	Y	
7	Have the borings been located to develop the maximum subsurface information while using a minimum number of borings, utilizing historic geotechnical explorations to the fullest extent possible?	Y	
8	Have the topography, geologic origin of materials, surface manifestation of soil conditions, and any other special design considerations been utilized in determining the spacing and depth of borings?	Y	
9	Have the borings been located so as to provide adequate overhead clearance for the equipment, clearance of underground utilities, minimize damage to private property, and minimize disruption of traffic, without compromising the quality of the exploration?	Y	

II. Reconnaissance and Planning Checklist

Planning - General		(Y/N/X)	Notes:
10	Have the scaled boring plans, showing all project and historic borings, and a schedule of borings in tabular format, been submitted to the District Geotechnical Engineer?	Y	
	The schedule of borings should present the following information for each boring:		
a.	exploration identification number	Y	
b.	location by station and offset	Y	
c.	estimated amount of rock and soil, including the total for each for the entire program.	Y	
Planning – Exploration Number		(Y/N/X)	Notes:
11	Have the coordinates, stations and offsets of all explorations (borings, soundings, test pits, etc.) been identified?	Y	
12	Has each exploration been assigned a unique identification number, in the following format X-ZZZ-W-YY, as per Section 303.2 of the SGE?	Y	
13	When referring to historic explorations that did not use the identification scheme in 12 above, have the historic explorations been assigned identification numbers according to Section 303.2 of the SGE?	Y	

II. Reconnaissance and Planning Checklist

Planning – Boring Types		(Y/N/X)	Notes:
14	Based on Sections 303.3 to 303.7.6 of the SGE, have the location, depth, and sampling requirements for the following boring types been determined for the project?		
	Check all boring types utilized for this project:		
	Existing Subgrades (Type A)	✓	
	Roadway Borings (Type B)		
	Embankment Foundations (Type B1)		
	Cut Sections (Type B2)		
	Sidehill Cut Sections (Type B3)		
	Sidehill Cut-Fill Sections (Type B4)		
	Sidehill Fill Sections on Unstable Slopes (Type B5)		
	Geohazard Borings (Type C)		
	Lakes, Ponds, and Low-Lying Areas (Type C1)		
	Peat Deposits, Compressible Soils, and Low Strength Soils (Type C2)		
	Uncontrolled Fills, Waste Pits, and Reclaimed Surface Mines (Type C3)		
	Underground Mines (C4)		
	Landslides (Type C5)		
	Rock Slope (Type C6)		
	Karst (Type C7)		
	Proposed Underground Utilities (Type D)		
	Structure Borings (Type E)		
	Bridges (Type E1)		
	Culverts (Type E2 a,b,c)		
	Retaining Walls (Type E3 a and b)		
	Noise Barrier (Type E4)		
	CCTV & High Mast Lighting Towers (Type E5)		
	Buildings and Salt Domes (Type E6)		

III.C. Subgrade Checklist

C-R-S: LAW-93-1.99	**PID:** 119504	**Reviewer:** RES	**Date:** 3/27/2024

Use this Checklist in conjunction with the Subgrade design guidance in GDM Section 600
If you do not have any subgrade work on the project, you do not have to fill out this checklist.

Subgrade		(Y/N/X)	Notes:
1	Has the subsurface exploration adequately characterized the soil or rock according to GDM Section 600?	Y	
a.	Has each sample been visually classified and inspected for the presence of gypsum? Has a moisture content been performed on each sample?	Y	
b.	Has mechanical classification (Plastic Limit (PL), Liquid Limit (LL), and gradation testing) been done on at least two samples from each boring within six feet of the proposed subgrade?	Y	
c.	Has the sulfate content of at least one sample from each boring within 3 feet of the proposed subgrade been determined, per Supplement 1122, Determining Sulfate Content in Soils?	X	Not included based on comments from ODOT
d.	Has the sulfate content of all samples that exhibit gypsum crystals been determined?	X	
e.	Have A-2-5, A-4b, A-5, A-7-5, A-8a, or A-8b soils within the top 3 feet of the proposed subgrade been mechanically classified?	X	
2	If soils classified as A-2-5, A-4b, A-5, A-7-5, A-8a, or A-8b, or having a LL>65, are present at the proposed subgrade (geotechnical profile), do the plans specify that these materials need to be removed and replaced or chemically stabilized?	X	
a.	If these materials are to be removed and replaced, have the station limits, depth, and lateral limits for the planned removal been provided?	X	
3	If there is any rock, shale, or coal present at the proposed subgrade (C&MS 204.05), do the plans specify the removal of the material?	X	
a.	If removal of any rock, shale, or coal is required, have the station limits, depth, and lateral limits for the planned removal of the material at proposed subgrade been provided?	X	

III.C. Subgrade Checklist

Subgrade	(Y/N/X)	Notes:
4 In accordance with GDM Section 600, do the SPT (N_{60})/HP values and existing moisture contents for the proposed subgrade soils indicate the need for subgrade stabilization?	N	
a. If removal and replacement is applicable, has the detail of subgrade removal been shown on the plans, including depth of removal, station limits, lateral extent, replacement material, and plan notes (Item 204 - Subgrade Compaction and Proof Rolling)?	X	
b. If chemical stabilization is applicable, has the detail of this treatment been shown on the plans, including depth, percentage of chemical, station limits, lateral extent, and plan notes?	X	
Indicate type of chemcial stabilization specified:		
cement stabilization		
lime stabilization		
5 If removal and replacement has been specified, do the plans include Plan Note G121 from L&D3?	X	
6 If drainage or groundwater is an issue with the proposed subgrade, has an appropriate drainage system (e.g., pipe, underdrains) been provided?	X	
7 Has an appropriate quantity of Proof Rolling (C&MS 204.06) and has Plan Note G111 from L&D3 been included in the plans?	X	
8 Has a design CBR value been provided?	Y	

VI.B. Geotechnical Reports

C-R-S: LAW-93-1.99	**PID:** 119504	**Reviewer:** RES	**Date:** 3/27/2024

General		(Y/N/X)	Notes:
1	Has an electronic copy of all geotechnical submissions been provided to the District Geotechnical Engineer (DGE)?		
2	Has the first complete version of a geotechnical report being submitted been labeled as 'Draft'?	Y	
3	Subsequent to ODOT's review and approval, has the complete version of the revised geotechnical report being submitted been labeled 'Final'?	X	
4	Has the boring data been submitted in a native format that is DIGGS (Data Interchange for Geotechnical and Geoenvironmental) compatable? gINT files meet this demand?		
5	Does the report cover format follow ODOT's Brand and Identity Guidelines Report Standards found at http://www.dot.state.oh.us/brand/Pages/default.aspx ?	Y	
6	Have all geotechnical reports being submitted been titled correctly as prescribed in Section 706.1 of the SGE?	Y	
Report Body		(Y/N/X)	Notes:
7	Do all geotechnical reports being submitted contain the following:		
a.	an Executive Summary as described in Section 706.2 of the SGE?	Y	
b.	an Introduction as described in Section 706.3 of the SGE?	Y	
c.	a section titled "Geology and Observations of the Project," as described in Section 706.4 of the SGE?	Y	
d.	a section titled "Exploration," as described in Section 706.5 of the SGE?	Y	
e.	a section titled "Findings," as described in Section 706.6 of the SGE?	Y	
f.	a section titled "Analyses and Recommendations," as described in Section 706.7 of the SGE?	Y	
Appendices		(Y/N/X)	Notes:
8	Do all geotechnical reports being submitted contain all applicable Appendices as described in Section 706.8 of the SGE?	Y	
9	Do the Appendices present a site Boring Plan showing all boring locations as described in Section 706.8.1 of the SGE?	Y	

VI.B. Geotechnical Reports

Appendices		(Y/N/X)	Notes:
10	Do the Appendices include boring logs and color pictures of rock, if applicable, as described in Section 706.8.2 of the SGE?	Y	
11	Do the Appendices include reports of undisturbed test data as described in Section 706.8.3 of the SGE?	X	
12	Do the Appendices include calculations in a logical format to support recommendations as described in Section 706.8.4 of the SGE?	X	