Resource International, Inc.

LAW-93-11.21 IMPROVEMENTS
PID NO. 119949
LAWRENCE COUNTY, OHIO

ROADWAY EXPLORATION REPORT

Prepared For:
Korda/Nemeth Engineering, Inc.
1650 Watermark Drive
Columbus, OH 43215

Prepared By:
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Rii Project No. W-24-074

February 2026

RESOURCE INTERNATIONAL, INC.
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February 20, 2026

Ms. Christine Placek, P.E.
Senior Associate/Transportation Engineer
Korda/Nemeth Engineering, Inc.
1650 Watermark Drive
Columbus, Ohio 43215

Re: Roadway Exploration Report
LAW-93-11.21 Improvements
PID 119949
Lawrence County, Ohio
Rii Project No. W-24-074

Ms. Placek:

Resource International, Inc. (Rii) is pleased to submit this roadway exploration report for the above referenced project. Engineering logs have been prepared and are attached to this report along with the results of laboratory testing. This report includes recommendations for the design and construction of the proposed improvements along State Route 93 from approximately Straight Line Mile (SLM) 11.21 to SLM 11.66 in Lawrence County, Ohio.

We sincerely appreciate the opportunity to be of continued service to you on this project. If you have any questions regarding the structure foundation exploration, or this report, please do not hesitate to contact us.

Sincerely,

RESOURCE INTERNATIONAL, INC.

Daniel E. Karch, P.E.
Director – Geotechnical Services, Ohio

Jonathan P. Sterenberg, P.E.
Vice President – Geotechnical Services

Enclosure: Roadway Exploration Report

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EXECUTIVE SUMMARY

This report is a presentation of the roadway exploration performed for the proposed improvements to State Route 93 from approximately Straight Line Mile (SLM) 11.21 to SLM 11.66 in Lawrence County, Ohio.

The proposed improvements include realigning SR 93 along Little Pine Creek and raising the existing roadway grade above the flood level which occurs from Private Road 10472 to approximately 2,300 feet south. The proposed profile adjustments will occur along SR 93 for a total of 2,400 feet. Due to the proposed roadway widening, the project also includes regrading of the existing rock slope from Sta. 592+00 to 595+50. Finally, a 5-foot extension of the existing 4-foot by 2-foot four-sided box culvert located at Sta. 610+00 to the east is planned to accommodate the roadway widening.

Exploration and Findings

August 7 and 9, 2024, A total of nine (9) borings were performed for the proposed roadway improvements. The borings were performed within the existing roadway. All borings encountered 16.5 to 19.25 inches of asphalt. Boring B-008-0-24 encountered 7.75 inches of aggregate base below the asphalt.

Below surface material, existing fill was encountered in all borings with the exception of B-005-0-24. The fill extended to depths ranging from 3.0 to 8.5 feet below existing grade and was described as sandy silt, silt and clay, silty clay, and gravel with sand (ODOT A-4a, A-6a, A-6b, A-1-b). The fill contained construction debris consisting of asphalt, coal, rock fragments and organic material.

Underlying the surficial and existing fill materials, natural soils were encountered, consisting of both cohesive and granular deposits. The natural cohesive soils were described as sandy silt and silt and clay (ODOT A-4a, A-6a). The granular soils were described as fine sand and coarse and fine sand (ODOT A-3, A-3a).

Bedrock was encountered in borings B-001-0-24 through B-004-0-24 and B-007-0-24 at depths ranging from 9.0 to 33.8 feet beneath the existing ground surface. The bedrock was described as moderately to highly weathered light gray to light brown sandstone.

Groundwater seepage was encountered in borings B-001-0-24 and B-005-0-24 through B-009-0-24 at depths ranging from 4.5 to 11.0 feet below the ground surface. Measurable groundwater was observed at the completion of drilling of the borings at depths ranging from 6.8 to 10.7 feet below existing grade.

Analyses and Recommendations

The subgrade soils along the alignment, within the project corridor, are anticipated to consist of predominantly cohesive materials comprised of stiff to hard sandy silt and silt and clay (ODOT A-4a, A-6a).

Based on the Section 605 of the ODOT GDM guidelines, when approximately 30 percent or more of the subgrade area requires stabilization, consideration should be given to utilizing a global stabilization option. For this project, 38 percent of the subgrade areas are anticipated to require stabilization based on the soil borings performed. Per ODOT GDM Subgrade Analysis, global stabilization recommendations are based upon the overall average site parameters, as noted in the following table.

Average Site Parameters

Alignment	Average N_{60L}	Average PI	Average Moisture	Average Optimum Moisture	Average Group Index	Average CBR
SR 93	17	10	22	12	7	7

1. *Existing ground surface elevations were interpolated from topographic basemapping provided by Korda.*
2. *Estimated from proposed roadway grade elevation minus 18-inches for estimated pavement build-up thickness.*

Applying the averages from Table 7 and based on the results of the Subgrade Analysis spreadsheet prepared in accordance with Section 605 of the ODOT GDM, Rii recommends the following global stabilization option within the project limits:

Option 1. Undercut 12-inch of subgrade and replace with Item 204 Granular Material Type B, Type C or Type D. It is recommended that Item 204 Geotextile be placed at the bottom of the undercut.

Option 2. Chemically stabilize the upper 12-inches of subgrade soils along the entire alignment section with the Item 206 Cement. For estimating purposes, utilize a cement content of 5.0 percent by weight of soil. Actual application rates shall be verified by the contractor under Item 206.06 Mixture Design for Chemically Stabilized Soils.

Based on the conditions encountered across the subject site, **it is recommended that pavement design be based on a CBR value of 7** with a corresponding resilient modulus, M_R, of 8,400 psi. Correlation charts indicate a modulus of subgrade reaction (K) of 165 pci and a soil support value (SSV) of 5.0

Based on design information available to Rii, it is understood that the existing 4-foot by 2-foot culvert located at Sta. 610+00 will be extended approximately 5 feet to the east to accommodate the proposed roadway widening. Based on the available plans, the existing culvert bears at an elevation of 597.5 feet. It is considered that the proposed extension will bear at the same elevation. The soils at the anticipated bearing elevation consists of very soft sandy silt (ODOT A-4a). The soft conditions extend to a significant depth below the proposed bearing level. As such, Rii offers the following remediation options:

Option 1

It is recommended that 4 feet of existing soils below the proposed bearing level be over excavated and replaced with either ODOT Item 304 or ODOT Item 613 LSM to the proposed bearing level. The over excavation should extend down and out at a 45-degree angle from the outside edge of the footing to remove the soft soils from the zone of influence. All excavations should follow OSHA guidelines. If ODOT Item 304 is used as backfill, Item 204 Geotextile should be placed along the bottom and sides of the excavation with sufficient excess that the geotextile can fully encapsulate the Item 304. ODOT Item 703 No. 2 stone compacted into the base of the over excavation may be required to provide a stable working platform. After remediation, culvert footings bearing at or below an elevation of 597.5 feet can be proportioned to meet the following bearing capacity requirements:

- Nominal bearing resistance of q_n = 1.04 ksf at the service limit state.
- Nominal bearing resistance of q_n = 2.50 ksf at the strength limit state.
- LRFD Bearing Resistance Factor of φ = 1.0 at the service limit state.
- LRFD Bearing Resistance Factor of φ = 0.55 at the strength limit state.

The bearing resistance at service limit state is the bearing pressure that results in a **maximum total settlement of 1.0 inch**.

Option 2

Alternatively, the bearing soils can be stabilized using 24 inches of over excavation and replacement with a system of geogrid and crushed stone. In order, from the bottom of the over excavation to the proposed bearing elevation, the system should consist of the following:

1. Item 204 Geotextile
2. Item 204 Geogrid (minimum allowable tensile strength of 2,000 lb/ft)
3. 12 inches of Item 304
4. Item 204 Geogrid (minimum allowable tensile strength of 2,000 lb/ft)

5. 12 inches of Item 304.

As with Option 1, the Item 204 Geotextile should be placed along the bottom and sides of the excavation with sufficient excess that the geotextile can fully encapsulate the Item 304. ODOT Item 703 No. 2 stone compacted into the base of the over excavation may be required to provide a stable working platform. Following remediation, footings of the culvert bearing at or below an elevation of 597.5 feet can be proportioned to meet the bearing capacity requirements:

- Nominal bearing resistance of q_n = 1.04 ksf at the service limit state.
- Nominal bearing resistance of q_n = 2.77 ksf at the strength limit state.
- LRFD Bearing Resistance Factor of φ = 1.0 at the service limit state.
- LRFD Bearing Resistance Factor of φ = 0.55 at the strength limit state.

The bearing resistance at service limit state is the bearing pressure that results in a **maximum total settlement of 1.6 inches**.

Rock Cut Slope

Based on the results of field and laboratory testing of the rock samples, the bedrock is classified as a Competent Unit. From the available plans, it is understood that the existing rock slope is currently 1H:1V. Based on the field review of the existing slope, no instability of the existing slope was observed. Per Table 1000-1 of the ODOT GDM, the slope should be designed based on engineering judgement. Rii recommends that the proposed cut slope be designed at no steeper than 0.5H:1V.

Please note that this executive summary does not contain all the information presented in the report. The unabridged subsurface exploration report should be read in its entirety to obtain a more complete understanding of the information presented.

1.0 INTRODUCTION

This report is a presentation of the roadway exploration performed for the proposed improvements to State Route 93 from approximately Straight Line Mile (SLM) 11.21 to SLM 11.66 in Lawrence County, Ohio.

The proposed improvements include realigning SR 93 along Little Pine Creek and raising the existing roadway grade above the flood level which occurs from Private Road 10472 to approximately 2,300 feet south. The proposed profile adjustments will occur along SR 93 for a total of 2,400 feet. Due to the proposed roadway widening, the project also includes regrading of the existing rock slope from Sta. 592+00 to 595+50. Finally, a 5-foot extension of the existing 4-foot by 2-foot four-sided box culvert located at Sta. 610+00 to the east is planned to accommodate the roadway widening.

The exploration was performed within general accordance of the Ohio Department of Transportation (ODOT) Specifications for Geotechnical Explorations (SGE), dated January 2024, and the ODOT Geotechnical Design Manual (GDM). The project site and general location of the proposed retaining walls are as shown on the vicinity map and boring plan presented in Appendix I.

2.0 RECONNAISSANCE AND PLANNING

2.1 Site Geology

Both the Illinoian and Wisconsinan glaciers advanced over two-thirds of the State of Ohio, leaving behind glacial features such as moraines, kame deposits, lacustrine deposits and outwash terraces. The glacial and non-glacial regions comprise five physiographic sections grouped by age, depositional process and geomorphic occurrence. Physiographically the site lies within the Ironton Plateau Region within the Allegheny Plateaus. The region is a moderately high relief dissected plateau, characterized by coarser grained coal-bearing rock sequences more common than in other regions of the Allegheny Plateau. The region also hosts common lacustrine clay-filled Teays Valley remnants.

Based on the bedrock geology and topography maps obtained from the Ohio Department of Natural Resources (ODNR), the underlying bedrock across the project site consists of the early-to-middle-Pennsylvanian-aged Breathitt Group. Little information is available for the composition of the Ohio Breathitt Group. Literature on the Kentucky Breathitt Group describes the formation as sandy shale and coarse sandstone with occasional coal seams, and a thickness of 550 feet. Based on borings performed for this investigation, the bedrock is a light gray to light brown fine to medium grained sandstone and was encountered at depths ranging from 9.0 to 33.5 feet below the existing roadway grade, corresponding to elevations ranging from 592.8 to 568.7 feet.

2.2 Observations of the Project

The site of the proposed LAW-93-11.21 project is located in western Lawrence County, Ohio, with the project limits stretching from the approximately 0.28 miles northwest of Sun Flower Road to 0.5 miles southwest of Private Road 11014. Little Pine Creek is located along the western edge of the existing roadway. Land use surrounding the majority of the project vicinity is predominantly residential.

3.0 EXPLORATION

A total of nine (9) borings were performed for the proposed roadway improvements. The borings were performed between August 7 and 9, 2024. The roadway borings were advanced to depths ranging from 11.8 to 40.0 feet below the existing ground surface. The boring locations are summarized in Table 1 and are illustrated on the boring plan presented in Appendix I of this report.

Table 1. Test Boring Summary

Boring	Reference Alignment	Latitude [1]	Longitude [1]	Ground Elevation (feet) [2]	Boring Depth (feet)
B-001-0-24	SR 93	38.6463579	-82.6705502	602.3	11.8
B-002-0-24	SR 93	38.6468412	-82.6699395	601.8	22.0
B-003-0-24	SR 93	38.6469404	-82.6698193	601.6	19.8
B-004-0-24	SR 93	38.6470378	-82.6696969	601.5	20.0
B-005-0-24	SR 93	38.6477064	-82.6688173	601.7	15.0
B-006-0-24	SR 93	38.6483751	-82.6677032	602.7	25.0
B-007-0-24	SR 93	38.6492615	-82.6668781	602.2	33.8
B-008-0-24	SR 93	38.6499481	-82.6662704	603.8	40.0
B-009-0-24	SR 93	38.6508590	-82.6655072	604.0	20.0

1. *Coordinates provided by Korda.*
2. *Ground surface elevations were estimated from basemapping provided by Korda.*

A total of three (3) pavement cores collected at the locations of borings B-001-0-24, B-008-0-24 and B-009-0-24.

The borings performed were drilled with a Diedrich D-50 track-mounted rotary drilling machine, utilizing 3.25-inch inside diameter hollow-stem augers to advance the holes between sampling attempts. Standard penetration testing (SPT) and split spoon sampling were performed continuously, at 2.5-foot intervals, and/or at 5-foot intervals to the top of rock or to the boring completion depths.

The SPT, per the American Society for Testing and Materials (ASTM) designation D1586, is conducted using a 140-pound hammer falling 30.0 inches to drive a 2.0-inch outside diameter split spoon sampler 18.0 inches. Driving resistance is recorded on the boring logs in terms of blows per 6-inch interval of the driving distance. The second and third intervals are added to obtain the number of blows per foot (N). Standard penetration blow counts aid in determining soil properties applicable in foundation system design. Measured blow count (N_m) values are corrected to an equivalent (60%) energy ratio, N_{60}, by the following equation. Both values are represented on boring logs presented in Appendix III.

$$N_{60} = N_m*(ER/60)$$

Where:
N_m = measured N value
ER = drill rod energy ratio, expressed as a percent, for the system used

The hammers for the Diedrich D-50 drill rig operated by Rii on this project was calibrated on March 25, 2024 and has a drill rod energy ratio of 91.1 percent, respectively. Per the ODOT Specifications for Geotechnical Explorations (SGE), an energy ratio of 90.0 percent was used for the calculation of N_{60} values.

Hand penetrometer readings, which provide a rough estimate of the unconfined compression strength (UCS) of the soil, were reported on the boring logs in units of tons per square foot (tsf) and were utilized to classify the consistency of the cohesive soil in each layer. An indirect estimate of the unconfined compressive strength of the cohesive split spoon samples can also be made from a correlation with the blow counts (N_{60}). Please note that split spoon samples are considered to be disturbed and the laboratory determination of their shear strengths may vary from undisturbed conditions.

The depth to bedrock was determined by auger refusal. Auger refusal is defined as no or insignificant movement of augers with the weight of the drill rig driving the augers. Where the borings required rock core samples, an NQ-sized double-tube diamond bit core barrel (utilizing wire line equipment) was used to core the bedrock. Coring produced a 1.85-inch diameter core from which the type of rock and its geological characteristics were determined.

The rock cores obtained from the borings were logged in the field and visually classified in the Rii laboratory. The retrieved core was analyzed to identify the type of rock, color, mineral content, bedding planes and other geological and mechanical features of interest in this project. The Rock Quality Designation (RQD) for each rock core run was calculated according to the following equation:

$$RQD = \frac{\sum \text{segments equal to or longer than 4.0 inches}}{\text{core run length}} \text{ x } 100$$

The RQD value aids in estimating the general quality of the rock and is used in conjunction with other parameters to designate the quality of the rock mass.

Upon completion of field work, the borings were backfilled with bentonite chips and soil cuttings. Where borings penetrated the existing pavement, an equivalent thickness of quick set concrete was used to repair the pavement surface.

During drilling, field personnel prepared field logs showing the encountered subsurface conditions. Soil samples obtained from the drilling operation were preserved and sealed in glass jars and delivered to the soil laboratory. In the laboratory, the recovered soil and rock samples were visually classified, and select samples from the borings performed for the subject structures were tested, as noted in Table 2.

Table 2. Laboratory Test Schedule

Laboratory Test	Test Designation	Number of Tests Performed
Natural Moisture Content	ASTM D 2216	78
Plastic and Liquid Limits	AASHTO T89, T90	16
Gradation – Sieve/Hydrometer	AASHTO T88	19
Sulfate Content	ODOT Supplement 1122	9
Uniaxial Compressive Strength of Intact Rock Cores	ASTM D7012, Method C	3
Slake Durability	ASTM D4644	2

The tests performed are necessary to classify existing soil according to the ODOT classification system and to estimate engineering properties of importance in determining foundation design and construction recommendations. Results of the laboratory testing are presented on the individual boring logs in Appendix III. A description of the soil and rock terms used throughout this report is presented in Appendix II.

4.0 FINDINGS

Interpreted engineering logs have been prepared based on the field logs, visual examination of samples and laboratory test results. Classification follows the respective version of the ODOT SGE at the time the exploration borings were performed. The following is a summary of what was found in the test borings and what is represented on the boring logs.

4.1 Surface Materials

The borings were performed within the existing roadway. All borings encountered 16.5 to 19.25 inches of asphalt. Boring B-008-0-24 encountered 7.75 inches of aggregate base below the asphalt.

Findings of the pavement cores performed are summarized in Table 3 below. Details of the surface findings are provided on the individual boring logs in Appendix III and pavement core data sheets in Appendix V.

Table 3. Pavement Core Data

Core ID	Asphalt Thickness (in)	Aggregate Base Thickness (in)
B-001-0-24	16.50	0.0
B-008-0-24	19.25	7.75
B-009-0-24	17.50	0.0

4.2 Subsurface Soils

Below surface material, existing fill was encountered in all borings with the exception of B-005-0-24. The fill extended to depths ranging from 3.0 to 8.5 feet below existing grade and was described as sandy silt, silt and clay, silty clay, and gravel with sand (ODOT A-4a, A-6a, A-6b, A-1-b). The fill contained construction debris consisting of asphalt, coal, rock fragments and organic material.

Underlying the existing fill, the natural soils were encountered, consisting of both cohesive and granular deposits. The natural cohesive soils were described as sandy silt and silt and clay (ODOT A-4a, A-6a). The granular soils were described as fine sand and coarse and fine sand (ODOT A-3, A-3a).

The shear strength and consistency of the cohesive soils are primarily derived from the hand penetrometer values (HP). The cohesive soils encountered ranged from very soft ($0.0 < HP \leq 0.5$ tsf) to very stiff ($2.0 < HP \leq 4.0$ tsf). The unconfined compressive strength of the cohesive soil samples tested, obtained from the hand penetrometer, ranged from 0.0 to over 2.25 tsf. The relative density of granular soils is primarily derived from SPT blow counts (N_{60}). Based on the SPT blow counts obtained, the granular soils encountered ranged from very loose ($0 < N_{60} \leq 5$ blows per foot [bpf]) to very dense ($N_{60} > 50$ bpf). Blow counts recorded from the SPT sampling within the granular soil deposits ranged from 0 to 53 bpf.

Natural moisture contents of the soil samples tested ranged from 14 to 35 percent. The natural moisture contents of the cohesive soil samples tested for plasticity ranged from 3 percent below to 10 percent above their corresponding plastic limits. In general, the soil exhibited natural moisture contents considered to be slightly to significantly above optimum moisture levels.

4.3 Bedrock

Bedrock was encountered in borings B-001-0-24 through B-004-0-24 and B-007-0-24 at depths ranging from 9.0 to 33.8 feet beneath the existing ground surface. The bedrock was described as moderately to highly weathered light gray to light brown sandstone. Additional descriptions of the rock core samples are presented on the boring logs in Appendix III.

Table 4. Top of Bedrock Elevations

Boring Number	Ground Surface Elevation [1] (feet)	Top of Bedrock		Top of cored rock	
		Depth (feet)	Elevation (feet)	Depth (feet)	Elevation (feet)
B-002-0-24	601.8	9.0	592.8	9.3	592.5
B-003-0-24	601.6	9.0	592.6	9.8	591.8
B-003-0-24	601.5	10.0	591.5	10.0	591.5

1. Ground surface elevations were obtained from basemapping provided by Korda.

The percent recovery and RQD values of the bedrock core runs and unconfined compressive strength test results in borings are summarized below in Table 5.

Table 5. Rock Core Summary

Boring	Core No.	Depth (feet)	Recovery (%)	RQD (%)
B-002-0-24	RC-1	9.3 – 12.0	12	0
	RC-2	12.0 – 17.0	93	63
	RC-3	17.0 – 22.0	100	100
B-003-0-24	RC-1	9.8 – 14.8	97	75
	RC-2	14.8 – 19.8	95	63
B-004-0-24	RC-1	10.0 – 15.0	88	52
	RC-2	15.0 – 20.0	100	75

It should be noted that bedrock experienced mechanical breaks during the drilling and coring processes. Rii attempted to account for fresh, manmade breaks during tabulation of the RQD analysis. The percent recovery of the rock core runs ranged from 12 to 100 percent, and the RQD values ranged from 0 to 100 percent. The rock mass quality, according to the RQD values, ranged from very poor (RQD ≤ 25%) to excellent (90% < RQD ≤ 100%), but were generally fair (50% < RQD ≤ 75%).

4.4 Groundwater

Groundwater seepage was encountered in borings B-001-0-24 and B-005-0-24 through B-009-0-24 at depths ranging from 4.5 to 11.0 feet below the ground surface. Measurable groundwater was observed at the completion of drilling of the borings at depths ranging from 6.8 to 10.7 feet below existing grade.

Please note that short-term water level readings, especially in cohesive soils, are not necessarily an accurate indication of the actual groundwater level. In addition, groundwater levels or the presence of groundwater are considered to be dependent on seasonal fluctuations in precipitation.

A more comprehensive description of what was encountered during the drilling process may be found on the individual boring logs in Appendix III.

5.0 ANALYSES AND RECOMMENDATIONS

Data obtained from the drilling and testing program have been used to determine the shear strength parameters for the soil encountered at the site. These parameters have been used to provide recommendations for the design of the proposed roadway improvements and culvert structure and general earthwork recommendations, which are discussed in the following paragraphs.

Design details of the proposed roadway improvements were provided by Korda. It is understood that the proposed roadway profile adjustments will occur along 2,400 feet of SR 93 between approximately SLM 11.21 and SLM 11.66. Due to the proposed roadway widening, the project also includes regrading of the existing rock slope from Sta. 592+00 to 595+50. Finally, a 5-foot extension of the existing 4-foot by 2-foot four-sided box culvert located at Sta. 610+00 to the east is planned to accommodate the roadway widening.

5.1 General Embankment and Subgrade Preparation

Embankment construction and subgrade preparation should be performed in accordance with the ODOT CMS Items 203 and 204. Prior to embankment construction or subgrade preparation, perform clearing and grubbing, in accordance with Item 201 and remove existing pavement and base materials, as well as other structures or obstructions, as necessary, in accordance with Item 202. The site should be stripped of any topsoil,

organics, or other deleterious, or unsuitable materials within the footprint of the proposed embankment and subgrade.

Material to be utilized as borrow should be restricted to conform to Item 203 for embankment and Item 204 for subgrade. All embankment material should be spread and compacted in accordance with Item 204. Frozen material should not be incorporated into any new fill or built upon with new fill or pavement materials.

5.2 Pavement Subgrade Recommendations

The subgrade soils along the alignment, within the project corridor, are anticipated to consist of predominantly cohesive materials comprised of stiff to hard sandy silt and silt and clay (ODOT A-4a, A-6a). Based on the soil conditions encountered during drilling, it is estimated that the subgrade soils within the upper portions of the proposed subgrade will require some level of stabilization under ODOT GDM. The depth and type of subgrade stabilization/modification is determined by subgrade analysis following ODOT GDM guidelines, utilizing SPT N_{60} values, HP values, moisture content values (relative to OMC values) and the type of subgrade soils encountered.

Based on the existing and proposed grades estimated from the plan and profile information provided by Korda, and the assumption that the thickness of the existing and proposed pavement buildup along the widened and improved pavement sections will be similar (approximately 18.0 inches), an approximate amount of cut and/or fill depths required to achieve proposed subgrade elevation at the boring locations have been estimated and is summarized below in Table 6.

Table 6. Summary of Proposed Cut/Fill Depths

Boring No.	Station	Offset	Existing Ground Surface Elevation, feet [1]	Proposed Subgrade Elevation, feet [2]	Cut (C), Fill (F) Depth, feet
B-001-0-24	592+05	9’ RT	602.3	600.7	1.6 C
B-002-0-24	594+43	9’ RT	601.8	600.1	1.7 C
B-003-0-24	594+93	8’ RT	601.6	600.3	1.3 C
B-004-0-24	595+51	7’ RT	601.5	600.5	1.0 C
B-005-0-24	599+04	20’ LT	601.7	600.9	0.8 C
B-006-0-24	603+01	1’ RT	602.7	602.4	0.3 C
B-007-0-24	606+98	18’ LT	602.2	602.5	0.3 F
B-008-0-24	610+10	3’ LT	603.8	602.5	1.3 C
B-009-0-24	42+50	7’ LT	690.2	688.6	1.6 C

5.2.1 Subgrade Stabilization

Based on the Section 605 of the ODOT GDM guidelines, when approximately 30 percent or more of the subgrade area requires stabilization, consideration should be given to utilizing a global stabilization option. For this project, 38 percent of the subgrade areas are anticipated to require stabilization based on the soil borings performed. Per ODOT GDM Subgrade Analysis, global stabilization recommendations are based upon the overall average site parameters, as noted in Table 7. The Subgrade Analysis spreadsheet output is provided in Appendix V.

Table 7. Average Site Parameters

Alignment	Average N_{60L}	Average PI	Average Moisture	Average Optimum Moisture	Average Group Index	Average CBR
SR 93	17	10	22	12	7	7

1. *Existing ground surface elevations were interpolated from topographic basemapping provided by Korda.*
2. *Estimated from proposed roadway grade elevation minus 18-inches for estimated pavement build-up thickness.*

Applying the averages from Table 7 and based on the results of the Subgrade Analysis spreadsheet prepared in accordance with Section 605 of the ODOT GDM, Rii recommends the following global stabilization option within the project limits:

Option 1. Undercut 12-inch of subgrade and replace with Item 204 Granular Material Type B, Type C or Type D. It is recommended that Item 204 Geotextile be placed at the bottom of the undercut.

Option 2. Chemically stabilize the upper 12-inches of subgrade soils along the entire alignment section with the Item 206 Cement. For estimating purposes, utilize a cement content of 5.0 percent by weight of soil. Actual application rates shall be verified by the contractor under Item 206.06 Mixture Design for Chemically Stabilized Soils.

Per Section 600 of the ODOT GDM requirements the entire subgrade should be stabilized using one of the global stabilization options provided above. Upon completion of the stabilization, the entire subgrade should be proof rolled to verify that stability has been achieved.

5.2.2 Subgrade Design Considerations

Based on the conditions encountered across the subject site, **it is recommended that pavement design be based on a CBR value of 7** with a corresponding resilient modulus, M_R, of 8,400 psi. Correlation charts indicate a modulus of subgrade reaction (K) of 165 pci and a soil support value (SSV) of 5.0.

Per ODOT GDM, soils with sulfate content in excess of 5,000 ppm cannot be chemically stabilized due to the potential for sulfate heave in the soil. Based on the results of the testing, the sulfate contents of the subgrade soils range from less than 100 to 140 ppm. Therefore, soil with sulfate content greater than 5,000 ppm was not encountered in any boring.

Please note that the recommended CBR values assume that the materials utilized for the subgrade in fill areas are equivalent to, or better than materials at the existing subgrade elevation. Sources of borrow material should be designated in advance of construction. The material should be tested in the laboratory to verify the soil exhibits a minimum design CBR value of 7.

Pavement design is dependent on the inclusion of adequate surface and subsurface drainage in order to maintain the compacted subgrade near optimum moisture conditions throughout the lifetime of the pavement. Based on the elevated natural moisture contents compared to the optimum values, as shown in the boring logs and subgrade analysis, it is recommended that underdrains be considered for the proposed improvements. Under drains should be installed in accordance with the specifications in Item 204 of the ODOT CMS.

5.3 Culvert Foundation Recommendations

Based on design information available to Rii, it is understood that the existing 4-foot by 2-foot culvert located at Sta. 610+00 will be extended approximately 5 feet to the east to accommodate the proposed roadway widening. Based on the available plans, the existing culvert bears at an elevation of 597.5 feet. It is considered that the proposed extension will bear at the same elevation. The soils at the anticipated bearing elevation consists of very soft sandy silt (ODOT A-4a). The soft conditions extend to a significant depth below the proposed bearing level. As such, Rii offers the following remediation options:

Option 1

It is recommended that 4 feet of existing soils below the proposed bearing level be over excavated and replaced with either ODOT Item 304 or ODOT Item 613 LSM to the proposed bearing level. The over excavation should extend down and out at a 45-degree angle from the outside edge of the footing to remove the soft soils from the zone of influence. All excavations should follow OSHA guidelines. If ODOT Item 304 is used as backfill, Item 204 Geotextile should be placed along the bottom and sides of the excavation with sufficient

excess that the geotextile can fully encapsulate the Item 304. ODOT Item 703 No. 2 stone compacted into the base of the over excavation may be required to provide a stable working platform. After remediation, culvert footings bearing at or below an elevation of 597.5 feet can be proportioned to meet the following bearing capacity requirements:

- Nominal bearing resistance of q_n = 1.04 ksf at the service limit state.
- Nominal bearing resistance of q_n = 2.50 ksf at the strength limit state.
- LRFD Bearing Resistance Factor of φ = 1.0 at the service limit state.
- LRFD Bearing Resistance Factor of φ = 0.55 at the strength limit state.

The bearing resistance at service limit state is the bearing pressure that results in a **maximum total settlement of 1.0 inch**.

Option 2

Alternatively, the bearing soils can be stabilized using 24 inches of over excavation and replacement with a system of geogrid and crushed stone. In order, from the bottom of the over excavation to the proposed bearing elevation, the system should consist of the following:

6. Item 204 Geotextile
7. Item 204 Geogrid (minimum allowable tensile strength of 2,000 lb/ft)
8. 12 inches of Item 304
9. Item 204 Geogrid (minimum allowable tensile strength of 2,000 lb/ft)
10. 12 inches of Item 304.

As with Option 1, the Item 204 Geotextile should be placed along the bottom and sides of the excavation with sufficient excess that the geotextile can fully encapsulate the Item 304. ODOT Item 703 No. 2 stone compacted into the base of the over excavation may be required to provide a stable working platform. Following remediation, footings of the culvert bearing at or below an elevation of 597.5 feet can be proportioned to meet the bearing capacity requirements:

- Nominal bearing resistance of q_n = 1.04 ksf at the service limit state.
- Nominal bearing resistance of q_n = 2.77 ksf at the strength limit state.
- LRFD Bearing Resistance Factor of φ = 1.0 at the service limit state.
- LRFD Bearing Resistance Factor of φ = 0.55 at the strength limit state.

The bearing resistance at service limit state is the bearing pressure that results in a **maximum total settlement of 1.6 inches**.

A geotechnical resistance factor of φ_T=0.80 should be considered when calculating the factored shear resistance between the soil and foundation for sliding for cast-in-place concrete.

In order to protect against frost, footings should be placed at a minimum frost depth of 36.0 inches below the adjacent exterior grade.

5.4 Lateral Earth Pressure Parameters

For the soil types encountered in the borings, the "in-situ" unit weight (γ), cohesion (c), effective angle of friction (φ'), and lateral earth pressure coefficients for at-rest conditions (k_o), active conditions (k_a), and passive conditions (k_p) have been estimated and are provided in Table 8 and Table 9.

Table 8. Estimated Undrained (Short-Term) Soil Parameters for Design

Soil Type	γ (pcf) [1]	c (psf)	φ	k_a	k_o	k_p
Soft to Medium Stiff Cohesive Soil	115	750	0°	N/A	N/A	N/A
Stiff Cohesive Soil	120	1,500	0°	N/A	N/A	N/A
Very Stiff to Hard Cohesive Soil	125	3,000	0°	N/A	N/A	N/A
Very Loose to Loose Granular Soil	120	0	28°	0.32	0.53	5.07
Medium Dense Granular Soil	125	0	32°	0.27	0.47	6.82
Dense to Very Dense Granular Soil	130	0	36°	0.23	0.41	9.09
Compacted Cohesive Engineered Fill	120	2,000	0°	N/A	N/A	N/A
Compacted Granular Engineered Fill	120	0	32°	0.27	0.47	6.82

1. *When below groundwater table, use effective unit weight, $\gamma' = \gamma - 62.4$ pcf and add hydrostatic water pressure.*

Table 9. Estimated Drained (Long-Term) Soil Parameters for Design

Soil Type	γ (pcf) [1]	c' (psf)	φ'	k_a	k_o	k_p
Soft to Medium Stiff Cohesive Soil	115	0	26°	0.35	0.56	4.53
Stiff Cohesive Soil	120	0	27°			
Very Stiff to Hard Cohesive Soil	125	0	28°	0.32	0.53	5.07
Very Loose to Loose Granular Soil	120	0	28°	0.32	0.53	5.07
Medium Dense Granular Soil	125	0	32°	0.27	0.47	6.82
Dense to Very Dense Granular Soil	130	0	36°	0.23	0.41	9.09
Compacted Cohesive Engineered Fill	120	0	30°	0.30	0.50	5.58
Compacted Granular Engineered Fill	120	0	32°	0.27	0.47	6.82

1. *When below groundwater table, use effective unit weight, γ' = γ - 62.4 pcf and add hydrostatic water pressure.*

These parameters are considered appropriate for the design of all subsurface structures and any excavation support systems. Subsurface structures (where the top of the structure is restrained from movement) should be designed based on at-rest conditions (k_o). For proposed temporary retaining structures (where the top of the structure is allowed to move), earth pressure distributions should be based on active (k_a) and passive (k_p) conditions. Active earth pressure is developed as the structure moves away from the backfill or retained soil, while passive pressure is developed as the structure moves towards the backfill. A relatively small amount of lateral movement is needed to reach the active condition (≥ 0.1 percent of the height), whereas the movements required to engage the passive condition are approximately ten times greater than those required to develop active earth pressure. The values in this table have been estimated from correlation charts based on minimum standards specified for compacted engineered fill materials.

These recommendations do not take into consideration the effect of any surcharge loading or a sloped ground surface (a flat surface is assumed). Earth pressures on excavation support systems will be dependent on the type of sheeting and method of bracing or anchorage. Surcharge loads, such as that imposed by traffic loading, will create additional lateral loading on the subsurface structures and excavation support systems. The resulting lateral earth pressure should be evaluated based on active (k_a) and at-rest (k_o) conditions and the anticipated magnitude of the loading.

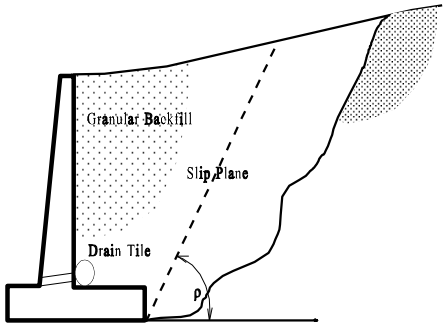
Temporary retaining structures should be designed using the undrained soil parameters provided in Table 8, and the design should follow all applicable guidelines for the type of retaining structure utilized. Permanent retaining structures should be design using the drained soil parameters provided in Table 9. Regardless of whether the retaining structure is temporary or permanent, the effective unit weight (γ' = γ - 62.4 pcf) plus the hydrostatic water pressure ($\gamma_w * h_w$, where h_w is the height of water behind the wall above the base of the wall) should be utilized below the design groundwater level. The lateral earth pressure

coefficients should only be applied to the horizontal pressure resulting from the effective overburden pressure, and should not be applied to the hydrostatic water pressure.

In order to alleviate the build-up of hydrostatic pressure behind the walls, a minimum of 2.0 feet of clean free-draining granular fill (i.e., No. 57 gravel) should be placed full depth behind the walls. If granular fill other than No. 57 gravel is used, it should not have more than 8 percent (by weight) passing the No. 200 screen, and should be compacted to 95 percent of the maximum dry density as determined by the Standard Proctor Test (ASTM D698). A perforated, corrugated drain tile, wrapped with filter fabric, should be placed along the perimeter at the base of the wall for drainage purposes. A clay cap (minimum 1.0-foot thick) should be placed overtop the granular backfill to deter inflow of the surface water. The drainage system should properly outlet to a sewer or to a properly sized sump pump system.

The 2.0 feet of free draining material placed behind the wall prevents the formation of hydrostatic pressures as noted above. However, unless the free draining granular backfill is placed beyond the slip plane (see Figure 1), it has no influence on the equivalent fluid weight of the soil. If free-draining granular fill (meeting the requirements listed above) is to be placed beyond the slip plane ($\rho=45^{\circ}$ for at-rest conditions; $\rho=45°+\varphi/2$ for active conditions), the values presented for the compacted granular engineered fill can be employed, consequently lowering the pressures on the wall.

Figure 1. Slip Plane



Backfill Rankine Zone with Select Backfill

5.5 Rock Slope Evaluation

It is understood that the existing rock slope between Sta. 592+00 to 595+50 will be regarded to accommodate the proposed roadway widening. Rii evaluated the existing rock slope in accordance with Section 1000 of the ODOT GDM. Rii observed the existing rock slope in the field, collected representative samples, designated as L-1 and L-2, from the existing rock slope for slake durability testing, and collected rock cores from borings with SR 93 adjacent to the existing rock slope for evaluation of RQD and uniaxial compressive strength. Samples L-1 and L-2 were collected from the rock slope approximately 10 and

15 feet, respectively, west of boring B-003-0-24 along the project alignment from locations representative of the rock mass.

5.5.1 Parameters Utilized in Rock Slope Evaluation

The shear strength parameters utilized in the slope stability analyses for the analysis of the existing conditions and proposed slope remediations are provided in Tables 7 and 8.

Table 10. Rock Core Summary

Boring / Sample	Core No.	Depth (feet)	Recovery (%)	RQD (%)	Uniaxial Compressive Strength (psi)	Strength Description	SDI (Id2) (%)
B-002-0-24	RC-1	9.3 – 12.0	12	0	--	--	--
	RC-2	12.0 – 17.0	93	63	4,962	Moderately Strong	--
	RC-3	17.0 – 22.0	100	100	--	--	--
B-003-0-24	RC-1	9.8 – 14.8	97	75	5,223	Moderately Strong	--
	RC-2	14.8 – 19.8	95	63	--	--	--
B-004-0-24	RC-1	10.0 – 15.0	88	52	4,691	Moderately Strong	--
	RC-2	15.0 – 20.0	100	75	--	--	--
L-1	--	--	--	--	--	--	94.14
L-2	--	--	--	--	--	--	92.35

Based on the results of field and laboratory testing of the rock samples, the bedrock is classified as a Competent Unit. From the available plans, it is understood that the existing rock slope is currently 1H:1V. Based on the field review of the existing slope, no instability of the existing slope was observed. Per Table 1000-1 of the ODOT GDM, the slope should be designed based on engineering judgement. Rii recommends that the proposed cut slope be designed at no steeper than 0.5H:1V.

5.6 Construction Considerations

All site work shall conform to local codes, and to the latest ODOT CMS, including that all excavation and embankment preparation and construction should follow ODOT Item 200 (Earthwork).

5.6.1 Excavation Considerations

All excavations should be shored / braced or laid back at a safe angle in accordance to Occupational Safety and Health Administration (OSHA) guidelines. During excavation, if slopes cannot be laid back to OSHA Standards due to adjacent structures or other obstructions, temporary shoring may be required. The following table should be utilized as a general guide for implementing OSHA guidelines when estimating excavation back slopes at the various boring locations. Actual excavation back slopes must be field verified by qualified personnel at the time of excavation in strict accordance with OSHA guidelines.

Table 11. Excavation Back Slopes

Soil	Maximum Back Slope	Notes
Soft to Medium Stiff Cohesive	1.5 : 1.0	Above Ground Water Table and No Seepage
Stiff Cohesive	1.0 : 1.0	Above Ground Water Table and No Seepage
Very Stiff to Hard Cohesive	0.75 : 1.0	Above Ground Water Table and No Seepage
All Granular & Cohesive Soil Below Ground Water Table or with Seepage	1.5 : 1.0	None
Rock to 3.0' +/- below Auger Refusal	0.75 : 1.0	Above Ground Water Table and No Seepage
Stable Rock	Vertical	Above Ground Water Table and No Seepage

5.6.2 Groundwater Considerations

Based on the groundwater observations made during drilling, groundwater may be encountered during excavations for the proposed culvert extension, but is not anticipated to be encountered elsewhere along the project alignment. Where groundwater is encountered, proper groundwater control should be employed and maintained to prevent disturbance to excavation bottoms consisting of cohesive soil, and to prevent the possible development of a quick or "boiling" condition where soft silts and/or fine sands are encountered. It is preferable that the groundwater level, if encountered, be maintained at least 36 inches below the deepest excavation. Any seepage or groundwater encountered at this site should be able to be controlled by pumping from temporary sumps. Additional measures may be required depending on seasonal fluctuations of the groundwater level. Note that determining and maintaining actual groundwater levels during construction is the responsibility of the contractor.

6.0 LIMITATIONS OF STUDY

The above recommendations are predicated upon construction inspection by a qualified soil technician under the direct supervision of a professional geotechnical engineer. Adequate testing and inspection during construction are considered necessary to assure an adequate foundation system and are part of our recommendations.

The recommendations for this project were developed utilizing soil and bedrock information obtained from the test borings that were made at the proposed site. At this time, we would like to point out that soil borings only depict the soil and bedrock conditions at the specific locations and time at which they were made. The conditions at other locations on the site may differ from those occurring at the boring locations.

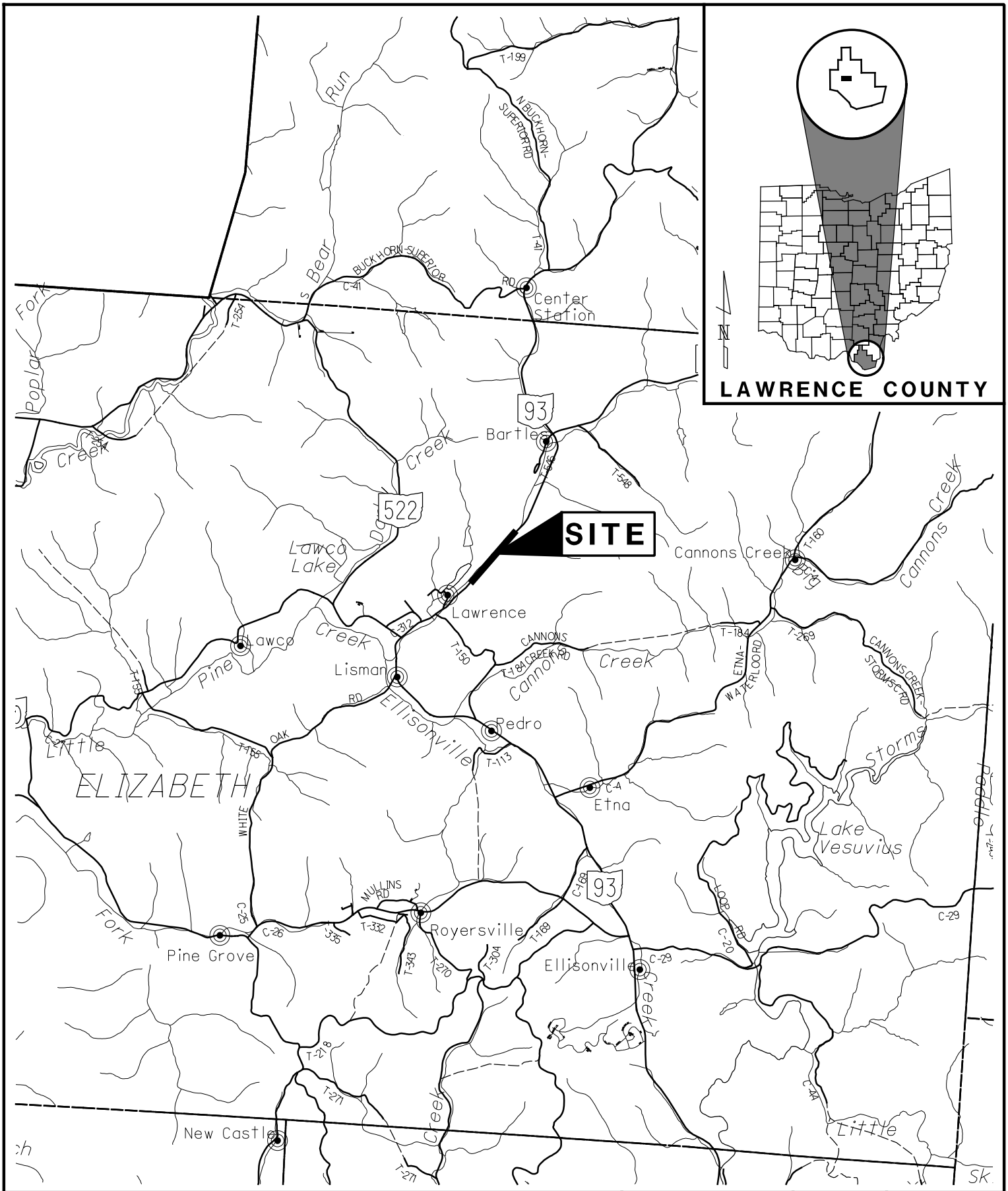
The conclusions and recommendations herein have been based upon the available soil information and the preliminary design details furnished by a representative of the owner of the proposed project. Any revision in the plans for the proposed construction from those anticipated in this report should be brought to the attention of the geotechnical engineer to determine whether any changes in the foundation or earthwork recommendations are necessary. If deviations from the noted subsurface conditions are encountered during construction, they should also be brought to the attention of the geotechnical engineer.

The scope of our services does not include any environmental assessment or investigation for the presence or absence or hazardous or toxic materials in the soil, groundwater or surface water within or beyond the site studied. Any statements in this report or on the test boring logs regarding odors, staining of soils or other unusual conditions observed are strictly for the information of our client.

Our professional services have been performed, our findings obtained, and our recommendations prepared in accordance with generally accepted geotechnical engineering principles and practices. Resource International is not responsible for the conclusions, opinions or recommendations made by others based upon the data included.

APPENDIX I

VICINITY MAP AND BORING PLAN



VICINITY MAP

LAW-93-11.21 IMPROVEMENTS

LAWRENCE COUNTY, OHIO

RII PROJECT NO. W-24-074		DRAWN JAS
		REVIEWED DEK
SCALE: 1"=5000' 0 2500 5000		DATE 9/4/2024

RESOURCE INTERNATIONAL Rii

LAW-93-11.21

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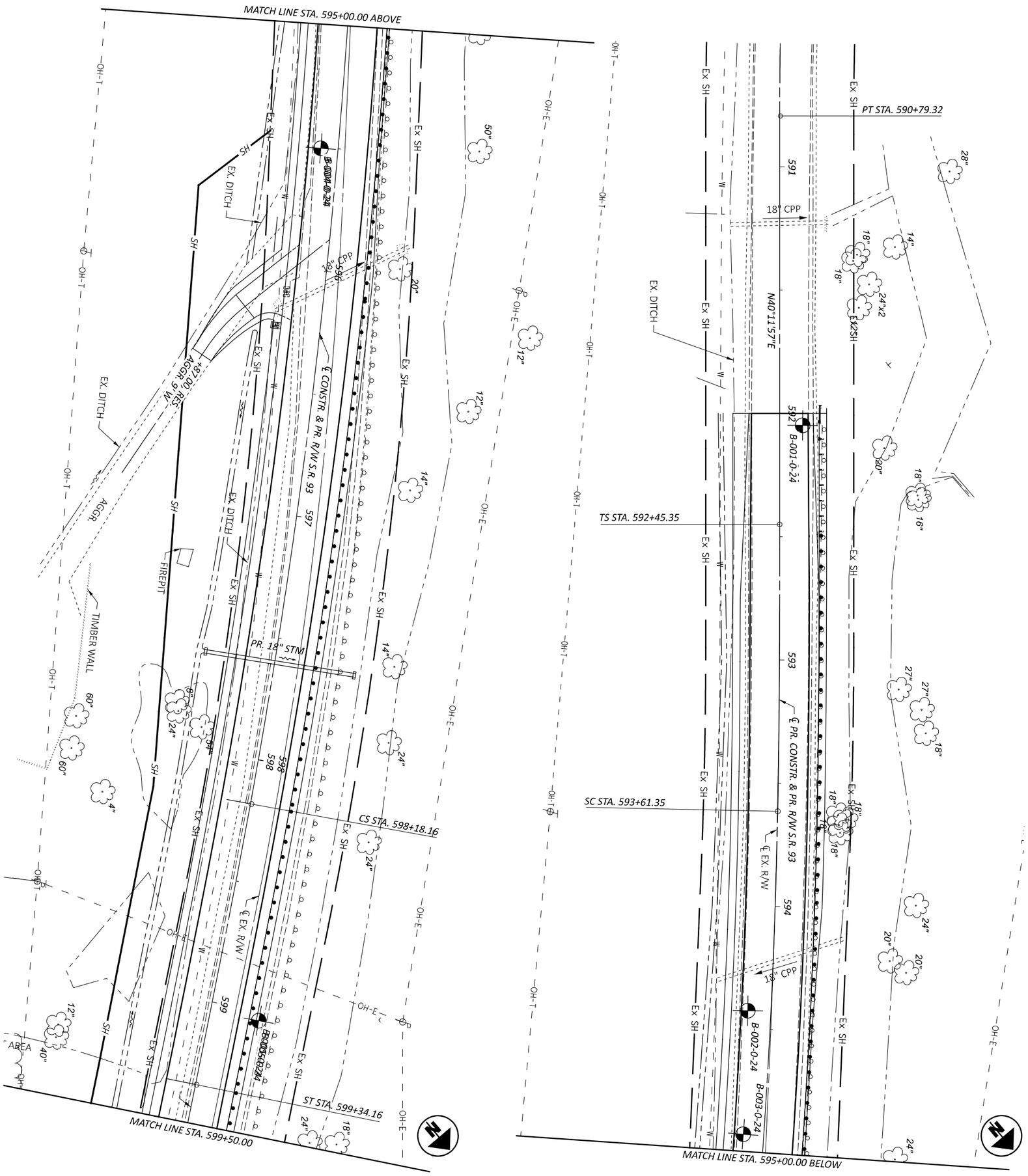

BORING PLAN
STA. 590+50.00 TO STA. 599+50.00

HORIZONTAL SCALE IN FEET
0 20
10 40

DESIGN AGENCY
RESOLUTE
6800 PRESIDENTIAL GATEWAY
COLUMBUS, OH 43231
(614) 882-4949

DESIGNER JAS
REVIEWER DEK
PROJECT ID 119949
SUBSET 1 TOTAL 0
SHEET P.0 TOTAL 0

MM-DD-YY

MODEL: CLP_S093 - Plan 3 PAPERSIZE: 17x11 (in.) DATE: 9/5/2024 TIME: 10:22:06 AM USER: juans
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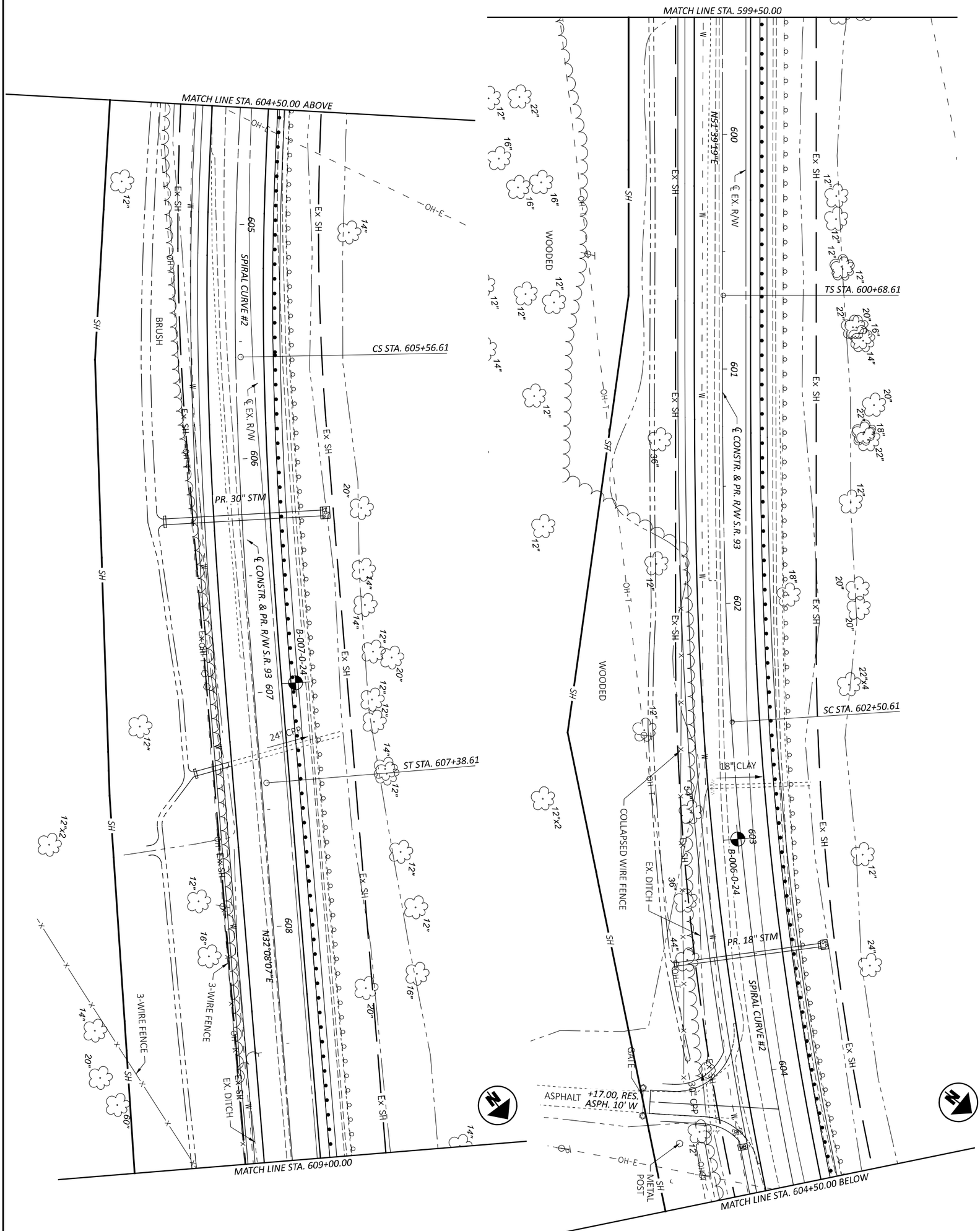

BORING PLAN
STA. 599+50.00 TO STA. 609+00.00

HORIZONTAL SCALE IN FEET
0 20
10 40

DESIGN AGENCY
RESOURCE INTERNATIONAL
6500 PREMIERPARK GATEWAY
COLUMBIA, MD 21046
(844) 825-4360

DESIGNER JAS
REVIEWER DEK
PROJECT ID 119949
SUBSET 1 TOTAL 0
SHEET P.0 TOTAL 0

MM-DD-YY

LAW-93-11.21

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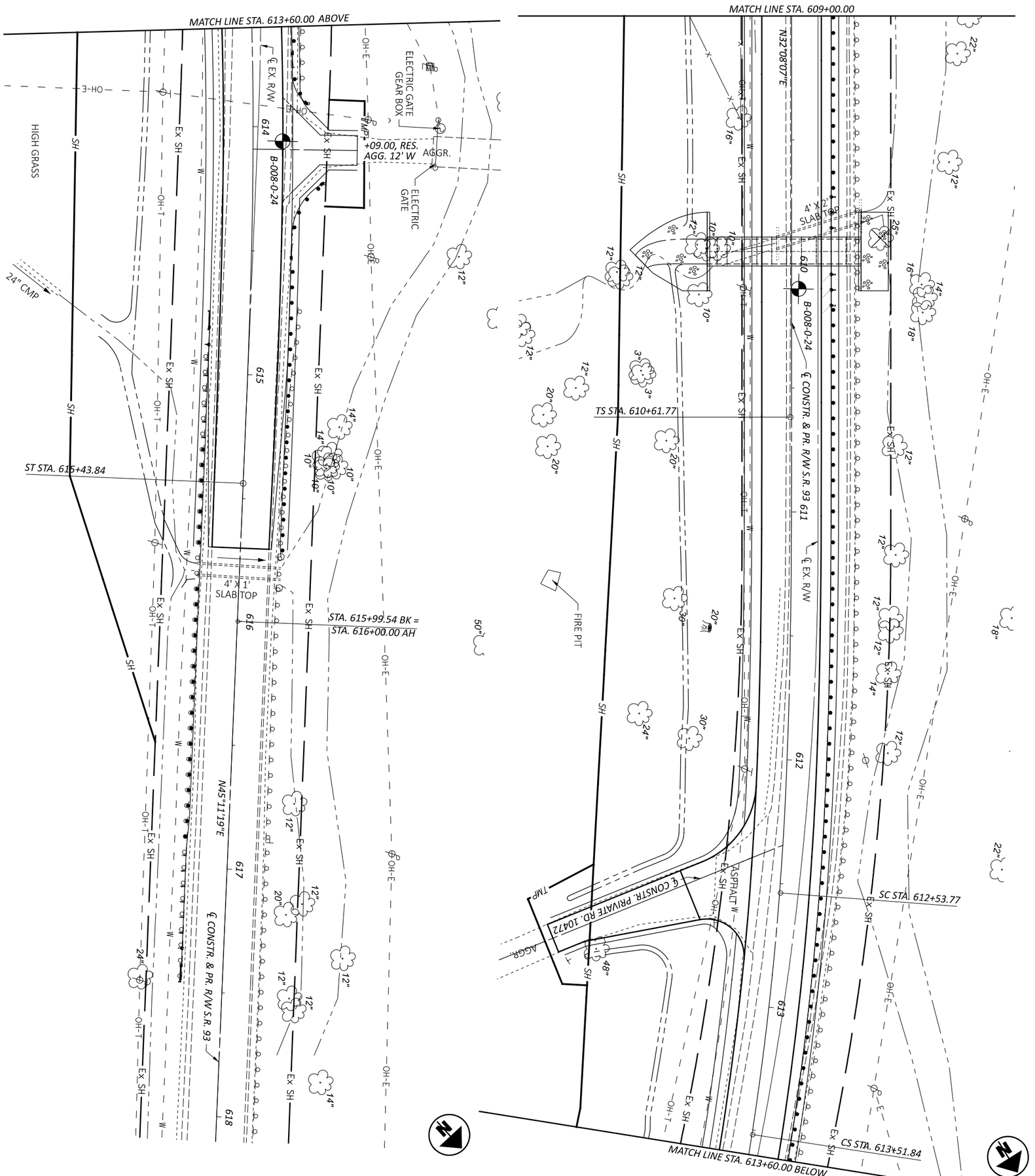


BORING PLAN
STA. 609+00.00 TO STA. 618+00.00

HORIZONTAL SCALE IN FEET
0 20
10 40

DESIGN AGENCY	RESOURCE INTERNATIONAL
	6500 PRESIDENTIAL GATEWAY COLUMBIA, SC 29209 (864) 882-4580
DESIGNER	JAS
REVIEWER	DEK MM-DD-YY
PROJECT ID	119949
SUBSET	1 / TOTAL 0
SHEET	P.0 / TOTAL 0

APPENDIX II

DESCRIPTION OF SOIL AND ROCK TERMS

DESCRIPTION OF SOIL TERMS

The following terminology was used to describe soils throughout this report and is generally adapted from ASTM 2487/2488 and ODOT Specifications for Geotechnical Explorations.

Granular Soils – ODOT A-1, A-2, A-3, A-4 (non-plastic)
The relative compactness of granular soils is described as:

Description	Blows per foot – SPT (N_{60})		
Very Loose	Below		5
Loose	5	-	10
Medium Dense	11	-	30
Dense	31	-	50
Very Dense	Over		50

Cohesive Soils – ODOT A-4, A-5, A-6, A-7, A-8
The relative consistency of cohesive soils is described as:

Description	Unconfined Compression (tsf)		
Very Soft	Less than		0.25
Soft	0.25	-	0.5
Medium Stiff	0.5	-	1.0
Stiff	1.0	-	2.0
Very Stiff	2.0	-	4.0
Hard	Over		4.0

Gradation - The following size-related denominations are used to describe soils:

Soil Fraction		Size
Boulders		Larger than 12”
Cobbles		12” to 3”
Gravel	coarse	3” to ¾“
	fine	¾” to 2.0 mm (¾” to #10 Sieve)
Sand	coarse	2.0 mm to 0.42 mm (#10 to #40 Sieve)
	fine	0.42 mm to 0.074 mm (#40 to #200 Sieve)
Silt		0.074 mm to 0.005 mm (#200 to 0.005 mm)
Clay		Smaller than 0.005 mm

Modifiers of Components - The following modifiers indicate the range of percentages of the minor soil components:

Term	Range		
Trace	0%	-	10%
Little	10%	-	20%
Some	20%	-	35%
And	35%	-	50%

Moisture Table - The following moisture-related denominations are used to describe cohesive soils:

Term	Range - ODOT
Dry	Well below Plastic Limit
Damp	Below Plastic Limit
Moist	Above PL to 3% below LL
Wet	3% below LL to above LL

Organic Content – The following terms are used to describe organic soils:

Term	Organic Content (%)
Slightly organic	2-4
Moderately organic	4-10
Highly organic	>10

Bedrock – The following terms are used to describe the relative strength of bedrock:

Description	Field Parameter
Very Weak	Can be carved with knife and scratched by fingernail. Pieces 1 in. thick can be broken by finger pressure.
Weak	Can be grooved or gouged with knife readily. Small, thin pieces can be broken by finger pressure.
Slightly Strong	Can be grooved or gouged 0.05 in deep with knife. 1 in. size pieces from hard blows of geologist hammer.
Moderately Strong	Can be scratched with knife or pick. 1/4 in. size grooves or gouges from blows of geologist hammer.
Strong	Can be scratched with knife or pick with difficulty. Hard hammer blows to detach hand specimen.
Very Strong	Cannot be scratched by knife or pick. Hard repeated blows of geologist hammer to detach hand specimen.
Extremely Strong	Cannot be scratched by knife or pick. Hard repeated blows of geologist hammer to chip hand specimen.

DESCRIPTION OF ROCK TERMS

The following terminology was used to describe the rock throughout this report and is generally adapted from ASTM D5878 and the ODOT Specifications for Geotechnical Explorations.

Weathering – Describes the degree of weathering of the rock mass:

Description	Field Parameter
Unweathered	No evidence of any chemical or mechanical alteration of the rock mass. Mineral crystals have a right appearance with no discoloration. Fractures show little or not 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 as evident by a dull appearance. Surfaces may have a pitted appearance with weathering "halos" evident. Isolated zones of varying rock strengths due to alteration may be present. 10 to 15% of the rock volume presents alterations.
Highly Weathered	Entire rock mass appears discolored and dull. Some pockets of slightly to moderately weathered rock may be present and some areas of severely weathered materials may be present.
Severely Weathered	Majority of the rock mass reduced to a soil-like state with relic rock structure discernable. Zones of more resistant rock may be present but the material can generally be molded and crumbled by hand pressures.

Strength of Bedrock – The following terms are used to describe the relative strength of bedrock:

Description	Field Parameter
Very Weak	Can be carved with knife and scratched by fingernail. Pieces 1 in. thick can be broken by finger pressure.
Weak	Can be grooved or gouged with knife readily. Small, thin pieces can be broken by finger pressure.
Slightly Strong	Can be grooved or gouged 0.05 in deep with knife. 1 in. size pieces from hard blows of geologist hammer.
Moderately Strong	Can be scratched with knife or pick. 1/4 in. size grooves or gouges from blows of geologist hammer.
Strong	Can be scratched with knife or pick with difficulty. Hard hammer blows to detach hand specimen.
Very Strong	Cannot be scratched by knife or pick. Hard repeated blows of geologist hammer to detach hand specimen.
Extremely Strong	Cannot be scratched by knife or pick. Hard repeated blows of geologist hammer to chip hand specimen.

Bedding Thickness – Description of bedding thickness as the average perpendicular distances between bedding surfaces:

Description	Thickness
Very Thick	Greater than 36 inches
Thick	18 to 36 inches
Medium	10 to 18 inches
Thin	2 to 10 inches
Very Thin	0.4 to 2 inches
Laminated	0.1 to 0.4 inches
Thinly Laminated	Less than 0.1 inches

Fracturing – Describes the degree and condition of fracturing (fault, joint, or shear):

Degree of Fracturing

Description	Spacing
Unfractured	Greater than 10 feet
Intact	3 to 10 feet
Slightly Fractured	1 to 3 feet
Moderately Fractured	

Aperture Width

Description	Width
Open	Greater than 0.2 inches
Narrow	0.05 to 0.2 inches
Tight	Less than 0.05 inches

Surface Roughness

Description	Criteria
Very Rough	Near vertical steps and ridges occur on surface
Slightly Rough	Asperities on the surfaces distinguishable
Slickensided	Surface has smooth, glassy finish, evidence of Striations

RQD – Rock Quality Designation (calculation shown in report) and Rock Quality (ODOT, GB 3, January 13, 2006):

RQD %	Rock Index Property Classification (based on RQD, not slake durability index)
0 – 25%	Very Poor
26 – 50%	Poor
51 – 70%	Fair
71 – 85%	Good
86 – 100%	Very Good

CLASSIFICATION OF SOILS

Ohio Department of Transportation

(The classification of a soil is found by proceeding from top to bottom of the chart.
The first classification that the test data fits is the correct classification.)

SYMBOL	DESCRIPTION	Classifcation		LL_O/LL x 100*	% Pass #40	% Pass #200	Liquid Limit (LL)	Plastic Index (PI)	Group Index Max.	REMARKS
		AASHTO	OHIO							
	Gravel and/or Stone Fragments	A-1-a			30 Max.	15 Max.		6 Max.	0	Min. of 50% combined gravel, cobble and boulder sizes
	Gravel and/or Stone Fragments with Sand	A-1-b			50 Max.	25 Max.		6 Max.	0	
	Fine Sand	A-3			51 Min.	10 Max.	NON-PLASTIC		0	
	Coarse and Fine Sand	--	A-3a			35 Max.		6 Max.	0	Min. of 50% combined coarse and fine sand sizes
	Gravel and/or Stone Fragments with Sand and Silt	A-2-4				35 Max.	40 Max.	10 Max.	0	
		A-2-5					41 Min.			
	Gravel and/or Stone Fragments with Sand, Silt and Clay	A-2-6				35 Max.	40 Max.	11 Min.	4	
		A-2-7					41 Min.			
	Sandy Silt	A-4	A-4a	76 Min.		36 Min.	40 Max.	10 Max.	8	Less than 50% silt sizes
	Silt	A-4	A-4b	76 Min.		50 Min.	40 Max.	10 Max.	8	50% or more silt sizes
	Elastic Silt and Clay	A-5		76 Min.		36 Min.	41 Min.	10 Max.	12	
	Silt and Clay	A-6	A-6a	76 Min.		36 Min.	40 Max.	11 - 15	10	
	Silty Clay	A-6	A-6b	76 Min.		36 Min.	40 Max.	16 Min.	16	
	Elastic Clay	A-7-5		76 Min.		36 Min.	41 Min.	$\leq$LL-30	20	
	Clay	A-7-6		76 Min.		36 Min.	41 Min.	>LL-30	20	
	Organic Silt	A-8	A-8a	75 Max.		36 Min.				W/o organics would classify as A-4a or A-4b
	Organic Clay	A-8	A-8b	75 Max.		36 Min.				W/o organics would classify as A-5, A-6a, A-6b, A-7-5 or A-7-6

MATERIAL CLASSIFIED BY VISUAL INSPECTION

 Sod and Topsoil

 Pavement or Base

 Uncontrolled Fill (Describe)

 Bouldery Zone

Peat

* Only perform the oven-dried liquid limit test and this calculation if organic material is present in the sample.

APPENDIX III

BORING LOGS

ROCK CORE PHOTOGRAPHS

BORING LOGS

Definitions of Abbreviations

AS = Auger sample

GI = Group index as determined from the Ohio Department of Transportation classification system

HP = Unconfined compressive strength as determined by a hand penetrometer (tons per square foot)

LL_o = Oven-dried liquid limit as determined by ASTM D4318. Per ASTM D2487, if LL_o/LL is less than 75 percent, soil is classified as "organic".

LOI = Percent organic content (by weight) as determined by ASTM D2974 (loss on ignition test)

PID = Photo-ionization detector reading (parts per million)

QR = Unconfined compressive strength of intact rock core sample as determined by ASTM D2938 (pounds per square inch)

QU = Unconfined compressive strength of soil sample as determined by ASTM D2166 (pounds per square foot)

RC = Rock core sample

REC = Ratio of total length of recovered soil or rock to the total sample length, expressed as a percentage

RQD = Rock quality designation – estimate of the degree of jointing or fracture in a rock mass, expressed as a percentage:

$$\frac{\sum \text{segments equal to or longer than 4.0 inches}}{\text{core run length}} \times 100$$

S = Sulfate content (parts per million)

SPT = Standard penetration test blow counts, per ASTM D1586. Driving resistance recorded in terms of blows per 6-inch interval while letting a 140-pound hammer free fall 30 inches to drive a 2-inch outer diameter (O.D.) split spoon sampler a total of 18 inches. The second and third intervals are added to obtain the number of blows per foot (N_m).

N_{60} = Measured blow counts corrected to an equivalent (60 percent) energy ratio (ER) by the following equation: $N_{60} = N_m*(ER/60)$

SS = Split spoon sample

2S = For instances of no recovery from standard SS interval, a 2.5 inch O.D. split spoon is driven the full length of the standard SS interval plus an additional 6.0 inches to obtain a representative sample. Only the final 6.0 inches of sample is retained. Blow counts from 2S sampling are not correlated with N_{60} values.

3S = Same as 2S, but using a 3.0 inch O.D. split spoon sampler.

TR = Top of rock

W = Initial water level measured during drilling

▽ = Water level measured at completion of drilling

Classification Test Data

Gradation (as defined on Description of Soil Terms):

GR = % Gravel
SA = % Sand
SI = % Silt
CL = % Clay

Atterberg Limits:

LL = Liquid limit
PL = Plastic limit
PI = Plasticity Index
WC = Water content (%)

RESOURCE INTERNATIONAL, INC.

PROJECT: LAW-93-11.21	DRILLING FIRM / OPERATOR: RII / IS/SD	DRILL RIG: DIEDRICH D-50 (# 313)	STATION / OFFSET: 592+05 / 9' LT.	**EXPLORATION ID B-001-0-24**
TYPE: ROADWAY	SAMPLING FIRM / LOGGER: RII / MJ	HAMMER: AUTOMATIC	ALIGNMENT: SR 93	
PID: 119949 SFN: NA	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 3/25/24	ELEVATION: 602.3 (MSL) EOB: 11.8 ft.	PAGE 1 OF 1
START: 8/7/24 END: 8/7/24	SAMPLING METHOD: SPT	ENERGY RATIO (%): 90	LAT / LONG: 38.646358, -82.670550	

MATERIAL DESCRIPTION AND NOTES	ELEV. 602.3	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
1.4' - ASPHALT (16.5")	600.9	1																	
FILL: HARD, BROWN TO GRAY **SANDY SILT**, LITTLE TO SOME CLAY, TRACE FINE GRAVELS, DAMP. -SANDSTONE FRAGMENTS IN SS-2	597.9	2 3 4	3 7 7	21	92	SS-1	4.5+	9	19	29	27	16	24	16	8	14	A-4a (2)	320	
			2 5 4	14	78	SS-2	4.5+	4	14	28	32	22	24	16	8	14	A-4a (4)	-	
MEDIUM STIFF, BROWN TO GRAY **SANDY SILT**, SOME CLAY, TRACE FINE GRAVEL, MOIST. -TRACE COAL FRAGMENTS OBSERVED IN SS-3	594.8	5 6 7	1 1 1	3	83	SS-3	2.25	-	-	-	-	-	-	-	-	35	A-4a (V)	-	
			0 0 0	0	83	SS-4	0.50	-	-	-	-	-	-	-	-	26	A-4a (V)	-	
VERY SOFT, BROWN TO GRAY **SANDY SILT**, SOME CLAY, WET.	591.9	8 9 10 W 591.9	0 0 0	0	64	SS-5	0.00	0	1	45	33	21	24	17	7	27	A-4a (4)	-	
			0 0 0	0	100	SS-6	-	-	-	-	-	-	-	-	-	29	A-4a (V)	-	
VERY DENSE, GRAY **FINE SAND**, LITTLE SILT, WET.	590.5	11 EOB	0 1 50/5"	-	100	SS-7	-	-	-	-	-	-	-	-	-	26	A-3 (V)	-	

NOTES: SEEPAGE @ 4.4'; GROUNDWATER ENCOUNTERED INITIALLY @ 10.4'

ABANDONMENT METHODS, MATERIALS, QUANTITIES: COMPACTED WITH THE AUGER 50 LBS BENTONITE CHIPS AND SOIL CUTTINGS; PAVEMENT PATCHED WITH CONCRETE .

RESOURCE INTERNATIONAL, INC.

PROJECT: LAW-93-11.21	DRILLING FIRM / OPERATOR: RII / IS/SD	DRILL RIG: DIEDRICH D-50 (# 313)	STATION / OFFSET: 594+43 / 9' RT.	**EXPLORATION ID B-002-0-24**
TYPE: ROADWAY	SAMPLING FIRM / LOGGER: RII / MJ	HAMMER: AUTOMATIC	ALIGNMENT: SR 93	
PID: 119949 SFN: NA	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 3/25/24	ELEVATION: 601.8 (MSL) EOB: 22.0 ft.	PAGE 1 OF 1
START: 8/7/24 END: 8/7/24	SAMPLING METHOD: SPT	ENERGY RATIO (%): 90	LAT / LONG: 38.646841, -82.669940	

MATERIAL DESCRIPTION AND NOTES	ELEV. 601.8	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
1.4' - ASPHALT (17.0")	600.4	1																	
FILL: HARD, BROWN TO GRAY **SILT AND CLAY**, LITTLE COARSE TO FINE SAND, TRACE FINE GRAVEL, DAMP. -TRACE ORGANICS IN SS-1 -SANDSTONE FRAGMENTS IN SS-2	597.3	2 3 4	5 5 5 7 10 3	15 20	92 50	SS-1 SS-2	1.75 4.5+	- -	-	-	-	-	-	-	-	13 11	A-6a (V) A-6a (V)	400 -	
STIFF, BROWN **SANDY SILT**, LITTLE CLAY, TRACE FINE GRAVEL, MOIST.	592.8	5 6 7 8	1 1 1 1 2 2 1 1 3	3 6 6	69 36 56	SS-3 SS-4 SS-5	1.50 1.00 0.75	- -	-	-	-	-	-	-	-	26 22 22	A-4a (V) A-4a (V) A-4a (V)	- - -	
SANDSTONE : GRAY.	592.5	9	50/3"	-	100	SS-6	-	- -	-	-	-	-	-	-	-	7	Rock (V)	-	
SANDSTONE : LIGHT GRAY TO LIGHT BROWN, HIGHLY TO MODERATELY WEATHERED, SLIGHTLY STRONG, FINE TO MEDIUM GRAINED, MEDIUM BEDDED, MICACEOUS, FRACTURED, OPEN APERTURES, VERY ROUGH SURFACE, VERY BLOCKY TO DESINTEGRATED STRUCTURE, FAIR SURFACE CONDITION. RC-2: MODERATELY FRACTURED, MASSIVE TO BLOCKY STRUCTURE, GOOD SURFACE CONDITION -QU @ 16.5' = 4,962 PSI RC-3: LIGHT GRAY, INTACT/MASSIVE STRUCTURE, GOOD SURFACE CONDITION	579.8	10 11 12 13 14 15 16 17 18 19 20 21 22 EOB	12 63 100		100 93 100	RC-1 RC-2 RC-3											CORE CORE CORE		

NOTES: GROUNDWATER NOT ENCOUNTERED DURING DRILLING

ABANDONMENT METHODS, MATERIALS, QUANTITIES: COMPACTED WITH THE AUGER 200 LBS BENTONITE CHIPS AND SOIL CUTTINGS; PAVEMENT PATCHED WITH CONCRETE .

000-23 RII STA ODOT LOG SUL(8.5 X 11) - OH DOT.GDT - 9/19/24 11:39 - U:\GI8\PROJECTS\2024\W-24-074.GPJ

RESOURCE INTERNATIONAL, INC.

PROJECT: LAW-93-11.21	DRILLING FIRM / OPERATOR: RII / IS/SD	DRILL RIG: DIEDRICH D-50 (# 313)	STATION / OFFSET: 594+93 / 8' RT.	**EXPLORATION ID B-003-0-24**
TYPE: ROADWAY	SAMPLING FIRM / LOGGER: RII / MJ	HAMMER: AUTOMATIC	ALIGNMENT: SR 93	
PID: 119949 SFN: NA	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 3/25/24	ELEVATION: 601.6 (MSL) EOB: 19.8 ft.	PAGE 1 OF 1
START: 8/8/24 END: 8/8/24	SAMPLING METHOD: SPT	ENERGY RATIO (%): 90	LAT / LONG: 38.646940, -82.669819	

MATERIAL DESCRIPTION AND NOTES	ELEV. 601.6	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
1.4' - ASPHALT (17.0")	600.2																		
FILL: STIFF TO HARD, BROWN TO GRAY **SILT AND CLAY**, LITTLE COARSE TO FINE SAND, TRACE FINE GRAVEL, MOIST.			8 5 4	14	0	SS-1	1.00	-	-	-	-	-	-	-	-	15	A-6a (V)	410	
-SANDSTONE FRAGMENTS THROUGHOUT	597.1		15 8 7	23	44	SS-2	4.5+	-	-	-	-	-	-	-	-	16	A-6a (V)	-	
MEDIUM STIFF, BROWN TO GRAY **SANDY SILT**, LITTLE CLAY, TRACE FINE GRAVEL, MOIST.			3 2 3	8	50	SS-3	1.25	-	-	-	-	-	-	-	-	25	A-4a (V)	-	
			1 2 4	9	0	SS-4	0.75	3	8	33	38	18	23	17	6	21	A-4a (4)	-	
-WOOD FRAGMENTS IN SS-5	592.6		1 2 3	8	92	SS-5	-	-	-	-	-	-	-	-	-	20	A-4a (V)	-	
SANDSTONE : GRAY.	591.8		16 50/3"	-	35	SS-6	-	-	-	-	-	-	-	-	-	13	Rock (V)	-	
SANDSTONE : LIGHT GRAY TO LIGHT BROWN, HIGHLY WEATHERED, SLIGHTLY STRONG, FINE TO MEDIUM GRAINED, MEDIUM BEDDED, MICACEOUS, MODERATELY FRACTURED, NARROW APERTURES, VERY ROUGH SURFACES, INTACT/MASSIVE TO BLOCKY, GOOD SURFACE CONDITION. -QU @ 13.2' = 5,233 PSI			84		98	RC-1											CORE		
			70		96	RC-2											CORE		
	581.8	EOB																	

NOTES: GROUNDWATER NOT ENCOUNTERED DURING DRILLING

ABANDONMENT METHODS, MATERIALS, QUANTITIES: COMPACTED WITH THE AUGER 200 LBS BENTONITE CHIPS AND SOIL CUTTINGS; PAVEMENT PATCHED WITH CONCRETE .

RESOURCE INTERNATIONAL, INC.

PROJECT: LAW-93-11.21	DRILLING FIRM / OPERATOR: RII / IS/SD	DRILL RIG: DIEDRICH D-50 (# 313)	STATION / OFFSET: 595+51 / 7' RT.	**EXPLORATION ID B-004-0-24**
TYPE: ROADWAY	SAMPLING FIRM / LOGGER: RII / MJ	HAMMER: AUTOMATIC	ALIGNMENT: SR 93	
PID: 119949 SFN: NA	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 3/25/24	ELEVATION: 601.5 (MSL) EOB: 20.0 ft.	PAGE 1 OF 1
START: 8/8/24 END: 8/8/24	SAMPLING METHOD: SPT	ENERGY RATIO (%): 90	LAT / LONG: 38.647038, -82.669697	

MATERIAL DESCRIPTION AND NOTES	ELEV. 601.5	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
1.4' - ASPHALT (16.5")	600.1																		
FILL: VERY STIFF, BROWN **SILT AND CLAY**, TRACE COARSE TO FINE SAND, TRACE FINE GRAVEL, MOIST. -ASPHALT FRAGMENTS IN SS-1	598.5		7 4 3	11	44	SS-1	2.25	0	1	6	63	30	36	21	15	25	A-6a (10)	300	
STIFF TO VERY STIFF, BROWN TO GRAY **SANDY SILT**, LITTLE TO SOME CLAY, TRACE FINE GRAVEL, DAMP TO MOIST.	595.5		12 6 4	15	42	SS-2	1.25	7	10	31	31	21	25	17	8	14	A-4a (3)	-	
			2 2 2	6	36	SS-3	1.25	-	-	-	-	-	-	-	-	28	A-4a (V)	-	
SOFT, BROWN TO GRAY **SANDY SILT**, LITTLE TO SOME CLAY, TRACE FINE GRAVEL, DAMP TO MOIST. -SANDSTONE AND SILTSTONE FRAGMENTS IN SS-5 AND SS-6	591.6		1 0 1	2	39	SS-4	0.00	-	-	-	-	-	-	-	-	27	A-4a (V)	-	
			0 0 1	2	53	SS-5	0.00	1	5	34	42	18	26	18	8	27	A-4a (5)	-	
			0 50/6"	-	100	SS-6	-	-	-	-	-	-	-	-	-	21	A-4a (V)	-	
SANDSTONE : LIGHT GRAY TO LIGHT BROWN, HIGHLY WEATHERED, SLIGHTLY STRONG, FINE TO MEDIUM GRAINED, MEDIUM BEDDED, MICACEOUS, MODERATELY FRACTURED, NARROW APERTURES, VERY ROUGH TO SLIGHTLY ROUGH SURFACES, INTACT/MASSIVE TO BLOCKY, GOOD SURFACE CONDITION. -QU @ 14.5' = 4,691 PSI			52		88	RC-1										CORE		
			75		100	RC-2										CORE		
	581.5	EOB																	

NOTES: GROUNDWATER NOT ENCOUNTERED DURING DRILLING

ABANDONMENT METHODS, MATERIALS, QUANTITIES: COMPACTED WITH THE AUGER 200 LBS BENTONITE CHIPS AND SOIL CUTTINGS; PAVEMENT PATCHED WITH CONCRETE .

RESOURCE INTERNATIONAL, INC.

PROJECT: LAW-93-11.21	DRILLING FIRM / OPERATOR: RII / IS/SD	DRILL RIG: DIEDRICH D-50 (# 313)	STATION / OFFSET: 599+04 / 20' LT.	**EXPLORATION ID B-005-0-24**
TYPE: ROADWAY	SAMPLING FIRM / LOGGER: RII / MJ	HAMMER: AUTOMATIC	ALIGNMENT: SR 93	
PID: 119949 SFN: NA	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 3/25/24	ELEVATION: 601.7 (MSL) EOB: 15.0 ft.	PAGE 1 OF 1
START: 8/8/24 END: 8/8/24	SAMPLING METHOD: SPT	ENERGY RATIO (%): 90	LAT / LONG: 38.647706, -82.668817	

MATERIAL DESCRIPTION AND NOTES	ELEV. 601.7	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
1.4' - ASPHALT (16.5")	600.3	1																	
0.4' - AGGREGATE BASE (4.5")	599.9	2	6 16 26	63	0	SS-1	-	-	-	-	-	-	-	-	-	-	A-6a (V)	440	
VERY SOFT TO STIFF, BROWN **SILT AND CLAY**, LITTLE COARSE TO FINE SAND, TRACE FINE GRAVEL, MOIST.		3	3 2 2	6	50	SS-2	1.50	1	1	11	54	33	36	21	15	24	A-6a (10)	-	
		4																	
		5	0 0 0	0	100	SS-3	1.25	0	0	18	51	31	30	18	12	28	A-6a (9)	-	
		6																	
W 594.8		7	0 0 0	0	50	SS-4	0.00	-	-	-	-	-	-	-	-	26	A-6a (V)	-	
		8	0 0 1	2	100	SS-5	0.00	-	-	-	-	-	-	-	-	23	A-6a (V)	-	
	592.7	9																	
VERY LOOSE TO LOOSE, BROWN TO GRAY **SANDY SILT**, LITTLE CLAY, TRACE FINE GRAVEL, MOIST.		10	0 0 0	0	100	SS-6	0.00	-	-	-	-	-	-	-	-	25	A-4a (V)	-	
		11	2 0 0	0	67	SS-7	-	-	-	-	-	-	-	-	-	32	A-4a (V)	-	
		12																	
		13	1 2 3	8	89	SS-8	-	-	-	-	-	-	-	-	-	22	A-4a (V)	-	
		14	1 2 4	9	78	SS-9	-	-	-	-	-	-	-	-	-	24	A-4a (V)	-	
	586.7	15																	
		EOB																	

NOTES: SEEPAGE @ 4.5'; GROUNDWATER ENCOUNTERED INITIALLY @ 4.5' AND AT COMPLETION @ 6.9'; CAVE-IN DEPTH @ 9.3'

ABANDONMENT METHODS, MATERIALS, QUANTITIES: COMPACTED WITH THE AUGER 50 LBS BENTONITE CHIPS AND SOIL CUTTINGS; PAVEMENT PATCHED WITH CONCRETE .

RESOURCE INTERNATIONAL, INC.

PROJECT: LAW-93-11.21	DRILLING FIRM / OPERATOR: RII / IS/SD	DRILL RIG: DIEDRICH D-50 (# 313)	STATION / OFFSET: 603+01 / 1' RT.	**EXPLORATION ID B-006-0-24**
TYPE: ROADWAY	SAMPLING FIRM / LOGGER: RII / MJ	HAMMER: AUTOMATIC	ALIGNMENT: SR 93	
PID: 119949 SFN: NA	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 3/25/24	ELEVATION: 602.7 (MSL) EOB: 25.0 ft.	PAGE 1 OF 1
START: 8/8/24 END: 8/8/24	SAMPLING METHOD: SPT	ENERGY RATIO (%): 90	LAT / LONG: 38.648375, -82.667703	

MATERIAL DESCRIPTION AND NOTES	ELEV. 602.7	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
1.5' - ASPHALT (18.0")	601.2																		
0.4' - SLAG BASE (4.0")	600.8																		
FILL: STIFF TO HARD, BROWNISH GRAY **SANDY SILT**, SOME CLAY, TRACE FINE GRAVEL, DAMP. -TRACE ASPHALT FRAGMENTS IN SS-1	599.2		4 10 9	29	92	SS-1	4.5+	5	4	21	47	23	29	20	9	19	A-4a (7)	410	
STIFF, BROWN **SANDY SILT**, SOME CLAY, MOIST.	597.7		1 2 2	6	69	SS-2	1.50	0	0	35	38	27	25	16	9	22	A-4a (6)	-	
VERY LOOSE, BROWN TO GRAY **SANDY SILT**, LITTLE CLAY, MOIST.	593.2	W 593.2	0 0 0	0	100	SS-3	-	-	-	-	-	-	-	-	-	31	A-4a (V)	-	
			0 0 0	0	83	SS-4	-	-	-	-	-	-	-	-	-	27	A-4a (V)	-	
			0 0 0	0	81	SS-5	-	-	-	-	-	-	-	-	-	25	A-4a (V)	-	
VERY LOOSE TO LOOSE, BROWN **FINE SAND**, LITTLE SILT, MOIST.	584.7		1 1 2	5	92	SS-6	-	-	-	-	-	-	-	-	-	29	A-3 (V)	-	
			1 1 1	3	78	SS-7	-	-	-	-	-	-	-	-	-	26	A-3 (V)	-	
			1 2 3	8	92	SS-8	-	-	-	-	-	-	-	-	-	21	A-3 (V)	-	
			1 2 2	6	100	SS-9	-	-	-	-	-	-	-	-	-	23	A-3 (V)	-	
			1 1 1	3	100	SS-10	-	-	-	-	-	-	-	-	-	23	A-3 (V)	-	
MEDIUM STIFF, BROWNISH GRAY **SANDY SILT**, LITTLE CLAY, MOIST.	579.7		2 1 2	5	50	SS-11	0.50	-	-	-	-	-	-	-	-	29	A-4a (V)	-	
			1 1 1	3	69	SS-12	0.75	-	-	-	-	-	-	-	-	24	A-4a (V)	-	
VERY LOOSE, BROWNISH GRAY **FINE SAND**, LITTLE SILT, WET.	577.7	EOB	2 0 0	0	78	SS-13	-	-	-	-	-	-	-	-	-	25	A-3 (V)	-	

NOTES: SEEPAGE @ 5.0'; GROUNDWATER ENCOUNTERED INITIALLY @ 9.5'; CAVE-IN DEPTH @ 10.3'

ABANDONMENT METHODS, MATERIALS, QUANTITIES: COMPACTED WITH THE AUGER 100 LBS BENTONITE CHIPS AND SOIL CUTTINGS; PAVEMENT PATCHED WITH CONCRETE .

RESOURCE INTERNATIONAL, INC.

PROJECT: LAW-93-11.21	DRILLING FIRM / OPERATOR: RII / IS/SD	DRILL RIG: DIEDRICH D-50 (# 313)	STATION / OFFSET: 606+97 / 18' LT.	**EXPLORATION ID B-007-0-24**
TYPE: ROADWAY	SAMPLING FIRM / LOGGER: RII / MJ	HAMMER: AUTOMATIC	ALIGNMENT: SR 93	
PID: 119949 SFN: NA	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 3/25/24	ELEVATION: 602.2 (MSL) EOB: 33.8 ft.	PAGE 1 OF 2
START: 8/9/24 END: 8/9/24	SAMPLING METHOD: SPT	ENERGY RATIO (%): 90	LAT / LONG: 38.649262, -82.666878	

MATERIAL DESCRIPTION AND NOTES	ELEV. 602.2	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
1.4' - ASPHALT (17.0")	600.8	1																	
FILL: STIFF, GRAY **SANDY SILT**, SOME CLAY, TRACE FINE GRAVEL, MOIST. -TRACE ORGANICS IN SS-1	598.7	2	2 3 3	9	89	SS-1	1.50	0	1	23	49	27	27	17	10	24	A-4a (8)	440	
FILL: MEDIUM STIFF, BROWN **SILTY CLAY**, LITTLE COARSE TO FINE SAND, MOIST. -TRACE ASPHALT FRAGMENTS IN SS-2	595.7	4	1 2 2	6	44	SS-2	0.75	0	0	12	51	37	35	19	16	28	A-6b (10)	-	
		6	1 1 1	3	64	SS-3	0.50	-	-	-	-	-	-	-	-	26	A-6b (V)	-	
MEDIUM STIFF, BROWNISH GRAY **SANDY SILT**, SOME CLAY, TRACE FINE GRAVEL, MOIST.	591.7	8	1 1 1	3	89	SS-4	0.00	-	-	-	-	-	-	-	-	26	A-4a (V)	-	
		10	1 1 2	5	83	SS-5	0.00	-	-	-	-	-	-	-	-	26	A-4a (V)	-	
LOOSE, GRAY **SANDY SILT**, WET.	589.2	▽ 591.5 W 591.2																	
		12	3 2 3	8	81	SS-6	-	-	-	-	-	-	-	-	-	29	A-4a (V)	-	
MEDIUM STIFF TO SOFT, BROWN **SANDY SILT**, LITTLE CLAY, TRACE FINE GRAVEL, MOIST.		14	2 2 2	6	50	SS-7	0.75	-	-	-	-	-	-	-	-	27	A-4a (V)	-	
		16	1 0 0	0	67	SS-8	0.50	-	-	-	-	-	-	-	-	28	A-4a (V)	-	
		18	0 0 0	0	100	SS-9	0.50	-	-	-	-	-	-	-	-	28	A-4a (V)	-	
		20	0 0 0	0	83	SS-10	0.50	-	-	-	-	-	-	-	-	28	A-4a (V)	-	
		22	0 0 0	0	75	SS-11	0.50	-	-	-	-	-	-	-	-	28	A-4a (V)	-	
	575.2	24																	
LOOSE, BROWN **COARSE AND FINE SAND**, WET.		26																	
		28	1 2 3	8	33	SS-12	-	-	-	-	-	-	-	-	-	23	A-3a (V)	-	

PID: 119949	SFN: NA	PROJECT: LAW-93-11.21	STATION / OFFSET: 60697, 18' LT.	START: 8/9/24	END: 8/9/24	PG 2 OF 2	B-007-0-24

MATERIAL DESCRIPTION AND NOTES	ELEV.	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
LOOSE, BROWN **COARSE AND FINE SAND**, WET. *(continued)*	572.2	31 32 33																	
-HEAVING SANDS @ 33.5'	568.7																		
SANDSTONE : BROWN.	568.5	EOB	50/3"	-	100	SS-13	-	-	-	-	-	-	-	-	-	14	Rock (V)	-	

NOTES: GROUNDWATER INITIALLY ENCOUNTERED @ 11.0' AND AT COMPLETION @ 10.7'

ABANDONMENT METHODS, MATERIALS, QUANTITIES: COMPACTED WITH THE AUGER 200 LBS BENTONITE CHIPS AND SOIL CUTTINGS; PAVEMENT PATCHED WITH CONCRETE .

RESOURCE INTERNATIONAL, INC.

PROJECT: LAW-93-11.21	DRILLING FIRM / OPERATOR: RII / IS/SD	DRILL RIG: DIEDRICH D-50 (# 313)	STATION / OFFSET: 610+10 / 3' LT.	**EXPLORATION ID B-008-0-24**
TYPE: ROADWAY	SAMPLING FIRM / LOGGER: RII / MJ	HAMMER: AUTOMATIC	ALIGNMENT: SR 93	
PID: 119949 SFN: NA	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 3/25/24	ELEVATION: 603.8 (MSL) EOB: 40.0 ft.	PAGE 1 OF 2
START: 8/9/24 END: 8/9/24	SAMPLING METHOD: SPT	ENERGY RATIO (%): 90	LAT / LONG: 38.649948, -82.666270	

MATERIAL DESCRIPTION AND NOTES	ELEV. 603.8	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
1.6' - ASPHALT (19.25")	602.2	1																	
0.6' - AGGREGATE BASE (7.75")	601.6	2																	
FILL: MEDIUM DENSE, BROWN AND RED **GRAVEL WITH SAND**, LITTLE SILT, TRACE CLAY, MOIST.	600.3	3	20 10 4	21	33	SS-1	-	41	15	21	- 23 -		-	-	-	8	A-1-b (V)	480	
MEDIUM STIFF, BROWN AND RED TO BROWN **SILT AND CLAY**, SOME COARSE TO FINE SAND, TRACE FINE GRAVEL, MOIST.	597.3	4	1 1 2	5	56	SS-2	-	0	5	25	41	29	30	18	12	26	A-6a (8)	-	
		5																	
		6	1 1 1	3	0	SS-3	0.50	-	-	-	-	-	-	-	-	27	A-6a (V)	-	
VERY SOFT, BROWN TO GRAY **SANDY SILT**, SOME CLAY, MOIST.		7	0 0 2	3	75	SS-4	-	0	1	46	28	25	23	16	7	25	A-4a (4)	-	
		8 ▽ 595.3																	
		9	1 0 1	2	53	SS-5	-	-	-	-	-	-	-	-	-	26	A-4a (V)	-	
	591.8	10																	
VERY LOOSE, BROWN TO GRAY **COARSE AND FINE SAND**, TRACE FINE GRAVEL, TRACE CLAY, TRACE SILT, MOIST. -TRACE COAL OBSERVED IN SS-6		11																	
		12																	
		13																	
		14	1 1 1	3	92	SS-6	-	3	31	51	7	8	NP	NP	NP	33	A-3a (0)	-	
	586.8	15																	
MEDIUM STIFF, BROWN TO GRAY **SANDY SILT**, LITTLE CLAY, TRACE FINE GRAVEL, MOIST.		16																	
		17																	
		18																	
		19	2 1 1	3	58	SS-7	0.50	-	-	-	-	-	-	-	-	31	A-4a (V)	-	
	581.8	20																	
		21																	
		22																	
		23																	
VERY LOOSE TO LOOSE, GRAY TO BROWN **FINE SAND**, LITTLE SILT, WET.		24	3 1 2	5	100	SS-8	-	-	-	-	-	-	-	-	-	26	A-3 (V)	-	
		25																	
		26																	
		27																	
		28																	
		29	5 2 4	9	86	SS-9	-	-	-	-	-	-	-	-	-	25	A-3 (V)	-	

000-23 RII STA ODOT LOG SUL(8.5 X 11) - OH DOT.GDT - 3/31/25 09:54 - U:\GI8\PROJECTS\2024\W-24-074.GPJ

PID: 119949	SFN: NA	PROJECT: LAW-93-11.21	STATION / OFFSET: 61010, 3' LT.	START: 8/9/24	END: 8/9/24	PG 2 OF 2	B-008-0-24

MATERIAL DESCRIPTION AND NOTES	ELEV.	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
VERY LOOSE TO LOOSE, GRAY TO BROWN **FINE SAND**, LITTLE SILT, WET. *(continued)*	573.8	31																	
	F S 571.8	32																	
MEDIUM DENSE TO DENSE, BROWN **COARSE AND FINE SAND**, TRACE FINE GRAVEL, TRACE SILT, MOIST.		33																	
		34	7 9 9	27	100	SS-10	-	3	36	47	- 14 -		-	-	-	18	A-3a (V)	-	
		35																	
		36																	
		37																	
		38																	
		39	12 13 22	53	83	SS-11	-	-	-	-	-	-	-	-	-	17	A-3a (V)	-	
	563.8	EOB 40																	

NOTES: GROUNDWATER INITIALLY ENCOUNTERED @ 8.5' AND AT COMPLETION @ 8.4'; CAVE-IN DEPTH @ 15.8'

ABANDONMENT METHODS, MATERIALS, QUANTITIES: COMPACTED WITH THE AUGER 100 LBS BENTONITE CHIPS AND SOIL CUTTINGS; PAVEMENT PATCHED WITH CONCRETE .

RESOURCE INTERNATIONAL, INC.

PROJECT: LAW-93-11.21	DRILLING FIRM / OPERATOR: RII / IS/SD	DRILL RIG: DIEDRICH D-50 (# 313)	STATION / OFFSET: 614+06 / 12' LT.	**EXPLORATION ID B-009-0-24**
TYPE: ROADWAY	SAMPLING FIRM / LOGGER: RII / MJ	HAMMER: AUTOMATIC	ALIGNMENT: SR 93	
PID: 119949 SFN: NA	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 3/25/24	ELEVATION: 604.0 (MSL) EOB: 20.0 ft.	PAGE 1 OF 1
START: 8/9/24 END: 8/9/24	SAMPLING METHOD: SPT	ENERGY RATIO (%): 90	LAT / LONG: 38.650859, -82.665507	

MATERIAL DESCRIPTION AND NOTES	ELEV. 604.0	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
1.5' - ASPHALT (17.5")	602.5																		
FILL: SOFT TO MEDIUM STIFF, GRAYISH BROWN TO BROWN **SANDY SILT**, SOME CLAY, TRACE FINE GRAVEL, MOIST.	599.0	W 599.0	2 1 2	5	75	SS-1	0.50	1	2	35	38	24	25	16	9	21	A-4a (5)	460	
			1 0 0	0	72	SS-2	0.50	0	2	42	30	26	24	15	9	24	A-4a (4)	-	
FILL: VERY LOOSE, BROWNISH GRAY **SANDY SILT**, TRACE CLAY, MOIST.			1 1 0	2	100	SS-3	-	-	-	-	-	-	-	-	-	27	A-4a (V)	-	
		▽ 597.2																	
-TRACE ASPHALT FRAGMENTS IN SS-4	595.5		2 1 2	5	33	SS-4	-	-	-	-	-	-	-	-	-	25	A-4a (V)	-	
VERY LOOSE TO LOOSE, BROWN TO DARK GRAY **SANDY SILT**, WET.			1 1 0	2	100	SS-5	-	-	-	-	-	-	-	-	-	24	A-4a (V)	-	
			3 3 3	9	100	SS-6	-	-	-	-	-	-	-	-	-	24	A-4a (V)	-	
	584.0	EOB	4 3 3	9	100	SS-7	-	-	-	-	-	-	-	-	-	19	A-4a (V)	-	

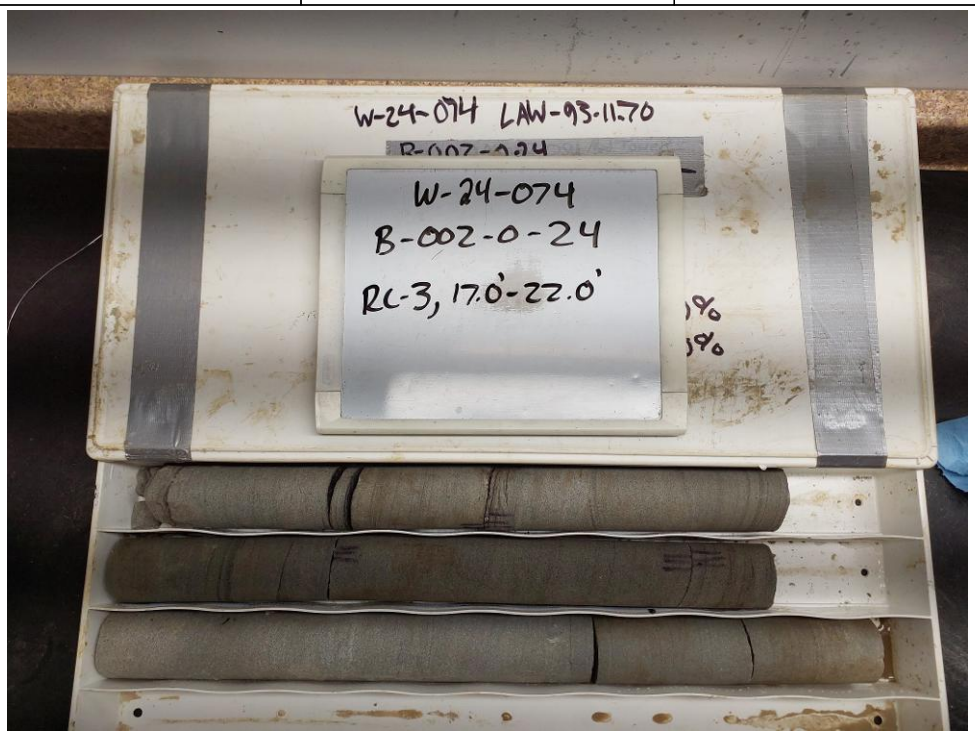
NOTES: GROUNDWATER INITIALLY ENCOUNTERED @ 5.0' AND AT COMPLETION @ 6.8'

ABANDONMENT METHODS, MATERIALS, QUANTITIES: COMPACTED WITH THE AUGER 100 LBS BENTONITE CHIPS AND SOIL CUTTINGS; PAVEMENT PATCHED WITH CONCRETE .

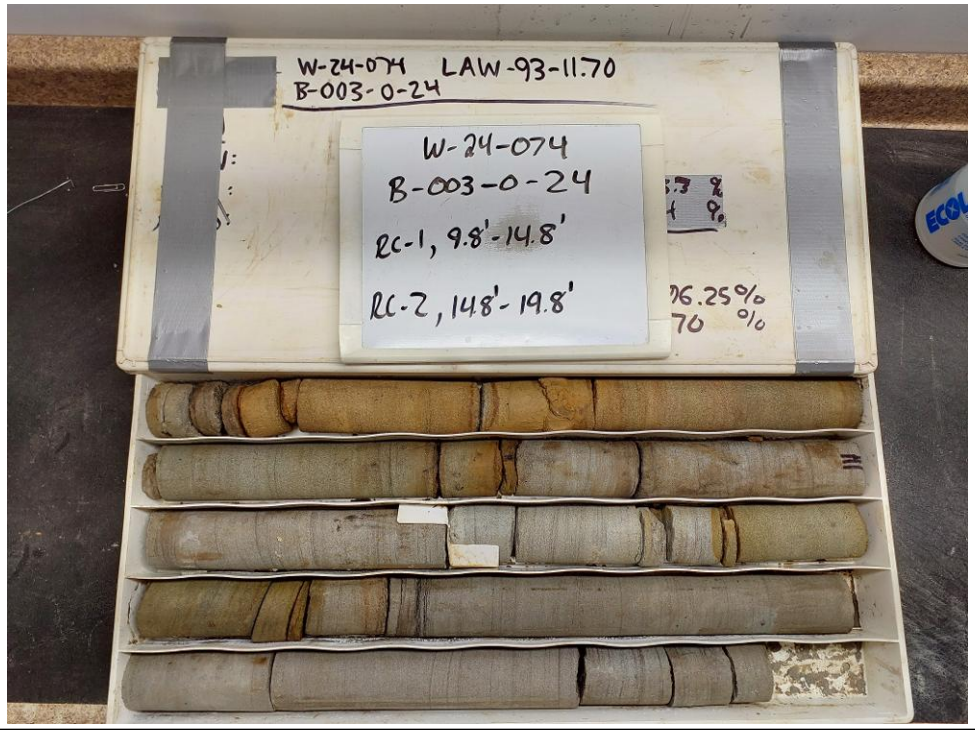
Project Name:	Location:	Project No.:
LAW-93-11.21	Lawrence County, Ohio	W-24-074

Photo No. 1	
Boring: B-002-0-24	
RC-1: 9.3'-12.0' REC (%): 12 RQD (%): 0	
RC-2: 12.0'-17.0' REC (%): 93 RQD (%): 63	

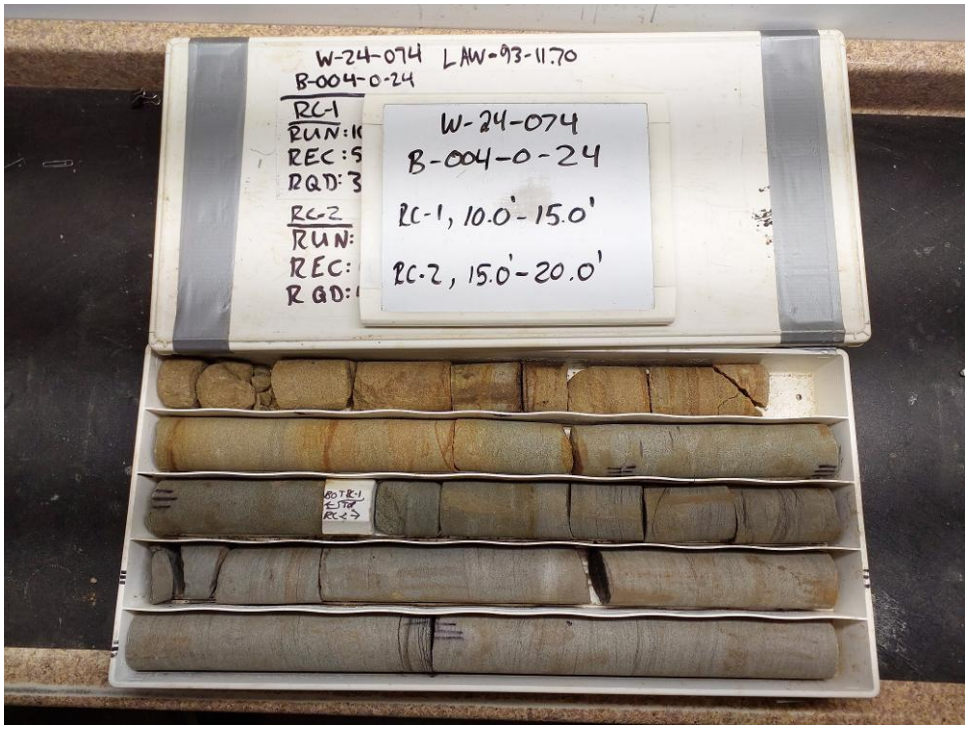
Project Name:	Location:	Project No.:
LAW-93-11.21	Lawrence County, Ohio	W-24-074

Photo No. 2	
Boring: B-002-0-24	
RC-3: 17.0'-22.0' REC (%): 100 RQD (%): 100	

Project Name:	Location:	Project No.:
LAW-93-11.21	Lawrence County, Ohio	W-24-074

Photo No. **3**	
Boring: B-003-0-24	
RC-1: 9.8'-14.8' REC (%): 97 RQD (%): 75	
RC-2: 14.8'-19.8' REC (%): 95 RQD (%): 63	

Project Name:	Location:	Project No.:
LAW-93-11.70	Lawrence County, Ohio	W-24-074

Photo No. **4**	
Boring: B-004-0-24	
RC-1: 10.0'-15.0' REC (%): 88 RQD (%): 52	
RC-2: 15.0'-20.0' REC (%): 100 RQD (%): 75	

APPENDIX IV

LABORATORY TEST RESULTS

RESOURCE INTERNATIONAL, INC.
Engineering Consultants

6350 Presidential Gatew.
Columbus, OH 43231
Phone (614) 823-4949

9885 Rockside Road
Cleveland, OH 44125
Phone (216) 573-0955

4480 Lake Forest Drive
Cincinnati, Ohio 45242
Phone (513) 769-6998

Uniaxial Compressive Strength of Intact Rock Core Specimens

(ASTM D 7012-14)

Project: LAW-93-11.21
Project No.: W-24-074
Date of Testing: 8/29/2024
Test Performed by: KL/EM

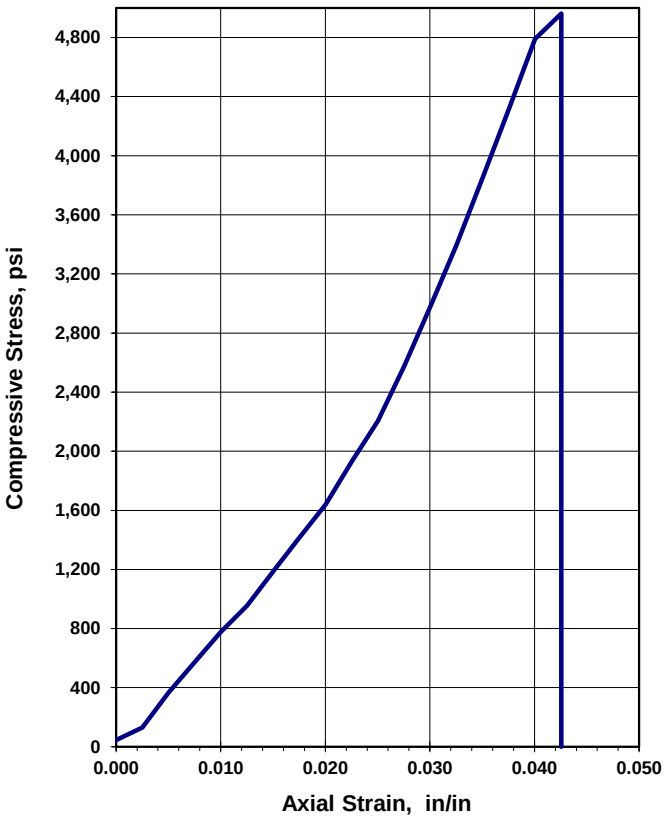
Rock Description: Gray Sandstone
Rock Formation:

Boring No.:	B-002		Average Length:	3.994	in
Sample No:	RC-2		Average Diameter:	1.971	in
Depth (ft):	16.5'	feet	Length to diameter ratio:	2.026	
Moisture condition:	As received		Cross Sectional Area:	3.051	in^2
Sample Mass:	469.13	grams	Volume:	0.0071	ft^3
Testing Temperature:	23	^oC	Unit Weight (sample specimen)*:	146.65	lbs/ft3
Rate of Loading:	47.6	lbs/sec	Failure Load:	15,140	lbs
Testing Time:	318	sec	Axial Strain at Failure:	0.0426	in/in
(Rate 2-15 mir			Compressive Strength:	4,962	psi

Sample Preparation: Per ASTM D4543

**Actual test sample used for unit weight prior to testing.*

Unconfined Compression Test



Before Testing

After Failure

REMARKS:

RESOURCE INTERNATIONAL, INC.
Engineering Consultants

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Uniaxial Compressive Strength of Intact Rock Core Specimens

(ASTM D 7012-14)

Project: LAW-93-11.21
Project No.: W-24-074
Date of Testing: 8/29/2024
Test Performed by: KL/EM

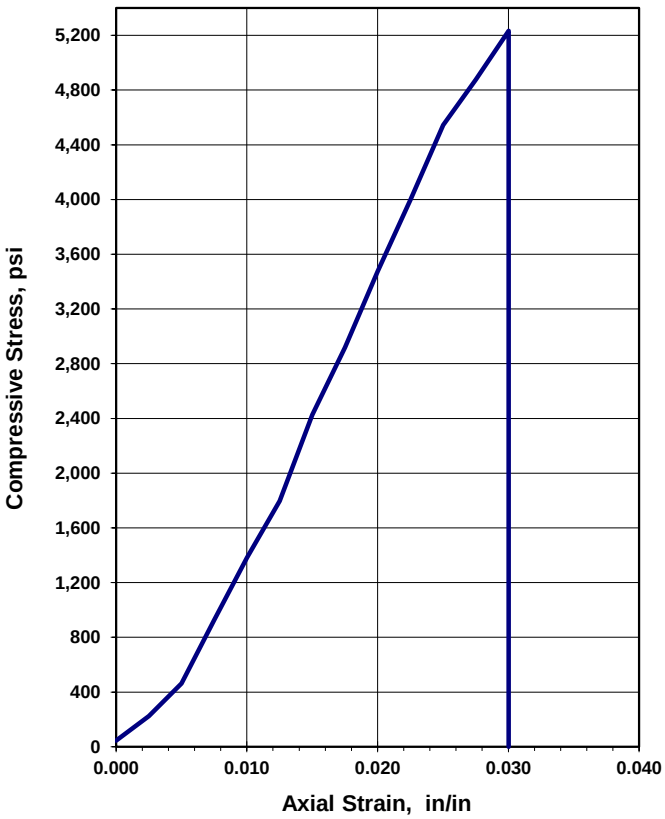
Rock Description: Gray Sandstone
Rock Formation:

Boring No.:	B-003		Average Length:	3.997	in
Sample No:	RC-1		Average Diameter:	1.982	in
Depth (ft):	13.2'	feet	Length to diameter ratio:	2.017	
Moisture condition:	As received		Cross Sectional Area:	3.085	in^2
Sample Mass:	479.51	grams	Volume:	0.0071	ft^3
Testing Temperature:	23	^oC	Unit Weight (sample specimen)*:	148.13	lbs/ft3
Rate of Loading:	57.2	lbs/sec	Failure Load:	16,144	lbs
Testing Time:	282	sec	Axial Strain at Failure:	0.0300	in/in
(Rate 2-15 mir			Compressive Strength:	5,233	psi

Sample Preparation: Per ASTM D4543

**Actual test sample used for unit weight prior to testing.*

Unconfined Compression Test



Before Testing

After Failure

REMARKS:

RESOURCE INTERNATIONAL, INC.
Engineering Consultants

6350 Presidential Gatew.
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Cincinnati, Ohio 45242
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Uniaxial Compressive Strength of Intact Rock Core Specimens

(ASTM D 7012-14)

Project: LAW-93-11.21
Project No.: W-24-074
Date of Testing: 8/29/2024
Test Performed by: KL/EM

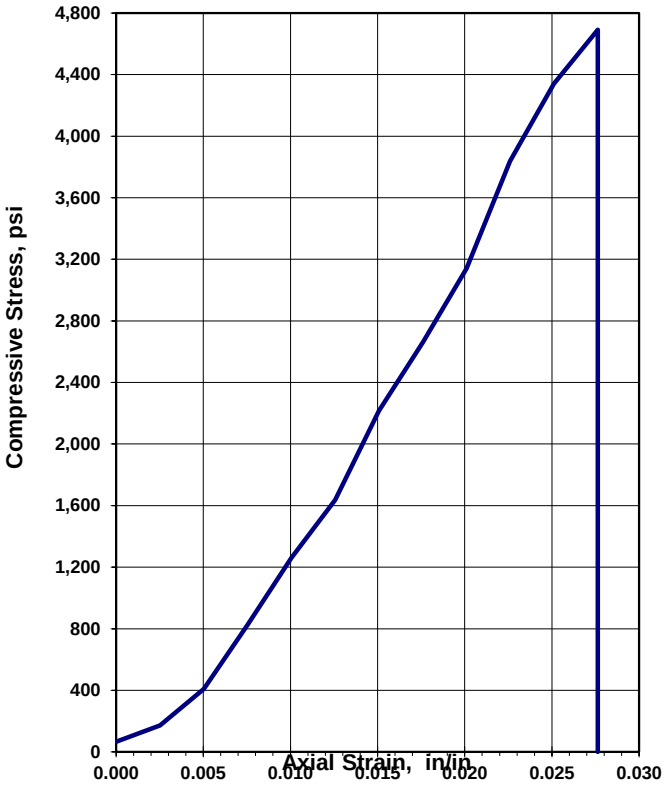
Rock Description: Gray Sandstone
Rock Formation:

Boring No.:	B-004		Average Length:	3.981	in
Sample No:	RC-1		Average Diameter:	1.945	in
Depth (ft):	14.5'	feet	Length to diameter ratio:	2.047	
Moisture condition:	As received		Cross Sectional Area:	2.971	in^2
Sample Mass:	456.17	grams	Volume:	0.0068	ft^3
Testing Temperature:	23	^oC	Unit Weight (sample specimen)*:	146.92	lbs/ft3
Rate of Loading:	50.5	lbs/sec	Failure Load:	13,939	lbs
Testing Time:	276	sec	Axial Strain at Failure:	0.0276	in/in
(Rate 2-15 mir			Compressive Strength:	4,691	psi

Sample Preparation: Per ASTM D4543

**Actual test sample used for unit weight prior to testing.*

Unconfined Compression Test



Before Testing

After Failure

REMARKS:

RESOURCE INTERNATIONAL, INC.
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Slake Durability of Shales and Similar Weak Rocks

(ASTM D4644-08)

Project:	LAW-93-11.70	Boring No.	
Project No:	W-24-074	Sample ID:	L-1
Date:	8/22/2024	Technician:	ML
Sample Description:	Sandstone		

Initial Moisture Content:

Drum/Container ID: 1 Mass of Drum:	1191.76
Mass of Drum + Sample (wet)	1705.32
Mass of Drum + Sample (oven dried)	1700.35
Mass of sample (oven dried):	508.59
Moisture Content of Sample:	0.98

Data After 1st Cycle:

Mass of Drum + Sample (wet)	1713.91	Water Temp:	
Mass of Drum + Sample (oven dried)	1680.93	Start:	20.9
Mass of sample (oven dried):	489.17	Finish:	21.1
Moisture Content of Sample:	6.74	Time:	10AM

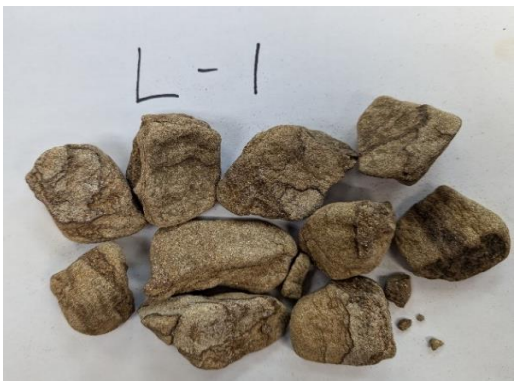
Data After 2nd Cycle:

Mass of Drum + Sample (wet)	1703.0	Water Temp:	
Mass of Drum + Sample (oven dried)	1670.55	Start:	19.8
Mass of sample (oven dried):	478.79	Finish:	20.4
Moisture Content of Sample:	6.78	Time:	9AM

Slake Durability Index:	94.14
Type	I

Type I: Intact, virtually unchanged; Type II: Partially intact, large and small frags.; Type III: Exclusively small fragments

Photographs of Sample

Before Testing:	After Testing:
	

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Phone (216) 573-0955

4480 Lake Forest Drive
Cincinnati, OH 45242
Phone (513) 769-6998

Slake Durability of Shales and Similar Weak Rocks

(ASTM D4644-08)

Project:	LAW-93-11.70	Boring No.	
Project No:	W-24-074	Sample ID:	L-2
Date:	8/22/2024	Technician:	ML
Sample Description:	Siltstone		

Initial Moisture Content:

Drum/Container ID: 2 Mass of Drum:	1190.95
Mass of Drum + Sample (wet)	1688.31
Mass of Drum + Sample (oven dried)	1683.47
Mass of sample (oven dried):	492.52
Moisture Content of Sample:	0.98

Data After 1st Cycle:

Mass of Drum + Sample (wet)	1688.36	Water Temp:	
Mass of Drum + Sample (oven dried)	1660.2	Start:	21.0
Mass of sample (oven dried):	469.25	Finish:	21.0
Moisture Content of Sample:	6.00	Time:	10AM

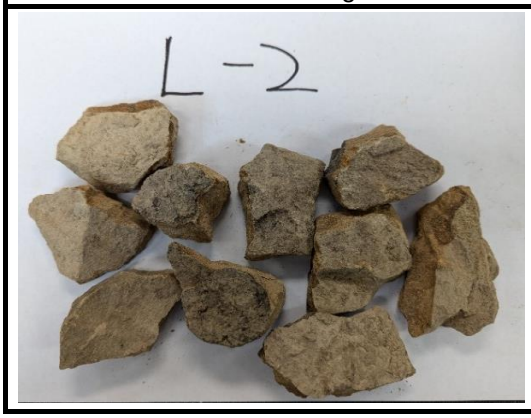
Data After 2nd Cycle:

Mass of Drum + Sample (wet)	1674.2	Water Temp:	
Mass of Drum + Sample (oven dried)	1645.78	Start:	19.6
Mass of sample (oven dried):	454.83	Finish:	20.0
Moisture Content of Sample:	6.26	Time:	9AM

Slake Durability Index:	92.35
Type	I

Type I: Intact, virtually unchanged; Type II: Partially intact, large and small frags.; Type III: Exclusively small fragments

Photographs of Sample

Before Testing:	After Testing:
	

APPENDIX V

PAVEMENT CORE DATA SHEETS

6350 Presidential Gateway
Columbus, Ohio 43231
Telephone: (614) 823-4949
Fax Number: (614) 823-4990

Pavement Core Data Summary

PROJECT: LAW-93-11.21 Improvements
LOCATION: Lawrence County, Ohio
JOB No.: W-24-074

BORING/CORE No.: B-001-0-24
DATE CORE OBTAINED: 8/7/2024
CORE OBTAINED BY: IS, SD, MJ

Core Composition

Core Number	Lift Thickness (in.)	Lift Number	Asphalt: Surface Binder	Asphalt: Intermediate Binder	Asphalt: Base Binder	Concrete	Aggregate/Granular Base	Other		
B-001-0-24	2.75	6		✓						
	3.00	5		✓						
	3.50	4		✓						
	1.75	3		✓						
	1.75	2		✓						
	3.75	1		✓						

Comments/Remarks

- Layers 1, 3, and 4 have slag.
- Layer 1 has voids.
- Layer 2 is deteriorating.
- Layer 4 is broken in 3 pieces.
- Layers 5 and 6 are separated.
- Aggregate Base: None

Total Pavement Thickness =	16.50 in.	Total Asphalt Thickness =	16.50 in.	Total Concrete Thickness =	0.00 in.	Total Base Thickness =	0.00 in.

6350 Presidential Gateway
Columbus, Ohio 43231
Telephone: (614) 823-4949
Fax Number: (614) 823-4990

Pavement Core Data Summary

PROJECT	LAW-93-11.21 Improvements
LOCATION	Lawrence County, Ohio
JOB No.	W-24-074
BORING/CORE No.	B-008-0-24
DATE CORE OBTAINED	8/7/2024
CORE OBTAINED BY	IS, SD, MJ

Core Composition

Core Number	Lift Thickness (in.)	Lift Number	Asphalt: Surface Binder	Asphalt: Intermediate Binder	Asphalt: Base Binder	Concrete	Aggregate/Granular Base	Other		
B-008-0-24	2.75	6		✓						
	1.75	5		✓						
	1.25	4		✓						
	4.75	3		✓						
	2.00	2		✓						
	6.75	1		✓						
	7.75						✓			

Comments/Remarks

- Layer 1 is deteriorating, broken, has voids and slag.
- Layer 2 has some voids and slag.
- Layers 2 and 3 are separated.
- Layers 3 and 5 have voids.
- Layer 4 is deparated and deteriorating.
- Layers 5 and 6 are starting to deteriorate.
- Layer 6 has trace voids.
- Aggregate Base: A-2-4, A-1-b

Total Pavement Thickness =	19.25	in.	Total Asphalt Thickness =	19.25	in.	Total Concrete Thickness =	0.00	in.	Total Base Thickness =	7.75	in.

6350 Presidential Gateway
Columbus, Ohio 43231
Telephone: (614) 823-4949
Fax Number: (614) 823-4990

Pavement Core Data Summary

PROJECT	LAW-93-11.21 Improvements
LOCATION	Lawrence County, Ohio
JOB No.	W-24-074
BORING/CORE No.	B-009-0-24
DATE CORE OBTAINED	8/9/2024
CORE OBTAINED BY	IS, SD, MJ

Core Composition

Core Number	Lift Thickness (in.)	Lift Number	Asphalt: Surface Binder	Asphalt: Intermediate Binder	Asphalt: Base Binder	Concrete	Aggregate/Granular Base	Other		
B-009-0-24	6.50			✓						
	11.00				✓					

Comments/Remarks

- Layer 1 has slag and is separated.
- Layer 2 has slag, voids, separated in 3 parts, upper portion broken.
- Aggregate Base: None.

Total Pavement Thickness =	17.50	in.	Total Asphalt Thickness =	17.50	in.	Total Concrete Thickness =	0.00 in.	Total Base Thickness =	0.00 in.

APPENDIX VI

CALCULATIONS – SUBGRADE ANALYSIS

OHIO DEPARTMENT OF TRANSPORTATION

OFFICE OF GEOTECHNICAL ENGINEERING

PLAN SUBGRADES
Geotechnical Design Manual Section 600

Instructions: Enter data in the shaded cells only.
(Enter state route number, project description,county, consultant's name, prepared by name, and date prepared. This information will be transferred to all other sheets. The date prepared must be entered in the appropriate cell on this sheet to remove these instructions prior to printing.)

LAW-93-11.21
119949

Profile adjustments to 2,400 feet of SR 93 in Lawrence County, Ohio.

Resource International, Inc.

Prepared By: Daniel E. Karch, P.E.
Date prepared: Friday, September 20, 2024

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NO. OF BORINGS: 9

OHIO DEPARTMENT OF TRANSPORTATION

Subgrade Analysis

V. 14.7 4/4/2024

#	Boring ID	Alignment	Station	Offset	Dir	Drill Rig	ER	Boring EL.	Proposed Subgrade EL	Cut Fill
1	B-001-0-24	CL SR 93	592+05	9	Rt	Diedrich D-50	90	602.3	600.7	1.6 C
2	B-002-0-24	CL SR 93	594+43	9	Rt	Diedrich D-50	90	601.8	600.1	1.7 C
3	B-003-0-24	CL SR 93	594+93	8	Rt	Diedrich D-50	90	601.6	600.3	1.3 C
4	B-004-0-24	CL SR 93	595+51	7	Rt	Diedrich D-50	90	601.5	600.5	1.0 C
5	B-005-0-24	CL SR 93	599+04	20	Lt	Diedrich D-50	90	601.7	600.9	0.8 C
6	B-006-0-24	CL SR 93	603+01	1	Rt	Diedrich D-50	90	602.7	602.4	0.3 C
7	B-007-0-24	CL SR 93	606+98	18	Lt	Diedrich D-50	90	602.2	602.5	0.3 F
8	B-008-0-24	CL SR 93	610+10	3	Lt	Diedrich D-50	90	603.8	602.5	1.3 C
9	B-009-0-24	CL SR 93	614+06	12	Lt	Diedrich D-50	90	604.0	603.6	0.4 C

OHIO DEPARTMENT OF TRANSPORTATION

Subgrade Analysis

V. 14.7 4/4/2024

#	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	SS-1	1.4	2.9	-0.2	1.3	21		4.5	24	16	8	27	16	43	14	11	A-4a	2	320		Mc			206 Cement or 204 Geotextile
	001-0	SS-2	2.9	4.3	1.3	2.7	14		4.5	24	16	8	32	22	54	14	11	A-4a	4			N_{60} & Mc			
	24	SS-3	4.3	5.8	2.7	4.2	3		2.25							35	10	A-4a	8						
		SS-4	5.8	7.3	4.2	5.7	0	21	0.5							26	10	A-4a	8						
2	B	SS-1	1.5	3.0	-0.2	1.3	15		1.75							13	14	A-6a	10	400					206 Cement or 204 Geotextile
	002-0	SS-2	3.0	4.5	1.3	2.8	20		4.5							11	14	A-6a	10						
	24	SS-3	4.5	6.0	2.8	4.3	3		1.5							26	10	A-4a	8						
		SS-4	6.0	7.5	4.3	5.8	6	15	1							22	10	A-4a	8						
3	B	SS-1	1.5	3.0	0.2	1.7	14		1							15	14	A-6a	10	410		HP		12"	206 Cement or 204 Geotextile
	003-0	SS-2	3.0	4.5	1.7	3.2	23		4.5							16	14	A-6a	10						
	24	SS-3	4.5	6.0	3.2	4.7	8		1.25							25	10	A-4a	8						
		SS-4	6.0	7.5	4.7	6.2	9	14	0.75	23	17	6	38	18	56	21	12	A-4a	4						
4	B	SS-1	1.5	3.0	0.5	2.0	11		2.25	36	21	15	63	30	93	25	16	A-6a	10	300		N_{60} & Mc		12"	206 Cement or 204 Geotextile
	004-0	SS-2	3.0	4.5	2.0	3.5	15		1.25	25	17	8	31	21	52	14	12	A-4a	3						
	24	SS-3	4.5	6.0	3.5	5.0	6		1.25							28	10	A-4a	8						
		SS-4	6.0	7.5	5.0	6.5	2	11	0							27	10	A-4a							
5	B	SS-1	1.5	3.0	0.7	2.2	63										14	A-6a	10	440					206 Cement or 204 Geotextile
	005-0	SS-2	3.0	4.5	2.2	3.7	6		1.5	36	21	15	54	33	87	24	16	A-6a	10						
	24	SS-3	4.5	6.0	3.7	5.2	0		0	30	18	12	51	31	82	28	14	A-6a	9						
		SS-4	6.0	7.5	5.2	6.7	0	30	0							26	14	A-6a							
6	B	SS-1	2.0	3.5	1.7	3.2	29		4.5	29	20	9	47	23	70	19	15	A-4a	7	410		Mc			206 Cement or 204 Geotextile
	006-0	SS-2	3.5	5.0	3.2	4.7	6		1.5	25	16	9	38	27	65	22	11	A-4a	6						
	24	SS-3	5.0	6.5	4.7	6.2	0										10	A-4a	8						
		SS-4	6.5	8.0	6.2	7.7	0	29									10	A-4a							
7	B	SS-1	2.0	3.5	2.3	3.8	9		1.5	27	17	10	49	27	76	24	12	A-4a	8	440					206 Cement or 204 Geotextile
	007-0	SS-2	3.5	5.0	3.8	5.3	6		0.75	35	19	16	51	37	88	28	16	A-6b	10						
	24	SS-3	5.0	6.5	5.3	6.8	3		0.5								16	A-6b							
		SS-4	6.5	8.0	6.8	8.3	3	9	0								10	A-4a							
8	B	SS-1	2.0	3.5	0.7	2.2	21						12	11	23	8	6	A-1-b	0	480					206 Cement or 204 Geotextile
	008-0	SS-2	3.5	5.0	2.2	3.7	5			30	18	12	41	29	70	26	14	A-6a	8						
	24	SS-3	5.0	6.5	3.7	5.2	3		0.5							27	14	A-6a	10						
		SS-4	6.5	8.0	5.2	6.7	3	21								25	10	A-4a							
9	B	SS-1	2.0	3.5	1.6	3.1	5		0.5	25	16	9	38	24	62	21	11	A-4a	5	460		HP & Mc			206 Cement or 204 Geotextile
	009-0	SS-2	3.5	5.0	3.1	4.6	0		0.5	24	15	9	30	26	56	24	10	A-4a	4						
	24	SS-3	5.0	6.5	4.6	6.1	2									27	10	A-4a	8						
		SS-4	6.5	8.0	6.1	7.6	5	5								25	10	A-4a							

OHIO DEPARTMENT OF TRANSPORTATION

Subgrade Analysis

V. 14.7 4/4/2024

PID: 119949

County-Route-Section: LAW-93-11.21
No. of Borings: 9

Geotechnical Consultant: Resource International, Inc.
Prepared By: Daniel E. Karch, P.E.
Date prepared: 9/20/2024

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):	0"
Average(HP):	12"
Global Geogrid Average(N60L):	0"
Average(HP):	0"

Design CBR	7

% Samples within 3 feet of subgrade			
$N_{60} \leq 5$	15%	HP ≤ 0.5	6%
$N_{60} < 12$	24%	0.5 < HP ≤ 1	3%
$12 \leq N_{60} < 15$	6%	1 < HP ≤ 2	15%
$N_{60} \geq 20$	18%	HP > 2	21%
M+	15%		
Rock	0%		
Unsuitable Soil	0%		

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

% Proposed Subgrade Surface	
Unstable & Unsuitable	38%
Unstable	38%
Unsuitable (Soil & Rock)	0%

	N_{60}	N_{60L}	HP	LL	PL	PI	Silt	Clay	P 200	M_C	M_{OPT}	GI
Average	9	17	1.59	28	18	10	40	25	65	22	12	7
Maximum	63	30	4.50	36	21	16	63	37	93	35	16	10
Minimum	0	5	0.00	23	15	6	12	11	23	8	6	0

Classification Counts by Sample

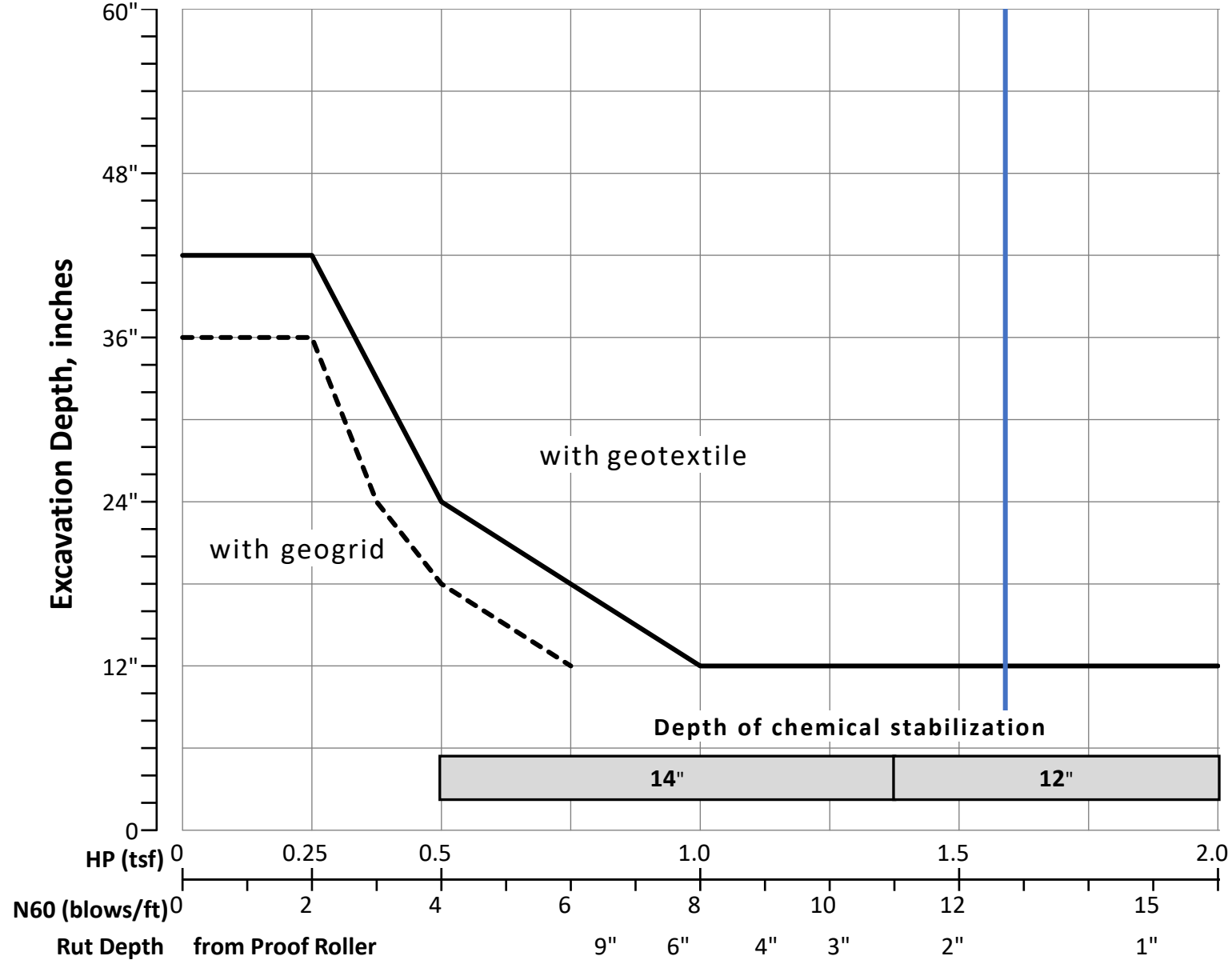
ODOT Class	UCF	Rock	A-1-a	A-1-b	A-2-4	A-2-5	A-2-6	A-2-7	A-3	A-3a	A-4a	A-4b	A-5	A-6a	A-6b	A-7-5	A-7-6	A-8a	A-8b	Totals
Count	0	0	0	1	0	0	0	0	0	0	22	0	0	11	2	0	0	0	0	36
Percent	0%	0%	0%	3%	0%	0%	0%	0%	0%	0%	61%	0%	0%	31%	6%	0%	0%	0%	0%	100%
% Rock|Granular|Cohesive	0%	0%	64%									36%								100%
Surface Class Count	0	0	0	1	0	0	0	0	0	0	7	0	0	8	0	0	0	0	0	16
Surface Class Percent	0%	0%	0%	6%	0%	0%	0%	0%	0%	0%	44%	0%	0%	50%	0%	0%	0%	0%	0%	100%

OHIO DEPARTMENT OF TRANSPORTATION

Subgrade Analysis

V. 14.7 4/4/2024

Fig. 600-1 – Subgrade Stabilization



OVERRIDE TABLE

Calculated Average	New Values	Check to Override
1.59	0.50	☐ HP
17.22	6.00	☐ N60L

Average HP

Average N_{60L}

APPENDIX VII

CALCULATIONS – SHALLOW FOUNDATIONS - CULVERT

W-24-074 LAW-93-11.21 ***Option 1***

Lawrence County, Ohio

Calculated By: DEK Date: 4/22/2025

Checked By: Date:

Shallow Foundation Bearing Resistance - Wingwalls / Headwalls

Borings B-008-0-24

Anticipated foundation bearing elevation: 597.5 feet

Foundation Dimensions:			
Type: Wingwall/Headwall			
B =	5.3	ft	
L =	11.5	ft	
D_f =	2.5	ft	
D_w =	0.0	ft	Below ground surface

Soil Layer 1 (Upper layer):		
Type: Crushed Stone Aggregate (304)		
c_1 =	0	psf
γ_1 =	130	pcf
φ_1 =	37	deg
H =	4.0	ft

Soil Layer 2 (Lower stratum):		
Type: Sandy Silt (A-4a)		
c_2 =	350	psf
γ_2 =	105	pcf
φ_2 =	0	deg

$$q_n = cN_{cm} + \gamma D_f N_{qm} C_{wq} + \tfrac{1}{2}\gamma B N_{\gamma m} C_{w\gamma}$$

$$N_{cm} = N_c s_c i_c$$
$$N_{qm} = N_q s_q d_q i_q$$
$$N_{\gamma m} = N_\gamma s_\gamma i_\gamma$$

	Soil 1		Soil 2	
q_n =	19.69	ksf	2.09	ksf
N_{cm} =	75.41		5.60	
N_{qm} =	63.92		1.00	
$N_{\gamma m}$ =	53.99		0.00	
N_c =	55.63		5.14	
N_q =	42.92		1.00	
N_γ =	66.19		0.00	
s_c =	1+(5.3 ft/11.5 ft)(42.92/55.63) =	1.356	1+(5.3 ft/11.5 ft)(1/5.14) =	1.090
s_q =	1+(5.3 ft/11.5 ft)tan(37°) =	1.347	1+(5.3 ft/11.5 ft)tan(0°) =	1.000
s_γ =	1-0.4(5.3 ft/11.5 ft) =	0.816	1-0.4(5.3 ft/11.5 ft) =	0.816
i_c =	1.000		1.000	
i_q =	1.000		1.000	
i_γ =	1.000		1.000	
d_q =	1+2tan(37°)[1-sin(37°)]²tan⁻¹(2.5 ft/5.3 ft) =	1.105	1+2tan(0°)[1-sin(0°)]²tan⁻¹(2.5 ft/5.3 ft) =	1.000
C_{wq} =	0.0 ft < 2.5 ft =	0.500	0.0 ft < 2.5 ft =	0.500
$C_{w\gamma}$ =	0.0 ft < 1.5(5.3 ft) + 2.5 ft =	0.500	0.0 ft < 1.5(5.3 ft) + 2.5 ft =	0.500

$$H_{crit} = \frac{(3B)\ln\left(\frac{q_1}{q_2}\right)}{2\left(1+\frac{B}{L}\right)} = 12.2 \text{ ft} > 4.0 \text{ ft}$$ Use Layered Analysis

$$q_n = \left[q_2 + \left(\frac{1}{K}\right)c_1' \cot\varphi_1'\right] e^{2\left[1+\left(\frac{B}{L}\right)\right]K\tan\varphi_1'\left(\frac{H}{B}\right)} - \left(\frac{1}{K}\right)c_1' \cot\varphi_1' = 4.55 \text{ ksf}$$

$$K = \frac{1-\sin^2\varphi_1'}{1+\sin^2\varphi_1'} = 0.468$$

$$\cot\varphi_1' = 0.573$$

$$\tan\varphi_1' = 0.754$$

$$q_R = q_n \cdot \phi_b = 2.50 \text{ ksf}$$

φ_b = 0.55

Project No. W-24-074
Settlement - Column Footing

Option 1

Calculated By: DEK Date: 04.15.2025
Checked By: Date:

Existing groundsurface elevation = 600.8 feet
Boring No. B-008-0-24 Approximate bearing elevation= 597.5 feet
Overburden Pressure 406.25 psf

B = 5.3 ft
L = 11.5 ft
D_w = 0.0 ft
q = 1,040 psf

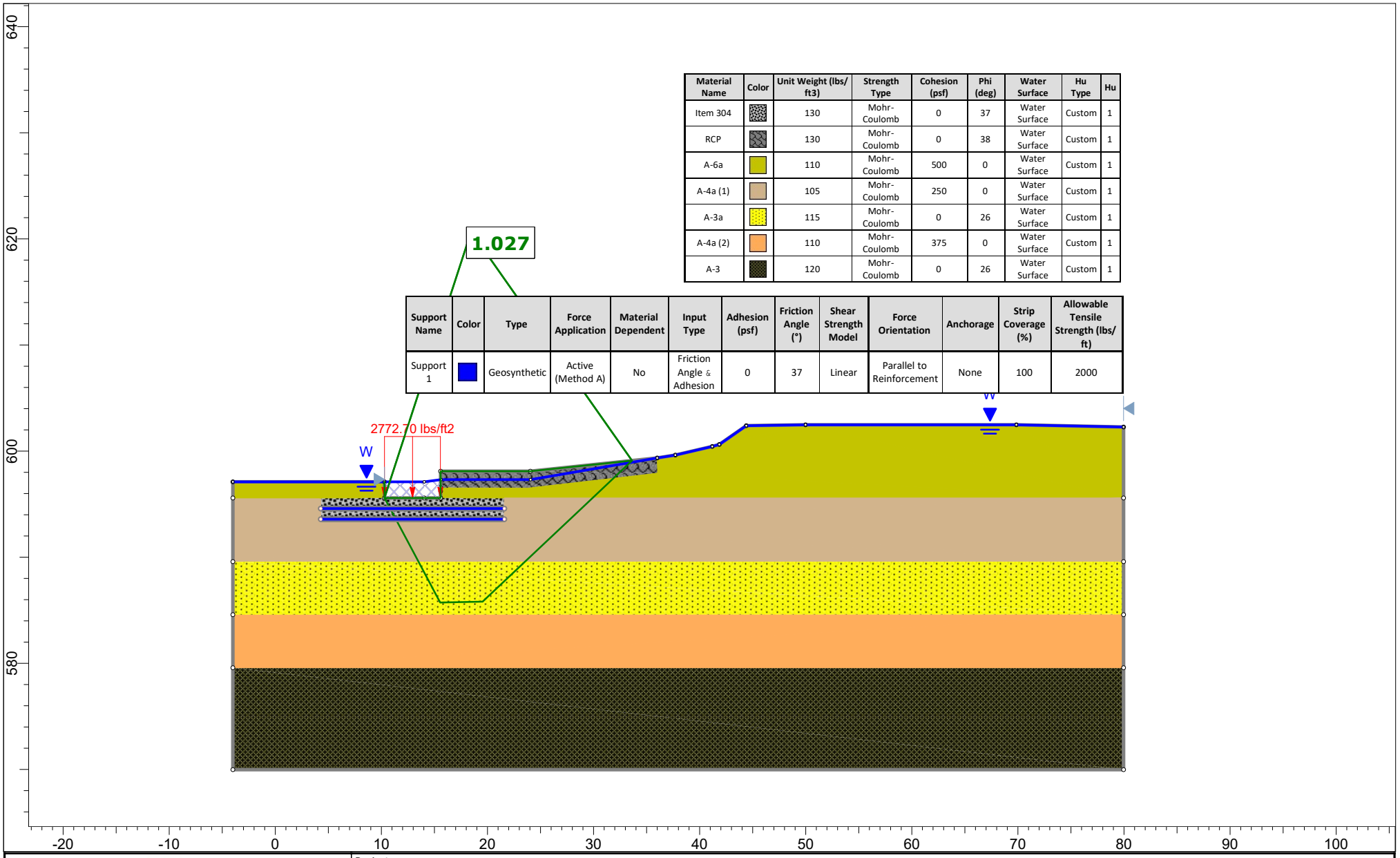
Over excavate and Replace

Layer	Soil Class.	Soil Type	Layer Depth (ft)		Elevation (ft.msl)		Layer Thickness H (ft)	Depth to Midpoint (ft)	γ (pcf)	σ_{vo} Bottom (psf)	σ_{vo} Midpoint (psf)	σ_{vo}' Midpoint (psf)	σ_p' (1) (psf)	LL	C_c (2)	C_r (3)	e_o (4)	N_{60}	$(N1)_{60}$ (5)	C' (6)	Z_f/B	I (7)	$\Delta\sigma_v$ (8) (psf)	σ_{vf}' Midpoint (psf)	S_c (9,10) (ft)	S_c (in)
	A-1-b	G	0.0	2.0	597.5	595.5	2.0	1.0	130	666	536	474	474					50	74	292	0.19	0.982	1,021	1,495	0.003	0.000
	A-1-b	G	2.0	4.0	595.5	593.5	2.0	3.0	130	926	796	609	609					50	70	268	0.57	0.732	761	1,370	0.003	0.000
	A-4a	C	4.0	6.0	593.5	591.5	2.0	5.0	105	1,136	1,031	719	719	23	0.117	0.018	0.452				0.94	0.483	502	1,222	0.037	0.445
	A-3a	G	6.0	8.0	591.5	589.5	2.0	7.0	115	1,366	1,251	814	814					3	4	45	1.32	0.330	343	1,158	0.007	0.082
	A-3a	G	8.0	10.0	589.5	587.5	2.0	9.0	115	1,596	1,481	920	920					3	4	45	1.70	0.238	247	1,167	0.005	0.056
	A-3a	G	10.0	12.0	587.5	585.5	2.0	11.0	115	1,826	1,711	1,025	1,025					3	4	45	2.08	0.179	186	1,211	0.003	0.039
	A-4a	C	12.0	14.0	585.5	583.5	2.0	13.0	110	2,046	1,936	1,125	1,125	25	0.135	0.020	0.467				2.45	0.140	146	1,271	0.010	0.117
	A-4a	C	14.0	16.0	583.5	581.5	2.0	15.0	110	2,266	2,156	1,220	1,220	25	0.135	0.020	0.467				2.83	0.113	118	1,338	0.007	0.088
	A-3	G	16.0	18.0	581.5	579.5	2.0	17.0	120	2,506	2,386	1,325	1,325					7	8	40	3.21	0.093	97	1,422	0.002	0.018
	A-3	G	18.0	20.0	579.5	577.5	2.0	19.0	120	2,746	2,626	1,441	1,441					7	8	40	3.58	0.078	82	1,522	0.001	0.014
	A-3	G	20.0	22.0	577.5	575.5	2.0	21.0	120	2,986	2,866	1,556	1,556					7	8	40	3.96	0.067	70	1,625	0.001	0.011
	A-3	G	22.0	24.0	575.5	573.5	2.0	23.0	120	3,226	3,106	1,671	1,671					7	7	39	4.34	0.058	60	1,731	0.001	0.009
	A-3	G	24.0	26.0	573.5	571.5	2.0	25.0	120	3,466	3,346	1,786	1,786					7	7	39	4.72	0.051	53	1,839	0.001	0.008
	A-3a	G	26.0	28.0	571.5	569.5	2.0	27.0	130	3,726	3,596	1,911	1,911					35	36	100	5.09	0.045	47	1,958	0.000	0.003
	A-3a	G	28.0	30.0	569.5	567.5	2.0	29.0	130	3,986	3,856	2,047	2,047					35	35	98	5.47	0.040	42	2,088	0.000	0.002
	A-3a	G	30.0	32.0	567.5	565.5	2.0	31.0	130	4,246	4,116	2,182	2,182					35	34	96	5.85	0.036	37	2,219	0.000	0.002
	A-3a	G	32.0	34.0	565.5	563.5	2.0	33.0	130	4,506	4,376	2,317	2,317					35	33	94	6.23	0.032	34	2,351	0.000	0.002
																							Total Settlement:			0.896 in

1. $\sigma_p' = \sigma_{vo}' + \sigma_m$, Estimate σ_m of 0 psf for normally consolidated soil deposit
2. $C_c = 0.009(LL-10)$; Ref. Table 26, FHWA GEC 5
3. $C_r = 0.15(C_c)$ for medium stiff to stiff natural soil deposits and existing fill material, 0.075 to $0.10(C_c)$ for very stiff to hard natural soil deposits, and 0.05(Cc) for new embankment fill; Ref. Section 5.4.2.5 of FHWA GEC 5
4. $e_o = (C_c/1.15)+0.35$; Ref. Table 8-2, Holtz and Kovacs 1981
5. $(N1)_{60} = C_n N_{60}$, where $C_N = [0.77\log(40/\sigma_{vo}')] \leq 2.0$ ksf; Ref. Section 10.4.6.2.4, AASHTO LRFD BDS
6. Bearing capacity index; Ref. Figure 10.6.2.4.2-1, AASHTO LRFD BDS
7. Influence factor for rectangular footing
8. $\Delta\sigma_v = q_o(I)$
9. $S_c = [C_c/(1+e_o)](H)\log(\sigma_{vf}'/\sigma_{vo}')$ for $\sigma_p' \leq \sigma_{vo}' < \sigma_{vf}'$; $[C_r/(1+e_o)](H)\log(\sigma_p'/\sigma_{vo}')$ for $\sigma_{vo}' < \sigma_{vf}' \leq \sigma_p'$; $[Cr/(1+e_o)](H)\log(\sigma_p'/\sigma_{vo}') + [C_c/(1+e_o)](H)\log(\sigma_{vf}'/\sigma_p')$ for $\sigma_{vo}' < \sigma_p' < \sigma_{vf}'$; Ref. Section 10.6.2.4.3, AASHTO LRFD BDS (Cohesive soil layers)
10. $S_c = H(1/C')\log(\sigma_{vf}'/\sigma_{vo}')$; Ref. Section 10.6.2.4.2, AASHTO LRFD BDS (Granular soil layers)

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Hu Type	Hu
Item 304		130	Mohr-Coulomb	0	37	Water Surface	Custom	1
RCP		130	Mohr-Coulomb	0	38	Water Surface	Custom	1
A-6a		110	Mohr-Coulomb	500	0	Water Surface	Custom	1
A-4a (1)		105	Mohr-Coulomb	250	0	Water Surface	Custom	1
A-3a		115	Mohr-Coulomb	0	26	Water Surface	Custom	1
A-4a (2)		110	Mohr-Coulomb	375	0	Water Surface	Custom	1
A-3		120	Mohr-Coulomb	0	26	Water Surface	Custom	1

Support Name	Color	Type	Force Application	Material Dependent	Input Type	Adhesion (psf)	Friction Angle (°)	Shear Strength Model	Force Orientation	Anchorage	Strip Coverage (%)	Allowable Tensile Strength (lbs/ft)
Support 1		Geosynthetic	Active (Method A)	No	Friction Angle & Adhesion	0	37	Linear	Parallel to Reinforcement	None	100	2000



Project	LAW-93-11.21		
Analysis Description	B-008-0-24 Undrained Strength Limit		
Drawn By	DEK	Scale 1:150	Company Rii
Date	4/16/2025, 3:01:29 PM		File Name LE 204 Geogrid Strength Limit add'l 12-in 304.slmd

SLIDEINTERPRET 9.024

Project No. W-24-074
Settlement - Column Footing

Option 2

Calculated By: DEK Date: 04.15.2025
Checked By: Date:

Boring No. B-008-0-24

Existing groundsurface elevation =	600.8	feet
Approximate bearing elevation=	597.5	feet
Overburden Pressure	406.25	psf

B =	5.3	ft
L =	11.5	ft
D_w =	0.0	ft
q =	1,040	psf

Over excavate and Replace

Layer	Soil Class.	Soil Type	Layer Depth (ft)		Elevation (ft.msl)		Layer Thickness H (ft)	Depth to Midpoint (ft)	γ (pcf)	σ_{vo} Bottom (psf)	σ_{vo} Midpoint (psf)	σ_{vo}' Midpoint (psf)	σ_p' (1) (psf)	LL	C_c (2)	C_r (3)	e_o (4)	N_{60}	$(N1)_{60}$ (5)	C' (6)	Z_f/B	I (7)	$\Delta\sigma_v$ (8) (psf)	σ_{vf}' Midpoint (psf)	S_c (9,10) (ft)	S_c (in)
	A-1-b	G	0.0	2.0	597.5	595.5	2.0	1.0	130	666	536	474	474					50	74	292	0.19	0.982	1,021	1,495	0.003	0.000
	A-4a	C	2.0	4.0	595.5	593.5	2.0	3.0	105	876	771	584	584	23	0.117	0.018	0.452				0.57	0.732	761	1,345	0.058	0.701
	A-4a	C	4.0	6.0	593.5	591.5	2.0	5.0	105	1,086	981	669	669	23	0.117	0.018	0.452				0.94	0.483	502	1,172	0.039	0.470
	A-3a	G	6.0	8.0	591.5	589.5	2.0	7.0	115	1,316	1,201	764	764					3	4	45	1.32	0.330	343	1,108	0.007	0.086
	A-3a	G	8.0	10.0	589.5	587.5	2.0	9.0	115	1,546	1,431	870	870					3	4	45	1.70	0.238	247	1,117	0.005	0.058
	A-3a	G	10.0	12.0	587.5	585.5	2.0	11.0	115	1,776	1,661	975	975					3	4	45	2.08	0.179	186	1,161	0.003	0.041
	A-4a	C	12.0	14.0	585.5	583.5	2.0	13.0	110	1,996	1,886	1,075	1,075	25	0.135	0.020	0.467				2.45	0.140	146	1,221	0.010	0.122
	A-4a	C	14.0	16.0	583.5	581.5	2.0	15.0	110	2,216	2,106	1,170	1,170	25	0.135	0.020	0.467				2.83	0.113	118	1,288	0.008	0.092
	A-3	G	16.0	18.0	581.5	579.5	2.0	17.0	120	2,456	2,336	1,275	1,275					7	8	40	3.21	0.093	97	1,372	0.002	0.019
	A-3	G	18.0	20.0	579.5	577.5	2.0	19.0	120	2,696	2,576	1,391	1,391					7	8	40	3.58	0.078	82	1,472	0.001	0.015
	A-3	G	20.0	22.0	577.5	575.5	2.0	21.0	120	2,936	2,816	1,506	1,506					7	8	40	3.96	0.067	70	1,575	0.001	0.012
	A-3	G	22.0	24.0	575.5	573.5	2.0	23.0	120	3,176	3,056	1,621	1,621					7	8	40	4.34	0.058	60	1,681	0.001	0.010
	A-3	G	24.0	26.0	573.5	571.5	2.0	25.0	120	3,416	3,296	1,736	1,736					7	7	39	4.72	0.051	53	1,789	0.001	0.008
	A-3a	G	26.0	28.0	571.5	569.5	2.0	27.0	130	3,676	3,546	1,861	1,861					35	36	101	5.09	0.045	47	1,908	0.000	0.003
	A-3a	G	28.0	30.0	569.5	567.5	2.0	29.0	130	3,936	3,806	1,997	1,997					35	35	99	5.47	0.040	42	2,038	0.000	0.002
	A-3a	G	30.0	32.0	567.5	565.5	2.0	31.0	130	4,196	4,066	2,132	2,132					35	34	97	5.85	0.036	37	2,169	0.000	0.002
	A-3a	G	32.0	34.0	565.5	563.5	2.0	33.0	130	4,456	4,326	2,267	2,267					35	34	95	6.23	0.032	34	2,301	0.000	0.002
																							Total Settlement:			1.642 in

1. $\sigma_p' = \sigma_{vo}' + \sigma_m$, Estimate σ_m of 0 psf for normally consolidated soil deposit
2. $C_c = 0.009(LL-10)$; Ref. Table 26, FHWA GEC 5
3. $C_r = 0.15(C_c)$ for medium stiff to stiff natural soil deposits and existing fill material, 0.075 to $0.10(C_c)$ for very stiff to hard natural soil deposits, and 0.05(Cc) for new embankment fill; Ref. Section 5.4.2.5 of FHWA GEC 5
4. $e_o = (C_c/1.15)+0.35$; Ref. Table 8-2, Holtz and Kovacs 1981
5. $(N1)_{60} = C_n N_{60}$, where $C_N = [0.77\log(40/\sigma_{vo}')] \leq 2.0$ ksf; Ref. Section 10.4.6.2.4, AASHTO LRFD BDS
6. Bearing capacity index; Ref. Figure 10.6.2.4.2-1, AASHTO LRFD BDS
7. Influence factor for rectangular footing
8. $\Delta\sigma_v = q_e(I)$
9. $S_c = [C_c/(1+e_o)](H)\log(\sigma_{vf}'/\sigma_{vo}')$ for $\sigma_p' \leq \sigma_{vo}' < \sigma_{vf}'$; $[C_r/(1+e_o)](H)\log(\sigma_p'/\sigma_{vo}')$ for $\sigma_{vo}' < \sigma_{vf}' \leq \sigma_p'$; $[Cr/(1+e_o)](H)\log(\sigma_p'/\sigma_{vo}') + [C_c/(1+e_o)](H)\log(\sigma_{vf}'/\sigma_p')$ for $\sigma_{vo}' < \sigma_p' < \sigma_{vf}'$; Ref. Section 10.6.2.4.3, AASHTO LRFD BDS (Cohesive soil layers)
10. $S_c = H(1/C')\log(\sigma_{vf}'/\sigma_{vo}')$; Ref. Section 10.6.2.4.2, AASHTO LRFD BDS (Granular soil layers)