REVISED REPORT
GEOTECHNICAL EXPLORATION
DEL-315-00.86
PID: 110446
DELAWARE COUNTY, OHIO

Prepared For:

WSP USA
Two Miranova Place, Suite 450
Columbus, OH 43215

Prepared by:

NATIONAL ENGINEERING AND ARCHITECTURAL SERVICES INC.
2800 Corporate Exchange Drive, Suite 240
Columbus, Ohio 43231

NEAS PROJECT 23-0032

November 10, 2023

National Engineering & Architectural Services Inc.

EXECUTIVE SUMMARY

The Ohio Department of Transportation has proposed a safety improvement project, DEL-315-00.86 (PID: 110446), in Delaware County, Ohio. The project is planned for Olentangy River Road, stretching between Abbotsford Green Drive and Jewett Road in Delaware County, Ohio. The proposed improvements include: 1) enhancing the roadway along Olentangy River Road between Abbotsford Green Drive and Jewett Road to increase safety and alleviate congestion; 2) replacing the headwall of the culvert at Bartholomew Run located near the intersection of Jewett Road and Olentangy River Road; 3) constructing a retaining wall, which will be designed as part of the culvert extension.

National Engineering & Architectural Services, Inc. (NEAS) has been contracted to perform geotechnical engineering services for the project. The purpose of the geotechnical engineering services was to perform geotechnical explorations within the project limits to obtain information concerning the subsurface soil and groundwater conditions relevant to the design and construction of the project. The scope of work performed by NEAS as part of the referenced project included: a review of published geotechnical information; performing 6 test borings for the proposed construction; laboratory testing of soil samples in accordance with the ODOT's Specifications for Geotechnical Explorations (SGE) (ODOT, 2023); performing geotechnical engineering analysis to assess subgrade stabilization requirements, pavement design parameters; and development of this summary report.

NEAS acknowledges that the primary goal of the project is to enhance safety, alleviate congestion and replace the culvert headwall within the specified project limits. To achieve these objectives, a subgrade exploration and subsequent analysis were conducted for the referenced project. The exploration was carried out in line with NEAS's proposal to WSP USA, dated February 28, 2023, and with the provisions of ODOT's SGE (ODOT, 2023). The subgrade analysis was performed in accordance with ODOT's Geotechnical Design Manual (GDM) (ODOT [1], 2023) and Pavement Design Manual (PDM) (ODOT, 2022).

The subgrade conditions in the project area exhibit a relatively consistent profile, primarily comprising cohesive soils classified as A-6a, A-6b, and A-7-6. Additionally, there are minor occurrences of granular soils classified as A-1-b, A-2-4 and A-2-6.

Based on our analysis, subgrade soils labeled as "unstable" according to ODOT's GDM were identified at various locations throughout the project. NEAS recommends addressing this by implementing local stabilization using Item 204 'Excavate and Replace with Geotextile' wherever unstable subgrade materials are encountered. The excavated material should then be replaced with Item 204 'Granular Material Type C' in accordance with Section 608 "Excavate and Replace (Item 204)" of the ODOT GDM.

Additionally, as per ODOT's GDM, 'For all other roadways, if it's determined that 30 percent or more of the subgrade area must be stabilized, consider stabilizing the entire project (global stabilization).' This consideration should include a cost analysis of the options. If the global stabilization is chosen, the project's subgrade soils should be stabilized globally using Item 204 'Excavate and Replace' to a depth of 12 inches for the entire project area. Another alternative is global chemical stabilization to a depth of 12 inches utilizing cement as the stabilization chemical. **Designer should perform a cost analysis of the stabilization options using bid tabs.** Stabilization limits should extend 18-inches beyond the edge of the proposed paved roadway, shoulder or median.

The existing 18'x7' box culvert carrying SR-315 over Bartholomew Run is intended to extend approximately 23'-6" long from the outlet. According to the site plan prepared by WSP USA, the bottom of the outlet footing is positioned at approximately 756.0 ft in elevation, which indicates that the footing will be embedded into the bedrock since bedrock was encountered at an elevation of 760.0 ft in boring B-002-0-92. The bearing resistance of the bedrock will significantly exceed the bearing pressure exerted by the headwall and the wingwall. Therefore, the bearing capacity should not pose any concerns at the culvert outlet location. Additionally, there is no need to be concerned about global stability.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF APPENDICES

1. INTRODUCTION

1.1. General

National Engineering & Architectural Services, Inc. (NEAS) presents our Geotechnical Exploration Report for the proposed DEL-315-00.86 project (PID: 110446) along Olentangy River Road between Abbotsford Green Drive and Jewett Road in Delaware County, Ohio. The proposed improvements include: 1) enhancing the roadway along Olentangy River Road between Abbotsford Green Drive and Jewett Road to increase safety and alleviate congestion; 2) replacing the headwall of the culvert at Bartholomew Run located near the intersection of Jewett Road and Olentangy River Road; 3) constructing a retaining wall, which will be designed as part of the culvert extension.

This report presents a summary of the project encountered surficial and subsurface conditions and our recommendations for subgrade stabilization and pavement design parameters for the planned improvements. The pavement subgrade analysis and recommendations presented are in accordance with ODOT's Geotechnical Design Manual (GDM) (ODOT [1], 2023) and Pavement Design Manual (PDM) (ODOT, 2022).

The exploration was conducted in general accordance with NEAS's proposal to WSP USA, dated February 28, 2023, and with the provisions of ODOT's *Specifications for Geotechnical Explorations* (SGE) (ODOT, 2023).

The scope of work performed by NEAS as part of the referenced project included: a review of published geotechnical information; performing 6 total test borings; laboratory testing of soil samples in accordance with the SGE; performing geotechnical engineering analysis to assess subgrade stabilization requirements, pavement design parameters; and development of this summary report.

2. GEOLOGY AND OBSERVATIONS OF THE PROJECT

2.1. Geology and Physiography

The project site is located within the Central Ohio Clayey Till Plain. This area is characterized as the moderate-relief (100 ft), surface of clayey till, well defined moraines with intervening flat-lying ground moraine and intermorainal lake basins. The geology in this region is described as clayey, high lime Wisconsinan-age fill from a northeastern source and lacustrine materials over Lower Paleozoic-age carbonate rocks and, in the east, shales (ODGS, 1998).

Based on the Quaternary geology map of Ohio, the geology at the project site is mapped as Silty clay till that consist of Hayesville, Lavery, Marysville and Woodington Tills. It's described as ground moraine, flat to gently undulating (Pavey, et al 1999).

Based on the Bedrock Geologic Units Map of Ohio (USGS & ODGS, 2006), bedrock within the project area consists of shale, limestone, of the Ohio Shale group and Delaware Limestone group formation. The Ohio Shale group formation is comprised of Devonian-age shale, black to greenish gray, weathered brown in color, carbonaceous to clayey, laminated to thin bedded, fissile parting, carbonate and/or siderite in lowermost 50 feet that include Olentangy shale south of central Delaware. The Delaware Limestone group formation is comprised of Devonian-age limestone, gray to brown in color, thin to massive bedded, argillaceous partings, nodules and layers, carbonaceous, petroliferous odor as much as 45 feet thick. Based on the ODNR bedrock topography map of Ohio, the bedrock elevation of the project site can be

expected to be 750 to 775 ft above mean sea level (amsl), putting the bedrock at depths 4 ft to 27 ft below ground surface (bgs).

The soils at the project site have been mapped (Web Soil Survey) by the Natural Resources Conservation Service (USDA, 2015) as primarily mix of Scioto silt loam and Udorthents, clayey-urban land complex. The Scioto silt loam is comprised of both coarse- and fine-grained soils and classifies as A-1, A-2, A-4, A-6 and A-7 according to the AASHTO method of soil classification.

2.2. Hydrology/Hydrogeology

Groundwater at the project site is anticipated to align with the elevation of the nearby Olentangy River, given its significant hydraulic influence in the project's vicinity. The water level of the Olentangy River can serve as a general indicator of the local groundwater table. Nevertheless, it is important to noted that perched groundwater systems may exist in certain areas due to the presence of fine-grained soils, impeding the permeation of groundwater to the phreatic surface.

The project area north of the Jewett Rd and Olentangy River Road intersection falls within either Zone X or Zone AE of the flood hazard, as indicated by by the Federal Emergency Management Agency's (FEMA) National Flood Hazard mapping program (FEMA, 2016). Conversely, the project to the south of the Jewett Rd and Olentangy River Road intersection does not lie within the 1% annual chance hazard zone.

2.3. Mining and Oil/Gas Production

No abandoned mines are noted on ODNR's abandoned Underground Mine Locator in the vicinity of the project site (ODNR [1], 2023). In addition, no wells were found in the vicinity area of the project limit according to ODNR's oil & gas locator (ODNR [2], 2023).

2.4. Historical Records and Previous Phases of Project Exploration

The following report/plans were available for review and evaluation for this report:

- Structure Foundation Investigation Sheets for DEL-315-0087, dated March 1992.
- Structure Foundation Investigation Sheets for DEL-315-0.86, dated March 2009.

Historical soil borings associated with the above plans were reviewed and listed in Table 1 below. The historical boring locations are shown in Appendix A, and the historical boring logs are attached in Appendix B.

Table 1: Historical Boring Summary

Boring Number	Latitude	Longitude	Elevation (ft)	Depth (ft)	Bedrock Elevation (ft)	Bedrock Depth (ft)
B-001-0-92	40.149102	-83.043535	772.6	19.2	763.4	9.2
B-002-0-92	40.149231	-83.043550	771.8	21.8	760.0	11.8
B-037-0-09	40.149743	-83.043876	770.5	34.4	756.2	14.3
B-038-0-09	40.150076	-83.044129	772.9	27.1	764.4	8.5
B-039-0-09	40.150458	-83.044323	776.2	26.1	770.2	6.0
B-040-0-09	40.150986	-83.044514	776.1	25.0	772.2	3.9

2.5. Field Reconnaissance

A field reconnaissance visit for the entire project area was carried out on August 10, 2023, encompassing SR-315 and Jewett Road. During the visit, site conditions, including the current state of the pavement, were carefully observed and documented through photographs. Below is a summary of the observed land use and pavement conditions, along with images highlighting notable pavement distress

The land use of the project area along SR-315 and Jewett Road comprises forested areas, grasslands, and residential properties, primarily consisting of family homes. Overall, the pavement condition along the designated section of SR-315 and Jewett Road was noted to be fair to good, exhibiting marginal signs of weathering and surface wear. During the observation, occasional low-severity longitudinal and transverse cracking, along with intermittent low to moderate severity edge cracking, were identified along the roadway within the project zone (Photographs 1 and 2).

The designated project section of the roadway exhibited effective drainage, with water channeled appropriately to drainage swales or absorbed by grassy/vegetated embankment slopes. There were no observed issues of ponding water or evident drainage deficiencies during our visit.

Photograph 1: SR-315 Pavement Wear

Photograph 2: SR-315 Pavement Wear

3. GEOTECHNICAL EXPLORATION

3.1. Exploration Program

The subsurface exploration was conducted by NEAS on September 13, 2023, and included 6 boring drilled to depths between 6.1 and 7.5 ft below ground surface (bgs). All borings were utilized in this report. The boring locations were selected by NEAS in general accordance with the guidelines contained in the SGE with the intent to evaluate subgrade soil and groundwater conditions. Project exploration locations were located and surveyed in the field by Project Surveyor after the completion of drilling. Each individual project boring log (included within Appendix B) includes the recorded boring latitude and longitude and the corresponding ground surface elevation, as shown on Table 2 below. The boring locations are depicted on the Boring Location Map provided in Appendix A.

Table 2: Project Boring Infomation

Boring Number	Latitude	Longitude	Elevation (ft)	Depth (ft)
B-001-0-23	40.144619	-83.041233	779.2	7.5
B-002-0-23	40.145338	-83.041587	780.0	7.5
B-003-0-23	40.146085	-83.041851	780.1	6.1
B-004-0-23	40.146888	-83.042350	778.6	7.5
B-005-0-23	40.147920	-83.042788	775.4	7.5
B-006-0-23	40.148911	-83.043708	775.9	7.5
Notes:	*1. Boring locations and corresponding ground surface elevation were surveyed in the field.*			

Borings were drilled using a CME 45B truck-mounted drilling rig utilizing 3.25-inch (inner diameter) hollow stem augers. Soil samples for subgrade borings were recovered continuously at 1.5 ft interval drilled to end of boring (EOB). Each boring was sampled using an 18-inch split spoon sampler (AASHTO T-206 “Standard Method for Penetration Test and Split Barrel Sampling of Soils.”). The soil samples obtained from the exploration program were visually observed in the field by NEAS field representative

and preserved for review by a geologist for possible laboratory testing. Standard penetration tests (SPT) were conducted using a CME auto hammer that has been calibrated to be 72.6 % efficient as indicated on the boring logs (Appendix B).

Field boring logs were prepared by drilling personnel and included pavement description, lithological description, SPT results recorded as blows per 6-inch increment of penetration and estimated unconfined shear strength values on specimens exhibiting cohesion (using a hand-penetrometer). After completing the borings, the boreholes were backfilled with auger cuttings (soil cuttings) and patched accordingly with cold patch asphalt when drilling through the roadway.

3.2. Laboratory Testing Program

The laboratory testing program consisted of classification testing, moisture content and sulfate content determinations. Data from the laboratory testing program were incorporated on the boring logs (Appendix B). Soil samples will be held at the laboratory until Stage 2 approval, at which point they will be disposed of.

3.2.1. Classification Testing

Representative soil samples were selected for index properties (Atterberg limits) and gradation testing for classification purposes. At each boring location, the upper two samples obtained below the proposed top of subgrade elevation were generally tested while additional samples in each boring were selected for testing with the intent of properly classifying the subsurface soil and groundwater conditions within the planned project limits. Soils not selected for testing were compared to laboratory tested samples and classified visually. Moisture content testing was conducted on all samples. The laboratory testing was performed in general accordance with applicable AASHTO specifications and ODOT Supplements.

Final classification of soil strata in accordance with AASHTO M-145 “Classification of Soils and Soil-Aggregate Mixtures for Highway Construction Purposes,” as modified by ODOT “Classification of Soils” was made once laboratory test results became available. The results of the soil classification are presented on the boring logs in Appendix B.

3.2.2. Standard Penetration Test Results

Standard Penetration Tests (SPT) and split-barrel (commonly known as split-spoon) sampling of soils were performed at varying intervals (i.e., continuous intervals) in the project borings performed. To account for the high efficiency (automatic) hammers used during SPT sampling, field SPT N-values were converted based on the calibrated efficiency (energy ratio) of the specific drill rig's hammer. Field N-values were converted to an equivalent rod energy of 60% (N_{60}) for use in analysis or for correlation purposes. The resulting N_{60} values are shown on the boring logs provided in Appendix B.

3.2.3. Sulfate Testing

Sulfate testing was generally performed on one sample from each subgrade/roadway boring performed for pavement/subgrade design purposes. The selected samples were tested in accordance with ODOT Supplement 1122, “Determining Sulfate Content in Soils” dated July 17, 2015. In general, the upper most sample (within 3 ft of the proposed subgrade elevation) from each boring was tested when feasible. Testing results are summarized in Table 3 below, and presented on the boring logs within Appendix B.

Table 3: Sulfate Test Summary by Boring

Boring ID	Sample	Depth (ft)	Dilution Ratio	Average Sulfate Content (ppm)
B-001-0-22	SS-1	1.5 - 3.0	20	53
B-002-0-22	SS-1	1.5 - 3.0	20	40
B-003-0-22	SS-1	1.5 - 3.0	20	20
B-004-0-22	SS-1	1.5 - 3.0	20	33
B-005-0-22	SS-1	1.5 - 3.0	20	47
B-006-0-22	SS-1	1.5 - 3.0	20	60

4. FINDINGS

The subsurface conditions encountered during NEAS's explorations are described in the following subsections and/or on each boring log presented in Appendix B. The boring logs represent NEAS's interpretation of the subsurface conditions encountered at each boring location based on our site observations, field logs, visual review of the soil samples by NEAS's geologist, and laboratory test results. The lines designating the interfaces between various soil strata on the boring logs represent the approximate interface location; the actual transition between strata may be gradual and indistinct. The subsurface soil and groundwater characterizations included herein, including summary test data, are based on the subsurface findings from the geotechnical explorations performed by NEAS as part of the referenced project. For the purposes of this report and our analysis the term 'subgrade' has been assumed to represent soils and/or soil conditions from 1.5 ft below proposed final pavement grades to a depth of 7.5 ft below the proposed pavement grades.

4.1. Existing Pavement

The pavement section thicknesses in terms of asphalt, concrete and granular base were measured at representative project subgrade borings during the subsurface exploration for the project and are recorded on the test boring logs provided in Appendix B. A summary of these measurements is provided in Table 4 below.

Table 4: Measured Pavement Thickness at Boring Locations

Boring ID	Proposed Alignment	Drilled Depth (ft)	Asphalt Thickness (in)	Concrete Thickness (in)	Base Thickness (in)	Total Thickness (in)
B-001-0-23	Olentangy Rd/ SR 315	7.5	13.0	0.0	0.0	13.0
B-002-0-23	Olentangy Rd/ SR 315	7.5	13.0	0.0	0.0	13.0
B-003-0-23	Olentangy Rd/ SR 315	6.1	13.0	0.0	0.0	13.0
B-004-0-23	Olentangy Rd/ SR 315	7.5	14.0	0.0	0.0	14.0
B-005-0-23	Olentangy Rd/ SR 315	7.5	12.0	0.0	0.0	12.0
B-006-0-23	Jewett Road	7.5	8.0	0.0	0.0	8.0

4.2. Subgrade Conditions

The subgrade conditions in the project area exhibit a relatively consistent profile, primarily comprising cohesive soils classified as A-6a, A-6b, and A-7-6. Additionally, there are minor occurrences of granular soils classified as A-1-b, A-2-4 and A-2-6. A summary of the encountered subgrade conditions along the project site is provided below.

4.2.1. SR 315 (Olentangy River Road)

The borings performed along SR 315 included borings B-001-0-23 through B-005-0-23.

Along SR 315, sixty-five percent (65%) of the soil samples were identified as fine-grained soils and were comprised of: 1) Silt and Clay (A-6a, 30% of samples); 2) Silty Clay (A-6b, 30% of samples); and 3) Clay (A-7-6, one sample). With respect to the consistency of the fine-grained soils, the descriptions varied from very stiff to hard correlating to converted SPT-N values (N_{60}) between 7 and 15 blows per foot (bpf). Natural moisture contents ranged from 10 to 24 percent. Based on Atterberg Limit tests performed on representative samples of the fine-grained subgrade soils obtained, the liquid and plastic limits ranged from 31 to 38 percent and from 17 to 21 percent, respectively.

Thirty-five percent (35%) of the samples taken along SR 315 were classified as granular, non-cohesive soils and were comprised of: 1) Stone fragments with sand (A-1-b, 20% of samples); 2) Gravel and Stone Fragments with Sand and Silt (A-2-4, one sample); 3) Gravel and Stone Fragments with Sand and Silt (A-2-6, 10% of samples). With respect to the relative density of the granular soils, the descriptions varied from loose to very dense correlating to N_{60} values between 5 bpf to refusal. Natural moisture contents ranged from 1 to 17 percent.

4.2.2. Jewett Road

The boring performed along Jewett Road included B-006-0-23.

Along Jewett Road, seventy-five percent (75%) of the soil samples were identified as fine-grained soils and were comprised of Silt and Clay (A-6a, 75% of samples). With respect to the consistency of the fine-grained soils, it can be described as very stiff correlating to converted SPT-N values (N_{60}) between 8 and 11 blows per foot (bpf). Natural moisture contents ranged from 14 to 17 percent. Based on Atterberg Limit tests performed on representative samples of the fine-grained subgrade soils obtained along the project portions, the liquid and plastic limits are between 32 to 34 percent and 18 to 19 percent, respectively.

Twenty-five percent (25%) of the samples taken along the proposed roadway were classified as granular, non-cohesive soils and were comprised of Gravel and Stone Fragments with Sand and Silt (A-2-4, one sample). With respect to the relative density of the coarse-grained soils, it can be described as medium dense correlating to N_{60} value of 18 bpf. Natural moisture content was 13 percent.

5. ANALYSES AND RECOMMENDATIONS

We understand that the objective of this project is to improve the roadway along Olentangy River Road between Abbotsford Green Drive and Jewett Road, aiming to increase safety, reduce congestion and replace the headwall of the culvert located adjacent to the intersection of Jewett Road and Olentangy River Road. For this purpose, the subgrade analysis was performed in accordance with ODOT's GDM criteria utilizing the ODOT provided subgrade analysis spreadsheet (SubgradeAnalysis.xls, version 14.6 dated February 11, 2022). Input information for the spreadsheet was based on the soil characteristics gathered during NEAS's exploration (i.e., SPT results, laboratory test results, etc.).

Based on our evaluation of the subsurface conditions and our geotechnical engineering analyses of the proposed project, it is our opinion that subgrade conditions are generally satisfactory, and pavement can be supported by the underlying subsurface material utilizing local Excavate and Replace or global Excavate and Replace per ODOT's GDM where proof rolling shows signs of weak soil and where rock isn't present within the proposed subgrade. Further details regarding our subgrade analysis and the recommended remediation are provided in Section 5.1 and Section 5.2 of this report, respectively.

5.1. Subgrade Analysis

A subgrade analysis was performed to identify the method, location, and dimensions (including depth) of required subgrade stabilization for the project. In addition to identifying stabilization recommendations, pavement design parameters are also determined to aid in pavement section design. The subsections below present the results of our subgrade analysis including pavement design parameters and unsuitable subgrade conditions identified within the project limits. Subgrade analysis spreadsheets are provided in Appendix C.

5.1.1. Pavement Design Recommendations

It is our understanding that pavement analysis and design is to be performed to determine the proposed pavement section within the project limits to improve safety. A subgrade analysis was performed using the subgrade soil data obtained during our field exploration program to evaluate the soil characteristics to develop pavement parameters for use in pavement design. The subgrade analysis parameters recommended for use in pavement design are presented in Table 5 below. Provided in the table are ranges of maximum, minimum and average N_{60L} values for the indicated segments as well as the design CBR value recommended for use in pavement design.

Table 5: Pavement Design Parameters

Segment	Maximum N_{60L}	Minimum N_{60L}	Average N_{60L}	Average PI Values	Design CBR*
SR 315	30	5	12	15	7
Jewett Road	8	8	8	15	8
Entire Project	**30**	**5**	**12**	**15**	**7**

5.1.2. Unsuitable Subgrade

Per ODOT's GDM, the presence of select subgrade conditions are prohibited within the subgrade zone for new pavement construction. These prohibited subgrade conditions generally include the presence of rock, specific soil types, and soils with a liquid limit greater than 65 percent. With respect to the proposed improvement project these subgrade conditions are further discussed in the following subsections.

5.1.2.1. Rock

Rock was not encountered at or close to subgrade elevation at the boring locations performed within the project limits. According to ODOT's GDM, if rock is encountered within 24 inches of the bottom of the proposed asphalt or concrete pavement, it is to be removed in accordance with Section 204.05 of the ODOT CMS and replaced with Item 204 Embankment.

5.1.2.2. Prohibited Soils

Prohibited soil types, as per the ODOT's GDM, including A-4b, A-2-5, A-7-5, A-8a, A-8b, and soils with liquid limits greater than 65, were not encountered within the subgrade of the project limits.

5.1.3. Unstable Soils

The GDM recommends subgrade stabilization for soils in which the N_{60} value of a particular soil sample (SS) at a referenced boring location is less than 12 bpf and in some cases less than 15 bpf (i.e., where moisture content is greater than optimum plus 3 percent). Based on the specific N_{60} value at the subject boring, *Figure B - Subgrade Stabilization* recommends a depth of subgrade stabilization for ODOT standard stabilization methods. For the purposes of this report the term 'weak soils' has been assumed to represent subgrade soils of these conditions. It should be noted that although a soil sample's N_{60} value

may meet the criteria to be considered a weak soil, the depth in which the weak soil is encountered in relation to the proposed subgrade is considered when each individual subgrade boring is analyzed. For example, if the subgrade analysis recommends excavating and replacing 12 inches within weak soil underlying 18 inches of stable material, it would be unreasonable to recommend the removal of both the stable and unstable material for a total of 30 inches of excavate and replace.

Based on N_{60} values encountered in the project borings, our subgrade analysis recommends excavation and replacement to depths of 12 inches to 15 inches at selected locations. Information on the boring location where weak soils were encountered and determined to have a potential impact on subgrade performance is shown in Table 6 below. Also included is the associated subgrade analysis recommended remediation depth at that location.

Table 6: Unstable (Weak) Soils Location Summary

Boring ID	Sample ID	N_{60}	Moisture Above Optimum (%)	Depth Below Subgrade (ft)	Remediation Depth (inches)
					Excavate and Replace (Item 204 w/ Geotextile)
Olentangy River Road					
B-001-0-23	SS-1	13	3	0.0 - 1.5	12
B-002-0-23	SS-1	7	1	0.0 - 1.5	15
B-005-0-23	SS-1	7	5	0.0 - 1.5	15
Jewett Road					
B-006-0-23	SS-1	8	3	0.0 - 1.5	12

It should be noted that *Figure B - Subgrade Stabilization* does not apply to soil types A-1-a, A-1-b, A-3, or A-3a, nor to soils with N_{60L} values of 15 or more. Per GDM guidance, *these soils should be reworked to stabilize the subgrade.*

5.1.3.1. High Moisture Content Soils

High moisture content soils are defined by the GDM as soils that exceed the estimated optimum moisture content (per *Figure A - Optimum Moisture Content*) for a given classification by 3 percent or more. According to the GDM, soils determined to be above the identified moisture content levels are a likely indicative of an unstable subgrade and may require some form of subgrade stabilization. Similar to our analysis of weak soils, although a soil sample's moisture content may meet the criteria to be considered high, the depth in which the high moisture soil is encountered in relation to the proposed subgrade is considered when each individual subgrade boring is analyzed for stabilization recommendations. Based on the subsurface exploration performed, a high moisture content soils within the proposed subgrade of the project were encountered in two borings as shown in Table 7 below.

Table 7: High Moisture Soils Summary

Boring ID	Sample ID	Moisture Content (%)	Optimum Moisture Content (%)	Moisture Above Optimum (%)	Depth Below Subgrade (ft)
Olentangy River Road					
B-001-0-23	SS-1	19	16	3	0.0 - 1.5
	SS-2	24	16	8	1.5 - 3.0
B-002-0-23	SS-2	21	16	5	1.5 - 3.0
B-005-0-23	SS-1	20	15	5	0.0 - 1.5
Jewett Road					
B-006-0-23	SS-1	17	14	3	0.0 - 1.5

5.2. Stabilization Recommendations

5.2.1. Subgrade Stabilization

Based on the results of our analysis, subgrade soils designated as “unstable” according to ODOT’s GDM were identified at various locations throughout the project, as mentioned in sections 5.1.2 and 5.1.3 of this report. Additionally, subgrade soils designated as “unstable” due to high moisture content were encountered in borings described in section 5.1.3.1 of this report. NEAS recommends local stabilization in the form of Item 204, Excavate and Replace with Geotextile, where unstable subgrade materials are encountered. Excavation limits and depths for each roadway which needs stabilization are summarized in Table 8 below. The excavated material should be replaced with Item 204, Granular Material Type C, following the guidelines Section 608, "Excavate and Replace (Item 204)" of ODOT GDM. Additionally, as per ODOT’s GDM, ‘For all other roadways, if it’s determined that 30 percent or more of the subgrade area must be stabilized, consider stabilizing the entire project (global stabilization).’ This consideration should include a cost analysis of the options. If the global stabilization is chosen, the project’s subgrade soils should be stabilized globally using Item 204 ‘Excavate and Replace’ to a depth of 12 inches for the entire project area. Stabilization limits should extend 18-inches beyond the edge of the proposed paved roadway, shoulder or median.

Table 8: Stabilization Recommendation Summary

Start Station	End Station	Excavate and Replace w/ Item 204[(1)] (inches)	Borings Considered
Olentangy River Road			
Begin	29+49	12	B-001-0-23
30+88	32+29	15	B-002-0-23
38+90	End	15	B-005-0-23
Jewett Road			
Begin	End	12	B-006-0-23

5.2.2. Chemical Stabilization

Another alternative is global chemical stabilization to a depth of 12 inches utilizing cement as the stabilization chemical. Designer should perform a cost analysis of the stabilization options using bid tabs. Generally, chemical stabilization is more economical when stabilizing large areas (approximately greater than 1 mile of roadway) per ODOT's GDM.

If chemical stabilization is selected as the method of subgrade stabilization, cement is recommended to be utilized as the stabilizing chemical for the referenced roadways as the subgrade soils consist primarily of moderately plastic silt combinations and guidance from ODOT's GDM states that " Cement may be used to stabilize unstable subgrades which have a Plasticity Index (PI) of 20 or less". Additionally, the chemical stabilization of the subgrade soils of the above referenced roadway should be performed to the recommended depths provided above and extend a minimum of 18-inches beyond the edge of the paved roadway, shoulder or median. The mix design should be conducted in accordance with ODOT's CMS Supplement 1120 (Mixture Design for Chemically Stabilized Soils). For design purposes it may be assumed that the cement addition will be 5% using the following formula.

$$\text{Cement: } C = 0.75 \times T \times 115 \times 0.05$$

Where:

C = amount of chemical in pounds / square yard and

T = thickness of the treatment zone in inches

A dry density of 115-pounds per cubic foot (pcf) is assumed.

It should be noted that per ODOT's GDM, *typical chemical stabilization equipment cannot stabilize areas less than 8 ft in width.* If it is anticipated that the project will require multiple maintenance of traffic phases, it is recommended that the roadway work is coordinated with the maintenance of traffic schemes in such a way that an 8-ft minimum width for chemical stabilization exists. If areas of less than 8 ft in width are anticipated, subgrade soils may be excavated out, mixed with stabilization chemical, and compacted in place, though this method is not practical for large areas.

5.3. Culvert Headwall Foundation Design

According to the site plan created by WSP USA, the existing 18'x7' box culvert carrying SR-315 over Bartholomew Run proposed structure is intended to extend approximately 23'-6" long from the outlet. The invert elevation at the proposed culvert outlet is at 759.04 ft amsl. A comprehensive review of the shallow foundation was conducted for the proposed outlet headwall and wingwall of the culvert.

5.3.1. Headwall/Wingwall Design Assumptions

For the design of the proposed culvert substructure, AASHTO's Publication LRFD Bridge Design Specifications, 9th Edition (AASHTO LRFD, 2020), ODOT's Bridge Design Manual (BDM) (ODOT GDM, 2023), ODOT's Geotechnical Design Manual (BDM) (ODOT GDM, 2023), and the project conditions dictate analysis parameters and design minimums/constraints are to be used in the analysis and design process. The referenced parameters and design minimums/constraints that where significant to our analyses consist of the following:

- Porous backfill is to be placed from back of the wall extending from top of footing elevation to top of earth backfill with a width not less than 2 feet.
- Retained soils behind the porous backfill are to consist of material placed and compacted in accordance with Item 203, Roadway Excavation and Embankment, of the ODOT Construction and Material Specifications (CMS).
- Retained fill soils will meet the minimum design soil parameters per ODOT's BDM Table 307-1 as shown in Table 9 below.

Table 9: Design Soil Parameters for Fill Materials

Type of Soil	Soil Unit Weight (pcf)	Friction Angle (°)	Cohesion (psf)
Granular Material Type B, per 703.16.C	120	30	0

5.3.2. Bearing Resistance

At the proposed culvert outlet location, bedrock was encountered at an elevation of 760.0 ft in boring B-002-0-92. According to the historical boring log of B-002-0-92, the bedrock was characterized as hard, gray, fine to medium grain, solid, fossiliferous limestone, with some upper zones displaying signs of breakage. Additionally, various fractures and joints, including horizontal, diagonal, and vertical orientations were observed in the rock cores. According to the site plan prepared by WSP USA, the bottom of the outlet footing is positioned at approximately 756.04 ft in elevation, which indicates that the footing will be embedded into the bedrock. Therefore, the bearing capacity should not pose any concerns at the culvert outlet location. The bearing resistance of the bedrock will significantly exceed the bearing pressure exerted by the headwall and the wingwall.

5.3.3. Global Stability

As the culvert headwall and wingwall footing will be embedded into the bedrock, there is no need to be concerned about global stability.

6. QUALIFICATIONS

The investigation was performed in accordance with accepted geotechnical engineering practice for the purpose of characterizing the subsurface and groundwater within the project limits. This report has been prepared for WSP USA and their design consultants to be used solely in evaluating the culvert extension, roadway subgrade, and pavement design parameter that will serve as the basis for development of design and construction of the roadway improvement project. The assessment of general site environmental conditions or the presence of pollutants in the soil, rock and groundwater of the site was beyond the scope of this geotechnical exploration. Our recommendations are based on the results of our field explorations, laboratory tests results from representative soil samples, and geotechnical engineering analyses. The results of the field explorations and laboratory tests, which form the basis of our recommendations, are presented in the appendices as noted. This report does not reflect any variations that may occur between the borings or elsewhere on the site, or variations whose nature and extent may not become evident until a later stage of construction. If any changes occur in the nature, design or location of the proposed roadway, the conclusions and recommendations contained in this report should not be considered valid until they are reviewed and have been modified or verified in writing by a geotechnical engineer.

It has been a pleasure to be of service to WSP USA in performing this geotechnical exploration for the DEL-315-00.86. Please call if there are any questions, or if we can be of further service.

Respectfully Submitted,

Chunmei (Melinda) He, Ph.D., P.E.
Geotechnical Engineer

Derar Tarawneh, Ph.D., E.I.
Staff Engineer

REFERENCES

FEMA. (2016). *National Flood Hazard Layer kmz v3.0.* Federal Emergency Management Agency.

ODGS. (1998). Physiographic regions of Ohio: Ohio Department of Natural Resources, Division of Geological Survey. page-size map with text, 2p., scale 1:2,100,00.

ODGS. (2003). Bedrock-topography data for Ohio: Ohio Department of Natural Resources, Division of Geological Survey Map BG-3, 1 CD-ROM, GIS file formats. Revised January 9, 2004.

ODNR [1]. (2016). Ohio Abandoned Mine Locator Interactive Map. *Mines of Ohio*. Ohio Department of Natural Resources, Division of Geological Survey & Division of Mineral Resources. Retrieved from https://gis.ohiodnr.gov/MapViewer/?config= OhioMines

ODNR [2]. (2016). Ohio Oil & Gas Locator Interactive Map. *Ohio Oil & Gas Wells*. Ohio Department of Natural Resources, Division of Oil and Gas. Retrieved from https://gis.ohiodnr.gov/MapViewer/?config= oilgaswells

ODOT [1]. (2023). *Geotechnical Design Manual.* Columbus, Ohio: Ohio Department of Transportation: Office of Geotechnical Engineering. Retrieved from https://www.dot.state.oh.us/Divisions/Engineering /Geotechnical/Geotechnical_Documents/GB1_Plan_Subgrades.pdf

ODOT. (2022). *Pavement Design Manual.* Columbus, Ohio: Ohio Department of Transportation: Office of Pavement Engineering. Retrieved from http://www.dot.state.oh.us/Divisions/Engineering/ Pavement/Pavement%20Design%20%20Rehabilitation%20Manual/Complete_PDM_2015-07-17_version.pdf

ODOT. (2023). *Specifications for Geotechnical Explorations.* Ohio Department of Transportation: Office of Geotechnical Engineering.

Pavey, R. R., Goldthwait, R. P., Brockman, C. S., Hull, D. N., Swinford, E. M., & Van Horn, R. G. (1999). Quarternary geology of Ohio: Ohio Department of Natural Resources, Division of Geological Survey Map M-2. 1:500,000-scale map and 1:250,000-scale GIS files.

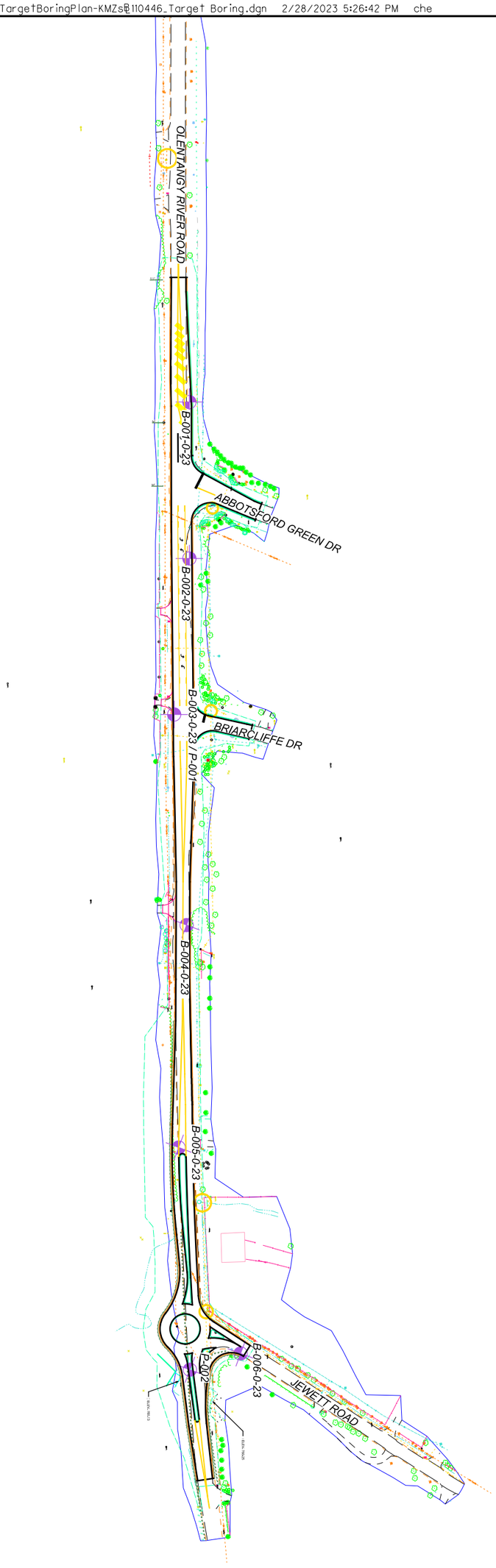
USDA. (2015, September). Web Soil Survey. Retrieved from http://websoilsurvey.nrcs.usda.gov

USGS & ODGS. (2006, June). Geologic Units of Ohio. *ohgeol.kmz*. United States Geologic Survey.

APPENDIX A

BORING LOCATION PLAN

P:\PROPOSALS\DEL-315-0.86 (Jewett Rd)_WSP\Geotechnical Fee Proposal\TargetBoringPlan-KMZs\110446_Target Boring.dgn 2/28/2023 5:26:42 PM che



0 0 / 0 0	DEL-315-0.86	TARGET BORING PLAN OLENTANGY RIVER ROAD	DRAWN CH CHECKED XXX	0 100 50 200 HORIZONTAL SCALE IN FEET	N


B-040-0-09
B-039-0-09
B-038-0-09
315
B-037-0-09
Orientangy River
B-002-0-92
B-001-0-92
127
Jewett Rd
Google Earth
1985
40°09'02.26" N 83°02'45.19" W elev 890 ft eye alt 1868 ft

APPENDIX B

BORING LOG

PROJECT: DEL-315-0.86	DRILLING FIRM / OPERATOR: NEAS / JL	DRILL RIG: CME 45B	STATION / OFFSET: 28+09, 15' LT.
TYPE: SUBGRADE	SAMPLING FIRM / LOGGER: NEAS / JL	HAMMER: CME AUTOMATIC	ALIGNMENT: SR-315
PID: 110446 SFN:	DRILLING METHOD: 4.00" FA	CALIBRATION DATE: 1/24/22	ELEVATION: 779.2 (MSL) EOB: 7.5 ft.
START: 9/13/23 END: 9/13/23	SAMPLING METHOD: SPT	ENERGY RATIO (%): 72.6	LAT / LONG: 40.144619, -83.041233

EXPLORATION ID B-001-0-23

PAGE 1 OF 1

MATERIAL DESCRIPTION AND NOTES	ELEV. 779.2	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
13.0" ASPHALT (DRILLERS DESCRIPTION)	778.1	1																	
VERY STIFF TO HARD, BROWN, **SILTY CLAY**, SOME SAND, TRACE TO SOME GRAVEL, DAMP TO MOIST		2	6 4 7	13	78	SS-1	3.75	8	9	12	41	30	38	21	17	19	A-6b (10)	53	
		3	4 5 4	11	83	SS-2	3.75	-	-	-	-	-	-	-	-	24	A-6b (V)	-	
		4	3 5 6	13	78	SS-3	4.00	23	15	8	30	24	35	19	16	13	A-6b (6)	-	
		5	3 4 6	12	89	SS-4	4.25	-	-	-	-	-	-	-	-	22	A-6b (V)	-	
	771.7	6 EOB																	
		7																	

NOTES: GROUNDWATER NOT ENCOUNTERED DURING DRILLING. HOLE DID NOT CAVE. DRILLED AS STAKED.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: PLACED 0.5 BAG ASPHALT PATCH; SHOVELED SOIL CUTTINGS

PROJECT: DEL-315-0.86	DRILLING FIRM / OPERATOR: NEAS / JL	DRILL RIG: CME 45B	STATION / OFFSET: 30+88, 13' LT.
TYPE: SUBGRADE	SAMPLING FIRM / LOGGER: NEAS / JL	HAMMER: CME AUTOMATIC	ALIGNMENT: SR-315
PID: 110446 SFN:	DRILLING METHOD: 4.00" FA	CALIBRATION DATE: 1/24/22	ELEVATION: 780.0 (MSL) EOB: 7.5 ft.
START: 9/13/23 END: 9/13/23	SAMPLING METHOD: SPT	ENERGY RATIO (%): 72.6	LAT / LONG: 40.145338, -83.041587

EXPLORATION ID B-002-0-23

PAGE 1 OF 1

MATERIAL DESCRIPTION AND NOTES	ELEV. 780.0	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
13.0" ASPHALT (DRILLERS DESCRIPTION)	778.9	1																	
VERY STIFF, BROWN, **SILTY CLAY**, LITTLE TO SOME GRAVEL, LITTLE SAND, DAMP TO MOIST	775.5	2	10 3 3	7	83	SS-1	2.50	25	9	10	32	24	37	20	17	17	A-6b (7)	40	
		3	3 4 5	11	72	SS-2	4.00	-	-	-	-	-	-	-	-	21	A-6b (V)	-	
HARD, BROWN, **SILT AND CLAY**, SOME GRAVEL, SOME SAND, DAMP	772.5	4	4 6 5	13	72	SS-3	4.25	31	20	10	22	17	31	17	14	10	A-6a (2)	-	
		5	4 5 4	11	89	SS-4	4.25	-	-	-	-	-	-	-	-	15	A-6a (V)	-	
		EOB 6 7																	

NOTES: GROUNDWATER NOT ENCOUNTERED DURING DRILLING. HOLE DID NOT CAVE. DRILLED AS STAKED.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: PLACED 0.5 BAG ASPHALT PATCH; SHOVELED SOIL CUTTINGS

PROJECT: DEL-315-0.86	DRILLING FIRM / OPERATOR: NEAS / JL	DRILL RIG: CME 45B	STATION / OFFSET: 33+69, 17' RT.	EXPLORATION ID B-003-0-23
TYPE: SUBGRADE	SAMPLING FIRM / LOGGER: NEAS / JL	HAMMER: CME AUTOMATIC	ALIGNMENT: SR-315	
PID: 110446 SFN:	DRILLING METHOD: 4.00" FA	CALIBRATION DATE: 1/24/22	ELEVATION: 780.1 (MSL) EOB: 6.1 ft.	PAGE 1 OF 1
START: 9/13/23 END: 9/13/23	SAMPLING METHOD: SPT	ENERGY RATIO (%): 72.6	LAT / LONG: 40.146085, -83.041851	

MATERIAL DESCRIPTION AND NOTES	ELEV. 780.1	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	SO4 ppm	BACK FILL
13.0" ASPHALT (DRILLERS DESCRIPTION)	779.0																		
DENSE TO VERY DENSE, GRAY AND BROWN, **STONE FRAGMENTS WITH SAND**, LITTLE SILT, TRACE CLAY, DAMP		1	18 22 13	42	78	SS-1	-	47	19	11	16	7	NP	NP	NP	7	A-1-b (0)	20	
		2																	
		3	13 18 22	48	83	SS-2	-	43	22	11	17	7	NP	NP	NP	7	A-1-b (0)	-	
		4																	
		5	16 50/4"	-	80	SS-3	-	-	-	-	-	-	-	-	-	6	A-1-b (V)	-	
	774.0	EOB 6																	
POSSIBLE ENCOUNTER WITH LIMESTONE COBBLE/BOULDER			50/1"	-	100	SS-4	-	-	-	-	-	-	-	-	-	1	A-1-b (V)	-	

NOTES: GROUNDWATER NOT ENCOUNTERED DURING DRILLING. HOLE DID NOT CAVE. DRILLED AS STAKED.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: PLACED 0.5 BAG ASPHALT PATCH; SHOVELED SOIL CUTTINGS

PROJECT: DEL-315-0.86	DRILLING FIRM / OPERATOR: NEAS / JL	DRILL RIG: CME 45B	STATION / OFFSET: 36+92, 10' LT.
TYPE: SUBGRADE	SAMPLING FIRM / LOGGER: NEAS / JL	HAMMER: CME AUTOMATIC	ALIGNMENT: SR-315
PID: 110446 SFN:	DRILLING METHOD: 4.00" FA	CALIBRATION DATE: 1/24/22	ELEVATION: 778.6 (MSL) EOB: 7.5 ft.
START: 9/13/23 END: 9/13/23	SAMPLING METHOD: SPT	ENERGY RATIO (%): 72.6	LAT / LONG: 40.146888, -83.042350

EXPLORATION ID B-004-0-23

PAGE 1 OF 1

MATERIAL DESCRIPTION AND NOTES	ELEV. 778.6	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
14.0" ASPHALT (DRILLERS DESCRIPTION)	777.4	1																	
MEDIUM DENSE, BROWN, **GRAVEL WITH SAND, SILT, AND CLAY**, DAMP	775.6	2	18 6 7	16	72	SS-1	-	-	-	-	-	-	-	-	-	12	A-2-6 (V)	33	
VERY STIFF, BROWN, **SILT AND CLAY**, SOME SAND, LITTLE TO SOME GRAVEL, DAMP	772.6	3 4 5 6	5 6 6	15	72	SS-2	4.00	24	17	16	22	21	35	20	15	17	A-6a (3)	-	
			3 3 4	8	78	SS-3	4.00	-	-	-	-	-	-	-	-	18	A-6a (V)	-	
MEDIUM DENSE, BROWN, **GRAVEL WITH SAND AND SILT**, LITTLE CLAY, MOIST	771.1	7 EOB	3 5 4	11	78	SS-4	-	31	18	17	22	12	NP	NP	NP	15	A-2-4 (0)	-	

NOTES: GROUNDWATER NOT ENCOUNTERED DURING DRILLING. HOLE DID NOT CAVE. DRILLED AS STAKED.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: PLACED 0.5 BAG ASPHALT PATCH; SHOVELED SOIL CUTTINGS

PROJECT: DEL-315-0.86	DRILLING FIRM / OPERATOR: NEAS / JL	DRILL RIG: CME 45B	STATION / OFFSET: 40+87, 7' RT.
TYPE: SUBGRADE	SAMPLING FIRM / LOGGER: NEAS / JL	HAMMER: CME AUTOMATIC	ALIGNMENT: SR-315
PID: 110446 SFN:	DRILLING METHOD: 4.00" FA	CALIBRATION DATE: 1/24/22	ELEVATION: 775.4 (MSL) EOB: 7.5 ft.
START: 9/13/23 END: 9/13/23	SAMPLING METHOD: SPT	ENERGY RATIO (%): 72.6	LAT / LONG: 40.147920, -83.042788

EXPLORATION ID B-005-0-23

MATERIAL DESCRIPTION AND NOTES	ELEV. 775.4	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
12.0" ASPHALT (DRILLERS DESCRIPTION)	774.4																		
VERY STIFF, BROWN AND DARK BROWN, **SILT AND CLAY**, LITTLE TO SOME SAND, LITTLE GRAVEL, DAMP	770.9	1 2 3 4	3 3 3 2 3 3	7	83	SS-1	2.75	17	5	13	41	24	33	20	13	20	A-6a (7)	47	
				7	89	SS-2	3.50	15	17	14	34	20	31	20	11	15	A-6a (4)	-	
VERY STIFF, BROWN, **CLAY**, SOME SILT, LITTLE SAND, TRACE GRAVEL, IRON STAINING, MOIST	769.4	5	3 3 3	7	67	SS-3	2.75	-	-	-	-	-	-	-	-	24	A-7-6 (V)	-	
LOOSE, BROWN, **GRAVEL WITH SAND, SILT, AND CLAY**, IRON STAINING, MOIST	767.9	6 7 EOB	3 1 3	5	39	SS-4	-	-	-	-	-	-	-	-	-	17	A-2-6 (V)	-	

NOTES: GROUNDWATER NOT ENCOUNTERED DURING DRILLING. HOLE DID NOT CAVE. DRILLED AS STAKED.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: PLACED 0.5 BAG ASPHALT PATCH; SHOVELED SOIL CUTTINGS

PROJECT: DEL-315-0.86	DRILLING FIRM / OPERATOR: NEAS / JL	DRILL RIG: CME 45B	STATION / OFFSET: 28+83, 11' LT.
TYPE: SUBGRADE	SAMPLING FIRM / LOGGER: NEAS / JL	HAMMER: CME AUTOMATIC	ALIGNMENT: CLP_JEWETT
PID: 110446 SFN:	DRILLING METHOD: 4.00" FA	CALIBRATION DATE: 1/24/22	ELEVATION: 775.9 (MSL) EOB: 7.5 ft.
START: 9/13/23 END: 9/13/23	SAMPLING METHOD: SPT	ENERGY RATIO (%): 72.6	LAT / LONG: 40.148911, -83.043708

EXPLORATION ID B-006-0-23

PAGE 1 OF 1

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
8.0" ASPHALT (DRILLERS DESCRIPTION)	775.2																		
VERY STIFF, BROWN AND ORANGISH BROWN, **SILT AND CLAY**, SOME SAND, LITTLE TO SOME GRAVEL, DAMP		1 2 3 4 5 6 7	4 3 4	8	67	SS-1	3.50	16	10	15	33	26	32	18	14	17	A-6a (6)	60	
			3 3 4	8	44	SS-2	4.00	25	17	14	24	20	34	19	15	15	A-6a (3)	-	
			2 3 6	11	61	SS-3	4.00	-	-	-	-	-	-	-	-	14	A-6a (V)	-	
	769.9																		
MEDIUM DENSE, BROWN, **GRAVEL WITH SAND AND SILT**, LITTLE CLAY, DAMP	768.4	EOB	5 6 9	18	67	SS-4	-	-	-	-	-	-	-	-	-	13	A-2-4 (V)	-	

NOTES: GROUNDWATER NOT ENCOUNTERED DURING DRILLING. HOLE DID NOT CAVE. DRILLED AS STAKED.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: PLACED 0.5 BAG ASPHALT PATCH; SHOVELED SOIL CUTTINGS

BBC&M JOB: 011-12121-T00

BBCM

PROJECT: DEL-315-0.86	DRILLING FIRM / OPERATOR: BBCM / M. WOLF	DRILL RIG: D50 AW RODS	STATION / OFFSET: 48+07.9, 9.9 RT
TYPE: ROADWAY	SAMPLING FIRM / LOGGER: BBCM / D. GODWIN	HAMMER: SAFETY HAMMER	ALIGNMENT: S.R. 315 CENTERLINE
PID: 78041 BR ID:	DRILLING METHOD: 3.25" HSA / NQ2	CALIBRATION DATE: 10/13/09	ELEVATION: 770.5 (MSL) EOB: 34.4 ft.
START: 10/26/09 END: 10/27/09	SAMPLING METHOD: SPT / NQ2	ENERGY RATIO (%): 83	COORD: 176466 N, 1516392 E

EXPLORATION ID **B-037-0-09**

PAGE 1 OF 2

MATERIAL DESCRIPTION AND NOTES	ELEV. 770.5	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
ASPHALT - 12 INCHES	769.5																	
Fill: Stiff to very-stiff brown and gray **SILTY CLAY**, little fine to coarse sand, trace fine to coarse gravel, few asphalt fragments, damp.	767.5		2 6 5	15	53	SS-1	1.7-2.2	-	-	-	-	-	-	-	-	18	A-6b (V)	
Possible Fill: Stiff brown **SILTY CLAY**, some fine sand, trace coarse sand, trace fine gravel, few roots, damp.			3 2 3	7	60	SS-2	1.2-1.5	1	4	31	42	22	33	16	17	19	A-6b (9)	
Loose brown **GRAVEL WITH SAND, SILT AND CLAY**, few roots, few limestone fragments, damp.	763.5		2 4 5	12	60	SS-3	1.0-1.5	-	-	-	-	-	-	-	-	23	A-6b (V)	
		AD	2 3 3	8	80	SS-4		14	36	27	13	10	31	19	12	16	A-2-6 (0)	
	759.5		2 3	-	100	SS-5A		-	-	-	-	-	-	-	-	22	A-6b (V)	
Stiff to very-stiff brown mottled with gray **SILTY CLAY**, little fine to coarse sand, trace fine gravel, few limestone fragments, few pockets of fine to coarse sand, damp.	758.2	TR	3 20	32	45	SS-5B		-	-	-	-	-	-	-	-	36	A-6b (V)	
SHALE, brown, severely weathered, few very thin limestone layers.	756.3	W	35 50/0.3"	-	50	SS-6		-	-	-	-	-	-	-	-	-	Rock (V)	
LIMESTONE, gray, moderately to slightly weathered, strong to very strong, medium to thick bedding, slightly crystalline, stylolitic, cherty, dolomitic, fossiliferous, slightly vuggy, fractured to intact, RQD=66%, REC=84%.			58		94	NQ2-7											CORE	
- Few small (1"-2") drops of core barrel were noted between 15.5' and 22.4'. - Lost water return at 27.4'.			75		90	NQ2-8											CORE	
			52		68	NQ2-9											CORE	

BBC&M JOB: 011-12121-T00

BBCM

PID: 78041	BR ID:	PROJECT: DEL-315-0.86	STATION / OFFSET: 48+07.9, 9.9 RT	START: 10/26/09	END: 10/27/09	PG 2 OF 2	B-037-0-09

MATERIAL DESCRIPTION AND NOTES	ELEV. 740.5	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
LIMESTONE, gray, moderately to slightly weathered, strong to very strong, medium to thick bedding, slightly crystalline, stylolitic, cherty, dolomitic, fossiliferous, slightly vuggy, fractured to intact, RQD=66%, REC=84%. *(continued)*			75		88	NQ2-10											CORE	
	736.1	EOB	71		100	NQ2-11											CORE	

- Encountered seepage at 11.4'.
- Encountered auger refusal at 14.4'.
- Groundwater measured at 10.5' in boring prior to coring.

NOTES: SEE ABOVE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: SOIL CUTTINGS

BBCM

PROJECT: DEL-315-0.86	DRILLING FIRM / OPERATOR: BBCM / M. WOLF	DRILL RIG: D50 AW RODS	STATION / OFFSET: 49+49.1, 5.0 RT	EXPLORATION ID: B-038-0-09
TYPE: ROADWAY	SAMPLING FIRM / LOGGER: BBCM / D. GODWIN	HAMMER: SAFETY HAMMER	ALIGNMENT: S.R. 315 CENTERLINE	
PID: 78041 BR ID:	DRILLING METHOD: 3.25" HSA / NQ2	CALIBRATION DATE: 10/13/09	ELEVATION: 772.9 (MSL) EOB: 27.1 ft.	PAGE: 1 OF 1
START: 10/29/09 END: 10/30/09	SAMPLING METHOD: SPT / NQ2	ENERGY RATIO (%): 83	COORD: 176588 N, 1818322 E	

MATERIAL DESCRIPTION AND NOTES	ELEV. 772.9	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CB	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	MON. WELL
ASPHALT - 12 INCHES	771.9																	
Fill: Very-stiff to hard brown and reddish-brown **SILTY CLAY**, little to some fine to coarse sand, trace fine to coarse gravel, few limestone fragments, damp.			22 10 5	21	33	SS-1	4.0-4.5+	-	-	-	-	-	-	-	-	17	A-6b (V)	
			2 3 5	11	80	SS-2	3.7-4.0	6	12	17	35	30	38	20	18	15	A-6b (9)	
	766.4		2	-	100	SS-3A	3.5-4.2+	-	-	-	-	-	-	-	-	22	A-6b (V)	
Dense to very-dense brown and gray **GRAVEL** (shale and limestone fragments), little to some fine to coarse sand, trace silt, dry.	764.4		10 31	57	33	SS-3B		-	-	-	-	-	-	-	-	-	A-1-a (V)	
LIMESTONE, brown and gray, slightly to moderately weathered, moderately strong to strong, laminated to thin bedding, cherty, slight hydrocarbon odor, contains zones with numerous shale partings, fractured to moderately fractured, RQD=12%, REC=84%.		TR	50/0.1"	-	100	SS-4		-	-	-	-	-	-	-	-	-	Rock (V)	
		▼ 46 days	24		86	NQ2-5											CORE	
- Lost water circulation between 12.1' and 13.6'. - Q_u = 7,834 psi (Depth=9.0' to 9.5')																		
	757.2		23		87	NQ2-6											CORE	
LIMESTONE, gray, slightly weathered, strong to very strong, thick to very thick bedding, slightly crystalline, fossiliferous, stylolitic, moderately to slightly fractured, RQD=88%, REC=97%.																		
- Lost water return between 17.1' and 17.7'. - Lost water return below 23.5'. - Core barrel dropped from 23.5' to 24.5'.			93		100	NQ2-7											CORE	
- Q_u = 15,771 psi (Depth=16.4' to 16.9') - Q_u = 15,847 psi (Depth=19.9' to 20.4')																		
	745.8	EOB	80		93	NQ2-8											CORE	

- Encountered auger refusal at 8.6'
- No seepage noted prior to rock coring.
- Installed groundwater monitoring well.

NOTES: SEE ABOVE.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: MONITORING WELL

BBC&M JOB: 011-12121-T00

BBCM

PROJECT: DEL-315-0.86	DRILLING FIRM / OPERATOR: BBCM / M. WOLF	DRILL RIG: D50 AW RODS	STATION / OFFSET: 50+99.5, 5.1 RT	EXPLORATION ID B-039-0-09
TYPE: ROADWAY	SAMPLING FIRM / LOGGER: BBCM / D. GODWIN	HAMMER: SAFETY HAMMER	ALIGNMENT: S.R. 315 CENTERLINE	
PID: 78041 BR ID:	DRILLING METHOD: 3.25" HSA / NQ2	CALIBRATION DATE: 10/13/09	ELEVATION: 776.2 (MSL) EOB: 26.1 ft.	PAGE 1 OF 1
START: 10/27/09 END: 10/28/09	SAMPLING METHOD: SPT / NQ2	ENERGY RATIO (%): 83	COORD: 176728 N, 1816269 E	

MATERIAL DESCRIPTION AND NOTES	ELEV. 776.2	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
ASPHALT - 12 INCHES	775.2																	
Fill: Dense brown **GRAVEL WITH SAND**, little silt, trace clay, few limestone fragments, dry.	773.2		28 22 9	43	67	SS-1		42	23	11	17	7	-	-	-	6	A-1-b (V)	
Possible Fill: Very-dense **GRAVEL** (fragmented limestone), little to some fine to coarse sand, trace silt, dry.	770.2		50-0.3'	-	100	SS-2		-	-	-	-	-	-	-	-	8	A-1-a (V)	
LIMESTONE, gray, moderately to highly weathered, strong to very strong, medium to thick bedding, fractured, RQD=0%, REC=40%.		TR	50-0.1'	-	100	SS-3		-	-	-	-	-	-	-	-	8	Rock (V)	
			0		58	NQ2-4											CORE	
- Few small (1"- 2") drops of core barrel were noted between 6.1' and 12.8'.			0		33	NQ2-5											CORE	
LIMESTONE, brown and gray, moderately to slightly weathered, moderately to very strong, laminated to thin bedding, cherty, slight hydrocarbon odor, numerous shale partings, moderately to highly fractured, RQD=26%, REC=93%.	763.4		23		93	NQ2-6											CORE	
-Lost water return at 13.5'. - Q_u = 20,006 psi (Depth=15.3' to 15.8')																		
LIMESTONE, gray, slightly weathered, strong to very strong, laminated to thick bedding, fossiliferous, slightly crystalline, few shale partings, RQD=65%, REC=79%.	756.3		62		95	NQ2-7											CORE	
	750.1	EOB	54		69	NQ2-8											CORE	

- Encountered auger refusal at 6.1'.
- No seepage noted prior to coring.
- Lost water return below 13.5'.

NOTES: SEE ABOVE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: SOIL CUTTINGS

BBC&M JOB: 011-I2121-T00

BBCM

PROJECT: DEL-315-0.86	DRILLING FIRM / OPERATOR: BBCM / M. WOLF	DRILL RIG: D50 AW RODS	STATION / OFFSET: 52+99.5, 4.9 RT	EXPLORATION ID B-040-0-09
TYPE: ROADWAY	SAMPLING FIRM / LOGGER: BBCM / D. GODWIN	HAMMER: SAFETY HAMMER	ALIGNMENT: S.R. 315 CENTERLINE	
PID: 78041 BR ID:	DRILLING METHOD: 3.25" HSA / NQ2	CALIBRATION DATE: 10/13/09	ELEVATION: 776.1 (MSL) EOB: 25.0 ft.	PAGE 1 OF 1
START: 10/28/09 END: 10/29/09	SAMPLING METHOD: SPT / NQ2	ENERGY RATIO (%): 83	COORD: 176921 N, 1816217 E	

MATERIAL DESCRIPTION AND NOTES	ELEV. 776.1	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
ASPHALT - 12 INCHES	775.1																	
Fill: Dense brown **GRAVEL WITH SAND,** little silt, trace clay, few limestone fragments, dry.	773.1		22 19 9	39	67	SS-1		52	14	10	16	8	-	-	-	6	A-1-b (V)	
Fill: Very-stiff brown and gray **CLAY,** little fine to coarse sand, trace fine to coarse gravel, damp.	772.2		3	-	100	SS-2A	2.5	-	-	-	-	-	45	22	23	25	A-7-6 (V)	
		TR	15 50/0.1'	-	100	SS-2B	2.7	-	-	-	-	-	-	-	-	-	Rock (V)	
LIMESTONE, brown, moderately weathered, moderately strong to strong, thick bedding, cherty, fractured to moderately fractured, few vertical fractures, few shale laminations, RQD=5%, REC=94%.	764.3		0		87	NQ2-3											CORE	
			8		100	NQ2-4											CORE	
LIMESTONE, gray, slightly to moderately weathered, strong to very strong, thick to very thick bedding, cherty, fossiliferous, slightly crystalline, stylolitic, few shale laminations, RQD=75%, REC=91%.			68		90	NQ2-5											CORE	
			78		100	NQ2-6											CORE	
	751.1	EOB	79		83	NQ2-7											CORE	

- Encountered auger refusal at 5.0'.
- No seepage noted prior to rock coring.

NOTES: SEE ABOVE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: SOIL CUTTINGS

ODOT LOG (8.5 X 11) - CURRENT - OH DOT.GDT 3/18/10 14:55 - G:\SKETCHPRO_EC\I2121-T00.GPJ

MASON-deVERTEUIL GEOTECHNICAL SERVICES, 6035 HUNTLEY ROAD, COLUMBUS, OHIO 43229, 614/888-0576

Client: Dodson-Lindblom Associates, Inc.

Project: Bridge DEL-315-0087 over Bartholomew Run

M-V Job No 91229

LOG OF Boring B-1

Location: Sta 45+62, 7.8' left of c

Date Drilled: 8-21-91

WATER OBSERVATIONS: Water seepage at: None
Water level at completion: 2.9' (within hollow stem)
3.1' (with hollow stem removed)

DEPTH in feet	ELEVATION in feet	PENETRATION Blows per 6"	RECOVERY in inches	SAMPLE NO. DRIVE	SAMPLE NO. PRESS	HAND PENETROMETER (tsf)	DESCRIPTION	% Agg.	% C.S.	% M.S.	% F.S.	% Silt	% Clay
0	772.6						Asphaltic concrete thickness - 13"						
							Aggregate base - 10"						
1.9	770.7	50	3	1		—	FILL: Very dense, gray limestone fragments						
3.5	769.1	12 15 16	10	2		—	Possible FILL: Very stiff, brown SILTY CLAY (A-6a), some fine to coarse sand, trace gravel; damp						
5													
6.0	766.6	9 13 17	10	3		4.5+	Hard, brown SILTY CLAY (A-6a), some fine to coarse sand, little gravel; damp	5	17	—	18	32	28
							@ 8.5' - 9.2', with numerous limestone fragments						
9.2	763.4	20 50 ②	5	4			Auger refusal @ 9.0'						
10		CORE 72"	REC 71"	RQD 52%			LIMESTONE, gray, hard, fine to medium grain, thick-bedded, solid, horizontal fractures and joints throughout (most of horizontal fractures caused by coring)						
							@ 10.7' - 19.2', fossiliferous						
15		CORE 44"	REC 44"	RQD 75%									
19.2	753.4						Bottom of Boring - 19.2'						
20													

Notes:
Used hollow stem augers - 0.0' - 9.0'
Used NX core barrel - 9.0' - 19.2'

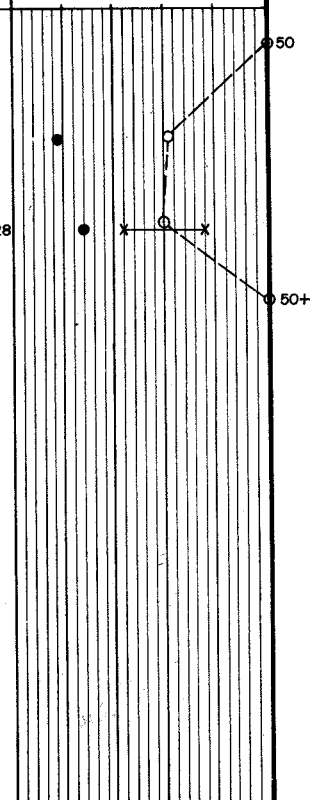
STANDARD PENETRATION (N) Blows per foot

10 20 30 40

MOISTURE CONTENT - %

PL Natural LL

10 20 30 40



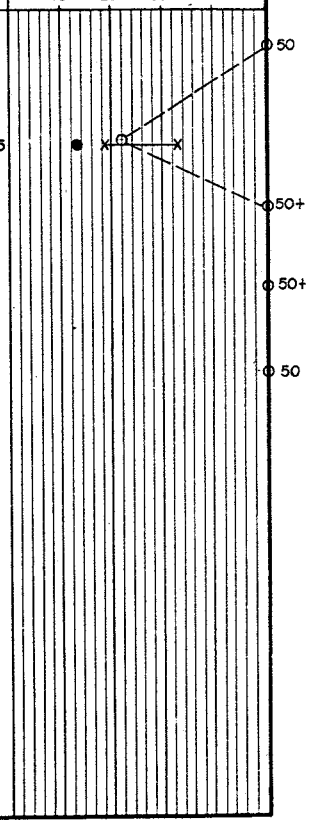
MASON-deVERTEUIL GEOTECHNICAL SERVICES, 6035 HUNTLEY ROAD, COLUMBUS, OHIO 43229, 614/888-0576

Client: Dodson-Lindblom Associates, Inc. | Project: Bridge DEL-315-0087 over Bartholomew Run | M-V Job No. 91229

LOG OF Boring B-2 | Location: Sta 46+04, 7.7' right of ℄ | Date Drilled: 8-21-91

WATER OBSERVATIONS: Water seepage at: None
Water level at completion: 8.0' (within hollow stem)
8.5' (with hollow stem removed)

DEPTH in feet	ELEVATION in feet	PENETRATION Blows per 6"	RECOVERY in inches	SAMPLE NO. DRIVE	SAMPLE NO. PRESS	HAND PENETROMETER (tsf)	DESCRIPTION	% Agg.	% C.S.	% M.S.	% F.S.	% Silt	% Clay	STANDARD PENETRATION (N) Blows per foot (10 20 30 40)	MOISTURE CONTENT - % PL Natural LL (10 20 30 40)
0	771.8						Asphaltic concrete thickness - 16" Aggregate base thickness - 9"								
2.1	769.7	50 (3)	3	1			FILL: Asphalt fragments								
3.5	768.3	9 12 10	8	2		4.5	Hard, brown SILTY CLAY (A-6a), some fine to coarse sand, little gravel; contains limestone fragments; damp	8	14	—	21	32	25		
5.7	766.1	31 50 (3)	3	3			Very dense, gray LIMESTONE fragments (highly weathered limestone bedrock, in-place)								
10		50 (3)	1	4											
11.8	760.0	50	2	5			Auger refusal @ 11.8'								
15		CORE 42"	REC 41"	RQD 23%			LIMESTONE, gray, hard, fine grain, thick bedded, solid, horizontal fractures and joints common (most of horizontal fractures caused by coring) @ 11.8' - 12.1', and 14.3' - 15.3', badly broken @ 12.1' - 21.8', fossiliferous @ 15.7', 0.05' thick clay seam								
		CORE 55"	REC 55"	RQD 56%											
20		CORE 23"	REC 20"	RQD 87%			@ 20.5', black lamination								
21.8	750.0						Bottom of Boring - 21.8'								
25							Notes: Used hollow stem augers - 0.0' - 11.8' Used NX core barrel - 11.8' - 21.8'								



APPENDIX C

GEOTECHNICAL SUBGRADE ANALYSIS SPREADSHEETS

ENTIRE PROJECT

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.)

DEL-315-0.86
110446

Roadway improvement , replacement the culver headwall located at the intersection between Jewett Rd and Olentangy river road- Entire Project

NEAS, INC

Prepared By: Derar M Tarawneh
Date prepared: Tuesday, September 26, 2023

Chunmei (Melinda) He, Ph.D., P.E.
2800 Corporate Exchange Drive
Suite 240
Columbus, OH 43231
614.714.0299 Ext 111
che@neasinc.com

NO. OF BORINGS: 6

#	Boring ID	Alignment	Station	Offset	Dir	Drill Rig	ER	Boring EL.	Proposed Subgrade EL	Cut Fill
1	B-001-0-23	Olentangy Rd/ SR315	28+09	15	Lt	CME 45B	73	779.2	777.7	1.5 C
2	B-002-0-23	Olentangy Rd/ SR315	30+88	13	Lt	CME 45B	73	780.0	778.5	1.5 C
3	B-003-0-23	Olentangy Rd/ SR315	33+69	17	Rt	CME 45B	73	780.1	778.6	1.5 C
4	B-004-0-23	Olentangy Rd/ SR315	36+92	10	Lt	CME 45B	73	778.6	777.1	1.5 C
5	B-005-0-23	Olentangy Rd/ SR315	40+87	7	Rt	CME 45B	73	775.4	773.9	1.5 C
6	B-006-0-23	Jewett Road	28+83	11	Lt	CME 45B	73	775.9	774.4	1.5 C

OHIO DEPARTMENT OF TRANSPORTATION

Subgrade Analysis

V. 14.6 2/11/2022

#	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	1.5	3.0	0.0	1.5	13		3.75	38	21	17	41	30	71	19	16	A-6b	10	53		N_{60} & Mc		**12"**	
	001-0	SS-2	3.0	4.5	1.5	3.0	11		3.75							24	16	A-6b	16			N_{60} & Mc			
	23	SS-3	4.5	6.0	3.0	4.5	13		4	35	19	16	30	24	54	13	16	A-6b	6						
		SS-4	6.0	7.5	4.5	6.0	12	11	4.25							22	16	A-6b	16						
2	B	SS-1	1.5	3.0	0.0	1.5	7		2.5	37	20	17	32	24	56	17	16	A-6b	7	40		N_{60}		**15"**	
	002-0	SS-2	3.0	4.5	1.5	3.0	11		4							21	16	A-6b	16			N_{60} & Mc			
	23	SS-3	4.5	6.0	3.0	4.5	13		4.25	31	17	14	22	17	39	10	14	A-6a	2						
		SS-4	6.0	7.5	4.5	6.0	11	7	4.25							15	14	A-6a	10						
3	B	SS-1	1.5	3.0	0.0	1.5	42			NP	NP	NP	16	7	23	7	6	A-1-b	0	20					
	003-0	SS-2	3.0	4.5	1.5	3.0	48			NP	NP	NP	17	7	24	7	6	A-1-b	0						
	23	SS-3	4.5	5.5	3.0	4.0	50									6	6	A-1-b	0						
		SS-4	6.0	6.1	4.5	4.6	50	30								1	6	A-1-b	0						
4	B	SS-1	1.5	3.0	0.0	1.5	16									12	10	A-2-6	4	33					
	004-0	SS-2	3.0	4.5	1.5	3.0	15		4	35	20	15	22	21	43	17	15	A-6a	3						
	23	SS-3	4.5	6.0	3.0	4.5	8		4							18	14	A-6a	10						
		SS-4	6.0	7.5	4.5	6.0	11	8		NP	NP	NP	22	12	34	15	10	A-2-4	0						
5	B	SS-1	1.5	3.0	0.0	1.5	7		2.75	33	20	13	41	24	65	20	15	A-6a	7	47		N_{60} & Mc		**15"**	
	005-0	SS-2	3.0	4.5	1.5	3.0	7		3.5	31	20	11	34	20	54	15	15	A-6a	4			N_{60}			
	23	SS-3	4.5	6.0	3.0	4.5	7		2.75							24	18	A-7-6	16						
		SS-4	6.0	7.5	4.5	6.0	5	5								17	10	A-2-6	4						
6	B	SS-1	1.5	3.0	0.0	1.5	8		3.5	32	18	14	33	26	59	17	14	A-6a	6	60		N_{60} & Mc		**12"**	
	006-0	SS-2	3.0	4.5	1.5	3.0	8		4	34	19	15	24	20	44	15	14	A-6a	3			N_{60}			
	23	SS-3	4.5	6.0	3.0	4.5	11		4							14	14	A-6a	10						
		SS-4	6.0	7.5	4.5	6.0	18	8								13	10	A-2-4	0						

PID: 110446

County-Route-Section: DEL-315-0.86

No. of Borings: 6

Geotechnical Consultant: NEAS, INC

Prepared By: Derar M Tarawneh

Date prepared: 9/26/2023

Chemical Stabilization Options		
320	Rubblize & Roll	No
206	Cement Stabilization	Option
	Lime Stabilization	No
206	Depth	12''

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

Design CBR	7

% Samples within 6 feet of subgrade			
$N_{60} \leq 5$	4%	HP ≤ 0.5	0%
$N_{60} < 12$	54%	0.5 < HP ≤ 1	0%
$12 \leq N_{60} < 15$	17%	1 < HP ≤ 2	0%
$N_{60} \geq 20$	17%	HP > 2	67%
M+	21%		
Rock	0%		
Unsuitable	0%		

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

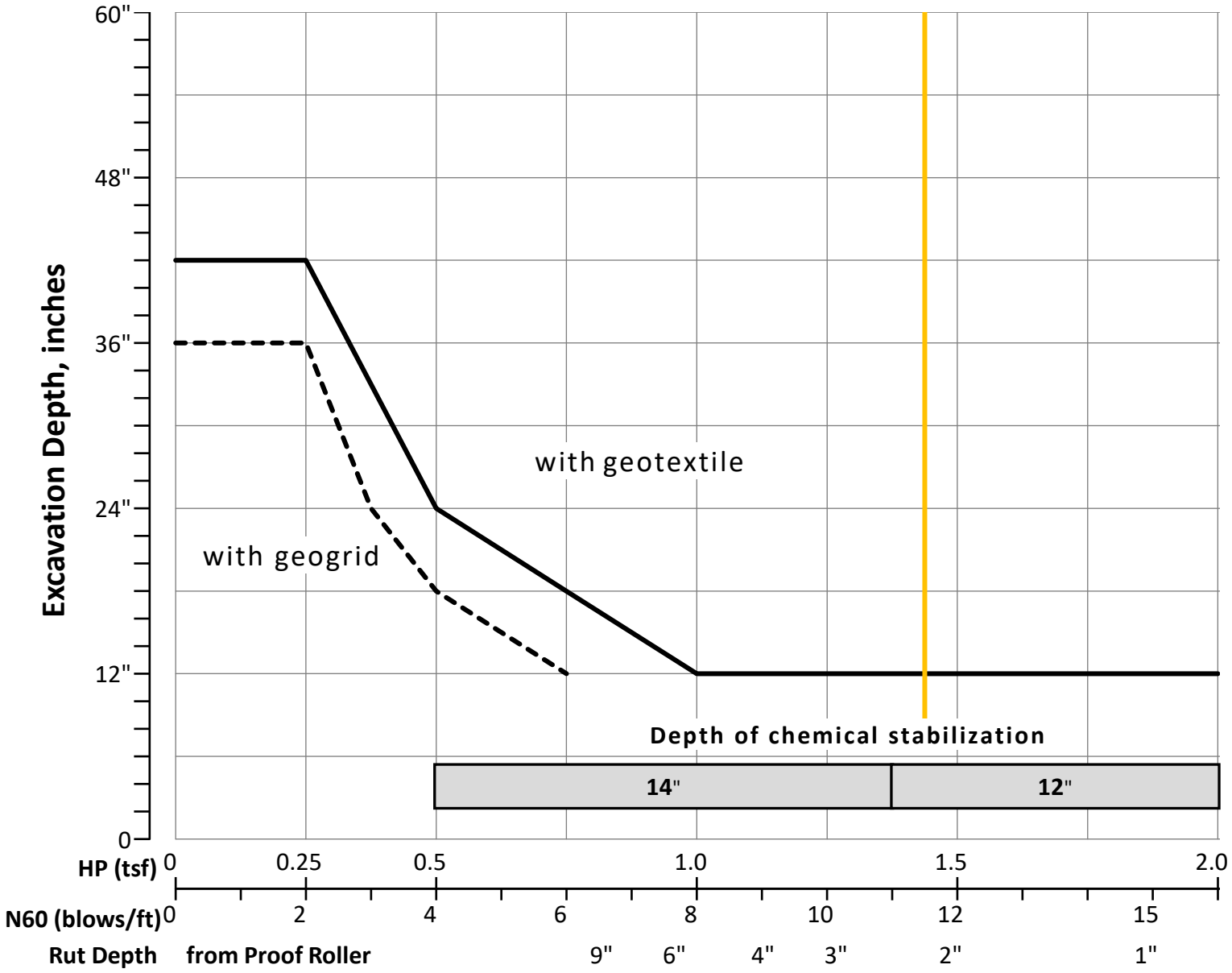
% Proposed Subgrade Surface	
Unstable & Unsuitable	67%
Unstable	67%
Unsuitable	0%

	N_{60}	N_{60L}	HP	LL	PL	PI	Silt	Clay	P 200	M_C	M_{OPT}	GI
Average	17	12	3.70	34	19	15	28	19	47	15	13	6
Maximum	50	30	4.25	38	21	17	41	30	71	24	18	16
Minimum	5	5	2.50	31	17	11	16	7	23	1	6	0

Classification Counts by Sample

ODOT Class	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	4	2	0	2	0	0	0	0	0	0	9	6	0	1	0	0	24
Percent	0%	0%	17%	8%	0%	8%	0%	0%	0%	0%	0%	0%	38%	25%	0%	4%	0%	0%	100%
% Rock|Granular|Cohesive	0%	33%									67%								100%
Surface Class Count	0	0	2	0	0	1	0	0	0	0	0	0	5	4	0	0	0	0	12
Surface Class Percent	0%	0%	17%	0%	0%	8%	0%	0%	0%	0%	0%	0%	42%	33%	0%	0%	0%	0%	100%

Fig. 600-1 – Subgrade Stabilization



OVERRIDE TABLE

Calculated Average	New Values	Check to Override
3.70	0.50	☐ HP
11.50	6.00	☐ N60L

Average HP
Average N_{60L}

OLENTANGY RIVER ROAD / SR 315

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.)

DEL-315-0.86
110446

Roadway improvement , replacement the culver headwall located at the intersection between Jewett Rd and Olentangy river road- Olentangy Rd/SR 315

NEAS, INC

Prepared By: Derar M Tarawneh
Date prepared: Tuesday, September 26, 2023

Chunmei (Melinda) He, Ph.D., P.E.
2800 Corporate Exchange Drive
Suite 240
Columbus, OH 43231
614.714.0299 Ext 111
che@neasinc.com

NO. OF BORINGS: 5

#	Boring ID	Alignment	Station	Offset	Dir	Drill Rig	ER	Boring EL.	Proposed Subgrade EL	Cut Fill
1	B-001-0-23	Olentangy Rd/ SR315	28+09	15	Lt	CME 45B	73	779.2	777.7	1.5 C
2	B-002-0-23	Olentangy Rd/ SR315	30+88	13	Lt	CME 45B	73	780.0	778.5	1.5 C
3	B-003-0-23	Olentangy Rd/ SR315	33+69	17	Rt	CME 45B	73	780.1	778.6	1.5 C
4	B-004-0-23	Olentangy Rd/ SR315	36+92	10	Lt	CME 45B	73	778.6	777.1	1.5 C
5	B-005-0-23	Olentangy Rd/ SR315	40+87	7	Rt	CME 45B	73	775.4	773.9	1.5 C

OHIO DEPARTMENT OF TRANSPORTATION

Subgrade Analysis

V. 14.6 2/11/2022

#	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	1.5	3.0	0.0	1.5	13		3.75	38	21	17	41	30	71	19	16	A-6b	10	53		N_{60} & Mc		**12"**	
	001-0	SS-2	3.0	4.5	1.5	3.0	11		3.75							24	16	A-6b	16			N_{60} & Mc			
	23	SS-3	4.5	6.0	3.0	4.5	13		4	35	19	16	30	24	54	13	16	A-6b	6						
		SS-4	6.0	7.5	4.5	6.0	12	11	4.25							22	16	A-6b	16						
2	B	SS-1	1.5	3.0	0.0	1.5	7		2.5	37	20	17	32	24	56	17	16	A-6b	7	40		N_{60}		**15"**	
	002-0	SS-2	3.0	4.5	1.5	3.0	11		4							21	16	A-6b	16			N_{60} & Mc			
	23	SS-3	4.5	6.0	3.0	4.5	13		4.25	31	17	14	22	17	39	10	14	A-6a	2						
		SS-4	6.0	7.5	4.5	6.0	11	7	4.25							15	14	A-6a	10						
3	B	SS-1	1.5	3.0	0.0	1.5	42			NP	NP	NP	16	7	23	7	6	A-1-b	0	20					
	003-0	SS-2	3.0	4.5	1.5	3.0	48			NP	NP	NP	17	7	24	7	6	A-1-b	0						
	23	SS-3	4.5	5.5	3.0	4.0	50									6	6	A-1-b	0						
		SS-4	6.0	6.1	4.5	4.6	50	30								1	6	A-1-b	0						
4	B	SS-1	1.5	3.0	0.0	1.5	16									12	10	A-2-6	4	33					
	004-0	SS-2	3.0	4.5	1.5	3.0	15		4	35	20	15	22	21	43	17	15	A-6a	3						
	23	SS-3	4.5	6.0	3.0	4.5	8		4							18	14	A-6a	10						
		SS-4	6.0	7.5	4.5	6.0	11	8		NP	NP	NP	22	12	34	15	10	A-2-4	0						
5	B	SS-1	1.5	3.0	0.0	1.5	7		2.75	33	20	13	41	24	65	20	15	A-6a	7	47		N_{60} & Mc		**15"**	
	005-0	SS-2	3.0	4.5	1.5	3.0	7		3.5	31	20	11	34	20	54	15	15	A-6a	4			N_{60}			
	23	SS-3	4.5	6.0	3.0	4.5	7		2.75							24	18	A-7-6	16						
		SS-4	6.0	7.5	4.5	6.0	5	5								17	10	A-2-6	4						

PID: 110446

County-Route-Section: DEL-315-0.86

No. of Borings: 5

Geotechnical Consultant: NEAS, INC

Prepared By: Derar M Tarawneh

Date prepared: 9/26/2023

Chemical Stabilization Options		
320	Rubblize & Roll	Option
206	Cement Stabilization	Option
	Lime Stabilization	No
206	Depth	12''

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

Design CBR	7

% Samples within 6 feet of subgrade			
$N_{60} \leq 5$	5%	HP ≤ 0.5	0%
$N_{60} < 12$	50%	0.5 < HP ≤ 1	0%
$12 \leq N_{60} < 15$	20%	1 < HP ≤ 2	0%
$N_{60} \geq 20$	20%	HP > 2	65%
M+	20%		
Rock	0%		
Unsuitable	0%		

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

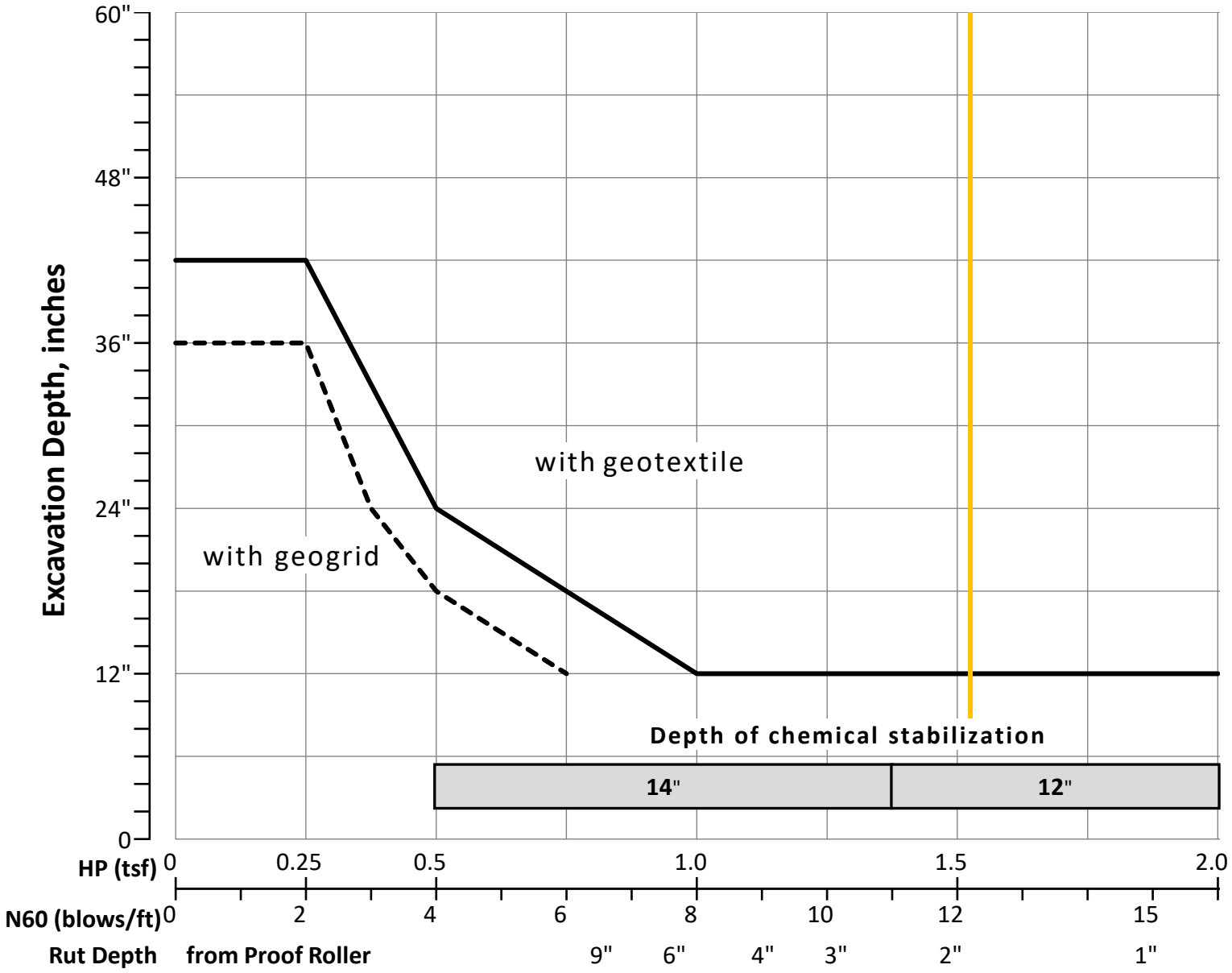
% Proposed Subgrade Surface	
Unstable & Unsuitable	60%
Unstable	60%
Unsuitable	0%

	N_{60}	N_{60L}	HP	LL	PL	PI	Silt	Clay	P 200	M_C	M_{OPT}	GI
Average	18	12	3.67	34	20	15	28	19	46	15	13	7
Maximum	50	30	4.25	38	21	17	41	30	71	24	18	16
Minimum	5	5	2.50	31	17	11	16	7	23	1	6	0

Classification Counts by Sample

ODOT Class	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	4	1	0	2	0	0	0	0	0	0	6	6	0	1	0	0	20
Percent	0%	0%	20%	5%	0%	10%	0%	0%	0%	0%	0%	0%	30%	30%	0%	5%	0%	0%	100%
% Rock|Granular|Cohesive	0%	35%									65%								100%
Surface Class Count	0	0	2	0	0	1	0	0	0	0	0	0	3	4	0	0	0	0	10
Surface Class Percent	0%	0%	20%	0%	0%	10%	0%	0%	0%	0%	0%	0%	30%	40%	0%	0%	0%	0%	100%

Fig. 600-1 – Subgrade Stabilization



OVERRIDE TABLE

Calculated Average	New Values	Check to Override
3.67	0.50	☐ HP
12.20	6.00	☐ N60L

Average HP
Average N_{60L}

JEWETT ROAD

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.)

DEL-315-0.86
110446

Roadway improvement , replacement the culver headwall located at the intersection between Jewett Rd and Olentangy river road- Jewett Road

NEAS, INC

Prepared By: Derar M Tarawneh
Date prepared: Tuesday, September 26, 2023

Chunmei (Melinda) He, Ph.D., P.E.
2800 Corporate Exchange Drive
Suite 240
Columbus, OH 43231
614.714.0299 Ext 111
che@neasinc.com

NO. OF BORINGS: 1

#	Boring ID	Alignment	Station	Offset	Dir	Drill Rig	ER	Boring EL.	Proposed Subgrade EL	Cut Fill
1	B-006-0-23	Jewett Road	28+83	11	Lt	CME 45B	73	775.9	774.4	1.5 C

OHIO DEPARTMENT OF TRANSPORTATION

Subgrade Analysis

V. 14.6 2/11/2022

#	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 006-0 23	SS-1	1.5	3.0	0.0	1.5	8		3.5	32	18	14	33	26	59	17	14	A-6a	6	60		N_{60} & Mc		12"	
		SS-2	3.0	4.5	1.5	3.0	8		4	34	19	15	24	20	44	15	14	A-6a	3			N_{60}			
		SS-3	4.5	6.0	3.0	4.5	11		4							14	14	A-6a	10						
		SS-4	6.0	7.5	4.5	6.0	18	8								13	10	A-2-4	0						

PID: 110446

County-Route-Section: DEL-315-0.86

No. of Borings: 1

Geotechnical Consultant: NEAS, INC

Prepared By: Derar M Tarawneh

Date prepared: 9/26/2023

Chemical Stabilization Options		
320	Rubblize & Roll	No
206	Cement Stabilization	Option
	Lime Stabilization	No
206	Depth	14''

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

Design CBR	8

% Samples within 6 feet of subgrade			
$N_{60} \leq 5$	0%	HP ≤ 0.5	0%
$N_{60} < 12$	75%	0.5 < HP ≤ 1	0%
$12 \leq N_{60} < 15$	0%	1 < HP ≤ 2	0%
$N_{60} \geq 20$	0%	HP > 2	75%
M+	25%		
Rock	0%		
Unsuitable	0%		

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

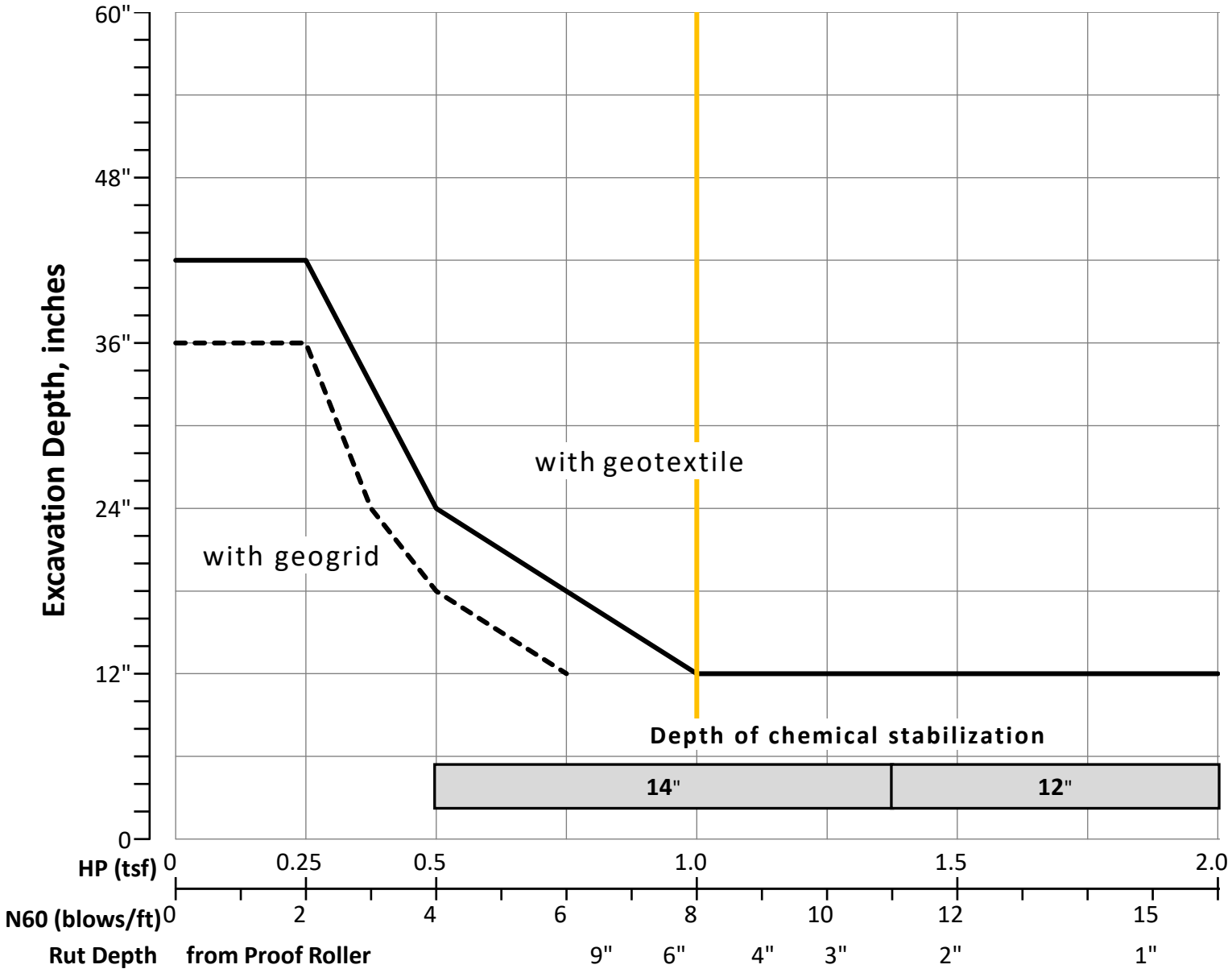
% Proposed Subgrade Surface	
Unstable & Unsuitable	100%
Unstable	100%
Unsuitable	0%

	N_{60}	N_{60L}	HP	LL	PL	PI	Silt	Clay	P 200	M_C	M_{OPT}	GI
Average	11	8	3.83	33	19	15	29	23	52	15	13	5
Maximum	18	8	4.00	34	19	15	33	26	59	17	14	10
Minimum	8	8	3.50	32	18	14	24	20	44	13	10	0

Classification Counts by Sample

ODOT Class	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	0	0	3	0	0	0	0	0	4
Percent	0%	0%	0%	25%	0%	0%	0%	0%	0%	0%	0%	0%	75%	0%	0%	0%	0%	0%	100%
% Rock|Granular|Cohesive	0%	25%									75%								100%
Surface Class Count	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	2
Surface Class Percent	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	100%	0%	0%	0%	0%	0%	100%

Fig. 600-1 – Subgrade Stabilization



OVERRIDE TABLE

Calculated Average	New Values	Check to Override
3.83	0.50	☐ HP
8.00	6.00	☐ N60L

Average HP
Average N_{60L}