FINAL REPORT
SUBGRADE EXPLORATION REPORT
FRA-270-32.92
FRANKLIN COUNTY, OHIO
PID#: 113663

Prepared For:

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NEAS PROJECT 22-0063

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EXECUTIVE SUMMARY

The Ohio Department of Transportation (ODOT) has proposed an Interchange improvements and safety enhancement project (FRA-270-32.92, PID 113663) for the Interstate Route (IR) 270 Southbound (SB) exit ramp to Easton Way in Franklin County, Ohio. The project consists of converting the existing single-lane free flow exist ramp to Easton way into two-lane exit that opens three lanes, terminating at a new signal at the southbound ramp intersection with Easton Way.

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. Between December 29, 2022, and January 23, 2023, NEAS performed the site reconnaissance and exploration program for the project. The project included 10 borings drilled to a depth of 7.5 ft to 23.9 ft below ground surface (bgs) for subgrade characterization purposes.

The subgrade conditions in the project area are relatively consistent and are generally comprised of either fill soils (i.e., embankment/roadway fill) or natural soils .With respect to sulfate within the subgrade soil, based on the project laboratory testing program, each subgrade soil sample tested was determined to have a sulfate content of less than 5,000 parts per million (i.e., lower than the level which ODOT considers high and may prevent the use of chemical stabilization).

Based on our evaluation of the subsurface conditions and our geotechnical engineering analyses of the proposed intersection improvement project, it is our opinion that subgrade conditions are generally satisfactory, and pavement can be designed without the need for extreme levels of remediation.

Unstable subgrade conditions, including areas of weak soils and high moisture content soils, were encountered throughout the project area. NEAS recommend Spot stabilization in the form of Excavate and Replace to the depths between 12 inches below the proposed subgrade starting from STA 1385+02 to 1392+30. Another alternative is local chemical stabilization to a depth of 12 inches utilizing either cement or lime 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). A minimum 8 ft wide roadway work will be required for the chemical stabilization option. NEAS's opinion that the subgrade soils will provide adequate pavement support assuming it is designed and constructed in accordance with the recommendations provided within this report, as well as all applicable ODOT standards and specifications.

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1. INTRODUCTION

1.1. General

National Engineering & Architectural Services, Inc. (NEAS) presents our Subgrade and Roadway Exploration Report for the proposed VAR-Statewide Safety design project (FRA-270-32.92, PID 113663) for the IR-270 SB exit ramp to Easton Way in Franklin County, Ohio. The interchange improvements proposed to accomplish this objective consist of converting the existing single-lane exit ramp into a two-lane exit ramp that opens to three lanes as well as a new signal and possibly the relocation of two high mast light towers. This report presents a summary of the project encountered surficial and subsurface conditions and our recommendations for subgrade stabilization and pavement design parameters for: 1) the conversion of the existing single-lane free flow exit ramp to Easton Way into a two-lane exit ramp that opens to three lanes; 2) the construction of a new signal at the southbound intersection with Easton Way and 3) the relocation of two high mast light towers. The analysis performed as part of this report has been performed in accordance with ODOT's January 2019 revision of *Geotechnical Bulletin 1* (GB1) (ODOT [1], 2022) and *Pavement Design Manual* (PDM) (ODOT, 2022).

The exploration was conducted in general accordance with NEAS's proposal to EMH&T, dated September 29, 2022, 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 10 total test borings (all of which were utilized within this report as part of the roadway exploration); laboratory testing of soil samples in accordance with the SGE; performing geotechnical engineering analysis to assess subgrade stabilization requirements and recommended 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 Columbus Lowland Till Plains, a subdivision of the Southern Ohio Loamy Till Plain. This is a moderately low relief (25 ft) lowland surrounded in all directions by relative uplands, having a broad regional slope toward the Scioto Valley, containing many larger streams. Elevations of the region range from 600 to 850 ft above mean sea level (amsl) (950 ft amsl near Powell Moraine). The geology within this region is described as Wisconsinan-age till that is high lime in the west to medium-lime in the east. The geology is also described as containing extensive outwash in Scioto Valley overlying deep Devonian- to Mississippian-age carbonate rocks, shales, and siltstones (ODGS, 1998).

Based on the Quaternary Geology Map of Ohio (Pavey, et, al, 1999) The geology at the project site is mapped as a late Wisconsinan-age ice-deposited silty loam till soils of ground moraine that are flat to gently undulating.

Based on the Bedrock Geologic Units Map of Ohio (USGS & ODGS, 2006), bedrock within the project area consists of Shale of the Ohio Shale formation. This formation is comprised of Devonian-age Shale. The Shale in this formation is described as brownish black to greenish gray and weathers to brown in color, carbonaceous to clayey, laminated to thin bedded, fissile parting, and a petroliferous odor. The bedrock appears to follow the natural topography of the site which slopes gently downwards from west to east. (ODGS, 2003). Based on the ODNR bedrock topography map of Ohio, bedrock elevations at the project

site can be expected to be between 850 to 825 ft amsl, putting bedrock at a depth of about 35 ft below ground surface (bgs) to rock outcroppings.

The soils at the project site near Easton Way have been mapped (Web Soil Survey) by the Natural Resources Conservation Service (USDA, 2015) as primarily a combination of Bennington silt loam and Condit silt loam. The soils in the project area along the IR-270 SB portion have been mapped (Web Soil Survey) by the Natural Resources Conservation Service (USDA, 2015) as primarily a combination of Bennington silt loam, and Udorthents with the northern most portion of the project containing Pewamo silty clay loam. Udorthents are soils that have been disturbed by large amounts of cutting and filling, and as such are not rated according to the AASHTO method of soil classification. Soils in the Bennington series are characterized as very deep, somewhat poorly drained soils formed in loamy till of medium lime content on ground moraines and end moraines. The Bennington series is comprised of primarily fine-grained soils and classifies as A-4, A-6, and A-7 type soils according to the AASHTO method of soil classification. Soils in the Condit series are characterized as very deep, very poorly drained soils formed in loamy till on ground moraines. The Condit series is comprised of primarily fine-grained soils and classifies as A-4, A-6, and A-7 type soils according to the AASHTO method of soil classification. Soils in the Pewamo series are characterized as very deep, very poorly drained soils formed in till on moraines, near-shore zones, and lake plains. The Pewamo series is comprised of primarily fine-grained soils and classifies as A-6, and A-7 type soils according to the AASHTO method of soil classification.

2.2. Hydrology/Hydrogeology

There is not much historical information about groundwater at the project site. The site is equidistant between Alum Creek and Big Walnut Creek. The nearest water well logs are also from the 1950's. Water well (ID# 146919) located about 1,150 ft north of the intersection between Stelzer Rd. and Easton Way shows a static water level of 852 ft amsl. The water level of the aforementioned water well may be generally representative of the local groundwater table. However, it should be noted that perched groundwater systems may be existent in areas due to the presence of fine-grained soils making it difficult for groundwater to permeate to the phreatic surface.

The project site is not located within a regulatory flood hazard area based on available mapping by the Federal Emergency Management Agency's (FEMA) National Flood Hazard mapping program (FEMA, 2019).

2.3. Mining and Oil/Gas Production

No mines were noted on ODNR's Abandoned Underground Mine Locator in the vicinity of the project site. (ODNR [1], 2016).

No oil or gas wells were noted on ODNR's Oil and Gas Well Locator in the vicinity of the project site (ODNR [1], 2020).

2.4. Historical Records and Previous Phases of Project Exploration

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

- Structure Profile Sheets and Boring Logs for Project FRA-270-32.46 dated April 6, 1993.
- Roadway Soil Profile Sheets and Boring Logs for Project FRA-270-31.34 dated October, 1993.

Historical soil borings associated with the above plans were reviewed, however, they were not utilized for our analysis, and therefore, are not referenced or presented within this report.

2.5. Field Reconnaissance

A field reconnaissance visit for the overall project area was conducted on December 29, 2022, within the project limits. Site conditions, including the existing land conditions and pavement conditions, were noted, and photographed during the visit. Photographs of notable features and a summary of our observations by road segment are provided below.

2.5.1. Land Use and Cover

The land use of most of the project area consists of commercial property and residential properties (i.e., single family homes, apartments, etc.).

2.5.2. IR-270 SB Exit Ramp to Easton Way

In general, the pavement condition along this section of IR-270 SB was observed to be good with some signs of surface wear. Moderate severity longitudinal cracking was observed along this section as well as crack sealing deficiencies. The shoulders in this section were in noticeably worse condition than the rest of the roadway. Moderate severity transverse and longitudinal cracking was observed along the shoulder as well as edge cracking and crack sealing deficiencies (Photograph 1). The roadway in this section starts on an embankment above the surrounding land to the north with slopes of roughly 2H:1V (2 ft Horizontal to 1 ft Vertical). The roadway then transitions to be level with the surrounding land near the SB exit ramp to Easton Way. The roadway drains to drainage ditches on the outside shoulder of the roadway as well as a culvert near where the exit ramp curves off from IR-270 (Photograph 2). Some erosion control in the form of riprap was observed near the culvert. The area was lightly vegetated for the most part with some standing water observed near the drainage ditch. The flexible pipe culvert itself appeared to be in good condition with only minor warping at the outlet (Photograph 3). The area appeared to be stable with no signs of geotechnical instability.

Photograph 1: Overall Pavement Condition of IR-270 SB Exit Ramp to Easton Way

Photograph 2: Erosion Protection near Culvert and Signs of Standing Water

Photograph 3: Flexible Pipe Culvert

2.5.3. Easton Way

The pavement condition along the project section of Easton Way was observed to be poor with signs of surface wear. High severity longitudinal and transverse cracking was observed along this section as well as potholing, patching, map cracking and crack sealing deficiencies (Photograph 4). The roadway in this section is situated near the grade of the surrounding land starting from the west, and then transitions to an embankment above the surrounding land as it approaches IR-270. A retaining wall was observed beside Easton Way for the portion on an embankment. The retaining wall was observed to be in good condition with minor pop-outs, cracking, and efflorescence (Photograph 5). The roadway gently rises from west to east. The roadway drains to drainage ditches on the outside shoulders of the roadway. The area is lightly vegetated for the most part with standing water observed on the northern shoulder of Easton Way

(Photograph 6). Signs of standing water such as cattails were also observed in the area encompassed by Easton Way and the IR-270 SB exit ramp to Easton Way.

Photograph 4: Overall Pavement Condition of Easton Way

Photograph 5: Retaining Walls Near Eastern Portion of Easton Way

Photograph 6: Standing water at Edge of Easton Way

3. GEOTECHNICAL EXPLORATION

3.1. Exploration Program

The subsurface exploration for the roadway portion of the project was conducted by NEAS between January 18, 2023, and January 23, 2023, and included 10 borings drilled to a depth 7.5 ft to 23.9 ft bgs. The boring locations were selected by NEAS in general accordance with the guidelines contained in the SGE with the intent to evaluate subsurface soil and groundwater conditions. Borings were typically located either within existing pavement areas that are planned to undergo full-depth replacement or within areas where widening and/or realignment is planned. Target boring locations were located in the field by NEAS prior to drilling utilizing handheld GPS equipment and the boring locations were drilled in areas that were not restricted by underground utilities or dictated by terrain (i.e., steep embankment slopes). Each as-drilled project boring location and corresponding ground surface elevation was surveyed in the field following drilling. Each individual project boring log (included within Appendix B) includes the recorded boring latitude and longitude location (based on the surveyed Ohio State Plane North, NAD83, location) and the corresponding ground surface elevation, as summarized in Table 1.

Table 1: Project Boring Infomation

Boring Number	Latitude	Longitude	Elevation (NAVD 88) (ft)	Station	Offest	Depth (ft)	Type
B-001-0-22	40.054159	-82.903340	869.3	1367+72	30' RT	7.5	Subgrade
B-002-0-22	40.053451	-82.903143	861.0	1370+36	7' LT	7.5	Subgrade
B-003-0-22	40.052161	-82.902936	847.0	1375+10	2' RT	7.5	Subgrade
B-004-0-22	40.051011	-82.902826	843.8	1379+29	8' LT	7.5	Subgrade
B-005-0-22	40.050024	-82.902887	841.5	1382+89	3' LT	7.5	Subgrade
B-006-0-22	40.048897	-82.903298	848.7	1387+14	23' LT	23.9	Lighting Tower/Subgrade
B-007-0-22	40.048343	-82.904214	854.4	1390+34	15' LT	23.8	Lighting Tower/Subgrade
B-008-0-22	40.048154	-82.903390	861.1	75+62	31' LT	7.5	Subgrade
B-009-0-22	40.048239	-82.905585	850.7	1394+26	7' RT	7.5	Subgrade
B-010-0-22	40.048319	-82.906878	847.4	65+81	76' LT	7.5	Subgrade
Notes:	*1. Boring locations and corresponding ground surface elevation were surveyed in the field.*						

Borings were drilled using a CME 45B track-mounted drilling rig utilizing 3.25-inch (inner diameter) hollow stem augers. Soil samples for subgrade borings were typically recovered continuously to a depth of 7.5 ft bgs then at 2.5 ft to the terminated boring depths, each 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 the NEAS field representative and preserved for review by a Geologist for possible laboratory testing. Standard penetration tests (SPT) were conducted using CME auto hammer that has been calibrated to be 72.6 % efficient on January 24, 2022, as indicated on the boring logs (Appendix B).

Field boring logs were prepared by drilling personnel and included pavement description (where present), 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). Groundwater level observations were recorded both during and after the completion of drilling. These groundwater level observations are included on the individual boring logs (provided in Appendix B). After completing the borings, the boreholes were backfilled with either auger cuttings, bentonite chips, or a combination of these materials and patched accordingly with the cold patch asphalt and/or cement when drilling through the roadway.

3.2. Laboratory Testing Program

The laboratory testing program consisted of classification testing, moisture content determinations and sulfate content testing. Data from the laboratory testing program were incorporated onto the boring logs (Appendix B). Soil samples are retained at the laboratory until Stage 2 approval after which time they will be discarded.

3.2.1. Classification Testing

Representative soil samples were selected for index property (Atterberg Limits) and gradation testing for classification purposes on approximately 50% of the samples. At each boring location, the upper two samples obtained below the proposed top of subgrade elevation were generally tested while additional samples 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/strata 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 continuously 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 2 below, and presented on the boring logs within Appendix B.

Table 2: 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	100	4200
B-002-0-22	SS-1	1.5 - 3.0	100	3233
B-003-0-22	SS-1	1.5 - 3.0	20	20
B-004-0-22	SS-1	1.5 - 3.0	20	200
B-005-0-22	SS-1	1.5 - 3.0	20	80
B-006-0-22	SS-1	0.0 - 1.5	20	1533
B-007-0-22	SS-1	0.0 - 1.5	20	233
B-008-0-22	SS-1	1.5 - 3.0	20	467
B-009-0-22	SS-1	1.5 - 3.0	20	540
B-010-0-22	SS-1	0.0 - 1.5	20	213

3.3. Pavement Coring Exploration Program

The coring exploration program for this project was conducted by NEAS on February 9, 2023 and included a total of two (2) pavement cores. Pavement cores were obtained at two project boring locations (B-002-0-22 and B-008-0-22) performed through the existing shoulder. Measurements, location information, photographs and other details of each core sample can be found in the Pavement Core Logs included within Appendix D. The approximate location for each core is depicted on the Boring Location Plan provided in Appendix A.

Cores were drilled using a portable electric powered coring drill with a 4-inch (outer diameter) diamond tipped drill bit and utilizing water as the circulating fluid. Asphalt thicknesses were measured in the field after the cores were extracted and down-hole measurements were made. Each core sample was then photographed, logged, and stored for transportation to NEAS's laboratory. Following field documentation and photographs, the core holes were backfilled to existing grade with asphalt patch. Once in the laboratory the cores were: 1) remeasured for thickness verification and photographed; 2) checked for composition; and, 3) reviewed for individual layer identification and subsequent measurements.

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. It should be noted that 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 thickness in terms of asphalt, concrete, and granular base was measured at a representative subgrade/roadway boring. Pavement section thicknesses were measured during the subsurface exploration and are recorded on the test boring log provided in Appendix B. A summary of these measurements is provided in Table 3 below.

Table 3: 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-001-0-22	270 SB Ramp	7.5	9.5	0.0	8.5	18.0
B-002-0-22	270 SB Ramp	7.5	11.0	0.0	7.0	18.0
B-003-0-22	270 SB Ramp	7.5	0.0	0.0	9.5	9.5
B-005-0-22	270 SB Ramp	7.5	12.0	0.0	6.0	18.0
B-008-0-22	Easton Way	7.5	8.5	0.0	9.5	18.0
B-009-0-22	Easton Way	7.5	11.0	0.0	7.0	18.0

4.2. Subgrade Conditions

The subgrade conditions in the project area are relatively consistent and are generally comprised of either fill soils (i.e., embankment/roadway fill) or natural soils. A brief summary of the subgrade conditions encountered along the project site is below.

4.2.1. IR-270 SB Ramp

Eighty seven percent (87%) of soil samples were identified as fine-grained soils and were comprised of: 1) Sandy Silt (A-4a, one sample); 2) Silt and Clay (A-6a, 16% of samples); 3) Silty Clay (A-6b, 23% of samples); and, 4) Clay (A-7-6, 45% of samples). With respect to the consistency of the fine-grained soils, the descriptions varied from stiff to hard correlating to N_{60} values between 11 and 28 bpf and hand penetrometer readings between 1.25 and 4.50 tsf. Natural moisture contents ranged from 11 to 25 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 ranged from 23 to 46 percent and from 17 to 22 percent, respectively.

The remaining fourteen percent (13%) of soil samples were identified as non-cohesive granular soils and were comprised of: 1) Gravel with Sand (A-1-b, one sample); 2) Gravel with Sand and Silt (A-2-4, 7% of samples); and 3) Gravel with Sand, Silt and Clay (A-2-6, one sample). With respect to the relative density of the granular soils, it can be described as medium dense correlating to N_{60} values between 12 and 18 bpf. Natural moisture contents ranged from 2 to 13 percent.

4.2.2. Easton Way

Eighty-two percent (82%) of soil samples were identified as fine-grained soils and were comprised of: 1) Silt and Clay (A-6a, 18% of samples); 2) Silty Clay (A-6b, 55% of samples); and, 3) Clay (A-7-6, one sample). With respect to the consistency of the fine-grained soils, the descriptions varied from stiff to hard correlating to N_{60} values between 11 and 28 bpf and hand penetrometer readings between 1.75 and 4.50 tsf. Natural moisture contents ranged from 13 to 25 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 ranged from 32 to 40 percent and from 18 to 24 percent, respectively.

The remaining fourteen percent (18%) of soil samples were identified as non-cohesive granular soils and were comprised of: 1) Gravel (A-1-a, one sample); and, 2) Gravel with Sand, Silt and Clay (A-2-6, one

sample). With respect to the relative density of the granular soils, it can be described as medium dense correlating to N_{60} values between 16 and 23 bpf. Natural moisture contents ranged from 5 to 14 percent.

4.2.3. Groundwater

Groundwater was not encountered during drilling and after drilling in all the project borings performed as part of the referenced project. It should be noted that groundwater is affected by many hydrologic characteristics in the area and may vary from those measured at the time of the exploration.

5. ANALYSES AND RECOMMENDATIONS

We understand that EMHT is working with ODOT to develop a construction plans for an interchange improvement located on the IR-270 SB exit ramp to Easton Way. The project consists of converting the existing single-lane free flow exist ramp to Easton way into two-lane exit that opens three lanes, terminating at a new signal at the southbound ramp intersection with Easton Way. Two high mast lighting towers right next to the exist ramp will be impacted and need relocation. For this purpose, a roadway exploration and subsequent analysis was completed for the referenced project. The analysis completed for the proposed roadway improvements included a subgrade (GB1) analysis. The subgrade analysis was performed in accordance with ODOT's GB1 criteria utilizing the ODOT provided *GB1: Subgrade Analysis Spreadsheet* (GB1_SubgradeAnalysis.xls, Version 14.5 dated February 11, 2022). Input information for the spreadsheet was based on the soil characteristics gathered during NEAS's subgrade exploration (i.e., SPT results, laboratory test results, etc.). A GB1 analysis was performed for the entire project as well as for each of the referenced roadway segments individually.

Based on our evaluation of the subsurface conditions and our geotechnical engineering analyses of the proposed interchange improvement project, it is our opinion that the subgrade conditions encountered are generally satisfactory and pavement can be designed without the need for extreme levels of remediation. The following sections provide further detail about the analysis performed and the recommended remediation.

5.1. Soil Profile for Light Tower

The roadway improvement project may impact the high mast lighting towers next to the exist ramp. Each tower boring was reviewed, and a generalized material profile was developed. Utilizing the generalized soil profile, engineering properties for each soil strata were estimated based on their field (i.e., SPT N_{60} values, hand penetrometer values, etc.) and laboratory (i.e., Atterberg Limits, grain size, etc.) test results using correlations provided in published engineering manuals, research reports and guidance documents. The developed soil profile and estimated engineering soil properties (with cited correlation/reference material) used in our analysis is summarized per tower location (per boring) within Tables 4 and 5, below.

Table 4: Soil profile and Estimated Engineering Properties (B-006-0-22)

LIGHT TOWER: B-006-0-22				
Soil Description	**Unit Weight[1] (pcf)**	**Undrained Shear Strength[2] (psf)**	**Effective Cohesion[3] (psf)**	**Effective Friction Angle[3] (degrees)**
Clay Depth (848.7 ft - 835.7 ft)	110	1600	150	22
Sandy Silt Depth (835.7 ft - 830.2 ft)	122	4850	375	28
Sandy Silt Depth (830.2 ft - 828.2 ft)	115	3100	250	27
Silt Depth (828.2 ft - 824.8 ft)	118	-	-	32

Notes:
1. *Values interpreted from Geotechnical Bulletin 7 Table 1.*
2. *Values calculated from Terzaghi and Peck (1967) if $N1_{60}$<52, else Stroud and Butler (1975) was used.*
3. *Values interpreted from Geotechnical Bulletin 7 Table 2 for cohesive soils and LRFD BDS Table 10.4.6.2.4-1 and ODOT GDM Table 400-3 for granular soils.*

Table 5: Soil profile and Estimated Engineering Properties (B-007-0-22)

LIGHT TOWER: B-007-0-22				
Soil Description	**Unit Weight[1] (pcf)**	**Undrained Shear Strength[2] (psf)**	**Effective Cohesion[3] (psf)**	**Effective Friction Angle[3] (degrees)**
Clay Depth (854.4 ft - 852.9 ft)	110	1600	150	22
Gravel with Sand, Silt and Clay Depth (852.9 ft - 851.4 ft)	112	-	-	33
Clay Depth (851.4 ft - 841.4 ft)	112	2050	200	23
Silt and Clay Depth (841.4 ft - 833.9 ft)	118	3550	300	26
Sandy Silt Depth (833.9 ft - 830.6 ft)	118	4250	300	27

Notes:
1. *Values interpreted from Geotechnical Bulletin 7 Table 1.*
2. *Values calculated from Terzaghi and Peck (1967) if $N1_{60}$<52, else Stroud and Butler (1975) was used.*
3. *Values interpreted from Geotechnical Bulletin 7 Table 2 for cohesive soils and LRFD BDS Table 10.4.6.2.4-1 and ODOT GDM Table 400-3 for granular soils.*

5.2. Subgrade Analysis

A GB1 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 GB1 analysis including pavement design parameters and unsuitable subgrade conditions identified within the project limits. GB1 analysis spreadsheets are provided in Appendix C.

5.2.1. Pavement Design Recommendations

It is our understanding that pavement analysis and design is to be performed to determine the proposed pavement sections for the segments within the project limits to undergo full depth replacement. A GB1 analysis was performed using the subgrade soil data obtained during our field exploration program to evaluate the soil characteristics and develop pavement parameters for use in pavement design. The subgrade analysis parameters recommended for use in pavement design are presented in Table 6 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 6: Pavement Design Parameters

Segment	Maximum N_{60L}	Minimum N_{60L}	Average N_{60L}	Average PI Values	Design CBR
IR-270 SB Ramp	19	11	15	17	6
Easton Way	23	11	18	18	6
Entire Project	**23**	**11**	**15**	**17**	**6**

5.2.2. Unsuitable Subgrade

Unsuitable soil types per the GB1 include A-4b, A-2-5, A-5, A-7-5, A-8a, A-8b, and soils with liquid limits greater than 65. Unsuitable soils were not encountered through the project limits.

5.2.2.1. Rock

Rock was not encountered at or close to subgrade elevation at the boring locations performed within the project limits. Per ODOT's GB1, 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 204.05 of the ODOT CMS and replaced with Item 204 Embankment.

5.2.3. Unstable Soils

The GB1 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* within the GB1 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 GB1 recommends an excavate and replace of 12 inches within a 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 within the project borings, our GB1 analysis suggests the need for 12 inches of either chemical treatment or excavate and replace at select locations. A summary of the boring locations where unstable soils were encountered and determined to have a potential impact on subgrade performance are shown in Table 7 below, per the roadway segment for which they were encountered. Also included is the associated GB1 recommended remediation depth at that location.

Table 7: 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)	Chemical Stabilization (Item 206)
IR-270 SB Ramp						
B-006-0-22	SS-2	11	3	(-) 0.5 - 1.0	12	12
B-006-0-22	SS-3	11	7	1.0 - 2.5	12	12
B-007-0-22	SS-1	13	0	(-) 0.9 - 0.6	12	12
B-007-0-22	SS-2	12	3	0.6 - 2.1	12	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 GB1 guidance, *these soils should be reworked to stabilize the subgrade.*

5.2.3.1. High Moisture Content Soils

High moisture content soils are defined by the GB1 as soils that exceed the estimated optimum moisture content (per *Figure A - Optimum Moisture Content* within the GB1) for a given classification by 3 percent or more. Per the GB1, soils determined to be above the identified moisture content levels are a likely indication of the presence 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 as shown in Table 8 below.

Table 8: High Moisture Soils Summary

Boring ID	Sample ID	Moisture Content (%)	Optimum Moisture Content (%)	Moisture Above Optimum (%)	Depth Below Subgrade (ft)
IR-270 SB Ramp					
B-004-0-22	SS-2	21	18	3	1.4 - 2.9
B-006-0-22	SS-2	22	19	3	(-) 0.5 - 1.0
B-006-0-22	SS-3	25	18	7	1.0 - 2.5
B-007-0-22	SS-2	13	10	3	0.6 - 2.1
Easton Way					
B-008-0-22	SS-2	19	16	3	1.5 - 3.0
B-010-0-22	SS-2	14	10	4	0.0 - 1.5

5.3. Stabilization Recommendations

5.3.1. Subgrade Stabilization

Based on the results of our analysis, subgrade soils designated by ODOT's GB1 as "unstable" were present at various locations throughout the project as mentioned in section 5.1.3 of this report. Also, Subgrade soils designated as "unstable" via high moisture content were encountered in borings described in section 5.1.3.1 in this report. Although these materials were encountered at different locations throughout the project, guidance for ODOTs GB1 states that "*if it is determined that 30 percent or more of the subgrade area must be stabilized, consider stabilizing the entire project (global stabilization)"* and since less than 30 % of the soils need to be stabilized, therefore, NEAS recommends local stabilization in the form of Item 204 Excavate and Replace where the unstable subgrade materials are encountered. Excavation limits and depths for each roadway which needs stabilization are summarized in Table 9 below the proposed subgrade with the excavated material being replaced with Item 204 Granular Material Type C in accordance with Section F "Excavate and Replace (Item 204)" of the ODOT GB1. Stabilization limits should extend 18-inches beyond the edge of the proposed paved roadway, shoulder or median and it is recommended removing any topsoil, existing pavement materials or abandoned structure foundation materials.

Table 9: Stabilization Recommendation Summary

Start Station	End Station	Excavate and Replace w/ Item 204[(1)] (inches)	Chemical Stabilization (inches)	Unsuitable Subgrade Conditions	Borings Considered
IR-270 SB Ramp					
1385+02	1392+30	12	12	-	B-006-0-22 & B-007-0-22

5.3.2. Chemical Stabilization

Another alternative is global chemical stabilization to a depth of 12 inches utilizing either cement or lime 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 GB1.

Additionally, the chemical stabilization of the subgrade soils of the above referenced roadway should be performed to the recommended depths provided in 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.

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

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 GB1, *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.

5.3.3. Embankment Construction Recommendations

Based on the project proposed cross-sections, sidehill fills will be required for the 270 SB CD Road. For sidehill fills planned on existing slopes steeper than 4H:1V, ODOT's GB2 recommends that *the embankment slopes be constructed utilizing special benching in order to blend the new embankment with the existing slope to prevent the development of a weak shear plane at the interface between the proposed fill and existing slope material* (ODOT [2], 2017). A special benching scheme similar to that shown in Figure 1 of the ODOT GB2 should be used in areas where special benching is recommended. The height and width dimensions of the special benching scheme shown in the figure should be arranged to minimize the required cut and fill quantities, though the height of a single bench shall not exceed 20 ft without a stability analysis and design per OSHA requirements. Additionally, it may be appropriate to adjust the bench slope shown from a 1H:1V to a 1.5H:1V slope since the existing slope is made up of both Type B and Type C materials. The benched material should be replaced with compacted engineered fill per Item 203 of the ODOT CMS, while proper lift thicknesses and material density should be maintained in the proposed fill per Item 203.06 of the ODOT CMS. In situations where it is not practical to extend the final bench through the existing roadway due to maintenance of traffic concerns, a benching scheme similar to that shown in Figure 1a of the ODOT GB2 can be used in order to avoid impacting the existing roadway, guardrail or shoulder. This scheme results in the placement of a temporary over-steepened fill that can later be "shaved-off" to bring the slope to the final proposed grade.

6. QUALIFICATIONS

This investigation was performed in accordance with accepted geotechnical engineering practice for the purpose of characterizing the subsurface conditions along the referenced portions of roadways. This report has been prepared for EMH&T Engineers, Surveyors, Planners, Scientists, ODOT and their design consultants to be used solely in evaluating the subgrade soils within the project limits and presenting geotechnical engineering recommendations specific to this 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. In the event that any changes occur in the nature, design or location of the proposed interchange improvement work, 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 EMH&T Engineers, Surveyors, Planners, Scientists in performing this geotechnical exploration for the FRA-270-32.92 interchange improvement project. 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

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APPENDIX A

BORING LOCATION PLAN

HORIZONTAL SCALE IN FEET
0 50 100 200

TARGET BORING PLAN

FRA-270-32.92

MODEL: Target boring plan PAPERSIZE: 34x22 (in.) DATE: 9/28/2022 TIME: 4:07:01 PM USER: mjasiewicz
P:\PROPOSALS\FRA-270-32.92 SB at Easton Way (PID 113663)\113663\admin\contracts\Fee Proposal\Geotechnical Fee Proposal\CADD Files\113663_BP001_MWJ.dgn

DESIGN AGENCY	National Engineering & Architectural Services Inc.
DESIGNER	MWJ
REVIEWER	CH 09-28-22
PROJECT ID	113663
SUBSET 1	TOTAL 1
SHEET P.0	TOTAL 0

APPENDIX B

SOIL BORING LOGS

PROJECT: FRA-270-32.92
TYPE: SUBGRADE
PID: 113663 SFN:
START: 1/18/23 END: 1/18/23

DRILLING FIRM / OPERATOR: NEAS / ASHBAUGH
SAMPLING FIRM / LOGGER: NEAS / JL
DRILLING METHOD: 3.25" HSA
SAMPLING METHOD: SPT

DRILL RIG: CME 45B
HAMMER: CME AUTOMATIC
CALIBRATION DATE: 1/24/22
ENERGY RATIO (%): 72.6

STATION / OFFSET: 1367+72, 30' RT.
ALIGNMENT: PROP. I-270 SB CD RD
ELEVATION: 869.3 (MSL) EOB: 7.5 ft.
LAT / LONG: 40.054159, -82.903340

EXPLORATION ID B-001-0-22

MATERIAL DESCRIPTION AND NOTES	ELEV. 869.3	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
9.5" ASPHALT AND 8.5" BASE (DRILLERS DESCRIPTION)	867.8																		
MEDIUM DENSE, GRAY, **GRAVEL WITH SAND AND SILT**, TRACE CLAY, DAMP **(FILL)**	866.3	1	7 5 5	12	28	SS-1	-	39	25	9	17	10	23	17	6	6	A-2-4 (0)	4200	
VERY STIFF TO HARD, BROWNISH GRAY, **CLAY**, "AND" SILT, LITTLE TO SOME SAND, TRACE GRAVEL, DAMP		2	7 6 7	16	50	SS-2	3.00	4	7	13	37	39	43	20	23	18	A-7-6 (14)	-	
		3	7 8 9	21	67	SS-3	4.50	-	-	-	-	-	-	-	-	14	A-7-6 (V)	-	
		4	8 7 7	17	72	SS-4	4.50	-	-	-	-	-	-	-	-	18	A-7-6 (V)	-	
	861.8	5 EOB																	
		6																	
		7																	

NOTES: GROUNDWATER NOT ENCOUNTERED DURING DRILLING. HOLE DID NOT CAVE.

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

PROJECT: FRA-270-32.92	DRILLING FIRM / OPERATOR: NEAS / ASHBAUGH	DRILL RIG: CME 45B	STATION / OFFSET: 1370+36, 7' LT.
TYPE: SUBGRADE	SAMPLING FIRM / LOGGER: NEAS / JL	HAMMER: CME AUTOMATIC	ALIGNMENT: PROP. I-270 SB EXIT RP
PID: 113663 SFN:	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 1/24/22	ELEVATION: 861.0 (MSL) EOB: 7.5 ft.
START: 1/18/23 END: 1/18/23	SAMPLING METHOD: SPT	ENERGY RATIO (%): 72.6	LAT / LONG: 40.053451, -82.903143

EXPLORATION ID B-002-0-22

PAGE 1 OF 1

MATERIAL DESCRIPTION AND NOTES	ELEV. 861.0	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
11.0" ASPHALT AND 7.0" BASE (DRILLERS DESCRIPTION)	859.5	1																	
MEDIUM DENSE, GRAY, **GRAVEL WITH SAND**, LITTLE SILT, TRACE CLAY, DAMP **(FILL)**	857.8	2	6 7 6	16	22	SS-1	-	48	28	9	12	3	NP	NP	NP	2	A-1-b (0)	3233	
HARD, BROWN AND ORANGISH BROWN, **SILTY CLAY**, SOME SAND, LITTLE GRAVEL, CONTAINS INTERBEDDED SEAMS OF GRAVEL WITH SAND, DAMP TO MOIST	855.0	3 4 5	7 8 8	19	39	SS-2	4.50	13	14	15	30	28	35	18	17	13	A-6b (7)	-	
			8 9 9	22	44	SS-3	4.25	-	-	-	-	-	-	-	-	19	A-6b (V)	-	
VERY STIFF, BROWNISH GRAY, **CLAY**, SOME SILT, LITTLE SAND, TRACE GRAVEL, DAMP	853.5	6 7 EOB	7 8 9	21	50	SS-4	4.00	-	-	-	-	-	-	-	-	15	A-7-6 (V)	-	

NOTES: GROUNDWATER NOT ENCOUNTERED DURING DRILLING. HOLE DID NOT CAVE.

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

PROJECT: FRA-270-32.92	DRILLING FIRM / OPERATOR: NEAS / ASHBAUGH	DRILL RIG: CME 45B	STATION / OFFSET: 1375+10, 2' RT.
TYPE: SUBGRADE	SAMPLING FIRM / LOGGER: NEAS / JL	HAMMER: CME AUTOMATIC	ALIGNMENT: PROP. I-270 SB EXIT RP
PID: 113663 SFN:	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 1/24/22	ELEVATION: 847.0 (MSL) EOB: 7.5 ft.
START: 1/18/23 END: 1/18/23	SAMPLING METHOD: SPT	ENERGY RATIO (%): 72.6	LAT / LONG: 40.052161, -82.902936

EXPLORATION ID B-003-0-22

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
9.5" BASE (DRILLERS DESCRIPTION)	847.0 846.2																		
VERY STIFF, DARK BROWN AND DARK GRAY, **SILTY CLAY**, SOME SAND, SOME GRAVEL, SLIGHTLY ORGANIC, CONTAINS NO INTACT SOIL FOR HP READINGS, DAMP	844.0	1–2–3	5 6 7	16	33	SS-1	-	22	17	12	25	24	37	18	19	13	A-6b (6)	20	
MEDIUM DENSE, DARK BROWN AND DARK GRAY, **GRAVEL WITH SAND AND SILT**, TRACE CLAY, SLIGHTLY ORGANIC, DAMP	842.5	3–4	5 7 8	18	50	SS-2	-	34	12	23	22	9	27	17	10	9	A-2-4 (0)	-	
HARD, BROWN AND DARK GRAY, **SILTY CLAY**, SOME SAND, TRACE GRAVEL, CONTAINS WOOD FRAGMENTS, SLIGHTLY ORGANIC, DAMP	841.0	5–6	8 9 8	21	56	SS-3	4.50	9	10	14	37	30	34	18	16	14	A-6b (9)	-	
HARD, BROWN, **SANDY SILT**, SOME CLAY, LITTLE GRAVEL, DAMP	839.5	7 EOB	9 10 11	25	50	SS-4	4.50	-	-	-	-	-	-	-	-	11	A-4a (V)	-	

NOTES: GROUNDWATER NOT ENCOUNTERED DURING DRILLING. HOLE DID NOT CAVE.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: SHOVELED SOIL CUTTINGS

PROJECT: FRA-270-32.92	DRILLING FIRM / OPERATOR: NEAS / ASHBAUGH	DRILL RIG: CME 45B	STATION / OFFSET: 1379+29, 8' LT.	EXPLORATION ID B-004-0-22
TYPE: SUBGRADE	SAMPLING FIRM / LOGGER: NEAS / JL	HAMMER: CME AUTOMATIC	ALIGNMENT: PROP. I-270 SB EXIT RP	
PID: 113663 SFN:	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 1/24/22	ELEVATION: 843.8 (MSL) EOB: 7.5 ft.	PAGE 1 OF 1
START: 1/18/23 END: 1/18/23	SAMPLING METHOD: SPT	ENERGY RATIO (%): 72.6	LAT / LONG: 40.051011, -82.902826	

MATERIAL DESCRIPTION AND NOTES	ELEV. 843.8	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
5.0" TOPSOIL (DRILLERS DESCRIPTION)	843.4																		
HARD, BROWN MOTTLED WITH ORANGISH BROWN AND GRAY, **CLAY**, SOME SILT, LITTLE SAND, TRACE GRAVEL, IRON STAINING, SS-2 AND SS-3 CONTAIN NO INTACT SOIL FOR HP READINGS, DAMP TO MOIST		1	4 6 7	16	67	SS-1	4.25	3	5	11	35	46	46	20	26	18	A-7-6 (16)	200	
		2																	
		3	6 6 7	16	61	SS-2	-	5	8	12	34	41	44	20	24	21	A-7-6 (14)	-	
		4																	
		5	8 7 9	19	44	SS-3	-	-	-	-	-	-	-	-	-	20	A-7-6 (V)	-	
	837.8	6																	
HARD, BROWN, **SILT AND CLAY**, SOME SAND, TRACE GRAVEL, DAMP	836.3	7 EOB	8 9 11	24	28	SS-4	4.50	-	-	-	-	-	-	-	-	17	A-6a (V)	-	

NOTES: GROUNDWATER NOT ENCOUNTERED DURING DRILLING. HOLE DID NOT CAVE.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: SHOVELED SOIL CUTTINGS

PROJECT: FRA-270-32.92	DRILLING FIRM / OPERATOR: NEAS / ASHBAUGH	DRILL RIG: CME 45B	STATION / OFFSET: 1382+89, 3' LT.	EXPLORATION ID B-005-0-22
TYPE: SUBGRADE	SAMPLING FIRM / LOGGER: NEAS / JL	HAMMER: CME AUTOMATIC	ALIGNMENT: PROP. I-270 SB EXIT RP	
PID: 113663 SFN:	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 1/24/22	ELEVATION: 841.5 (MSL) EOB: 7.5 ft.	PAGE 1 OF 1
START: 1/19/23 END: 1/19/23	SAMPLING METHOD: SPT	ENERGY RATIO (%): 72.6	LAT / LONG: 40.050024, -82.902887	

MATERIAL DESCRIPTION AND NOTES	ELEV. 841.5	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
12.0" ASPHALT AND 6.0" BASE (DRILLERS DESCRIPTION)	840.0																		
VERY STIFF, BROWN, **SILT AND CLAY**, SOME GRAVEL, SOME SAND, CONTAINS NO INTACT SOIL FOR HP READINGS, MOIST	838.5	1	5 7 7	17	44	SS-1	-	35	11	12	23	19	28	17	11	13	A-6a (2)	80	
VERY STIFF TO HARD, BROWN, **SILT AND CLAY**, SOME SAND, LITTLE GRAVEL, DAMP		2	6 6 8	17	56	SS-2	3.50	18	11	14	31	26	30	18	12	15	A-6a (5)	-	
		3	7 8 9	21	50	SS-3	3.75	-	-	-	-	-	-	-	-	14	A-6a (V)	-	
	834.0	4	9 10 10	24	67	SS-4	4.50	-	-	-	-	-	-	-	-	16	A-6a (V)	-	
		EOB 5																	
		6																	
		7																	

NOTES: GROUNDWATER NOT ENCOUNTERED DURING DRILLING. HOLE DID NOT CAVE.

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

PROJECT: FRA-270-32.92	DRILLING FIRM / OPERATOR: NEAS / ASHBAUGH	DRILL RIG: CME 45B	STATION / OFFSET: 1387+14, 23' LT.	EXPLORATION ID B-006-0-22
TYPE: LIGHT TOWER	SAMPLING FIRM / LOGGER: NEAS / JL	HAMMER: CME AUTOMATIC	ALIGNMENT: PROP. I-270 SB EXIT RP	
PID: 113663 SFN:	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 1/24/22	ELEVATION: 848.7 (MSL) EOB: 23.9 ft.	PAGE 1 OF 1
START: 1/20/23 END: 1/20/23	SAMPLING METHOD: SPT	ENERGY RATIO (%): 72.6	LAT / LONG: 40.048897, -82.903298	

MATERIAL DESCRIPTION AND NOTES	ELEV. 848.7	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
3.5" TOPSOIL (DRILLERS DESCRIPTION)	848.4																		
VERY STIFF TO HARD, BROWN MOTTLED WITH DARK GRAY AND ORANGISH BROWN, **CLAY**, SOME TO "AND" SILT, LITTLE TO SOME SAND, TRACE GRAVEL, SLIGHTLY ORGANIC, IRON STAINING, DAMP TO MOIST SS-2 CONTAINS MANY WOOD FRAGMENTS		1	4 4 5	11	61	SS-1	3.25	8	7	10	36	39	46	19	27	20	A-7-6 (16)	1533	
		2	3 4 5	11	50	SS-2	3.50	8	7	12	38	35	43	22	21	22	A-7-6 (13)	-	
		3	4 4 5	11	67	SS-3	3.00	-	-	-	-	-	-	-	-	25	A-7-6 (V)	-	
		4	4 5 4	11	50	SS-4	3.75	-	-	-	-	-	-	-	-	22	A-7-6 (V)	-	
		5	4 6 4	12	56	SS-5	3.50	-	-	-	-	-	-	-	-	23	A-7-6 (V)	-	
		6																	
		7	4 5 6	13	67	SS-6	4.50	-	-	-	-	-	-	-	-	22	A-7-6 (V)	-	
		8																	
		9	6 7 11	22	44	SS-7	2.50	-	-	-	-	-	-	-	-	18	A-7-6 (V)	-	
		10																	
	835.7	11																	
HARD, BROWN BECOMING GRAY, **SANDY SILT**, SOME CLAY, LITTLE TO SOME GRAVEL, DAMP		12	7 13 15	34	56	SS-8	4.50	22	10	15	31	22	25	16	9	11	A-4a (4)	-	
		13																	
		14																	
		15	8 19 17	44	61	SS-9	4.50	-	-	-	-	-	-	-	-	10	A-4a (V)	-	
		16																	
		17																	
		18	8 11 10	25	67	SS-10	4.50	-	-	-	-	-	-	-	-	12	A-4a (V)	-	
	828.2	19																	
MEDIUM DENSE TO VERY DENSE, GRAY, **SILT**, SOME SAND, LITTLE CLAY, TRACE GRAVEL, WET		20																	
		21	8 9 8	21	89	SS-11	-	4	6	17	59	14	NP	NP	NP	18	A-4b (8)	-	
		22																	
	824.8	23																	
SS-12 CONTAINS NO RECOVERY		EOB	50/5"	-	0	SS-12	-	-	-	-	-	-	-	-	-	-			-

NOTES: GROUNDWATER NOT ENCOUNTERED DURING DRILLING. HOLE DID NOT CAVE.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: SHOVELED SOIL CUTTINGS

STANDARD ODOT LOG W/ SULFATES (8.5 X 11) - OH DOT.GDT - 2/14/23 12:25 - X:\ACTIVE PROJECTS\ACTIVE SOIL PROJECTS\FRA-270-32.92 (EASTON)\GINT FILES\FRA-270-32.92.GPJ

PROJECT: FRA-270-32.92	DRILLING FIRM / OPERATOR: NEAS / ASHBAUGH	DRILL RIG: CME 45B	STATION / OFFSET: 1390+34, 15' LT.	EXPLORATION ID B-007-0-22
TYPE: LIGHT TOWER	SAMPLING FIRM / LOGGER: NEAS / JL	HAMMER: CME AUTOMATIC	ALIGNMENT: PROP. I-270 SB EXIT RP	
PID: 113663 SFN:	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 1/24/22	ELEVATION: 854.4 (MSL) EOB: 23.8 ft.	PAGE 1 OF 1
START: 1/20/23 END: 1/20/23	SAMPLING METHOD: SPT	ENERGY RATIO (%): 72.6	LAT / LONG: 40.048343, -82.904214	

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
3.5" TOPSOIL (DRILLERS DESCRIPTION)	854.4																		
STIFF, BROWN MOTTLED WITH DARK GRAY AND ORANGISH BROWN, **CLAY**, SOME SILT, SOME SAND, LITTLE GRAVEL, CONTAINS ROOTS, DAMP	854.1		6 5 6	13	50	SS-1	1.50	15	15	12	30	28	41	21	20	18	A-7-6 (9)	233	
MEDIUM DENSE, BROWN MOTTLED WITH DARK GRAY AND ORANGISH BROWN, **GRAVEL WITH SAND, SILT, AND CLAY**, CONTAINS ROOTS, DAMP	852.9		5 4 6	12	67	SS-2	-	35	20	13	18	14	32	19	13	13	A-2-6 (1)	-	
STIFF TO VERY STIFF, BROWN MOTTLED WITH DARK GRAY AND ORANGISH BROWN, **CLAY**, SOME SILT, SOME SAND, LITTLE GRAVEL, DAMP TO MOIST	851.4		4 4 5	11	72	SS-3	2.50	-	-	-	-	-	-	-	-	20	A-7-6 (V)	-	
			5 6 7	16	78	SS-4	1.25	-	-	-	-	-	-	-	-	22	A-7-6 (V)	-	
			6 6 7	16	78	SS-5	2.25	-	-	-	-	-	-	-	-	18	A-7-6 (V)	-	
			6 7 8	18	50	SS-6	2.50	-	-	-	-	-	-	-	-	23	A-7-6 (V)	-	
	841.4		7 8 9	21	44	SS-7	3.50	-	-	-	-	-	-	-	-	22	A-7-6 (V)	-	
HARD, BROWN AND GRAY, **SILT AND CLAY**, SOME SAND, TRACE TO LITTLE GRAVEL, DAMP			8 10 19	35	61	SS-8	4.50	17	9	16	33	25	31	18	13	13	A-6a (6)	-	
			9 9 11	24	67	SS-9	4.50	-	-	-	-	-	-	-	-	13	A-6a (V)	-	
	833.9		11 10 12	27	72	SS-10	4.50	-	-	-	-	-	-	-	-	12	A-6a (V)	-	
VERY STIFF, BROWN AND GRAY, **SANDY SILT**, LITTLE CLAY, TRACE GRAVEL, DAMP			13 14 17	38	33	SS-11	4.00	-	-	-	-	-	-	-	-	10	A-4a (V)	-	
SS-12 CONTAINS NO RECOVERY	830.6	EOB	50/3"	-	0	SS-12	-	-	-	-	-	-	-	-	-	-		-	

NOTES: GROUNDWATER NOT ENCOUNTERED DURING DRILLING. HOLE DID NOT CAVE.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: SHOVELED SOIL CUTTINGS

PROJECT: FRA-270-32.92	DRILLING FIRM / OPERATOR: NEAS / ASHBAUGH	DRILL RIG: CME 45B	STATION / OFFSET: 75+62, 31' LT.	EXPLORATION ID B-008-0-22
TYPE: SUBGRADE	SAMPLING FIRM / LOGGER: NEAS / JL	HAMMER: CME AUTOMATIC	ALIGNMENT: EXIST EASTON WAY RW	
PID: 113663 SFN:	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 1/24/22	ELEVATION: 861.1 (MSL) EOB: 7.5 ft.	PAGE 1 OF 1
START: 1/23/23 END: 1/23/23	SAMPLING METHOD: SPT	ENERGY RATIO (%): 72.6	LAT / LONG: 40.048154, -82.903390	

MATERIAL DESCRIPTION AND NOTES	ELEV. 861.1	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
8.5" ASPHALT AND 9.5" BASE (DRILLERS DESCRIPTION)	859.6																		
MEDIUM DENSE, DARK GRAY, **GRAVEL**, SOME SAND, TRACE SILT, TRACE CLAY, DAMP **(FILL)**	858.1	1	7 7 8	18	33	SS-1	-	56	24	8	9	3	NP	NP	NP	5	A-1-a (0)	467	
VERY STIFF, BROWN AND GRAY, **SILTY CLAY**, LITTLE SAND, TRACE TO LITTLE GRAVEL, DAMP TO MOIST		2	6 5 4	11	61	SS-2	3.25	12	8	11	34	35	40	20	20	19	A-6b (11)	-	
		3	5 6 5	13	78	SS-3	2.25	-	-	-	-	-	-	-	-	25	A-6b (V)	-	
	853.6	4	4 6 4	12	83	SS-4	2.25	-	-	-	-	-	-	-	-	21	A-6b (V)	-	
		EOB 5																	
		6																	
		7																	

NOTES: GROUNDWATER NOT ENCOUNTERED DURING DRILLING. HOLE DID NOT CAVE.

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

STANDARD ODOT LOG W/ SULFATES (8.5 X 11) - OH DOT.GDT - 2/14/23 12:25 - X:\ACTIVE PROJECTS\ACTIVE SOIL PROJECTS\FRA-270-32.92 (EASTON)\GINT FILES\FRA-270-32.92.GPJ

PROJECT: FRA-270-32.92	DRILLING FIRM / OPERATOR: NEAS / ASHBAUGH	DRILL RIG: CME 45B	STATION / OFFSET: 1394+26, 7' RT.	EXPLORATION ID B-009-0-22
TYPE: SUBGRADE	SAMPLING FIRM / LOGGER: NEAS / JL	HAMMER: CME AUTOMATIC	ALIGNMENT: EXIST I-270 SB EXIT RP	
PID: 113663 SFN:	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 1/24/22	ELEVATION: 850.7 (MSL) EOB: 7.5 ft.	PAGE 1 OF 1
START: 1/20/23 END: 1/20/23	SAMPLING METHOD: SPT	ENERGY RATIO (%): 72.6	LAT / LONG: 40.048239, -82.905585	

MATERIAL DESCRIPTION AND NOTES	ELEV. 850.7	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
11.0" ASPHALT AND 7.0" BASE (DRILLERS DESCRIPTION)	849.2	1																	
HARD, BROWN, **SILTY CLAY**, LITTLE TO SOME SAND, TRACE GRAVEL, IRON STAINING, DAMP		2	7 7 9	19	33	SS-1	4.50	3	6	13	37	41	40	20	20	17	A-6b (12)	540	
		3	7 9 10	23	28	SS-2	4.50	5	8	15	37	35	34	18	16	13	A-6b (10)	-	
	844.7	4	10 11 12	28	50	SS-3	4.50	-	-	-	-	-	-	-	-	14	A-6b (V)	-	
STIFF, DARK GRAY, **CLAY**, SOME SILT, SOME SAND, SOME GRAVEL, SLIGHTLY ORGANIC, CONTAINS WOOD FRAGMENTS, DAMP	843.2	5 6 7 EOB	9 10 11	25	72	SS-4	1.75	-	-	-	-	-	-	-	-	20	A-7-6 (V)	-	

NOTES: GROUNDWATER NOT ENCOUNTERED DURING DRILLING. HOLE DID NOT CAVE.

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

PROJECT: FRA-270-32.92
TYPE: SUBGRADE
PID: 113663 SFN:
START: 1/20/23 END: 1/20/23

DRILLING FIRM / OPERATOR: NEAS / ASHBAUGH
SAMPLING FIRM / LOGGER: NEAS / JL
DRILLING METHOD: 3.25" HSA
SAMPLING METHOD: SPT

DRILL RIG: CME 45B
HAMMER: CME AUTOMATIC
CALIBRATION DATE: 1/24/22
ENERGY RATIO (%): 72.6

STATION / OFFSET: 65+81, 76' LT.
ALIGNMENT: EXIST EASTON WAY RW
ELEVATION: 847.4 (MSL) EOB: 7.5 ft.
LAT / LONG: 40.048319, -82.906878

EXPLORATION ID B-010-0-22

MATERIAL DESCRIPTION AND NOTES	ELEV. 847.4	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
5.0" TOPSOIL (DRILLERS DESCRIPTION)	847.0																		
MEDIUM DENSE, DARK GRAY, **GRAVEL AND STONE FRAGMENTS WITH SAND, SILT, AND CLAY**, SLIGHTLY ORGANIC, DAMP **(FILL)**	844.4	1	5 7 6	16	39	SS-1	-	46	21	9	15	9	32	20	12	10	A-2-6 (0)	213	
		2	8 9 10	23	50	SS-2	-	-	-	-	-	-	-	-	-	14	A-2-6 (V)	-	
HARD, DARK GRAY, **SILT AND CLAY**, LITTLE TO SOME SAND, TRACE TO LITTLE STONE FRAGMENTS, STONE FRAGMENTS ARE VERY WEAK SHALE, RELIC ROCK STRUCTURE, DAMP		3	9 9 11	24	56	SS-3	4.50	6	9	15	42	28	39	24	15	16	A-6a (9)	-	
		4	11 11 12	28	22	SS-4	4.50	-	-	-	-	-	-	-	-	16	A-6a (V)	-	
		5	11 14 12	31	17	SS-5	4.50	-	-	-	-	-	-	-	-	12	A-6a (V)	-	
	839.9	6 EOB																	

NOTES: GROUNDWATER NOT ENCOUNTERED DURING DRILLING. HOLE DID NOT CAVE.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: SHOVELED SOIL CUTTINGS

APPENDIX C

GEOTECHNICAL BULLETIN 1 (GB1) 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.)

FRA-270-32.92-Entire Project
113663

VAR-Statewide Safety Design [Converting a single lane ramp to two-lane exit that opens to 3 lanes]

NEAS, Inc.

Prepared By: Derar Tarawneh, Ph.D., E.I.
Date prepared: Monday, February 13, 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: 10

#	Boring ID	Alignment	Station	Offset	Dir	Drill Rig	ER	Boring EL.	Proposed Subgrade EL	Cut Fill
1	B-001-0-22	IR-270 SB Ramp	1367+72	30	RT	CME 45B	73	869.3	867.8	1.5 C
2	B-002-0-22	IR-270 SB Ramp	1370+36	7	LT	CME 45B	73	861.0	859.8	1.2 C
3	B-003-0-22	IR-270 SB Ramp	1375+10	2	RT	CME 45B	73	847.0	846.1	0.9 C
4	B-004-0-22	IR-270 SB Ramp	1379+29	8	LT	CME 45B	73	843.8	842.2	1.6 C
5	B-005-0-22	IR-270 SB Ramp	1382+89	3	LT	CME 45B	73	841.5	840.7	0.8 C
6	B-006-0-22	IR-270 SB Ramp	1387+14	23	LT	CME 45B	73	848.7	846.7	2.0 C
7	B-007-0-22	IR-270 SB Ramp	1390+34	15	LT	CME 45B	73	854.4	853.5	0.9 C
8	B-008-0-22	Easton Way	75+62	31	LT	CME 45B	73	861.1	859.6	1.5 C
9	B-009-0-22	IR-270 SB Ramp	1394+26	7	RT	CME 45B	73	850.7	849.2	1.5 C
10	B-010-0-22	Easton Way	65+81	76	LT	CME 45B	73	847.4	845.9	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	12			23	17	6	17	10	27	6	10	A-2-4	0	4200					
	001-0	SS-2	3.0	4.5	1.5	3.0	16		3	43	20	23	37	39	76	18	18	A-7-6	14						
	22	SS-3	4.5	6.0	3.0	4.5	21		4.5							14	18	A-7-6	16						
		SS-4	6.0	7.5	4.5	6.0	17	12	4.5							18	18	A-7-6	16						
2	B	SS-1	1.5	3.0	0.3	1.8	16			NP	NP	NP	12	3	15	2	6	A-1-b	0	3233					
	002-0	SS-2	3.0	4.5	1.8	3.3	19		4.5	35	18	17	30	28	58	13	16	A-6b	7						
	22	SS-3	4.5	6.0	3.3	4.8	22		4.25							19	16	A-6b	16						
		SS-4	6.0	7.5	4.8	6.3	21	16	4							15	18	A-7-6	16						
3	B	SS-1	1.5	3.0	0.6	2.1	16			37	18	19	25	24	49	13	16	A-6b	6	20					
	003-0	SS-2	3.0	4.5	2.1	3.6	18			27	17	10	22	9	31	9	10	A-2-4	0						
	22	SS-3	4.5	6.0	3.6	5.1	21		4.5	34	18	16	37	30	67	14	16	A-6b	9						
		SS-4	6.0	7.5	5.1	6.6	25	16	4.5							11	10	A-4a							
4	B	SS-1	1.5	3.0	-0.1	1.4	16		4.25	46	20	26	35	46	81	18	18	A-7-6	16	200					
	004-0	SS-2	3.0	4.5	1.4	2.9	16			44	20	24	34	41	75	21	18	A-7-6	14			Mc			
	22	SS-3	4.5	6.0	2.9	4.4	19									20	18	A-7-6	16						
		SS-4	6.0	7.5	4.4	5.9	24	16	4.5							17	14	A-6a	10						
5	B	SS-1	1.5	3.0	0.7	2.2	17			28	17	11	23	19	42	13	14	A-6a	2	80					
	005-0	SS-2	3.0	4.5	2.2	3.7	17		3.5	30	18	12	31	26	57	15	14	A-6a	5						
	22	SS-3	4.5	6.0	3.7	5.2	21		3.75							14	14	A-6a	10						
		SS-4	6.0	7.5	5.2	6.7	24	17	4.5							16	14	A-6a							
6	B	SS-1	0.0	1.5	-2.0	-0.5	11		3.25	46	19	27	36	39	75	20	18	A-7-6	16	1533					
	006-0	SS-2	1.5	3.0	-0.5	1.0	11		3.5	43	22	21	38	35	73	22	19	A-7-6	13			N_{60} & Mc		12"	
	22	SS-3	3.0	4.5	1.0	2.5	11		3							25	18	A-7-6	16			N_{60} & Mc		12"	
		SS-4	4.5	6.0	2.5	4.0	11	11	3.75							22	18	A-7-6	16						
7	B	SS-1	0.0	1.5	-0.9	0.6	13		1.5	41	21	20	30	28	58	18	18	A-7-6	9	233		HP		12"	
	007-0	SS-2	1.5	3.0	0.6	2.1	12			32	19	13	18	14	32	13	10	A-2-6	1			N_{60} & Mc		12"	
	22	SS-3	3.0	4.5	2.1	3.6	11		2.5							20	18	A-7-6	16						
		SS-4	4.5	6.0	3.6	5.1	16	11	1.25							22	18	A-7-6	16						
8	B	SS-1	1.5	3.0	0.0	1.5	18			NP	NP	NP	9	3	12	5	6	A-1-a	0	467					
	008-0	SS-2	3.0	4.5	1.5	3.0	11		3.25	40	20	20	34	35	69	19	16	A-6b	11			N_{60} & Mc			
	22	SS-3	4.5	6.0	3.0	4.5	13		2.25							25	16	A-6b	16						
		SS-4	6.0	7.5	4.5	6.0	12	11	2.25							21	16	A-6b	16						
9	B	SS-1	1.5	3.0	0.0	1.5	19		4.5	40	20	20	37	41	78	17	16	A-6b	12	540					
	009-0	SS-2	3.0	4.5	1.5	3.0	23		4.5	34	18	16	37	35	72	13	16	A-6b	10						
	22	SS-3	4.5	6.0	3.0	4.5	28		4.5							14	16	A-6b	16						
		SS-4	6.0	7.5	4.5	6.0	25	19	1.75							20	18	A-7-6	16						

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	
10	B	SS-1	0.0	1.5	-1.5	0.0	16			32	20	12	15	9	24	10	10	A-2-6	0	213					
	010-0	SS-2	1.5	3.0	0.0	1.5	23									14	10	A-2-6	4			Mc			
	22	SS-3	3.0	4.5	1.5	3.0	24		4.5	39	24	15	42	28	70	16	19	A-6a	9						
		SS-4	4.5	6.0	3.0	4.5	28	23	4.5							16	14	A-6a	10						

OHIO DEPARTMENT OF TRANSPORTATION

Subgrade Analysis

V. 14.6 2/11/2022

PID: 113663

County-Route-Section: FRA-270-32.92-Entire Project
No. of Borings: 10

Geotechnical Consultant: NEAS, Inc.
Prepared By: Derar Tarawneh, Ph.D., E.I.
Date prepared: 2/13/2023

Chemical Stabilization Options		
320	Rubblize & Roll	Option
206	Cement Stabilization	Option
	Lime Stabilization	Option
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	6

% Samples within 6 feet of subgrade			
$N_{60} \leq 5$	0%	HP ≤ 0.5	0%
$N_{60} < 12$	13%	0.5 < HP ≤ 1	0%
$12 \leq N_{60} < 15$	13%	1 < HP ≤ 2	8%
$N_{60} \geq 20$	37%	HP > 2	66%
M+	16%		
Rock	0%		
Unsuitable	0%		

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

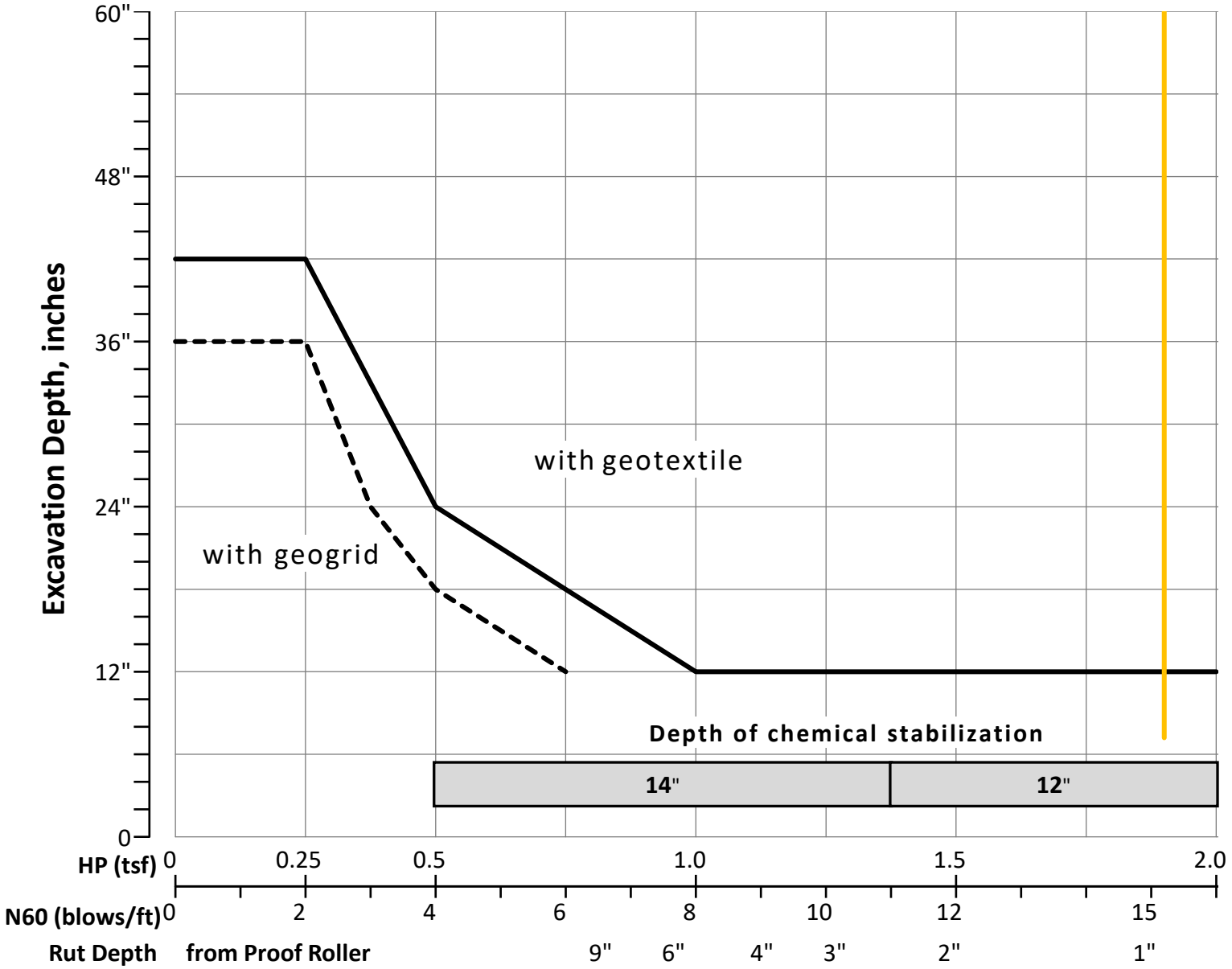
% Proposed Subgrade Surface	
Unstable & Unsuitable	29%
Unstable	29%
Unsuitable	0%

	N_{60}	N_{60L}	HP	LL	PL	PI	Silt	Clay	P 200	M_C	M_{OPT}	GI
Average	18	15	3.63	36	19	17	29	26	55	16	15	11
Maximum	28	23	4.50	46	24	27	42	46	81	25	19	16
Minimum	11	11	1.25	23	17	6	9	3	12	2	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	1	1	2	0	2	0	0	0	1	0	0	7	10	0	14	0	0	38
Percent	0%	3%	3%	5%	0%	5%	0%	0%	0%	3%	0%	0%	18%	26%	0%	37%	0%	0%	100%
% Rock|Granular|Cohesive	0%	18%									82%								100%
Surface Class Count	0	1	1	2	0	3	0	0	0	0	0	0	3	5	0	9	0	0	24
Surface Class Percent	0%	4%	4%	8%	0%	13%	0%	0%	0%	0%	0%	0%	13%	21%	0%	38%	0%	0%	100%

Fig. 600-1 – Subgrade Stabilization



OVERRIDE TABLE

Calculated Average	New Values	Check to Override
3.63	0.50	☐ HP
15.20	6.00	☐ N60L

Average HP
Average N_{60L}

IR-270 SB EXIT RAMP

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.)

FRA-270-32.92-IR-270 SB Ramp
113663
VAR-Statewide Safety Design [Converting a single lane ramp to two-lane exit that opens to 3 lanes]

NEAS, Inc.

Prepared By: Derar Tarawneh, Ph.D., E.I.
Date prepared: Monday, February 13, 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: 8

#	Boring ID	Alignment	Station	Offset	Dir	Drill Rig	ER	Boring EL.	Proposed Subgrade EL	Cut Fill
1	B-001-0-22	IR-270 SB Ramp	1367+72	30	RT	CME 45B	73	869.3	867.8	1.5 C
2	B-002-0-22	IR-270 SB Ramp	1370+36	7	LT	CME 45B	73	861.0	859.8	1.2 C
3	B-003-0-22	IR-270 SB Ramp	1375+10	2	RT	CME 45B	73	847.0	846.1	0.9 C
4	B-004-0-22	IR-270 SB Ramp	1379+29	8	LT	CME 45B	73	843.8	842.2	1.6 C
5	B-005-0-22	IR-270 SB Ramp	1382+89	3	LT	CME 45B	73	841.5	840.7	0.8 C
6	B-006-0-22	IR-270 SB Ramp	1387+14	23	LT	CME 45B	73	848.7	846.7	2.0 C
7	B-007-0-22	IR-270 SB Ramp	1390+34	15	LT	CME 45B	73	854.4	853.5	0.9 C
8	B-009-0-22	IR-270 SB Ramp	1394+26	7	RT	CME 45B	74	850.7	849.2	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	12			23	17	6	17	10	27	6	10	A-2-4	0	4200					
	001-0	SS-2	3.0	4.5	1.5	3.0	16		3	43	20	23	37	39	76	18	18	A-7-6	14						
	22	SS-3	4.5	6.0	3.0	4.5	21		4.5							14	18	A-7-6	16						
		SS-4	6.0	7.5	4.5	6.0	17	12	4.5							18	18	A-7-6	16						
2	B	SS-1	1.5	3.0	0.3	1.8	16			NP	NP	NP	12	3	15	2	6	A-1-b	0	3233					
	002-0	SS-2	3.0	4.5	1.8	3.3	19		4.5	35	18	17	30	28	58	13	16	A-6b	7						
	22	SS-3	4.5	6.0	3.3	4.8	22		4.25							19	16	A-6b	16						
		SS-4	6.0	7.5	4.8	6.3	21	16	4							15	18	A-7-6	16						
3	B	SS-1	1.5	3.0	0.6	2.1	16			37	18	19	25	24	49	13	16	A-6b	6	20					
	003-0	SS-2	3.0	4.5	2.1	3.6	18			27	17	10	22	9	31	9	10	A-2-4	0						
	22	SS-3	4.5	6.0	3.6	5.1	21		4.5	34	18	16	37	30	67	14	16	A-6b	9						
		SS-4	6.0	7.5	5.1	6.6	25	16	4.5							11	10	A-4a							
4	B	SS-1	1.5	3.0	-0.1	1.4	16		4.25	46	20	26	35	46	81	18	18	A-7-6	16	200					
	004-0	SS-2	3.0	4.5	1.4	2.9	16			44	20	24	34	41	75	21	18	A-7-6	14			Mc			
	22	SS-3	4.5	6.0	2.9	4.4	19									20	18	A-7-6	16						
		SS-4	6.0	7.5	4.4	5.9	24	16	4.5							17	14	A-6a	10						
5	B	SS-1	1.5	3.0	0.7	2.2	17			28	17	11	23	19	42	13	14	A-6a	2	80					
	005-0	SS-2	3.0	4.5	2.2	3.7	17		3.5	30	18	12	31	26	57	15	14	A-6a	5						
	22	SS-3	4.5	6.0	3.7	5.2	21		3.75							14	14	A-6a	10						
		SS-4	6.0	7.5	5.2	6.7	24	17	4.5							16	14	A-6a							
6	B	SS-1	0.0	1.5	-2.0	-0.5	11		3.25	46	19	27	36	39	75	20	18	A-7-6	16	1533					
	006-0	SS-2	1.5	3.0	-0.5	1.0	11		3.5	43	22	21	38	35	73	22	19	A-7-6	13			N_{60} & Mc		12"	
	22	SS-3	3.0	4.5	1.0	2.5	11		3							25	18	A-7-6	16			N_{60} & Mc		12"	
		SS-4	4.5	6.0	2.5	4.0	11	11	3.75							22	18	A-7-6	16						
7	B	SS-1	0.0	1.5	-0.9	0.6	13		1.5	41	21	20	30	28	58	18	18	A-7-6	9	233		HP		12"	
	007-0	SS-2	1.5	3.0	0.6	2.1	12			32	19	13	18	14	32	13	10	A-2-6	1			N_{60} & Mc		12"	
	22	SS-3	3.0	4.5	2.1	3.6	11		2.5							20	18	A-7-6	16						
		SS-4	4.5	6.0	3.6	5.1	16	11	1.25							22	18	A-7-6	16						
8	B	SS-1	1.5	3.0	0.0	1.5	19		4.5	40	20	20	37	41	78	17	16	A-6b	12	540					
	009-0	SS-2	3.0	4.5	1.5	3.0	23		4.5	34	18	16	37	35	72	13	16	A-6b	10						
	22	SS-3	4.5	6.0	3.0	4.5	28		4.5							14	16	A-6b	16						
		SS-4	6.0	7.5	4.5	6.0	25	19	1.75							20	18	A-7-6	16						

OHIO DEPARTMENT OF TRANSPORTATION

Subgrade Analysis

V. 14.6 2/11/2022

PID: 113663

County-Route-Section: FRA-270-32.92-IR-270 SB Ramp
No. of Borings: 8

Geotechnical Consultant: NEAS, Inc.
Prepared By: Derar Tarawneh, Ph.D., E.I.
Date prepared: 2/13/2023

Chemical Stabilization Options		
320	Rubblize & Roll	Option
206	Cement Stabilization	Option
	Lime Stabilization	Option
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	6

% Samples within 6 feet of subgrade			
$N_{60} \leq 5$	0%	HP ≤ 0.5	0%
$N_{60} < 12$	13%	0.5 < HP ≤ 1	0%
$12 \leq N_{60} < 15$	10%	1 < HP ≤ 2	10%
$N_{60} \geq 20$	36%	HP > 2	65%
M+	13%		
Rock	0%		
Unsuitable	0%		

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

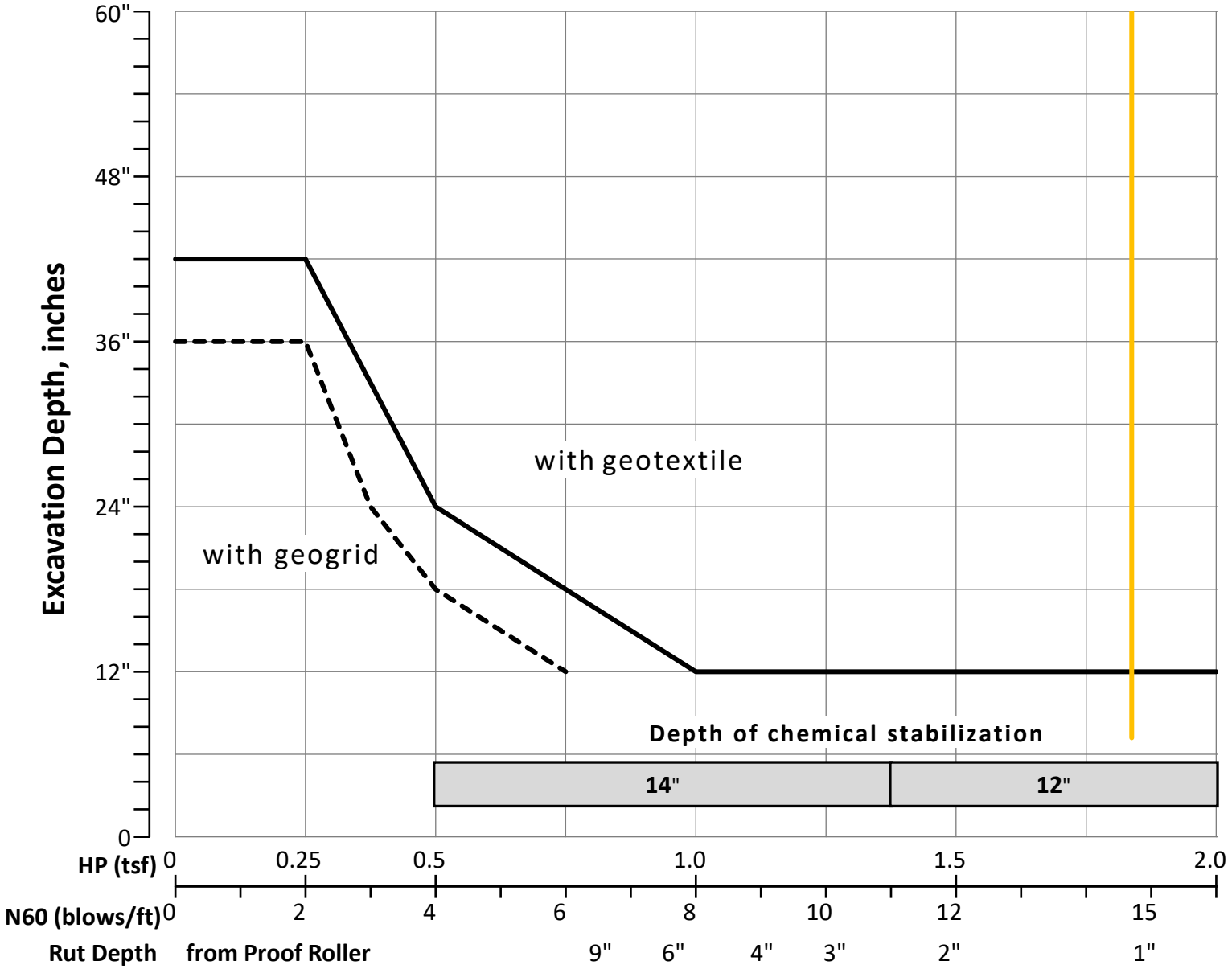
% Proposed Subgrade Surface	
Unstable & Unsuitable	26%
Unstable	26%
Unsuitable	0%

	N_{60}	N_{60L}	HP	LL	PL	PI	Silt	Clay	P 200	M_C	M_{OPT}	GI
Average	18	15	3.70	36	19	17	29	27	56	16	16	11
Maximum	28	19	4.50	46	22	27	38	46	81	25	19	16
Minimum	11	11	1.25	23	17	6	12	3	15	2	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	1	2	0	1	0	0	0	1	0	0	5	7	0	14	0	0	31
Percent	0%	0%	3%	6%	0%	3%	0%	0%	0%	3%	0%	0%	16%	23%	0%	45%	0%	0%	100%
% Rock|Granular|Cohesive	0%	16%									84%								100%
Surface Class Count	0	0	1	2	0	1	0	0	0	0	0	0	2	4	0	9	0	0	19
Surface Class Percent	0%	0%	5%	11%	0%	5%	0%	0%	0%	0%	0%	0%	11%	21%	0%	47%	0%	0%	100%

Fig. 600-1 – Subgrade Stabilization



OVERRIDE TABLE

Calculated Average	New Values	Check to Override
3.70	0.50	☐ HP
14.75	6.00	☐ N60L

Average HP
Average N_{60L}

EASTON WAY

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.)

FRA-270-32.92-Easton Way
113663
VAR-Statewide Safety Design [Converting a single lane ramp to two-lane exit that opens to 3 lanes]

NEAS, Inc.

Prepared By: Derar Tarawneh, Ph.D., E.I.
Date prepared: Monday, February 13, 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: 3

#	Boring ID	Alignment	Station	Offset	Dir	Drill Rig	ER	Boring EL.	Proposed Subgrade EL	Cut Fill
1	B-008-0-22	Easton Way	75+62	31	Lt	CME 45B	73	861.1	859.6	1.5 C
2	B-009-0-22	Easton Way	69+45	62	Lt	CME 45B	73	850.7	849.2	1.5 C
3	B-010-0-22	Easton Way	65+81	76	Lt	CME 45B	73	847.4	845.9	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	18			NP	NP	NP	9	3	12	5	6	A-1-a	0	467					
	008-0	SS-2	3.0	4.5	1.5	3.0	11		3.25	40	20	20	34	35	69	19	16	A-6b	11			N_{60} & Mc			
	22	SS-3	4.5	6.0	3.0	4.5	13		2.25							25	16	A-6b	16						
		SS-4	6.0	7.5	4.5	6.0	12	11	2.25							21	16	A-6b	16						
2	B	SS-1	1.5	3.0	0.0	1.5	19		4.5	40	20	20	37	41	78	17	16	A-6b	12	540					
	009-0	SS-2	3.0	4.5	1.5	3.0	23		4.5	34	18	16	37	35	72	13	16	A-6b	10						
	22	SS-3	4.5	6.0	3.0	4.5	28		4.5							14	16	A-6b	16						
		SS-4	6.0	7.5	4.5	6.0	25	19	1.75							20	18	A-7-6	16						
3	B	SS-1	0.0	1.5	-1.5	0.0	16			32	20	12	15	9	24	10	10	A-2-6	0	213					
	010-0	SS-2	1.5	3.0	0.0	1.5	23									14	10	A-2-6	4			Mc			
	22	SS-3	3.0	4.5	1.5	3.0	24		4.5	39	24	15	42	28	70	16	19	A-6a	9						
		SS-4	4.5	6.0	3.0	4.5	28	23	4.5							16	14	A-6a	10						

OHIO DEPARTMENT OF TRANSPORTATION

Subgrade Analysis

V. 14.6 2/11/2022

PID: 113663

County-Route-Section: FRA-270-32.92-Easton Way
No. of Borings: 3

Geotechnical Consultant: NEAS, Inc.
Prepared By: Derar Tarawneh, Ph.D., E.I.
Date prepared: 2/13/2023

Chemical Stabilization Options		
320	Rubblize & Roll	Option
206	Cement Stabilization	Option
	Lime Stabilization	Option
206	Depth	NA

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

Design CBR	6

% Samples within 6 feet of subgrade			
$N_{60} \leq 5$	0%	HP ≤ 0.5	0%
$N_{60} < 12$	9%	0.5 < HP ≤ 1	0%
$12 \leq N_{60} < 15$	18%	1 < HP ≤ 2	9%
$N_{60} \geq 20$	55%	HP > 2	73%
M+	18%		
Rock	0%		
Unsuitable	0%		

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

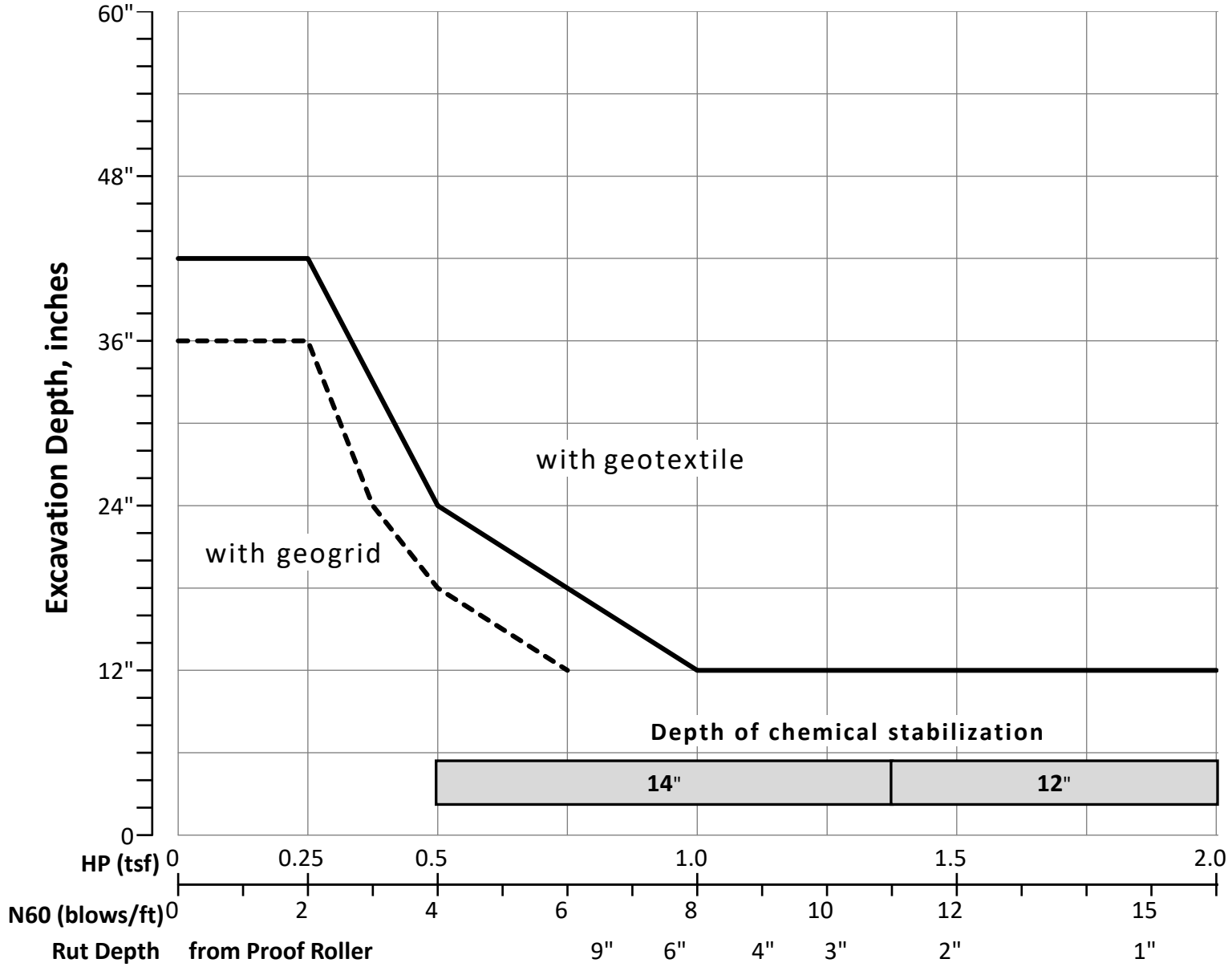
% Proposed Subgrade Surface	
Unstable & Unsuitable	29%
Unstable	29%
Unsuitable	0%

	N_{60}	N_{60L}	HP	LL	PL	PI	Silt	Clay	P 200	M_C	M_{OPT}	GI
Average	20	18	3.56	38	21	18	32	28	60	16	15	11
Maximum	28	23	4.50	40	24	20	42	41	78	25	19	16
Minimum	11	11	1.75	32	18	12	9	3	12	5	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	1	0	0	0	1	0	0	0	0	0	0	2	6	0	1	0	0	11
Percent	0%	9%	0%	0%	0%	9%	0%	0%	0%	0%	0%	0%	18%	55%	0%	9%	0%	0%	100%
% Rock|Granular|Cohesive	0%	18%									82%								100%
Surface Class Count	0	1	0	0	0	2	0	0	0	0	0	0	1	3	0	0	0	0	7
Surface Class Percent	0%	14%	0%	0%	0%	29%	0%	0%	0%	0%	0%	0%	14%	43%	0%	0%	0%	0%	100%

Fig. 600-1 – Subgrade Stabilization



OVERRIDE TABLE

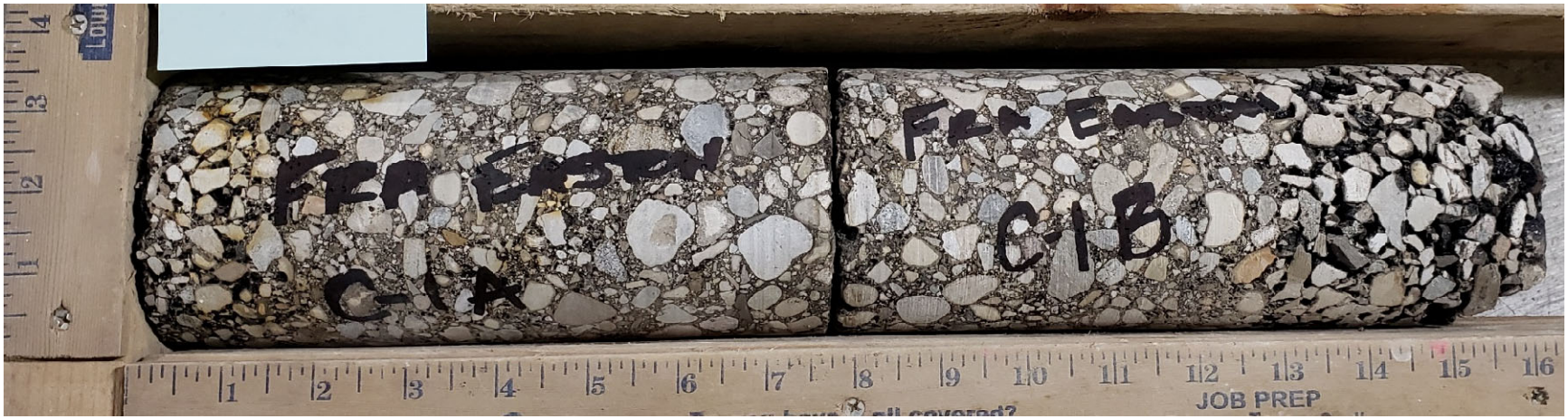
Calculated Average	New Values	Check to Override
3.56	0.50	☐ HP
17.67	6.00	☐ N60L

Average HP
Average N_{60L}

APPENDIX D

PAVEMENT CORE LOGS

Core Photo: P.C.-1



Core Information				
Core Diameter (in):			**3.75**	
Core Total Length (in):			**16.75**	
Layers	Core Composition & Thickness (in)			Remarks/ Condition
	Asphalt	Concrete	Brick	
1	1.25			Good
2	6.25			Good
3	5.5			Good
4	3.75			Good
Rebar Encountered	N/A			

Pavement & Core Photo Log

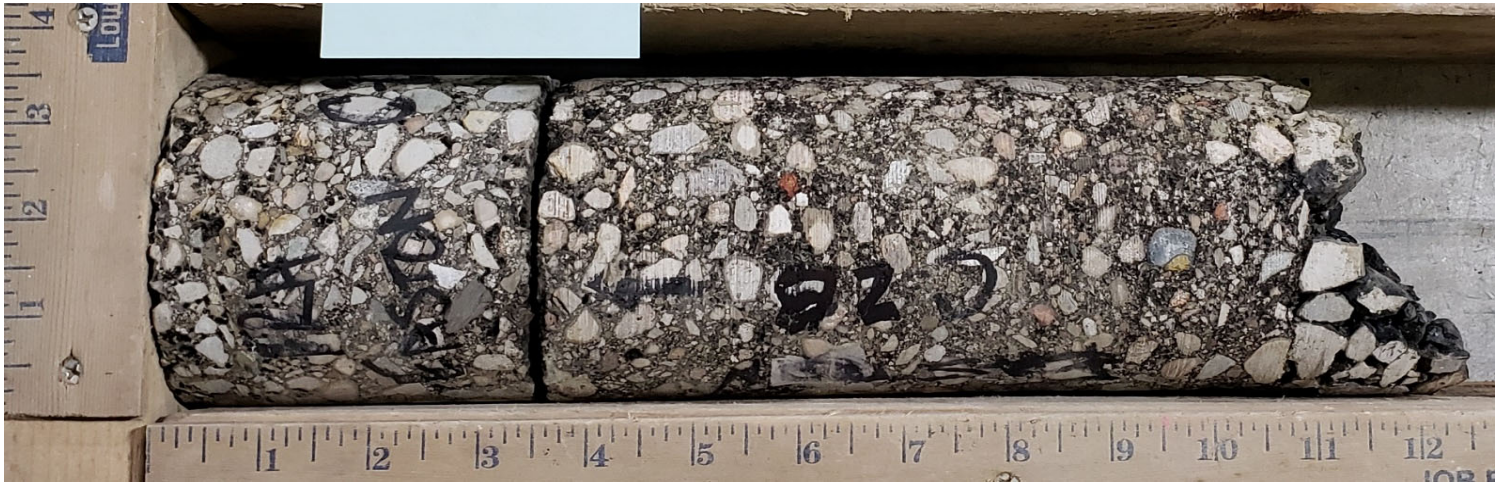
National Engineering & Architectural Services Inc.

Roadway Project

FRA-270-32.92

NEAS Project No.:	113663
Date:	2/9/2023
Taken By:	LR
Scale:	N/A

Core Photo: P.C.-2



Core Information				
Core Diameter (in):			**3.75**	
Core Total Length (in):			**13**	
Layers	Core Composition & Thickness (in)			Remarks/ Condition
	Asphalt	Concrete	Brick	
1	1.25			Good
2	2.25			Good
3	7.5			Good
4	2			Good
Rebar Encountered	N/A			

Pavement & Core Photo Log

National Engineering & Architectural Services Inc.

Roadway Project

FRA-270-32.92

NEAS Project No.:	113663
Date:	2/9/2023
Taken By:	LR
Scale:	N/A