RESOURCE INTERNATIONAL, INC.
6350 Presidential Gateway
Columbus, Ohio 43231
T: 614.823.4949

February 25, 2019

Ms. Shelby Ingle, P.E.
Project Manager
Crawford, Murphy & Tilly
84 Remick Blvd.
Springboro, OH 45066

Re: Draft Subgrade Exploration
GRE- SR 444- 4.60
Central Avenue Reconstruction
ODOT PID No. 107120
Fairborn, Ohio
Rii Project No. W-18-111

Ms. Ingle:

Resource International, Inc. is pleased to submit this draft subgrade exploration report for the above-referenced project. Engineering logs have been prepared and are attached to this report along with the results of laboratory testing. This report includes recommendations for the design and construction of the proposed Central Avenue (SR 444) Reconstruction project in Fairborn, Ohio.

We appreciate having been given the opportunity to be of service to you on this project. If you have any questions concerning the subgrade exploration or this report, please do not hesitate to contact us.

Sincerely,

RESOURCE INTERNATIONAL, INC.

Leila Sadeghi, Ph.D.
Staff Engineer – Geotechnical and Pavement Services

Brian R. Trenner, P.E.
Director – Geotechnical Services

Enclosure: Draft Subgrade Exploration Report

TABLE OF CONTENTS

APPENDICES

EXECUTIVE SUMMARY

Resource International, Inc. (Rii) has completed a subgrade exploration report for the reconstruction of the proposed Central Avenue (SR 444) Reconstruction project in Fairborn, Ohio. The project is understood to consist of the reconstruction of Central Avenue from Lindberg Drive to Dayton Drive. Based on profile information provided by Crawford, Murphy and Tilly (CMT), it is understood that the proposed grade of Central Avenue will remain within 1.2 feet of the existing grade. The proposed grade at stations 243+69, 247+44, 257+32, 261+48 and 269+45 will be lowered up to 0.3 feet. The proposed grade will be lowered 1.2 feet and elevated 0.05 feet at station 251+65 and station 265+92, respectively.

Exploration and Findings

On August 10, 2018, a total of seven (7) borings, designated as B-001-0-18 through B-007-0-18, were advanced to depths ranging from 7.0 to 9.4 feet below the existing ground surface grade at the locations illustrated on the boring plan presented in Appendix I of the full report.

All of the borings were performed within the existing pavement of Central Avenue. All of the borings, except B-005-0-18, encountered a full-depth asphalt pavement consisting of 4.0 to 6.0 inches of asphalt. Boring B-005-0-18 encountered a composite pavement consisting of 5.0 inches of asphalt overlying 12.0 inches of concrete. Aggregate base with a thickness ranging from 7.0 to 14.0 inches was encountered below pavement structure in all of the borings.

Beneath the surface materials, natural cohesive and granular soils were encountered extending to the boring termination depths. The cohesive soils were generally described as medium stiff to very stiff brown and dark brown to dark gray and black sandy silt, silt and clay, silty clay and clay (ODOT A-4a, A-6a, A-6b, A-7-6). The granular soils were generally described as loose to dense, brown and dark brown to gray and dark gray gravel, gravel and sand, gravel with sand, silt and clay, and coarse and fine sand (ODOT A-1-a, A-1-b, A-2-6, A-3a).

Bedrock was not encountered in any of the borings performed for this exploration.

Analysis and Recommendations

The soils at the proposed subgrade elevation consist of cohesive materials comprised of medium stiff to very stiff silt and clay, silty clay and clay (ODOT A-6a, A-6b, A-7-6) and granular materials compromised of loose to medium dense gravel with sand, silt and clay (ODOT A-2-6). Based on the soil conditions encountered during the drilling phase, it is estimated that the subgrade soils will require some level of stabilization under ODOT GB1. Based on profile information provided by CMT, it is understood that

the proposed grade of Central Avenue will be lowered up to 0.3 feet at most of the alignment except stations 251+65 and 265+92. The proposed grade at station 251+65 will be lowered approximately 1.2 feet and the proposed grade at station 265+92 will be elevated approximately 0.05 feet.

Based on the ODOT GB1, the overall average site parameters are noted as follows:

Overall Average Site Parameters

Average N_{60L}	Average PI	Average Moisture	Average Optimum Moisture	Average Group Index	Design CBR
6	18	15	12	5	8

Global stabilization options were determined based on N_{60} of 8, rather than N_{60L} of 6, based the soil conditions present within 3.0 feet of the proposed subgrade elevation. California Bearing Ratio (CBR) values for the entire project ranged from 3 to 12 with an average of 8. If it is elected to proceed with global stabilization, it is recommended that pavement design be based on the average CBR of 8 with a corresponding resilient modulus, M_R, of 9,600 psi. Correlation charts indicate a modulus of subgrade reaction (K) of 182 pci and a soil support value (SSV) of 5.4. If station by station stabilization option will be utilized, due to presence of marginal soils at subgrade elevation, it is recommended that pavement design be based on a CBR of 5 with a corresponding resilient modulus, M_R, of 6,000 psi, modulus of subgrade reaction (K) of 135 pci and soil support value (SSV) of 3.8.

In general, the majority of the subgrade soils within the limits of the pavement replacement will require stabilization for pavement support in its current condition. Station by station and global stabilization options are provided in Section 5.1.1 and 5.1.2 of the full report, respectively.

In addition, per ODOT GB1, soils with sulfate content in excess of 5,000 ppm cannot be chemically stabilized due to the potential for sulfate heave in the soil. Based on the results of the testing, the sulfate contents of the subgrade soils range from 113 to 327 parts per million (ppm or mg/kg of material). Therefore, soil with a sulfate content greater than 5,000 ppm was not encountered in any of the borings.

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

1.0 INTRODUCTION

This report is a presentation of the subgrade exploration for the proposed Central Avenue (SR 444) Reconstruction project in Fairborn, Ohio. It is understood that Central Avenue will be reconstructed from Lindberg Drive to Dayton Drive. The total project length is approximately 0.54 miles. Based on profile information provided by Crawford, Murphy and Tilly (CMT), it is understood that the proposed grade of Central Avenue will remain within 1.2 feet of the existing grade. The proposed grade at stations 243+69, 247+44, 257+32, 261+48 and 269+45 will be lowered up to 0.3 feet. The proposed grade will be lowered 1.2 feet and elevated 0.05 feet at station 251+65 and station 265+92, respectively. Potential improvements along Central Avenue within the project limit include full-depth pavement reconstruction, curb replacement and minor drainage improvements. It is understood that the project alignment crosses the Norfolk Southern railway but the project does not include any work within 10 feet of the tracks.

2.0 GEOLOGY AND OBSERVATIONS OF THE PROJECT

2.1 Site Geology

Both the Illinoian and Wisconsinan glaciers advanced over two-thirds of the State of Ohio, leaving behind glacial features such as moraines, kame deposits, lacustrine deposits and outwash terraces. The glacial and non-glacial regions comprise five physiographic sections grouped by age, depositional process and geomorphic occurrence. Physiographically, the site lies within the Southern Ohio Loamy Till Plain of the Central Lowland Province. This region is characterized by relatively flat-lying silty loam till ground moraine, interspersed with end and recessional moraines, outwash and alluvial deposits. Ground moraines are deposited during the retreat of a glacier which results in an undifferentiated mixture of clay, silt, sand and gravel. End moraines are normally associated with ice melting that is neither advancing nor retreating for a period of time. Recessional moraines are deposited during the retreat of a glacial ice sheet. Both end and recessional moraines are commonly associated with boulder belts. Outwash deposits consist of undifferentiated sand and gravel deposited by meltwater in front of glacial ice and often occurs as valley terraces or low plains. Alluvium and alluvial terrace deposits range in composition from silty clay to cobble sized particles and are usually deposited in present and former floodplain areas. Kame deposits, steep sided alluvial cone (river transported material) deposited by glacial meltwaters against an ice front are present throughout the region. Typically, a kame is comprised of poorly graded and bedded sand and gravel.

Based on bedrock geology and topography maps obtained from the Ohio Department of Natural Resources (ODNR), the bedrock underlying the glacial deposits consists of the Upper Ordovician-aged Cincinnati Group. The Cincinnati Group consists of interbedded shale, limestone, and dolomite. The shale is calcareous, dolomitic and silty and ranges from various shades of gray, olive, red and green in color. The limestone and dolomite are finely to coarsely crystalline and argillaceous, and contain thin to medium, irregular,

nodular to wavy bedding and range from shades of gray, olive and yellowish gray. The unit contains sparse to abundant fossils. According to bedrock topography mapping, the site lies on an irregularly shaped slope of a bedrock valley wall. This bedrock valley roughly follows the Mad River and branches to the southeast south of the City of Fairborn. The bedrock valley bottom lies approximately at an elevation of 600± feet mean sea level. The site lies along the side of the bedrock valley with the bedrock sloping downward to the north, from an approximate elevation of 800 feet msl at the southern end of the project to 700 feet msl at the northern end of the project. The depth to bedrock in the vicinity of the site ranges from approximately 34 to 135 feet below the ground surface.

2.2 Existing Site Conditions

The project is located along Central Avenue from Lindberg Drive to Dayton Drive in City of Fairborn in Greene County, Ohio. The existing Central Avenue is a four-lane bidirectional roadway with full-depth asphalt or composite asphalt over concrete pavement that is extended north to south. Curbs and sidewalks present along the majority of alignment. It is understood that the Average Annual Daily Traffic (AADT) within the project limit is in the order of 11,000 vehicles per day (vpd). The existing pavement along the project alignment is in poor condition exhibiting severe longitudinal and alligator cracking as well as patch deterioration at some areas and has numerous utility cuts. The project alignment traverses primarily residential properties and some commercial properties. It is understood that the roadway also traverses Norfolk Southern railway. The existing profile grade along Central Avenue is pretty flat with the elevation of approximately 834 feet mean sea level (msl). The grade elevation is approximately ten (10) feet higher in elevation where the roadway crosses the railroad.

3.0 EXPLORATION

On August 10, 2018, a total of seven (7) borings, designated as B-001-0-18 through B-007-0-18, were advanced to depths ranging from 7.0 to 9.4 feet below the existing ground surface grade. The borings were drilled at the locations illustrated on the boring plan presented in Appendix I of this report and summarized in Table 1.

Table 1. Test Boring Summary

Reference Alignment	Boring Number	Station	Offset	Latitude	Longitude	Ground Elevation (feet msl)	Boring Depth (feet)
Central Avenue (SR 444)	B-001-0-18	243+69	17' RT.	39.812113	-84.023746	834.4	7.7
	B-002-0-18	247+44	20' LT.	39.812959	-84.022975	836.4	7.5
	B-003-0-18	251+65	24' RT.	39.813782	-84.021895	845.9	7.0
	B-004-0-18	257+32	17' LT.	39.815344	-84.021727	839.1	7.0
	B-005-0-18	261+48	15' RT.	39.816475	-84.021507	833.9	9.4
	B-006-0-18	265+92	15' LT.	39.817699	-84.021494	834.1	7.5
	B-007-0-18	269+45	6' RT.	39.818661	-84.021326	835.5	7.5

The boring locations were determined and located in the field by Rii representatives. The final (as drilled) boring locations were surveyed by representatives of CMT, and the surveyed coordinates and elevations are provided on the boring logs in Appendix III.

In addition to the borings performed, pavement cores were also obtained at all of the boring locations to determine the existing pavement thickness, composition and condition. Photographs of the retained pavement cores are presented in Appendix III, immediately following the respective boring logs. The cores were retained with a portable, 4.0-inch diameter thin-walled, pavement core bit.

The borings were drilled with a truck mounted auger drilling machine, utilizing a 4.5-inch outside diameter, solid flight auger to advance the holes. Standard penetration test (SPT) and split spoon sampling was performed continuously to a depth of 6.0 feet below the pavement section in all of the borings. The SPT, per the American Society for Testing and Materials (ASTM) designation D1586, is conducted using a 140-pound hammer falling 30.0 inches to drive a 2.0-inch outside diameter split spoon sampler 18.0 inches. Rii utilized an automatic drop hammer to generate consistent energy transfer to the sampler. Driving resistance is recorded on the boring logs in terms of blows per 6.0-inch interval of the driving distance. The second and third intervals are added to obtain the number of blows per foot (N). SPT blow counts aid in determining soil properties applicable in pavement design. The measured blow count (N) values were corrected to an equivalent (60%) energy ratio, N_{60}, by the following equation, and are represented on the boring logs in Appendix III.

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

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

The hammer for the CME 55 truck mounted drill rig used for this project was calibrated on September 22, 2016, and has a drill rod energy ratio of 85.9 percent.

Upon completion of drilling, the borings were backfilled with a mixture of sand or bentonite chips and soil cuttings, and any pavement surfaces were repaired with an equivalent thickness of cold patch asphalt or quick set concrete.

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

Table 2. Laboratory Test Schedule

Laboratory Test	Test Designation	Number of Tests Performed
Natural Moisture Content	ASTM D2216	28
Plastic and Liquid Limits	AASHTO T89, T90	14
Sieve/Hydrometer	AASHTO T88	14
Sulfate Content – Colorimetric Method	ODOT S1122	7

The tests performed are necessary to classify existing soil according to the Ohio Department of Transportation (ODOT) classification system and to estimate engineering properties of importance for pavement design and construction recommendations. Results of the laboratory testing are presented on the boring logs in Appendix III. A description of the soil terms used throughout this report is presented in Appendix II.

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

4.0 FINDINGS

Interpreted engineering logs have been prepared from field logs, visual examination of samples and laboratory test results. Classification follows the current version of the ODOT Specifications for Geotechnical Engineering (SGE). The following is a generalization of what was found in the test borings and what is represented on the boring logs.

4.1 Surface Material

Table 3 below notes the measured pavement section at each boring location:

Table 3. Summary of Pavement Thicknesses

Boring Number	Station	Offset	Asphalt Thickness (in)	Concrete Thickness (in)	Aggregate Base Thickness (in)
B-001-0-18	243+69	17' RT.	6.00	-	8.50
B-002-0-18	247+44	20' LT.	5.00	-	13.00
B-003-0-18	251+65	24' RT.	5.00	-	7.00
B-004-0-18	257+32	17' LT.	5.00	-	7.00
B-005-0-18	261+48	15' RT.	5.00	12.00	12.00
B-006-0-18	265+92	15' LT.	4.00	-	14.00
B-007-0-18	269+45	6' RT.	5.00	-	7.00

All of the borings were performed within the existing pavement of Central Avenue. All of the borings, except B-005-0-18, encountered a full-depth asphalt pavement consisting of 4.0 to 6.0 inches of asphalt. Boring B-005-0-18 encountered a composite pavement consisting of 5.0 inches of asphalt overlying 12.0 inches of concrete. Aggregate base with a thickness ranging from 7.0 to 14.0 inches was encountered below pavement structure in all of the borings.

4.2 Subsurface Soils

Beneath the surface materials, natural cohesive and granular soils were encountered extending to the boring termination depths. The cohesive soils were generally described as medium stiff to very stiff brown and dark brown to dark gray and black sandy silt, silt and clay, silty clay and clay (ODOT A-4a, A-6a, A-6b, A-7-6). The granular soils were generally described as loose to dense, brown and dark brown to gray and dark gray gravel, gravel and sand, gravel with sand, silt and clay, and coarse and fine sand (ODOT A-1-a, A-1-b, A-2-6, A-3a).

The shear strength and consistency of the cohesive soils are primarily derived from the hand penetrometer values (HP). The cohesive soil encountered ranged from medium stiff ($0.5 < HP \leq 1.0$ tsf) to very stiff ($2.0 < HP \leq 4.0$ tsf). The unconfined compressive strength of the cohesive soil samples tested, obtained from the hand penetrometer, ranged from 1.0 to 3.5 tsf. The relative density of the granular soils is derived from the SPT blow counts (N_{60}). The relative density of the granular soil ranges from loose ($5 \leq N_{60} \leq 10$ blows per foot [bpf]) to dense ($31 \leq N_{60} \leq 50$ bpf). Overall blow counts recorded from the SPT sampling ranged from 7 to 42 blows per foot (bpf).

Natural moisture contents of the soil samples tested ranged from 5 to 29 percent. The natural moisture contents of the cohesive soil samples tested for plasticity index ranged from 11 percent below to 10 percent above their corresponding plastic limits. In general, the soil exhibited natural moisture contents considered to be significantly below to significantly above optimum moisture levels.

Sulfate testing was performed in accordance with the ODOT Supplement 1122 in the upper soils of the existing subgrade along the project alignment, as outlined in the current ODOT Geotechnical Bulletin GB1: Plan Subgrades (GB1). Based on the results of the testing, the sulfate contents of the subgrade soils range from 67 to 307 parts per million (ppm or mg/kg of material). Results of the sulfate testing at each boring location tested are provided on the respective boring log in Appendix III.

4.3 Bedrock

Bedrock was not encountered in any of the borings performed for this exploration.

4.4 Groundwater

Groundwater was not encountered during or at the completion of drilling in any of the borings performed for this exploration. Please note that short-term water level readings, especially in cohesive materials, are not necessarily an accurate indication of the actual groundwater level. In addition, groundwater levels and the presence of groundwater are considered to be dependent on seasonal fluctuations in precipitation.

A more comprehensive description of the soil encountered during the drilling program can be found on the boring logs in Appendix III.

5.0 ANALYSES AND RECOMMENDATIONS

Data obtained from the drilling and testing program have been used to determine pavement support capabilities for the soils encountered at the site. These parameters have been used to provide guidelines for the design of the pavement system, as well as the construction specifications related to the placement of the pavement and general earthwork recommendations, which is discussed in the following paragraphs.

5.1 Pavement Subgrade Recommendations

The soils at the proposed subgrade elevation consist of cohesive materials comprised of medium stiff to very stiff silt and clay, silty clay and clay (ODOT A-6a, A-6b, A-7-6) and granular materials compromised of loose to medium dense gravel with sand, silt and clay (ODOT A-2-6). Based on the soil conditions encountered during the drilling phase, it is estimated that the subgrade soils will require some level of stabilization under ODOT GB1. Based on profile information provided by CMT, it is understood that the proposed grade of Central Avenue will be lowered up to 0.3 feet at most of the alignment except stations 251+65 and 265+92. The proposed grade at station 251+65 will be lowered approximately 1.2 feet and the proposed grade at station 265+92 will be elevated approximately 0.05 feet.

The moisture content of cohesive soil has a significant effect on the physical properties of the material. It should be noted that the moisture contents provided on the boring logs, and utilized in this analysis, represent the conditions during the drilling phase of the project. The referenced borings for subgrade analysis were drilled on August 10, 2018. These soil conditions, especially in the surficial soils, may not coincide with the soil conditions that will be encountered during construction. Consequently, the extent/need for subgrade improvement is entirely dependent on the subgrade conditions (i.e., moisture contents) encountered at the time of construction.

5.1.1 Station by Station Stabilization Recommendations

It is understood that specific, “station by station” recommendations for subgrade stabilization under GB1 are required for anticipated stabilization quantities. Therefore, a summary of recommended excavation and replacement quantities, as well as chemical stabilization quantities, in reference to boring locations are presented in Table 4. A complete analysis of each soil boring, looking at the proposed subgrade soils at each location, is presented in Appendix IV. Please note that the excavation and replacement depths in Table 4 were measured from the proposed subgrade elevation, which is estimated to be 1.2 feet on average below the proposed roadway profile grade.

Table 4. Subgrade Treatment Summary

From Station [1]	To Station [1]	Length (feet)	Representative Boring(s)	GB1 Subgrade Stabilization
242+66 (Begin Project)	254+49	1183	B-001-0-18 to B-003-0-18	Proof roll and excavate 12 inches and replace with ODOT Item 703.16C granular material, Type B, C or D, with 712.09 Geotextile Fabric Type D.
254+49	259+40	492	B-004-0-18	Proof roll and excavate 30 inches and replace with ODOT Item 703.16C granular material, Type B, C or D, with 712.09 Geotextile Fabric Type D. If shallow utilities are present, then excavate 18 inches and replace with ODOT Item 703.16C granular material, Type B or C, with 712.09 Geotextile Fabric Type D at the bottom of the excavation and Geogrid (ODOT SS 861) in the middle of the granular material.
259+40	263+70	430	B-005-0-18	Proof roll and excavate 24 inches and replace with ODOT Item 703.16C granular material, Type B, C or D, with 712.09 Geotextile Fabric Type D. If shallow utilities are present, then excavate 12 inches and replace with ODOT Item 703.16C granular material, Type B or C, with 712.09 Geotextile Fabric Type D at the bottom of the excavation and Geogrid (ODOT SS 861) in the middle of the granular material.
263+70	267+69	399	B-006-0-18	Proof roll and excavate 12 inches and replace with ODOT Item 703.16C granular material, Type B, C or D, with 712.09 Geotextile Fabric Type D.
267+69	269+86 (End Project)	217	B-006-0-18	Proof roll and excavate 24 inches and replace with ODOT Item 703.16C granular material, Type B, C or D, with 712.09 Geotextile Fabric Type D. If shallow utilities are present, then excavate 12 inches and replace with ODOT Item 703.16C granular material, Type B or C, with 712.09 Geotextile Fabric Type D at the bottom of the excavation and Geogrid (ODOT SS 861) in the middle of the granular material.

1. *Beginning and ending station limits determined from plan information provided by CMT. Station limits estimated based on soil conditions encountered during the field exploration. Actual limits of stabilization may vary based on the conditions encountered during construction.*

Note that the limits of the treatment areas are based upon the "Limitation of the Study", defined in Section 6.0 of this subgrade exploration report.

Please note that the limits and depth of stabilization provided in the table above are estimated based on the soil conditions encountered in the borings performed during the field exploration. Actual limits and depth of stabilization may differ from the recommendations provided. Per ODOT GB1 requirements, if it is elected to perform station by station stabilization, the entire subgrade should be proof rolled to identify the actual limits of unstable subgrade and depth of stabilization required. Upon completion

of the stabilization, areas that required stabilization should be proof rolled to verify that stability has been achieved.

5.1.2 Global Stabilization

Based on the ODOT GB1, when approximately 30 percent or more of the subgrade requires stabilization, consideration should be given to utilizing a global stabilization option. Per ODOT GB1, global stabilization recommendations are based upon the overall average site parameters, as noted in Table 5.

Table 5. Average Site Parameters

Average N_{60L}	Average PI	Average Moisture	Average Optimum Moisture	Average Group Index	Design CBR
6	18	15	12	5	8

Global stabilization options were determined based on N_{60} of 8, rather than N_{60L} of 6, based the soil conditions present within 3.0 feet of the proposed subgrade elevation. Applying the averages in Table 5, GB1 recommends the following global stabilization options, which should be evaluated based upon a cost and constructability analysis:

Option 1. Chemically stabilize the entire subgrade with 14-inches of cement, as per ODOT Item 206. For estimating purposes, utilize a cement content of 6.0 percent by weight of soil. Actual application rates shall be verified by the contractor under Item 206.06 Mixture Design for Chemically Stabilized Soils.

Option 2. Stone stabilize the entire subgrade via an 18-inch undercut and replacement with ODOT Item 703.16C granular material, Type B, C or D installed over ODOT Item 712.09 Geotextile Fabric, Type D as detailed in accordance with ODOT Item 204.

Per ODOT GB1 requirements, if it is elected to perform global stabilization, the entire subgrade should be stabilized using one of the global stabilization options provided above (proof rolling of the subgrade prior to stabilization is not required). Upon completion of the stabilization, the entire subgrade should be proof rolled to verify that stability has been achieved.

5.1.3 Subgrade Design Considerations

California Bearing Ratio (CBR) values for the entire project ranged from 3 to 12 with an average of 8. If it is elected to proceed with global stabilization of the entire subgrade, it is recommended that pavement design be based on the average CBR of 8 with a corresponding resilient modulus, M_R, of 9,600 psi. Correlation charts indicate a modulus of subgrade reaction (K) of 182 pci and a soil support value (SSV) of 5.4. If station by station stabilization will be utilized, due to presence of marginal soils at subgrade elevation, it is recommended that pavement design be based on a CBR of 5 with a corresponding resilient modulus, M_R, of 6,000 psi, modulus of subgrade reaction (K) of 135 pci and soil support value (SSV) of 3.8.

In general, the majority of the subgrade soils within the limits of the pavement replacement will require stabilization for pavement support in its current condition. Fine-grained soils, such as silt (ODOT A-4b), have the potential to create a frost-susceptible subgrade. During construction, it is recommended that this type of material, if encountered, be over-excavated and completely removed from within 3.0 feet of the proposed finished subgrade elevation. The over-excavation should be backfilled with engineered fill in accordance with ODOT Item 203. Based on the soil conditions encountered in the borings performed for this project, frost-susceptible soils were not encountered in the borings performed for this exploration.

In addition, per ODOT GB1, soils with sulfate content in excess of 5,000 ppm cannot be chemically stabilized due to the potential for sulfate heave in the soil. Based on the results of the testing, the sulfate contents of the subgrade soils range from 113 to 327 parts per million (ppm or mg/kg of material). Therefore, soil with a sulfate content greater than 5,000 ppm was not encountered in any of the borings.

Please note that the recommended CBR values assume that the materials utilized for the road subgrade in fill areas are equivalent to, or better than materials at the existing subgrade elevation. Sources of borrow material should be designated in advance of construction. The material should be tested in the laboratory to verify the soil exhibits a minimum design CBR value of 8.

Pavement design is dependent on the inclusion of adequate surface and subsurface drainage in order to maintain the compacted subgrade near optimum moisture conditions throughout the lifetime of the pavement. If underdrain systems are considered, they should be installed in accordance to the specifications presented in Item 204.

5.2 Construction Considerations

All site work shall conform to the latest ODOT Construction and Materials Specifications (CMS) including the requirements that all excavation, embankment preparation and construction follow ODOT Item 200 (Earthwork).

5.2.1 Excavation Considerations

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

Table 6. Excavation Back Slopes

Soil	Maximum Back Slope	Notes
Soft to Medium Stiff Cohesive	1.5 : 1.0	Above Ground Water Table and No Seepage
Stiff Cohesive	1.0 : 1.0	Above Ground Water Table and No Seepage
Very Stiff to Hard Cohesive	0.75 : 1.0	Above Ground Water Table and No Seepage
All Granular & Cohesive Soil Below Ground Water Table or with Seepage	1.5 : 1.0	None

5.2.2 Groundwater Considerations

Based on the groundwater observations made during drilling, little to no groundwater seepage is anticipated during construction. However, where/if groundwater is encountered, proper groundwater control should be employed and maintained to prevent disturbance to excavation bottoms consisting of cohesive soil, and to prevent the possible development of a quick or "boiling" condition where soft silts and/or fine sands are encountered. It is preferable that the groundwater level, if encountered, be maintained at least 36.0 inches below the deepest excavation. Any seepage or groundwater encountered at this site should be able to be controlled by pumping from temporary sumps. Additional measures may be required depending on seasonal fluctuations of the groundwater level. Note that determining and maintaining actual groundwater levels during construction is the responsibility of the contractor.

6.0 LIMITATIONS OF STUDY

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

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

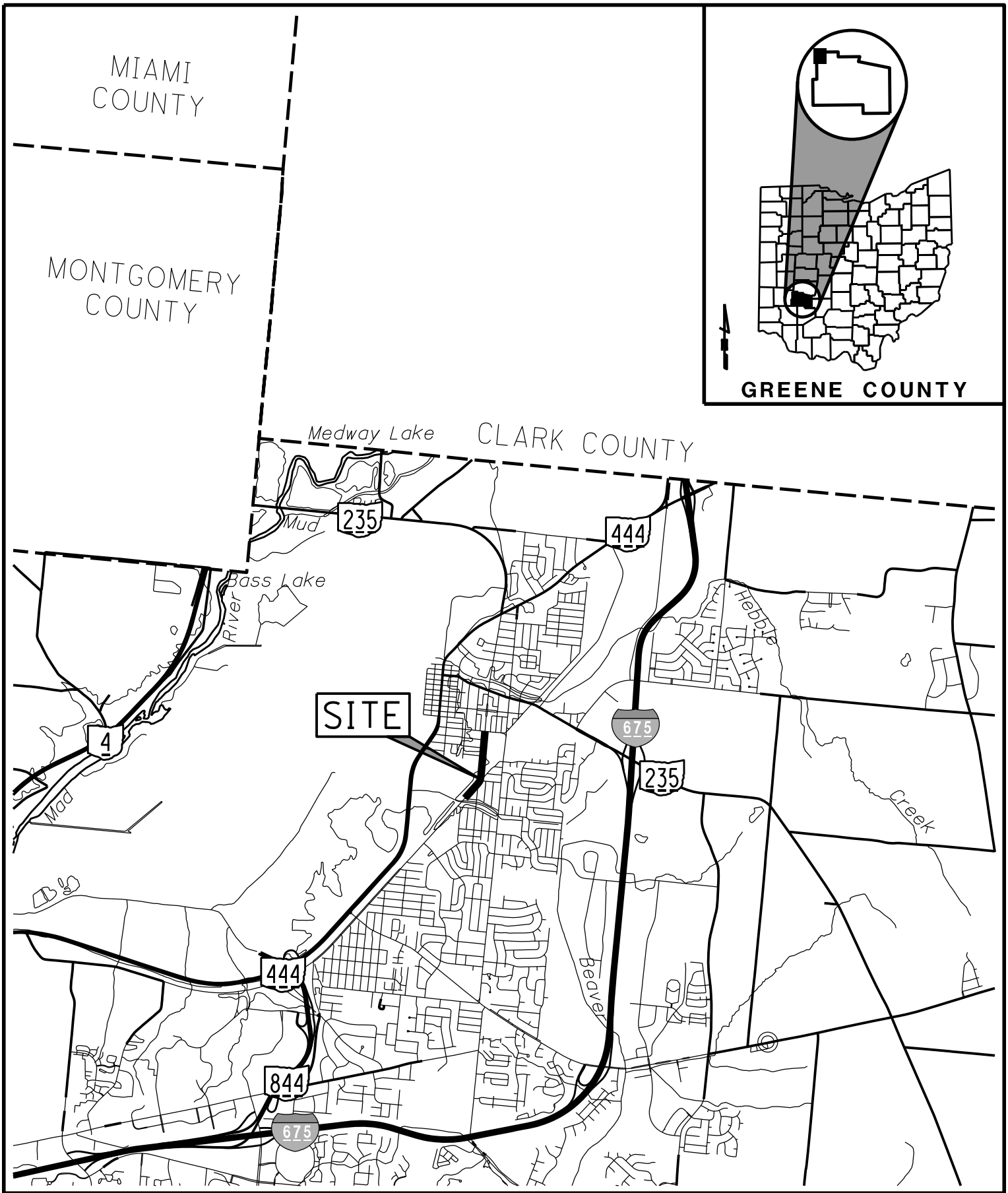
The conclusions and recommendations herein have been based upon the available soil and bedrock information and the design details furnished by a representative of the owner of the proposed project. Any revision in the plans for the proposed construction from those anticipated in this report should be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

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

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

APPENDIX I

VICINITY MAP AND BORING PLAN



VICINITY MAP
GRE-SR 444-4.60 CENTRAL AVE. RECONSTRUCTION
GREENE COUNTY, OHIO

RII PROJECT NO.
W-18-111

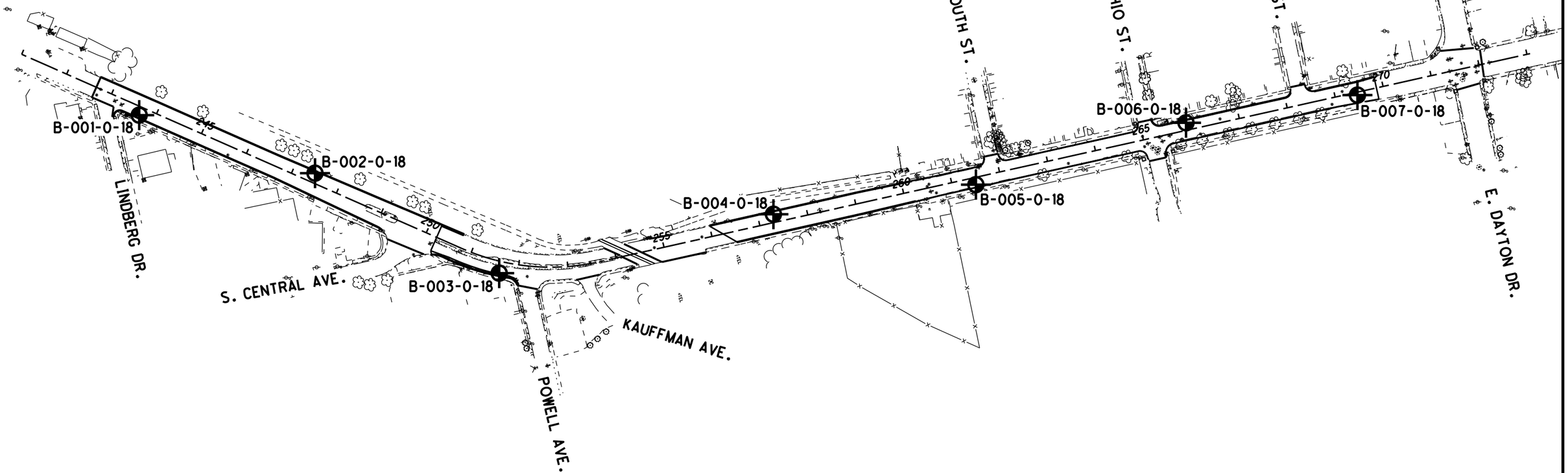
SCALE: 1"=5000'
0 2500 5000

DRAWN
RRM

REVIEWED
BRT

DATE
2-15-19

RESOURCE INTERNATIONAL
Rii



BORING PLAN

GRE-SR 444-4.60 CENTRAL AVENUE RECONSTRUCTION
GREENE COUNTY, OHIO

RII PROJECT NO. W-18-111	DRAWN RRM
SCALE: 1"=200' (0 100 200)	REVIEWED BRT
	DATE 2-15-19

RESOURCE INTERNATIONAL Rii

APPENDIX II

DESCRIPTION OF SOIL TERMS

DESCRIPTION OF SOIL TERMS

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

CLASSIFICATION OF SOILS

Ohio Department of Transportation

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

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

MATERIAL CLASSIFIED BY VISUAL INSPECTION

 Sod and Topsoil

 Pavement or Base

 Uncontrolled Fill (Describe)

 Bouldery Zone

Peat

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

APPENDIX III

BORING LOGS:

B-001-0-18 THROUGH B-007-0-18

BORING LOGS

Definitions of Abbreviations

AS = Auger sample

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

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

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

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

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

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

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

RC = Rock core sample

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

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

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

S = Sulfate content (parts per million)

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

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

SS = Split spoon sample

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

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

TR = Top of rock

W = Initial water level measured during drilling

▼ = Water level measured at completion of drilling

Classification Test Data

Gradation (as defined on Description of Soil Terms):

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

Atterberg Limits:

LL = Liquid limit
PL = Plastic limit
PI = Plasticity Index

WC = Water content (%)

RESOURCE INTERNATIONAL, INC.

PROJECT: GRE-SR444-4.60	DRILLING FIRM / OPERATOR: RII / S.B.	DRILL RIG: CME 55 (SN 386345)	STATION / OFFSET: 243+69 / 17' RT	**EXPLORATION ID B-001-0-18**	
TYPE: SUBGRADE	SAMPLING FIRM / LOGGER: RII / J.P.	HAMMER: AUTOMATIC	ALIGNMENT: CL SR 444		PAGE 1 OF 1
PID: 107120 BR ID: NA	DRILLING METHOD: 4.5" - CFA	CALIBRATION DATE: 9/22/16	ELEVATION: 834.4 (MSL) EOB: 7.7 ft.		
START: 8/10/18 END: 8/10/18	SAMPLING METHOD: SPT	ENERGY RATIO (%): 85.9	COORD: 39.812113, -84.023746		

MATERIAL DESCRIPTION AND NOTES	ELEV. 834.4	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
0.5'- ASPHALT (6.0")	833.9																	
0.7'- AGGREGATE BASE (8.5")	833.2	1																
MEDIUM DENSE, BROWN **GRAVEL WITH SAND, SILT, AND CLAY**, MOIST. -SS-1: SULFATE CONTENT = 67 PPM	831.7	2	5 5 5	14	56	SS-1	2.25	27	27	18	14	14	25	14	11	16	A-2-6 (0)	
STIFF, BROWN **SILT AND CLAY**, SOME COARSE TO FINE SAND, LITTLE FINE GRAVEL, MOIST.		3	2 3 2	7	33	SS-2	2.00	-	-	-	-	-	-	-	-	17	A-6a (V)	
		4																
		5	2 3 2	7	0	SS-3	-	-	-	-	-	-	-	-	-	-		
		6	5	-	100	2S-3A	1.75	15	12	21	31	21	25	14	11	15	A-6a (4)	
	826.7	7 EOB	1 2 2	6	33	SS-4	1.75	-	-	-	-	-	-	-	-	-	A-6a (V)	

NOTES: GROUNDWATER NOT ENCOUNTERED DURING DRILLING

ABANDONMENT METHODS, MATERIALS, QUANTITIES: COMPACTED WITH THE AUGER 25 LBS BENTONITE CHIPS AND SOIL CUTTINGS; PLACED ASPHALT COLD PATCH

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

Pavement Core Data Summary

PROJECT	GRE-SR444-4.60 Central Avenue Reconstruction
LOCATION	Fairborn, Ohio
JOB No.	W-18-111
BORING/CORE No.	B-001-0-18
DATE CORE OBTAINED	8/10/2018
CORE OBTAINED BY	SB / LK / JP

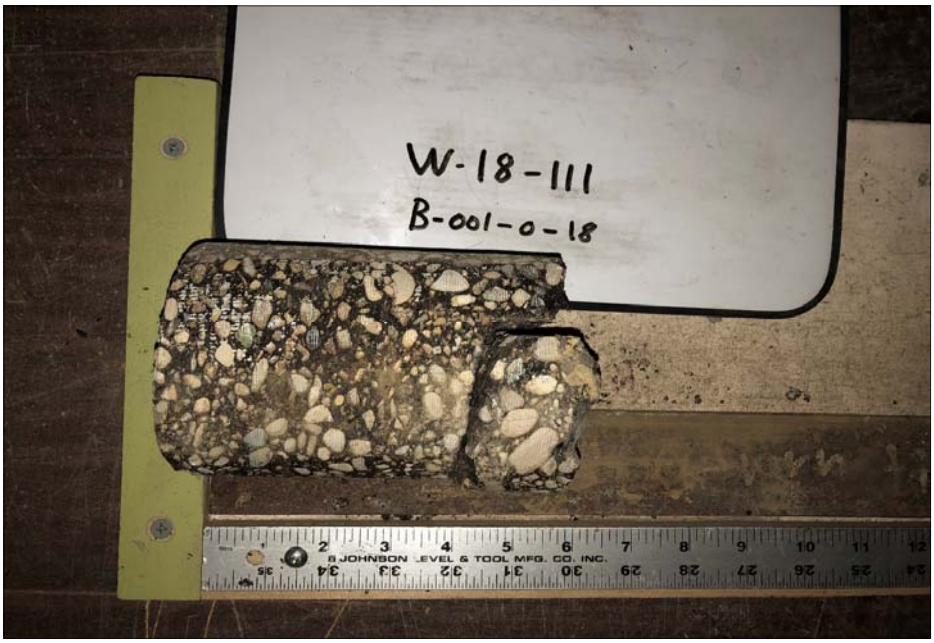
Core Composition

Core Number	Lift Thickness (in.)	Asphalt			Concrete	Aggregate/Granular Base	Other			
		404	402	301						
B-001-0-18	1.25	✓								
	1.75	✓								
	1.00	✓								
	1.25		✓							
	0.75			✓						
	8.50					✓				

Comments/Remarks

- Core splits at 4.0".
- Trace voids throughout.

Total Pavement Thickness =	6.00	in.	Total Asphalt Thickness =	6.00	in.	Total Concrete Thickness =	0.00	in.	Total Base Thickness =	8.50	in.



RESOURCE INTERNATIONAL, INC.

PROJECT: GRE-SR444-4.60	DRILLING FIRM / OPERATOR: RII / S.B.	DRILL RIG: CME 55 (SN 386345)	STATION / OFFSET: 247+44 / 20' LT	**EXPLORATION ID**	
TYPE: SUBGRADE	SAMPLING FIRM / LOGGER: RII / J.P.	HAMMER: AUTOMATIC	ALIGNMENT: CL SR 444	**B-002-0-18**	
PID: 107120 BR ID: NA	DRILLING METHOD: 4.5" - CFA	CALIBRATION DATE: 9/22/16	ELEVATION: 836.4 (MSL) EOB: 7.5 ft.	PAGE	
START: 8/10/18 END: 8/10/18	SAMPLING METHOD: SPT	ENERGY RATIO (%): 85.9	COORD: 39.812959, -84.022975	1 OF 1	

MATERIAL DESCRIPTION AND NOTES	ELEV. 836.4	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
0.4'-ASPHALT (5.0")	836.0																	
1.1'-AGGREGATE BASE (13.0")	834.9	1																
VERY STIFF, DARK BROWN **SILTY CLAY**, SOME TO "AND" COARSE TO FINE SAND, TRACE FINE GRAVEL, DRY TO MOIST. -SS-1: SULFATE CONTENT = 100 PPM		2	1 3 5	11	94	SS-1	3.50	5	9	20	36	30	37	16	21	5	A-6b (11)	
	831.9	3 4	2 2 2	6	56	SS-2	3.50	4	33	27	13	23	39	15	24	17	A-6b (3)	
LOOSE, BROWN **COARSE AND FINE SAND**, TRACE SILT, TRACE FINE GRAVEL, MOIST.		5	3 2 3	7	72	SS-3	-	-	-	-	-	-	-	-	-	7	A-3a (V)	
	828.9	6 7	3 3 4	10	50	SS-4	-	-	-	-	-	-	-	-	-	7	A-3a (V)	
		EOB																

NOTES: GROUNDWATER NOT ENCOUNTERED DURING DRILLING

ABANDONMENT METHODS, MATERIALS, QUANTITIES: COMPACTED WITH THE AUGER 25 LBS BENTONITE CHIPS AND SOIL CUTTINGS; PLACED ASPHALT COLD PATCH

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

Pavement Core Data Summary

PROJECT	GRE-SR444-4.60 Central Avenue Reconstruction
LOCATION	Fairborn, Ohio
JOB No.	W-18-111
BORING/CORE No.	B-002-0-18
DATE CORE OBTAINED	8/10/2018
CORE OBTAINED BY	SB / LK / JP

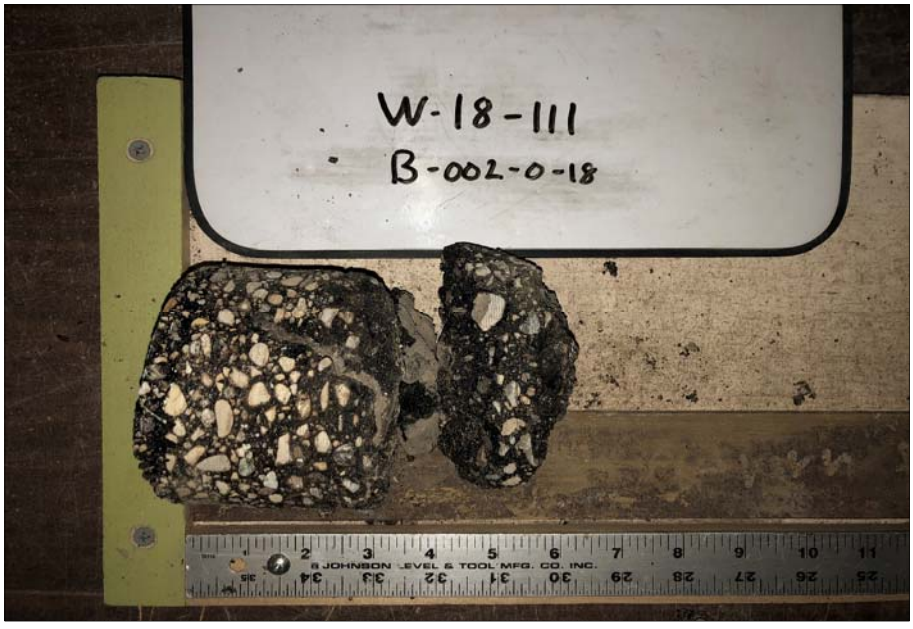
Core Composition

Core Number	Lift Thickness (in.)	Asphalt			Concrete	Aggregate/Granular Base	Other			
		404	402	301						
B-002-0-18	1.25	✓								
	1.75	✓								
	2.00		✓							
	13.00					✓				

Comments/Remarks

- Core separates at 3.0".
- Numerous small voids within the first 1.25" of core.
- Cracks present between 1.25"-3.0".
- Core is highly deteriorated between 3.0:-5.0".

Total Pavement Thickness =	5.00	in.	Total Asphalt Thickness =	5.00	in.	Total Concrete Thickness =	0.00	in.	Total Base Thickness =	13.00	in.



RESOURCE INTERNATIONAL, INC.

PROJECT: GRE-SR444-4.60	DRILLING FIRM / OPERATOR: RII / S.B.	DRILL RIG: CME 55 (SN 386345)	STATION / OFFSET: 251+65 / 24' RT	**EXPLORATION ID B-003-0-18**	
TYPE: SUBGRADE	SAMPLING FIRM / LOGGER: RII / J.P.	HAMMER: AUTOMATIC	ALIGNMENT: CL SR 444		
PID: 107120 BR ID: NA	DRILLING METHOD: 4.5" - CFA	CALIBRATION DATE: 9/22/16	ELEVATION: 845.9 (MSL) EOB: 7.0 ft.		PAGE 1 OF 1
START: 8/10/18 END: 8/10/18	SAMPLING METHOD: SPT	ENERGY RATIO (%): 85.9	COORD: 39.813782, -84.021895		

MATERIAL DESCRIPTION AND NOTES	ELEV. 845.9	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
0.4'-ASPHALT (5.0")	845.5																	
0.6'- AGGREGATE BASE (7.0")	844.9																	
VERY STIFF, DARK BROWN **CLAY**, LITTLE SILT, "AND" COARSE TO FINE SAND, LITTLE FINE GRAVEL, MOIST. -SS-1: SULFATE CONTENT = 133 PPM	844.1	1	2 3 4	10	89	SS-1A	2.75	16	31	16	14	23	49	15	34	18	A-7-6 (5)	
		2				SS-1B	-	-	-	-	-	-	-	-	-	13	A-3a (V)	
LOOSE TO MEDIUM DENSE, BROWN **COARSE AND FINE SAND**, LITTLE SILT, TRACE CLAY, TRACE FINE GRAVEL, MOIST TO VERY MOIST.		3	2 2 4	9	78	SS-2	-	10	24	44	12	10	NP	NP	NP	8	A-3a (0)	
		4	4 4 6	14	78	SS-3	-	-	-	-	-	-	-	-	-	7	A-3a (V)	
		5	5 8 6	20	83	SS-4	-	-	-	-	-	-	-	-	-	5	A-3a (V)	
	838.9	EOB 7																

NOTES: GROUNDWATER NOT ENCOUNTERED DURING DRILLING

ABANDONMENT METHODS, MATERIALS, QUANTITIES: COMPACTED WITH THE AUGER 25 LBS BENTONITE CHIPS AND SOIL CUTTINGS; PLACED ASPHALT COLD PATCH

0-2018-ODOT BORING LOG RII - OH DOT.GDT - 2/15/19 14:56 - U:\GI\8\PROJECTS\2018\W-18-111.GPJ

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

Pavement Core Data Summary

PROJECT	GRE-SR444-4.60 Central Avenue Reconstruction
LOCATION	Fairborn, Ohio
JOB No.	W-18-111
BORING/CORE No.	B-003-0-18
DATE CORE OBTAINED	8/10/2018
CORE OBTAINED BY	SB / LK / JP

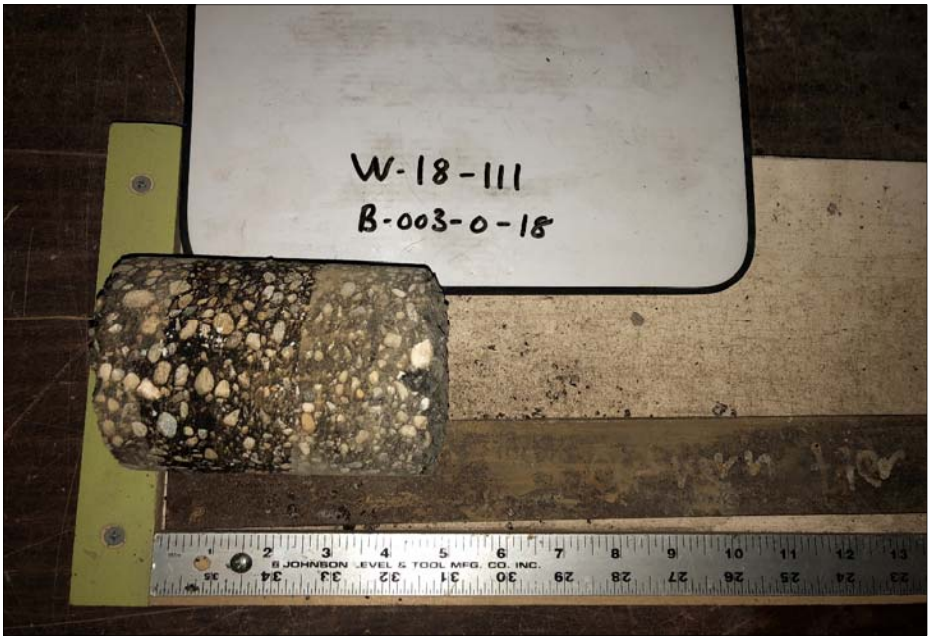
Core Composition

Core Number	Lift Thickness (in.)	Asphalt			Concrete	Aggregate/Granular Base	Other			
		404	402	301						
B-003-0-18	1.75	✓								
	1.50	✓								
	1.75	✓								
	7.00					✓				

Comments/Remarks

- Core is intact.
- Trace voids throughout.

Total Pavement Thickness =	5.00	in.	Total Asphalt Thickness =	5.00	in.	Total Concrete Thickness =	0.00	in.	Total Base Thickness =	7.00	in.



RESOURCE INTERNATIONAL, INC.

PROJECT: GRE-SR444-4.60	DRILLING FIRM / OPERATOR: RII / S.B.	DRILL RIG: CME 55 (SN 386345)	STATION / OFFSET: 257+32 / 17' LT	**EXPLORATION ID B-004-0-18**	
TYPE: SUBGRADE	SAMPLING FIRM / LOGGER: RII / J.P.	HAMMER: AUTOMATIC	ALIGNMENT: CL SR 444		
PID: 107120 BR ID: NA	DRILLING METHOD: 4.5" - CFA	CALIBRATION DATE: 9/22/16	ELEVATION: 839.1 (MSL) EOB: 7.0 ft.		PAGE 1 OF 1
START: 8/10/18 END: 8/10/18	SAMPLING METHOD: SPT	ENERGY RATIO (%): 85.9	COORD: 39.815344, -84.021727		

MATERIAL DESCRIPTION AND NOTES	ELEV. 839.1	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
0.4'- ASPHALT (5.0")	838.7																	
0.6'- AGGREGATE BASE (7.0")	838.1																	
LOOSE, DARK BROWNISH GRAY **GRAVEL WITH SAND, SILT, AND CLAY**, MOIST. -SS-1: SULFATE CONTENT = 87 PPM	836.6	1 2	6 4 2	9	56	SS-1	-	32	20	18	18	12	24	12	12	10	A-2-6 (0)	
MEDIUM STIFF, DARK GRAY **SILT AND CLAY**, "AND" COARSE TO FINE SAND, SOME FINE GRAVEL, MOIST.	835.1	3	1 2 3	7	89	SS-2	1.00	23	22	19	23	13	27	13	14	17	A-6a (1)	
STIFF TO VERY STIFF, DARK GRAY **SILTY CLAY**, SOME COARSE TO FINE SAND, LITTLE FINE GRAVEL, MOIST.	832.1	4 5	1 2 1	4	61	SS-3	1.25	-	-	-	-	-	-	-	-	23	A-6b (V)	
EOB		6 7	2 4 4	11	94	SS-4	3.25	-	-	-	-	-	-	-	-	22	A-6b (V)	

NOTES: GROUNDWATER NOT ENCOUNTERED DURING DRILLING

ABANDONMENT METHODS, MATERIALS, QUANTITIES: COMPACTED WITH THE AUGER 25 LBS BENTONITE CHIPS AND SOIL CUTTINGS; PLACED ASPHALT COLD PATCH

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

Pavement Core Data Summary

PROJECT	GRE-SR444-4.60 Central Avenue Reconstruction
LOCATION	Fairborn, Ohio
JOB No.	W-18-111
BORING/CORE No.	B-004-0-18
DATE CORE OBTAINED	8/10/2018
CORE OBTAINED BY	SB / LK / JP

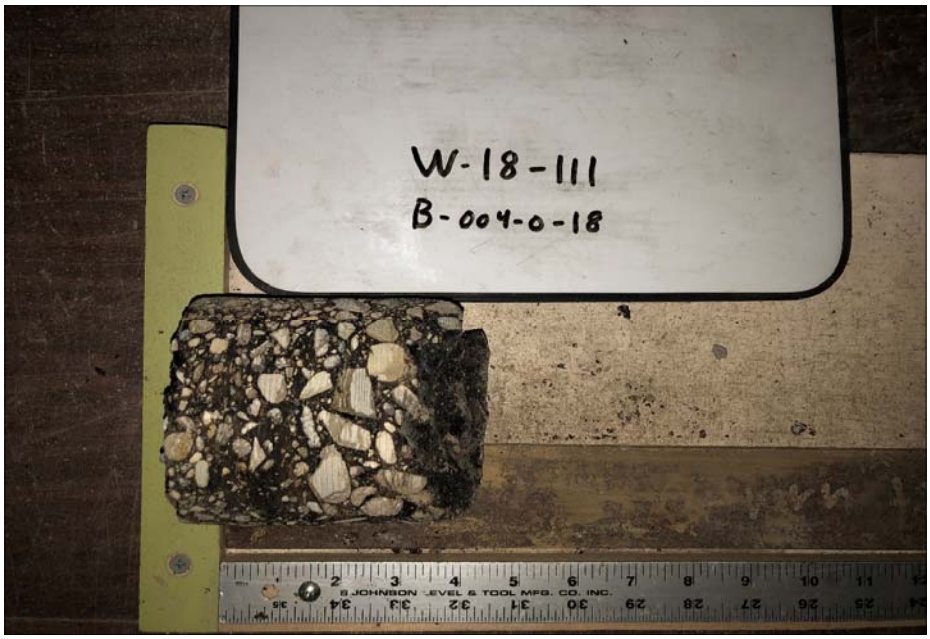
Core Composition

Core Number	Lift Thickness (in.)	Asphalt			Concrete	Aggregate/Granular Base	Other			
		404	402	301						
B-004-0-18	2.00	✓								
	1.75		✓							
	1.25			✓						
	7.00					✓				

Comments/Remarks

- Core is intact.
- Trace voids throughout.

Total Pavement Thickness =	5.00	in.	Total Asphalt Thickness =	5.00	in.	Total Concrete Thickness =	0.00	in.	Total Base Thickness =	7.00	in.



RESOURCE INTERNATIONAL, INC.

PROJECT: GRE-SR444-4.60	DRILLING FIRM / OPERATOR: RII / S.B.	DRILL RIG: CME 55 (SN 386345)	STATION / OFFSET: 261+48 / 15' RT	**EXPLORATION ID B-005-0-18**	
TYPE: SUBGRADE	SAMPLING FIRM / LOGGER: RII / J.P.	HAMMER: AUTOMATIC	ALIGNMENT: CL SR 444		
PID: 107120 BR ID: NA	DRILLING METHOD: 4.5" - CFA	CALIBRATION DATE: 9/22/16	ELEVATION: 833.9 (MSL) EOB: 9.4 ft.		PAGE 1 OF 1
START: 8/10/18 END: 8/10/18	SAMPLING METHOD: SPT	ENERGY RATIO (%): 85.9	COORD: 39.816475, -84.021507		

MATERIAL DESCRIPTION AND NOTES	ELEV. 833.9	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
0.4'-ASPHALT (5.0")	833.5																	
1.0'-CONCRETE (12.0")	832.5																	
1.0'-AGGREGATE BASE (12.0")	831.5																	
MEDIUM STIFF, BROWN TO DARK BROWN **SILT AND CLAY**, LITTLE COARSE TO FINE SAND, TRACE FINE GRAVEL, MOIST. -SS-1: SULFATE CONTENT = 73 PPM	830.0		1 2 2	6	61	SS-1	1.00	9	9	8	49	25	30	15	15	20	A-6a (10)	
MEDIUM DENSE TO DENSE, BROWN TO DARK BROWN **GRAVEL**, SOME COARSE TO FINE SAND, TRACE SILT, TRACE CLAY, MOIST. -ATTEMPTED SHELBY TUBE @ 3.9' WITH REFUSAL @ 4.9' AND NO RECOVERY					0	ST-2	-	-	-	-	-	-	-	-	-	-		
			14 16 13	42	56	SS-3	-	59	19	9	10	3	NP	NP	NP	13	A-1-a (0)	
	826.0		10 9 10	27	56	SS-4	-	-	-	-	-	-	-	-	-	9	A-1-a (V)	
MEDIUM STIFF, BROWN **SANDY SILT**, TRACE CLAY, TRACE FINE GRAVEL, MOIST.	824.5	EOB	10 10 11	30	83	SS-5	1.00	-	-	-	-	-	-	-	-	10	A-4a (V)	

NOTES: GROUNDWATER NOT ENCOUNTERED DURING DRILLING

ABANDONMENT METHODS, MATERIALS, QUANTITIES: COMPACTED WITH THE AUGER 37.5 LBS BENTONITE CHIPS AND SOIL CUTTINGS; PLACED CONCRETE

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

Pavement Core Data Summary

PROJECT	GRE-SR444-4.60 Central Avenue Reconstruction
LOCATION	Fairborn, Ohio
JOB No.	W-18-111
BORING/CORE No.	B-005-0-18
DATE CORE OBTAINED	8/10/2018
CORE OBTAINED BY	SB / LK / JP

Core Composition

Core Number	Lift Thickness (in.)	Asphalt			Concrete	Aggregate/Granular Base	Other			
		404	402	301						
B-005-0-18	2.00	✓								
	3.00		✓							
	12.00				✓					
	12.00					✓				

Comments/Remarks

- Core separates at 5.0".
- Concrete is stripped.
- Trace voids along contact points.
- Concrere is broken into fragments and highly deteriorated.

Total Pavement Thickness =	17.00 in.	Total Asphalt Thickness =	5.00 in.	Total Concrete Thickness =	12.00 in.	Total Base Thickness =	12.00 in.

RESOURCE INTERNATIONAL, INC.

PROJECT: GRE-SR444-4.60	DRILLING FIRM / OPERATOR: RII / S.B.	DRILL RIG: CME 55 (SN 386345)	STATION / OFFSET: 265+92 / 15' LT	**EXPLORATION ID**	
TYPE: SUBGRADE	SAMPLING FIRM / LOGGER: RII / J.P.	HAMMER: AUTOMATIC	ALIGNMENT: CL SR 444	**B-006-0-18**	
PID: 107120 BR ID: NA	DRILLING METHOD: 4.5" - CFA	CALIBRATION DATE: 9/22/16	ELEVATION: 834.1 (MSL) EOB: 7.5 ft.	PAGE	
START: 8/10/18 END: 8/10/18	SAMPLING METHOD: SPT	ENERGY RATIO (%): 85.9	COORD: 39.817699, -84.021494	1 OF 1	

MATERIAL DESCRIPTION AND NOTES	ELEV. 834.1	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
0.4'- ASPHALT (4.0")	833.8																	
1.2'-AGGREGATE BASE (14.0")	832.6	1																
VERY STIFF, DARK BROWN TO BLACK **CLAY**, SOME SILT, TRACE COARSE TO FINE SAND, TRACE FINE GRAVEL, MOIST. -SS-1: SULFATE CONTENT = 93 PPM	831.1	2	2 3 4	10	89	SS-1	3.00	1	4	6	59	30	45	21	24	29	A-7-6 (15)	
VERY STIFF, DARK BROWN TO BLACK **SILTY CLAY**, "AND" FINE TO COARSE SAND, SOME FINE GRAVEL, MOIST.	829.6	3 4	3 2 4	9	33	SS-2	3.00	21	22	14	26	17	37	17	20	27	A-6b (4)	
LOOSE, DARK BROWN **GRAVEL WITH SAND, SILT, AND CLAY**, MOIST.	828.1	5	3 3 3	9	83	SS-3	-	-	-	-	-	-	-	-	-	19	A-2-6 (V)	
LOOSE, DARK GRAY **GRAVEL AND SAND**, TRACE SILT, TRACE CLAY, MOIST.	826.6	6 7	3 3 2	7	33	SS-4	-	-	-	-	-	-	-	-	-	14	A-1-b (V)	
		EOB																

NOTES: GROUNDWATER NOT ENCOUNTERED DURING DRILLING

ABANDONMENT METHODS, MATERIALS, QUANTITIES: COMPACTED WITH THE AUGER 25 LBS BENTONITE CHIPS AND SOIL CUTTINGS; PLACED ASPHALT COLD PATCH

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

Pavement Core Data Summary

PROJECT	GRE-SR444-4.60 Central Avenue Reconstruction
LOCATION	Fairborn, Ohio
JOB No.	W-18-111
BORING/CORE No.	B-006-0-18
DATE CORE OBTAINED	8/10/2018
CORE OBTAINED BY	SB / LK / JP

Core Composition

Core Number	Lift Thickness (in.)	Asphalt 404	Asphalt 402	Asphalt 301	Concrete	Aggregate/Granular Base	Other			
B-006-0-18	1.25	✓								
	2.75		✓							
	14.00					✓				

Comments/Remarks

- Core is intact.
- Trace voids throughout.

Total Pavement Thickness =	4.00 in.	Total Asphalt Thickness =	4.00 in.	Total Concrete Thickness =	0.00 in.	Total Base Thickness =	14.00 in.

RESOURCE INTERNATIONAL, INC.

PROJECT: GRE-SR444-4.60	DRILLING FIRM / OPERATOR: RII / S.B.	DRILL RIG: CME 55 (SN 386345)	STATION / OFFSET: 269+45 / 6' RT	**EXPLORATION ID B-007-0-18**	
TYPE: SUBGRADE	SAMPLING FIRM / LOGGER: RII / J.P.	HAMMER: AUTOMATIC	ALIGNMENT: CL SR 444		
PID: 107120 BR ID: NA	DRILLING METHOD: 4.5" - CFA	CALIBRATION DATE: 9/22/16	ELEVATION: 835.5 (MSL) EOB: 7.5 ft.		PAGE 1 OF 1
START: 8/10/18 END: 8/10/18	SAMPLING METHOD: SPT	ENERGY RATIO (%): 85.9	COORD: 39.818661, -84.021326		

MATERIAL DESCRIPTION AND NOTES	ELEV. 835.5	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
0.4'-ASPHALT (5.0")	835.1																	
0.6'- AGGREGATE BASE (7.0")	834.5																	
VERY STIFF, DARK BROWN **SILT AND CLAY**, SOME COARSE TO FINE SAND, LITTLE TO SOME FINE GRAVEL, DAMP TO MOIST. -SS-1: SULFATE CONTENT = 307 PPM		1 2 3 4 5	2 2 2	6	33	SS-1	3.00	13	12	10	44	21	32	17	15	19	A-6a (8)	
			1 2 1	4	56	SS-2	2.75	24	13	10	35	18	31	17	14	15	A-6a (5)	
	830.0		0 0 2	3	0	SS-3	-	-	-	-	-	-	-	-	-	-		
DENSE, BROWNISH GRAY **GRAVEL AND SAND**, TRACE SILT, TRACE CLAY, MOIST.		6	12	-	100	2S-3A	-	-	-	-	-	-	-	-	-	18	A-1-b (V)	
	828.0	7	9 12 11	33	72	SS-4	-	-	-	-	-	-	-	-	-	10	A-1-b (V)	
		EOB																

NOTES: GROUNDWATER NOT ENCOUNTERED DURING DRILLING

ABANDONMENT METHODS, MATERIALS, QUANTITIES: COMPACTED WITH THE AUGER 25 LBS BENTONITE CHIPS AND SOIL CUTTINGS; PLACED ASPHALT COLD PATCH

0-2018-ODOT BORING LOG RII - OH DOT.GDT - 2/15/19 14:56 - U:\GI\8\PROJECTS\2018\W-18-111.GPJ

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

Pavement Core Data Summary

PROJECT	GRE-SR444-4.60 Central Avenue Reconstruction
LOCATION	Fairborn, Ohio
JOB No.	W-18-111
BORING/CORE No.	B-007-0-18
DATE CORE OBTAINED	8/10/2018
CORE OBTAINED BY	SB / LK / JP

Core Composition

Core Number	Lift Thickness (in.)	Asphalt			Concrete	Aggregate/Granular Base	Other			
		404	402	301						
B-007-0-18	2.00	✓								
	1.50	✓								
	1.00		✓							
	0.50			✓						
	7.00					✓				

Comments/Remarks

- Core is intact.
- Deep groove around core at 3.5".
- Small voids throughout.

Total Pavement Thickness =	5.00	in.	Total Asphalt Thickness =	5.00	in.	Total Concrete Thickness =	0.00	in.	Total Base Thickness =	7.00	in.

APPENDIX IV

GB1 SUBGRADE STABILIZATION SUMMARY

OHIO DEPARTMENT OF TRANSPORTATION

OFFICE OF GEOTECHNICAL ENGINEERING

PLAN SUBGRADES
Geotechnical Bulletin GB1

GRE-SR444-4.60
107120

Geotechnical exploration for the reconstruction of Central Avenue (SR-444) from Lindberg Dr. to Dayton Dr. in Fairborn, Ohio. Total project length is 2,870 lineal feet.

Resource International, Inc.

Prepared By: Leila Sadeghi, Brian Trenner
Date prepared: Friday, February 15, 2019

Resource International, Inc.
6350 Presidential Gateway
Columbus, Ohio 43231

Phone: 614.823.4949 Fax: 614.823.4990
briant@resourceinternational.com

NO. OF BORINGS: 7

#	Boring ID	Alignment	Station	Offset	Dir	Drill Rig	ER	Boring EL.	Proposed Subgrade EL	Cut Fill
1	B-001-0-18	CL SR 444	243+69	17	Rt	CME 55 (SN 386345)	86	834.4	833.0	1.4 C
2	B-002-0-18	CL SR 444	247+44	20	Lt	CME 55 (SN 386345)	86	836.4	834.9	1.5 C
3	B-003-0-18	CL SR 444	251+65	24	Rt	CME 55 (SN 386345)	86	845.9	843.5	2.4 C
4	B-004-0-18	CL SR 444	257+32	17	Lt	CME 55 (SN 386345)	86	839.1	837.7	1.5 C
5	B-005-0-18	CL SR 444	261+48	15	Rt	CME 55 (SN 386345)	86	833.9	832.4	1.5 C
6	B-006-0-18	CL SR 444	265+92	15	Lt	CME 55 (SN 386345)	86	834.1	833.0	1.2 C
7	B-007-0-18	CL SR 444	269+45	6	Rt	CME 55 (SN 386345)	86	835.5	834.2	1.3 C

OHIO DEPARTMENT OF TRANSPORTATION

Subgrade Analysis

V. 14.3 7/20/2018

#	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 number only 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	1.2	2.7	-0.2	1.3	14		2.25	25	14	11	14	14	28	16	10	A-2-6	0	67		N_{60} & Mc		12"	12"
	001-0	SS-2	2.7	4.2	1.3	2.8	7		2							17	14	A-6a	10			N_{60} & Mc			
	18	2S-3A	4.2	6.2	2.8	4.8	7		1.75	25	14	11	31	21	52	15	14	A-6a	4						
		SS-4	6.2	7.7	4.8	6.3	6	6	1.75								14	A-6a	10						
2	B	SS-1	1.5	3.0	0.0	1.5	11		3.5	37	16	21	36	30	66	5	16	A-6b	11	100		N_{60}		12"	12"
	002-0	SS-2	3.0	4.5	1.5	3.0	6		3.5	39	15	24	13	23	36	17	16	A-6b	3			N_{60}			
	18	SS-3	4.5	6.0	3.0	4.5	7									7	8	A-3a	0						
		SS-4	6.0	7.5	4.5	6.0	10	6								7	8	A-3a	0						
3	B	SS-1A	1.0	2.5	-1.4	0.1	10		2.75	49	15	34	14	23	37	18	18	A-7-6	5	133		N_{60}		12"	12"
	003-0	SS-2	2.5	4.0	0.1	1.6	9			NP	NP	NP	12	10	22	8	8	A-3a	0						
	18	SS-3	4.0	5.5	1.6	3.1	14									7	8	A-3a	0						
		SS-4	5.5	7.0	3.1	4.6	20	9								5	8	A-3a	0						
4	B	SS-1	1.0	2.5	-0.5	1.1	9			24	12	12	18	12	30	10	10	A-2-6	0	87		N_{60}		12"	30"
	004-0	SS-2	2.5	4.0	1.1	2.6	7		1	27	13	14	23	13	36	17	14	A-6a	1			HP & Mc		18"	
	18	SS-3	4.0	5.5	2.6	4.1	4		1.25							23	16	A-6b	16						
		SS-4	5.5	7.0	4.1	5.6	11	4	3.25							22	16	A-6b	16						
5	B	SS-1	2.4	3.9	0.9	2.4	6		1	30	15	15	49	25	74	20	14	A-6a	10	73		HP & Mc		24"	24"
	005-0	SS-2	3.9	6.4	2.4	4.9	42						10	3	13	13	6	A-1-a	0						
	18	SS-3	6.4	7.9	4.9	6.4	27									9	6	A-1-a	0						
		SS-4	7.9	9.4	6.4	7.9	30	6	1							10	10	A-4a							
6	B	SS-1	1.5	3.0	0.3	1.9	10		3	45	21	24	59	30	89	29	18	A-7-6	15	93		N_{60} & Mc		12"	12"
	006-0	SS-2	3.0	4.5	1.9	3.4	9		3	37	17	20	26	17	43	27	16	A-6b	4			N_{60} & Mc			
	18	SS-3	4.5	6.0	3.4	4.9	9									19	10	A-2-6	4						
		SS-4	6.0	7.5	4.9	6.4	7	7								14	6	A-1-b	0						
7	B	SS-1	1.0	2.5	-0.3	1.2	6		3	32	17	15	44	21	65	19	14	A-6a	8	307		N_{60} & Mc		24"	24"
	007-0	SS-2	2.5	4.0	1.2	2.7	4		2.75	31	17	14	35	18	53	15	14	A-6a	5			N_{60}			
	18	SS-3	4.0	5.5	2.7	4.2	3										14	A-6a	10						
		SS-4	5.5	7.5	4.2	6.2	33	3								10	6	A-1-b	0						

OHIO DEPARTMENT OF TRANSPORTATION

Subgrade Analysis

V. 14.3 7/20/2018

PID: 107120

County-Route-Section: GRE-SR444-4.60
No. of Borings: 7

Geotechnical Consultant: Resource International, Inc.
Prepared By: Leila Sadeghi, Brian Trenner
Date prepared: 2/15/2019

Chemical Stabilization Options		
320	Rubblize & Roll	No
206	Cement Stabilization	Option
	Lime Stabilization	Option
206	Depth	16''

Excavate and Replace Stabilization Options	
Global Geotextile Override(N60L):	18''
Average(HP):	0''
Global Geogrid Override(N60L):	0''
Average(HP):	0''

Design CBR	8

% Samples within 6 feet of subgrade			
$N_{60} \leq 5$	11%	HP ≤ 0.5	0%
$N_{60} < 12$	78%	0.5 < HP ≤ 1	7%
$12 \leq N_{60} < 15$	7%	1 < HP ≤ 2	15%
$N_{60} \geq 20$	15%	HP > 2	33%
M+	26%		
Rock	0%		
Unsuitable	0%		

Excavate and Replace at Surface	
Average	18''
Maximum	30''
Minimum	12''

% Proposed Subgrade Surface	
Unstable & Unsuitable	71%
Unstable	71%
Unsuitable	0%

	N_{60}	N_{60L}	HP	LL	PL	PI	Silt	Clay	P 200	M_C	M_{OPT}	GI
Average	12	6	2.30	33	16	18	27	19	46	15	12	5
Maximum	42	9	3.50	49	21	34	59	30	89	29	18	16
Minimum	3	3	1.00	24	12	11	10	3	13	5	6	0

Classification Counts by Sample

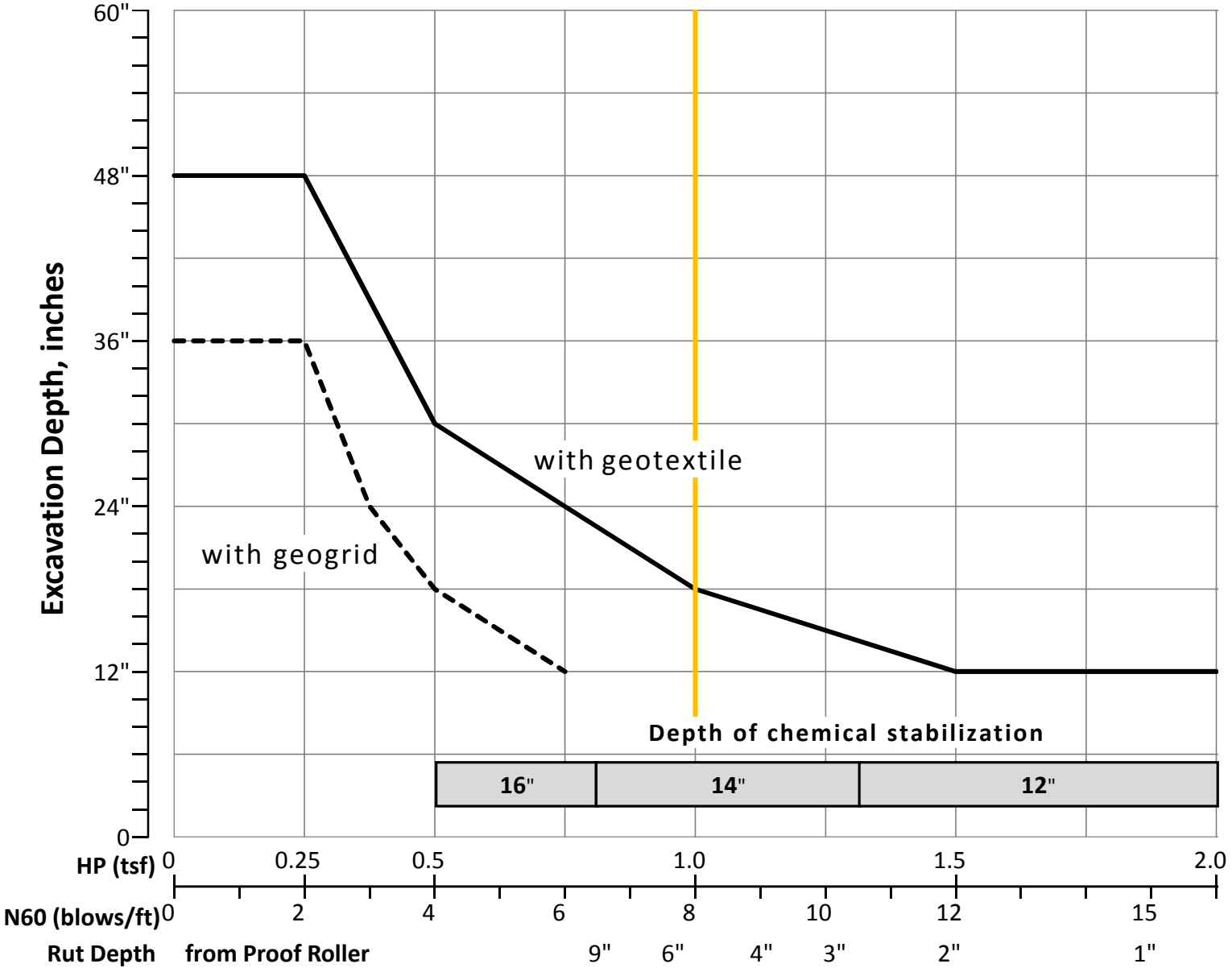
ODOT Class	Rock	A-1-a	A-1-b	A-2-4	A-2-5	A-2-6	A-2-7	A-3	A-3a	A-4a	A-4b	A-5	A-6a	A-6b	A-7-5	A-7-6	A-8a	A-8b	Totals
Count	0	2	2	0	0	3	0	0	5	1	0	0	8	5	0	2	0	0	28
Percent	0%	7%	7%	0%	0%	11%	0%	0%	18%	4%	0%	0%	29%	18%	0%	7%	0%	0%	100%
% Rock|Granular|Cohesive	0%	46%									54%								100%
Surface Class Count	0	1	0	0	0	2	0	0	2	0	0	0	6	4	0	2	0	0	17
Surface Class Percent	0%	6%	0%	0%	0%	12%	0%	0%	12%	0%	0%	0%	35%	24%	0%	12%	0%	0%	100%

OHIO DEPARTMENT OF TRANSPORTATION

Subgrade Analysis

V. 14.3 7/20/2018

GB1 Figure B – Subgrade Stabilization



OVERRIDE TABLE

Calculated Average	New Values	Check to Override
2.30		☐ HP
5.86	8.00	☑ N60L

Average HP

Average N_{60L}