Subgrade Exploration Report

DEL-SR 605 and Fancher Road Intersection Improvements
Harlem Township
September 17, 2020
Terracon Project No. N4195366

Prepared for:
2LMN, Inc
Lancaster, Ohio

Prepared by:
Terracon Consultants, Inc.
Columbus, Ohio

September 17, 2020

2LMN, Inc
2475 Sugar Grove Road SE
Lancaster, Ohio 43130

Attn: Mr. Adam L. Lanier, P.E., President
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E: Adam.Lanier@2LMN.com

Re: Subgrade Exploration Report
DEL-SR 605 and Fancher Road Intersection Improvements
Harlem Township
Terracon Project No. N4195366

Dear Mr. Lanier:

Terracon Consultants, Inc. (Terracon) has completed the subgrade exploration for the above referenced project. This study was performed in general accordance with Terracon Proposal No. PN4195366 dated October 23, 2019. which was authorized by 2LMN, Inc. via the "Subconsultant Work Order" dated April 22, 2020.

The intersection of State Route (SR) 605 and Fancher Road is a rural 4-legged intersection in Harlem Township of southern Delaware County approximately 3 miles north of New Albany. This report presents the findings of our subsurface exploration, laboratory testing results, subgrade analyses results and provides construction recommendations for the proposed roadway improvements including the construction of a new single lane roundabout and modifications to SR 605 and Fancher Road.

We appreciate the opportunity to be of service to you on this project. If you have any questions concerning this report or if we may be of further service, please contact us.

Sincerely,
Terracon Consultants, Inc.

Abdul K. Mohammed
Staff Engineer

Kevin M. Ernst, P.E.
Principal | Office Manager

REPORT TOPICS

Note: This report was originally delivered in a web-based format. **Orange Bold** text in the report indicates a referenced section heading. The PDF version also includes hyperlinks which direct the reader to that section and clicking on the ***GeoReport*** logo will bring you back to this page. For more interactive features, please view your project online at client.terracon.com.

ATTACHMENTS

Note: Refer to each individual Attachment for a listing of contents.

EXECUTIVE SUMMARY

Eleven (11) borings were performed to depths of approximately 10.5 feet for this project designated as B-001-0-20 through B-011-0-20. The borings were drilled on existing pavement and encountered 6 inches of asphalt and 6 to 12 inches aggregate base material. Beneath the pavement, Boring B-007-0-20 encountered possible fill materials to a depth of approximately 4.5 feet below the existing ground surface. The possible fill materials consisted of medium dense granular soils described as gravel and stone fragments (A-1-a). The natural overburden materials in the borings typically consisted of medium dense granular soils including sandy silt (A-4a), and medium stiff to very stiff cohesive soils including silt and clay, silty clay and clay (A-6a, A-6b, A-7-6).

Granular and cohesive soils with natural moisture contents more than 3 percent above the optimum moisture contents were observed in the borings B-002-0-20, B-004-0-20, B-002-0-20 B-008-0-20, B-009-0-20 and B-011-0-20 from the existing ground surface to depths of approximately between 1.5 and 4.5 feet indicating wet conditions. Unsuitable soils were not encountered in the borings.

Considering the high soil moisture contents encountered in the borings, installation of a drainage system including construction of underdrains and adequate ditches are recommended as a practical solution to promote drainage of the subgrade and improve subgrade stability for both SR 605 and Fancher Road improvements. In addition, we recommend that the soils along SR 605 and Fancher Road be reworked to stabilize the subgrade.

Based on the results of the subgrade analyses, a CBR value of 5 is recommended for design of the proposed construction of new single lane roundabout and widening along SR 605 and Fancher Road.

Groundwater was not encountered during drilling of the borings and for the short duration the borings remained open after completion of drilling.

This summary should be used in conjunction with the entire report for design purposes. It should be recognized that details were not included or fully developed in this section, and the report must be read in its entirety for a comprehensive understanding of the items contained herein. The section titled **General Comments** should be read for an understanding of the report limitations.

Subgrade Exploration Report

DEL-SR 605 and Fancher Road Intersection Improvements

Harlem Township

Terracon Project No. N4195366

September 17, 2020

INTRODUCTION

This report presents the results of our subsurface exploration and geotechnical engineering services performed for the proposed DEL-605-0.31 project to be located along State Route (SR) 605 and Fancher Road, Harlem Township. The purpose of these services is to provide information and geotechnical engineering recommendations relative to:

- Subsurface soil conditions
- Subgrade analysis
- Construction recommendations
- Short-term ground water conditions
- Subgrade preparation
- Pavement Design and thickness evaluation

The geotechnical subsurface exploration performed by Terracon for this project included the advancement of eleven (11) test borings to depth of about 10.5 feet below existing site grades. Proposed plan, profile and cross section drawings have not been provided to us as of the time of this submission. However, we have assumed that minimal amount of fill placement (≤ 2 feet) will be required to establish the proposed grades in the proposed improvement areas.

Maps showing the site and boring locations are shown in the **Site Location** and **Exploration Plan** sections, respectively. The results of the laboratory testing performed on soil samples obtained from the site during the field exploration are included on the boring logs and in the **Exploration Results** section.

GEOLOGY

The project site is located within the Galion Glaciated Low Plateau physiographic section of the Till Plains physiographic province. In general, the region is characterized as a rolling upland transitional between the gently rolling Till Plain and the hilly Glaciated Allegheny Plateau, which is mantled with thin to thick drift. Relief is moderate, with elevations ranging between approximately 800 to 1400 feet.

According to USGS surface geology maps, the surface bedrock is anticipated to be Maxville Limestone; Rushville, Logan, and Cuyahoga Formations, Undivided. The Mississippian-aged Maxville Limestone; Rushville, Logan and Cuyahoga Formations, Undivided consist of shale, siltstone, and sandstone, interbedded, with various shades of gray, yellow to brown weather

similar color. The sandstone is silty to granular, with local stringers of quartz pebbles. Shale is clayey to silty, and locally fossiliferous. Thickness varies from approximately 50 to 1300 feet. It is overlain by the Pottsville Group, with a base at the Sunbury Shale.

RECONNAISSANCE

The intersection of SR 605 and Fancher Road is a rural 4-legged intersection in Harlem Township of southern Delaware County approximately 3 miles north of New Albany. Site reconnaissance was performed by Terracon on May 5, 2020. At the time of our site reconnaissance visit, the existing SR 605 is a two lane, undivided roadway classified as a rural major collector with a 55-mph speed limit. Fancher Road is a two lane, undivided roadway classified as a rural major collector with a 45-mph speed limit. The existing pavement appeared to be in fair to good condition along SR 605 and Fancher Road. The ditch along SR 605 was poorly drained and standing water was observed on north east side along the pavement.

EXPLORATION

Field Exploration

A total of eleven (11) borings were performed between May 11, 2020 designated as B-001-0-20 through B-011-0-20. The borings were drilled through the existing roadway to depth of approximately 10.5 feet below the surface in general accordance with Section 303.3 of the Ohio Department of Transportation (ODOT) Specifications for Geotechnical Explorations (SGE) for roadway improvements.

Locations of the borings are illustrated on the attached **Exploration Plan** and summarized in the following table.

Boring Number	Alignment	Elevation [1] (feet)	Northing[1]	Easting[1]	Boring Depth (feet) [2]
B-001-0-20	Fancher Rd	1041.9	169826.74	1881939.487	10.5
B-002-0-20	Fancher Rd	1043.0	169823.19	1882207.005	10.5
B-003-0-20	SR-605	1044.6	169593.123	1881876.671	10.5
B-004-0-20	SR-605	1044.0	169304.51	1881844.962	10.5
B-005-0-20	SR-605	1040.7	169903.435	1881893.108	10.5
B-006-0-20	Fancher Rd	1040.1	169835.542	1881778.23	10.5
B-007-0-20	Fancher Rd	1039.5	169846.536	1881591.013	10.5
B-008-0-20	SR-605	1038.1	170101.456	1881904.756	10.5
B-009-0-20	Fancher Rd	1044.7	169821.414	1882393.758	10.5
B-010-0-20	Fancher Rd	1039.2	169856.603	1881380.813	10.5
B-011-0-20	SR-605	1037.6	170278.458	1881913.137	10.5

Boring Number	Alignment	Elevation [1] (feet)	Northing[1]	Easting[1]	Boring Depth (feet) [2]

1. The survey information including coordinates and ground surface elevations at the as drilled locations was provided by 2LMN, Inc.
2. Below ground surface

The boring locations were located in the field prior to drilling operations by Terracon personnel using a hand-held GPS unit. The coordinates and ground surface elevations presented on the preceding table, and boring logs, were obtained from the survey information provided by 2LMN Inc. Therefore, this information presented on the preceding table and the borings logs is based on the drilled locations.

We advanced the borings with a truck-mounted drill rig using continuous flight hollow stem augers through overburden materials. Soil samples were obtained continuously until the termination depth of the borings. The soil samples were obtained using the split-barrel sampling procedure. In the split-barrel sampling procedure, a standard 2-inch O.D. sampling spoon is driven into the boring with a 140-pound automatic SPT (Standard Penetration Test) hammer falling 30 inches. We recorded the number of blows required to advance the sampling spoon and the last 12 inches of an 18-inch sampling interval as the standard penetration resistance value (N-value). This value is corrected to an equivalent (60 percent) energy ratio (N_{60}) utilizing the hammer efficiency energy ratio. In addition, we observed and recorded groundwater levels during drilling and upon completion. The samples were placed in appropriate containers and taken to our soil laboratory for testing.

The field boring logs were prepared by a drilling crew that include sampling depths, penetration distances, and other relevant sampling information. Field logs include visual classifications of materials encountered during drilling, and our interpretation of subsurface conditions between samples. Final boring logs represent the geotechnical engineer's interpretation of field logs, and include modifications based on visual classification and laboratory tests.

Following the completion of drilling, the boreholes were sealed with a cement-bentonite grout. Where borings penetrated the existing pavement surface, the roadway surface was repaired using asphalt patch.

Laboratory Testing Program

As part of the testing program, all samples were examined in our laboratory by a geotechnical engineer. Soil samples were classified in general accordance with ODOT SGE Section 600 Laboratory Testing based on the texture and plasticity of the soils.

Laboratory tests were assigned to the samples in accordance with the latest ODOT Geotechnical Bulletin No.1 (GB-1). Atterberg limits, moisture content, and grain size analysis testing were performed on selected soil samples to obtain accurate information. In addition, sulfate testing was

performed on the samples within 1.5 to 4.5 feet below ground surface from each boring. The results of lab testing are shown on the boring logs and/or presented in the **Exploration Results** of this report.

FINDINGS

Boring logs have been prepared based on the information obtained from the field logs prepared at the time of drilling, and the visual examination performed in the laboratory. Soil classification was performed in general accordance with the current ODOT SGE. The logs have also been modified as necessary based on the results of the laboratory testing program. The following sections summarize the subsurface conditions encountered at the boring locations.

Subsurface Profile

In general, the borings encountered surface pavement materials underlain by cohesive and granular soils. Details on the soil types are presented in the following sections.

Conditions encountered at each boring location are indicated on the individual test boring logs. Stratification boundaries on the boring logs represent the approximate location of changes in soil types; in-situ, the transition between materials may be gradual. Details for each of the test borings can be found on the test boring logs in **Exploration Results** of this report. An **Exploration Plan** is also included in attachments.

In general, the borings indicated that the existing pavement section consisted mostly of asphalt over granular base material. The borings were drilled on existing pavement and encountered 6 inches of asphalt and 6 to 12 inches aggregate base material.

Borings B-007-0-20, encountered possible fill beneath the pavement materials to a depth range of about 1.0 to 4.5 feet below existing ground surface, consisting of gravel and/or stone fragments (A-1-a). Granular fill exhibited relative density of medium dense.

Below the granular base material, the test borings generally encountered native cohesive and granular soils to the termination depths of the borings. The cohesive soils encountered in the borings included silt and clay (A-6a), silty clay (A-6b) and clay (A-7-6) exhibiting consistencies ranging from medium stiff to very stiff. The granular soils encountered in the borings included sandy silt (A-4a) exhibiting relative density of medium dense.

Granular and cohesive soils with natural moisture contents more than 3 percent above the optimum moisture contents were observed in the borings B-002-0-20, B-004-0-20, B-002-0-20 B-008-0-20, B-009-0-20 and B-011-0-20 from the existing ground surface to depths of approximately between 1.5 and 4.5 feet indicating wet conditions. Unsuitable soils were not encountered in the borings.

Bedrock

Bedrock was not encountered in the borings to the depths explored.

Groundwater Conditions

Groundwater was not encountered during drilling of the borings and for the short duration the borings remained open after completion of drilling.

Groundwater level fluctuations occur due to seasonal variations in the amount of rainfall, runoff, and other factors not evident at the time the borings were performed. Therefore, groundwater levels during construction or at other times in the life of the pavement may be higher or lower than the levels indicated on the boring logs. The possibility of groundwater level fluctuations should be considered when developing the design and construction plans for the project.

Conditions encountered at each boring location are indicated on the individual boring logs. Stratification boundaries on the boring logs represent the approximate location of changes in soil types; in-situ, the transition between materials may be gradual. Details for each of the borings can be found on the boring logs in the **Exploration Results** attachment of this report.

Laboratory Testing

Based on our laboratory testing, the existing subgrade soils to a depth of up to about 10.5 feet below the surface have moisture contents ranging from about 10 to 30 percent, with an average moisture content of the subgrade soils across the project area of about 18 percent. Plasticity indices ranged from about 14 to 28, with an average plasticity index of about 21.

The table below summarizes the results of sulfate testing performed on the subgrade samples. It should be noted that samples with sulfate content greater than 5,000 parts per million (ppm) prohibit subgrade stabilization using chemical stabilization methods according to ODOT GB1 guideline. None of the test results exceeded the 5,000-ppm sulfate concentration level.

Boring ID	Sample Depth (feet) [1]	Sulfate Concentration (ppm)
B-001-0-20	1.5 - 3.0	47
B-002-0-20	1.5 - 3.0	80
B-003-0-20	1.5 - 3.0	77
B-005-0-20	3.0 - 4.5	216
B-006-0-20	3.0 - 4.5	33
B-007-0-20	1.5 - 3.0	73
B-008-0-20	1.5 - 3.0	57
B-009-0-20	1.5 - 3.0	79

1. Below ground surface

ANALYSIS AND RECOMMENDATION

Subgrade Analysis

In general, the soils at or near the anticipated pavement subgrade level consisted of medium dense granular possible fill material described as gravel with stone fragments (A-1-a), medium dense natural granular soils including sandy silt (A-4a), medium stiff to very stiff Clay (A-7-6), silt and clay (A-6a) and silty clay (A-6b) per the ODOT Classification system. Based on our laboratory testing, the existing subgrade soils to a depth of up to about 10.5 feet below the surface have moisture contents ranging from about 1 to 30 percent, with an average moisture content of the subgrade soils across the project area of about 17 percent. Plasticity indices ranged from about 14 to 28, with an average plasticity index of about 21.

Information regarding the proposed final subgrade elevations was not available as of the time of this submission. Therefore, for our analysis we have assumed that the proposed subgrade will be approximately 1.5 feet below existing ground surface at various boring locations. Generally, subgrade soils with a moisture content exceeding the optimum moisture content of the soil by three or more percentage points, are considered to be unstable soils, per ODOT GB1 guideline. Granular and cohesive soils with natural moisture contents greater than more than 3 percent above the optimum moisture contents were observed in 64% of the sample intervals within 3 feet of the subgrade. Overall, granular and cohesive soils with natural moisture contents more than 3 percent above the optimum moisture contents were observed in 45% of the samples within 6 feet of the subgrade in eleven borings.

The SPT N_{60} values in the roadway subgrade soils ranged from 6 to 30 blows per foot (bpf). The average SPT N_{60} value was about 16 bpf. The N_{60L} values (low N-values) for the anticipated subgrade soils encountered in the test borings ranged from 6 to 17 bpf, with an average N_{60L} value of 12 bpf. The unconfined compressive strength of cohesive soil samples as determined by a hand penetrometer ranged from 2.0 to 4.5 tsf with an average value of 3.85 tsf. A summary of the subgrade soils is tabulated on ODOT's **GB-1 Subgrade Analysis** spreadsheet in attachments section of this report.

Considering the high soil moisture contents encountered in the borings, installation of a drainage system including construction of underdrains and adequate ditches are recommended as a practical solution to promote drainage of the subgrade and improve subgrade stability for both SR 605 and Fancher Road improvements. In addition, we recommend that the soils along SR 605 and Fancher Road be reworked to stabilize the subgrade.

Laboratory California Bearing Ratio (CBR) testing was performed on the anticipated subgrade soils for this project. The average CBR value for the near surface soils encountered at the test boring locations B-001-0-20 and B-003-0-20 was about 4.75. Thus, based on ODOT's guidelines, we recommend an average CBR value of 5 be utilized in pavement design. The recommended

CBR value assumes that the subgrade improvement/stabilization recommended in this report is performed.

General Subgrade Preparation

Subgrade preparation for the new pavement, and shoulder areas should be performed in accordance with ODOT CMS Items 203 and 204. Prior to subgrade preparation, perform clearing and grubbing, including removal of stumps and roots, in accordance with ODOT CMS Item 201. Remove existing pavement and base materials as well as other structures or obstructions, as necessary, in accordance with ODOT CMS Item 202. The pavement subgrade should be stripped of any topsoil, organics, or other deleterious or unsuitable materials.

Once the new pavement areas have been stripped, excavated to the design subgrade elevation or to the design undercut elevation (if applicable), the exposed subgrade should be proof-rolled with a heavy piece of construction equipment to verify stability is achieved. It should be noted that fill containing organic materials or other deleterious materials may be encountered at other locations or at lower depths within the pavement alignment that were not disclosed by the borings. The actual depths and limits of undercutting should be determined by the Geotechnical Engineer in the field based on visual observations.

Any fill placed to achieve the final grade of the roadway pavement should follow requirements of ODOT CMS Item 203 and compacted to the specified percentage of the maximum dry density provided by ODOT CMS Item 204. The fill materials should be relatively free of debris, organic materials, and any deleterious materials deemed by the Geotechnical Engineer. No frozen materials should be incorporated into the fill, and no pavement, utilities, or fill should be placed on top of frozen materials.

All potential imported fill materials should be identified and approved by the Geotechnical Engineer prior to placement. Approval requires that moisture-density relationship tests, hydrometer analysis, and Atterberg limits be determined for each fill material prior to their placement. No particle size larger than two inches in any direction should be placed as fill, and any particle size greater than 3-inches should be broken down to less than 2-inches or removed from the lift. Aggregate base and pavement construction must be performed in accordance with ODOT CMS 300 and 400.

Subgrade Preparation and Stabilization

If the excavation depths are greater than 5 feet, the excavation sides will need to be laid back or shored. As a minimum, all excavations should be sloped or braced as required by Occupational Health and Safety Administration (OSHA) regulations to provide stability and safe working conditions. Reference to OSHA 29CFR, Part 1926, Subpart P should be included in the job specifications.

The grading contractor, by his contract, is usually responsible for designing and constructing stable, temporary excavations and should shore, slope or bench the sides of the excavations as required, to maintain stability of both the excavation sides and bottom. Slope heights, slope inclinations and/or excavation depths should in no case exceed those specified in local, state or federal safety regulations, including the current OSHA Excavation and Trench Safety Standards.

Under no circumstances should the information provided in this report be interpreted to mean that Terracon is responsible for construction site safety or the contractor's activities. Construction site safety is the sole responsibility of the contractor, who shall also be solely responsible for the means, methods, and sequencing of the construction operations.

Where structures, roadways, underground utilities, etc. exist adjacent to or within the zone of influence of the excavations, care must be taken to protect these structures, roadways, underground utilities, etc. from possible damages due to construction activities. If structures and underground utilities are located near an excavation, a pre-construction survey should be performed on all existing structures and underground utilities located within 100 feet of the excavation. It is the Contractor's responsibility to prevent undermining of existing foundations and prevent any damage to adjacent structures or facilities.

PAVEMENT DESIGN RECOMMENDATIONS

Project and Traffic Parameters

Parameter	Design Value
Design Life	20 years (2022 to 2042)
Opening Year ADT	8,130
Design Year ADT	9,820
Directional Distribution for 2-way traffic (D)	50% [1]
Lane Factor (LF)	100% (1 lane in each direction)
B:C Ratio	2:1 (rural, minor arterial)
24 hr Truck % (T24)	6%

1. D= 50% in the Pavement Design Manual.

As requested, we are providing recommended minimum flexible thickness design recommendations for the planned pavement and subgrade modifications.

Flexible Pavement

The following parameters were used with the ODOT Pavement Design Manual for evaluation of flexible pavements:

Parameter	Design Value
ESAL Conversion Factors	$B_{flexible}$ = 0.79 $C_{flexible}$ = 0.48
Total ESALs for the Design Period (Flexible Pavement)	1.46×10^6
Number of Trucks on Opening Day	493
Design Serviceability Loss	2.0 (flexible)
Reliability	85 (principal arterial, urban)
Overall Standard Deviation	0.49 (flexible)
Asphalt Concrete Structural Coefficients	0.43 (AC surface and intermediate courses) 0.36 (AC base course)
Item 304 Structural Coefficient	0.14
Drainage Coefficient	1.0 (Section 205.2)

Using the project and traffic parameters provided by 2LMN, Inc Consultants, the pavement parameters listed in the ODOT Pavement Design Manual, and the results of our Geotechnical Engineering Report dated June 19, 2020, we considered the following flexible pavement option:

Flexible Pavement Thickness Evaluation

Our Geotechnical Engineering Report dated June 19, 2020 included ODOT GB-1 subgrade analysis indicating that subgrade remediation could include installation of a drainage system including construction of underdrains, and adequate ditches are recommended as a practical solution to promote drainage of the subgrade and improve stability for both SR 605 and Fancher Road.

The following parameters were used for this pavement option:

Parameter	Design Value
CBR	5 (estimated CBR value based on ODOT GB1 Subgrade Analysis and Report of Geotechnical Exploration dated June 19, 2020)
Subgrade Resilient Modulus	6,000 psi (ODOT Pavement Design Manual Section 203.1)

Using these parameters and Figures 402-2 and 402-3 in the ODOT Pavement Design Manual, we estimated a minimum required Structural Number (SN) of about 3.85 which could be constructed using the following minimum pavement section:

FLEXIBLE PAVEMENT THICKNESS EVALUATION

Material Type	Thickness
Item 441 Asphalt Concrete Surface, Type 1 (448)	1.5”
301 Asphalt Concrete Base, PG64-22	5”
Item 304 Aggregate Base	10”
TOTAL	**16.50”**

Preventive Maintenance

Preventive maintenance should be planned and provided for through an on-going pavement management program. Preventive maintenance activities are intended to slow the rate of pavement deterioration, and to preserve the pavement investment. Preventive maintenance consists of both localized maintenance (e.g. crack and joint sealing and patching) and global maintenance. Preventive maintenance is usually the first priority when implementing a planned pavement maintenance program and provides the highest return on investment for pavements. Prior to implementing any maintenance, additional engineering observation is recommended to determine the type and extent of preventive maintenance.

GENERAL COMMENTS

Terracon should be retained to review the final design plans and specifications, so comments can be made regarding interpretation and implementation of our geotechnical recommendations in the design and specifications. Terracon should also be retained to provide observation and testing services during grading, excavation, foundation construction and other earth-related construction phases of the project.

This Subgrade Exploration Report has been prepared to present the findings of our exploration and present our recommendations pertaining to proposed improvements. The analysis and recommendations presented in this report are based upon the data obtained from the borings performed at the indicated locations and from other information discussed in this report. This report does not reflect variations that may occur between borings, across the site, or due to the modifying effects of construction or weather. The nature and extent of such variations may not become evident until during or after construction. If variations appear, we should be immediately notified so that further evaluation and supplemental recommendations can be provided.

Our Scope of Services does not include either specifically or by implication any environmental or biological (e.g., mold, fungi, bacteria) assessment of the site or identification or prevention of pollutants, hazardous materials or conditions. If the owner is concerned about the potential for such contamination or pollution, other studies should be undertaken.

Our services and any correspondence or collaboration through this system are intended for the sole benefit and exclusive use of our client for specific application to the project discussed and are accomplished in accordance with generally accepted geotechnical engineering practices with no third-party beneficiaries intended. Any third-party access to services or correspondence is solely for information purposes to support the services provided by Terracon to our client. Reliance upon the services and any work product is limited to our client and is not intended for third parties. Any use or reliance of the provided information by third parties is done solely at their own risk. No warranties, either express or implied, are intended or made.

Site characteristics as provided are for design purposes and not to estimate excavation cost. Any use of our report in that regard is done at the sole risk of the excavating cost estimator as there may be variations on the site that are not apparent in the data that could significantly impact excavation cost. Any parties charged with estimating excavation costs should seek their own site characterization for specific purposes to obtain the specific level of detail necessary for costing. Site safety, and cost estimating including, excavation support, and dewatering requirements/design are the responsibility of others. If changes in the nature, design, or location of the project are planned, our conclusions and recommendations shall not be considered valid unless we review the changes and either verify or modify our conclusions in writing.

ATTACHMENTS

FIELD EXPLORATION INFORMATION

SITE LOCATION AND EXPLORATION PLANS

Contents:

Site Location Plan
Exploration Plan

Note: All attachments are one page unless noted above.

SITE LOCATION

DEL-SR 605 and Fancher Road Intersection Improvements ■ Harlem Township
September 17, 2020 ■ Terracon Project No. N4195366

Terracon GeoReport

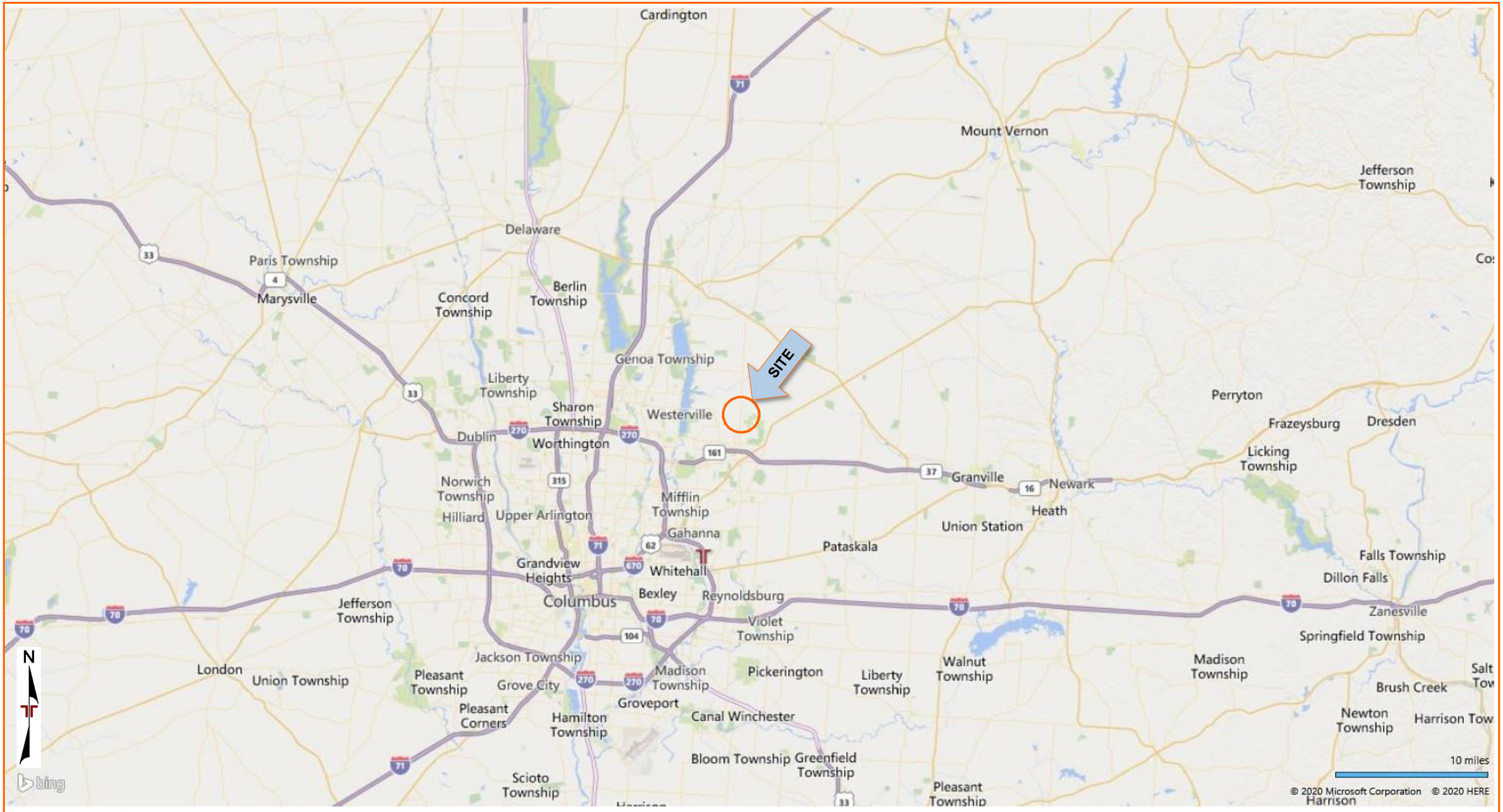

DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

MAP PROVIDED BY MICROSOFT BING MAPS

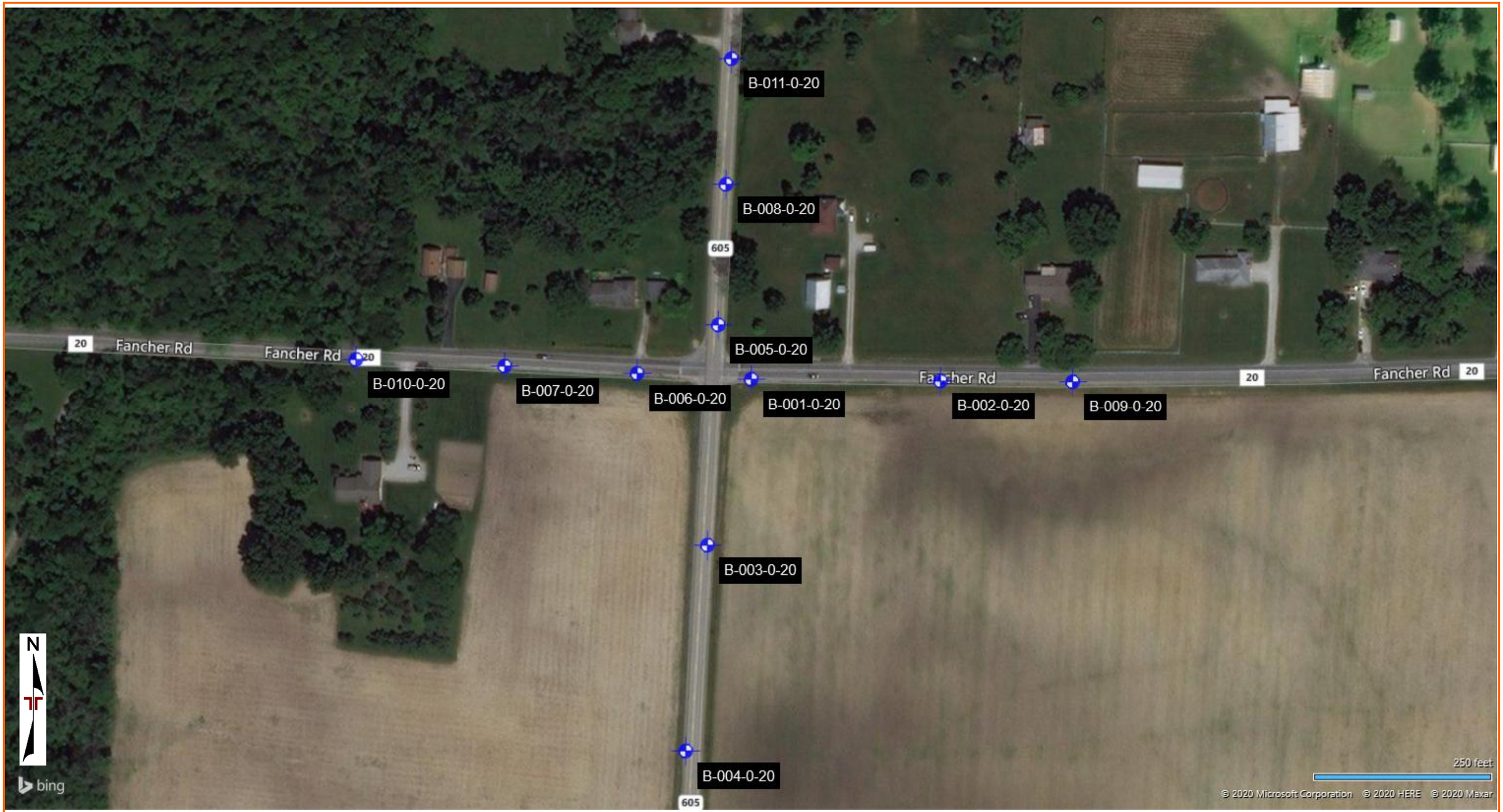

DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

MAP PROVIDED BY MICROSOFT BING MAPS

EXPLORATION RESULTS

Contents:

Note: All attachments are one page unless noted above.

BORING LOGS (B-001-0-20 THROUGH B-011-0-20)

(11 Pages)

PROJECT: DEL-605-00.31	DRILLING FIRM / OPERATOR: TERRACON / CMK	DRILL RIG: CME 45B (#3924)	STATION / OFFSET: 207+22, 14' LT.	EXPLORATION ID B-001-0-20
TYPE: ROADWAY	SAMPLING FIRM / LOGGER: TERRACON / SMB	HAMMER: SAFETY HAMMER	ALIGNMENT: FANCHER RD	
PID: SFN:	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 8/10/18	ELEVATION: 1041.9 (MSL) EOB: 10.5 ft.	PAGE 1 OF 1
START: 5/11/20 END: 5/11/20	SAMPLING METHOD: SPT	ENERGY RATIO (%): 90*	COORD: 169826.7400 N, 1881939.4870 E	

MATERIAL DESCRIPTION AND NOTES	ELEV. 1041.9	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	SO4 ppm	HOLE SEALED
Asphalt [6"]	1041.4																		
Base [6"]	1040.9																		
STIFF, BROWN AND GRAY, **SILTY CLAY**, TRACE SAND, TRACE GRAVEL, DAMP	1038.9	1 2 3 4	3 4 4	12	100	SS-1	4.50	14	6	11	30	39	34	13	21	23	A-6b (11)	<100	
STIFF TO VERY STIFF, BROWN, **SILT AND CLAY**, SOME SAND, SOME GRAVEL, DAMP	1032.9	5 6 7 8	3 4 5	14	89	SS-2	4.50	10	13	16	32	29	28	14	14	15	A-6a (7)	-	
			3 6 7	20	100	SS-3	4.50	-	-	-	-	-	-	-	-	14	A-6a (V)	-	
			3 4 6	15	100	SS-4	3.50	-	-	-	-	-	-	-	-	14	A-6a (V)	-	
			3 9 11	30	33	SS-5	3.00	-	-	-	-	-	-	-	-	16	A-6a (V)	-	
VERY STIFF, GRAYISH BROWN, **SILT AND CLAY**, SOME SAND, LITTLE GRAVEL, DAMP	1031.4	9 10 EOB	3 9 9	27	78	SS-6	4.50	-	-	-	-	-	-	-	-	12	A-6a (V)	-	

NOTES: CAVE-IN @ 8.5', * HAMMER EFFICIENCY = 91.4%, PER ODOT SGE MAXIMUM ENERGY RATIO VALUE OF 90% SHOULD BE UTILIZED

ABANDONMENT METHODS, MATERIALS, QUANTITIES: PLACED 0.25 BAG ASPHALT PATCH; TREMIED 20 GAL. BENTONITE GROUT

PROJECT: DEL-605-00.31	DRILLING FIRM / OPERATOR: TERRACON / CMK	DRILL RIG: CME 45B (#3924)	STATION / OFFSET: 209+93, 7' LT.
TYPE: ROADWAY	SAMPLING FIRM / LOGGER: TERRACON / SMB	HAMMER: SAFETY HAMMER	ALIGNMENT: FANCHER RD
PID: SFN:	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 8/10/18	ELEVATION: 1043.0 (MSL) EOB: 10.5 ft.
START: 5/11/20 END: 5/11/20	SAMPLING METHOD: SPT	ENERGY RATIO (%): 90*	COORD: 169823.1900 N, 1882207.0050 E

EXPLORATION ID B-002-0-20

PAGE 1 OF 1

MATERIAL DESCRIPTION AND NOTES	ELEV. 1043.0	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	HOLE SEALED
Asphalt [6"]	1042.5																		
Base [6"]	1042.0																		
VERY STIFF, BROWN AND GRAY, **SILTY CLAY**, LITTLE SAND, LITTLE GRAVEL, MOIST		1	3 3 3	9	89	SS-1	3.00	-	-	-	-	-	-	-	-	26	A-6b (V)	<100	
		2	2 2 2	6	89	SS-2	2.75	-	-	-	-	-	-	-	-	20	A-6b (V)	-	
		3	3 3 5	12	100	SS-3	4.00	-	-	-	-	-	-	-	-	22	A-6b (V)	-	
	1037.0	4																	
VERY STIFF, BROWN, **SILT AND CLAY**, SOME SAND, LITTLE GRAVEL, DAMP		5	3 4 7	17	100	SS-4	4.50	-	-	-	-	-	-	-	-	14	A-6a (V)	-	
		6	3 6 8	21	100	SS-5	4.50	-	-	-	-	-	-	-	-	15	A-6a (V)	-	
	1034.0	7																	
VERY STIFF, BROWN, **SILTY CLAY**, LITTLE SAND, SOME GRAVEL, MOIST TO WET		8	5 8 11	29	100	SS-6	-	-	-	-	-	-	-	-	-	12	A-6b (V)	-	
	1032.5	9																	
		10																	
		EOB																	

NOTES: CAVE-IN @ 8.0',* HAMMER EFFICIENCY = 91.4%, PER ODOT SGE MAXIMUM ENERGY RATIO VALUE OF 90% SHOULD BE UTILIZED

ABANDONMENT METHODS, MATERIALS, QUANTITIES: PLACED 0.25 BAG ASPHALT PATCH; TREMIED 20 GAL. BENTONITE GROUT

PROJECT: DEL-605-00.31	DRILLING FIRM / OPERATOR: TERRACON / CMK	DRILL RIG: CME 45B (#3924)	STATION / OFFSET: 104+92, 21' LT.	EXPLORATION ID B-003-0-20
TYPE: ROADWAY	SAMPLING FIRM / LOGGER: TERRACON / SMB	HAMMER: SAFETY HAMMER	ALIGNMENT: SR - 605	
PID: SFN:	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 8/10/18	ELEVATION: 1044.6 (MSL) EOB: 10.5 ft.	PAGE 1 OF 1
START: 5/11/20 END: 5/11/20	SAMPLING METHOD: SPT	ENERGY RATIO (%): 90*	COORD: 169593.1230 N, 1881876.6710 E	

MATERIAL DESCRIPTION AND NOTES	ELEV. 1044.6	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	SO4 ppm	HOLE SEALED
Asphalt [6"]	1044.1																		
Base [6"]	1043.6																		
VERY STIFF, REDDISH BROWN AND GRAY, **CLAY**, LITTLE SAND, TRACE GRAVEL, DAMP	1041.6	1	3 4 4	12	100	SS-1	4.00	18	7	9	27	39	44	16	28	18	A-7-6 (14)	<100	
VERY STIFF, BROWN, **SILT AND CLAY**, SOME SAND, LITTLE GRAVEL, DAMP	1038.6	2 3 4 5	3 4 6	15	100	SS-2	4.50	12	8	14	34	32	29	15	14	15	A-6a (8)	-	
VERY STIFF, BROWN, **SILTY CLAY**, SOME SAND, LITTLE GRAVEL, DAMP	1034.1	6 7 8 9 10	5 5 8	20	100	SS-3	4.50	-	-	-	-	-	-	-	-	15	A-6a (V)	-	
			4 4 6	15	100	SS-4	4.50	-	-	-	-	-	-	-	-	15	A-6b (V)	-	
			3 6 9	23	100	SS-5	4.50	-	-	-	-	-	-	-	-	16	A-6b (V)	-	
		EOB	6 7 8	23	100	SS-6	4.50	-	-	-	-	-	-	-	-	13	A-6b (V)	-	

NOTES: CAVE-IN @ 8.5', * HAMMER EFFICIENCY = 91.4%, PER ODOT SGE MAXIMUM ENERGY RATIO VALUE OF 90% SHOULD BE UTILIZED

ABANDONMENT METHODS, MATERIALS, QUANTITIES: PLACED 0.25 BAG ASPHALT PATCH; TREMIED 20 GAL. BENTONITE GROUT

PROJECT: DEL-605-00.31	DRILLING FIRM / OPERATOR: TERRACON / CMK	DRILL RIG: CME 45B (#3924)	STATION / OFFSET: 102+00, 8' LT.	EXPLORATION ID B-004-0-20
TYPE: ROADWAY	SAMPLING FIRM / LOGGER: TERRACON / SMB	HAMMER: SAFETY HAMMER	ALIGNMENT: SR - 605	
PID: SFN:	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 8/10/18	ELEVATION: 1044.0 (MSL) EOB: 10.5 ft.	PAGE 1 OF 1
START: 5/11/20 END: 5/11/20	SAMPLING METHOD: SPT	ENERGY RATIO (%): 90*	COORD: 169304.5100 N, 1881844.9620 E	

MATERIAL DESCRIPTION AND NOTES	ELEV. 1044.0	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	HOLE SEALED
Asphalt [6"]	1043.5	1																	
Base [10"]	1042.7																		
STIFF TO VERY STIFF, BROWN AND GRAY, **SILTY CLAY**, TRACE SAND, TRACE GRAVEL, DAMP		2	3 3 4	11	100	SS-1	4.25	-	-	-	-	-	-	-	-	25	A-6b (V)	-	
	1039.5	3 4	3 3 5	12	100	SS-2	3.50	-	-	-	-	-	-	-	-	23	A-6b (V)	-	
VERY STIFF, BROWN AND GRAY, **SILTY CLAY**, LITTLE SAND, LITTLE GRAVEL, DAMP		5	3 3 4	11	100	SS-3	4.00	-	-	-	-	-	-	-	-	15	A-6b (V)	-	
	1036.5	6 7	4 5 5	15	100	SS-4	4.50	-	-	-	-	-	-	-	-	16	A-6b (V)	-	
STIFF, BROWN AND GRAY, **SILTY CLAY**, SOME SAND, LITTLE GRAVEL, DAMP		8	3 3 5	12	100	SS-5	2.75	-	-	-	-	-	-	-	-	17	A-6b (V)	-	
	1035.0	9																	
VERY STIFF, BROWN, **SILT AND CLAY**, LITTLE SAND, SOME GRAVEL, DAMP		10	5 10 11	32	100	SS-6	4.50	-	-	-	-	-	-	-	-	13	A-6a (V)	-	
	1033.5 EOB																		

NOTES: CAVE-IN @ 8.0', * HAMMER EFFICIENCY = 91.4%, PER ODOT SGE MAXIMUM ENERGY RATIO VALUE OF 90% SHOULD BE UTILIZED

ABANDONMENT METHODS, MATERIALS, QUANTITIES: PLACED 0.25 BAG ASPHALT PATCH; TREMIED 20 GAL. BENTONITE GROUT

PROJECT: DEL-605-00.31	DRILLING FIRM / OPERATOR: TERRACON / CMK	DRILL RIG: CME 45B (#3924)	STATION / OFFSET: 108+02, 24' LT.
TYPE: ROADWAY	SAMPLING FIRM / LOGGER: TERRACON / SMB	HAMMER: SAFETY HAMMER	ALIGNMENT: SR - 605
PID: SFN:	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 8/10/18	ELEVATION: 1040.7 (MSL) EOB: 10.5 ft.
START: 5/11/20 END: 5/11/20	SAMPLING METHOD: SPT	ENERGY RATIO (%): 90*	COORD: 169903.4350 N, 1881893.1080 E

EXPLORATION ID B-005-0-20

PAGE 1 OF 1

MATERIAL DESCRIPTION AND NOTES	ELEV. 1040.7	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	HOLE SEALED
Asphalt [6"]	1040.2																		
Base [10"]	1039.4																		
MEDIUM DENSE, BROWNISH GRAY, **SANDY SILT**, TRACE GRAVEL, DAMP	1037.7	1	6 9 9	27	100	SS-1	-	-	-	-	-	-	-	-	-	17	A-4a (V)	-	
STIFF, REDDISH BROWN AND GRAY, **CLAY**, TRACE SAND, TRACE GRAVEL, DAMP	1034.7	2 3 4 5	3 6 6	18	33	SS-2	2.00	7	12	13	27	41	43	16	27	23	A-7-6 (14)	220	
		6	2 3 4	11	100	SS-3	3.50	-	-	-	-	-	-	-	-	20	A-7-6 (V)	-	
VERY STIFF, BROWN TO GRAY, **CLAY**, TRACE SAND, TRACE GRAVEL, DAMP	1030.2	7 8 9 10	3 4 5	14	100	SS-4	4.50	-	-	-	-	-	-	-	-	17	A-7-6 (V)	-	
		EOB	3 4 6	15	100	SS-5	4.50	-	-	-	-	-	-	-	-	16	A-7-6 (V)	-	
			7 7 7	21	100	SS-6	4.50	-	-	-	-	-	-	-	-	14	A-7-6 (V)	-	

NOTES: CAVE-IN @ 8.0', * HAMMER EFFICIENCY = 91.4%, PER ODOT SGE MAXIMUM ENERGY RATIO VALUE OF 90% SHOULD BE UTILIZED

ABANDONMENT METHODS, MATERIALS, QUANTITIES: PLACED 0.25 BAG ASPHALT PATCH; TREMIED 20 GAL. BENTONITE GROUT

PROJECT: DEL-605-00.31	DRILLING FIRM / OPERATOR: TERRACON / CMK	DRILL RIG: CME 45B (#3924)	STATION / OFFSET: 205+61, 10' LT.	EXPLORATION ID B-006-0-20
TYPE: ROADWAY	SAMPLING FIRM / LOGGER: TERRACON / SMB	HAMMER: SAFETY HAMMER	ALIGNMENT: FANCHER RD	
PID: SFN:	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 8/10/18	ELEVATION: 1040.1 (MSL) EOB: 10.5 ft.	PAGE 1 OF 1
START: 5/11/20 END: 5/11/20	SAMPLING METHOD: SPT	ENERGY RATIO (%): 90*	COORD: 169835.5420 N, 1881778.2300 E	

MATERIAL DESCRIPTION AND NOTES	ELEV. 1040.1	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	HOLE SEALED
Asphalt [6"]	1039.6																		
Base [12"]	1038.6																		
VERY STIFF, REDDISH BROWN AND GRAY, **CLAY**, LITTLE SAND, TRACE GRAVEL, DAMP	1037.1	1	4 4 6	15	67	SS-1	4.50	10	4	9	30	47	43	18	25	22	A-7-6 (15)	-	
VERY STIFF, REDDISH BROWN AND GRAY, **SILTY CLAY**, LITTLE SAND, TRACE GRAVEL, DAMP		2	4 4 4	12	50	SS-2	3.25	-	-	-	-	-	-	-	-	22	A-6b (V)	<100	
		3	3 5 6	17	78	SS-3	3.75	-	-	-	-	-	-	-	-	15	A-6b (V)	-	
		4	4 5 6	17	100	SS-4	4.50	-	-	-	-	-	-	-	-	15	A-6b (V)	-	
		5	4 7 7	21	100	SS-5	4.00	-	-	-	-	-	-	-	-	15	A-6b (V)	-	
	1031.1	6																	
VERY STIFF, BROWN AND GRAY, **SILTY CLAY**, SOME SAND, SOME GRAVEL, DAMP	1029.6	7	4 4 4	12	100	SS-6	3.00	-	-	-	-	-	-	-	-	14	A-6b (V)	-	
		8																	
		9																	
		10																	
		EOB																	

NOTES: CAVE-IN @ 8.5',* HAMMER EFFICIENCY = 91.4%, PER ODOT SGE MAXIMUM ENERGY RATIO VALUE OF 90% SHOULD BE UTILIZED

ABANDONMENT METHODS, MATERIALS, QUANTITIES: PLACED 0.25 BAG ASPHALT PATCH; TREMIED 20 GAL. BENTONITE GROUT

PROJECT: DEL-605-00.31	DRILLING FIRM / OPERATOR: TERRACON / CMK	DRILL RIG: CME 45B (#3924)	STATION / OFFSET: 203+71, 5' LT.	EXPLORATION ID B-007-0-20
TYPE: ROADWAY	SAMPLING FIRM / LOGGER: TERRACON / SMB	HAMMER: SAFETY HAMMER	ALIGNMENT: FANCHER RD	
PID: SFN:	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 8/10/18	ELEVATION: 1039.5 (MSL) EOB: 10.5 ft.	PAGE 1 OF 1
START: 5/11/20 END: 5/11/20	SAMPLING METHOD: SPT	ENERGY RATIO (%): 90*	COORD: 169846.5360 N, 1881591.0130 E	

MATERIAL DESCRIPTION AND NOTES	ELEV. 1039.5	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	HOLE SEALED
Asphalt [6"]	1039.0																		
Base [12"]	1038.0																		
MEDIUM DENSE, BROWNISH GRAY, **GRAVEL AND STONE FRAGMENTS**, TRACE SAND, TRACE SILT, DAMP ,**POSSIBLE FILL**	1035.0	1	5 5 5	15	89	SS-1	-	-	-	-	-	-	-	-	-	15	A-1-a (V)	<100	
		2																	
		3	3 3 3	9	89	SS-2	-	92	1	0	7	-	NP	NP	NP	1	A-1-a (0)	-	
		4																	
MEDIUM STIFF TO STIFF, BROWN AND GRAY, **CLAY**, TRACE SAND, TRACE GRAVEL, DAMP	1030.5	5	2 3 3	9	100	SS-3	2.00	-	-	-	-	-	-	-	-	30	A-7-6 (V)	-	
		6																	
		7	2 3 4	11	100	SS-4	3.50	-	-	-	-	-	-	-	-	21	A-7-6 (V)	-	
		8	2 3 4	11	100	SS-5	1.50	-	-	-	-	-	-	-	-	25	A-7-6 (V)	-	
VERY STIFF, BROWN, **SILTY CLAY**, LITTLE SAND, TRACE GRAVEL, DAMP	1029.0	9																	
EOB		10	3 4 5	14	100	SS-6	2.50	-	-	-	-	-	-	-	-	17	A-6b (V)	-	

NOTES: CAVE-IN @ 8.5', * HAMMER EFFICIENCY = 91.4%, PER ODOT SGE MAXIMUM ENERGY RATIO VALUE OF 90% SHOULD BE UTILIZED

ABANDONMENT METHODS, MATERIALS, QUANTITIES: PLACED 0.25 BAG ASPHALT PATCH; TREMIED 20 GAL. BENTONITE GROUT

PROJECT: DEL-605-00.31	DRILLING FIRM / OPERATOR: TERRACON / CMK	DRILL RIG: CME 45B (#3924)	STATION / OFFSET: 110+04, 7' LT.	EXPLORATION ID B-008-0-20
TYPE: ROADWAY	SAMPLING FIRM / LOGGER: TERRACON / SMB	HAMMER: SAFETY HAMMER	ALIGNMENT: SR - 605	
PID: SFN:	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 8/10/18	ELEVATION: 1038.1 (MSL) EOB: 10.5 ft.	PAGE 1 OF 1
START: 5/11/20 END: 5/11/20	SAMPLING METHOD: SPT	ENERGY RATIO (%): 90*	COORD: 170101.4560 N, 1881904.7560 E	

MATERIAL DESCRIPTION AND NOTES	ELEV. 1038.1	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	HOLE SEALED
Asphalt [6"]	1037.6																		
Base [12"]	1036.6																		
STIFF, BROWN, **SILT AND CLAY**, LITTLE SAND, TRACE GRAVEL, DAMP	1035.1	1 2 3 4 5 6 7 8 9 10	4 4 4	12	100	SS-1	3.00	-	-	-	-	-	-	-	-	21	A-6a (V)	<100	
MEDIUM DENSE, BROWN, **SANDY SILT**, SOME GRAVEL, DAMP	1032.1		3 3 4	11	33	SS-2	-	-	-	-	-	-	-	-	-	14	A-4a (V)	-	
			3 6 9	23	100	SS-3	-	-	-	-	-	-	-	-	-	15	A-4a (V)	-	
MEDIUM DENSE, BROWNISH GRAY, **SANDY SILT**, LITTLE GRAVEL, DAMP	1029.1		7 10 10	30	100	SS-4	-	-	-	-	-	-	-	-	-	10	A-4a (V)	-	
			6 8 8	24	89	SS-5	-	-	-	-	-	-	-	-	-	11	A-4a (V)	-	
VERY STIFF, BROWNISH GRAY, **SILT AND CLAY**, SOME SAND, LITTLE GRAVEL, DAMP	1027.6	EOB	5 7 7	21	100	SS-6	4.50	-	-	-	-	-	-	-	-	12	A-6a (V)	-	

NOTES: CAVE-IN @ 8.5',* HAMMER EFFICIENCY = 91.4%, PER ODOT SGE MAXIMUM ENERGY RATIO VALUE OF 90% SHOULD BE UTILIZED

ABANDONMENT METHODS, MATERIALS, QUANTITIES: PLACED 0.25 BAG ASPHALT PATCH; TREMIED 20 GAL. BENTONITE GROUT

PROJECT: DEL-605-00.31	DRILLING FIRM / OPERATOR: TERRACON / CMK	DRILL RIG: CME 45B (#3924)	STATION / OFFSET: 211+80, 7' RT.
TYPE: ROADWAY	SAMPLING FIRM / LOGGER: TERRACON / SMB	HAMMER: SAFETY HAMMER	ALIGNMENT: FANCHER RD
PID: SFN:	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 8/10/18	ELEVATION: 1044.7 (MSL) EOB: 10.5 ft.
START: 5/11/20 END: 5/11/20	SAMPLING METHOD: SPT	ENERGY RATIO (%): 90*	COORD: 169821.4140 N, 1882393.7580 E

EXPLORATION ID: B-009-0-20

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MATERIAL DESCRIPTION AND NOTES	ELEV. 1044.7	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	HOLE SEALED
Asphalt [6"]	1044.2																		
Base [12"]	1043.2																		
VERY STIFF, BROWN AND GRAY, **SILTY CLAY**, LITTLE SAND, LITTLE GRAVEL, DAMP		1	4 4 5	14	78	SS-1	4.50	-	-	-	-	-	-	-	-	21	A-6b (V)	<100	
		2	3 4 5	14	44	SS-2	4.00	12	7	15	31	35	34	16	18	16	A-6b (9)	-	
	1038.7	3	4 4 4	12	100	SS-3	4.00	-	-	-	-	-	-	-	-	20	A-6b (V)	-	
VERY STIFF, BROWN, **SILTY CLAY**, LITTLE SAND, SOME GRAVEL, DAMP		4	4 7 9	24	100	SS-4	4.50	-	-	-	-	-	-	-	-	13	A-6b (V)	-	
	1035.7	5	6 5 6	17	100	SS-5	3.00	-	-	-	-	-	-	-	-	12	A-6b (V)	-	
VERY STIFF, BROWNISH GRAY, **SILTY CLAY**, LITTLE SAND, SOME GRAVEL, MOIST	1034.2	6	2 4 4	12	100	SS-6	4.00	-	-	-	-	-	-	-	-	13	A-6b (V)	-	
		EOB 10																	

NOTES: CAVE-IN @ 8.0', * HAMMER EFFICIENCY = 91.4%, PER ODOT SGE MAXIMUM ENERGY RATIO VALUE OF 90% SHOULD BE UTILIZED

ABANDONMENT METHODS, MATERIALS, QUANTITIES: PLACED 0.25 BAG ASPHALT PATCH; TREMIED 20 GAL. BENTONITE GROUT

PROJECT: DEL-605-00.31	DRILLING FIRM / OPERATOR: TERRACON / CMK	DRILL RIG: CME 45B (#3924)	STATION / OFFSET: 201+61, 7' RT.
TYPE: ROADWAY	SAMPLING FIRM / LOGGER: TERRACON / SMB	HAMMER: SAFETY HAMMER	ALIGNMENT: FANCHER RD
PID: SFN:	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 8/10/18	ELEVATION: 1039.2 (MSL) EOB: 10.5 ft.
START: 5/11/20 END: 5/11/20	SAMPLING METHOD: SPT	ENERGY RATIO (%): 90*	COORD: 169856.6030 N, 1881380.8130 E

EXPLORATION ID B-010-0-20

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MATERIAL DESCRIPTION AND NOTES	ELEV. 1039.2	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	SO4 ppm	HOLE SEALED
Asphalt [6"]	1038.7																		
Base [12"]	1037.7																		
STIFF, BROWN, **SILTY CLAY**, LITTLE SAND, LITTLE GRAVEL, DAMP	1034.7	1 2 3 4	4 5 6	17	100	SS-1	3.50	-	-	-	-	-	-	-	-	16	A-6b (V)	-	
			4 6 7	20	22	SS-2	3.50	-	-	-	-	-	-	-	-	13	A-6b (V)	-	
STIFF TO VERY STIFF, BROWN, **SILT AND CLAY**, SOME SAND, LITTLE GRAVEL, DAMP	1033.2	5	4 7 9	24	100	SS-3	3.75	-	-	-	-	-	-	-	-	16	A-6a (V)	-	
VERY STIFF, BROWN AND GRAY, **SILTY CLAY**, SOME SAND, LITTLE GRAVEL, SHALE FRAGMENTS NOTED, DAMP	1030.2	6 7 8	5 7 10	26	100	SS-4	4.50	-	-	-	-	-	-	-	-	14	A-6b (V)	-	
			4 8 11	29	100	SS-5	4.50	-	-	-	-	-	-	-	-	13	A-6b (V)	-	
STIFF TO VERY STIFF, DARK GRAY, **SILT AND CLAY**, SOME SAND, LITTLE GRAVEL, SHALE FRAGMENTS NOTED, DAMP	1028.7	9 10 EOB	3 6 6	18	94	SS-6	4.50	-	-	-	-	-	-	-	-	12	A-6a (V)	-	

NOTES: CAVE-IN @ 8.0', * HAMMER EFFICIENCY = 91.4%, PER ODOT SGE MAXIMUM ENERGY RATIO VALUE OF 90% SHOULD BE UTILIZED

ABANDONMENT METHODS, MATERIALS, QUANTITIES: PLACED 0.25 BAG ASPHALT PATCH; TREMIED 20 GAL. BENTONITE GROUT

PROJECT: DEL-605-00.31	DRILLING FIRM / OPERATOR: TERRACON / CMK	DRILL RIG: CME 45B (#3924)	STATION / OFFSET: 111+81, 7' RT.
TYPE: ROADWAY	SAMPLING FIRM / LOGGER: TERRACON / SMB	HAMMER: SAFETY HAMMER	ALIGNMENT: SR - 605
PID: SFN:	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 8/10/18	ELEVATION: 1037.6 (MSL) EOB: 10.5 ft.
START: 5/11/20 END: 5/11/20	SAMPLING METHOD: SPT	ENERGY RATIO (%): 90*	COORD: 170278.4580 N, 1881913.1370 E

EXPLORATION ID B-011-0-20

PAGE 1 OF 1

MATERIAL DESCRIPTION AND NOTES	ELEV. 1037.6	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	SO4 ppm	HOLE SEALED
Asphalt [6"]	1037.1																		
Base [12"]	1036.1																		
MEDIUM DENSE, GRAYISH BROWN, **SANDY SILT**, DAMP		1	5 5 7	18	100	SS-1	-	-	-	-	-	-	-	-	-	15	A-4a (V)	-	
DARK BROWN SAND SEAMS NOTED @ 3.5'	1033.1	2 3 4	7 7 7	21	22	SS-2	-	-	-	-	-	-	-	-	-	16	A-4a (V)	-	
STIFF, OLIVE BROWN AND GRAY, **SILTY CLAY**, LITTLE SAND, TRACE GRAVEL, DAMP	1031.6	5	2 4 5	14	100	SS-3	2.25	-	-	-	-	-	-	-	-	22	A-6b (V)	-	
VERY STIFF, BROWN, **SILT AND CLAY**, SOME SAND, LITTLE GRAVEL, DAMP	1030.1	6 7	3 6 7	20	100	SS-4	4.50	-	-	-	-	-	-	-	-	14	A-6a (V)	-	
VERY STIFF, BROWN, **SILTY CLAY**, SOME SAND, LITTLE GRAVEL, DAMP	1028.6	8 9	5 10 10	30	100	SS-5	4.50	-	-	-	-	-	-	-	-	13	A-6b (V)	-	
VERY STIFF, BROWNISH GRAY, **SILTY CLAY**, SOME SAND, LITTLE GRAVEL, SHALE FRAGMENTS NOTED, DAMP	1027.1	10 EOB	10 10 7	26	94	SS-6	3.75	-	-	-	-	-	-	-	-	12	A-6b (V)	-	

NOTES: CAVE-IN @ 8.0', * HAMMER EFFICIENCY = 91.4%, PER ODOT SGE MAXIMUM ENERGY RATIO VALUE OF 90% SHOULD BE UTILIZED

ABANDONMENT METHODS, MATERIALS, QUANTITIES: PLACED 0.25 BAG ASPHALT PATCH; TREMIED 20 GAL. BENTONITE GROUT

ATTERBERG LIMITS AND GRAIN SIZE DISTRIBUTION

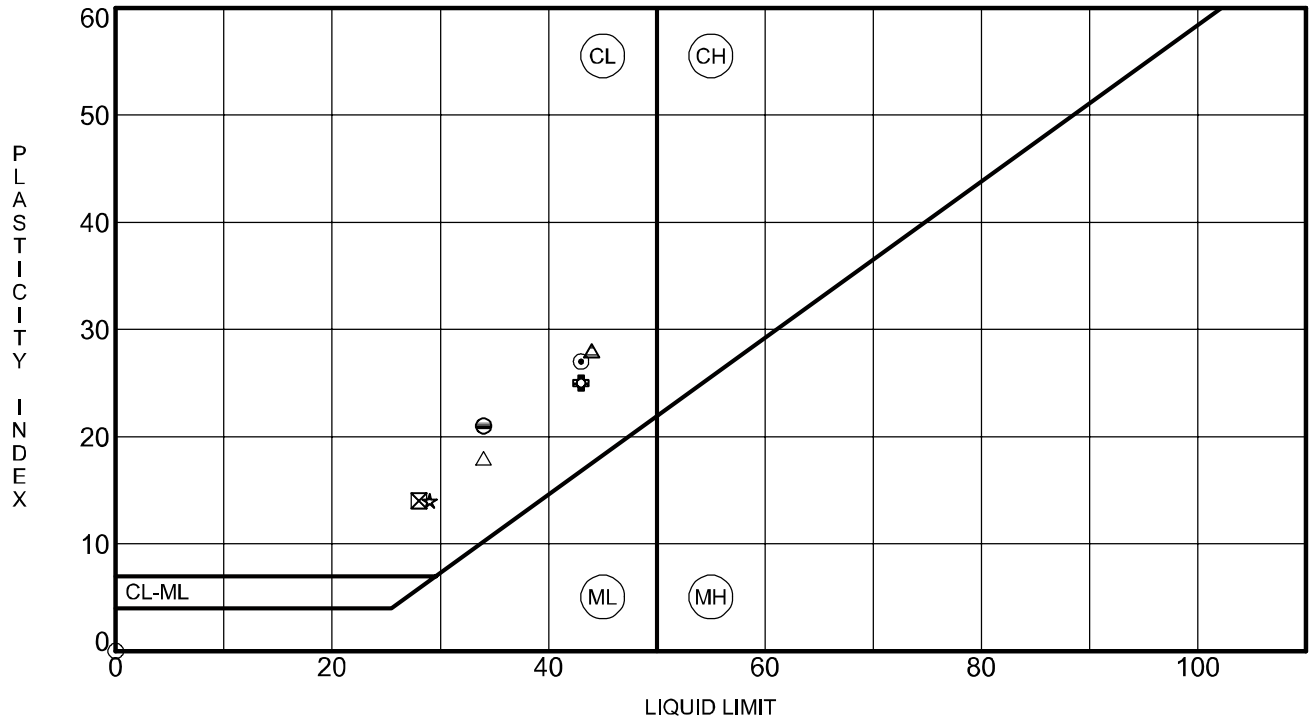
(3 pages)

ATTERBERG LIMITS' RESULTS

OHIO DEPARTMENT OF TRANSPORTION
OFFICE OF GEOTECHNICAL ENGINEERING

PROJECT DEL-605-00.31 **PID**

OGE NUMBER N4195366 **PROJECT TYPE** ROADWAY



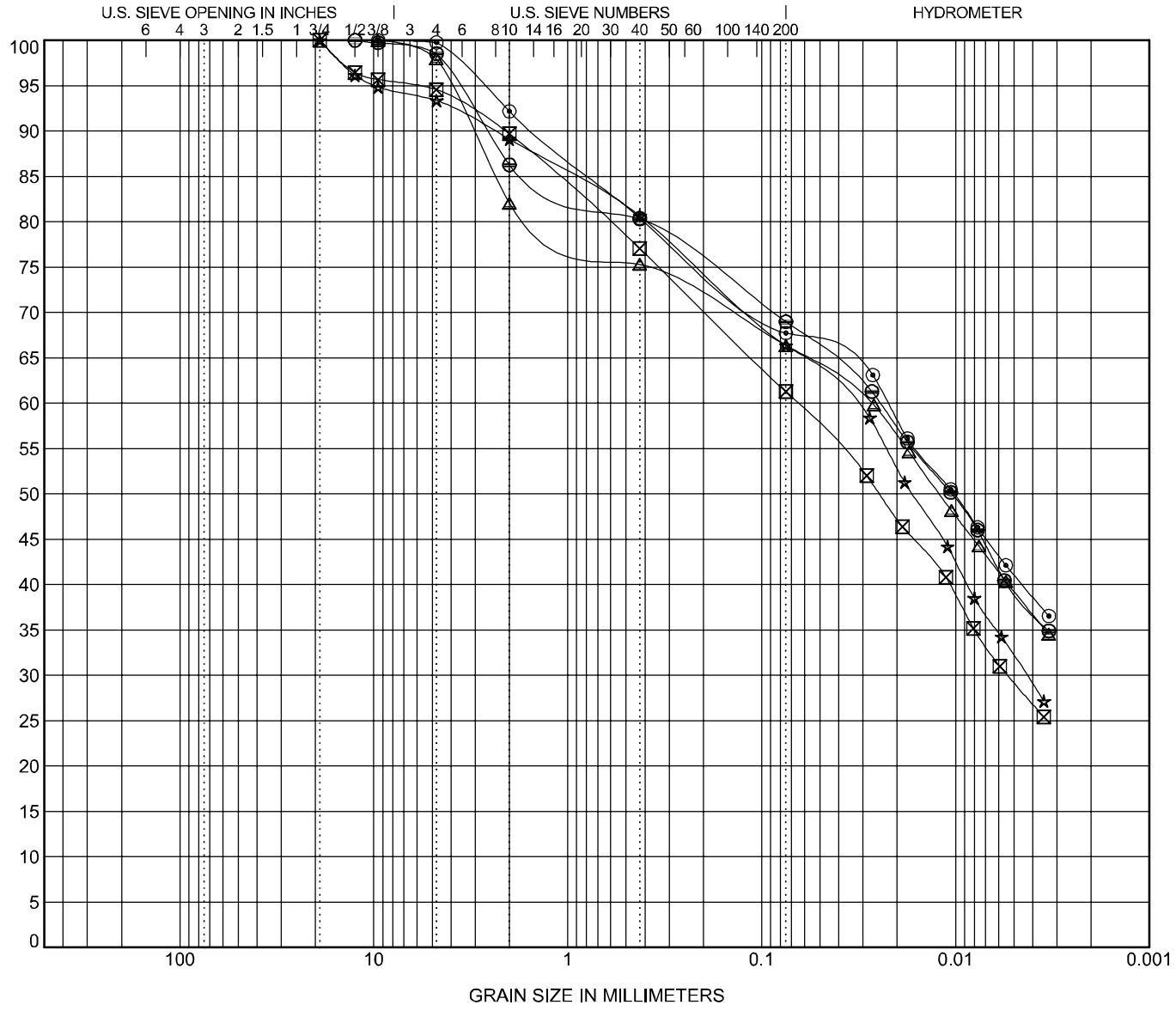
	Specimen Identification		LL	PL	PI	Fines	Classification
⊖	B-001-0-20	1.5	34	13	21	69	SANDY LEAN CLAY(CL)
⊠	B-001-0-20	3.0	28	14	14	61	SANDY LEAN CLAY(CL)
△	B-003-0-20	1.5	44	16	28	66	SANDY LEAN CLAY(CL)
☆	B-003-0-20	3.0	29	15	14	66	SANDY LEAN CLAY(CL)
⊙	B-005-0-20	3.0	43	16	27	68	SANDY LEAN CLAY(CL)
✿	B-006-0-20	1.5	43	18	25	77	LEAN CLAY with SAND(CL)
○	B-007-0-20	3.0	NP	NP	NP	7	POORLY GRADED GRAVEL with SILT and SAND(GP-GM)
△	B-009-0-20	3.0	34	16	18	66	SANDY LEAN CLAY(CL)

GRAIN SIZE DISTRIBUTION

OHIO DEPARTMENT OF TRANSPORTION
OFFICE OF GEOTECHNICAL ENGINEERING

PROJECT DEL-605-00.31 **PID**

OGE NUMBER N4195366 **PROJECT TYPE** ROADWAY



COBBLES	GRAVEL	SAND		SILT	CLAY
		coarse	fine		

Specimen Identification			ODOT (Modified AASHTO) ~ USCS Classification	LL	PL	PI
⊖	B-001-0-20	1.5	A-6b ~ SANDY LEAN CLAY(CL)	34	13	21
⊠	B-001-0-20	3.0	A-6a ~ SANDY LEAN CLAY(CL)	28	14	14
△	B-003-0-20	1.5	A-7-6 ~ SANDY LEAN CLAY(CL)	44	16	28
☆	B-003-0-20	3.0	A-6a ~ SANDY LEAN CLAY(CL)	29	15	14
⊙	B-005-0-20	3.0	A-7-6 ~ SANDY LEAN CLAY(CL)	43	16	27

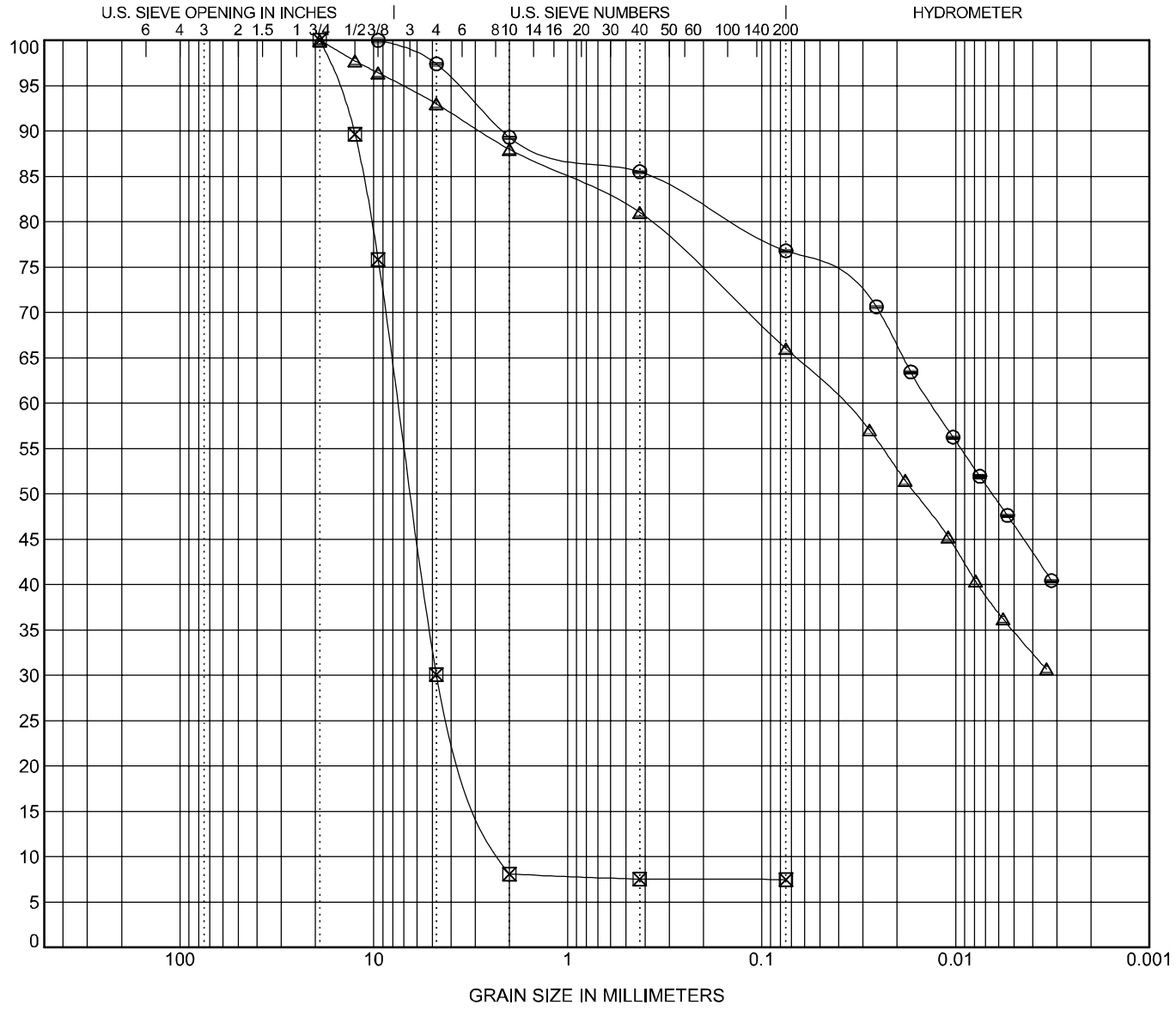
Specimen Identification			D90	D50	D30	D10	%G	%CS	%FS	%M	%C	Cc	Cu
⊖	B-001-0-20	1.5	2.601	0.01			14	6	11	30	39		
⊠	B-001-0-20	3.0	2.112	0.025	0.005		10	13	16	32	29		
△	B-003-0-20	1.5	3.079	0.012			18	7	9	27	39		
☆	B-003-0-20	3.0	2.393	0.017	0.004		12	8	14	34	32		
⊙	B-005-0-20	3.0	1.502	0.01			7	12	13	27	41		

GRAIN SIZE DISTRIBUTION

OHIO DEPARTMENT OF TRANSPORTION
OFFICE OF GEOTECHNICAL ENGINEERING

PROJECT DEL-605-00.31 **PID**

OGE NUMBER N4195366 **PROJECT TYPE** ROADWAY



COBBLES	GRAVEL	SAND		SILT	CLAY
		coarse	fine		

Specimen Identification			ODOT (Modified AASHTO) ~ USCS Classification	LL	PL	PI
⊖	B-006-0-20	1.5	A-7-6 ~ LEAN CLAY with SAND(CL)	43	18	25
⊠	B-007-0-20	3.0	A-1-a ~ POORLY GRADED GRAVEL with SILT and SAND(GP-GM)	NP	NP	NP
△	B-009-0-20	3.0	A-6b ~ SANDY LEAN CLAY(CL)	34	16	18

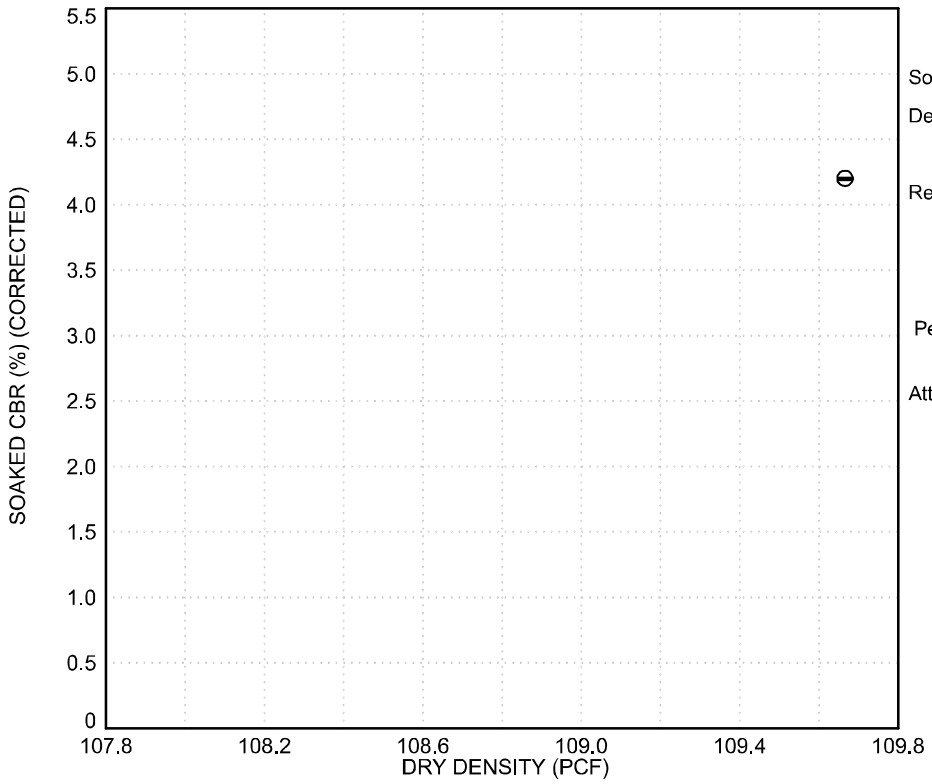
Specimen Identification			D90	D50	D30	D10	%G	%CS	%FS	%M	%C	Cc	Cu
⊖	B-006-0-20	1.5	2.153	0.006			10	4	9	30	47		
⊠	B-007-0-20	3.0	12.684	6.423	4.737	2.156	92	1	0	7		1.39	3.47
△	B-009-0-20	3.0	2.829	0.016			12	7	15	31	35		

CBR

(2 pages)

CALIFORNIA BEARING RATIO

ASTM D1883-07[2]



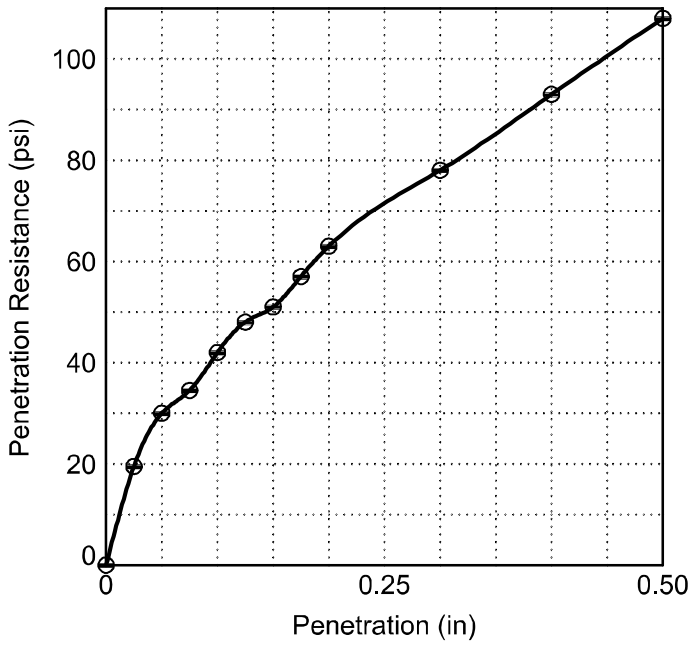
Source of Material: **B-001-0-20**

Description of Material: **A-6B ~ SANDY LEAN CLAY**

Remarks:

Percent Fines: **69.0 %**

Atterberg Limits: LL **34** PL **13** PI **21**



Sample No.	1
Sample Condition	Soaked
Compaction Method	ASTM 698C
Maximum Dry Density, (pcf)	112.9
Optimum Moisture Content, (%)	15.1
Dry Density before Soaking, (pcf)	109.67
Moisture Content, (%)	
After Compaction	15
Top 1" After Soaking	17.8
Surcharge,. (lbs)	20.00
Swell, (%)	1.11
Bearing Ratio, (%)	4.2

PROJECT: DEL-SR 605 and Fancher Rd Intersection

SITE: DEL-SR 605 and Fancher Road Delaware, OH

Terracon
800 Morrison Rd
Gahanna, OH

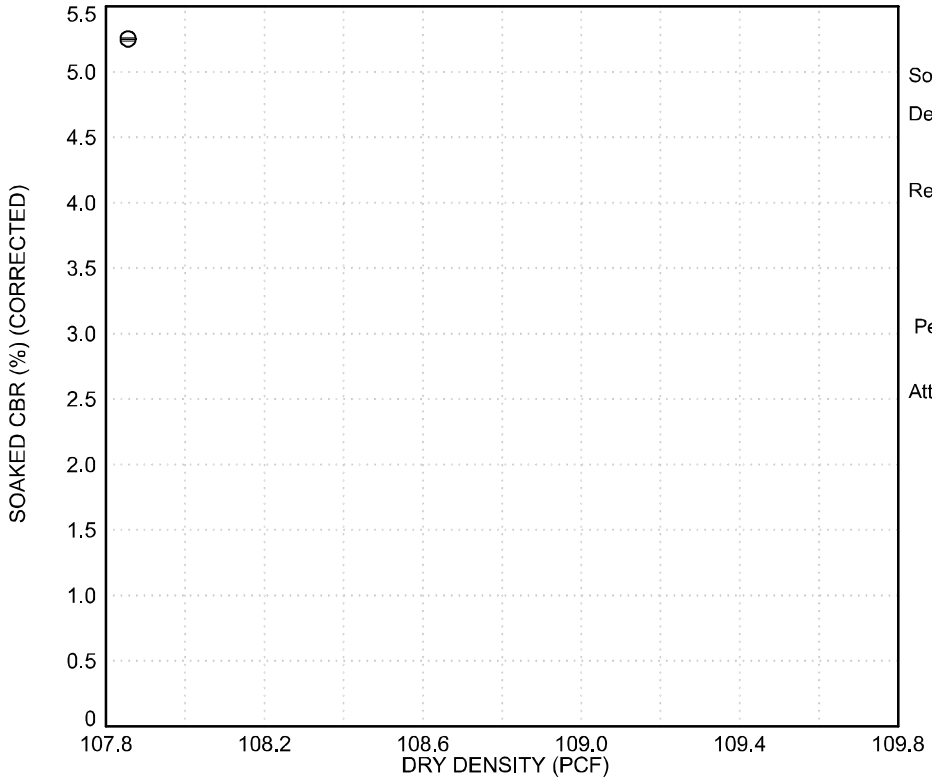
PROJECT NUMBER: N4195366

CLIENT: 2LMN, INC. Lancaster, OH

LABORATORY TESTS ARE NOT VALID IF SEPARATED FROM ORIGINAL REPORT. CBR 1 PT REPORT N4195366 DEL-SR 605 AND FA.GPJ TERRACON_DATATEMPLATE.GDT 5/18/20

CALIFORNIA BEARING RATIO

ASTM D1883-07[2]



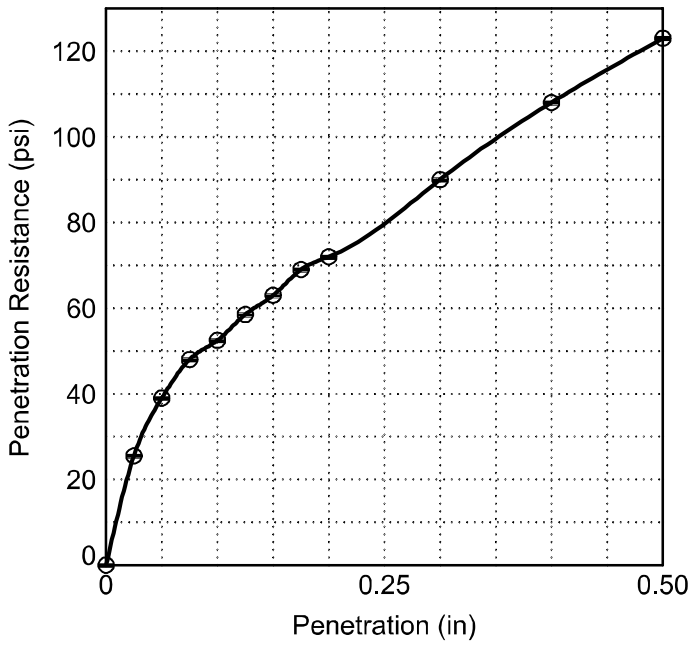
Source of Material: **B-003-0-20**

Description of Material: **A-7-6 ~SANDY LEAN CLAY**

Remarks:

Percent Fines: **66.0 %**

Atterberg Limits: LL **44** PL **16** PI **28**



Sample No.	1
Sample Condition	Soaked
Compaction Method	ASTM 698C
Maximum Dry Density, (pcf)	112.3
Optimum Moisture Content, (%)	15.4
Dry Density before Soaking, (pcf)	107.86
Moisture Content, (%)	
After Compaction	16.3
Top 1" After Soaking	19.1
Surcharge,. (lbs)	20.00
Swell, (%)	1.63
Bearing Ratio, (%)	5.3

PROJECT: DEL-SR 605 and Fancher Rd Intersection

SITE: DEL-SR 605 and Fancher Road Delaware, OH

Terracon
800 Morrison Rd
Gahanna, OH

PROJECT NUMBER: N4195366

CLIENT: 2LMN, INC. Lancaster, OH

SULFATE TEST RESULTS

(2 pages)

BOWSER-MORNER, INC.

Delivery Address: 4518 Taylorsville Road • Dayton, Ohio 45424 **Mailing Address**: P. O. Box 51 • Dayton, Ohio 45401

AASHTO/ISO 17025 Accredited • USACE Validated

LABORATORY REPORT

Report To: Terracon
Attn: S. Aaron Martin
800 Morrison Road
Columbus, OH 43230

Report Date: May 29, 2020
Job No.: 195867
Report No.: 431462
No. of Pages: 2

Report On: Laboratory Determination of Sulfate Content in Soils – Turbidimetric Method
Project: DEL-SR 605 and Fancher Rd Intersection – N4195366

On May 18, 2020, eight soil samples were submitted for determination of sulfate content in soils for the above referenced project. Testing was performed as specified by the client and in accordance with ODOT Supplement 1122, "Determining Sulfate Content in Soils by Turbidimetric Method".

Results are presented in the attached table.

Should you have any questions, or if we may be of further service, please contact me at (937) 236-8805, extension 322.

Respectfully submitted,
BOWSER-MORNER, INC.

Karl A. Fletcher, Vice President
Assistant Director, CMT &
Geotechnical Laboratories

KAF/blc
431462
1-File
1-samartin@terracon.com

Report To: Terracon

Project: DEL-SR 605 and Fancher Rd. Intersection

Job No.: 195867

Report No.: 431462

Date Received: 5/18/2020

Boring Number	Sample Number	Depth (ft)	Soaking Time (hr)	Dilution Ratio	Replicate Sample Readings			Average Reading	Sulfate Content (ppm)
					1	2	3		
B-20-1	1	1.0-2.5	16.0	20	2.3	2.6	2.1	2.3	47
B-20-2	1	1.0-2.5	16.0	20	6.0	3.0	3.0	4.0	80
B-20-3	1	1.0-2.5	16.0	20	3.2	5.4	3.0	3.9	77
B-20-5	1	3.5-5.0	16.0	20	10.0	10.9	11.5	10.8	216
B-20-6	2	3.5-5.0	16.0	20	1.5	1.8	1.7	1.7	33
B-20-7	1	1.0-2.5	16.0	20	3.9	3.9	3.2	3.7	73
B-20-8	1	1.0-2.5	16.0	20	3.4	2.8	2.4	2.9	57
B-20-9	1	1.0-2.5	16.0	20	4.3	3.5	4.1	4.0	79

GB-1 SUBGRADE ANALYSIS

Contents:

Note: All attachments are one page unless noted above.

OHIO DEPARTMENT OF TRANSPORTATION

OFFICE OF GEOTECHNICAL ENGINEERING

PLAN SUBGRADES
Geotechnical Bulletin GB1

DEL 605-0.31

Subgrade Analysis for The Proposed DEL- SR 605 and Fancher Road Intersection Improvements

Terracon Consultants, Inc.

Prepared By: Abdul Mohammed
Date prepared: Wednesday, June 17, 2020

Terracon Consultants, Inc.
800 Morrision Road
Columbus, Ohio 43230
Phone: 614-328-5167

abdulkaleem.mohammed@terracon.com

NO. OF BORINGS: 11

#	Boring ID	Alignment	Station	Offset	Dir	Drill Rig	ER	Boring EL.	Proposed Subgrade EL	Cut Fill
1	B-001-0-20	Fancher Rd	207+21.	14	Lt	CME 45B (#3924)	91	1040.9	1041.7	0.8 F
2	B-002-0-20	Fancher Rd	209+93.	7	Lt	CME 45B (#3924)	91	1042.0	1040.2	1.8 C
3	B-003-0-20	SR-605	104+92.	21	Rt	CME 45B (#3924)	91	1043.6	1041.4	2.2 C
4	B-004-0-20	SR-605	101+99.	8	Lt	CME 45B (#3924)	91	1042.7	1042.7	0.0
5	B-005-0-20	SR-605	108+01.	24	Rt	CME 45B (#3924)	91	1039.4	1040.2	0.8 F
6	B-006-0-20	Fancher Rd	205+61.	10	Lt	CME 45B (#3924)	91	1038.6	1039.9	1.3 F
7	B-007-0-20	Fancher Rd	203+71.	5	Lt	CME 45B (#3924)	91	1038.0	1038.0	0.0
8	B-008-0-20	SR-605	110+03.	7	Rt	CME 45B (#3924)	91	1036.6	1037.1	0.5 F
9	B-009-0-20	Fancher Rd	211+79.	7	Lt	CME 45B (#3924)	91	1043.2	1043.2	0.0
10	B-010-0-20	Fancher Rd	201+61.	7	Lt	CME 45B (#3924)	91	1037.7	1037.7	0.0
11	B-011-0-20	SR-605	111+80.	7	Rt	CME 45B (#3924)	91	1036.1	1036.3	0.2 F

OHIO DEPARTMENT OF TRANSPORTATION

Subgrade Analysis

V. 14.5 1/18/2019

#	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	1	1.5	3.0	2.3	3.8	12		4.5	34	13	21	30	39	69	23	16	A-6b	11	47					
	001-0	2	3.0	4.5	3.8	5.3	14		4.5	28	14	14	32	29	61	15	14	A-6a	7						
	20	3	4.5	6.0	5.3	6.8	20		4.5							14	14	A-6a							
		4	6.0	7.5	6.8	8.3	15	12	3.5							14	14	A-6a							
2	B	1	1.5	3.0	-0.3	1.2	9		3							26	16	A-6b	16	80		N_{60} & Mc		12''	
	002-0	2	3.0	4.5	1.2	2.7	6		2.75							20	16	A-6b	16			N_{60} & Mc			
	20	3	4.5	6.0	2.7	4.2	12		4							22	16	A-6b	16						
		4	6.0	7.5	4.2	5.7	17	6	4.5							14	14	A-6a	10						
3	B	1	1.5	3.0	-0.7	0.8	12		4	44	16	28	27	39	66	18	18	A-7-6	14	77					
	003-0	2	3.0	4.5	0.8	2.3	15		4.5	29	15	14	34	32	66	15	14	A-6a	8						
	20	3	4.5	6.0	2.3	3.8	20		4.5							15	14	A-6a	10						
		4	6.0	7.5	3.8	5.3	15	12	4.5							15	16	A-6b	16						
4	B	1	1.5	3.0	1.5	3.0	11		4.25							25	16	A-6b	16			N_{60} & Mc			
	004-0	2	3.0	4.5	3.0	4.5	12		3.5							23	16	A-6b	16						
	20	3	4.5	6.0	4.5	6.0	11		4							15	16	A-6b	16						
		4	6.0	7.5	6.0	7.5	15	11	4.5							16	16	A-6b							
5	B	1	1.5	3.0	2.3	3.8	27									17	10	A-4a	8						
	005-0	2	3.0	4.5	3.8	5.3	18		2	43	16	27	27	41	68	23	18	A-7-6	14	216					
	20	3	4.5	6.0	5.3	6.8	11		3.5							20	18	A-7-6							
		4	6.0	7.5	6.8	8.3	14	11	4.5							17	18	A-7-6							
6	B	1	1.5	3.0	2.8	4.3	15		4.5	43	18	25	30	47	77	22	18	A-7-6	15						
	006-0	2	3.0	4.5	4.3	5.8	12		3.25							22	16	A-6b	16	33					
	20	3	4.5	6.0	5.8	7.3	17		3.75							15	16	A-6b							
		4	6.0	7.5	7.3	8.8	17	12	4.5							15	16	A-6b							
7	B	1	1.5	3.0	1.5	3.0	15									15	6	A-1-a	0	73					
	007-0	2	3.0	4.5	3.0	4.5	9			0	0	NP	7		7	1	6	A-1-a	0						
	20	3	4.5	6.0	4.5	6.0	9		2							30	18	A-7-6	16						
		4	6.0	7.5	6.0	7.5	11	9	3.5							21	18	A-7-6							
8	B	1	1.5	3.0	2.0	3.5	12		3							21	14	A-6a	10	56		N_{60} & Mc			
	008-0	2	3.0	4.5	3.5	5.0	11									14	10	A-4a	8						
	20	3	4.5	6.0	5.0	6.5	23									15	10	A-4a	8						
		4	6.0	7.5	6.5	8.0	30	11								10	10	A-4a							
9	B	1	1.5	3.0	1.5	3.0	14		4.5							21	16	A-6b	16	79		N_{60} & Mc			
	009-0	2	3.0	4.5	3.0	4.5	14		4	34	16	18	31	35	66	16	16	A-6b	9						
	20	3	4.5	6.0	4.5	6.0	12		4							20	16	A-6b	16						
		4	6.0	7.5	6.0	7.5	24	12	4.5							13	16	A-6b							

OHIO DEPARTMENT OF TRANSPORTATION

Subgrade Analysis

V. 14.5 1/18/2019

#	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	1	1.5	3.0	1.5	3.0	17		3.5							16	16	A-6b	16						
	010-0	2	3.0	4.5	3.0	4.5	20		3.5							13	16	A-6b	16						
	20	3	4.5	6.0	4.5	6.0	24		3.75							16	16	A-6b	16						
		4	6.0	7.5	6.0	7.5	26	17	4.5							14	16	A-6b							
11	B	1	1.5	3.0	1.7	3.2	18									15	10	A-4a	8			Mc			
	011-0	2	3.0	4.5	3.2	4.7	21									16	10	A-4a	8						
	20	3	4.5	6.0	4.7	6.2	14		2.25							22	16	A-6b	16						
		4	6.0	7.5	6.2	7.7	20	14	4.5							14	14	A-6a							

PID:

County-Route-Section: DEL 605-0.31
No. of Borings: 11

Geotechnical Consultant: Terracon Consultants, Inc.
Prepared By: Abdul Mohammed
Date prepared: 6/17/2020

Chemical Stabilization Options		
320	Rubblize & Roll	No
206	Cement Stabilization	No
	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	5

% Samples within 6 feet of subgrade			
$N_{60} \leq 5$	0%	HP ≤ 0.5	0%
$N_{60} < 12$	23%	0.5 < HP ≤ 1	0%
$12 \leq N_{60} < 15$	28%	1 < HP ≤ 2	5%
$N_{60} \geq 20$	23%	HP > 2	77%
M+	15%		
Rock	0%		
Unsuitable	0%		

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

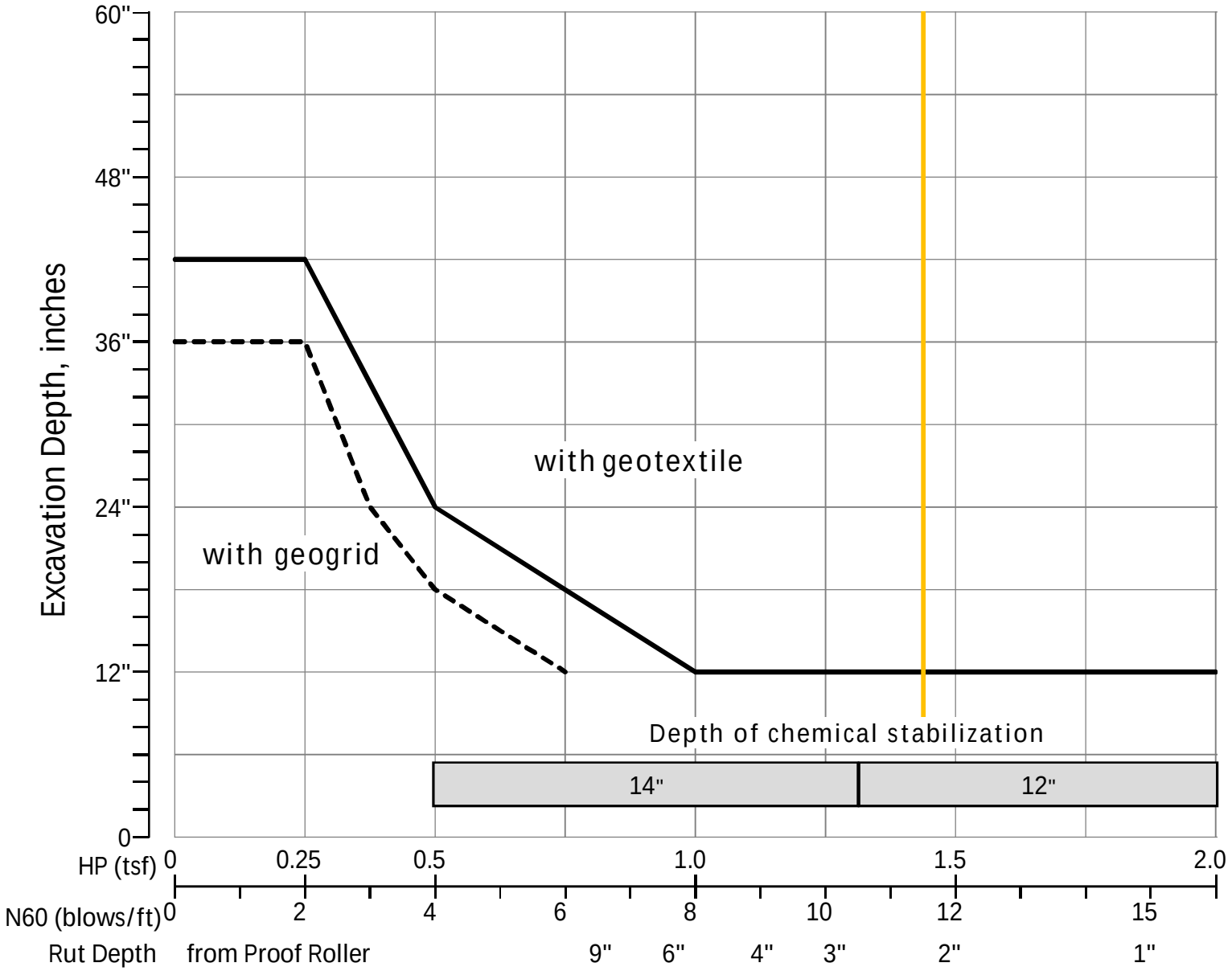
% Proposed Subgrade Surface	
Unstable & Unsuitable	43%
Unstable	43%
Unsuitable	0%

	N_{60}	N_{60L}	HP	LL	PL	PI	Silt	Clay	P 200	M_C	M_{OPT}	GI
Average	16	12	3.85	32	14	21	27	37	60	17	15	12
Maximum	30	17	4.50	44	18	28	34	47	77	30	18	16
Minimum	6	6	2.00	0	0	14	7	29	7	1	6	0

Classification Counts by Sample

ODOT Class	Rock	A-1-a	A-1-b	A-2-4	A-2-5	A-2-6	A-2-7	A-3	A-3a	A-4a	A-4b	A-5	A-6a	A-6b	A-7-5	A-7-6	A-8a	A-8b	Totals
Count	0	2	0	0	0	0	0	0	0	6	0	0	8	21	0	7	0	0	44
Percent	0%	5%	0%	0%	0%	0%	0%	0%	0%	14%	0%	0%	18%	48%	0%	16%	0%	0%	100%
% Rock|Granular|Cohesive	0%	18%									82%								100%
Surface Class Count	0	1	0	0	0	0	0	0	0	2	0	0	3	7	0	1	0	0	14
Surface Class Percent	0%	7%	0%	0%	0%	0%	0%	0%	0%	14%	0%	0%	21%	50%	0%	7%	0%	0%	100%

GB1 Figure B – Subgrade Stabilization



OVERRIDE TABLE

Calculated Average	New Values	Check to Override
3.85		☐ HP
11.55		☐ N60L

Average HP
Average N_{60L}

The subgrade analysis workbook consists of five worksheets. Each worksheet functions independently. In all of the worksheets the fields are color coded as follows:

- Every yellow highlighted field indicates a field to be entered by the user.
- Every salmon field is to indicate a problem/issue.
- Every gray or green field is a heading/informational field.

IMPORTANT: The sequence of filling out the data needs to be followed as outlined below:

1. Cover Sheet: this worksheet is designed for the purpose of entering the project information. Enter all the following fields:

County-Route-Section	This includes the county, route, section number assigned to the project.
PID	the Project Identification Number
Project Description	See Cover Sheet for list of example details
Geotechnical Consultant	The Geotechnical Consultant performing the analysis.
Prepared By	The preparer of the subgrade analysis
Date prepared	The date the analysis is performed.
Contact Information	Name, address, telephone #, and email address
No. of Borings	Enter the total number of borings within the alignment that is being analyzed.

2. Boring Logs Entry Worksheet: this worksheet has a programming code that will run in the background every time the sheet is activated and will make the sheet unresponsive for less than a minute. The code is designed to read the total number of borings from the cover sheet and generate the needed number of fields.
   a. All yellow highlighted fields are user's entry.
   b. ODOT has developed a text table export from gINT (GB 1 Borings Log Entry Tab) that will allow for copy and paste of all highlighted fields with the exception of proposed subgrade elevation. The designer must provide a proposed subgrade elevation in order for the spreadsheet to function properly.
   c. The Cut/Fill field is a calculated field that, based on the difference between the boring elevation and the proposed subgrade elevation, will highlight the cell either gray and adds the letter "C" to the end in a cut situation or highlights the cell in light purple and adds the letter "F" to the end in a fill situation.
   d. Every duplicate boring ID will be highlighted in salmon background and red text.
   e. IMPORTANT: After entering all the borings' information, the user must click "Add Subgrade Analysis Entry Fields" button. This will generate all the required fields in the "Subgrade Analysis" Worksheet.

3. Subgrade Analysis Worksheet:
   a. The boring number and boring ID is read from the "Boring Logs Entry Worksheet" excluding every boring that has six feet or more of fill.
   b. All yellow highlighted fields are to be entered by the user and salmon highlighted fields indicates a problem or issue.
   c. Every sample that has a Sulfate Content greater than or equal to 3000 will be highlighted in light salmon background. Every sample that has a Sulfate Content greater than or equal to 8000 will be highlighted in darker salmon background. Note the revised sulfate criteria in GB1 issued July 20, 2018.

d. Unsuitable/Unstable:

i. Unsuitable samples that are within 3 feet of the top of subgrade will be highlighted with salmon background and the class will be showing in this field.

ii. Unstable Samples that are within 3 feet of top of subgrade will be highlighted with salmon background and text to indicate the problem as follows:

Criterion	Stabilization Need Check	Text displayed in the field
A-1-a, A-1-b, A-3, or A-3a Soil Class	No Stabilization is needed	
HP ≥ 1.875	No Stabilization is needed	
N_{60} ≥ 15	No Stabilization is needed	
1.875 ≥ HP ≥ 1.5 and M_c≥ Opt. M_c+3	Unstable Subgrade	HP & Mc
15 ≥ N_{60} ≥ 12 and M_c≥ Opt. M_c+3	Unstable Subgrade	N_{60} & Mc
HP ≤ 1.5	Unstable Subgrade	HP
N_{60} ≤ 12	Unstable Subgrade	N_{60}

iii. The field is formulated to check for HP first and check for N_{60} second.

e. Excavate and Replace (Item 204) is going to be calculated based on the subgrade depth for each sample indicating an unsuitable or unstable problem.

f. Recommendation:

i. Geotextile Option is calculated and rounded to a multiple of 3 inches based on the subgrade depth for every sample indicating an unsuitable or unstable problem.

ii. GEOGRID Option is only offered in case of unstable subgrade problem and if the geotextile option indicates the need to excavate greater than 12 inches.

PLEASE NOTE: The Problem, Excavate & Replace, and Recommendation Fields are the responsibility of the Designer. These fields are being enhanced to attempt to capture the ODOT philosophy regarding the GB1 stabilization chart, but are considered still under development. If there are discrepancies between the spreadsheet output and the GB1 chart - the chart governs in conjunction with engineering judgement. Please contact Steve Taliaferro at stephen.taliaferro@dot.ohio.gov if you have any questions.

PLEASE NOTE: It is the Designer's responsibility to identify the most representative data when samples have been separated into multiple specimen (say 1.5 to 2.3 feet and 2.3 to 3.0 feet). The spreadsheet is not capable at this time of addressing this issue within a direct data export from gINT.

4. Results Summary:

All fields in this sheet are password protected and are either calculated or read from the other worksheets.

5. Graph Worksheet:

This worksheet is designed to read the average N_{60L} and the average HP from the Cover Sheet and plot a blue line for Average HP and orange line for Average N_{60L} on GB1 Figure B – Subgrade Stabilization. The Override Table can be used to enter HP and/or N_{60L} values that are different than the calculated averages. The Override values will change the global undercut recommendation in the Results Summary.

SUPPORTING INFORMATION

Contents:

Note: All attachments are one page unless noted above.

UNIFIED SOIL CLASSIFICATION SYSTEM

Terracon GeoReport

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests [A]					Soil Classification	
					Group Symbol	Group Name [B]
Coarse-Grained Soils: More than 50% retained on No. 200 sieve	**Gravels:** More than 50% of coarse fraction retained on No. 4 sieve	**Clean Gravels:** Less than 5% fines [C]	$Cu \geq 4$ and $1 \leq Cc \leq 3$ [E]		GW	Well-graded gravel [F]
			$Cu < 4$ and/or [$Cc<1$ or $Cc>3.0$] [E]		GP	Poorly graded gravel [F]
		Gravels with Fines: More than 12% fines [C]	Fines classify as ML or MH		GM	Silty gravel [F, G, H]
			Fines classify as CL or CH		GC	Clayey gravel [F, G, H]
	Sands: 50% or more of coarse fraction passes No. 4 sieve	**Clean Sands:** Less than 5% fines [D]	$Cu \geq 6$ and $1 \leq Cc \leq 3$ [E]		SW	Well-graded sand [I]
			$Cu < 6$ and/or [$Cc<1$ or $Cc>3.0$] [E]		SP	Poorly graded sand [I]
		Sands with Fines: More than 12% fines [D]	Fines classify as ML or MH		SM	Silty sand [G, H, I]
			Fines classify as CL or CH		SC	Clayey sand [G, H, I]
Fine-Grained Soils: 50% or more passes the No. 200 sieve	**Silts and Clays:** Liquid limit less than 50	**Inorganic:**	PI > 7 and plots on or above "A"		CL	Lean clay [K, L, M]
			PI < 4 or plots below "A" line [J]		ML	Silt [K, L, M]
		Organic:	Liquid limit - oven dried	< 0.75	OL	Organic clay [K, L, M, N]
			Liquid limit - not dried			Organic silt [K, L, M, O]
	Silts and Clays: Liquid limit 50 or more	**Inorganic:**	PI plots on or above "A" line		CH	Fat clay [K, L, M]
			PI plots below "A" line		MH	Elastic Silt [K, L, M]
		Organic:	Liquid limit - oven dried	< 0.75	OH	Organic clay [K, L, M, P]
			Liquid limit - not dried			Organic silt [K, L, M, Q]
Highly organic soils:	Primarily organic matter, dark in color, and organic odor				PT	Peat

[A] Based on the material passing the 3-inch (75-mm) sieve.

[B] If field sample contained cobbles or boulders, or both, add "with cobbles or boulders, or both" to group name.

[C] Gravels with 5 to 12% fines require dual symbols: GW-GM well-graded gravel with silt, GW-GC well-graded gravel with clay, GP-GM poorly graded gravel with silt, GP-GC poorly graded gravel with clay.

[D] Sands with 5 to 12% fines require dual symbols: SW-SM well-graded sand with silt, SW-SC well-graded sand with clay, SP-SM poorly graded sand with silt, SP-SC poorly graded sand with clay.

[E] $Cu = D_{60}/D_{10}$ $\quad Cc = \dfrac{(D_{30})^2}{D_{10} \times D_{60}}$

[F] If soil contains ≥ 15% sand, add "with sand" to group name.

[G] If fines classify as CL-ML, use dual symbol GC-GM, or SC-SM.

[H] If fines are organic, add "with organic fines" to group name.

[I] If soil contains ≥ 15% gravel, add "with gravel" to group name.

[J] If Atterberg limits plot in shaded area, soil is a CL-ML, silty clay.

[K] If soil contains 15 to 29% plus No. 200, add "with sand" or "with gravel," whichever is predominant.

[L] If soil contains ≥ 30% plus No. 200 predominantly sand, add "sandy" to group name.

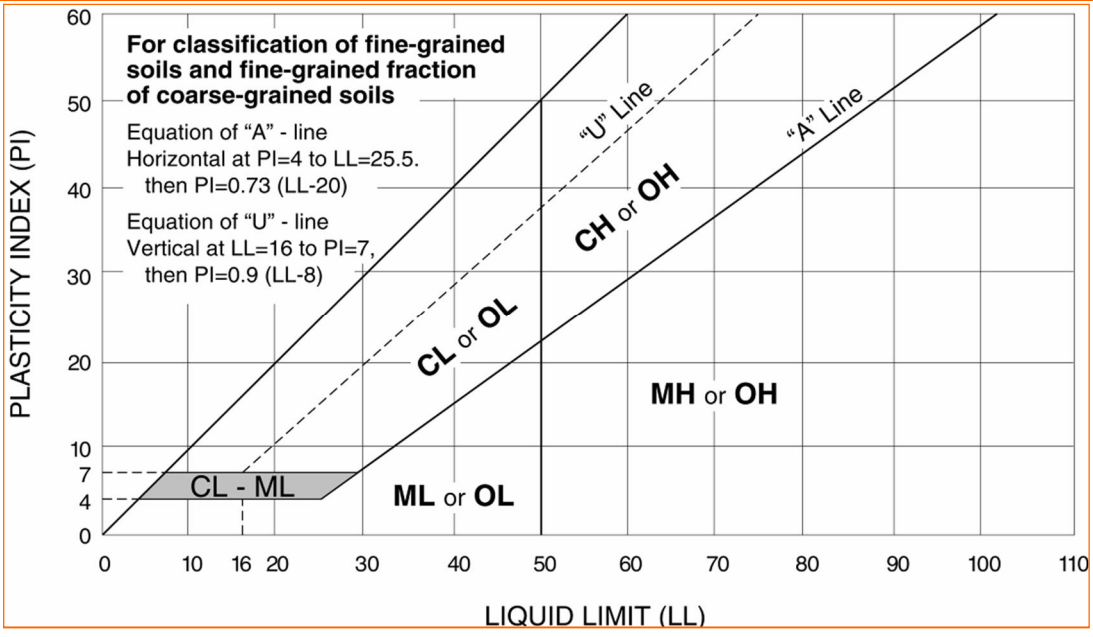
[M] If soil contains ≥ 30% plus No. 200, predominantly gravel, add "gravelly" to group name.

[N] PI ≥ 4 and plots on or above "A" line.

[O] PI < 4 or plots below "A" line.

[P] PI plots on or above "A" line.

[Q] PI plots below "A" line.



APPENDIX A.1 - ODOT Quick Reference for Visual Description of Soils

1) STRENGTH OF SOIL:

Non-Cohesive (granular) Soils - Compactness	
Description	**Blows Per Ft.**
Very Loose	≤ 4
Loose	5 – 10
Medium Dense	11 – 30
Dense	31 – 50
Very Dense	> 50

2) COLOR :

If a color is a uniform color throughout, the term is single, modified by an adjective such as light or dark. If the predominate color is shaded by a secondary color, the secondary color procedes the primary color. If two major and distinct colors are swirled throughout the soil, the colors are modified by the term "mottled"

3) PRIMARY COMPONENT

Use **DESCRIPTION** from ODOT Soil Classification Chart on Back

Cohesive (fine grained) Soils - Consistency

Description	Qu (TSF)	Blows Per Ft.	Hand Manipulation
Very Soft	<0.25	<2	Easily penetrates 2" by fist
Soft	0.25-0.5	2 - 4	Easily penetrates 2" by thumb
Medium Stiff	0.5-1.0	5 - 8	Penetrates by thumb with moderate effort
Stiff	1.0-2.0	9 - 15	Readily indents by thumb, but not penetrate
Very Stiff	2.0-4.0	16 - 30	Readily indents by thumbnail
Hard	>4.0	>30	Indent with difficulty by thumbnail

4) COMPONENT MODIFIERS:

Description	Percentage By Weight
Trace	0% - 10%
Little	10% - 20%
Some	20% - 35%
"And"	35% -50%

5) Soil Organic Content

Description	% by Weight
Slightly Organic	2% - 4%
Moderately Organic	4% - 10%
Highly Organic	> 10%

6) Relative Visual Moisture

Description	Criteria	
	Cohesive Soil	**Non-cohesive Soils**
Dry	Powdery; Cannot be rolled; Water content well below the plastic limit	No moisture present
Damp	Leaves very little moisture when pressed between fingers; Crumbles at or before rolled to $^1/_8$"; Water content below plastic limit	Internal moisture, but no to little surface moisture
Moist	Leaves small amounts of moisture when pressed between fingers; Rolled to $^1/_8$" or smaller before crumbling; Water content above plastic limit to -3% of the liquid limit	Free water on surface, moist (shiny) appearance
Wet	Very mushy; Rolled multiple times to $^1/_8$" or smaller before crumbles; Near or above the liquid limit	Voids filled with free water, can be poured from split spoon.

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	75 Min.		36 Min.	40 Max.	10 Max.	8	Less than 50% silt sizes
	Silt	A-4	A-4b	75 Min.		50 Min.	40 Max.	10 Max.	8	50% or more silt sizes
	Elastic Silt and Clay	A-5		75 Min.		36 Min.	41 Min.	10 Max.	12	
	Silt and Clay	A-6	A-6a	75 Min.		36 Min.	40 Max.	11 - 15	10	
	Silty Clay	A-6	A-6b	75 Min.		36 Min.	40 Max.	16 Min.	16	
	Elastic Clay	A-7-5		75 Min.		36 Min.	41 Min.	≦LL-30	20	
	Clay	A-7-6		75 Min.		36 Min.	41 Min.	>LL-30	20	
	Organic Silt	A-8	A-8a	74 Max.		36 Min.				W/o organics would classify as A-4a or A-4b
	Organic Clay	A-8	A-8b	74 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.