Fishbeck, Inc.
Toledo, Ohio

Geotechnical Subsurface Investigation
OTIC 91-18-07 Interchange Improvements
at MP 92
Freemont, Sandusky County, Ohio

April 2020

TTL associates inc
Environmental, Geotechnical
Engineering & Testing

1228 Euclid Ave., Ste. 320
Cleveland, OH 44115
T 419-324-2222
F 419-241-1808
www.ttlassoc.com

April 3, 2020 **TTL Project No. 1763902**

Mr. Jon Drummond, P.E.
Fishbeck Inc.
3220 Central Park West
Toledo, Ohio 43617

Geotechnical Subsurface Investigation
OTIC 91-18-07 Interchange Improvement - MP 92.0
Fremont, Sandusky County, Ohio

Dear Mr. Drummond:

Following is the report of the geotechnical subsurface investigation performed by TTL Associates, Inc. (TTL) at the site of the referenced project. This investigation was performed in general accordance with TTL Proposal No. 1763902, dated December 18, 2019 and subsequent authorization.

This report contains the results of our study, incorporates depicted ground surface elevations into the boring logs, and provides our engineering interpretation of the results with respect to the project characteristics, and our recommendations for design and construction of foundations and pavements. This report also incorporates geotechnical drilled shaft design parameters for the proposed new signs. Additionally, we provide the geotechnical parameters for pavement design based on current planned subgrade elevations.

Soil samples collected during this investigation will be stored at our laboratory for 90 days from the date of this report. The samples will be discarded after this time unless you request that they be saved or delivered to you.

Should you have any questions regarding this report or require additional information, please contact our office.

Sincerely,

TTL Associates, Inc.

Imad El Hajjar
Geotechnical Project Manager

David M. Vovak, P.E.
Cleveland Operations Director

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GEOTECHNICAL SUBSURFACE INVESTIGATION
OTIC 91-18-07 INTERCHANGE IMPROVEMENT - MP 92.0
FREMONT, SANDUSKY COUNTY, OHIO

FOR

FISHBECK INC.
3220 CENTRAL PARK WEST
TOLEDO, OHIO 43617

SUBMITTED

April 3, 2020
TTL PROJECT NO. 1763902

TTL ASSOCIATES, INC.
1228 EUCLID AVE., STE. 320
CLEVELAND, OH 44115
(419) 324-2222
(419) 321-6257 FAX

TABLE OF CONTENTS

Page No.

1.0 INTRODUCTION **1**
2.0 PROPOSED CONSTRUCTION **2**
3.0 INVESTIGATIVE PROCEDURES **3**
4.0 GENERAL SITE AND SUBSURFACE CONDITIONS **6**
4.1 General Site and Surface Conditions 6
4.2 Site Geology 7
4.3 General Soil Conditions 7
4.4 Groundwater Conditions 9
5.0 ANALYSES AND RECOMMENDATIONS **10**
5.1 Drilled Shaft Design Parameters 10
5.2 Seismic Considerations 11
5.3 Subgrades 11
5.3.1 Existing Subgrade 11
5.4 Flexible (Asphalt) Pavement Design 13
5.6 Rigid (Concrete) Pavement 14
5.7 Groundwater Control and Pavement Drainage 14
5.8 Excavations and Slopes 15
6.0 CONSTRUCTION RECOMMENDATIONS **16**
6.1 Site and Subgrade Preparation 16
6.2 Fill 18
7.0 QUALIFICATIONS OF RECOMMENDATIONS **19**

PLATES
Plate 1.0 Site Location Map
Plate 2.0 Test Boring Location Plan

APPENDICES
Logs of Test Borings
Legend Key
Pavement Cores Photographic Logs
Tabulation of Test Data
Laboratory Test Results
GB-1 Subgrade Analysis

1.0 INTRODUCTION

This geotechnical subsurface investigation report has been prepared for the proposed interchange improvements of the Ohio Turnpike Fremont Toll plaza that is located in the city of Fremont, Sandusky County, Ohio. The toll plaza is located near mile post (MP) 92 of the James W. Shocknessy Ohio Turnpike.

This report summarizes our understanding of the proposed construction, describes the investigative and testing procedures utilized to evaluate the subsurface conditions at the site, presents our findings from the field and laboratory testing, and provides our design and construction recommendations for foundations and pavement construction.

This investigation was performed in general accordance with TTL Proposal No. 1763902, dated December 18, 2019 and subsequent authorization.

The purpose of this investigation was to evaluate the subsurface conditions and laboratory data relative to the design and construction of foundations, and pavements at the referenced site. To accomplish this, TTL performed six test borings including two pavement cores, field and laboratory soil testing, a geotechnical engineering evaluation of the test results, and review of available geologic and soils data for the project area.

This report includes:

- A description of the surface, subsurface soil and groundwater conditions encountered in the borings.

- Recommendations for the design of the sign foundations and pavements.

- Recommendations concerning soil and groundwater-related construction procedures such as site preparation, earthwork, foundation construction, pavement subgrade preparation, and related field testing.

The scope of this study did not include an environmental assessment of the subsurface materials at this site.

2.0 PROPOSED CONSTRUCTION

We understand that it is planned to improve the existing interchanges of the Fremont toll plaza to convert the existing interchange to a roundabout. The roundabout is proposed along State Route OH-53, at the intersection with the exit ramps of the James W. Shocknessy Ohio Turnpike. We understand that the roundabouts and entrance tapers will be full-depth new pavement, and that final grades will approximate existing grades. We also understand that two new cantilever signs (Interchange Exit Direction Signs) are proposed along OH-53. Drilled shaft foundations are proposed for the sign structures.

Structural loads associated with the proposed cantilever signs, were not available at the time. It has been assumed that the proposed pavement areas will consist of standard and heavy-duty flexible (asphalt) sections and rigid (concrete) sections. Traffic volumes and loads were not provided.

3.0 INVESTIGATIVE PROCEDURES

Six test borings, designated as Borings B-1 through B-6, were drilled by TTL on March 9, 2020. The boring locations were located in the field by TTL using pacing methods utilizing the boring location plan that was attached to the proposal. Ground surface elevations at the boring locations were depicted from Google Earth. The approximate locations of the test borings are shown on the attached Test Boring Location Plan (Plate 2.0). The table below provides a summary of the test borings performed for this project.

Table 1. Test Boring Summary

Test Boring	Item	Location	Surface Elevation (Ft)	Depth (Ft)	Pavement Core
B-1	Cantilever Sign	Berm	582.0	15	N/A
B-2	Cantilever Sign	Berm	595.0	15	N/A
B-3	Pavement Design	Berm	596.0	6	N/A
B-4	Pavement Design	Berm	595.0	7	N/A
B-5	Pavement Design/Buildup	Pavement	595.0	7	1
B-6	Pavement Design/Buildup	Pavement	596.0	9	1

As noted in the table above, two pavement cores were obtained at Borings B-5 and B-6 using a 4-inch diameter single-wall, diamond-tipped core barrel attached to the drill rig. After pavement coring was completed, pavement thickness and composition were measured along the sidewall of the core-hole.

The test borings were performed in general accordance with geotechnical investigative procedures outlined in ASTM Standards D 1586 and D 5434. The test borings performed during this investigation were drilled with an ATV-mounted rotary drilling rig utilizing 3¼-inch inside diameter hollow-stem augers. During auger advancement, soil samples were collected at 2½-foot intervals to a depth of 10 feet and at 5-foot intervals thereafter using a split-spoon sampler. The soil samples were sealed in jars and transported to our laboratory for further classification and testing.

Split-spoon (SS) samples were obtained by the Standard Penetration Test (SPT) Method (ASTM D 1586), which consists of driving a 2-inch outside diameter split-spoon sampler into the soil with a 140-pound weight falling freely through a distance of 30 inches. The sampler was driven in three-to-four successive 6-inch increments with the number of blows per increment being recorded. The number of blows per increment was recorded at each depth interval, and these data are presented under the "SPT" column on the Logs of Test Borings attached to this report. The sum of the number of blows required to advance the sampler the

second and third 6-inch increments is termed the Standard Penetration Resistance, or Nm-value, and is typically reported in blows per foot (bpf). The Nm-values were corrected to an equivalent rod energy ratio of 60 percent, N60. The hammer/rod energy ratio for the truck-mounted drill rig (CME 75 Truck 111) was 70.8 percent, and was last calibrated on February 20, 2019. The N60-values are presented on the attached Logs of Test Borings

Pavement and soil conditions encountered in the pavement cores and test borings are presented in the Logs of Test Borings, along with information related to sample data, SPT results, water conditions observed in the borings, and laboratory test data. In conjunction with published data and typical correlations, the N_{60}-values can be evaluated as a measure of soil compactness/consistency as well as shear strength. It should be noted that these logs have been prepared on the basis of laboratory classification and testing, as well as field logs of the encountered soils.

All of the recovered samples of the subsoils were visually or manually classified in accordance with Ohio Department of Transportation (ODOT) Classification system . All samples of the subsoils were tested in our laboratory for moisture content (ASTM D 2216). Atterberg limits tests (ASTM D 4318) and particle size analyses (ASTM D 422) were performed on selected samples that represent the underlying soils conditions. Unconfined compressive strength estimates were obtained for the intact cohesive samples using a calibrated hand penetrometer. Laboratory tests that were performed for this investigation are on the following table.

Table 2. Laboratory Testing Summary

Laboratory Testing	Number of Tests
Moisture Content (ASTM D 2216)	23
Atterberg Limits (ASTM D 4318)	6
Particle Size Analysis w/Hydrometer (ASTM D 422)	6

Soil conditions encountered in the test borings are presented in the Logs of Test Borings, along with information related to sample data, SPT results, water conditions observed in the borings, and laboratory test data. It should be noted that these logs have been prepared on the basis of laboratory classification and testing as well as field logs of the encountered soils. The Logs of Test Boring, Tabulation of Test Data sheet, and lab testing outputs are attached to this report.

Experience indicates that the actual subsoil conditions at a site could vary from those generalized on the basis of test borings made at specific locations, especially at previously developed sites such as this site. Therefore, it is essential that a geotechnical engineer be retained to provide soil engineering services during the site preparation, excavation, and

foundation phases of the proposed project. This is to observe compliance with the design concepts, specifications, and recommendations, and to allow design changes in the event subsurface conditions differ from those anticipated prior to the start of construction.

4.0 GENERAL SITE AND SUBSURFACE CONDITIONS

4.1 General Site and Surface Conditions

Borings B-1 and B-2 are designated for the cantilever signs foundation design and were performed along the pavement shoulders with surface elevations of approximately elev. 582 and 595 feet above mean seal level (msl), respectively. Surface material consisted of a layer of asphalt that was 7 to 8 inches-thick. Borings B-3 through B-6 are designated for the new pavement design and were performed along the existing pavements or adjacent shoulders with ground surface elevation ranging from 595 to 596 feet msl. Boring B-3 was performed within a gravel area adjacent to the pavement shoulder and about 8 inches crushed stone subbase material was encountered at the surface. Boring B-4 was performed within the pavement shoulder along the exit ramp and about 3 inches of asphalt was encountered at the surface.

The pavement was cored in Borings B-5 and B-6. B-5 was performed within the pavement shoulder along the turnpike exit ramp and B-6 was performed within the driving lane along OH-53. Please note the following observations made based on our site visit and the review of available aerial and google earth street view photographs depicting the general conditions of the existing pavement.

- Signs of distress were noticeable throughout the pavement areas.
- Excessive longitudinal cracking down the center of the pavement areas were apparent.
- Transverse cracking, generally spanning from edge to edge of pavement were apparent.
- Some localized alligator cracking was observed as well.

The encountered surface materials at the core/boring locations are summarized in the following table.

Table 3. Encountered Pavement Thickness and Pavement Core Conditions Summary

Boring Number	Pavement Thickness (Inches)			Pavement Core Notes
	Asphalt	Concrete	Crushed Stone	
B-5	4.25	4.75	3	3 asphalt courses were apparent and underlain by a concrete layer. The crushed stone subbase was underlain by a 6-inch thick layer of sandy fill material.
B-6	5.25	-	9	3 asphalt courses were apparent. Pavement core exhibited separation at one apparent asphalt interface.

4.2 Site Geology

Published geologic maps from the Ohio Department of Natural Resources (ODNR) indicate that the project site is located within the glaciated portion of Ohio. These regions include upper profile soils consisting of Lacustrine Silt (LL) which typically have the following characteristics: deposited in low-velocity water of glacial and slack-water lakes; may contain fine sand or clay; well-laminated in distal portions of deltas, poorly-laminated elsewhere. These lacustrine deposits are underlain by predominantly silty and clayey glacial till, before encountering bedrock

Published bedrock maps show that multiple upper and lower Silurian formations could be encountered at the site. The norther portion of the site is underlain by the undivided Tymochtee and Greenfield Dolomite formations that consist of interbedded layers of Dolomite and Shale. The southern portion of the site is underlain by Dolomites of the Lockport Dolomite formation. ODNR references indicate top of rock at elevations roughly elevations 520 roughly 540 feet msl which is roughly 50 to 60 feet below existing grades.

4.3 General Soil Conditions

Based on the results of our field and laboratory tests, the subsoils encountered underlying the surface material can generally be characterized by a layer of fill material overlying stiff to very stiff native cohesive soils. Additional descriptions of the soil stratigraphy encountered in the borings are presented on the Logs of Test Borings attached to the report.

Granular Fill was encountered underlying the surface material in Borings B-1 and B-2 to depths of approximately 6 feet below existing grades (approximate Elevs. 576 and 589 feet msl), respectively. The granular fill material consisted predominantly of crushed stone fragments mixed with sand and silt. SPT N_{60}-values for the granular fill materials generally ranged from 24 to 89 blows per foot (bpf), indicating medium dense to dense consistency. Moisture contents generally ranged from 6 to 11 percent. These values, along with gradation results, are indicative of gravel mixed with sand and silt; A-2-6 in accordance with ODOT classification.

Cohesive Fill was encountered underlying the granular fill in Boring B-2 and underlying the surface material in Borings B-3 through B-6 to depths ranging between 2 and 8.5 feet below existing grades (approximate Elevs. 586 to 593 feet msl). The cohesive fill material consisted predominantly of clay mixed with silt containing varying amounts of sand, crushed stone fragments and organics. SPT N_{60}-values for the Stratum I soils generally ranged from 9 to 26

bpf, indicating stiff to very stiff consistency. Unconfined compressive strengths ranging from 2.5 to greater than 4.5 tsf were recorded within this stratum using a hand penetrometer (the highest obtainable reading using a calibrated hand penetrometer). Moisture contents ranged from 15 to 19 percent. Liquid limits ranged from 27 to 36 percent and plasticity index ranged from 14 to 19 percent were determined for three cohesive fill samples obtained from Borings B-2 (SS-3), B-4 (SS-1) and B-6 (SS-1) These values, along with gradation results, are indicative of silt and clay, and silty clay; A-6a and A-6b in accordance with ODOT classification.

Stratum I consisted of predominantly stiff to very stiff native cohesive soils and was encountered underlying the fill material in all the Borings. Borings B-3 through B-6 were terminated within this stratum at a depth ranging from 6 to 9 feet below existing grades (approximate Elev. 567 to 590 feet msl). Additionally, this stratum was encountered in Borings B-1 and B-2 to depth of 12 feet below existing grades (approximate Elev. 670 and 583 feet msl, respectively). Stratum I predominantly consisted predominantly of clay mixed with silt and varying amounts of sand and gravel. Trace amounts of organics were noted within this stratum in Boring B-2. SPT N_{60}-values for the Stratum I soils generally ranged from 17 to 30 bpf, indicating stiff to very stiff consistency. A seam of silty clay exhibiting hard consistency (SPT N_{60} = 38) was encountered within this stratum in Boring B-4 starting at 6 and extending to the boring termination depth of 7 feet. Unconfined compressive strengths ranging from 1.75 to greater than 4.5 tsf were recorded within this stratum using a hand penetrometer (the highest obtainable reading using a calibrated hand penetrometer). Moisture contents ranged from 19 to 28 percent. Liquid limits ranged from 44 to 49 percent and plasticity index ranged from 24 to 26 percent were determined for three Stratum I samples obtained from Borings B-1 (SS-4), B-3 (SS-2), and B-5 (SS-2). These values, along with gradation results, are indicative of clay and silty clay; A-7-6 and A-6b in accordance with ODOT classification.

Stratum II consisted of predominantly stiff native cohesive soils and was encountered underlying Stratum I in Borings B-1 and B-2 which were terminated within this stratum at a depth of 15 feet below existing grades (approximate Elev. 567 and 580 feet msl, respectively). Stratum II predominantly consisted predominantly of clay mixed with silt and varying amounts of sand and gravel. SPT N_{60}-values for the Stratum II soils generally ranged from 15 to 17 bpf, indicating stiff consistency. Unconfined compressive strengths ranging from 2.25 to 3.25 tsf were recorded within this stratum using a hand penetrometer (the highest obtainable reading using a calibrated hand penetrometer). Moisture contents ranged from 18 to 26 percent. These values, along with gradation results, are indicative of clay and silty clay; A-7-6 and A-6b in accordance with ODOT classification.

4.4 Groundwater Conditions

Groundwater was not encountered during drilling or observed upon completion of drilling in the soil borings. It should be noted that "perched" water may be present within the pavement stone subbase or the granular fill materials that are underlain by relatively impermeable cohesive soils. It should also be noted that the test borings were backfilled upon completion, so ample time may not have occurred to achieve stabilized water levels within the open boreholes in the predominantly clayey profile.

Based on the soil characteristics and groundwater conditions encountered in the borings, it is our opinion that the "normal" long-term groundwater table will be generally encountered at depths of approximately 15 feet or lower. However, groundwater elevations can fluctuate with seasonal and climatic influences. In particular, "perched" water may be encountered in fill materials or granular soils that are underlain by relatively impermeable cohesive soils. Therefore, the groundwater conditions may vary at different times of the year from those encountered during this investigation.

5.0 ANALYSES AND RECOMMENDATIONS

The following analyses and recommendations are based on our understanding of the proposed construction and upon the data obtained during our field exploration. If the project information or location as outlined is incorrect or should change significantly, a review of these recommendations should be made by TTL.

5.1 Drilled Shaft Design Parameters

It was indicated that two new cantilever signs (Interchange Exit Direction Signs) are proposed along OH-53. We have evaluated a drilled shaft foundation system with respect to the proposed construction and soil conditions encountered in Borings B-1 and B-2, which were performed adjacent to the roadway at the locations of the support posts of the proposed cantilever signs. The Drilled shaft foundations will derive axial capacity from side resistance and end-bearing and lateral resistance through soil-structure interactions which are dependent upon shaft material, diameter, soil properties, loading type, and bed slope of ground. The following table includes soil parameters for axial design and for lateral load-deflection evaluations using LPILE software at each boring location. It should be noted that the lateral capacity of these foundation elements is most likely to govern its foundation design.

Drilled Shaft Recommended Design Parameters at Boring B-1

Stratum	L-pile Soil Type	Soil Description	Bottom of Stratum Elevation (feet)	Avg. Undrained Shear Strength, c (psf)	Avg. Allowable Adhesion, c_a (psf)	Allowable End-Bearing Capacity (ksf)	Total Unit Weight (pcf)	K values (pci)		Strain at 50% Max. Stress, ε_{50}
								Static	Cyclic	
GF	5	Granular Fill	576	-	-	-	125	45	-	-
I	3	Stiff to Very Stiff Cohesive Soils	570	3,500	650	12.5	135	1,250	430	0.007
II	3	Stiff Cohesive Soils	-	2,000	440	7.5	135	650	250	0.005

Drilled Shaft Recommended Design Parameters at Boring B-2

Stratum	L-pile Soil Type	Soil Description	Bottom of Stratum Elevation (feet)	Avg. Undrained Shear Strength, c (psf)	Avg. Allowable Adhesion, c_a (psf)	Allowable End-Bearing Capacity (ksf)	Total Unit Weight (pcf)	K values (pci)		Strain at 50% Max. Stress, ε_{50}
								Static	Cyclic	
GF	5	Granular Fill	589	-	-	-	125	45	-	-
CF	1	Cohesive Fill	586	1,000	220	-	135	70	-	0.003
I	3	Stiff to Very Stiff Cohesive Soils	583	2,500	550	9.5	135	800	515	0.006
II	3	Stiff Cohesive Soils	-	2,000	440	7.5	135	650	250	0.005

1. Consider shaft resistance starting from a depth of 5 feet. Ignore skin friction contribution from the bottom length that is equal to the proposed shaft diameter
2. L-pile soil type designation
   a. Soil Type 5: Sand(Reese)
   b. Soil Type 1: Soft Clay (Reese)
   c. Soil Type 3: Stiff Clay without Free Water (Reese)

Allowable design values indicated in the above table are based on a nominal factor of safety of 2.5 applied to calculated ultimate values for shaft resistance and end-bearing capacity. As stated above, contribution of skin friction should be ignored for the portion of the bottom portion of the shaft that is equal to 1 x nominal shaft diameter.

Although not anticipated based on the conditions encountered during this investigation, if bouldery till or gravelly hardpan is encountered, it may be prudent to shorten the drilled shafts and use belled piers.

Total settlement of drilled shafts loaded to the allowable capacity is not expected to exceed ½ inch, including elastic compression of the shaft.

We do not recommend diameters less than 30 inches for drilled shafts. It should be noted that typical construction practice for small diameter drilled shafts no longer includes inspection at the bottom of the pier for bearing due to time and costs associates with casing and safe entry into the drilled foundation. Therefore, confirmation of bearing capacity should include sufficient acquisition of relatively "undisturbed" samples from the drilling operations to evaluate soil strength.

5.2 Seismic Considerations

We have reviewed seismic design parameters in accordance with International Building Code (IBC) criteria. It should be noted that the IBC Seismic Site Characterization is based on the upper 100 feet of the geologic profile. The structure borings for this investigation were terminated at a depth of 6 to 15 feet below existing grades. Therefore, our analysis is limited to the encountered overburden soil profile only.

Based on IBC Section 1613.3.2, which references ASCE 7-10, utilizing the SPT N-value method, the anticipated weighted average N-value for the profile should be greater than 15 but lower than 50 blows per foot (bpf). Based on this average N-value, the site can be characterized as Site Class D (stiff soils) in accordance with ASCE 7-10 Table 20.3-1.

5.3 Subgrades

5.3.1 Existing Subgrade

An evaluation of the subgrade soils was completed in general accordance with ODOT Geotechnical Bulletin GB-1 "Plan Subgrades" (January 18, 2019). We have assumed that final pavement cross-sections will approximate existing pavement cross-sections, which were an

average of 1 foot thick. Additionally, we have assumed that new grades will approximate existing grades. For our evaluations, we generally considered a proposed subgrade elevation 1 foot below existing grade.

Based on the conditions encountered in the borings, stiff cohesive fill material is anticipated to be encountered at the proposed subgrade elevation. The subgrade materials tested during our exploration were found to consist of ODOT A-6a, A-6b and A-7-6 soils. Based on GB-1, soils classified as ODOT A-4b, A-2-5, A-5, A-7-5, A-8a, A-8b, or rock have been designated as being problematic with respect to pavement subgrade support. None of these soil types were encountered at planned subgrade elevations in the borings performed for this exploration.

Moisture contents were generally greater than 3 percent higher than optimum for the collective soil samples from the upper 6 feet of the subgrade as determined using GB-1 criteria. Based on GB-1 criteria, subgrade soils with moisture contents greater than 3 percent above optimum indicate the potential presence of unstable subgrade that may require some form of subgrade stabilization.

The type and thickness of subgrade modification is determined by GB-1 criteria based on the average, low SPT N_{60}-value (N_{60L}) of the subgrade soils in a particular portion of the project area, soil type, and moisture content. Based on these criteria, 3 of the 4 borings (75 percent) contained subgrade soils which indicated subgrade modification is likely to be required. Possible alternatives for those areas where modification of the subgrade soils is indicated could include the following, using GB-1 criteria based on the encountered conditions:

- Undercut 12-inches of the existing subgrade and replacement with granular engineered fill, or
- Global chemical stabilization to a depth of 12 inches using lime (although sulfate content of the subgrade soils will preclude use of this method as discussed at the end of this section. (if economically feasible)

Where undercut and replacement is utilized, all fill should consist Item 703.16C, Granular Material Type B or Type C. It is recommended that geotextile fabric (referenced in ODOT Item 204, and specified as ODOT Item 712.09, Type D) be utilized on the subgrade at the bottom of the undercut zone. If particularly unstable subgrades are encountered during construction, or undercuts exceed approximately 18 inches, a geogrid could be used to reduce the total undercut and replacement of the unsuitable soils by 6 inches.

GB-1 indicates that, if it is determined that 30 percent or more of the subgrade area must be stabilized, consideration should be given to stabilizing the entire project (global chemical stabilization). However, GB-1 indicates that global chemical stabilization is generally more economical when stabilizing large areas (approximately greater than 1 mile of roadway). Due to the relatively small project areas, over-excavation and replacement with granular engineered fill is anticipated to be more economical.

It should be noted that GB-1 analyses are used as a pre-construction tool to plan subgrade modification alternatives. Actual subgrade modification will depend on field observations of proof-rolling conditions at the time of construction. Changes in soil moisture content could create more or less favorable subgrade conditions that may result in adjustments to subgrade modification or soil stabilization requirements at the time of construction.

5.4 Flexible (Asphalt) Pavement Design

Based on the GB-1 analyses, design CBR values of 4 percent was determined for the current exploration borings along SR-53. It should be noted that the CBR determination by the GB-1 spreadsheet is based on an **average** Group Index of all the evaluated samples. Group indices for the tested samples ranged from 8 to 17, which would correlate with a CBR value 3 to 7 percent. However, ODOT A-6a and A-6b soils were predominantly encountered in the upper 3 feet of the subgrade in each of the borings. Group Indices associated with these soils generally ranged from 8 to 16, which correlates with CBR values on the order of 4 to 6 percent. As such, based on the average design value calculations from GB-1, it does not appear to be unconservative to use the GB-1 design CBR values of 4 percent.

It should also be noted that the design CBR value is based on subgrades compacted to at least 100 percent of the maximum dry density as determined by ODOT supplement 1015 or verified as stable through proof-rolling in accordance with Section 5.5 of this report.

All pavement design and paving operations should conform to ODOT specifications. The pavement and subgrade preparation procedures outlined in this report should result in a reasonably workable and satisfactory pavement. It should be recognized, however, that all pavements need repairs or overlays over time as a result of progressive yielding under repeated loading for a prolonged period.

It is recommended that proof rolling, placement of aggregate base, and placement of asphalt be performed within as short a time period as possible. Exposure of the aggregate base to rain,

snow, or freezing conditions may lead to deterioration of the subgrade and/or base materials due to excessive moisture conditions and to difficulties in achieving the required compaction.

5.6 Rigid (Concrete) Pavement

Following the satisfactory completion of the site preparation operations outlined in Section 6.0 of this report, a modulus of subgrade reaction (k) of 125 pounds per cubic inch (pci) may be used for rigid pavement design. A concrete pavement section is recommended in the loading-unloading areas, areas of repetitive turning and within the driving aprons. The pavement section should be supported on subgrade soils that are placed and compacted in accordance with ODOT Item #203. As noted above, if loose embankment fill material was encountered at the pavement subgrade elevation, we recommended stabilizing the existing subgrade. This could be achieved by over-excavating 12-to-18 inches of the existing subgrade soils and replaced with newly placed and compacted engineered fill in accordance with ODOT Construction and Materials Specifications (CMS) Item 203.02 granular fill type B material. All paving operations should conform to the Ohio Turnpike Commission and the Ohio Department of Transportation (ODOT) specifications.

5.7 Groundwater Control and Pavement Drainage

Encountered groundwater conditions were previously discussed in Section 4.4. Based on the soil characteristics and groundwater conditions encountered in the borings, it is our opinion that the “normal” groundwater table can generally be encountered at depths of approximately 15 feet or lower.

Construction planning should include potential remedial measures to be implemented where excessive groundwater seepage or unstable subgrades are encountered in excavations. Dewatering methods may include multiple sumps or a system of well points. The type of dewatering system utilized will depend on construction practices, soil conditions encountered in the foundation excavations, seasonal conditions, and the depth of excavation. Additionally, the contractor will need to exercise diligence to control seepage and runoff to maintain a stable subgrade. Installation of utilities early in the site development may also alleviate unstable subgrade conditions.

Based on the poorly-drained nature of the clayey soils present at the site and anticipated cohesive fill material, it is anticipated that surface water infiltration may collect in the aggregate base course. Without adequate drainage, water will remain in the base for extended periods of time, creating localized wet, soft pockets. The presence of these pockets will increase the likelihood that pavement distress (cracking, potholes, etc.) will develop. Drainage

features may include grading the subgrade surface to slope downward to the outside edge of pavements and/or providing longitudinal edge drains connected to storm sewers or other outlets.

5.8 Excavations and Slopes

The sides of temporary excavations for building foundations, utility installations, and other construction should be adequately sloped to provide stable sides and safe working conditions. Otherwise, the excavation must be properly braced against lateral movements. In any case, applicable Occupational Safety and Health Administration (OSHA) safety standards must be followed. Based on the test borings, it is likely that excavations will encounter a range of soil conditions that include the following OSHA designations:

- Type A soils (cohesive soils with unconfined compressive strengths of 3,000 pounds per square foot (psf) or greater),
- Type B soils (cohesive soils with unconfined compressive strengths greater than 1,000 psf but less than 3,000 psf), and
- Type C soils (granular soils).

For temporary excavations in Type A, B, and C soils, side slopes must be no steeper than ¾ horizontal to 1 vertical (¾H:1V), 1H:1V, and 1½H:1V, respectively. For situations where a higher strength soil is underlain by a lower strength soil and the excavation extends into the lower strength soil, the slope of the entire excavation is governed by that required for the lower strength soil. In all cases, flatter slopes may be required if lower strength soils or adverse seepage conditions are encountered during construction.

6.0 CONSTRUCTION RECOMMENDATIONS

6.1 Site and Subgrade Preparation

Site and subgrade preparation activities should conform to ODOT Construction and Materials Specifications (CMS) Item 204 specifications. Site preparation activities should include the removal of vegetation, topsoil, root mats, pavements, and other deleterious non-soil materials from all proposed roadway areas. The actual amount of required stripping should be determined in the field by a geotechnical engineer or qualified representative.

Upon completion of the clearing and undercutting activities, all areas that are to receive fill, or that have been excavated to proposed final subgrade elevation, should be inspected by a geotechnical engineer. Pavement subgrades should be proof rolled in general accordance with ODOT CMS 204.06. The GB-1 analysis indicates options for "planned" subgrade modification of either over-excavation of unsuitable subgrade soils and replacement with new granular engineered fill, or global stabilization with lime to a depth of 12 inches.

At the time of inspection, the engineer may require proof rolling of the cohesive subgrades utilizing a 20- to 30-ton loaded truck or other pneumatic-tired vehicle of similar size and weight. If granular subgrade soils are present at the proposed subgrade elevation, proof rolling/compaction should be performed using a vibratory smooth-drum roller. The vehicle should make a sufficient number of passes, in two perpendicular directions, covering the proposed development area, to locate any soft, weak, or excessively wet soils that may be present at the time of construction.

The purpose of proof rolling the clayey subgrades is to locate any weak, soft, or excessively wet soils that may be present at the time of construction. The purpose of vibratory compaction for the granular materials is to densify zones of loose materials that are encountered in the upper portion of the soil profile, thereby providing more uniform subgrade support. We recommend a roller with a minimum dead weight on the drums of 8 tons, vibrating at 30 Hz or greater, and traveling at speeds not exceeding approximately 4 feet per second (about 3 miles per hour). These operational criteria should provide sufficient dynamic compaction energy to alleviate loose soil conditions within the zone of influence for subgrade support. Any unsuitable materials observed during the inspection and proof-rolling operations should be undercut and replaced with compacted fill or stabilized in place utilizing conventional remedial measures such as discing, aeration, and recompaction. Once the site has been proof rolled, inspected, and stabilized, the proof-rolled or inspected subgrades should not be exposed to wet

conditions. It should be recognized that during periods of wet weather, the clayey soils that will be exposed at design subgrades will tend to pond water for short periods of time, with the potential to deteriorate the prepared subgrade. Additionally, we recommend that the fill areas be constantly sloped for positive gravity drainage to avoid ponded water on fills, and that fill areas be sealed at the end of each day by smooth-drum rolling when there is a threat of precipitation.

The results of the proof-rolling and inspection operations will be partially dependent on construction operations, the moisture content of the soil, and the weather conditions prevalent at the time. If pumping or rutting is encountered and difficulty is experienced in the operation of construction equipment, TTL should be notified to determine which method of subgrade modification may be best suited for the conditions encountered. At that time, we may recommend that a small test area be used to determine the necessary depth of undercutting and stone replacement to achieve a stable subgrade condition.

6.2 Fill

Material for engineered fill or backfill required to achieve design grades should meet ODOT Item 203 "Embankment Fill" placement and compaction requirements. In general, suitable fills may consist of any non-organic soils having a maximum dry density as determined by ODOT Supplement 1015 of 100 pounds per cubic foot (pcf) or greater. On-site soils may be used as engineered fill materials provided that they are free of organic matter, debris, excessive moisture, and rock or stone fragments larger than 3 inches in diameter. Depending on seasonal conditions, the on-site soils may be wet of optimum and may require scarification and aeration to achieve satisfactory compaction. If the construction schedule does not allow for scarification and aeration activities, it may be more practical or economical to utilize imported granular fill.

Fill should be placed in uniform layers not more than 8 inches thick (loose measure) and adequately keyed into stripped and scarified soils. All fill placed within pavement areas should be compacted to a dry density consistent with the requirements of ODOT Item 203, based on the maximum dry density as determined ODOT Supplement 1015.

Fill placement shall be performed as symmetrical as possible across the entire site to prevent lateral stresses from developing on the existing bridge piers and their foundation components. Compaction of the new fill placement around existing bridge piers and abutments shall be accomplished through the use of portable compaction equipment (hand operated tampers or other equipment approved by the engineer). Furthermore, it is recommended to that self-propelled heavy compaction equipment be kept at least 5 feet away from the existing substructure elements.

The on-site soils in the vicinity of the proposed roundabout consist of cohesive soils. For the cohesive soils, a sheepsfoot roller should provide the most effective soil compaction. If new granular engineered fill is placed, a vibratory smooth-drum roller would be required to provide effective compaction.

Scarified subgrade soils and all fill material should be within 3 percent of the optimum moisture content to facilitate compaction. Furthermore, fill material should not be frozen or placed on a frozen base. It is recommended that all earthwork and site preparation activities be conducted under adequate specifications and properly monitored in the field by a qualified geotechnical testing firm.

7.0 QUALIFICATIONS OF RECOMMENDATIONS

Our evaluation of construction conditions for shaft design and pavement construction has been based on our understanding of the site and project information and the data obtained during our field investigation. The general subsurface conditions were based on interpretation of the subsurface data at specific boring locations. Regardless of the thoroughness of a subsurface investigation, there is the possibility that conditions between borings will differ from those at the boring locations, that conditions are not as anticipated by the designers, or that the construction process has altered the soil conditions. Therefore, experienced geotechnical engineers should observe earthwork and foundation construction to confirm that the conditions anticipated in design are noted. Otherwise, TTL assumes no responsibility for construction compliance with the design concepts, specifications, or recommendations.

The evaluations and recommendations presented in this report have been formulated on the basis of reported or assumed data relating to the location and finished grades for the proposed structure. Any significant change in this data in the final design plans should be brought to our attention for review and evaluation with respect to the prevailing subsoil conditions.

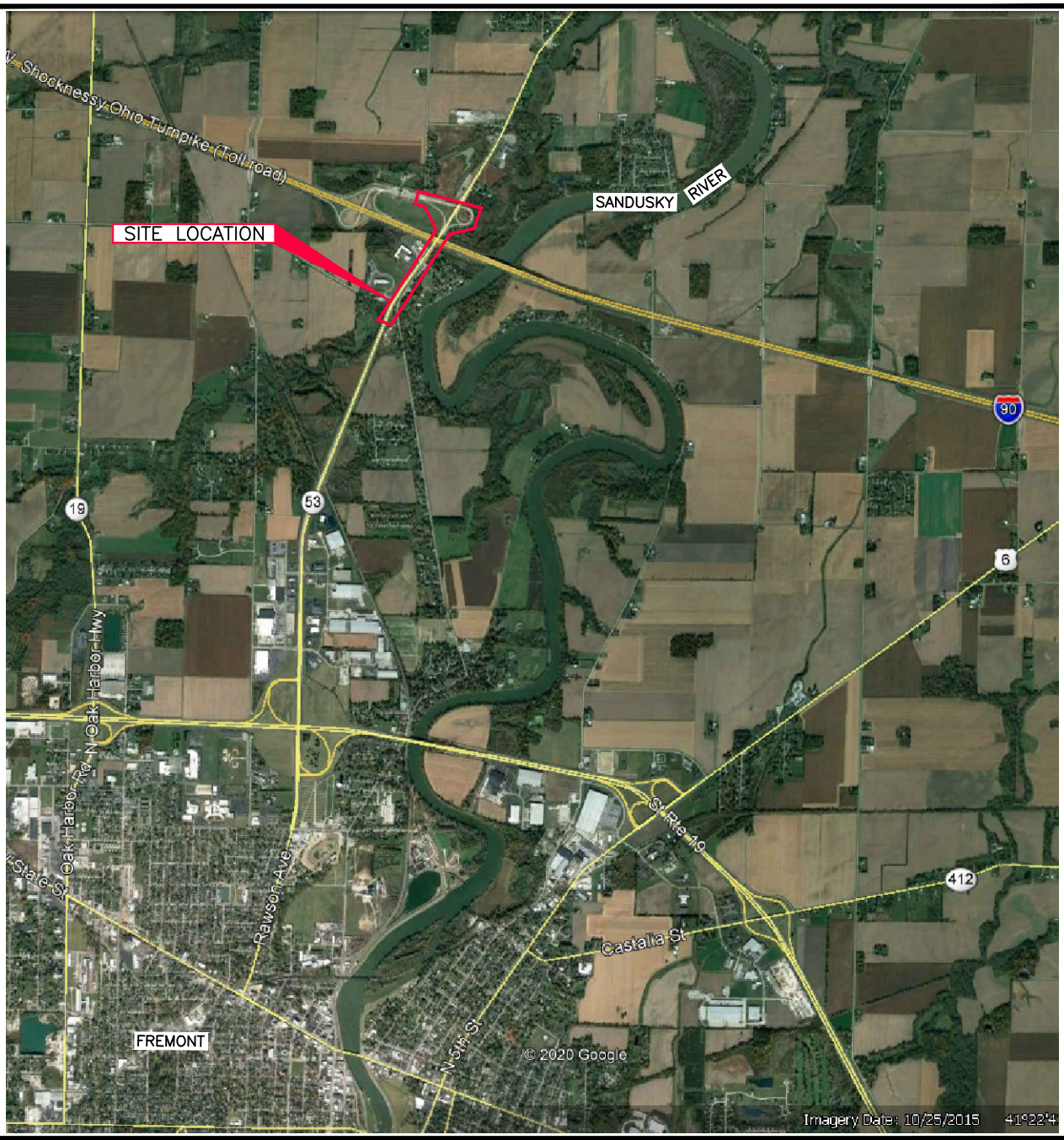
The nature and extent of variations between the borings may not become evident until the course of construction. If such variations are encountered, it will be necessary to reevaluate the recommendations of this report after on-site observations of the conditions.

Our professional services have been performed and our findings have been derived in accordance with generally accepted geotechnical engineering principles and practices. This warranty is in lieu of all other warranties either expressed or implied. TTL is not responsible for the conclusions, opinions, or recommendations of others based on this data.

-

Plates

Plate 1.0 **Site Location Map**
Plate 2.0 **Test Boring Location Map**



LEGEND

APPROXIMATE SITE LOCATIONS

N

APPROXIMATE SCALE – FEET

0 4,000 8,000

PLATE 1.0
SITE LOCATION MAP

OTIC 91–18–07 INTERCHANGE INPROVENENT – MP 92.0
FREMONT, OHIO

PREPARED FOR
FISHBECK INC.
3220 CENTRAL PARK WEST
TOLEDO, OHIO 4361

DRAWN	TRR/3–20–20	CHECKED	
REVISED		APPROVED	
JOB NO.	1763902		
DRAWING NUMBER	1763902–01G		

associates inc
Environmental, Geotechnical Engineering & Testing

N

LEGEND

B-1 APPROXIMATE TEST BORING LOCATION

APPROXIMATE SCALE – FEET

0 40 80

PLATE 2.0
TEST BORING LOCATION PLAN
OTIC 91-18-07 INTERCHANGE IMPROVEMENT – MP 92.0
FREMONT, OHIO

PREPARED FOR
FISHBECK INC.
3220 CENTRAL PARK WEST
TOLEDO, OHIO 4361

DRAWN TRR/3-20-20	CHECKED
REVISED	APPROVED
JOB NO. 1763902	
DRAWING NUMBER 1763902-02G	

ITL associates inc
Environmental, Geotechnical Engineering & Testing

APPENDIX A

Log of Test Borings

PROJECT: OTIC 91-18-07	DRILLING FIRM / OPERATOR: TTL / CW	DRILL RIG: CME 75 TRUCK 111	STATION / OFFSET:
TYPE: ROADWAY	SAMPLING FIRM / LOGGER: TTL / KKC	HAMMER: CME AUTOMATIC	ALIGNMENT:
PID: SFN:	DRILLING METHOD: 3.5" SSA	CALIBRATION DATE: 2/20/19	ELEVATION: 582.0 (NAVD88) EOB: 15.0 ft.
START: 3/9/20 END: 3/9/20	SAMPLING METHOD: SPT	ENERGY RATIO (%): 70.8	COORD: Not Recorded

EXPLORATION ID B-001-0-20

PAGE 1 OF 1

MATERIAL DESCRIPTION AND NOTES	ELEV. 582.0	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
ASPHALT - 7 INCHES	581.4																	
VERY DENSE, GRAY, **CRUSHED STONE WITH SAND AND SILT**, MOIST **FILL**	578.5	1, 2, 3	15 35 22	67	78	SS-1	NP	-	-	-	-	-	-	-	-	11	A-2-4 (V)	
MEDIUM DENSE, GRAY, **CRUSHED STONE WITH SAND AND SILT**, MOIST **FILL**	576.0	4, 5	5 8 12	24	100	SS-2	NP	-	-	-	-	-	-	-	-	9	A-2-4 (V)	
VERY STIFF, BROWN, **CLAY**, SOME SILT, LITTLE SAND, AND TRACE GRAVEL, MOIST		6, 7	9 10 14	28	61	SS-3	4.00	-	-	-	-	-	-	-	-	22	A-7-6 (V)	
@8.5': GRAY/BROWN, TRACE SAND	570.0	8, 9, 10, 11, 12	4 9 12	25	89	SS-4	>4.5	0	2	3	22	73	44	20	24	23	A-7-6 (14)	
@13.5'; STIFF, BROWN, **CLAY**, SOME SILT, LITTLE SAND, AND TRACE GRAVEL, MOIST	567.0	13, 14, 15 EOB	3 5 8	15	100	SS-5	3.25	-	-	-	-	-	-	-	-	26	A-7-6 (V)	

NOTES: "NP" - NON PLASTIC

ABANDONMENT METHODS, MATERIALS, QUANTITIES: PLACED 0.25 BAG ASPHALT PATCH; AUGER CUTTINGS MIXED WITH 0.5 BAG BENTONITE CHIPS

STANDARD ODOT SOIL BORING LOG (8.5 X 11) - OH DOT.GDT - 4/3/20 08:36 - S:\PROJECTS\1763902.GPJ

PROJECT: OTIC 91-18-07	DRILLING FIRM / OPERATOR: TTL / CW	DRILL RIG: CME 75 TRUCK 111	STATION / OFFSET:
TYPE: ROADWAY	SAMPLING FIRM / LOGGER: TTL / KKC	HAMMER: CME AUTOMATIC	ALIGNMENT:
PID: SFN:	DRILLING METHOD: 3.5" SSA	CALIBRATION DATE: 2/20/19	ELEVATION: 595.0 (NAVD88) EOB: 15.0 ft.
START: 3/9/20 END: 3/9/20	SAMPLING METHOD: SPT	ENERGY RATIO (%): 70.8	COORD: Not Recorded

EXPLORATION ID B-002-0-20

PAGE 1 OF 1

MATERIAL DESCRIPTION AND NOTES	ELEV. 595.0	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
ASPHALT - 8 INCHES	594.3																	
DENSE, GRAY, **CRUSHED STONE WITH SAND AND SILT**, MOIST **FILL**		1, 2	12 14 25	46	89	SS-1	NP	-	-	-	-	-	-	-	-	6	A-2-4 (V)	
@3.5': VERY DENSE		3, 4, 5	35 40 44	99	61	SS-2	NP	-	-	-	-	-	-	-	-	6	A-2-4 (V)	
	588.9	6																
VERY STIFF, GRAY, **SILT AND CLAY**, SOME SAND AND CRUSHED STONE, MOIST **FILL**		7	10 11 11	26	100	SS-3	>4.5	23	8	16	18	35	28	14	14	15	A-6a (5)	
	586.3	8																
STIFF TO VERY STIFF, BROWN/GRAY, **SILTY CLAY**, SOME SAND, TRACE GRAVEL, AND ORGANICS, MOIST		9, 10	8 10 10	24	83	SS-4	2.00	-	-	-	-	-	-	-	-	19	A-6b (V)	
	583.0	11, 12, 13																
@13.5'; STIFF, BROWN/GRAY, **SILTY CLAY**, LITTLE SAND, TRACE GRAVEL, MOIST		14	4 6 8	17	61	SS-5	2.25	-	-	-	-	-	-	-	-	18	A-6b (V)	
	580.0	EOB 15																

NOTES: "NP" - NON PLASTIC

ABANDONMENT METHODS, MATERIALS, QUANTITIES: PLACED 0.25 BAG ASPHALT PATCH; AUGER CUTTINGS MIXED WITH 0.5 BAG BENTONITE CHIPS

STANDARD ODOT SOIL BORING LOG (8.5 X 11) - OH DOT.GDT - 4/3/20 08:36 - S:\PROJECTS\1763902.GPJ

PROJECT: OTIC 91-18-07	DRILLING FIRM / OPERATOR: TTL / CW	DRILL RIG: CME 75 TRUCK 111	STATION / OFFSET:
TYPE: ROADWAY	SAMPLING FIRM / LOGGER: TTL / KKC	HAMMER: CME AUTOMATIC	ALIGNMENT:
PID: SFN:	DRILLING METHOD: 3.5" SSA	CALIBRATION DATE: 2/20/19	ELEVATION: 596.0 (NAVD88) EOB: 6.0 ft.
START: 3/9/20 END: 3/9/20	SAMPLING METHOD: SPT	ENERGY RATIO (%): 70.8	COORD: Not Recorded

EXPLORATION ID B-003-0-20

PAGE 1 OF 1

MATERIAL DESCRIPTION AND NOTES	ELEV. 596.0	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
CRUSHED STONE - 8 INCHES	595.3																	
STIFF, GRAY, **SILTY CLAY**, LITTLE SAND, TRACE CRUSHED STONE, AND ORGANICS, MOIST **FILL**	593.9	1	4 4 4 6	9	67	SS-1	4.25	-	-	-	-	-	-	-	-	18	A-6b (V)	
VERY STIFF, GRAY/BROWN, **CLAY**, SOME SILT AND TRACE SAND, MOIST		2, 3	7 7 11 11	21	75	SS-2	3.75	0	0	4	23	73	45	22	23	24	A-7-6 (14)	
@4.2': LITTLE SAND, TRACE GRAVEL, IRON OXIDE STAIN SEAM	590.0	4, 5	12 12 13 10	30	75	SS-3	1.75	-	-	-	-	-	-	-	-	27	A-7-6 (V)	
		EOB 6																

NOTES: NONE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: AUGER CUTTINGS MIXED WITH 0.25 BAG BENTONITE CHIPS

STANDARD ODOT SOIL BORING LOG (8.5 X 11) - OH DOT.GDT - 4/3/20 08:36 - S:\PROJECTS\1763902.GPJ

PROJECT: OTIC 91-18-07	DRILLING FIRM / OPERATOR: TTL / CW	DRILL RIG: CME 75 TRUCK 111	STATION / OFFSET:
TYPE: ROADWAY	SAMPLING FIRM / LOGGER: TTL / KKC	HAMMER: CME AUTOMATIC	ALIGNMENT:
PID: SFN:	DRILLING METHOD: 3.5" SSA	CALIBRATION DATE: 2/20/19	ELEVATION: 595.0 (NAVD88) EOB: 7.0 ft.
START: 3/9/20 END: 3/9/20	SAMPLING METHOD: SPT	ENERGY RATIO (%): 70.8	COORD: Not Recorded

EXPLORATION ID B-004-0-20

PAGE 1 OF 1

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
ASPHALT - 3 INCHES	595.0 / 594.7																	
STIFF, BROWN/GRAY, **SILTY CLAY**, LITTLE SAND, MOIST **FILL**	592.0	1, 2	18 8 5 4	15	75	SS-1	4.00	0	1	13	22	64	36	17	19	18	A-6b (12)	
VERY STIFF, BROWN/GRAY, **SILTY CLAY**, LITTLE SAND AND TRACE GRAVEL, MOIST @4.3': BLACK	589.0	3, 4	5 8 12 16	24	83	SS-2	3.75	-	-	-	-	-	-	-	-	28	A-6b (V)	
HARD, BROWN/GRAY, **SILTY CLAY**, LITTLE SAND AND TRACE GRAVEL, MOIST	588.0	5, 6, 7 EOB	14 16 16 18	38	75	SS-3	2.50	-	-	-	-	-	-	-	-	24	A-6b (V)	

NOTES: NONE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: PLACED 0.25 BAG ASPHALT PATCH; AUGER CUTTINGS MIXED WITH 0.25 BAG BENTONITE CHIPS

STANDARD ODOT SOIL BORING LOG (8.5 X 11) - OH DOT.GDT - 4/3/20 08:36 - S:\PROJECTS\1763902.GPJ

PROJECT: OTIC 91-18-07	DRILLING FIRM / OPERATOR: TTL / CW	DRILL RIG: CME 75 TRUCK 111	STATION / OFFSET:
TYPE: ROADWAY	SAMPLING FIRM / LOGGER: TTL / KKC	HAMMER: CME AUTOMATIC	ALIGNMENT:
PID: SFN:	DRILLING METHOD: 3.5" SSA	CALIBRATION DATE: 2/20/19	ELEVATION: 595.0 (NAVD88) EOB: 7.0 ft.
START: 3/9/20 END: 3/9/20	SAMPLING METHOD: SPT	ENERGY RATIO (%): 70.8	COORD: Not Recorded

EXPLORATION ID B-005-0-20

PAGE 1 OF 1

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
	595.0																	
ASPHALT - 4.25 INCHES	594.7																	
CONCRETE - 4.75 INCHES	594.2																	
CRUSHED STONE - 3 INCHES	594.0																	
LOOSE, BROWN, **FINE SAND**, TRACE SILT, MOIST **FILL**	593.5	1																
STIFF, BROWN/GRAY, **SILTY CLAY**, LITTLE SAND AND TRACE CRUSHED STONE, MOIST **FILL**	591.9	2	10 7 3 4	12	75	SS-1	3.75	-	-	-	-	-	-	-	-	19	A-6b (V)	
STIFF, GRAY/BROWN, **CLAY**, LITTLE SILT, TRACE SAND, GRAVEL, AND CALCITE STAIN SEAM, MOIST		3																
		4	4 7 8 10	18	79	SS-2	>4.5	3	3	5	18	71	49	21	28	23	A-7-6 (17)	
		5																
		6	7 7 10 14	20	67	SS-3	2.50	-	-	-	-	-	-	-	-	24	A-7-6 (V)	
@6.5': VERY STIFF	588.0	EOB 7																

NOTES: NONE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: PLACED 0.25 BAG ASPHALT PATCH; AUGER CUTTINGS MIXED WITH 0.25 BAG BENTONITE CHIPS

STANDARD ODOT SOIL BORING LOG (8.5 X 11) - OH DOT.GDT - 4/3/20 08:36 - S:\PROJECTS\1763902.GPJ

PROJECT: OTIC 91-18-07	DRILLING FIRM / OPERATOR: TTL / CW	DRILL RIG: CME 75 TRUCK 111	STATION / OFFSET:
TYPE: ROADWAY	SAMPLING FIRM / LOGGER: TTL / KKC	HAMMER: CME AUTOMATIC	ALIGNMENT:
PID: SFN:	DRILLING METHOD: 3.5" SSA	CALIBRATION DATE: 2/20/19	ELEVATION: 596.0 (NAVD88) EOB: 9.0 ft.
START: 3/9/20 END: 3/9/20	SAMPLING METHOD: SPT	ENERGY RATIO (%): 70.8	COORD: Not Recorded

EXPLORATION ID B-006-0-20

PAGE 1 OF 1

MATERIAL DESCRIPTION AND NOTES	ELEV. 596.0	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
ASPHALT - 5.25 INCHES	595.6																	
CRUSHED STONE - 9 INCHES	594.8																	
STIFF, BROWN/GRAY, **SILT AND CLAY**, SOME SAND AND TRACE CRUSHED STONE, MOIST **FILL**	591.7	1, 2	10 6 4 4	12	83	SS-1	2.50	3	3	25	23	46	27	14	13	18	A-6a (8)	
STIFF, GRAY/BROWN, **SILTY CLAY**, LITTLE SAND AND TRACE GRAVEL, MOIST @5': VERY STIFF, TRACE IRON OXIDE STAIN SEAM		3, 4	4 6 9 10	18	46	SS-2	4.00	-	-	-	-	-	-	-	-	24	A-6b (V)	
		5, 6	8 8 8 8	19	83	SS-3	3.25	-	-	-	-	-	-	-	-	24	A-6b (V)	
@7': STIFF		7, 8	9 8 6 6	17	75	SS-4	4.00	-	-	-	-	-	-	-	-	27	A-6b (V)	
	587.0	EOB 9																

NOTES: NONE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: PLACED 0.25 BAG ASPHALT PATCH; AUGER CUTTINGS MIXED WITH 0.5 BAG BENTONITE CHIPS

STANDARD ODOT SOIL BORING LOG (8.5 X 11) - OH DOT.GDT - 4/3/20 08:36 - S:\PROJECTS\1763902.GPJ

APPENDIX B

Legend Key

LEGEND KEY

Ohio Department of Transportation Soil Symbols

- A-1-a - Gravel and/or Stone Fragments
- A-1-b - Gravel and/or Stone Fragments with Sand
- A-2-4,A-2-5 - Gravel and/or Stone Fragments with Sand and Silt
- A-2-6,A-2-7 - Gravel and/or Stone Fragments with Sand, Silt and Clay
- A-3 - Fine Sand
- A-3a - Coarse and Fine Sand
- A-4a - Sandy Silt
- A-4b - Silt
- A-5 - Elastic Silt and Clay
- A-6a - Silt and Clay
- A-6b - Silty Clay
- A-7-5 - Elastic Clay
- A-7-6 - Clay
- A-8a - Organic Silt
- A-8b - Organic Clay
- Asphalt
- Sod and/or Topsoil
- Concrete
- Random Fill
- Peat
- Dolomite
- Weathered Dolomite
- Limestone
- Weathered Limestone
- Sandstone
- Weathered Sandstone
- Shale
- Weathered Shale

Sample Symbols

- SS - Split Spoon
- ST - Shelby Tube
- RC - Rock Core
- GS - Geoprobe Sleeve
- AU - Auger Cuttings
- GB - Grab

Notes:

1. Exploratory borings were drilled on March 9, 2020, using 3.25-inch diameter Hollow-stem augers.

2. These logs are subject to the limitations, conclusions, and recommendations in the report and should not be interpreted separate from the report.

3. The borings were located in the field by TTL, Inc. in accordance with a plan provided by Fishbek Inc.

4. Unconfined Compressive Strength (tsf):
   NP = Non-Plastic
   NI = Not Intact

APPENDIX C

Pavement Cores Photographic Logs

CORE LOG for B-5

Project: OTIC 91-18-07 Interchange Improvement - MP 92.0

Project Location: Freemont, Ohio

TTL Project No.: 1763902

Core Date: March 9, 2020

ASPHALT THICKNESS (in)	=	4.25
CONCRETE THICKNESS (in)	=	4.75
STONE (in)	=	3
CORE BARREL DIAMETER (in)	=	4

VISUAL DESCRIPTION:

Pavement core was intact. 3 asphalt courses were apparent and underlain by a concrete layer
The crushed stone subbase was underlain by a 6-inch thick layer of sandy fill material.

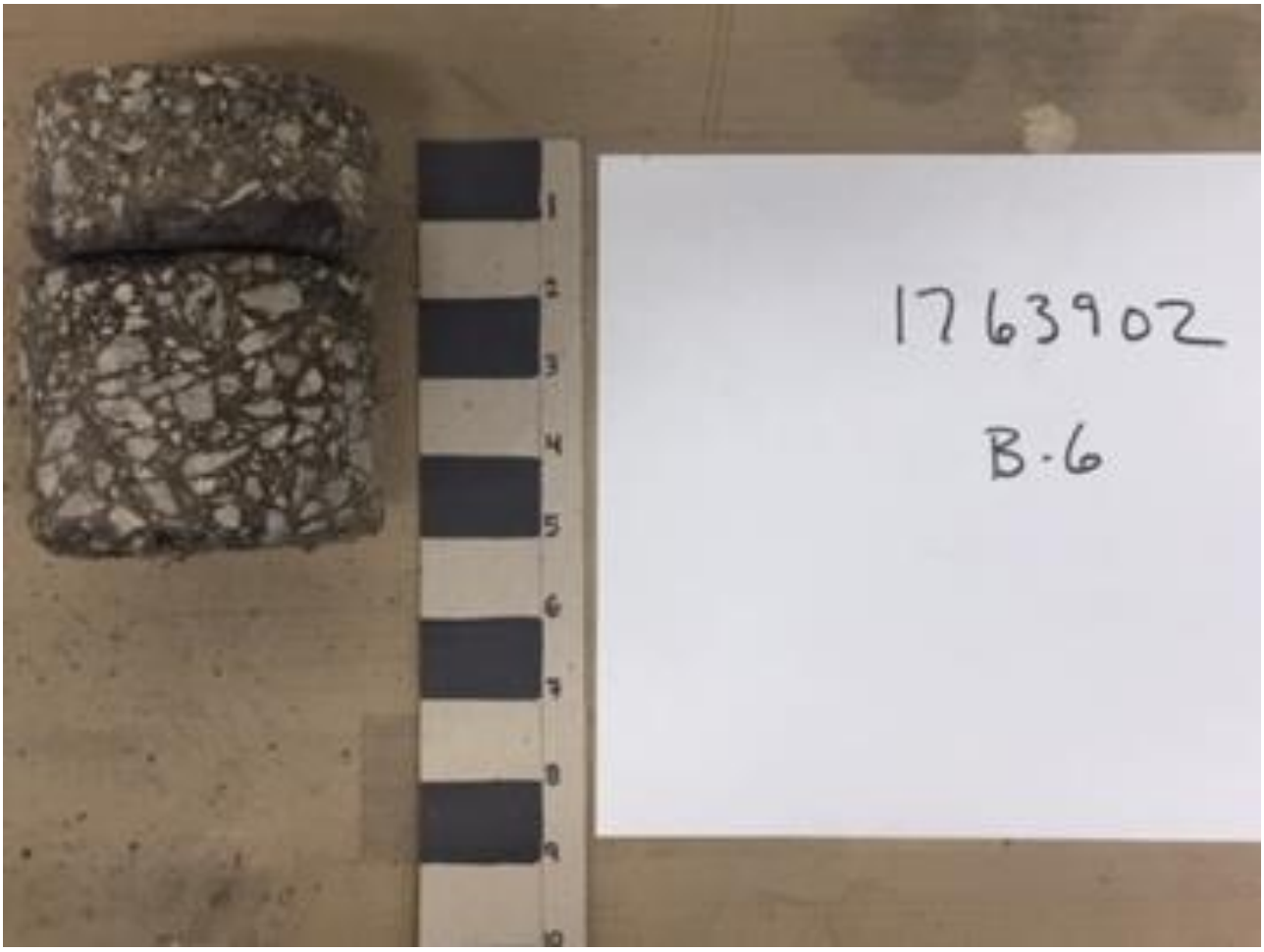
CORE LOG for B-6

Project: OTIC 91-18-07 Interchange Improvement - MP 92.0

Project Location: Freemont, Ohio

TTL Project No.: 1763902

Core Date: March 9, 2020



ASPHALT THICKNESS (in)	=	5.25
CONCRETE THICKNESS (in)	=	-
STONE (in)	=	9
CORE BARREL DIAMETER (in)	=	4

VISUAL DESCRIPTION:

3 asphalt courses were apparent. Pavement core exhibited separation at one apparent asphalt Interface.

APPENDIX D

Tabulation of Test Data

PROJECT: OTIC 91-18-07 Interchange Improvements - MP 92.0	**TTL Associates, Inc.**	PROJECT NO: 1763902

TABULATION OF TEST DATA

Boring Number	Sample Number	Sample Interval Depth (Feet)	Measured Standard Penetration, N_m (Blows per Foot)	Corrected Standard Penetration, N_{60} (Blows per Foot)	Natural Moisture Content (% of Dry Weight)	In-Place Dry Density (Pounds per Cubic Foot)	Unconfined Compressive Strength (Pounds per Square Foot)		Particle Size Distribution (%)					Atterberg Limits (%)			ODOT Soil Classification
									Gravel	Coarse Sand	Fine Sand	Silt	Clay	Liquid Limit	Plastic Limit	Plasticity Index	
B-001-0-20	SS-1	1.0-2.5	57	67	10.6												
	SS-2	3.5-5.0	20	24	9.1												
	SS-3	6.0-7.5	24	28	22.3		8,000										
	SS-4	8.5-10.0	21	25	22.9		9,000+		0	2	3	22	73	44	20	24	A-7-6 (14)
	SS-5	13.5-15.0	13	15	25.6		6,500										
B-002-20	SS-1	1.0-2.5	39	46	5.8												
	SS-2	3.5-5.0	84	99	6.2												
	SS-3	6.0-7.5	22	26	14.7		9,000+		23	8	16	18	35	28	14	14	A-6a (5)
	SS-4	8.5-10.0	20	24	19.4		4,000										
	SS-5	13.5-15.0	14	17	18.2		4,500										
B-003-20	SS-1	0.0-2.0	8	9	17.9		8,500										
	SS-2	2.0-4.0	18	21	24.2		7,500		0	0	4	23	73	45	22	23	A-7-6 (14)
	SS-3	4.0-6.0	25	30	27.2		3,500										

Unconfined compressive strength (UCS) generally derived from a calibrated hand penetrometer. UCS denoted with "*" determined by ASTM D 2166.

PROJECT: OTIC 91-18-07 Interchange Improvements - MP 92.0	**TTL Associates, Inc.**	PROJECT NO: 1763902

TABULATION OF TEST DATA

Boring Number	Sample Number	Sample Interval Depth (Feet)	Measured Standard Penetration, N_m (Blows per Foot)	Corrected Standard Penetration, N_{60} (Blows per Foot)	Natural Moisture Content (% of Dry Weight)	In-Place Dry Density (Pounds per Cubic Foot)	Unconfined Compressive Strength (Pounds per Square Foot)		Particle Size Distribution (%)					Atterberg Limits (%)			ODOT Soil Classification
									Gravel	Coarse Sand	Fine Sand	Silt	Clay	Liquid Limit	Plastic Limit	Plasticity Index	
B-004-0-20	SS-1	1.0-3.0	13	15	17.7		8,000		0	1	13	22	64	36	17	19	A-6b (12)
	SS-2	3.0-5.0	20	24	27.7		7,500										
	SS-3	5.0-7.0	32	38	24.3		5,000										
B-005-0-20	SS-1	1.0-3.0	10	12	19.0		7,500										
	SS-2	3.0-5.0	15	18	22.8		9,000+		3	3	5	18	71	49	21	28	A-7-6 (17)
	SS-3	5.0-7.0	17	20	23.8		5,000										
B-006-0-20	SS-1	1.0-3.0	10	12	17.9		5,000		3	3	25	23	46	27	14	13	A-6a (8)
	SS-2	3.0-5.0	15	18	24.1		8,000										
	SS-3	5.0-7.0	16	19	24.4		6,500										
	SS-4	7.0-9.0	14	17	27.3		8,000										

Unconfined compressive strength (UCS) generally derived from a calibrated hand penetrometer. UCS denoted with "*" determined by ASTM D 2166.

APPENDIX E

Laboratory Test Results

SUMMARY OF LABORATORY RESULTS

PROJECT OTIC 91-18-07 **PID**

OGE NUMBER N/A **PROJECT TYPE** ROADWAY

Borehole	Depth	Sample	Lab ID	G (%)	CS (%)	FS (%)	M (%)	C (%)	LL	PL	PI	M (%)	LOI (%)	ODOT CLASS	USCS CLASS	FLAGS				
																LL	PL	M	OC	NP
B-001-0-20	1.0	SS- SS-1	1									11								
B-001-0-20	3.5	SS- SS-2	2									9								
B-001-0-20	6.0	SS- SS-3	3									22								
B-001-0-20	8.5	SS- SS-4	4	0	2	3	22	73	44	20	24	23		A-7-6	CL					
B-001-0-20	13.5	SS- SS-5	5									26								
B-002-0-20	1.0	SS- SS-1	1									6								
B-002-0-20	3.5	SS- SS-2	2									6								
B-002-0-20	6.0	SS- SS-3	3	23	8	16	18	35	28	14	14	15		A-6a	CL					
B-002-0-20	8.5	SS- SS-4	4									19								
B-002-0-20	13.5	SS- SS-5	5									18								
B-003-0-20	0.0	SS- SS-1	1									18								
B-003-0-20	2.0	SS- SS-2	2	0	0	4	23	73	45	22	23	24		A-7-6	CL					
B-003-0-20	4.0	SS- SS-3	3									27								
B-004-0-20	1.0	SS- SS-1	1	0	1	13	22	64	36	17	19	18		A-6b	CL					
B-004-0-20	3.0	SS- SS-2	2									28								
B-004-0-20	5.0	SS- SS-3	3									24								
B-005-0-20	1.0	SS- SS-1	1									19								
B-005-0-20	3.0	SS- SS-2	2	3	3	5	18	71	49	21	28	23		A-7-6	CL					
B-005-0-20	5.0	SS- SS-3	3									24								
B-006-0-20	1.0	SS- SS-1	1	3	3	25	23	46	27	14	13	18		A-6a	CL					
B-006-0-20	3.0	SS- SS-2	2									24								
B-006-0-20	5.0	SS- SS-3	3									24								
B-006-0-20	7.0	SS- SS-4	4									27								

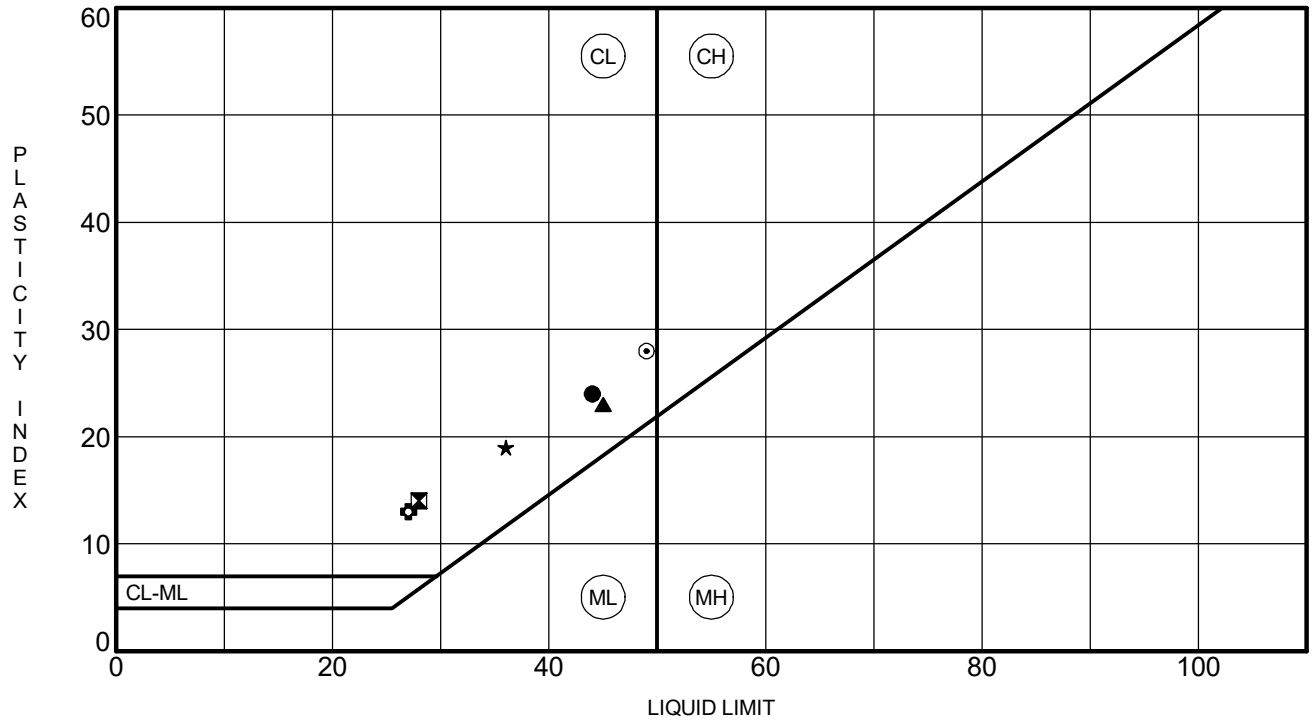
EXPLANATION OF FLAGS

LL - Check LL (flagged if less than PL or greater than 60)
PL - Check PL (flagged if greater than 50)
M - Check Moisture (flagged if greater than LL)
OC - Check ODOT Class (flagged if different from Visual class)
NP - Check NP (flagged if NP sample has significant clay content vs silt)

ATTERBERG LIMITS' RESULTS

PROJECT OTIC 91-18-07 **PID**

OGE NUMBER N/A **PROJECT TYPE** ROADWAY

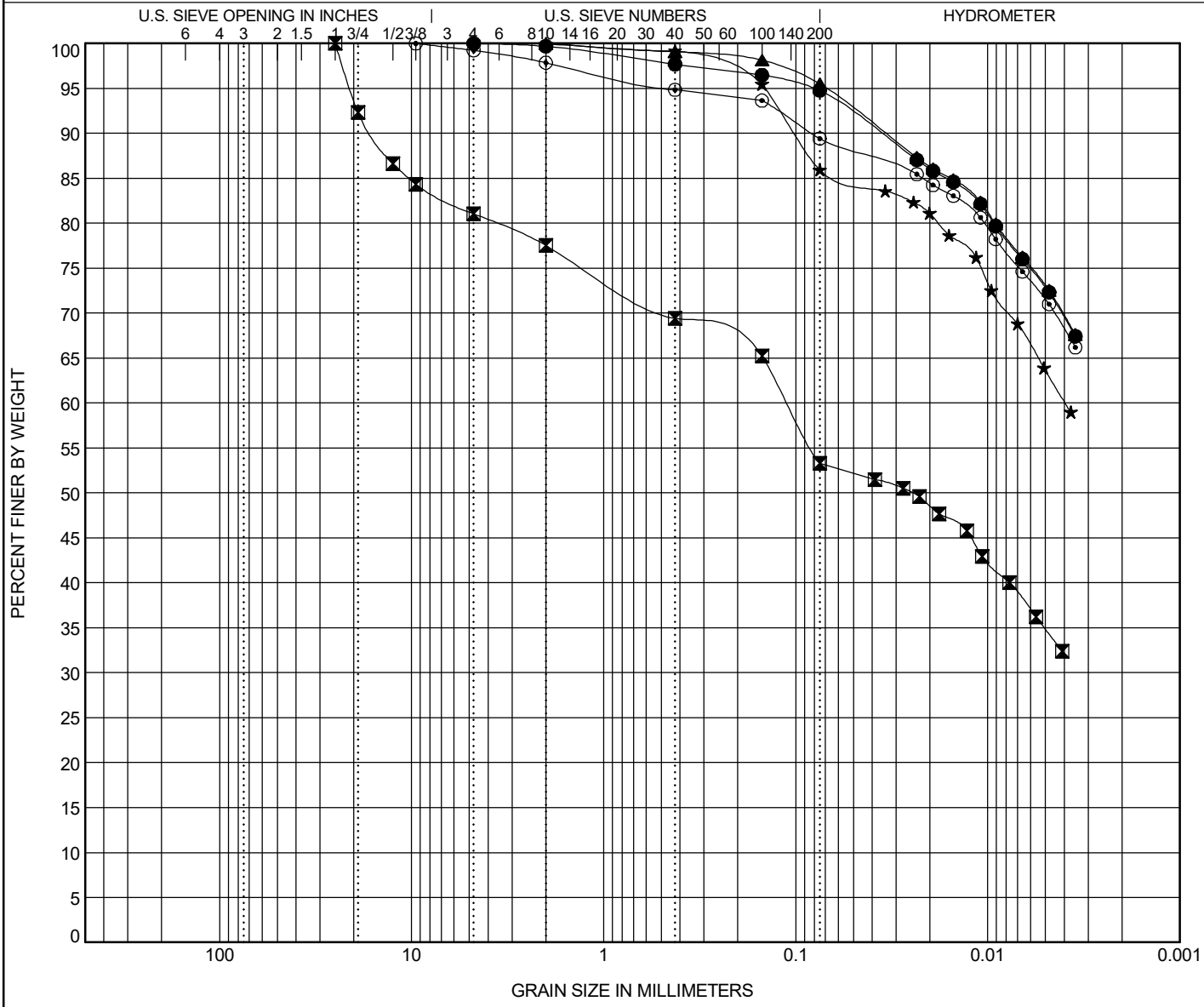


	Specimen Identification		LL	PL	PI	Fines	Classification
●	**B-001-0-20**	**8.5**	**44**	**20**	**24**	**95**	**LEAN CLAY(CL)**
⊠	**B-002-0-20**	**6.0**	**28**	**14**	**14**	**53**	**SANDY LEAN CLAY with GRAVEL(CL)**
▲	**B-003-0-20**	**2.0**	**45**	**22**	**23**	**96**	**LEAN CLAY(CL)**
★	**B-004-0-20**	**1.0**	**36**	**17**	**19**	**86**	**LEAN CLAY(CL)**
⊙	**B-005-0-20**	**3.0**	**49**	**21**	**28**	**89**	**LEAN CLAY(CL)**
✿	**B-006-0-20**	**1.0**	**27**	**14**	**13**	**69**	**SANDY LEAN CLAY(CL)**

GRAIN SIZE DISTRIBUTION

PROJECT OTIC 91-18-07 **PID**

OGE NUMBER N/A **PROJECT TYPE** ROADWAY



COBBLES	GRAVEL	SAND		SILT	CLAY
		coarse	fine		

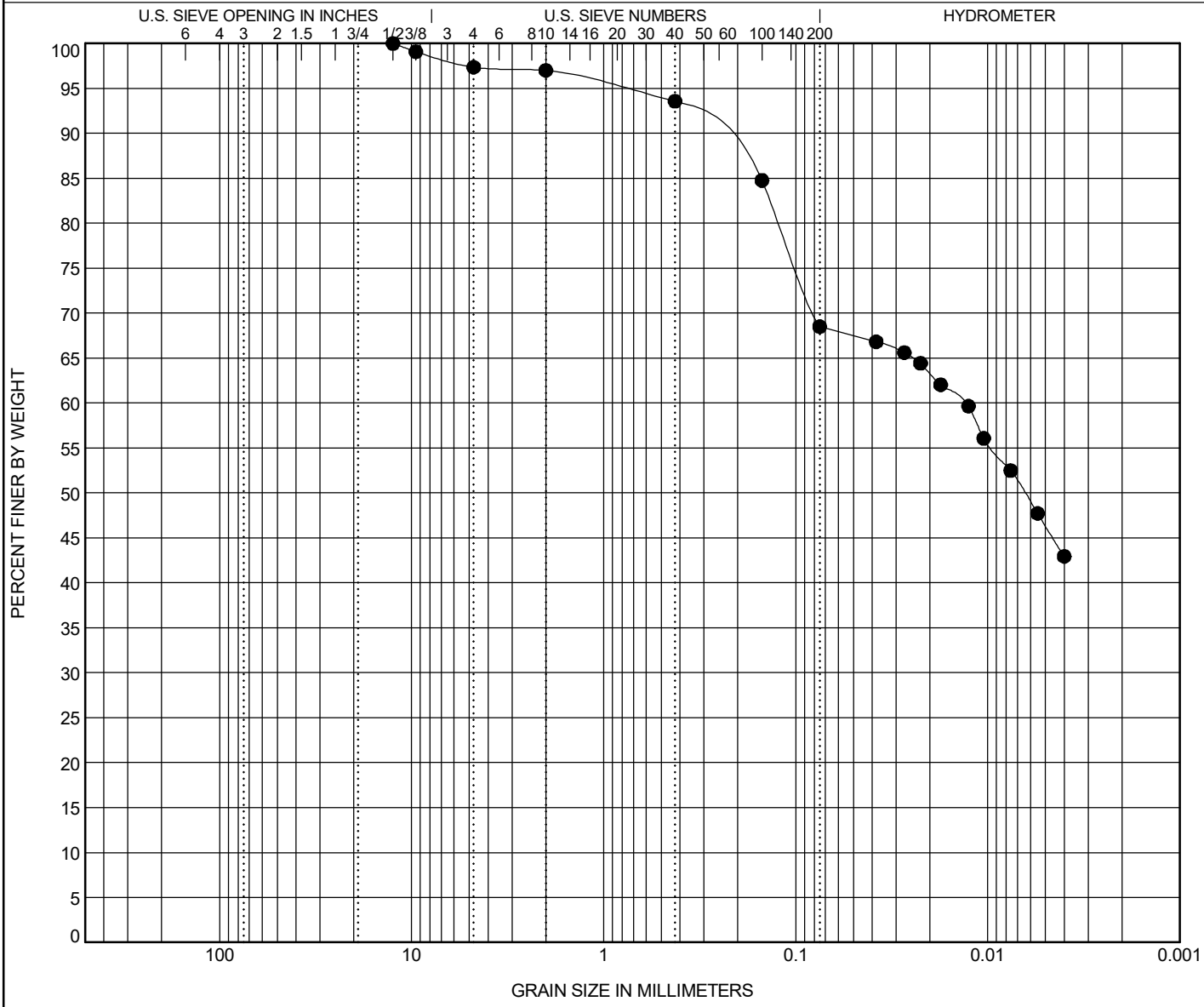
	Specimen Identification		ODOT (Modified AASHTO) ~ USCS Classification	LL	PL	PI
●	**B-001-0-20**	**8.5**	**A-7-6 ~ LEAN CLAY(CL)**	**44**	**20**	**24**
⊠	**B-002-0-20**	**6.0**	**A-6a ~ SANDY LEAN CLAY with GRAVEL(CL)**	**28**	**14**	**14**
▲	**B-003-0-20**	**2.0**	**A-7-6 ~ LEAN CLAY(CL)**	**45**	**22**	**23**
★	**B-004-0-20**	**1.0**	**A-6b ~ LEAN CLAY(CL)**	**36**	**17**	**19**
⊙	**B-005-0-20**	**3.0**	**A-7-6 ~ LEAN CLAY(CL)**	**49**	**21**	**28**

	Specimen Identification		D90	D50	D30	D10	%G	%CS	%FS	%M	%C	Cc	Cu
●	**B-001-0-20**	**8.5**	**0.036**				**0**	**2**	**3**	**22**	**73**		
⊠	**B-002-0-20**	**6.0**	**16.002**	**0.025**			**23**	**8**	**16**	**18**	**35**		
▲	**B-003-0-20**	**2.0**	**0.034**				**0**	**0**	**4**	**23**	**73**		
★	**B-004-0-20**	**1.0**	**0.101**				**0**	**1**	**13**	**22**	**64**		
⊙	**B-005-0-20**	**3.0**	**0.082**				**3**	**3**	**5**	**18**	**71**		

GRAIN SIZE DISTRIBUTION

PROJECT OTIC 91-18-07 **PID**

OGE NUMBER N/A **PROJECT TYPE** ROADWAY



COBBLES	GRAVEL	SAND		SILT	CLAY
		coarse	fine		

	Specimen Identification		ODOT (Modified AASHTO) ~ USCS Classification	LL	PL	PI
●	**B-006-0-20**	**1.0**	**A-6a ~ SANDY LEAN CLAY(CL)**	**27**	**14**	**13**

	Specimen Identification		D90	D50	D30	D10	%G	%CS	%FS	%M	%C	Cc	Cu
●	**B-006-0-20**	**1.0**	**0.278**	**0.006**			**3**	**3**	**25**	**23**	**46**		

APPENDIX G

GB-1 Subgrade Analysis

OHIO DEPARTMENT OF TRANSPORTATION

OFFICE OF GEOTECHNICAL ENGINEERING

PLAN SUBGRADES
Geotechnical Bulletin GB1

State Route 53
TTL PN: 1763902

Ohio Turnpike Interchange Improvments at MP 92

TTL Associates, Inc

Prepared By: Imad EL Hajjar
Date prepared: Friday, March 20, 2020

Imad El Hajjar
1228 EUCLID AVE., STE. 320
Cleveland, Ohio 44115

216-217-5449
ihajjar@ttlassoc.com

NO. OF BORINGS: 4

#	Boring ID	Alignment	Station	Offset	Dir	Drill Rig	ER	Boring EL.	Proposed Subgrade EL	Cut Fill
1	B-3	Pavement Design				CME 75 Truck-Mounted	71	596.0	596.0	0.0
2	B-4	Pavement Design				CME 75 Truck-Mounted	71	595.0	594.0	1.0 C
3	B-5	Pavement Design				CME 75 Truck-Mounted	71	595.0	594.0	1.0 C
4	B-6	Pavement Design				CME 75 Truck-Mounted	71	596.0	595.0	1.0 C

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	S-1	0.0	2.0	0.0	2.0	9		4.25							18	16	A-6b	16			N_{60}		12"	
	3	S-2	2.0	4.0	2.0	4.0	21		3.75	45	22	23	23	73	96	24	19	A-7-6	14						
		S-3	4.0	6.0	4.0	6.0	30		1.75							27	18	A-7-6	16						
								9																	
2	B	S-1	1.0	3.0	0.0	2.0	15		4	36	17	19	22	64	86	18	16	A-6b	12						
	4	S-2	3.0	5.0	2.0	4.0	24		3.75							28	16	A-6b	16						
		S-3	5.0	7.0	4.0	6.0	38		2.5							24	16	A-6b	16						
								15																	
3	B	S-1	1.0	3.0	0.0	2.0	12		3.75							19	16	A-6b	16			N_{60} & Mc		12"	
	5	S-2	3.0	5.0	2.0	4.0	18		4.5	49	21	28	18	71	89	23	18	A-7-6	17						
		S-3	5.0	7.0	4.0	6.0	20		2.5							24	18	A-7-6	16						
								12																	
4	B	S-1	1.0	3.0	0.0	2.0	12		2.5	27	14	13	23	46	69	18	14	A-6a	8			N_{60} & Mc		12"	
	6	S-2	3.0	5.0	2.0	4.0	18		4							24	16	A-6b	16						
		S-3	5.0	7.0	4.0	6.0	19		3.25							24	16	A-6b	16						
		S-4	7.0	9.0	6.0	8.0	17	12	4							27	16	A-6b							

PID: TTL PN: 176

County-Route-Section: State Route 53
No. of Borings: 4

Geotechnical Consultant: TTL Associates, Inc
Prepared By: Imad EL Hajjar
Date prepared: 3/20/2020

Chemical Stabilization Options		
320	Rubblize & Roll	Option
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	4

% Samples within 6 feet of subgrade			
$N_{60} \leq 5$	0%	HP ≤ 0.5	0%
$N_{60} < 12$	8%	0.5 < HP ≤ 1	0%
$12 \leq N_{60} < 15$	15%	1 < HP ≤ 2	8%
$N_{60} \geq 20$	39%	HP > 2	92%
M+	15%		
Rock	0%		
Unsuitable	0%		

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

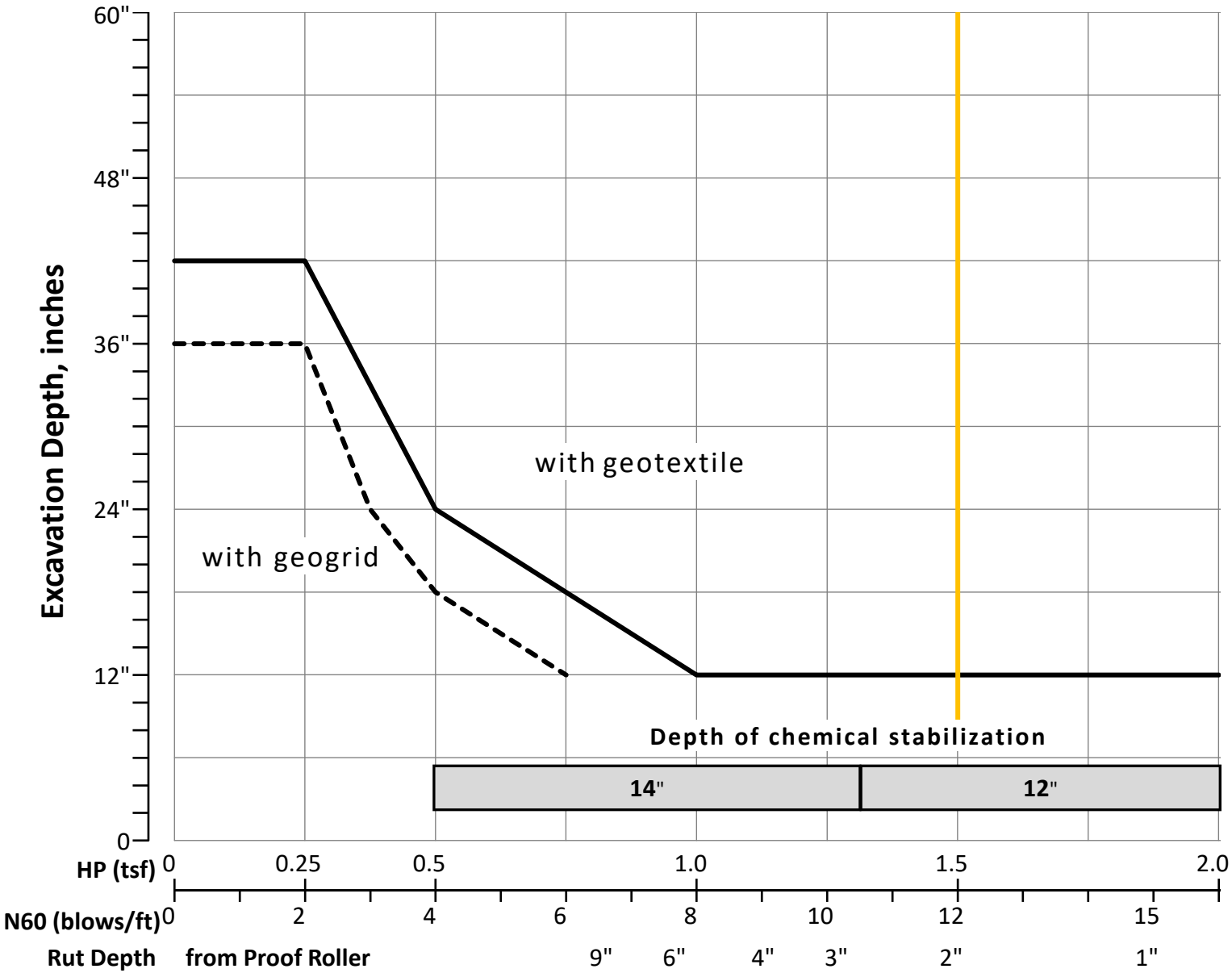
% Proposed Subgrade Surface	
Unstable & Unsuitable	38%
Unstable	38%
Unsuitable	0%

	N_{60}	N_{60L}	HP	LL	PL	PI	Silt	Clay	P 200	M_C	M_{OPT}	GI
Average	19	12	3.42	39	19	21	22	64	85	23	17	15
Maximum	38	15	4.50	49	22	28	23	73	96	28	19	17
Minimum	9	9	1.75	27	14	13	18	46	69	18	14	8

Classification Counts by Sample

ODOT Class	Rock	A-1-a	A-1-b	A-2-4	A-2-5	A-2-6	A-2-7	A-3	A-3a	A-4a	A-4b	A-5	A-6a	A-6b	A-7-5	A-7-6	A-8a	A-8b	Totals
Count	0	0	0	0	0	0	0	0	0	0	0	0	1	8	0	4	0	0	13
Percent	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	8%	62%	0%	31%	0%	0%	100%
% Rock|Granular|Cohesive	0%	0%									100%								100%
Surface Class Count	0	0	0	0	0	0	0	0	0	0	0	0	1	5	0	2	0	0	8
Surface Class Percent	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	13%	63%	0%	25%	0%	0%	100%

GB1 Figure B – Subgrade Stabilization



OVERRIDE TABLE

Calculated Average	New Values	Check to Override
3.42		☐ HP
12.00		☐ N60L

Average HP
Average N_{60L}