SOILS & STRUCTURES

REPORT OF GEOTECHNICAL INVESTIGATION FOR AB13 – LAVERGNE ROAD OVER BLACK RIVER

ALCONA TOWNSHIP
ALCONA COUNTY
MICHIGAN

AUGUST 8, 2023

Huron Engineering & Surveying, Inc.
3205 US-23 South
Alpena, Michigan 49707

Project No. 2022.2241

SOILS & STRUCTURES

August 8, 2023

Huron Engineering & Surveying, Inc.
3205 US-23 South
Alpena, Michigan 49707

Attention: Ms. Rebecca Rivard, P.E.

Regarding: AB13 – LaVergne Road over Black River
Alcona Township, Alcona County, Michigan
Project No. 2022.2241

Dear Ms. Rivard:

Soils & Structures is pleased to present this geotechnical investigation report for the AB13 – LaVergne Road over Black River project in Alcona Township, Alcona County, Michigan.

The investigation included two (2) test borings drilled to a depth of 50.0 feet in accordance with ASTM D 1586 procedures.

The report, test boring location plan and test boring logs are enclosed. The report provides soil related recommendations for the proposed culvert.

We appreciate the opportunity to provide engineering services to Huron Engineering & Surveying. If you have any questions regarding this report, please contact our office.

Sincerely,
Soils & Structures, Inc.

Malcolm Thompson

Malcolm P. Thompson, P.E.
MPT/mt

Reviewed by:

David W. Hohmeyer

David W. Hohmeyer, P.E.

SOILS & STRUCTURES

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Appendix

- Test Boring Location Plan
- General Soil Profile
- Test Boring Logs
- Laboratory Tests
- General Soil Information

Location of Soil Investigation

The soil investigation was located at the LaVergne Road crossing over the Black River in Alcona Township, Alcona County, Michigan.

Purpose of Investigation

The purpose of this investigation is to provide geotechnical engineering recommendations for the proposed culvert.

Design Information

The project consists of a new prefabricated timber bridge. The proposed timber bridge will replace an existing culvert on the Black River. The existing culvert consists of a corrugated metal arch culvert.

Allowable settlements of 0.6 inches for total settlement and 0.4 inches for differential settlement are assumed. If the actual design is significantly different than assumed in this report, then Soils & Structures should be contacted so that the recommendations included in this report may be reviewed and revised if necessary.

The greatest depth of excavation is anticipated to be approximately 14.0 feet which will be required for the construction of the bridge. Groundwater controls will be necessary.

If the actual culvert replacement details differ significantly from what was assumed in this report, then Soils & Structures should be contacted so that the recommendations included in this report may be reviewed and revised if necessary.

Tests Performed

The investigation included two test borings drilled to a depth of 50.0 feet. The test borings are designated as Test Boring One and Test Boring Two. The locations were determined jointly by Huron Engineering & Surveying and Soils & Structures, Inc. The test borings were conducted in accordance with ASTM D 1586 procedures. The ASTM D 1586 standard describes the procedure for sampling and testing soil using the Standard Penetration Test. An automatic hammer was used to obtain the soil samples.

The surface elevations at the test boring locations and additional points of reference were obtained with a Global Navigation Satellite System (GNSS) Receiver. The receiver was connected to the local MDOT CORS base station. Through this system, vertical measurements are obtained and referenced to the North American Vertical Datum (NAVD88). Horizontal measurements are also obtained at the test boring locations which are referenced to the Michigan State Plane Coordinate System. Both the vertical and horizontal measurements typically have an accuracy of approximately 0.5 inches. The measured test boring locations and surface elevations are represented in Table 1.

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Table 1: Measured Test Boring and Points of Reference Locations and Surface Elevations

Test Boring / Location	Elevation (feet)	Northing (feet)	Easting (feet)	Surface Cover
Test Boring One	601.3	542884.3	19955632.0	Asphalt
Test Boring Two	601.3	542875.8	19955707.8	Asphalt
Water Level of the Black River	592.8	542911.2	19955684.0	-
Base Setup VRS1	599.0	542890.0	19955618.1	-

Soil samples were classified according to the Unified Soil Classification System. This method is a standardized system for classifying soil according to its engineering properties. Please refer to the appendix of this report for the Unified Classification System Chart. The classification is shown in the "Material Description" column of the test boring logs.

The soil strength and the allowable soil bearing value were evaluated using the "N" value. The "N" value is the number of blows required to drive a soil sampler one foot with a standard 140 pound drop hammer. The sampler is driven a distance of 18.0 inches. The number of blows for each 6.0 inch increment is recorded. The sum of the second and third intervals is the "N" value. The number of blows for each 6.0 inch interval is shown on the test boring logs under the column labeled "Penetration." The "N" value for each sample is shown in the adjacent column.

Laboratory testing consisted of natural moisture content (ASTM D 2216), sieve analysis (ASTM D 6913), and loss on ignition testing (ASTM D 2974). The tests were performed on representative soil samples. The tests were performed in accordance with the ASTM standards listed above. The water content documents the presence of groundwater in the soil. The sieve test determines the particle distribution which is used to classify the soil and estimate its properties. Loss on ignition testing determines the amount of organic material present in a soil sample.

The U.S. Geological Survey Topographic map and the Quaternary Geology map of Southern Michigan were reviewed. These maps provide general geological information about the region. Publicly available well logs were reviewed to determine the depth of bedrock.

Description of Soil

The general soil profile consists of fill to depths of 5.5 to 14.0 feet over a layer of sand which extends to a depth of at least 50.0 feet. The upper layer of fill was placed during construction of the existing culvert and road. The natural soil is part of a lacustrine, or lake deposit from a former high-water stage of Lake Huron. Lake sediments typically form layered strata and are characterized by relatively uniform gradation. The depth to bedrock appears to be greater than 100.0 feet.

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Pavement is present at the surface. The pavement consists of 5.0 inches of asphalt over 7.0 inches of gravel which appears to be an aggregate base.

The upper 12.0 to 14.0 feet of the soil profile consists of dark brown sand with varying amounts of silt. Horizontal lenses of clay, silt, peat and wood are present in the upper portion of the soil profile at varying depths. The upper portion this layer is probably fill placed for the construction of the existing culvert and road. The "N" values of the upper sand layer range from 3 to 15, indicating the sand is in a loose to compact state. The "N" values correspond to an internal friction angle of 27 to 32 degrees.

The portion of the soil profile between depths of 14.0 and 17.0 feet in the area of Test Boring One consists of dark brown sand with a trace of wood. The "N" value of this portion of the soil profile is 24, indicating the sand is in a compact state. The "N" value corresponds to an internal friction angle of 32 degrees.

The portion of the soil profile between depths of 17.0 and at least 50.0 feet in the area of Test Boring One and between depths of 12.0 and at least 50.0 feet in the area of Test Boring Two consists of light brown to gray sand. Occasional lenses or seams of silt are present in this portion of the sand layer. The "N" values of this portion of the sand layer range from 8 to 59, indicating the sand is in a compact to extremely compact state. The "N" values correspond to an internal friction angle of 30 to 36 degrees. This portion of the sand layer is suitable to support deep foundations.

Description of Groundwater Conditions

The water table is present at depths between 8.5 and 9.0 feet. These depths correspond to an elevation of approximately 592.8 feet which was the water level of the Black River at the time the test borings were performed. The elevation of the water table is expected to change based on seasonal variation in precipitation.

Description of Sites

The site is located at the LaVergne Road crossing over the Black River in Alcona Township, Alcona County, Michigan. The site is surrounded by woods and private residences. The site consists of a paved road over a culvert. Photographs #1 and #2 show the site at the time the test borings were performed.

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Photograph #1: View of the existing culvert outlet and the Black River. (Project No. 2022.2241, AB13 – LaVergne Road over Black River, Alcona Township, Alcona County, Michigan, January, 2023)

Photograph #2: View of LaVergne Road at the Black River crossing. (Project No. 2022.2241, AB13 – LaVergne Road over Black River, Alcona Township, Alcona County, Michigan, January, 2023)

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Settlement

The maximum settlement of the structure is anticipated to be less than 0.5 inches provided the recommendations in this report are observed. Differential settlement will be approximately one half of the maximum value. These levels of settlement are within the recommended acceptable limits of 0.6 inches of total settlement and 0.4 inches of differential settlement.

Recommendations

Site & Subgrade Preparation

Trees and vegetation in the construction areas should be cleared and removed as part of subgrade preparation. The topsoil should be removed to the extent that all soil with an organic content of 3.0 percent or greater is removed. Soil containing roots should be removed to the extent that the root content by volume is 5.0 percent or less. All roots over 0.5 inches in diameter should be removed.

The existing culvert will be removed as a part of site preparation. Construction of the timber bridge will also require the removal of a significant portion of LaVergne Road. The road and embankment should be removed to the extent that the desired width of the Black River can be achieved.

The area adjacent to the bridge should be excavated to the required grade, and a cofferdam constructed as necessary to allow for construction of the abutments.

Fill or excavation may be required to adjust the grade of Black River Road to match the planned elevation of the new bridge. Fill should be placed following the recommendations in the "Fill" section of this report. Fill should be compacted to 95.0 percent of the soil's maximum density to its full depth.

Soil brought to the site for fill should be clean sand and gravel meeting MDOT specifications. The soil which will be used for fill should be kept free of topsoil and other organic materials. Compaction tests are recommended to check the compaction of the new fill.

Timber Piles

Timber piles are recommended to support the bridge. Timber piles should be treated and should be selected following the ASTM D25 Standard for Specifications for Round Treated Timber Piles. A lightweight hammer with appropriate cushions between the hammer and the pile should be used to avoid damaging the timber pile during installation. Splicing timber piles is not recommended.

The timber piles are anticipated to bear in the compact sand layer present at depths below 14.0 feet. The estimated pile length is 30.0 feet. The estimated pile length is based on a pile tip elevation of 570.0 feet and a cutoff elevation of 600.0 feet. If the cutoff elevation is different than assumed, pile lengths should be adjusted accordingly.

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Table 2 provides the calculated nominal pile driving resistance for pile tip diameters of 8.0 and 9.0 inches.

Table 2: Nominal Pile Driving Resistance for Timber Piles

Pile Tip Diameter (inches)	Pile Diameter 3.0 feet from Butt (inches)	Nominal Pile Driving Resistance (kips)
8.0	12.0	120.0
9.0	14.0	140.0

Timber piles should be ordered 5.0 feet longer than the estimated pile length to allow for additional driving distance if necessary or for the removal of the top of the pile if it is damaged during the driving process. Several test piles should be driven to verify the required depth prior to placing the order for the remaining piles. The nominal pile driving resistance should be verified using the FHWA-modified Gates Dynamic Formula. A resistance factor of 0.25 is recommended to calculate the factored nominal resistance.

Piles should be installed with a minimum center-to-center spacing of 3.0 times the pile diameter. An efficiency factor of 1.0 is recommended for piles spaced at least 3.0 times the pile diameter from the nearest pile. The piles should achieve the entire axial capacity in the portion of the pile below the anticipated scour depth. The contractor should submit the installation equipment calibration charts prior to mobilization.

Lateral Earth Pressure

Wing walls and abutments with different soil levels on either side should be designed as retaining walls. Sand should be used as backfill behind retaining and abutment walls. The sand should meet MDOT Class II specifications. The cantilevered walls should be designed using a soil density of 120 pounds per cubic foot and a coefficient of active earth pressure of 0.30 for level sand backfill. Braced excavations and foundation walls that will be braced against lateral movement at the top of the wall should be designed using a soil density of 120 pounds per cubic foot and a coefficient of at rest earth pressure of 0.45 for level sand backfill. The effects of any surcharge, unbalanced water forces or sloping backfill should also be included in the design. Weep holes or drains are recommended to reduce unbalanced hydrostatic forces.

Excavations

The in-situ sand and fill are OSHA type "C" soils. Excavations that will be entered by personnel should be based on OSHA requirements for a type "C" soil. Based on OSHA requirements, a maximum allowable side slope of 34 degrees (1.5H:1V) is recommended for excavations 4.0 to 20.0 feet deep. Excavations less than 4.0 feet deep may have vertical side slopes.

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A cofferdam is recommended for excavations that will extend a significant distance below the water table. Cofferdams should be designed by a registered engineer. The cofferdam should be designed so that the quick condition does not occur.

Fill

Fill should be compacted to a density of 95.0 percent of its maximum density to its full depth. The maximum density should be determined in accordance with the ASTM D 1557 standard. A maximum thickness per layer of 6.0 inches is recommended.

Soil brought to the site for structural fill should be sand meeting MDOT Class II requirements or ASTM requirements for a SP or SW which are the designations for clean sand. Compaction tests are recommended to confirm that the fill is compacted to the required density.

Fill should not be placed over frozen ground, snow or ice. Soil which contains frozen material should not be used as fill. During winter construction, removal of frozen ground may be necessary prior to placing fill.

Groundwater Management

Groundwater controls will be necessary for the construction of the abutments. The timber piles should achieve bearing below the anticipated scour depth.

Excavations that encounter groundwater less than 1.0 foot below the water table should be stabilized by placing 8.0 to 12.0 inches of coarse graded crushed stone aggregate over the bottom of the excavation.

Cofferdams may be necessary in order to control the size of excavations and simplify dewatering efforts. Cofferdams may be required by The Michigan Department of Environment, Great Lakes, and Energy.

Cofferdams should extend a sufficient distance below the bottom of the excavation so that a quick condition does not occur. The cofferdam design should include a hydraulic analysis to check for the quick condition. A safety factor of 2.0 is recommended.

Quality Control Testing

Compaction tests in accordance with ASTM D 6938 specifications are recommended to confirm that fill in the construction area is compacted to the specified density. While fill is being placed, compaction tests should be performed at the rate of one test per 400 cubic yards of fill and throughout the depth of the fill with a minimum of five tests at each 1.0-foot elevation interval. Full time inspection is recommended while the sand is compacted in the area of the bridge abutments and road. Tests should also be performed in the backfill over utilities. The maximum density should be determined in accordance with ASTM D 1557 or ASTM D 4253 procedures.

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Inspection of the timber pile installation is recommended. For each pile, the following information should be recorded: date and time of installation, driving resistance, surface elevation, tip elevation, cutoff elevation, pile length, obstructions, and offsets. The nominal pile driving resistance should be verified using the FHWA-modified Gates Dynamic Formula. Inspection should be performed by a geotechnical engineer.

A smooth 0.5-to-0.75-inch diameter rod should be used in conjunction with compaction tests to probe for loose areas below the culverts and in fill.

A dynamic cone should not be substituted for compaction tests for evaluating backfill.

Testing should be performed by technicians supervised by a registered geotechnical engineer.

General Conditions & Reliance

The report was prepared in accordance with generally accepted practices of the geotechnical engineering profession. The scope of work consisted of performing two test borings and providing soil related recommendations for the design and construction of the proposed timber bridge. The scope of work did not include an environmental study or wetland determination.

The report and the associated test borings were prepared specifically for the previously described project and site. Soils & Structures should be consulted if a significant change in the scope of the project is made.

The test borings represent point information and may not have encountered all of the soil types and materials present on this site. This report does not constitute a guarantee of the soil or groundwater conditions or that the test borings are an exact representation of the soil or groundwater conditions at all points on this site.

The descriptions and recommendations contained in this report are based on an interpretation of the test borings and laboratory tests. The test borings should not be used independently of the report. If soil conditions are encountered which are significantly different from the test borings, Soils & Structures should be consulted for additional recommendations.

The report and test borings may be relied upon by Huron Engineering & Surveying for the design, construction, permitting and financing associated with the construction of the AB13 – LaVergne Road over Black River project in Alcona Township, Alcona County, Michigan. The use of the report and test borings by third parties not associated with this project or for other sites has not been agreed upon by Soils & Structures. Soils & Structures does not recommend or consent to third party use or reliance of the report or test borings unless allowed to review the proposed use of these materials. Unless obtained in writing, consent to third party use should not be assumed. Third parties using the report or test boring logs do so at their own risk and are offered no guarantee or promise of indemnity.

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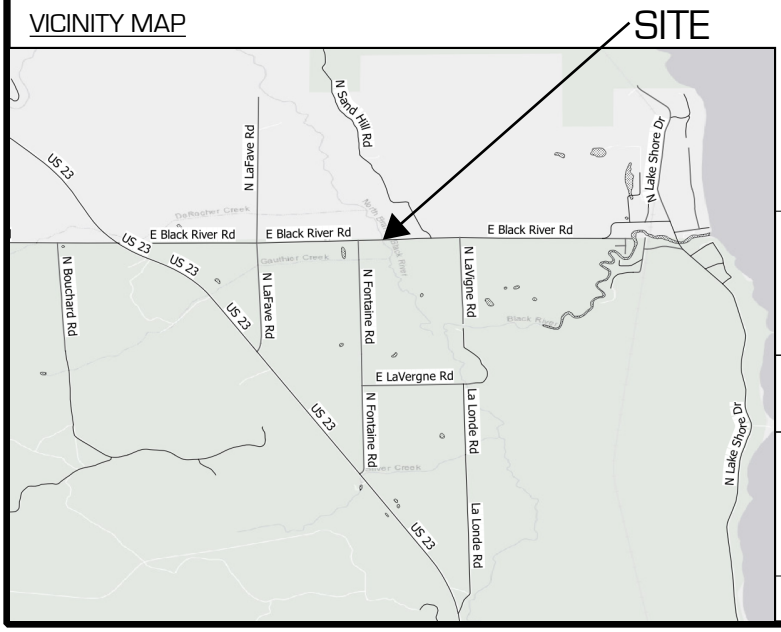
Appendix

Test Boring Location Plan
General Soil Profile
Test Boring Logs
Laboratory Tests
General Soil Information

VICINITY MAP



TEST BORING LOCATION PLAN
NTS

Note: The background of the test boring plan is a portion of an aerial photograph from Google Earth dated 6/22/2016

AB09 - Black River Road over North Branch Black River

Alcona Township, Alcona County, Michigan

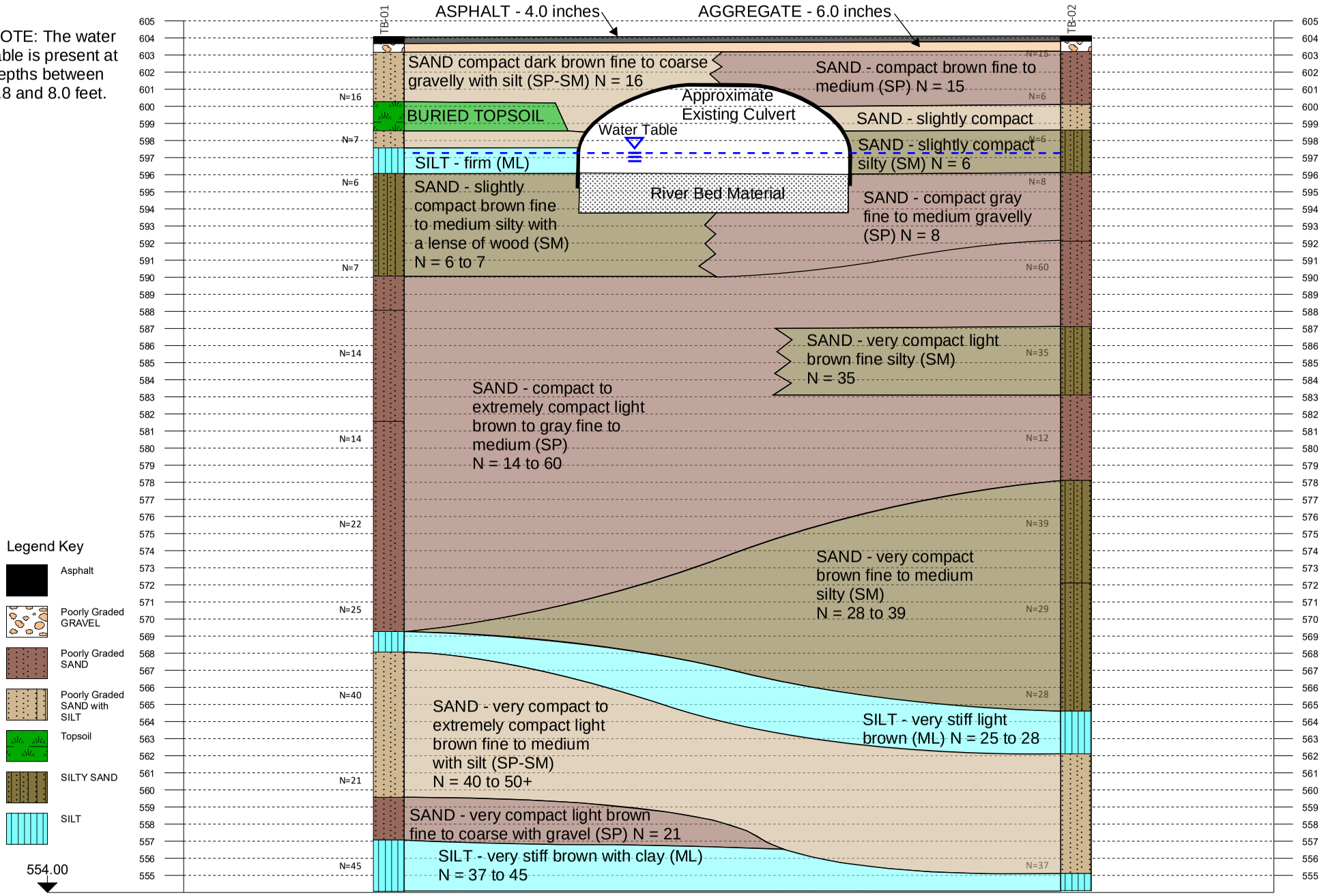
Soils & Structures, Inc.
6480 Grand Haven Road
Muskegon, Michigan 49441

JOB NO.: 2022.2241 DATE: 2-23-2023

Project Id:	2022.2242	Title:	Section line 1
Project Title:	Black River Road Crossing	Vertical Scale:	1:92
Location:	Alcona, Michigan	Horizontal Scale:	1:175
Client:	Huron Engineering and Surveying, Inc.	Engineer:	Malcolm Thompson, P.E.

GENERAL SOIL PROFILE

NOTE: The water table is present at depths between 6.8 and 8.0 feet.



Legend Key

- Asphalt
- Poorly Graded GRAVEL
- Poorly Graded SAND
- Poorly Graded SAND with SILT
- Topsoil
- SILTY SAND
- SILT

554.00

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Borehole ID: TB-01

Sheet 1 of 2

Project Name:	Black River Road Crossing	**Project Number:**	2022.2242
Project Location:	Alcona, Michigan	**Logged By:**	R Roda
Reviewed By:	M Thompson		
Client:	Huron Engineering and Surveying, Inc.	**Survey Datum:**	NAD 1983 StatePlane Michigan Central
Hole Depth:	50.00		
Date Started:	Jan 09 2023	**Completed:**	Jan 09 2023
Northing:	548074.0	**Easting:**	19953482.5
Elevation:	604.07		
Drilling Method:	3.25" Hollow Stem Auger	**Ground Water Levels**	
Equipment:	CME 750X	At Time of Drilling	8.00 on Jan 05 2023 - Groundwater Encountered
Hammer Type:	Automatic Hammer		
Notes:			

Depth	Material Description	Sample Type	Number	Recovery % RQD	Blow Counts	N-Value	Pocket Pen (tsf)	Shear Strength (tsf)	Moisture Content (%)	Atterberg Limits: Liquid Limit	Atterberg Limits: Plastic Limit	Atterberg Limits: Plasticity Index	USCS
0	ASPHALT - (4.0")												
1	GRAVEL - dark brown fine to medium with sand with a trace of silt (6.0")												
2			SPT-A	84	28-50/0.33'	100			4.5				SP-SM
3	SAND - compact dark brown fine to coarse gravelly with silt with a trace of cobbles (fill)												
4	BURIED TOPSOIL - compact black sandy (possible fill)		SPT-B	100	8-11-5	16			26.1				PT
5													
6	Organic Content = 7.3%												
7	SAND - slightly compact brown fine to medium with silt (possible fill)		SPT-C	100	5-5-2	7			75.6				SP-SM
8	SILT - firm dark brown with lenses of peat with seams of sand (possible fill)												
9			SPT-D	33	1-3-3	6			20.2				SM
10	Organic Content = 11.4%												
11	SAND - slightly compact brown fine to medium silty with a lense of wood												
12													
13													
14	SAND - slightly compact light brown to dark brown fine to medium		SPT-E	100	7-6-1	7			24.0				SM
15													
16	SAND - compact light brown to gray fine to medium												
17													
18													
19			SPT-F	100	7-7-7	14							SP
20													
21													
22													
23	SAND - compact to very compact gray to light brown fine to medium												
24			SPT-G	100	3-5-9	14			22.0				SP
25													
26													
27													
28													
29			SPT-H	100	3-7-15	22							SP
30													

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Borehole ID: TB-01

Sheet 2 of 2

Project Name:	Black River Road Crossing	**Project Number:**	2022.2242
Project Location:	Alcona, Michigan	**Logged By:**	R Roda
Reviewed By:	M Thompson		
Client:	Huron Engineering and Surveying, Inc.	**Survey Datum:**	NAD 1983 StatePlane Michigan Central
Hole Depth:	50.00		
Date Started:	Jan 09 2023	**Completed:**	Jan 09 2023
Northing:	548074.0	**Easting:**	19953482.5
Elevation:	604.07		
Drilling Method:	3.25" Hollow Stem Auger	**Ground Water Levels**	
Equipment:	CME 750X	At Time of Drilling	8.00 on Jan 05 2023 - Groundwater Encountered
Hammer Type:	Automatic Hammer		
Notes:			

Depth	Graphic	Material Description	Sample Type	Number	Recovery % RQD	Blow Counts	N-Value	Pocket Pen (tsf)	Shear Strength (tsf)	Moisture Content (%)	Atterberg Limits: Liquid Limit	Atterberg Limits: Plastic Limit	Atterberg Limits: Plasticity Index	USCS
31		SAND - compact to very compact gray to light brown fine to medium												
32														
33														
34				SPT-I	100	12-12-13	25			17.6				SP
35		SILT - very stiff light brown with clay and sand												
36		SAND - very compact light brown fine to medium with silt												
37														
38														
39				SPT-J	87	7-16-24	40			19.0				SP-SM
40														
41														
42														
43														
44				SPT-K	100	6-8-13	21							SP-SM
45		SAND - very compact light brown fine to coarse with gravel												
46														
47		SILT - very compact brown with clay with seams of sand												
48														
49				SPT-L	100	13-22-23	45		2.92	16.6				ML
50														
51														
52														
53														
54														
55														
56														
57														
58														
59														
60														

SOILS & STRUCTURES

Borehole ID: TB-02

Sheet 1 of 2

Project Name:	Black River Road Crossing	**Project Number:**	2022.2242
Project Location:	Alcona, Michigan	**Logged By:**	R Roda
Reviewed By:	M Thompson		
Client:	Huron Engineering and Surveying, Inc.	**Survey Datum:**	NAD 1983 StatePlane Michigan Central
Hole Depth:	50.00		
Date Started:	Jan 09 2023	**Completed:**	Jan 09 2023
Northing:	548069.8	**Easting:**	19953406.2
Elevation:	604.11		
Drilling Method:	3.25" Hollow Stem Auger	**Ground Water Levels**	
Equipment:	CME 750X	At Time of Drilling	8.00 on Jan 05 2023 - Groundwater Encountered
Hammer Type:	Automatic Hammer		
Notes:		After Drilling	6.80 on Jan 05 2023 - Static Water Level

Depth	Graphic	Material Description	Sample Type	Number	Recovery % RQD	Blow Counts	N-Value	Pocket Pen (tsf)	Shear Strength (tsf)	Moisture Content (%)	Atterberg Limits: Liquid Limit	Atterberg Limits: Plastic Limit	Atterberg Limits: Plasticity Index	USCS
0		ASPHALT - (4.0")												
1		GRAVEL - dark brown fine to medium with sand with a trace of silt (6.0")												
2		SAND - compact brown to light brown fine to medium with a trace of silt and gravel (fill)		SPT-A	47	9-6-9	15			3.3				SP
3														
4		SAND - slightly compact dark brown fine to coarse gravelly with silt (fill)		SPT-B	100	9-3-3	6			14.5				SP-SM
5														
6		SAND - slightly compact gray fine to coarse silty with gravel (possible fill)		SPT-C	53	4-3-3	6			15.2				SM
7														
8		SAND - compact gray fine to medium gravelly												
9				SPT-D	80	3-5-3	8			23.5				SP
10														
11														
12		SAND - extremely compact gray fine to medium with lenses of gravel												
13														
14				SPT-E	100	17-50-10	60							SP
15														
16														
17		SAND - very compact light brown fine silty												
18														
19				SPT-F	133	18-26-9	35			16.5				SM
20														
21		SAND - compact gray fine to medium												
22														
23														
24				SPT-G	87	6-4-8	12							SP
25														
26		SAND - very compact brown fine to medium silty												
27														
28														
29				SPT-H	100	6-21-18	39			17.3				SM
30														

SOILS & STRUCTURES

Borehole ID: TB-02

Sheet 2 of 2

Project Name:	Black River Road Crossing	**Project Number:**	2022.2242
Project Location:	Alcona, Michigan	**Logged By:**	R Roda
Reviewed By:	M Thompson		
Client:	Huron Engineering and Surveying, Inc.	**Survey Datum:**	NAD 1983 StatePlane Michigan Central
Hole Depth:	50.00		
Date Started:	Jan 09 2023	**Completed:**	Jan 09 2023
Northing:	548069.8	**Easting:**	19953406.2
Elevation:	604.11		
Drilling Method:	3.25" Hollow Stem Auger	**Ground Water Levels**	
Equipment:	CME 750X	At Time of Drilling	8.00 on Jan 05 2023 - Groundwater Encountered
Hammer Type:	Automatic Hammer		
Notes:		After Drilling	6.80 on Jan 05 2023 - Static Water Level

Depth	Graphic	Material Description	Sample Type	Number	Recovery % RQD	Blow Counts	N-Value	Pocket Pen (tsf)	Shear Strength (tsf)	Moisture Content (%)	Atterberg Limits: Liquid Limit	Atterberg Limits: Plastic Limit	Atterberg Limits: Plasticity Index	USCS
31		SAND - very compact brown fine to medium silty												
32		SAND - very compact light brown fine silty												
33														
34				SPT-I	100	10-22-7	29							SM
35														
36														
37														
38														
39				SPT-J	80	16-18-10	28			21.5				SM
40		SILT - very stiff light brown sandy												
41														
42		SAND - extremely compact brown fine to medium with silt												
43														
44				SPT-K	76	30-50/0.42'	100							SP-SM
45														
46														
47														
48														
49		SILT - very stiff brown with a trace of sand with lenses of clay		SPT-L	100	5-21-16	37							SP-SM
50														
51														
52														
53														
54														
55														
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58														
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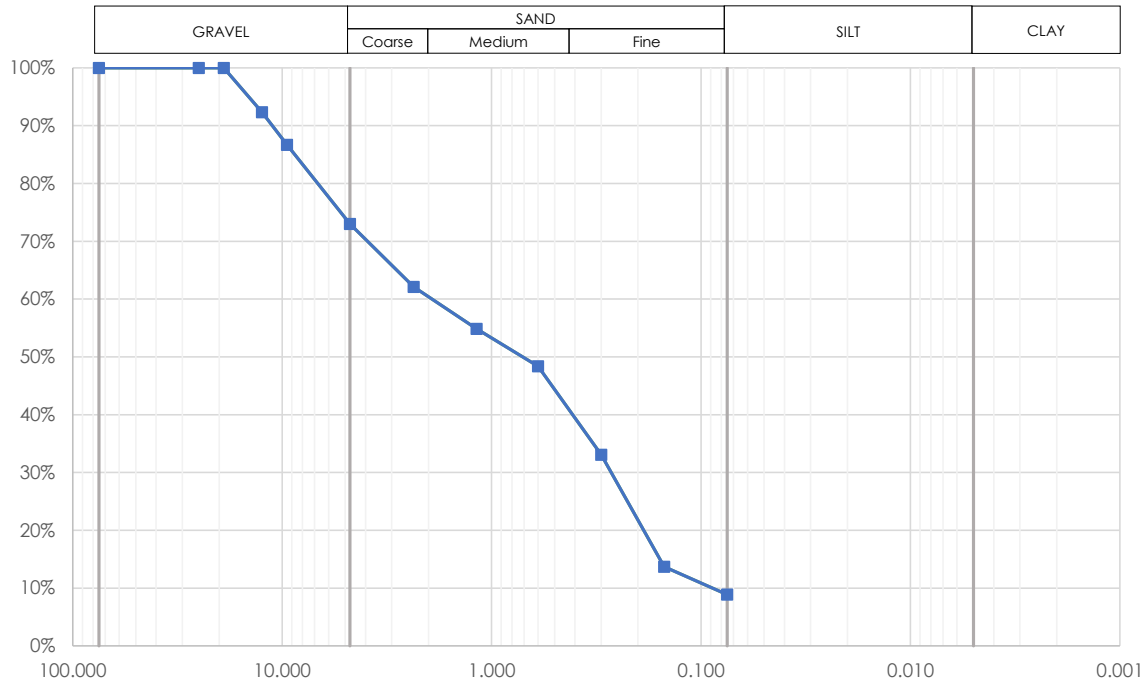
60														

SOILS & STRUCTURES

Particle Size Distribution Report

Project Name Black River Road Crossing
Project Number 2022.2242
Client Huron Engineering and Surveying, Inc.
Date 1/26/2023
Sample Location TB-01 Sample ID A Depth (ft) 1.0



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0%	0.0%	27.0%	13.1%	20.4%	30.6%	0.0%	0.0%
D85	**D60**	**D50**	**D30**	**D15**	**D10**	**Loss By Wash**	
8.9132	2.0191	0.7450	0.2763	0.1600	0.0925	8.9%	

Particle Size	
Sieve	**% Passing**
3 in.	100%
1 in.	100%
3/4 in.	100%
1/2 in.	92%
3/8 in.	87%
No. 4	73%
No. 8	62%
No. 16	55%
No. 30	48%
No. 50	33%
No. 100	14%
No. 200	8.9%

Hydrometer	
Particle Size (mm)	**% Passing**

Material Description
Fine to Coarse Gravelly SAND with Silt (SP-SM)

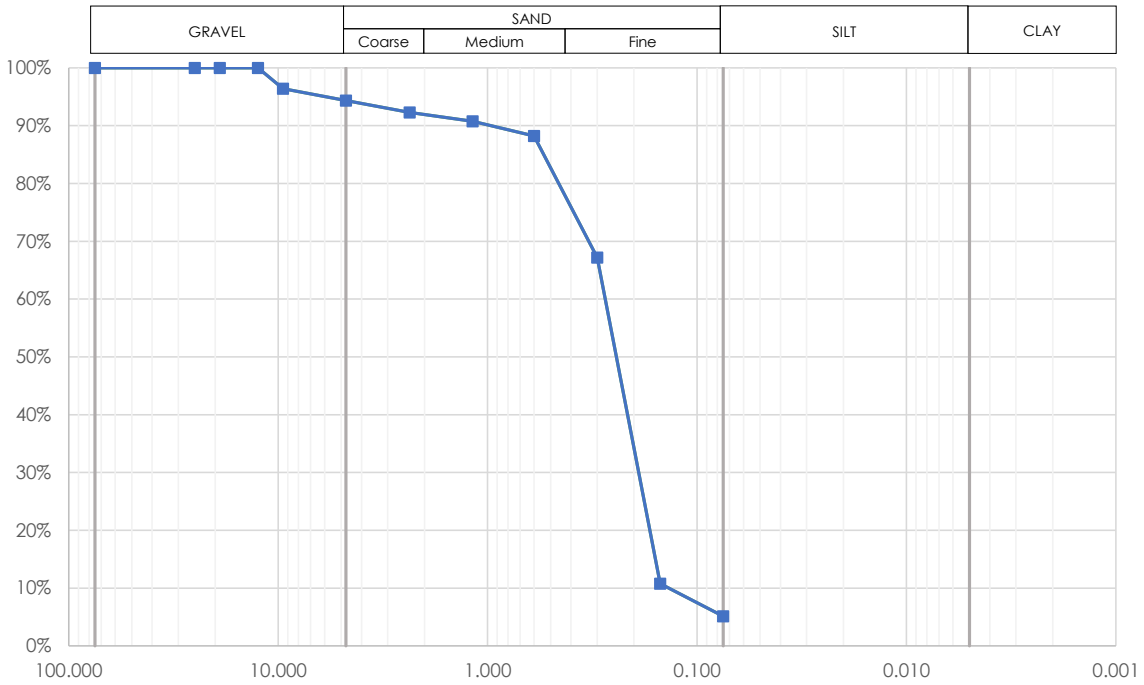
Remarks

Technician Checked Approved
mvanweelden

SOILS & STRUCTURES

Particle Size Distribution Report

Project Name Black River Road Crossing
Project Number 2022.2242
Client Huron Engineering and Surveying, Inc.
Date 1/26/2023
Sample Location TB-02 Sample ID A Depth (ft) 1.0



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0%	0.0%	5.6%	2.5%	15.9%	70.8%	0.0%	0.0%
D85	**D60**	**D50**	**D30**	**D15**	**D10**	**Loss By Wash**	
0.5543	0.2809	0.2543	0.2011	0.1613	0.1398	5.1%	

Particle Size	
Sieve	**% Passing**
3 in.	100%
1 in.	100%
3/4 in.	100%
1/2 in.	100%
3/8 in.	96%
No. 4	94%
No. 8	92%
No. 16	91%
No. 30	88%
No. 50	67%
No. 100	11%
No. 200	5.1%

Hydrometer	
Particle Size (mm)	**% Passing**

Material Description
Fine to Medium SAND with a Trace of Silt and Gravel (SP)

Remarks

Technician Checked Approved
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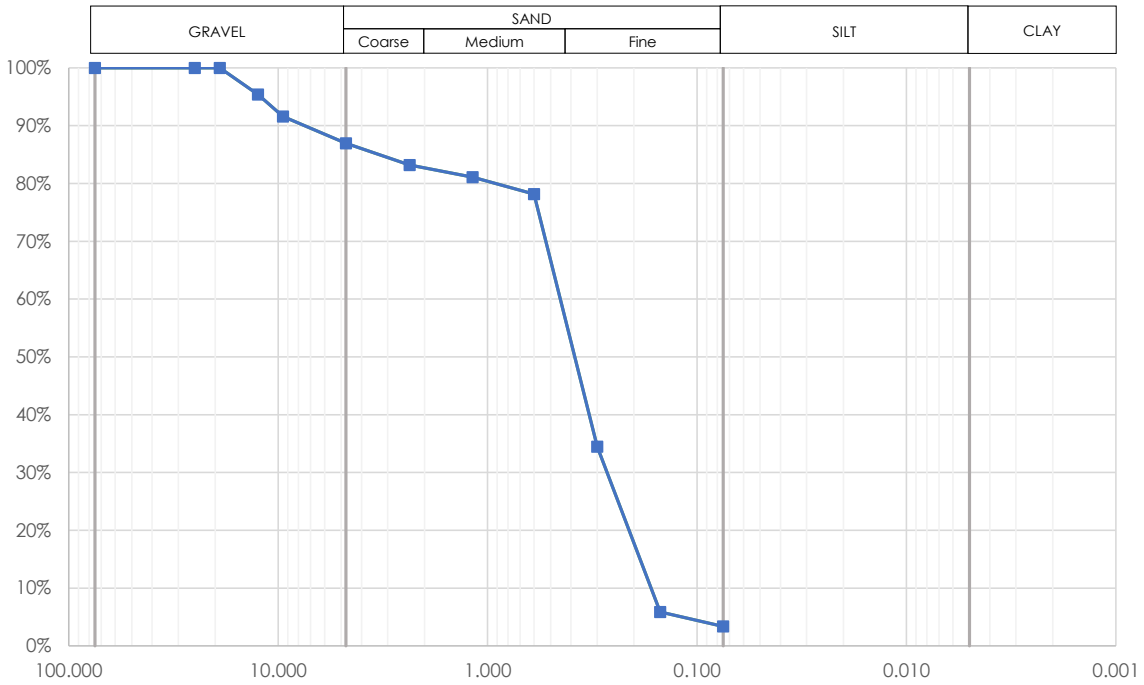
SOILS & STRUCTURES

Particle Size Distribution Report

Project Name Black River Road Crossing
Project Number 2022.2242
Client Huron Engineering and Surveying, Inc.
Date 1/26/2023
Sample Location TB-02 Sample ID D Depth (ft) 8.5



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0%	0.0%	13.0%	4.4%	29.9%	49.3%	0.0%	0.0%
D85	**D60**	**D50**	**D30**	**D15**	**D10**	**Loss By Wash**	
3.5019	0.4754	0.4067	0.2766	0.1979	0.1716	3.4%	

Particle Size	
Sieve	**% Passing**
3 in.	100%
1 in.	100%
3/4 in.	100%
1/2 in.	95%
3/8 in.	92%
No. 4	87%
No. 8	83%
No. 16	81%
No. 30	78%
No. 50	34%
No. 100	6%
No. 200	3.4%

Hydrometer	
Particle Size (mm)	**% Passing**

Material Description
Fine to Medium Gravelly SAND (SP)

Remarks

Technician Checked Approved
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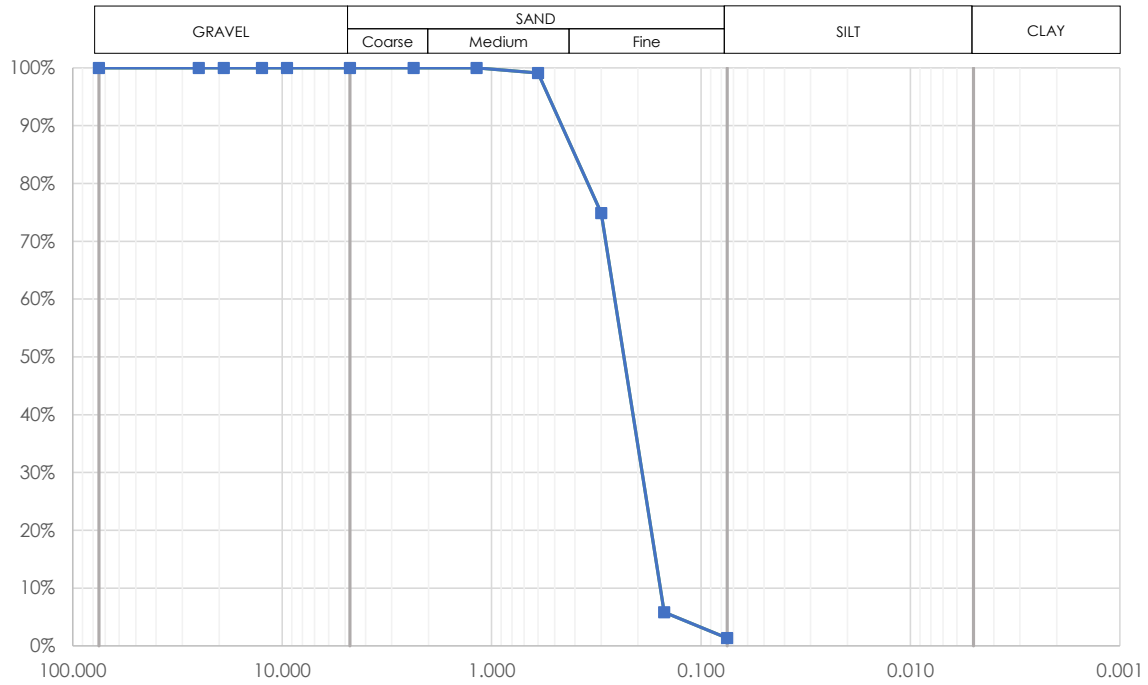
SOILS & STRUCTURES

Particle Size Distribution Report

Project Name Black River Road Crossing
Project Number 2022.2242
Client Huron Engineering and Surveying, Inc.
Date 1/26/2023
Sample Location TB-01 Sample ID E Depth (ft) 13.5



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0%	0.0%	0.0%	0.0%	15.0%	83.6%	0.0%	0.0%
D85	**D60**	**D50**	**D30**	**D15**	**D10**	**Loss By Wash**	
0.4253	0.2677	0.2459	0.2025	0.1699	0.1591	1.3%	

Particle Size	
Sieve	**% Passing**
3 in.	100%
1 in.	100%
3/4 in.	100%
1/2 in.	100%
3/8 in.	100%
No. 4	100%
No. 8	100%
No. 16	100%
No. 30	99%
No. 50	75%
No. 100	6%
No. 200	1.3%

Hydrometer	
Particle Size (mm)	**% Passing**

Material Description
Fine to Medium SAND (SP)

Remarks

Technician Checked Approved
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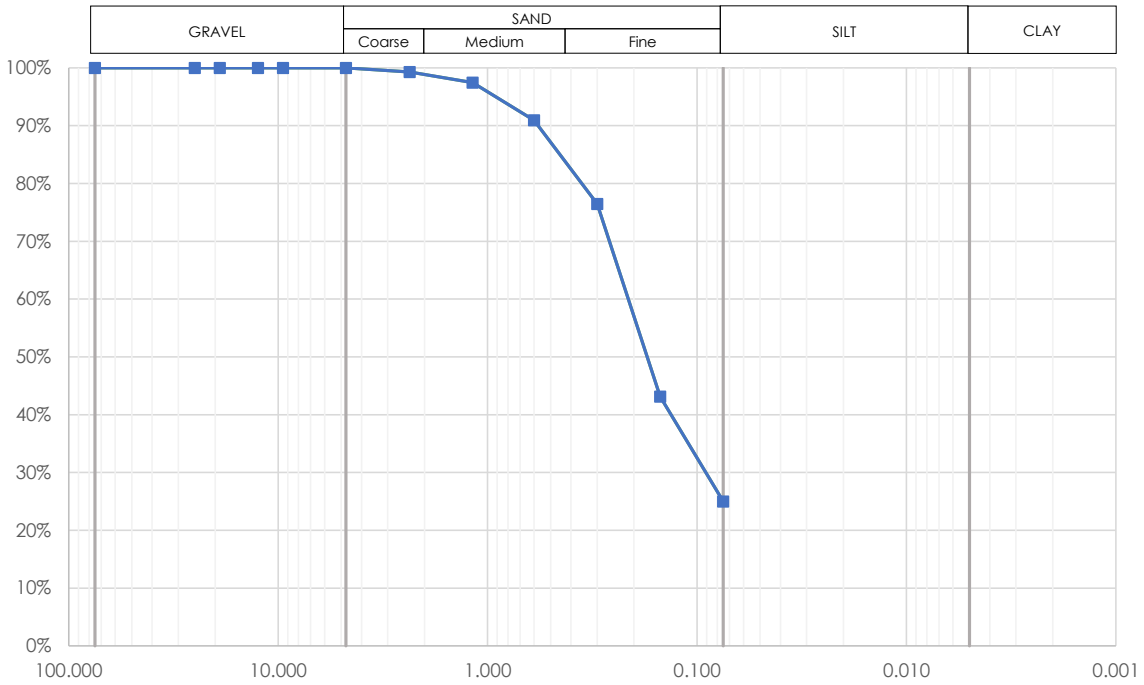
SOILS & STRUCTURES

Particle Size Distribution Report

Project Name Black River Road Crossing
Project Number 2022.2242
Client Huron Engineering and Surveying, Inc.
Date 1/26/2023
Sample Location TB-02 Sample ID H Depth (ft) 28.5



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0%	0.0%	0.0%	1.3%	16.2%	57.5%	0.0%	0.0%
D85	**D60**	**D50**	**D30**	**D15**	**D10**	**Loss By Wash**	
0.4770	0.2260	0.1810	0.0957	0.0450	0.0300	25.0%	

Particle Size	
Sieve	% Passing
3 in.	100%
1 in.	100%
3/4 in.	100%
1/2 in.	100%
3/8 in.	100%
No. 4	100%
No. 8	99%
No. 16	97%
No. 30	91%
No. 50	76%
No. 100	43%
No. 200	25.0%

Hydrometer	
Particle Size (mm)	% Passing

Material Description

Fine to Medium Silty SAND (SM)

Remarks

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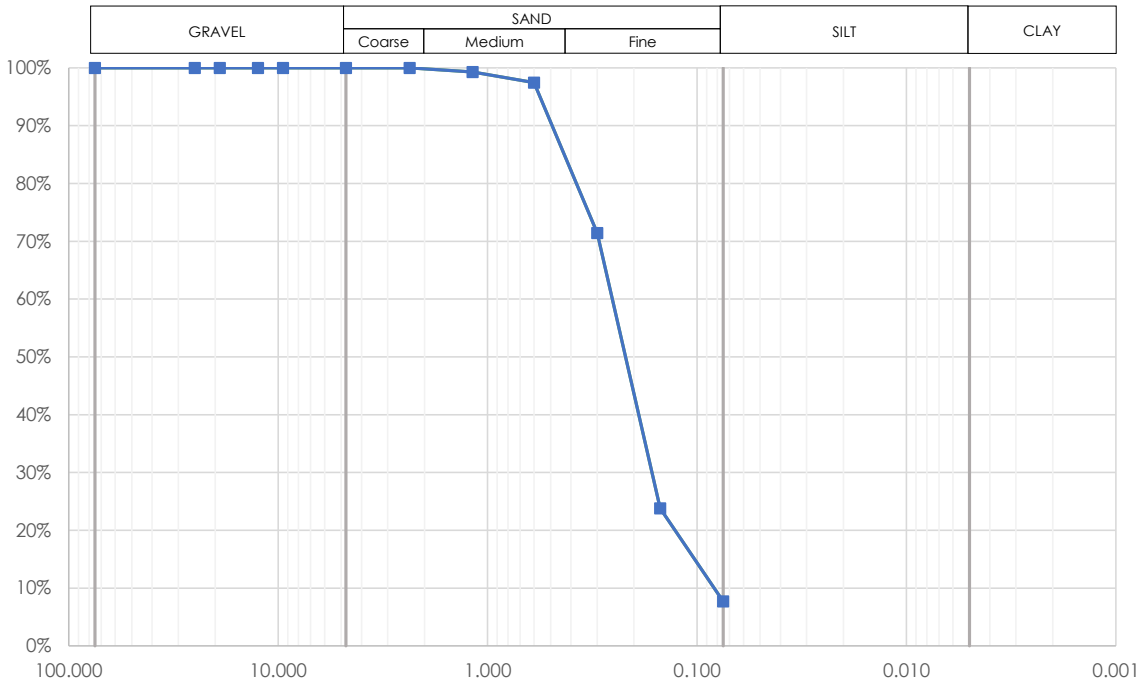
SOILS & STRUCTURES

Particle Size Distribution Report

Project Name Black River Road Crossing
Project Number 2022.2242
Client Huron Engineering and Surveying, Inc.
Date 1/26/2023
Sample Location TB-01 Sample ID J Depth (ft) 38.5



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0%	0.0%	0.0%	0.2%	17.5%	74.6%	0.0%	0.0%
D85	**D60**	**D50**	**D30**	**D15**	**D10**	**Loss By Wash**	
0.4565	0.2640	0.2325	0.1695	0.1090	0.0857	7.7%	

Particle Size	
Sieve	**% Passing**
3 in.	100%
1 in.	100%
3/4 in.	100%
1/2 in.	100%
3/8 in.	100%
No. 4	100%
No. 8	100%
No. 16	99%
No. 30	97%
No. 50	71%
No. 100	24%
No. 200	7.7%

Hydrometer	
Particle Size (mm)	**% Passing**

Material Description
Fine to Medium SAND with Silt (SP-SM)

Remarks

Technician Checked Approved
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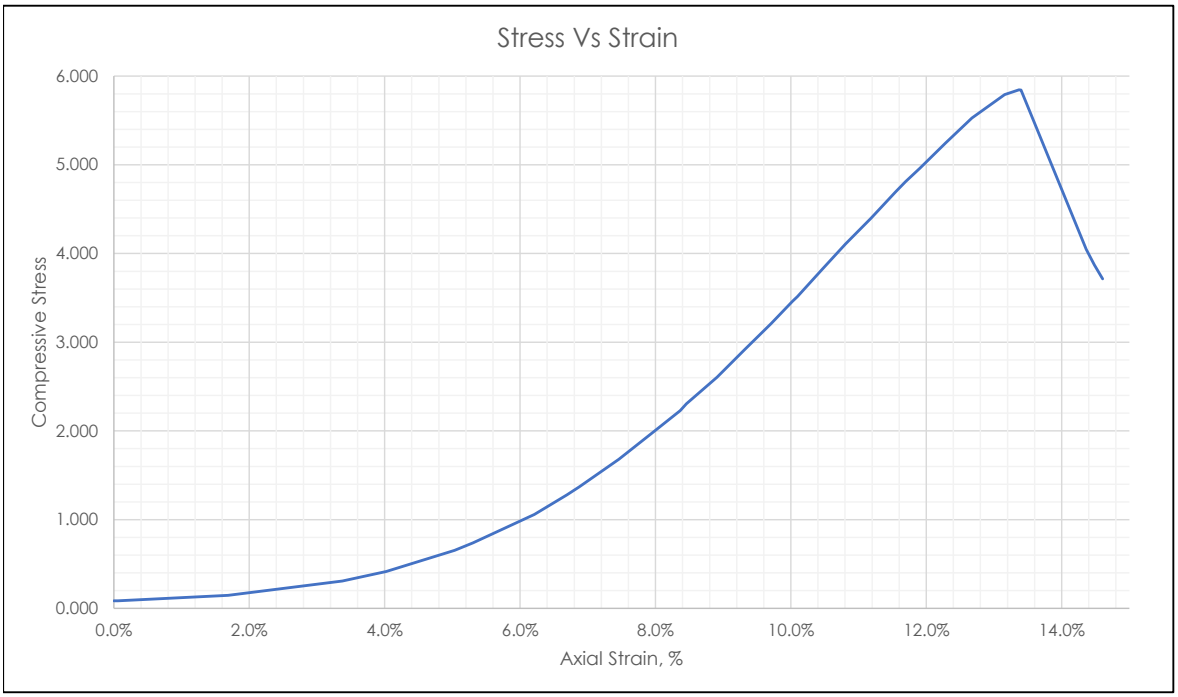
SOILS & STRUCTURES

Unconfined Compressive Strength

Project Name	Black River Road Crossing				
Project Number	2022.2242				
Date	1/26/2023				
Client	Huron Engineering and Surveying, Inc.				
Sample Location	TB-01	Sample ID	L	Depth (ft)	48.5



Sample ID	L
Unconfined Strength (tsf)	5.845
Undrained Shear Strength (tsf)	2.923
Failure Strain (%)	13.4%
Strain Rate, (in/min)	0.055
Moisture Content	16.6%
Wet Density (pcf)	134.2
Dry Density (pcf)	115.1
Void Ratio	0.4528
Saturation (%)	98.2%
Specimen Diameter (in)	1.45
Specimen Height (in)	3.04
Height/Diameter Ratio	2.10

Remarks

Technician | Checked | Approved mvanweelden

SOILS & STRUCTURES

Organic Content
ASTM D2974

Project Name Black River Road Crossing
Job Number 2022.2242
Client Huron Engineering and Surveying, Inc.
Date 1/26/2023

Sample Location		TB-01	TB-01		
Sample ID		B	C		
Depth	ft	3.5	6.0		
Sample Type		SPT	SPT		
Material Description		BURIED TOPSOIL - compact black sandy (possible fill)	SILT - firm dark brown with lenses of peat with seams of sand (possible fill)		
Container Weight	g	328.5	387.5		
Weight of Wet Soil & Container	g	405.8	609.9		
Weight of Dry Soil & Container	g	389.8	514.1		
Weight of Burnt Soil & Container	g	385.3	499.7		
Weight of Wet Soil	g	77.3	222.4		
Weight of Dry Soil	g	61.3	126.6		
Weight of Burnt Soil	g	56.8	112.2		
Percent Moisture		26.1%	75.7%		
Organic Content		7.3%	11.4%		
Remarks					

Sample Location					
Sample ID					
Depth	ft				
Sample Type					
Material Description					
Container Weight	g				
Weight of Wet Soil & Container	g				
Weight of Dry Soil & Container	g				
Weight of Burnt Soil & Container	g				
Weight of Wet Soil	g				
Weight of Dry Soil	g				
Weight of Burnt Soil	g				
Percent Moisture					
Organic Content					
Remarks					

Technician Checked Approved
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SOILS & STRUCTURES

General Information for Method of Field Investigation

The soil investigation was performed in accordance with the American Society of Testing and Materials method ASTM D 1586, which is the "Standard Test Method for Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils". Samples of compressible clays or organic soils are obtained in accordance with ASTM D 1587, which is the "Standard Practice for Thin-Walled Tube Sampling of Soils for Geotechnical Purposes." Rock may be cored in conjunction with the above methods as specified in ASTM D 2113 which is the "Standard Practice for Rock Core Drilling and Sampling of Rock for Site Investigation."

Field Testing

Standard Penetration Tests (SPT) in accordance with ASTM D 1586 were generally performed at depths of 2.0', 4.5', 7.0', 9.5' and 5.0' intervals thereafter.

Laboratory Testing

Samples obtained from the Standard Penetration Test, ASTM D 1586 or thin walled tube method, ASTM D 1587, were tested in the laboratory for the moisture content and density and/or particle size, where applicable. When soils sampled possessed sufficient cohesive properties, it was tested for its compressive strength in the unconfined state.

Natural Percent Moisture content (N.P.M.) of the soil is the percentage by weight of water contained in the soil sample compared to the dry weight of the solids of which the soil is composed. The NPM of select samples is determined in accordance with ASTM D 2216.

Natural Density (N.D.) of soil as reported on the appended boring logs is the natural wet density of the soils expressed in pounds per cubic foot.

The unconfined compressive strength of cohesive soils is determined in the laboratory on "undisturbed" select samples in accordance with ASTM D 2166. This test determines the maximum load required at a specified rate to deform the cohesive soil specimen length twenty (20%) percent. The primary purpose of the unconfined compression test is to obtain approximate quantitative values of the compressive strength of soils possessing sufficient coherence to permit testing in the unconfined state. The shear strength of the cohesive soil can be calculated from the results of the unconfined compressive strength test.

Color

When the color of the soils is uniform throughout, the color recorded will be such as brown, gray, and black and may be modified by adjectives such as light and dark. If the soils predominant color is shaded by secondary color, the secondary color precedes the primary color, such as gray-brown, or yellow-brown. If two major and distinct colors are swirled throughout the soil, the colors will be modified by the term mottled; such as mottled brown and gray.

Water Observations

Depth of water recorded in the test boring is measured from the ground surface to the water surface. Initial depth indicates water level during boring, completing depth indicates water level immediately after boring, and depth after "X" number of hours indicates water level after allowing the groundwater rise or fall over a period of time. Water observations in pervious soils are considered reliable groundwater levels for accurate groundwater measurements at the time the test borings were performed unless records are made over several days' time. Factors such as weather, soils porosity, etc., will cause the groundwater level to fluctuate for both pervious and impervious soils.

SOILS & STRUCTURES

Sample Type

If not otherwise indicated, the sample is a split-barrel liner sample ASTM D 1586.

"S.T.' – Shelby tube sample, ASTM D 1587
"A" – disturbed augered sample
"C" – rock core sampled ASTM D 2113
N.P.M. – Natural Percent Moisture of in-situ soils sample
N.D. – Natural Density of in-situ soils sample in pcf.
S.S. – Shear Strength of cohesive soils samples as determined by the Unconfined Compression tests in ksf.

Classification Data – Laboratory data to assist in classification of soils and classification of soils characteristics; i.e., plastic limit or liquid limit

Test Boring Logs

Particle Size	**Visual**
Boulders	Larger than 12" (300 mm)
Cobbles	12" to 3" (300 to 75 mm)
Gravel - Coarse	3" to ¾ " (75 to 19 mm)
Gravel – Fine	19.0 to 4.75 mm
Sand- Coarse	4.75 to 2.0 mm
Sand - Medium	2.0 to 0.425 mm
Sand - Fine	0.425 to 0.075 mm
Silt	0.075 to 0.002 mm
Clay	0.002 mm and smaller

Soils Components

Major Component	**Minor Component**
Gravel	Trace (1 - 10%)
Sand	Some (11 - 35%)
Silt/Clay	And (36 - 50%)

Condition of Soil Relative to Compactness

Granular Material	**"N" Value**
Loose	0 - 4
Slightly Compact	5 - 7
Compact	8 - 20
Very Compact	21 - 50
Extremely Compact	51 and above

Cohesive Material	**"N" Value**
Soft	0 - 4
Firm	5 - 7
Stiff	8 - 20
Very Stiff	21 - 50
Extremely Stiff	51 and above

"N" values in clay soils are not to be used as a measure of shear strength. However, they may be used as a general indication of strength.

SOILS & STRUCTURES

Unified Soil Classification System Chart

Major Divisions			Letter Symbol	Typical Descriptions
Coarse Grained Soils More than 50% of material is larger than No. 200 sieve size	Gravel – Gravelly Soils more than 50% of coarse fraction retained on No. 4 sieve	Clean gravels (little or no fines)	GW	Well-Graded gravels, gravel-sand mixtures, little or no fines
			GP	Poorly-Graded gravels, gravel-sand mixtures, little or no fines
		Gravel with Fines (appreciable amount of fines)	GM	Silty gravels, gravel-sand-silt mixtures
			GC	Clayey gravels, gravel-sand-clay mixtures
	Sand and Sandy Soils More than 50% of coarse fraction passing No. 4 sieve	Clean Sand (little or no fines)	SW	Well-Graded sands, gravelly sands, little or no fines
			SP	Poorly-Graded sands, gravelly sands, little or no fines
		Sand with Fines (appreciable amount of fines)	SM	Silty sands, sand-silt mixtures
			SC	Clayey sands, sand-clay mixtures
Fine Grained Soils More than 50% of material is smaller than No. 200 sieve size	Silts and Clays Liquid limit less than 50		ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity
			CL	Inorganic clays or low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays
			OL	Organic silts and organic silty clays or low plasticity
	Silts and Clays Liquid limit greater than 50		MH	Inorganic silts, micaceous or diatomaceous fine sand or silty soils
			CH	Inorganic clays of high plasticity, fat clays
			OH	Organic clays or medium to high plasticity, organic silts
	Highly organic soils		PT	Peat, humus, swamp soils with high organic contents

For Laboratory Classification of Fine Grained Soil
Plasticity Chart