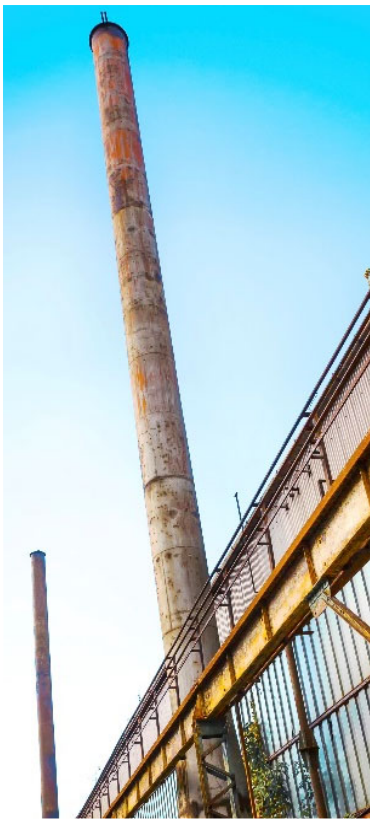
Geotechnical Investigation Report

Rehabilitation / Reconstruction of
Bobcaygeon Road and Scotch Line Road
Minden Hills, Ontario



347 Pido Road Peterborough Ontario K9J 6X7 Canada | 11202605 | 02 | Report No 1 | February 18, 2021

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1. Introduction

This report presents the results of a geotechnical investigation carried out in support of the proposed rehabilitation or reconstruction of Bobcaygeon Road and Scotch Line Road, in Minden Hills, Ontario. GHD was retained by Engage Engineering Ltd. (the Client) to complete the investigation. The work was conducted in accordance with our proposals PG-4564, dated July 18, 2019 and PG-4992 dated December 4, 2020.

The investigated areas (the Site) are illustrated on the attached Site Location Map (Figure 1) and include:

1. Bobcaygeon Road, from Scotch Line to approximately 3.1 km in the northerly direction; and
2. Scotch Line Road, from Bingham Road to Highway 35.

These sections of the roadway were identified by the owner to be in very poor condition and are identified for immediate rehabilitation. The purpose of this geotechnical investigation is to define the subsurface soil and groundwater conditions at the Sites and to develop geotechnical engineering recommendations regarding earthworks construction, reuse of existing soils as backfill material and road rehabilitation/reconstruction including pavement structure. The information contained in this report must in no way be construed as an opinion of this site's chemical, environmental, or hydrogeological status.

2. Field and Laboratory Procedures

Field investigations were conducted under the supervision of GHD staff on September 17th, 2019 and January 28, 2021. The work consisted of subsurface exploration by means of advancing and sampling a total of thirteen (13) exploratory boreholes to a depth of 1.5 to 3 meters (m) below ground surface or practical refusal. The location of each borehole is illustrated on the attached Borehole Location Plans (Figures 2-1 to 2-5).

A detailed log of each borehole was maintained and representative samples of the materials encountered in the boreholes were collected. A detailed log of each borehole is presented in Appendix A.

The boreholes were advanced using a truck-mounted drill rig equipped with continuous flight, solid stem power augers. Representative, disturbed samples of the strata penetrated were obtained directly from augers cuttings. Samples were also obtained using a split-barrel, 50 mm outer-diameter (OD) sampler advanced by a 63.5 kg hammer dropping approximately 760 mm. The results of these standard penetration tests (SPT's) are reported as "N" values on the borehole logs at the corresponding depths.

Soil samples obtained from the boreholes were inspected in the field immediately upon retrieval for type, texture, and colour. All test holes were backfilled following completion of the fieldwork. All samples were sealed in clean plastic containers and transported to the GHD laboratory for further visual-tactile examination, and to select appropriate samples for laboratory analysis.

Groundwater measurements and observations were obtained from the open boreholes during the drilling operations. Upon completion, the boreholes were backfilled with a mixture of auger cuttings and bentonite pellets, the surface of the asphalt was reinstated using cold-patch asphalt.

Physical laboratory testing was completed on representative soil samples, and consisted of moisture content tests on all samples recovered and gradation analyses on a total of twelve (12) representative soil samples including five (5) hydrometers. The analytical results of the moisture content tests are plotted on the attached logs. The results of the gradation test are incorporated into the borehole logs, and are presented graphically in Appendix B.

3. Site Location and Surface Conditions

The Site is located generally north of the Township of Minden Hills, Ontario. The investigated sections of Bobcaygeon Road and Scotch Line Road are rural sections of roadway supporting residential and commercial properties including a gravel pit located along the west side of Bobcaygeon Road and a Landfill located along the south side of Scotch Line Road. The existing roadway surface consisted of asphalt or surface treatment and appeared to be in very poor condition during our field investigation. Based on information provided b the Township of Minden Hill, sections of roadway within the investigated areas were assessed to have a Pavement Condition Index (PCI) of 43. Topography of the area is generally considered to be rolling to hilly terrain.

4. Subsurface Conditions

4.1 General

Details of the subsurface conditions encountered at the Site are graphically presented on the borehole logs (Appendix A). It should be noted that the boundaries between the strata have been inferred from the borehole observations and non-continuous samples. They generally represent a transition from one soil type to another, and should not be inferred to represent an exact plane of geological change. Further, conditions may vary between and beyond the boreholes.

The boreholes generally encountered a surficial layer of asphalt or surface treatment, over granular fill material, underlain by native soils consisting of loose to compact silt sand or soft to very stiff silt, underlain by inferred bedrock. Practical refusal to further auger advancement due to inferred bedrock was encountered in borehole BH2, BH7, BH8 and BH11 at depths ranging from 0.3m to 1.7m. Groundwater seepage and/or accumulation was observed in borehole BH-3 only at depths of 0.9m.

The following sections describe the major soil strata and subsurface conditions encountered during this investigation in more detail.

4.2 Surface Treatment

Surface treatment was encountered as the surficial material at boreholes BH1 to BH4. The surface treatment was observed to be approximately 13 mm thick, at each of the four (4) borehole locations.

4.3 Asphalt

Asphalt was encountered as the surficial material at borehole BH5 to BH8 and BH10 to BH13. The asphalt was observed to range from about 25mm to 60mm in thickness.

4.4 Fill

A layer of granular fill making up the current road base was observed to extend to depths ranging from 0.2 to 0.4 m below the surface of the asphalt, and consisted mainly of gravelly sand, with silt.

Moisture content tests conducted on samples of the granular fill yielded values ranging from approximately 3 % to 13 % moisture by weight indicating good to fair drainage capabilities. Grain size distribution analyses conducted on representative samples of the granular fill suggest the following compositional range: 8 to 27 % gravel, 62 to 77 % sand, and 11 to 15 % silt and clay-sized particles. The samples tested did not meet Ontario Provincial Standard Specifications (OPSS) for Granular B Type I material but met grain size distribution OPSS for Select Subgrade Material (SSM).

4.5 Silt

Light brown to brown silt containing variable amount of sand and few clay material was encountered below the granular fill in boreholes BH1, BH3 and BH4 and extended to the full depth of the investigation.

Moisture content tests conducted on samples of the silt yielded values ranging from approximately 3 to 31 % moisture by weight. Grain size distribution analyses conducted on representative samples of the material suggest the following compositional range: 0 % gravel, 4 to 22 % sand, and 78 to 96 % silt and clay-sized particles. Hydrometers performed on these samples indicated 78 to 90 % particles between 5 and 75 micrometers (µm).

4.6 Silty Sand

Light brown to brown silty sand was encountered beneath the fill layer in borehole BH5, BH6, BH7, BH10 and BH11 and extended to the full depth of the investigation.

Moisture content tests conducted on samples of the silty sand yielded values ranging from approximately 2 to 25 % moisture by weight. Grain size distribution analyses conducted on representative samples of the material suggest the following compositional range: 0 to 17 % gravel, 59 to 72 % sand, and 24 to 30 % silt and clay-sized particles. Hydrometers performed on these samples indicated 19 to 20 % particles between 5 and 75 micrometers (µm).

4.7 Inferred Bedrock

Borehole BH2, BH7, BH8 and BH11 encountered practical refusal to further borehole advancement during drilling operations at depths ranging from 0.3m to 1.7m. Based on the overall drilling results, and a general knowledge of subsurface conditions in the vicinity of this project, the cause of the refusal was inferred to be the presence of bedrock. Further exploration (i.e., test pitting and/or diamond coring) to confirm the bedrock presence and properties was not conducted as part of this investigation.

4.8 Groundwater

Groundwater observations and measurements were obtained from the open boreholes during and upon completion of drilling / excavation operations. Groundwater seepage and/or accumulation was observed in borehole BH3 only at depths of 0.9 m.

It must be noted that groundwater levels are transient and tend to fluctuate with the seasons, periods of precipitation, and temperature.

5. Discussion and Recommendations

Supporting data upon which our recommendations are based have been presented in the foregoing sections of this report. The following recommendations are governed by the physical properties of the subsurface materials that were encountered at the site and assume that they are representative of the overall site conditions. It should be noted that these conclusions and recommendations are intended for use by the designers only. Contractors bidding on or undertaking any work at the Site should examine the factual results of the assessment, satisfy themselves as to the adequacy of the information for construction, and make their own interpretation of this factual data as it affects their proposed construction techniques, equipment capabilities, costs, sequencing, and the like. Comments, techniques, or recommendations pertaining to construction should not be construed as instructions to the contractor.

The boreholes generally encountered a surficial layer of asphalt or surface treatment, over granular fill material, underlain by native soils consisting of loose to compact silt sand or soft to very stiff silt, underlain by inferred bedrock. Practical refusal to further auger advancement due to inferred bedrock was encountered in borehole BH2, BH7, BH8 and BH11 at depths ranging from 0.3m to 1.7m. Groundwater seepage and/or accumulation was observed in borehole BH-3 only at depths of 0.9m.

Details regarding our conclusions and recommendations are outlined in the following sections. In carrying out an assessment of what pavement thickness a road needs the main variables under consideration are, traffic volume, traffic type and silt content of the subgrade.

5.1 Traffic Data

The investigated sections of Bobcaygeon Road and Scotch Line Road are rural sections of roadway supporting residential and commercial properties including a gravel pit located along the west side of Bobcaygeon Road and a Landfill located along the south side of Scotch Line Road. The traffic volume and percentage of trucks for the investigated section of Bobcaygeon Road was obtained from the Township of Minden Hills. The following table outlines the traffic data for the various sections.

Table 5.1 Summary of Traffic Data

Road Section	Year	Location	AADT	% Trucks
Bobcaygeon Road	2019	From Scotch Line North to approximately 3.1 km	1039	18
Scotch Line Road	2018	From Bingham Road to Highway 35	1049	--

Percent of truck traffic for Scotch Lone Road was not available to GHD at the time or writing this report, however it is expected to be high to due the presence of a landfill on this section of road and gravel pits in the area.

5.2 Pavement Data

The existing road surface of the investigated roadway consists of surface treatment. The road section was observed to be in generally poor condition, with minor to severe centreline, wheel track, edge and transverse cracking. Various areas also showed signs of previous repairs or reinstatement.

In evaluating the existing pavement strength the layer thicknesses of the surface treatment and granulars is evaluated for relative strength by calculation of the Granular Base Equivalency (GBE). This evaluation equates the pavement thickness present currently in the road to an equivalent Granular ‘‘A’ thickness using a method outlined in the Ministry of Transport Pavement Design and Rehabilitation Manual. The following equivalency factors (Table 5.2) were used to calculate the GBE values. The lab gradation results for the Granulars were used in altering the existing GBE where the granular gradation was deemed worse than expected.

Table 5.2 GBE Pavement Design Factors

Pavement Component	Factor	
	Existing	New
Hot Mix	1.25	2.0
Surface Treatment	-(1)	-(1)
Base	0.75	1.0
Subbase	0.5	0.67
Pulverise Base & Surface Treatment	N/A	0.75

(1) GBE Factor not provided for this material.

The strength of the road required for the traffic expected on the road sections was determined from the AADT data from Minden Hills, the subgrade soil materials, and referencing it to the "Structural Design Guidelines for Flexible Pavements – Secondary Highways" in the Ministry of Transportations Ontario "Pavement Design and Rehabilitation Manual." The following table outlines the calculated existing GBE and the design GBE (based on AADT data) for this section of Bobcaygeon Road.

Table 5.3 Summary of Calculated and Design GBE

Road Section	Calculated GBE			Design (Target) GBE
	Min	Max	Average	
Bobcaygeon Road	137	360	211	440 – 540
Scotch Line Road	152	366	218	440 – 540

The existing GBE for the investigated section of roadway is considerably lower than the required GBE. Rehabilitation in the form of pulverization of existing road surface and placement of new road based followed by new asphalt hot mix layer could be considered if an overall grade raise of 215mm can be accommodated. If the platform can not support the elevation change, full reconstruction may be considered but the shallow depth of bedrock in some section of the roadway may be a limiting factor.

5.3 Pavement Reconstruction/Rehabilitation Recommendations

5.3.1 Road Rehabilitation

To achieve the target GBE, the following rehabilitation strategy could be considered should design plans be able to accommodate a grade raise and elevation change of 215mm.

1. Pulverize the existing surface to a depth of 200 mm resulting in some bulking for the full width of the road platform.
2. Grade, shape to the typical 2% crossfall road profile, then compact the pulverized road surface.

3. To maximize drainage potential and ensure satisfactory pavement performance, it is recommended that the material making up the shoulders should be removed to a depth of approximately 50 mm beyond the depth of rehabilitation, and extending outward to the rounding at the ditch, on both sides.

4. Place one 150 mm lift of Granular "A" full width of the platform conforming to the requirements of OPSS Form 1010 or equivalent. It is suggested that all granular material used as fill should have an in-situ moisture content with 2% of their optimum moisture content. All granular materials should be compacted to 100% SPMDD. Grade transitions at the project limits as needed.

5. Place one 50 mm lift of HL1 in accordance with OPSS 1150. All asphaltic concrete courses should be placed, spread and compacted conforming to OPS Form 310 or equivalent. All asphaltic concrete should be compacted to a minimum of 92.0 % of their respective laboratory Maximum Relative Densities (MRD's)

It is necessary to ensure that the ditching is deep enough to provide a gravity outlet to allow drainage of the road granulars layers. Over-shattering and/or removal of bedrock knobs is recommended in areas where shallow bedrock is present in order to ensure appropriate drainage.

The subsoils encountered are susceptible to strength loss or deformation if saturated or disturbed by construction traffic. Therefore care must be taken to protect exposed subgrade from excess moisture and from construction traffic.

5.3.2 Full Reconstruction

In areas were widening and/or realignment of the roadway will be required the following procedures should be implemented to prepare the proposed roadway for construction.

1. Remove any asphalt, free organic topsoil, organics and organic-bearing materials, loam, frozen earth, and boulders larger than 150 mm in diameter encountered at subgrade elevation for the full width of construction including shoulders. Some excavated inorganic soils may be suitable for use as pavement subgrade backfill, the existing granulars are expected to be suitable for reuse as select subgrade materials (SSM) as per OPSS. The reuse of all existing excavated soils is conditional on it being workable, at a suitable moisture content (within 2 % of optimum), and receiving final review and approval for such reuse at the time of construction.

2. Proof roll the subgrade for the purpose of detecting possible zones of overly wet or soft subgrade. Any deleterious areas thus delineated should be replaced with acceptable earth fill or granular material, with a suitable frost taper, compacted to a minimum of 98 % of its Standard Proctor maximum dry density (SPMDD).

3. Contour the subgrade surface to prevent ponding of water during the construction and to promote rapid drainage of the sub-base and base course materials.

4. To maximize drainage potential and ensure satisfactory pavement performance, granular material should extend across the shoulders and the ditch bottom should be deep enough as to allow granular material to drain. In portions of the road were insufficient grade is available, a 150 mm diameter perforated pipe subdrains should be installed below the bottom of the ditch. The pipe should be encased in filter fabric and surrounded by clear stone aggregate.

5. Construct transitions between varying depths of granular base materials at a rate of 1H:10V minimum.

The following minimum flexible pavement structure is recommended for the proposed reconstruction of this section of Bobcaygeon Road, based on traffic and pavement data present above.

Table 5.4 New Pavement Structure

Profile	Material	Minimum Thickness (mm)	In Conformance with OPSS Form
Asphalt Surface	H.L.1	50	1150
Granular Base	Granular "A"	150	1010
Granular Subbase	Granular "B"	450	

The following steps are recommended for optimum construction of the planned paved area:

1. The Granular "A" and "B" courses should be compacted to a minimum 100 % of their respective SPMDD's;
2. All asphaltic concrete courses should be placed, spread and compacted conforming to OPS Form 310 or equivalent. All asphaltic concrete should be compacted to a minimum of 92.0 % of their respective laboratory Maximum Relative Densities (MRD's); and
3. Adequate drainage should be provided to ensure satisfactory pavement performance.

In areas where shallow bedrock is encountered the roadway platform may need to be raised or bedrock shattered in order to accommodated the new pavement structure. Over-shattering and/or removal of bedrock knobs may be required in order to ensure appropriate drainage.

It is recommended that all fill material be placed in uniform lifts not exceeding 300 mm in thickness before compaction. It is suggested that all granular material used as fill should have an in-situ moisture content within 2 % of its optimum moisture content. All granular materials should be compacted to 100 % SPMDD. Granular materials should consist of Granular "A" and "B" conforming to the requirements of OPSS Form 1010 or equivalent.

It is noted that the above recommended pavement structures are for the end use of the project. During construction of the project the recommended granular depths may not be sufficient to support loadings encountered.

5.4 Closure

The recommendations made in this report are in accordance with our present understanding of the project. The subsurface investigation as performed in accordance with current, generally accepted guidelines. However, should any conditions at the site be encountered which differ from those at the test hole locations, it is requested that GHD be notified immediately in order to permit a reassessment of our recommendation in light of the changed conditions and exact project details. GHD requests that they be permitted to review the recommendations of this report after the drawings and specifications are complete, or if the final project details should differ from that mentioned in this report.

6. Statement of Limitations

The attached Statement of Limitations is an integral part of this report. Should questions arise regarding any aspect of this report, please contact our office.

Sincerely,

GHD

Leandro Ramos, P.Eng.

Nyle McIlveen, P.Eng.

STATEMENT OF LIMITATIONS

This report is intended solely for Engage Engineering Ltd., and other parties explicitly identified in the report and is prohibited for use by others without GHD's prior written consent. This report is considered GHD's professional work product and shall remain the sole property of GHD. Any unauthorized reuse, redistribution of or reliance on the report shall be at the Client and recipient's sole risk, without liability to GHD. Client shall defend, indemnify and hold GHD harmless from any liability arising from or related to Client's unauthorized distribution of the report. No portion of this report may be used as a separate entity; it is to be read in its entirety and shall include all supporting drawings and appendices.

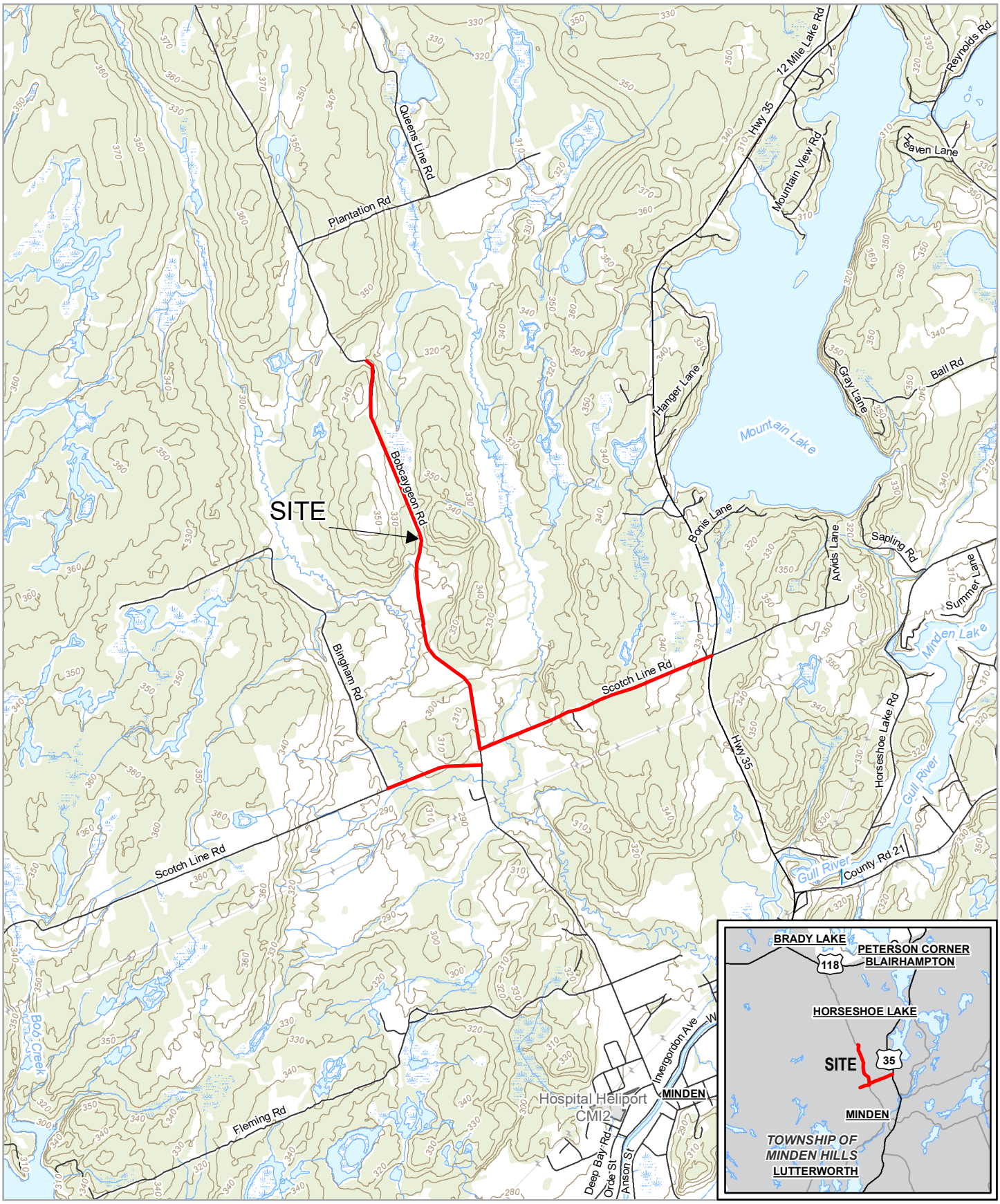
The recommendations made in this report are in accordance with our present understanding of the project, the current site use, ground surface elevations and conditions, and are based on the work scope approved by the Client and described in the report. The services were performed in a manner consistent with that level of care and skill ordinarily exercised by members of geotechnical engineering professions currently practicing under similar conditions in the same locality. No other representations, and no warranties or representations of any kind, either expressed or implied, are made. Any use which a third party makes of this report, or any reliance on or decisions to be made based on it, are the responsibility of such third parties.

All details of design and construction are rarely known at the time of completion of a geotechnical study. The recommendations and comments made in the study report are based on our subsurface investigation and resulting understanding of the project, as defined at the time of the study. We should be retained to review our recommendations when the drawings and specifications are complete. Without this review, GHD will not be liable for any misunderstanding of our recommendations or their application and adaptation into the final design.

By issuing this report, GHD is the geotechnical engineer of record. It is recommended that GHD be retained during construction of all foundations and during earthwork operations to confirm the conditions of the subsoil are actually similar to those observed during our study. The intent of this requirement is to verify that conditions encountered during construction are consistent with the findings in the report and that inherent knowledge developed as part of our study is correctly carried forward to the construction phases.

It is important to emphasize that a soil investigation is, in fact, a random sampling of a site and the comments included in this report are based on the results obtained at the thirteen (13) borehole locations only. The subsurface conditions confirmed at the 13 borehole locations may vary at other locations. The subsurface conditions can also be significantly modified by construction activities on site (e.g. excavation, dewatering and drainage, blasting, pile driving, etc.). These conditions can also be modified by exposure of soils or bedrock to humidity, dry periods or frost. Soil and groundwater conditions between and beyond the test locations may differ both horizontally and vertically from those encountered at the test locations and conditions may become apparent during construction which could not be detected or anticipated at the time of our investigation. Should any conditions at the site be encountered which differ from those found at the test locations, we request that we be notified immediately in order to permit a reassessment of our recommendations. If changed conditions are identified during construction, no matter how minor, the recommendations in this report shall be considered invalid until sufficient review and written assessment of said conditions by GHD is completed.

Enclosures



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Meters

Map Projection: Transverse Mercator
Horizontal Datum: North American 1983
Grid: NAD 1983 UTM Zone 17N

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GHD

ENGAGE ENGINEERING LTD.
BOBCAYGEON ROAD AND SCOTCH LINE ROAD
MINDEN HILLS, ONTARIO
GEOTECHNICAL INVESTIGATION

Project No. **11202605**
Revision No. **-**
Date **Feb 10, 2021**

SITE LOCATION MAP

FIGURE 1

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Meters

Map Projection: Transverse Mercator
Horizontal Datum: North American 1983
Grid: NAD 1983 UTM Zone 17N

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MINDEN HILLS, ONTARIO
GEOTECHNICAL INVESTIGATION

Project No. **11202605**
Revision No. **-**
Date **Feb 12, 2021**

BOREHOLE LOCATION PLAN

FIGURE 2-1

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Meters

Map Projection: Transverse Mercator
Horizontal Datum: North American 1983
Grid: NAD 1983 UTM Zone 17N

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MINDEN HILLS, ONTARIO
GEOTECHNICAL INVESTIGATION

Project No. **11202605**
Revision No. **-**
Date **Feb 12, 2021**

BOREHOLE LOCATION PLAN

FIGURE 2-2

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Meters

Map Projection: Transverse Mercator
Horizontal Datum: North American 1983
Grid: NAD 1983 UTM Zone 17N

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GEOTECHNICAL INVESTIGATION

Project No. **11202605**
Revision No. **-**
Date **Feb 12, 2021**

BOREHOLE LOCATION PLAN

FIGURE 2-3

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Meters

Map Projection: Transverse Mercator
Horizontal Datum: North American 1983
Grid: NAD 1983 UTM Zone 17N

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Project No. **11202605**
Revision No. **-**
Date **Feb 12, 2021**

BOREHOLE LOCATION PLAN

FIGURE 2-4

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Meters

Map Projection: Transverse Mercator
Horizontal Datum: North American 1983
Grid: NAD 1983 UTM Zone 17N

N

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MINDEN HILLS, ONTARIO
GEOTECHNICAL INVESTIGATION

Project No. **11202605**
Revision No. **-**
Date **Feb 12, 2021**

BOREHOLE LOCATION PLAN

FIGURE 2-5

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Appendix A
Borehole Logs

REFERENCE No.: 11202605-02 ENCLOSURE No.: A-1

BOREHOLE No.: BH1-19
ELEVATION: Existing Grade

BOREHOLE REPORT

Page: 1 of 1

CLIENT: Engage Engineering Ltd.
PROJECT: Bobcaygeon Road Rehabilitation, Minden Hills
LOGGED BY: J. McEachern DATE: 17 September 2019
DRILLING COMPANY: GET Drilling Ltd. METHOD: Solid Stem Augers and SS
NOTES:

LEGEND

- SS - SPLIT SPOON
- AS - AUGER SAMPLE
- ST - SHELBY TUBE
- CS - CORE SAMPLE
- ▼ - WATER LEVEL

Depth ft	Depth m	m Below Existing Grade	Stratigraphy	DESCRIPTION OF SOIL AND BEDROCK	Type and Number	Recovery %	Moisture Content %	Blows per 6 in. / 15 cm	Penetration Index N	Shear test (Cu) / Sensitivity (S) / Water content (%) / Atterberg limits (%) / "N" Value (blows / 0.3 m) / Field / Lab / RQD / CONE	COMMENTS
		0.0		GROUND SURFACE						10 20 30 40 50 60 70 80 90	
		0.0		**SURFACE TREATMENT** (13 mm)							Borehole open and free of groundwater accumulation upon compoletion of drilling
				FILL - Dark Brown Gravelly Sand, With Silt, Moist, Compact	SS-1a	100	3	20 14 9 10	23	○	**BH-1,SS-1a:** 21% Gravel 67% Sand 12% Silt and Clay Did not meet OPSS for Granular 'B' Type I gravel (12 % passing 75 µm)
1		0.3		**SILT** - Light Brown Silt, With Sand, Moist, Very Stiff	SS-1b		4			○	
2	0.5										
		0.8		Stiff							
3	1.0				SS-2	100	4	7 4 5	9	○×	
4											**BH-1,SS-1b:** 0% Gravel 22% Sand 78% Silt and Clay 78% between 5-75 µm
5	1.5	1.5		Very Stiff							
					SS-3	100	6	7 11 16	27	○ ×	
6	2.0										
7											
8	2.5				SS-4	100	7	7 6 6	12	○×	
9											
10	3.0										
					SS-5	100	11	6 7 7	14	○×	
11											
	3.5	3.5		END OF BOREHOLE							

BOREHOLE LOG GEOTECH 11202605-02-DWG-21-02-03, BOREHOLE LOGS, JM.GPJ GEOLOGIC.GDT 17/2/21

REFERENCE No.: 11202605-02 ENCLOSURE No.: A-2

BOREHOLE No.: BH2-19
ELEVATION: Existing Grade

BOREHOLE REPORT

Page: 1 of 1

CLIENT: Engage Engineering Ltd.
PROJECT: Bobcaygeon Road Rehabilitation, Minden Hills
LOGGED BY: J. McEachern DATE: 17 September 2019
DRILLING COMPANY: GET Drilling Ltd. METHOD: Solid Stem Augers and SS
NOTES:

LEGEND

- SS - SPLIT SPOON
- AS - AUGER SAMPLE
- ST - SHELBY TUBE
- CS - CORE SAMPLE
- ▼ - WATER LEVEL

Depth ft	Depth m	m Below Existing Grade	Stratigraphy	DESCRIPTION OF SOIL AND BEDROCK	Type and Number	Recovery %	Moisture Content %	Blows per 6 in. / 15 cm	Penetration Index N	Shear test (Cu) / Sensitivity (S) / Water content (%) / Atterberg limits (%) / "N" Value (blows / 0.3 m) / Field / Lab / RQD / CONE	COMMENTS
		0.0		GROUND SURFACE						10 20 30 40 50 60 70 80 90	
		0.0		**SURFACE TREATMENT** (13 mm)	SS-1a	100	3	17	100+		Borehole open and free of groundwater accumulation upon compoletion of drilling
		0.2		**FILL** - Brown Gravelly Sand, With Silt, Moist, Compact	SS-1b		4	50/4"			
		0.3		**BEDROCK** - Inferred Bedrock	SS-1c		3				
				END OF BOREHOLE							Auger refusal encountered at 0.25 m due to inferred presence of bedrock
1	0.5										
2											
3	1.0										
4											
5	1.5										
6	2.0										
7											
8	2.5										
9											
10	3.0										
11	3.5										

BOREHOLE LOG GEOTECH 11202605-02-DWG-21-02-03, BOREHOLE LOGS, JM.GPJ GEOLOGIC.GDT 17/2/21

REFERENCE No.: 11202605-02 ENCLOSURE No.: A-3

BOREHOLE No.: BH3-19
ELEVATION: Existing Grade

BOREHOLE REPORT

Page: 1 of 1

CLIENT: Engage Engineering Ltd.
PROJECT: Bobcaygeon Road Rehabilitation, Minden Hills
LOGGED BY: J. McEachern DATE: 17 September 2019
DRILLING COMPANY: GET Drilling Ltd. METHOD: Solid Stem Augers and SS
NOTES:

LEGEND

- SS - SPLIT SPOON
- AS - AUGER SAMPLE
- ST - SHELBY TUBE
- CS - CORE SAMPLE
- ▼ - WATER LEVEL

Depth (ft)	Depth (m)	m Below Existing Grade	Stratigraphy	DESCRIPTION OF SOIL AND BEDROCK	Type and Number	Recovery %	Moisture Content %	Blows per 6 in. / 15 cm	Penetration Index N	Shear test (Cu) / Sensitivity (S) / Water content (%) / Atterberg limits (%) / "N" Value (blows / 0.3 m) / RQD / CONE	COMMENTS
		0.0		GROUND SURFACE						10 20 30 40 50 60 70 80 90	
		0.0		**SURFACE TREATMENT** (13 mm)							Borehole open upon compoletion of drilling
				FILL - Dark Brown Gravelly Sand, With Silt, Moist, Compact	SS-1a	100	3	23 14 12	26	○	
1		0.3		**SILT** - Light Brown Silt, With Sand, Moist, Very Stiff	SS-1b		3			○	
	0.5										
2											
					SS-2a	100	5			○	
3		0.9		Few Sand and Clay, Soft				5 2 2	4		▼ WL - 0.9 m 9/17/2019 (Upon completion of drilling)
	1.0				SS-2b		27			○	
4											
5	1.5	1.5		Very Stiff							**BH-3,SS-3:** 0% Gravel 4% Sand 96% Silt and Clay 90% between 5-75 µm
					SS-3	100	16	7 7 11	18	⊗	
6											
	2.0										
7											
		2.3		Firm							
8								5 4 4			
	2.5				SS-4	100	25		8	× ○	
9											
10	3.0	3.0		Moist to Wet							
					SS-5	100	31	4 3 3	6	× ○	
11											
	3.5	3.5		END OF BOREHOLE							

BOREHOLE LOG GEOTECH 11202605-02-DWG-21-02-03, BOREHOLE LOGS, JM.GPJ GEOLOGIC.GDT 17/2/21

REFERENCE No.: 11202605-02 ENCLOSURE No.: A-4

BOREHOLE No.: BH4-19
ELEVATION: Existing Grade

BOREHOLE REPORT

Page: 1 of 1

CLIENT: Engage Engineering Ltd.
PROJECT: Bobcaygeon Road Rehabilitation, Minden Hills
LOGGED BY: J. McEachern DATE: 17 September 2019
DRILLING COMPANY: GET Drilling Ltd. METHOD: Solid Stem Augers and SS
NOTES:

LEGEND

- SS - SPLIT SPOON
- AS - AUGER SAMPLE
- ST - SHELBY TUBE
- CS - CORE SAMPLE
- ▼ - WATER LEVEL

Depth (ft)	Depth (m)	m Below Existing Grade	Stratigraphy	DESCRIPTION OF SOIL AND BEDROCK	Type and Number	Recovery %	Moisture Content %	Blows per 6 in. / 15 cm	Penetration Index N	Shear test (Cu) / Sensitivity (S) / Water content (%) / Atterberg limits (W_P, W_l) / "N" Value (blows / 0.3 m) / RQD / CONE — △ Field, □ Lab	COMMENTS
		0.0		GROUND SURFACE						10 20 30 40 50 60 70 80 90	
		0.0		**SURFACE TREATMENT** (13 mm)	AS-1		3			○	Borehole open and free of groundwater accumulation upon compoletion of drilling
1		0.3		**FILL** - Dark Brown Gravelly Sand, With Silt, Moist, Compact							**BH-4,AS-1:** 27% Gravel 62% Sand 11% Silt and Clay Did not meet OPSS for Granular 'B' Type I gravel (11 % passing 75 µm)
	0.5			**SILT** - Reddish Brown Silt, With Sand, Moist, Very Stiff	AS-2		10			○	
2		0.7		Brown Few Sand and Clay, Firm to Stiff							
3	1.0										
4					AS-3		9			○	
5	1.5										
6					AS-4		8			○	
7	2.0										
8	2.5										
9					AS-5		8			○	
10	3.0	3.0		END OF BOREHOLE							
11	3.5										

BOREHOLE LOG GEOTECH 11202605-02-DWG-21-02-03, BOREHOLE LOGS, JM.GPJ GEOLOGIC.GDT 17/2/21

REFERENCE No.: 11202605-02 ENCLOSURE No.: A-5

BOREHOLE No.: BH5-21
ELEVATION: Existing Grade

BOREHOLE REPORT

Page: 1 of 1

CLIENT: Engage Engineering Ltd.
PROJECT: Bobcaygeon Road Rehabilitation, Minden Hills
LOGGED BY: J. McEachern DATE: 28 January 2021
DRILLING COMPANY: GET Drilling Ltd. METHOD: Solid Stem Augers and SS
NOTES:

LEGEND

- SS - SPLIT SPOON
- AS - AUGER SAMPLE
- ST - SHELBY TUBE
- CS - CORE SAMPLE
- ▼ - WATER LEVEL

Depth ft	Depth m	m Below Existing Grade	Stratigraphy	DESCRIPTION OF SOIL AND BEDROCK	Type and Number	Recovery %	Moisture Content %	Blows per 6 in. / 15 cm	Penetration Index N	Shear test (Cu) / Sensitivity (S) / Water content (%) / Atterberg limits (W_P, W_l) / "N" Value (blows / 0.3 m) / Field / Lab / RQD / CONE — 10 20 30 40 50 60 70 80 90	COMMENTS
		0.0		GROUND SURFACE							
		0.1		**ASPHALT** (50 mm)							
				FILL - Light Brown Gravelly Sand, With Silt, Moist	AS-1		9			○	Borehole open and free of groundwater accumulation upon compoletion of drilling
1		0.4		Brown Silty Sand, With Gravel, Moist	AS-2		3			○	
2	0.5										
		0.8		**SILTY SAND** - Reddish Brown Silty Sand, Moist	AS-3		2			○	
3	1.0										
4											
5	1.5	1.5		END OF BOREHOLE							
6	2.0										
7											
8	2.5										
9											
10	3.0										
11	3.5										

REFERENCE No.: 11202605-02 ENCLOSURE No.: A-6

BOREHOLE No.: BH6-21
ELEVATION: Existing Grade

BOREHOLE REPORT

Page: 1 of 1

CLIENT: Engage Engineering Ltd.
PROJECT: Bobcaygeon Road Rehabilitation, Minden Hills
LOGGED BY: J. McEachern DATE: 28 January 2021
DRILLING COMPANY: GET Drilling Ltd. METHOD: Solid Stem Augers and SS
NOTES:

LEGEND

- SS - SPLIT SPOON
- AS - AUGER SAMPLE
- ST - SHELBY TUBE
- CS - CORE SAMPLE
- ▼ - WATER LEVEL

Depth ft	Depth m	m Below Existing Grade	Stratigraphy	DESCRIPTION OF SOIL AND BEDROCK	Type and Number	Recovery %	Moisture Content %	Blows per 6 in. / 15 cm	Penetration Index N	Shear test (Cu) / Sensitivity (S) / Water content (%) / Atterberg limits (%) / "N" Value (blows / 0.3 m) / RQD / CONE — 10 20 30 40 50 60 70 80 90	COMMENTS
		0.0		GROUND SURFACE							
		0.1		**ASPHALT** (50 mm)							
				FILL - Light Brown Gravelly Sand, With Silt, Moist	AS-1		6			○	Borehole open and free of groundwater accumulation upon compoletion of drilling
1		0.3		Brown Silty Sand, With Gravel, Moist	AS-2		22			○	**BH-6,AS1:** 8% Gravel 77% Sand 15% Silt and Clay Did not meet OPSS for Granular 'B' Type I gravel (15 % passing 75 µm)
2	0.5										
		0.7		**SILTY SAND** - Reddish Brown Silty Sand, Moist	AS-3		9			○	
3	1.0										
4											
5	1.5	1.5		END OF BOREHOLE							**BH-6,AS3:** 17% Gravel 59% Sand 24% Silt and Clay 20% between 5-75 µm
6											
7	2.0										
8											
9	2.5										
10											
11	3.0										
	3.5										

BOREHOLE LOG GEOTECH 11202605-02-DWG-21-02-03, BOREHOLE LOGS, JM.GPJ GEOLOGIC.GDT 17/2/21

REFERENCE No.: 11202605-02 ENCLOSURE No.: A-7

BOREHOLE No.: BH7-21
ELEVATION: Existing Grade

BOREHOLE REPORT

Page: 1 of 1

CLIENT: Engage Engineering Ltd.
PROJECT: Bobcaygeon Road Rehabilitation, Minden Hills
LOGGED BY: J. McEachern DATE: 28 January 2021
DRILLING COMPANY: GET Drilling Ltd. METHOD: Solid Stem Augers and SS
NOTES:

LEGEND

- SS - SPLIT SPOON
- AS - AUGER SAMPLE
- ST - SHELBY TUBE
- CS - CORE SAMPLE
- ▼ - WATER LEVEL

Depth (ft)	Depth (m)	m Below Existing Grade	Stratigraphy	DESCRIPTION OF SOIL AND BEDROCK	Type and Number	Recovery	Moisture Content	Blows per 6 in. / 15 cm	Penetration Index	Shear test (Cu) / Sensitivity (S) / Water content (%) / Atterberg limits (W_P, W_l) / "N" Value (blows / 0.3 m) / RQD / CONE	COMMENTS
		0.0		GROUND SURFACE		%	%		N	10 20 30 40 50 60 70 80 90	
		0.0		**ASPHALT** (25 mm)							
				FILL - Light Brown Gravelly Sand, With Silt, Moist	AS-1		9			○	Borehole open and free of groundwater accumulation upon compoletion of drilling
1											
	0.5										
2		0.7		Reddish Brown Silty Sand, Trace Gravel, Moist	AS-2		10			○	
		0.7		**SILTY SAND** - Dark Brown Silty Sand, trace Organics, Clay and Sand, Moist to Wet							
3	1.0										
4											
					AS-3		25			○	
5	1.5				AS-4		16			○	
		1.7		END OF BOREHOLE							Auger refusal at 1.7 meters due to inferred bedrock.
6											
	2.0										
7											
8	2.5										
9											
	3.0										
10											
11											
	3.5										

BOREHOLE LOG GEOTECH 11202605-02-DWG-21-02-03, BOREHOLE LOGS, JM.GPJ GEOLOGIC.GDT 17/2/21

REFERENCE No.: 11202605-02 ENCLOSURE No.: A-8

BOREHOLE No.: BH8-21
ELEVATION: Existing Grade

BOREHOLE REPORT

Page: 1 of 1

CLIENT: Engage Engineering Ltd.
PROJECT: Bobcaygeon Road Rehabilitation, Minden Hills
LOGGED BY: J. McEachern DATE: 28 January 2021
DRILLING COMPANY: GET Drilling Ltd. METHOD: Solid Stem Augers and SS
NOTES:

LEGEND

- SS - SPLIT SPOON
- AS - AUGER SAMPLE
- ST - SHELBY TUBE
- CS - CORE SAMPLE
- ▼ - WATER LEVEL

Depth ft	Depth m	m Below Existing Grade	Stratigraphy	DESCRIPTION OF SOIL AND BEDROCK	Type and Number	Recovery %	Moisture Content %	Blows per 6 in. / 15 cm	Penetration Index N	Shear test (Cu) / Sensitivity (S) / Water content (%) / Atterberg limits (W_p W_l) / "N" Value (blows / 0.3 m) / △ Field / □ Lab / ◆ RQD / ◎ CONE — 10 20 30 40 50 60 70 80 90	COMMENTS
		0.0		GROUND SURFACE							
		0.0		**ASPHALT** (25 mm)							
				FILL - Light Brown Gravelly Sand, With Silt, Moist	AS-1		13			○	
1		0.4		Reddish Brown Silty Sand, Trace Gravel, Moist	AS-2		12			○	
	0.5										
2		0.6		END OF BOREHOLE							
3	1.0										
4											
5	1.5										
6											
7	2.0										
8											
9	2.5										
10											
11	3.0										
	3.5										

Borehole open and free of groundwater accumulation upon compoletion of drilling

BH-8,AS2:
7% Gravel
68% Sand
25% Silt and Clay
Did not meet OPSS for Granular 'B' Type I gravel (25 % passing 75 µm)

Auger refusal at 0.6 meters due to inferred bedrock.

REFERENCE No.: 11202605-02 ENCLOSURE No.: A-9

BOREHOLE No.: BH9-21
ELEVATION: Existing Grade

BOREHOLE REPORT

Page: 1 of 1

CLIENT: Engage Engineering Ltd.
PROJECT: Bobcaygeon Road Rehabilitation, Minden Hills
LOGGED BY: J. McEachern DATE: 28 January 2021
DRILLING COMPANY: GET Drilling Ltd. METHOD: Solid Stem Augers and SS
NOTES:

LEGEND

- SS - SPLIT SPOON
- AS - AUGER SAMPLE
- ST - SHELBY TUBE
- CS - CORE SAMPLE
- ▼ - WATER LEVEL

Depth ft	Depth m	m Below Existing Grade	Stratigraphy	DESCRIPTION OF SOIL AND BEDROCK	Type and Number	Recovery %	Moisture Content %	Blows per 6 in. / 15 cm	Penetration Index N	Shear test (Cu) / Sensitivity (S) / Water content (%) / Atterberg limits (W_P, W_l) / "N" Value (blows / 0.3 m) — △ Field, □ Lab, ◆ RQD, ◎ CONE	COMMENTS
		0.0		GROUND SURFACE						10 20 30 40 50 60 70 80 90	
				FILL - Light Brown Gravelly Sand, With Silt, Moist	AS-1		4			○	Borehole open and free of groundwater accumulation upon compoletion of drilling
1					AS-2		6			○	**BH-9,AS1:** 23% Gravel 65% Sand 12% Silt and Clay Did not meet OPSS for Granular 'B' Type I gravel (12 % passing 75 µm)
2	0.5										
		0.8		Reddish Brown Silty Sand, Moist	AS-3		8			○	
3	1.0										
4											
5	1.5	1.5		END OF BOREHOLE							**BH-9,AS3:** 0% Gravel 72% Sand 28% Silt and Clay 19% between 5-75 µm
6	2.0										
7											
8	2.5										
9											
10	3.0										
11	3.5										

REFERENCE No.: 11202605-02 ENCLOSURE No.: A-10

BOREHOLE No.: BH10-21
ELEVATION: Existing Grade

BOREHOLE REPORT

Page: 1 of 1

CLIENT: Engage Engineering Ltd.
PROJECT: Bobcaygeon Road Rehabilitation, Minden Hills
LOGGED BY: J. McEachern DATE: 28 January 2021
DRILLING COMPANY: GET Drilling Ltd. METHOD: Solid Stem Augers and SS
NOTES:

LEGEND

- SS - SPLIT SPOON
- AS - AUGER SAMPLE
- ST - SHELBY TUBE
- CS - CORE SAMPLE
- ▼ - WATER LEVEL

Depth (ft)	Depth (m)	m Below Existing Grade	Stratigraphy	DESCRIPTION OF SOIL AND BEDROCK	Type and Number	Recovery	Moisture Content	Blows per 6 in. / 15 cm	Penetration Index	Shear test (Cu) / Sensitivity (S) / Water content (%) / Atterberg limits (W_P, W_l) / "N" Value (blows / 0.3 m) / △ Field / □ Lab / ◆ RQD / ◎ CONE	COMMENTS
		0.0		GROUND SURFACE		%	%		N	10 20 30 40 50 60 70 80 90	
		0.1		**ASPHALT** (50 mm)							
				FILL - Light Brown Gravelly Sand, With Silt, Moist	AS-1		8			○	
1		0.3		Reddish Brown Silty Sand, Trace Gravel, Moist	AS-2		10			○	
	0.5										
2		0.7		**SILTY SAND** - Light Brown Silty Sand, Moist	AS-3		12			○	
3	1.0										
4		1.2		Moist to Wet							
5	1.5	1.5		END OF BOREHOLE							Borehole open and free of groundwater accumulation upon compoletion of drilling
6											
7	2.0										
8											
9	2.5										
10											
	3.0										
11											
	3.5										

BOREHOLE LOG GEOTECH 11202605-02-DWG-21-02-03, BOREHOLE LOGS, JM.GPJ GEOLOGIC.GDT 17/2/21

REFERENCE No.: 11202605-02 ENCLOSURE No.: A-11

BOREHOLE No.: BH11-21
ELEVATION: Existing Grade

BOREHOLE REPORT

Page: 1 of 1

CLIENT: Engage Engineering Ltd.
PROJECT: Bobcaygeon Road Rehabilitation, Minden Hills
LOGGED BY: J. McEachern DATE: 28 January 2021
DRILLING COMPANY: GET Drilling Ltd. METHOD: Solid Stem Augers and SS
NOTES:

LEGEND

- SS - SPLIT SPOON
- AS - AUGER SAMPLE
- ST - SHELBY TUBE
- CS - CORE SAMPLE
- ▼ - WATER LEVEL

Depth ft	Depth m	m Below Existing Grade	Stratigraphy	DESCRIPTION OF SOIL AND BEDROCK	Type and Number	Recovery %	Moisture Content %	Blows per 6 in. / 15 cm	Penetration Index N	Shear test (Cu) / Sensitivity (S) / Water content (%) / Atterberg limits (%) / "N" Value (blows / 0.3 m) / Field / Lab / RQD / CONE	COMMENTS
		0.0		GROUND SURFACE						10 20 30 40 50 60 70 80 90	
		0.1		**ASPHALT** (60 mm)							
				FILL - Brown Gravelly Sand, Moist	AS-1		9			○	
1		0.3		With Silt	AS-2		13			○	
	0.5										
2		0.6		END OF BOREHOLE							
3	1.0										
4											
5	1.5										
6											
7	2.0										
8											
9	2.5										
10											
11	3.0										
	3.5										

Borehole open and free of groundwater accumulation upon compoletion of drilling
BH-11,AS2:
13% Gravel
74% Sand
13% Silt and Clay
Did not meet OPSS for Granular 'B' Type I gravel (13 % passing 75 µm)
Auger refusal at 0.6 meters due to inferred bedrock.

BOREHOLE LOG GEOTECH 11202605-02-DWG-21-02-03, BOREHOLE LOGS, JM.GPJ GEOLOGIC.GDT 17/2/21

REFERENCE No.: 11202605-02 ENCLOSURE No.: A-12

BOREHOLE No.: BH12-21
ELEVATION: Existing Grade

BOREHOLE REPORT

Page: 1 of 1

CLIENT: Engage Engineering Ltd.
PROJECT: Bobcaygeon Road Rehabilitation, Minden Hills
LOGGED BY: J. McEachern DATE: 28 January 2021
DRILLING COMPANY: GET Drilling Ltd. METHOD: Solid Stem Augers and SS
NOTES:

LEGEND

- SS - SPLIT SPOON
- AS - AUGER SAMPLE
- ST - SHELBY TUBE
- CS - CORE SAMPLE
- ▼ - WATER LEVEL

Depth ft	Depth m	m Below Existing Grade	Stratigraphy	DESCRIPTION OF SOIL AND BEDROCK	Type and Number	Recovery %	Moisture Content %	Blows per 6 in. / 15 cm	Penetration Index N	Shear test (Cu) / Sensitivity (S) / Water content (%) / Atterberg limits (%) / "N" Value (blows / 0.3 m) / Field / Lab / RQD / CONE	COMMENTS
		0.0		GROUND SURFACE						10 20 30 40 50 60 70 80 90	
		0.1		**ASPHALT** (50 mm)							
				FILL - Light Brown Gravelly Sand, With Silt, Moist	AS-1		11				Borehole open and free of groundwater accumulation upon compoletion of drilling
1		0.4		Brown Silty Sand, With Gravel, Moist	AS-2		3				
2	0.5	0.7		**SILTY SAND** - Brown Silty Sand, Trace Gravel, Moist	AS-3		10				
3	1.0										
4		1.4		Reddish Brown	AS-4		10				
5	1.5	1.5		END OF BOREHOLE							**BH-12,AS3:** 6% Gravel 64% Sand 30% Silt and Clay 20% between 5-75 µm
6											
7	2.0										
8											
9	2.5										
10											
11	3.0										
	3.5										

BOREHOLE LOG GEOTECH 11202605-02-DWG-21-02-03, BOREHOLE LOGS, JM.GPJ GEOLOGIC.GDT 17/2/21

REFERENCE No.: 11202605-02 ENCLOSURE No.: A-13

BOREHOLE No.: BH13-21
ELEVATION: Existing Grade

BOREHOLE REPORT

Page: 1 of 1

CLIENT: Engage Engineering Ltd.
PROJECT: Bobcaygeon Road Rehabilitation, Minden Hills
LOGGED BY: J. McEachern DATE: 28 January 2021
DRILLING COMPANY: GET Drilling Ltd. METHOD: Solid Stem Augers and SS
NOTES:

LEGEND

- SS - SPLIT SPOON
- AS - AUGER SAMPLE
- ST - SHELBY TUBE
- CS - CORE SAMPLE
- ▼ - WATER LEVEL

Depth (ft)	Depth (m)	m Below Existing Grade	Stratigraphy	DESCRIPTION OF SOIL AND BEDROCK	Type and Number	Recovery %	Moisture Content %	Blows per 6 in. / 15 cm	Penetration Index N	Shear test (Cu) / Sensitivity (S) / Water content (%) / Atterberg limits (%) / "N" Value (blows / 0.3 m) / RQD / CONE — Field △ Lab □	COMMENTS
		0.0		GROUND SURFACE						10 20 30 40 50 60 70 80 90	
		0.1		**ASPHALT** (50 mm)							
				FILL - Brown Gravelly Sand, With Silt, Moist	AS-1		5			○	
1											
	0.5	0.5		Light Brown	AS-2		3			○	
2		0.7		**SILTY SAND** - Brown Silty Sand trace Gravel, Moist	AS-3		6			○	
3	1.0										
4		1.2		Moist to Wet	AS-4		15			○	
5	1.5	1.5		END OF BOREHOLE							
6											
7	2.0										
8											
9	2.5										
10											
11	3.0										
	3.5										

Borehole open and free of groundwater accumulation upon compoletion of drilling

BH-13,AS1:
18% Gravel
68% Sand
14% Silt and Clay
Did not meet OPSS for Granular 'B' Type I gravel (14 % passing 75 µm)

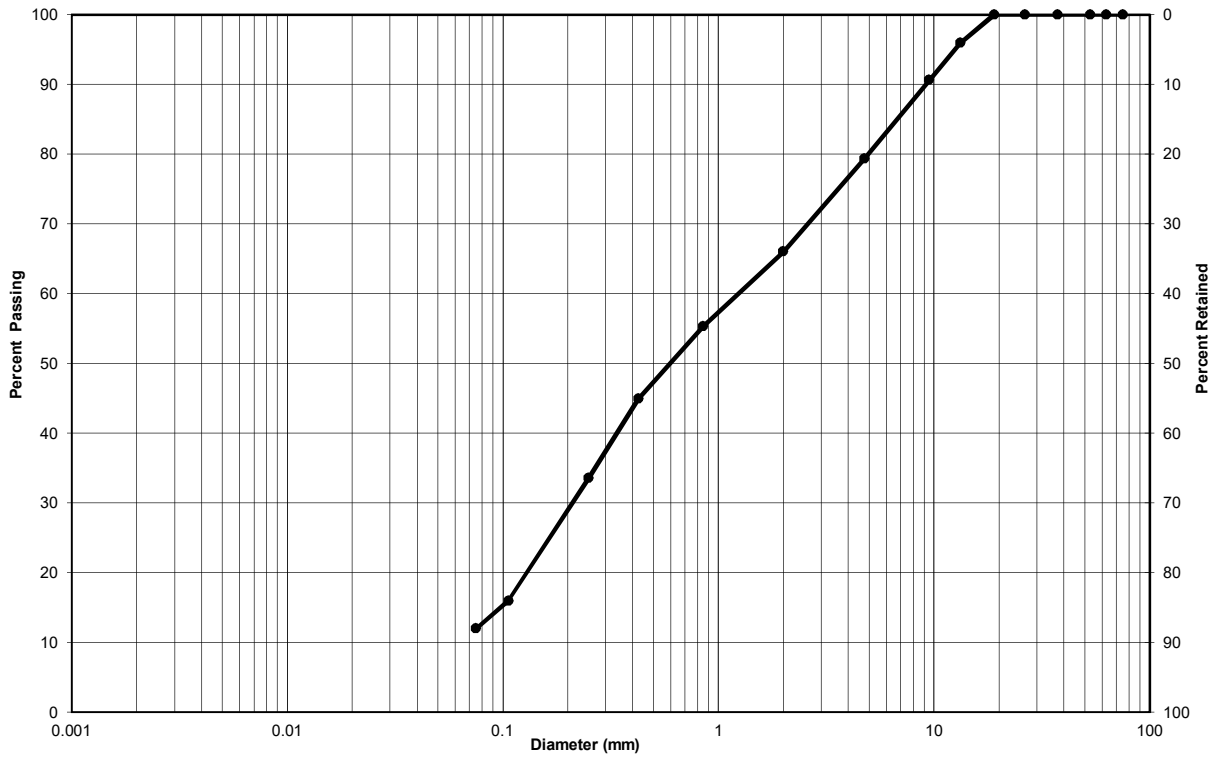
BOREHOLE LOG GEOTECH 11202605-02-DWG-21-02-03, BOREHOLE LOGS, JM.GPJ GEOLOGIC.GDT 17/2/21

Appendix B
Geotechnical Laboratory Testing Results

Particle-Size Analysis of Soils (Geotechnical) (USCS) (ASTM D422)

Client:	Engage Engineering	**Lab no.:**	SS-19-87
Project/Site:	Bobcaygeon Road, Minden Hills	**Project no.:**	11202605-01

Borehole no.:	BH-1	Sample no.:	SS-1a
Depth:	0.01-0.28m	Enclosure:	B-1



Clay & Silt	Sand			Gravel	
	Fine	Medium	Coarse	Fine	Coarse
Unified Soil Classification System					

Soil Description	Gravel	Sand	Clay & Silt
	21	67	12

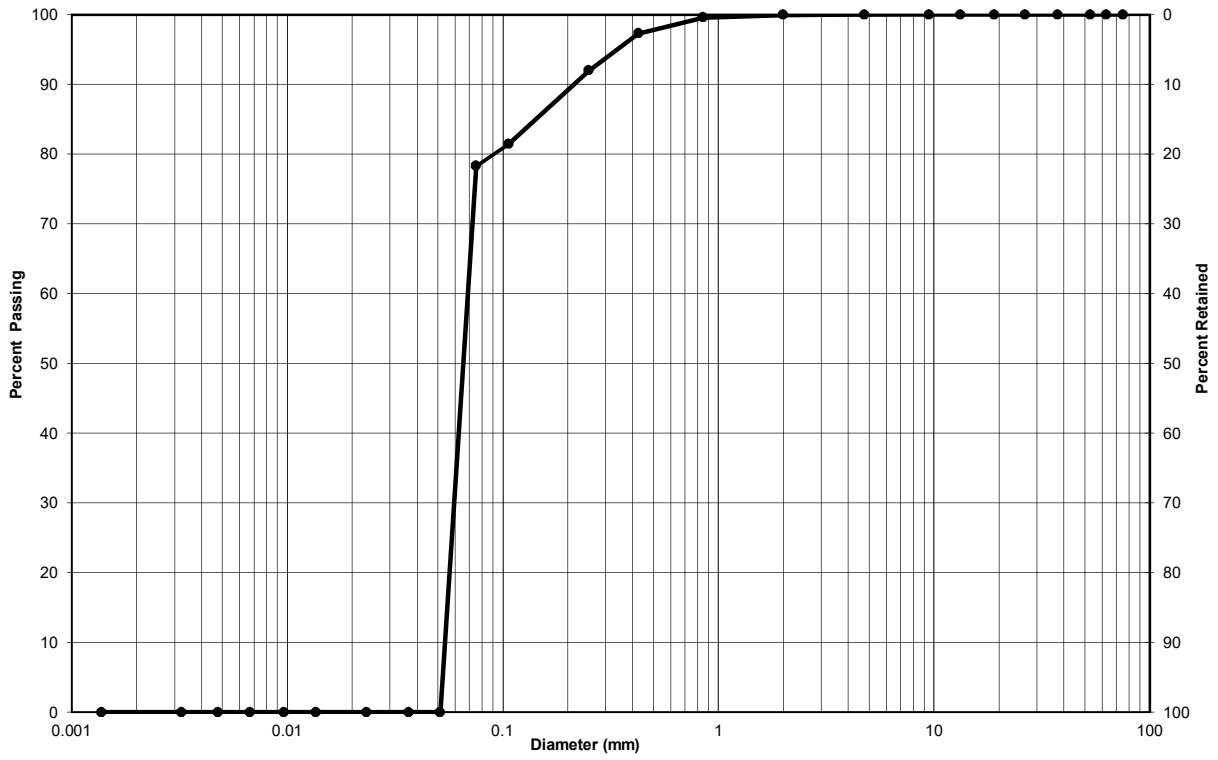
Remarks:

Performed by:	Josh Sullivan	**Date:**	September 30, 2019
Verified by:		**Date:**	September 30, 2019

Particle-Size Analysis of Soils (Geotechnical) (USCS) (ASTM D422)

Client:	Engage Engineering	**Lab no.:**	SS-19-87
Project/Site:	Bobcaygeon Road, Minden Hills	**Project no.:**	11202605-01

Borehole no.:	BH-1	Sample no.:	SS-1b
Depth:	0.28-0.60m	Enclosure:	B-2



Clay & Silt	Sand			Gravel	
	Fine	Medium	Coarse	Fine	Coarse
Unified Soil Classification System					

Soil Description	Gravel	Sand	Clay & Silt
	0	22	78

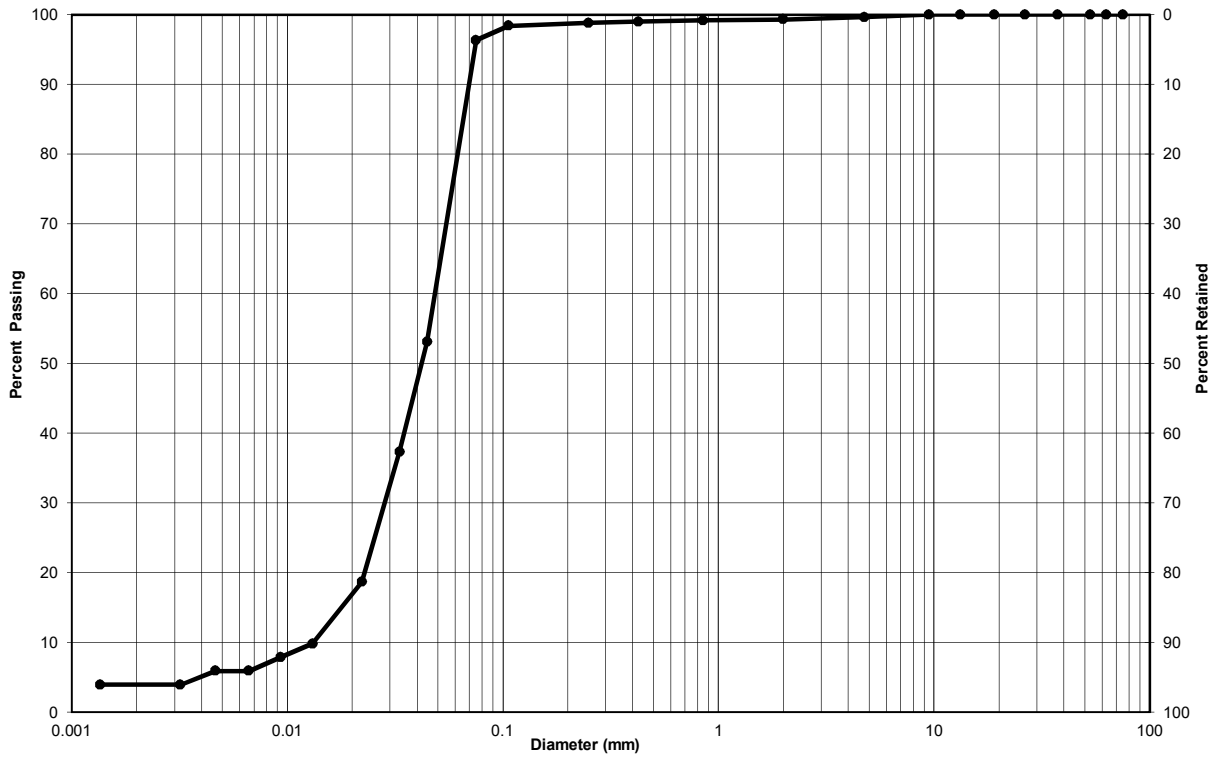
Remarks:

Performed by:	Josh Sullivan	**Date:**	September 30, 2019
Verified by:		**Date:**	September 30, 2019

Particle-Size Analysis of Soils (Geotechnical) (USCS) (ASTM D422)

Client:	Engage Engineering	**Lab no.:**	SS-19-87
Project/Site:	Bobcaygeon Road, Minden Hills	**Project no.:**	11202605-01

Borehole no.:	BH-3	Sample no.:	SS-3
Depth:	1.5-2m	Enclosure:	B-3



Clay & Silt	Sand			Gravel	
	Fine	Medium	Coarse	Fine	Coarse
Unified Soil Classification System					

Soil Description	Gravel	Sand	Clay & Silt
	0	4	96

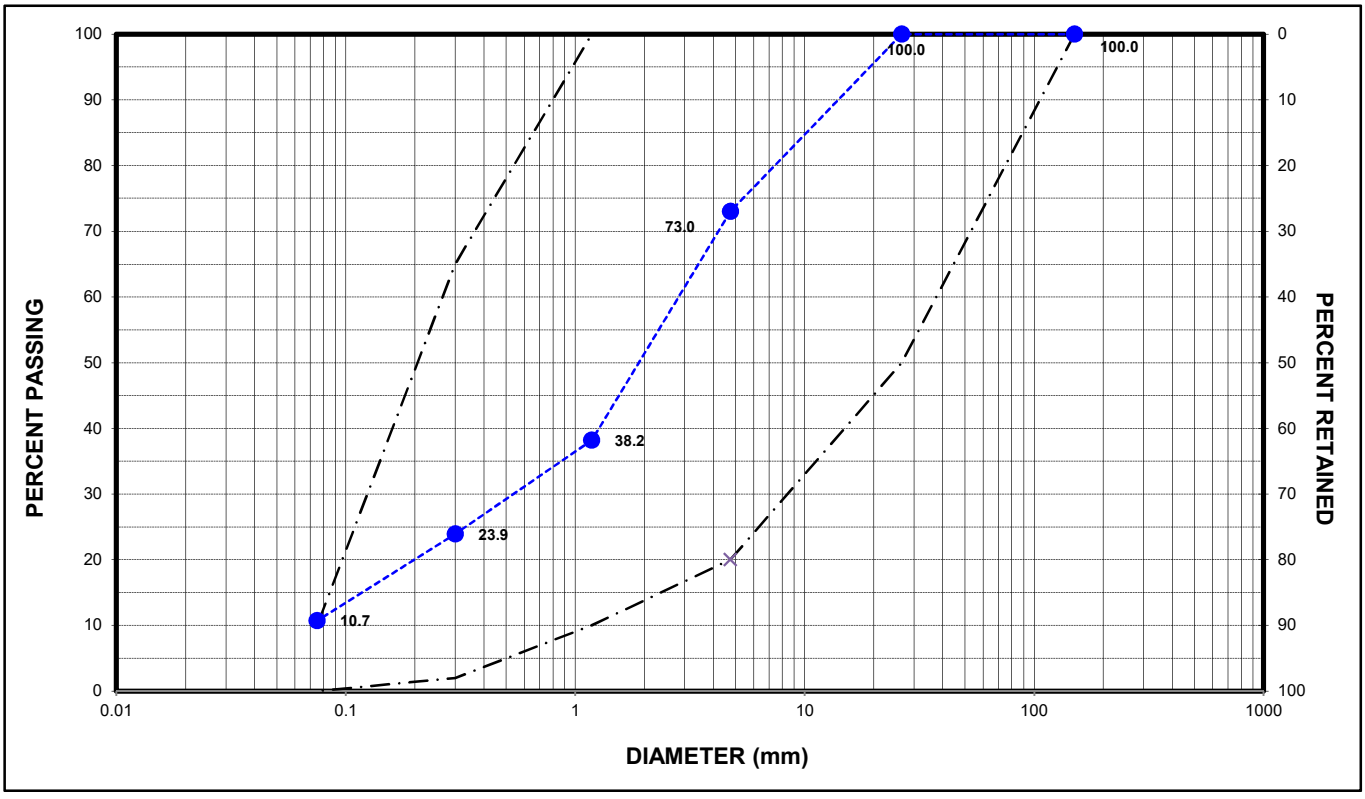
Remarks:

Performed by:	Josh Sullivan	**Date:**	September 30, 2019
Verified by:		**Date:**	September 30, 2019

GRANULAR B TYPE I - SIEVE ANALYSIS (QUARRY) (LS-602)

Client:	Engage Engineering	**Lab No.:**	SS-19-87
Project/Site:	Bobcaygeon Road, Minden Hills	**Project No.:**	11202605-01
Source:	BH-4 AS-1	Enclosures:	B-4
Sampled by:	J. M.	Date sampled:	September 18, 2019

Sieve Size (mm)	Sample % Passing	OPSS 1010 Gradation Specification		
		Minimum %	-	Maximum %
150.0	**100**	100	-	
26.50	**100.0**	50	-	100
4.75	**73.0**	20	-	100
1.18	**38.2**	10	-	100
0.300	**23.9**	2	-	65
0.075	* **10.7**	0	-	10



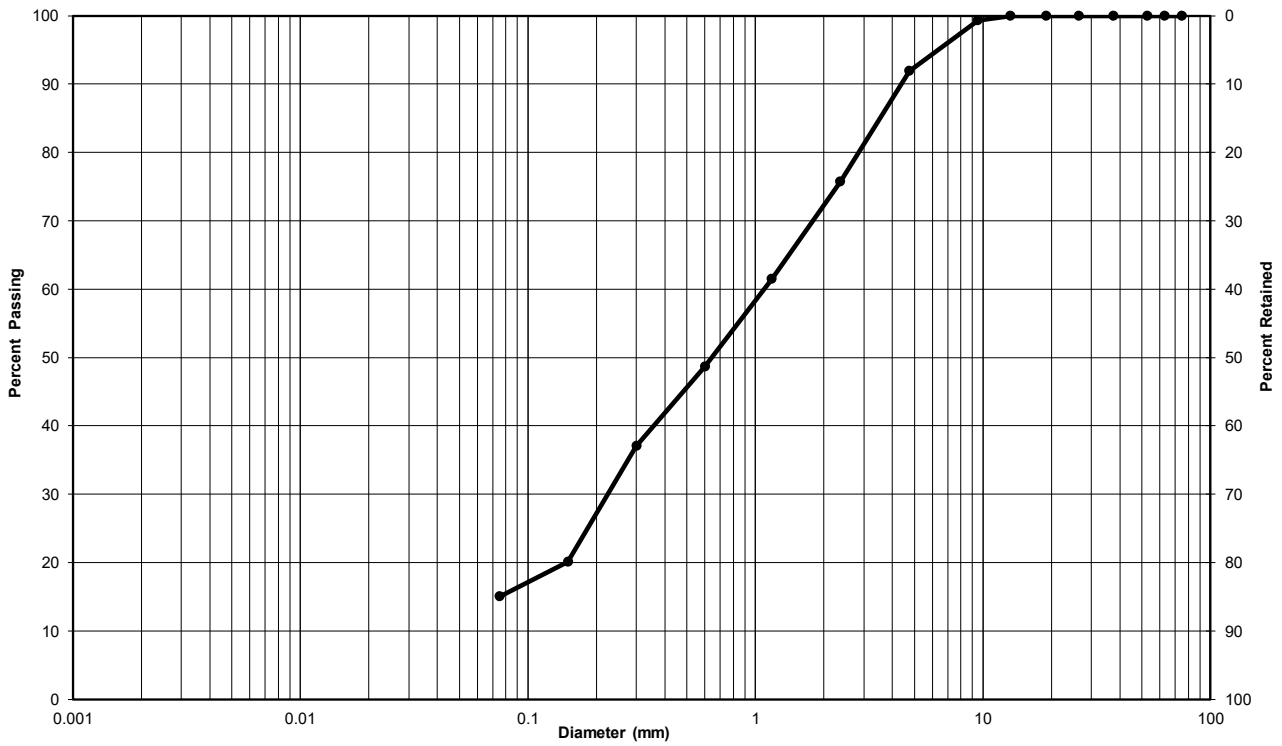
Remarks:

Sample meets OPSS specifications for: GRANULAR B TYPE I - SIEVE ANALYSIS (QUARRY)

Performed by:	Josh Sullivan	**Date:**	September 30, 2019
Verified by:		**Date:**	September 30, 2019

Particle-Size Analysis of Soils (Geotechnical) (USCS) (ASTM D422)

Client:	Engage Engineering	**Lab no.:**	SS-21-04
Project/Site:	Minden Hills	**Project no.:**	11202605-02
Borehole no.:	BH6-21	Sample no.:	AS1
Depth:	0.05-0.33m	Enclosure:	B-5



Clay & Silt	Sand			Gravel	
	Fine	Medium	Coarse	Fine	Coarse
Unified Soil Classification System					

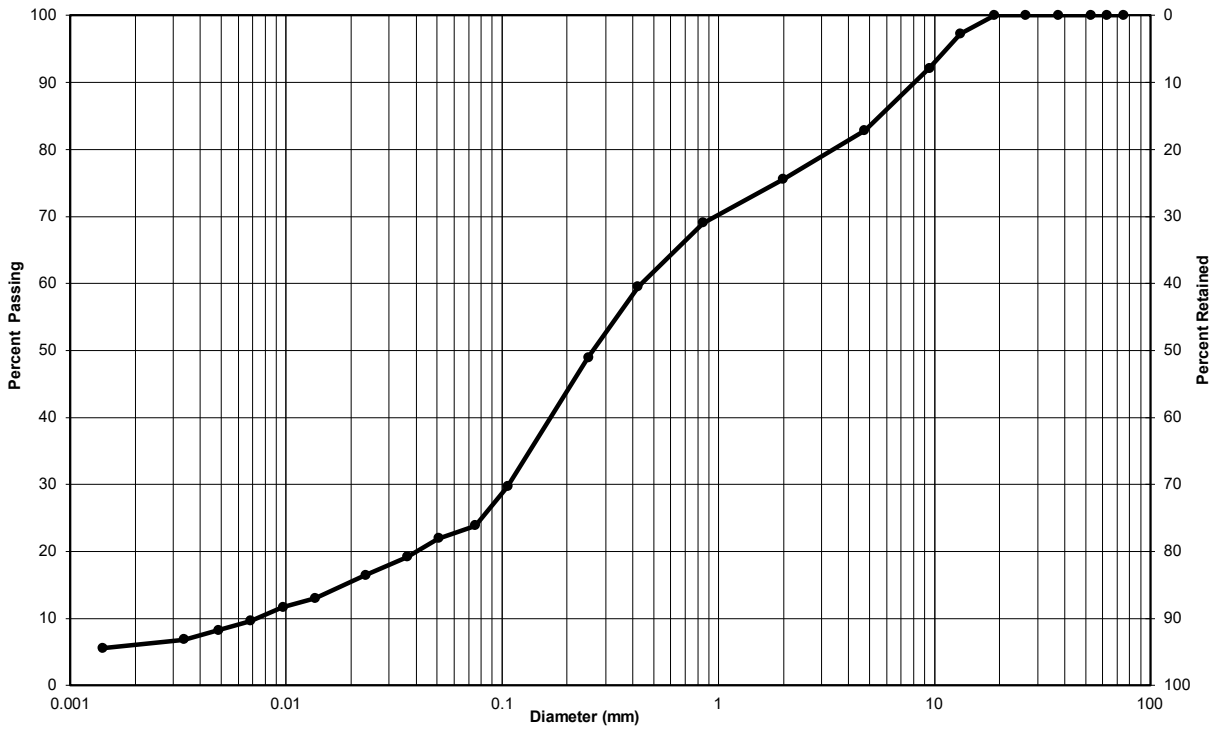
Soil Description	Gravel	Sand	Clay & Silt
	8	77	15

Remarks:

Performed by:	Alex Fawcett	**Date:**	February 3, 2021
Verified by:	Joe Sullivan	**Date:**	February 5, 2021

Particle-Size Analysis of Soils (Geotechnical) (USCS) (ASTM D422)

Client:	Engage Engineering	**Lab no.:**	SS-21-04
Project/Site:	Minden Hills	**Project no.:**	11202605-02
Borehole no.:	BH6-21	Sample no.:	AS3
Depth:	0.7-1.2m	Enclosure:	B-6



Clay & Silt	Sand			Gravel	
	Fine	Medium	Coarse	Fine	Coarse
Unified Soil Classification System					

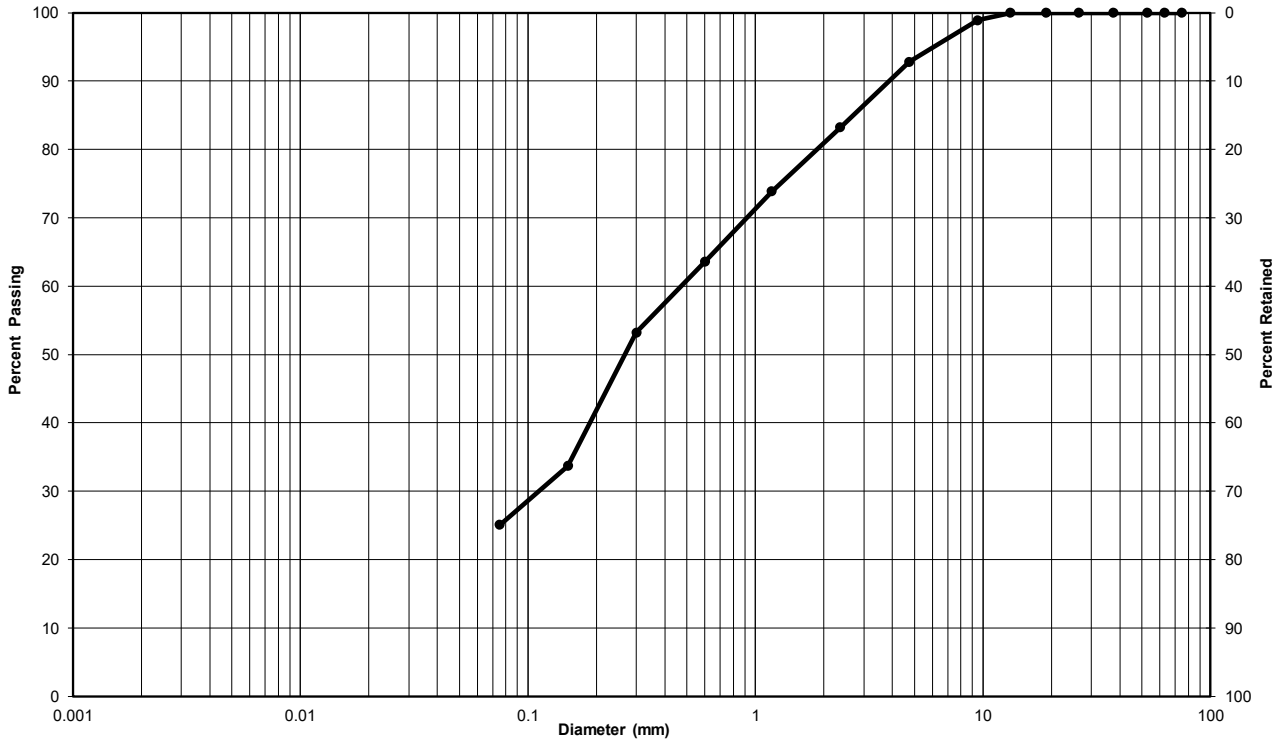
Soil Description	Gravel (%)	Sand (%)	Clay & Silt (%)
	17	59	24
Silt-size particles (%):	18		
Clay-size particles (%) (<0.002mm):	6		

Remarks: More information is available upon request.

Performed by:	Alex Fawcett	**Date:**	February 3, 2021
Verified by:	Joe Sullivan	**Date:**	February 5, 2021

Particle-Size Analysis of Soils (Geotechnical) (USCS) (ASTM D422)

Client:	Engage Engineering	**Lab no.:**	SS-21-04
Project/Site:	Minden Hills	**Project no.:**	11202605-02
Borehole no.:	BH8-21	Sample no.:	AS2
Depth:	0.4-0.6m	Enclosure:	B-7



Clay & Silt	Sand			Gravel	
	Fine	Medium	Coarse	Fine	Coarse
Unified Soil Classification System					

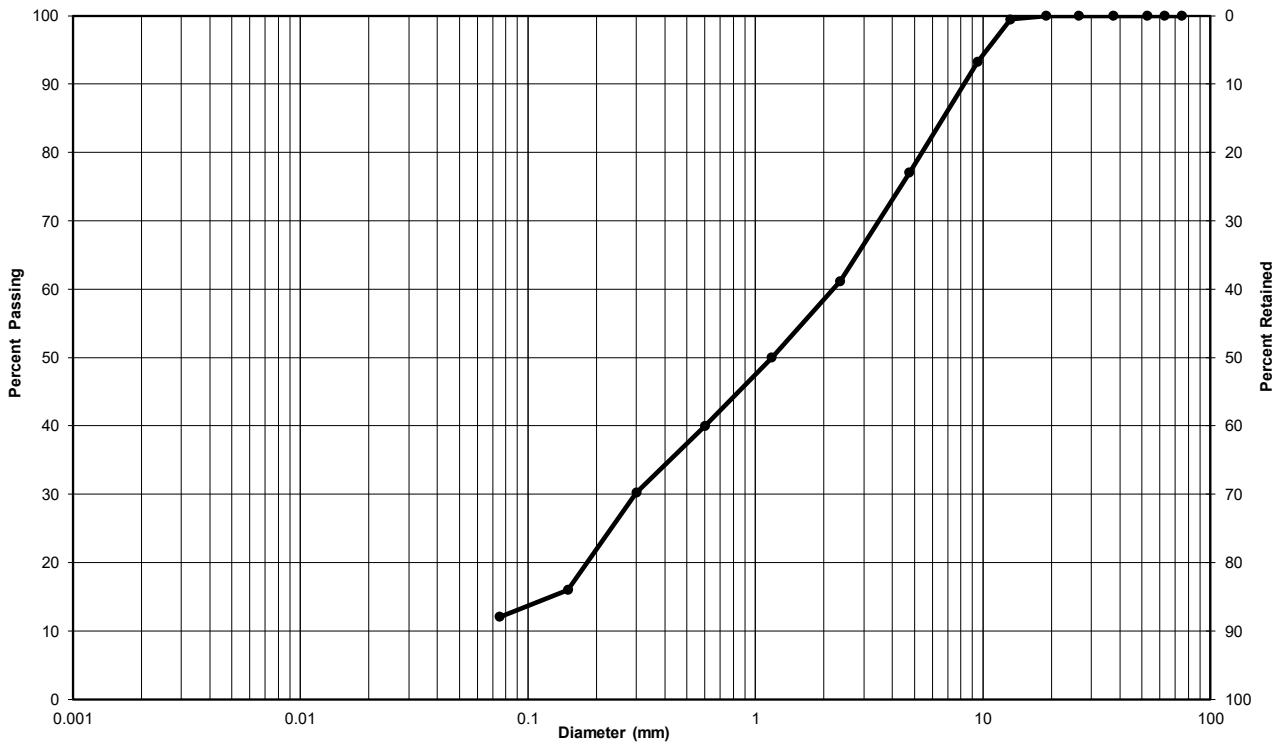
Soil Description	Gravel	Sand	Clay & Silt
	7	68	25

Remarks:

Performed by:	Alex Fawcett	**Date:**	February 3, 2021
Verified by:	Joe Sullivan	**Date:**	February 5, 2021

Particle-Size Analysis of Soils (Geotechnical) (USCS) (ASTM D422)

Client:	Engage Engineering	**Lab no.:**	SS-21-04
Project/Site:	Minden Hills	**Project no.:**	11202605-02
Borehole no.:	BH9-21	Sample no.:	AS1
Depth:	0-0.3m	Enclosure:	B-8



Clay & Silt	Sand			Gravel	
	Fine	Medium	Coarse	Fine	Coarse
Unified Soil Classification System					

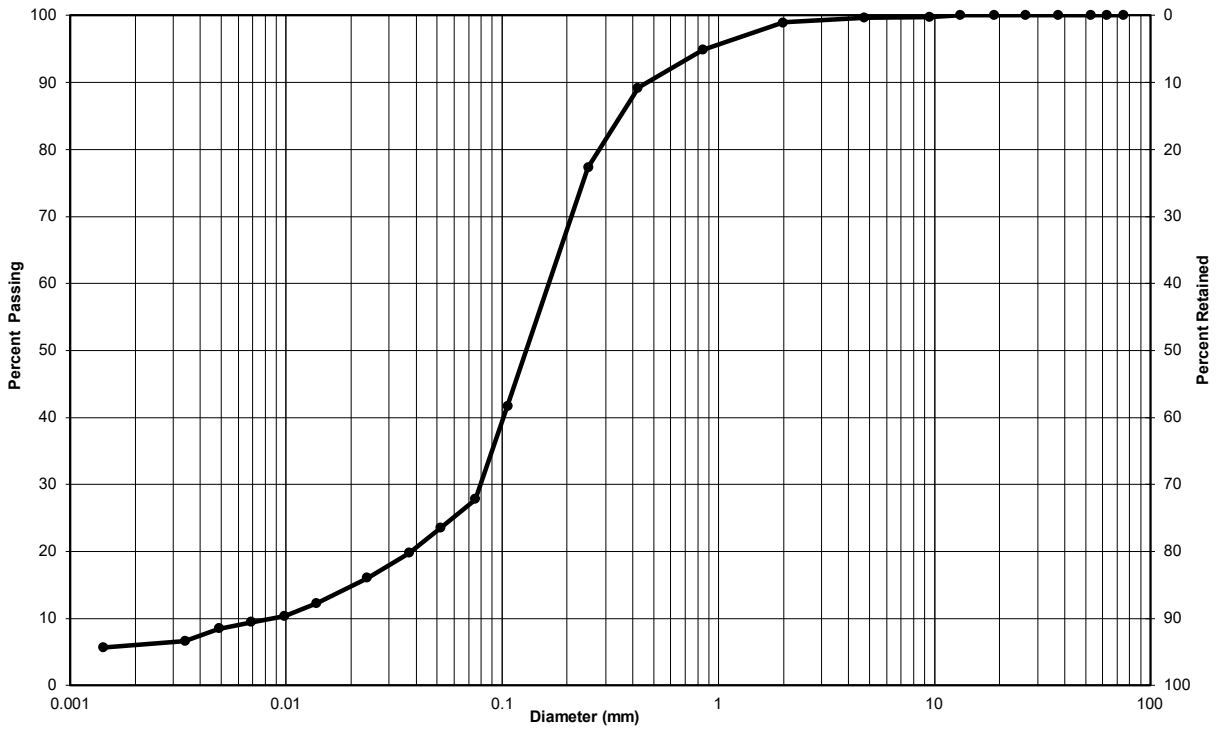
Soil Description	Gravel	Sand	Clay & Silt
	23	65	12

Remarks:

Performed by:	Alex Fawcett	**Date:**	February 3, 2021
Verified by:	Joe Sullivan	**Date:**	February 5, 2021

Particle-Size Analysis of Soils (Geotechnical) (USCS) (ASTM D422)

Client:	Engage Engineering	**Lab no.:**	SS-21-04
Project/Site:	Minden Hills	**Project no.:**	11202605-02
Borehole no.:	BH9-21	Sample no.:	AS3
Depth:	0.8-1.5m	Enclosure:	B-9



Clay & Silt	Sand			Gravel	
	Fine	Medium	Coarse	Fine	Coarse
Unified Soil Classification System					

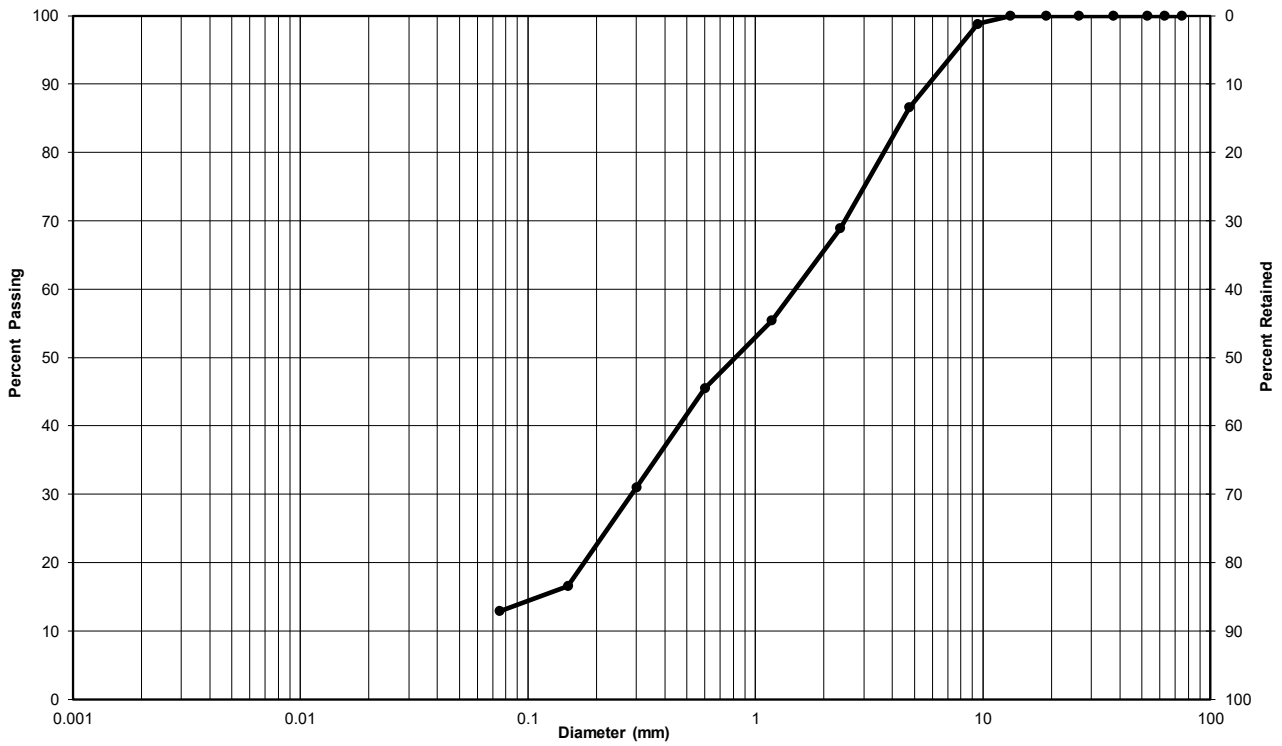
Soil Description	Gravel (%)	Sand (%)	Clay & Silt (%)
	0	72	28
Silt-size particles (%):	22		
Clay-size particles (%) (<0.002mm):	6		

Remarks: More information is available upon request.

Performed by:	Alex Fawcett	**Date:**	February 3, 2021
Verified by:	Joe Sullivan	**Date:**	February 5, 2021

Particle-Size Analysis of Soils (Geotechnical) (USCS) (ASTM D422)

Client:	Engage Engineering	**Lab no.:**	SS-21-04
Project/Site:	Minden Hills	**Project no.:**	11202605-02
Borehole no.:	BH11-21	Sample no.:	AS2
Depth:	0.3-0.6m	Enclosure:	B-10



Clay & Silt	Sand			Gravel	
	Fine	Medium	Coarse	Fine	Coarse
Unified Soil Classification System					

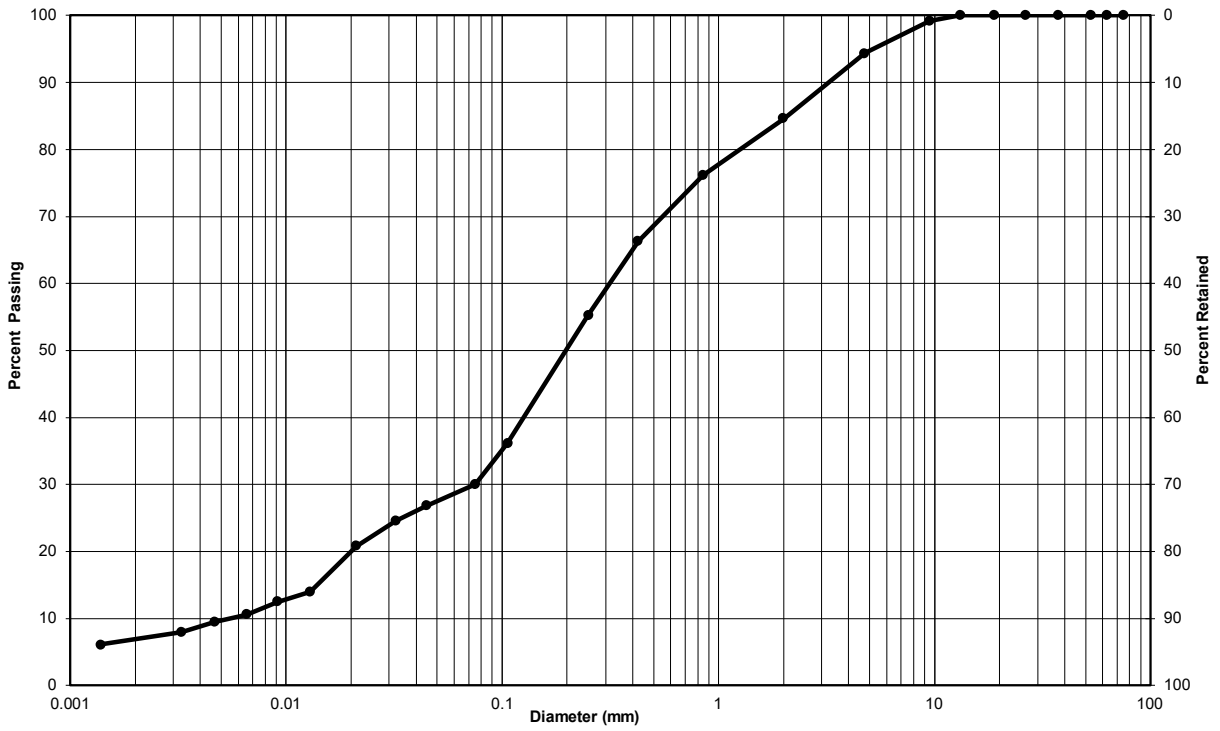
Soil Description	Gravel	Sand	Clay & Silt
	13	74	13

Remarks:

Performed by:	Alex Fawcett	**Date:**	February 3, 2021
Verified by:	Joe Sullivan	**Date:**	February 5, 2021

Particle-Size Analysis of Soils (Geotechnical) (USCS) (ASTM D422)

Client:	Engage Engineering	**Lab no.:**	SS-21-04
Project/Site:	Minden Hills	**Project no.:**	11202605-02
Borehole no.:	BH12-21	Sample no.:	AS3
Depth:	0.7-1.2m	Enclosure:	B-11



Clay & Silt	Sand			Gravel	
	Fine	Medium	Coarse	Fine	Coarse
Unified Soil Classification System					

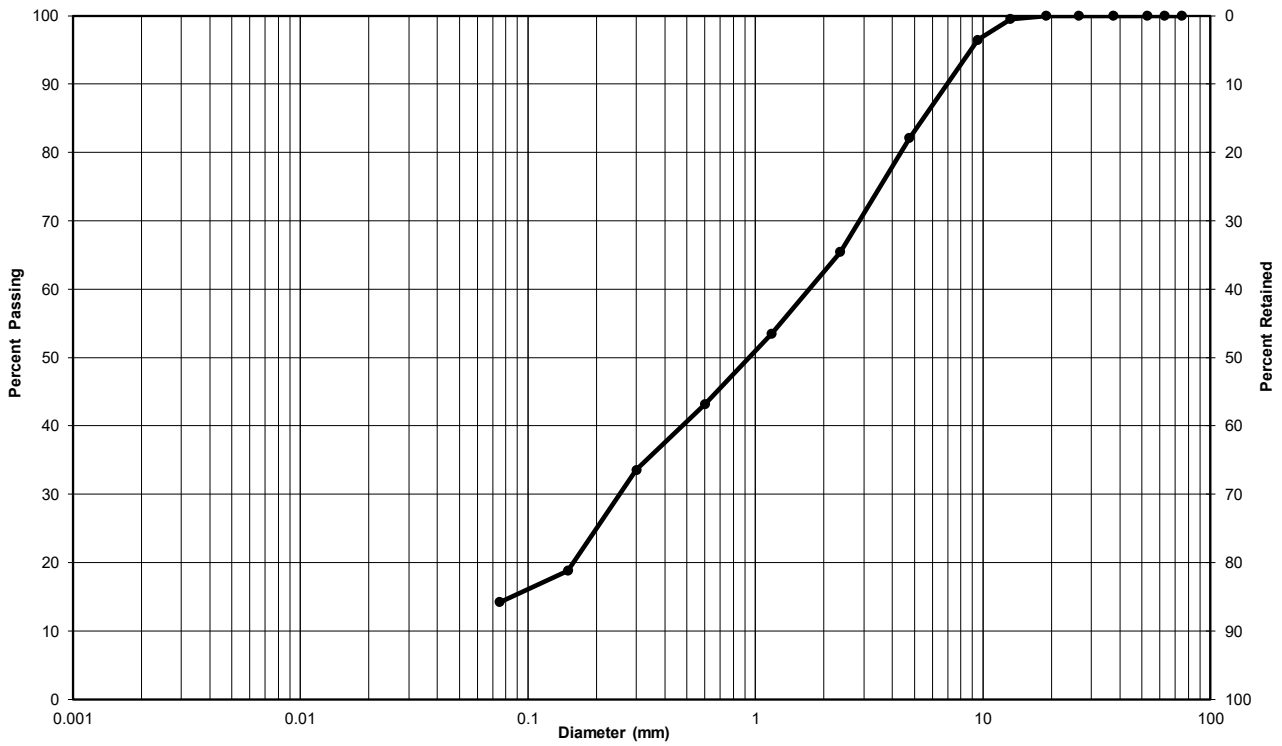
Soil Description	Gravel (%)	Sand (%)	Clay & Silt (%)
	6	64	30
Silt-size particles (%):	23		
Clay-size particles (%) (<0.002mm):	7		

Remarks: More information is available upon request.

Performed by:	Alex Fawcett	**Date:**	February 3, 2021
Verified by:	Joe Sullivan	**Date:**	February 5, 2021

Particle-Size Analysis of Soils (Geotechnical) (USCS) (ASTM D422)

Client:	Engage Engineering	**Lab no.:**	SS-21-04
Project/Site:	Minden Hills	**Project no.:**	11202605-02
Borehole no.:	BH13-21	Sample no.:	AS1
Depth:	0.05-0.5m	Enclosure:	B-13



Clay & Silt	Sand			Gravel	
	Fine	Medium	Coarse	Fine	Coarse
Unified Soil Classification System					

Soil Description	Gravel	Sand	Clay & Silt
	18	68	14

Remarks:

Performed by:	Alex Fawcett	**Date:**	February 3, 2021
Verified by:	Joe Sullivan	**Date:**	February 5, 2021

about GHD

GHD is one of the world's leading professional services companies operating in the global markets of water, energy and resources, environment, property and buildings, and transportation. We provide engineering, environmental, and construction services to private and public sector clients.

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