Geotechnical Investigation

Boundary Road Swing Bridge
Simcoe County / City of Kawartha Lakes, Ontario

MMM Group Limited

October 20, 2015

347 Pido Road, Unit 29, Peterborough, Ontario, Canada

K0J 6X7

11103905| 01 | Report No. 1

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1. Introduction

This report presents the results of a Geotechnical Investigation that was conducted for the proposed rehabilitation of the Boundary Road Swing Bridge spanning the Talbot River, at the boundary of Simcoe County (west of bridge) and City of Kawartha Lakes (east of bridge), Ontario, Canada. GHD Limited (GHD) was retained by MMM Group Ltd. (the Client) to complete this geotechnical investigation. The work conducted for this investigation was carried out under the authorization of Mr. Andy Huctwith, representing the Client, in accordance with our proposal PG-3057-1 dated March 23, 2015.

It is GHD's understanding that the south pier abutment has reportedly exhibited some lateral movement ("tilting") in the past. It is further our understanding that the bridge has a weight restriction of 8 tonnes.

Based on correspondence with the Client, it is GHD's understanding that the project shall consist of removing the swing span (bridge deck and steel beams), conducting repairs to the piers and central piers, and replacing the (repaired or replacement) swing span.

2. Purpose and Scope

The purpose of this geotechnical investigation is to assess and/or provide:

- Depth and nature of the existing foundation material;
- If settlement of pier and abutments has occurred;
- Bearing capacity of the foundation material below the bridge supports;
- Information to confirm recommendations for any repair or replacement of foundation elements. This includes recommendatations for soil parameters related to tie-back methods to remediate an lateral movement of the south abutment; and
- Condition and compressive strength of existing concrete bridge support.

The information contained herein must in no way be construed as an opinion of this site's chemical or environmental status.

The following scope of work was performed in order to accomplish the foregoing purposes.

1. Underground services were cleared prior to advancing the boreholes. The boreholes were located as shown on the Test Hole Location Plan (Figure 1).
2. The subsurface conditions were explored by advancing, sampling and logging a total of five (5) boreholes as follows:
    (a) Two (2) boreholes to 6.7 metres below existing grade (mbeg) in the approaches (one on each side of the existing bridge);
    (b) One (1) borehole to 6.7 mbeg behind the existing north abutment;

(c) One (1) borehole to 14.2 mbeg behind the existing south abutment; and

(d) One (1) borehole to 9.1 metres below the existing bridge deck (about 1.2 m into the river bed material before encountering practical refusal to further advancement), adjacent to the centre pier.

3. The existing concrete was explored by coring two (2) cores (100 mm in diameter) into the existing the piers, as follows:

   (a) One (1) vertical core was advanced into the bridge seat on the north abutment; and

   (b) One (1) horizontal core was advanced in the west abutment wall of the south pier.

4. Traffic control was performed in accordance with Ontario Traffic Manual Book 7 throughout the fieldwork. Closure of the Bridge/Road was coordinated by the Trent Severn.

5. The ground at the borehole locations was reinstated as close as possible to its original condition upon completion of the fieldwork. The coreholes were filled using high strength concrete.

6. Physical laboratory analysis of the encountered material was carried out including grain size analysis and moisture content tests of soil samples, and unconfined compressive strength testing on the two (2) concrete cores samples obtained.

7. Geotechnical engineering analysis of acquired field and laboratory data have been compiled in this report outlining our findings, conclusions, and geotechnical engineering recommendations.

3. Field and Laboratory Procedures

A field investigation was conducted under the supervision of GHD staff on July 27 and 28, 2015. The work consisted of subsurface exploration by means of advancing and sampling a total of five (5) exploratory boreholes to depths ranging from 6.7 to 14.2 mbeg. Note that the top of the existing bridge deck was used as “existing grade” for borehole BH-3. Two (2) 100 mm diameter concrete cores were obtained from the existing concrete piers.

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 were 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. Representative, disturbed samples of the strata penetrated were also obtained directly from auger cuttings. The borehole adjacent to the centre pier was advanced by cutting an access hole through the existing wooden bridge deck, and running steel casing down into the river bed. Representative, disturbed samples were obtained using casing and continuous SPT sampling from that point down.

The concrete cores were obtained using an electric core drill equipped with a diamond core barrel.

Soil and core 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, in accordance with O.Reg. 903. All soil samples were sealed in clean plastic containers while core samples were stored in cardboard boxes. All samples were 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. Groundwater data is presented on individual borehole logs.

Elevations of the existing grade at each borehole were obtained in respect to a local benchmark. The Geodectic Survey of Canada benchmark BM No. 3193 was used to obtain the elevations of the boreholes. The geodetic elevation of this benchmark was provided to GHD from the Client as 243.7413 m.

Physical laboratory testing was completed on soil samples, and consisted of moisture content tests on all samples recovered, and gradation analyses on a total of three (3) representative soil samples (including hydrometers). The analytical results of the moisture content are plotted on the attached logs. The results of the gradation testing are incorporated into the borehole logs, and are presented graphically in Appendix B. Unconfined compressive strength testing was conducted on a total of two (2) concrete core samples and reported in Section 5 of this report.

4. Site Location and Conditions

The Site is located along Boundary Road (also known as Simcoe Street) at the eastern boundary of Simcoe County and the western boundary of City of Kawartha Lakes, Ontario. The site is located west of Bolsover, and southeast of Brechin, Ontario. The Boundary Road Swing Bridge spans the Talbot River, and is located at the north shoreline of the river; an existing causeway runs from the south abutment to the south shoreline. Surrounding properties are generally rural residential to the north with some commercial to the south. At the time of the investigation the water surface of the river was approximately 2.4 m below the top of the bridge deck surface. The road surface of Boundary Road is generally flat along the length of the road, with an elevation change across the borehole locations of approximately 0.4 m.

5. Subsurface Conditions

5.1 General

Details of the subsurface conditions encountered at the Site are presented graphically 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.

With the exception of the borehole adjacent to the centre pier, the boreholes generally encountered a surficial layer of asphalt, over fill, over native soils consisting predominantly of sand and silty sand. Groundwater seepage and/or accumulation was observed in three (3) of the boreholes during drilling operations at depths ranging from 2.7 to 3.3 mbeg. Borehole BH-5 encountered caving of the borehole upon completion at approximately 0.9 mbeg; groundwater was present below this depth but measurement was not able to be completed.

The following sections describe the major soil strata and subsurface conditions encountered during this investigation in more detail. A summary of the conditions encountered in borehole BH-3 is provides in Section 5.2, while Section 5.3 describes the conditions encountered in the remaining boreholes.

5.2 Borehole BH-3

Borehole BH-3 was advanced adjacent to the centre pier, through the existing wooden bridge deck. The existing wooden deck was approximately 100 mm thick. The water level in the Talbot River was approximately 2.4 m below the top of the bridge deck. The river bed was approximately 7.9 m below the top of the deck. A layer of sandy silt (generally sedimentary deposits in the river bed) was encountered at a depth of approximately 7.9 m below the top of the deck and extended to the depth at which practical refusal occurred. Practical refusal to further borehole advancement occurred in BH-3 at 9.1 m below top of deck, the nature of the refusal was inferred to be boulders or possibly an extension of the pier, however this was not confirmed as part of this investigation.

The sandy silt encountered in BH-3 between 7.9 and 9.1 m below top of deck was generally black in colour, with gravel, trace organics and occasional cobbles. The sandy silt was generally in a wet, compact in-situ state. Moisture content tests conducted on samples of the sandy silt soils yielded values that ranged from approximately 13 to 19 % moisture by weight. A grain size distribution analysis conducted on a representative sample of the sandy silt suggests the following composition: 19 % gravel, 28 % sand, 53 % silt and clay-sized particles. Hydrometer analysis conducted on this sample suggests it contains approximately 46% between 5 and 75 µm in size.

5.3 Remaining Boreholes (BH-1, BH-2, BH-4, BH-5)

5.3.1 Asphalt

Boreholes BH-1, 2, 4 and 5 encountered a surficial layer of asphalt. The asphalt thickness was approximately 75 mm.

5.3.2 Fill

Boreholes BH-1, 2, 4 and 5 encountered layers of fill immediately beneath the asphalt. The fill extended to depths ranging from approximately 3.0 to 6.1 mbeg. The fill generally consisted of an upper layer of granular based fill consisting of brown gravelly sand. Beneath the granular based fill layers of earth fill was encountered. The earth fill generally consisted of silty sand and sandy silt. The fill was noted to exist in a very loose to compact, moist to wet in-situ state. Moisture content tests conducted on samples of the fill yielded values ranging from approximately 3 to 25 % moisture by weight.

5.3.3 Silty Sand

Boreholes BH-1, 2, 4 and 5 encountered a layer of silty sand immediately beneath the fill. The silty sand was first encountered at a depths ranging from approximately 3.0 to 6.1 mbeg and extended to the full depth of the investigation (ranging from approximately 6.7 to 14.2 mbeg). The silty sand was generally grey and black in colour (layered), and existed in a very loose to very dense, moist to wet in-situ condition. Moisture content tests conducted on samples of the sand yielded values ranging from of approximately 13 to 33 % moisture by weight. Grain size distribution analyses conducted on representative samples of the silty sand soil suggest the following compositional ranges: 0 % gravel, 69 to 71 % sand, 29 to 31 % silt and clay-sized particles. Hydrometer analyses conducted on these samples suggest they contain approximately 24 % particles between 5 and 75 μm in size.

5.3.4 Groundwater

Groundwater observations and measurements were obtained from the open boreholes during and upon completion of drilling each borehole. Groundwater seepage and/or accumulation was observed in three (3) of the boreholes (BH-1, 2, and 4) during drilling operations at depths ranging from 2.7 to 3.3 mbeg. Borehole BH-5 encountered caving of the borehole upon completion at approximately 0.9 mbeg; groundwater was present below this depth but measurement was not able to be completed.

It must be noted that groundwater levels are transient and tend to fluctuate with the seasons, periods of precipitation, and temperature. It is expected that the groundwater levels at this location will closely approximate the water level in the river.

5.4 Concrete Cores

Two (2) concrete cores were obtained from the existing structure. The first core (CH-1) was obtained as a vertical core, from the swing bridge seat on the north abutment. This core was approximately 255 mm in depth and had an unconfined compressive strength of approximately 18.7 MPa. The second core (CH-2) was obtained as a horizontal core, from the west wall of the south abutment. This core was approximately 355 mm in depth and had an unconfined compressive strength of approximately 56.0 MPa. The concrete cores were generally light grey in colour, however the outer 100 to 150 mm of core CH-2 was a dark grey (greenish grey colour). The nominal aggregate size in core CH-1 was approximately 40 mm, while the nominal aggregate size in core CH-2 was approximately 19 mm. The aggregate in core CH-1 appears to sub-rounded to sub-angular, while the aggregate in core CH-2 appears to sub-angular to angular. An image of the concrete cores is provided as Figure 5.1.

Figure 5.1 Concrete Cores

6. 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.

Based on the information gathered during this investigation, with the exception of the borehole adjacent to the centre pier, the boreholes generally encountered a surficial layer of asphalt, over fill, over native soils (consisting predominantly of sand and silty sand). Groundwater seepage and/or accumulation was observed in three (3) of the boreholes during drilling operations at depths ranging from 2.7 to 3.3 mbeg.

6.1 Bridge Replacement

It is GHD's understanding that the Client and owner intend to maintain the existing foundations as they presently exist (with repairs and/or inclusion of a tie-back system for the southern pier where reported "tilting" has previously occurred). The repaired/replaced swing span shall be founded on the rehabilitated existing foundations. The Client has reported that the new bridge's loading will not increase from the existing loadings.

It is noted that the fill and upper portions of the silty sand would not be capable of withstanding the existing loadings, and therefore if the existing pier or abutments were founded within such incompetent materials, evidence of foundation failure or distress(es) would be visible or otherwise made themselves apparent in the existing structure.

Generally the existing foundations and structure have not shown any reported or observed evidence of foundation distress or failure, with the exception of the southern abutments reported “tilting”. This reported outwards lateral movement at the top of the abutment (ie, “tilting”) is considered to be primarily due to lateral earth pressures behind the abutment. No evident signs of settlement were observed at the abutments or pier. It is subsequently concluded that the pier and abutments are founded on sufficiently compact native soils.

It recommended that the south abutment be stabilized by utilizing an anchoring system based on either tie backs or dead-man anchoring. The anchoring system must be designed by an experienced and qualified engineer. For design purposes, soils immediately behind the southern abutment are assigned a unit weight of 18 kN/m^3, and internal angle of friction of 28º.

The concrete core at the north abutment was retrieved as one piece, but had hairline fractures, which became evident after retrieval. The concrete seats of the abutments showed evidence of overall distress. These zones of weakened concrete in these surficial areas of the abutments should be removed and refaced appropriately with new concrete. The concrete core at the south abutment was obtained from the west abutment wall. The vertical faces of the abutments did not exhibit the same level of distress as the horizontal portions, minor repairs may be necessary on the vertical faces of the abutment walls to address any localized distresses. Significant concrete distresses were noted on the centre pier; the Client stated to GHD that a new concrete cap will be constructed while the swing span is removed.

Based on the conditions observed, the lack of any foundation failure or distresses (excluding the lateral movement), the refacing of the existing concrete, and the basis that the new bridge decking will not exceed existing loads, it is our professional opinion that that the existing foundations and founding materials in their present state possess the ability to provide the minimum necessary bearing and structural stability for the proposed new bridge decking.

It is recommended that the bridge Owner implement a program that regularly surveys and monitors the elevation and any lateral movements of key elements of the bridge, including both abutments and the centre pier. This will allow the Owner and consultants to better assess any future movements that may occur, and appropriately identify any subsequent further methods of remediation if needed.

Should the design of the bridge alter substantially from the parameters provided to GHD during the preparation of this report, GHD must be allowed the opportunity to review the revised design parameters and provide an update to our recommendations, if necessary.

7. 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

Pete Hynes, P.Eng.

Garnet Brenchley, P.Eng.

STATEMENT OF LIMITATIONS

This report is intended solely for the MMM Group 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.

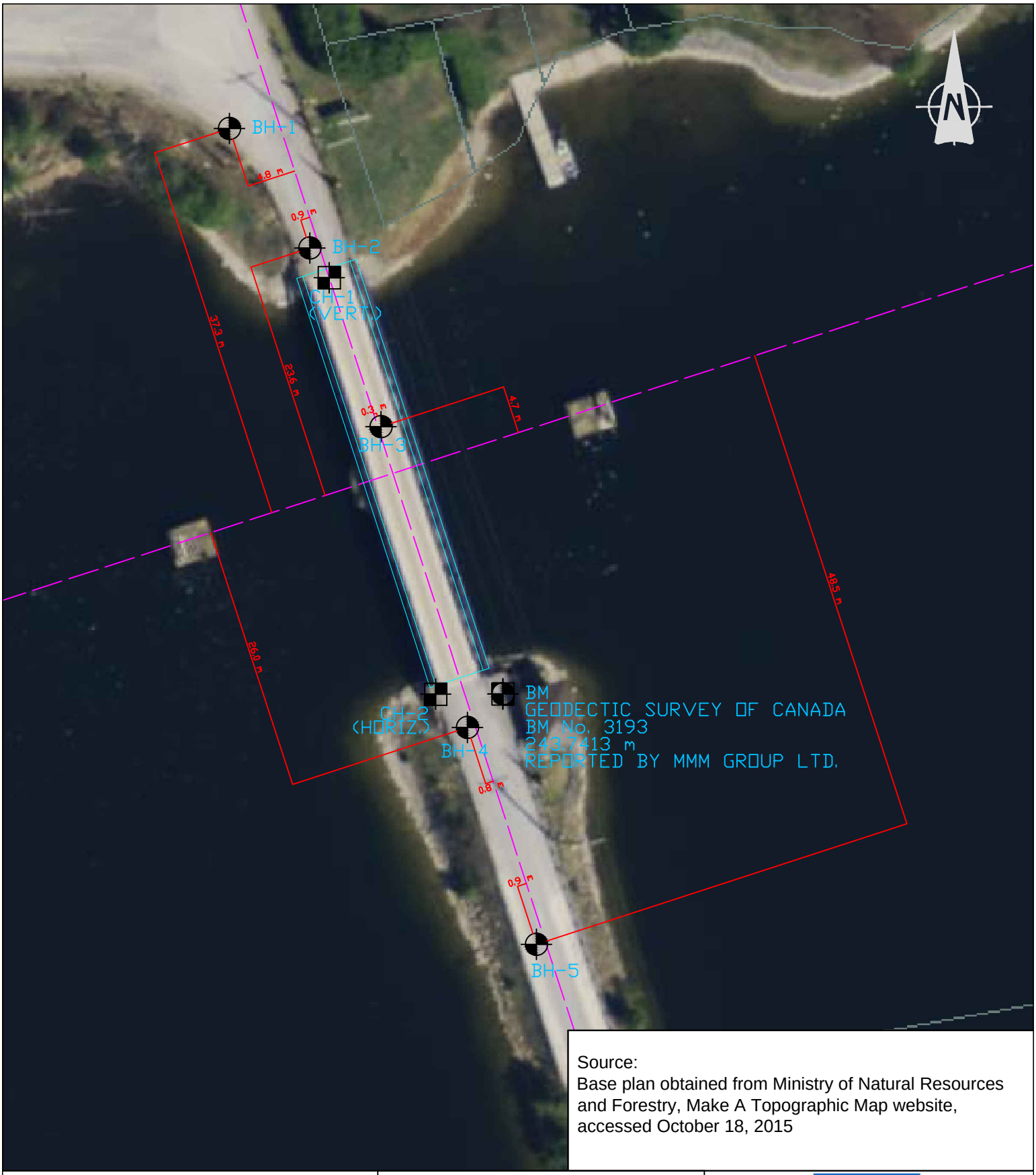
The recommendations made in this report are in accordance with our present understanding of the project, the current site use, ground surface elevations and conditions, and are based on the work scope approved by the Client and described in the report. The services were performed in a manner consistent 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 seven (7) test hole locations only. The subsurface conditions confirmed at the 7 test hole locations may vary at other locations. The subsurface conditions can also be significantly modified by construction activities on site (eg. 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



Source:
Base plan obtained from Ministry of Natural Resources and Forestry, Make A Topographic Map website, accessed October 18, 2015

TEST HOLE LOCATION PLAN

GEOTECHNICAL INVESTIGATION
BOUNDARY ROAD SWING BRIDGE
SIMCOE COUNTY / CITY OF KAWARTHA LAKES, ONTARIO

PROJECT NO. :	11103905-01
SCALE :	N.D.
DATE :	OCTOBER, 2015
PLATE NO. :	1

GHD
347 PIDO ROAD, UNIT 29
PETERBOROUGH, ON K9J 6X7
(705) 749-3317 FAX (705) 749-9248 WEB: www.ghd.com

Appendix A
Borehole Logs

REFERENCE No.: 11103905-01 ENCLOSURE No.: A-1

BOREHOLE No.: BH-1
ELEVATION: 99.8 m

BOREHOLE REPORT

Page: 1 of 1

CLIENT: MMM Group
PROJECT: Boundary Road Swing Bridge
LOGGED BY: P. Hynes DATE: July 27, 2015
DRILLING COMPANY: Walker Drilling METHOD: Truck-mount Drill Rig
NOTES: Elevation based on Geodetic Survey of Canada BM No. 3193 next to control panel (243.7413 m)

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	COMMENTS
		0.0		GROUND SURFACE						
		0.1		**ASPHALT** (75 mm)						
1		0.2		**FILL** - Brown Gravelly Sand, moist, compact	SS-1	100	12	16 17 7 4	24	
2				Brown to reddish brown Silty Sand, with Gravel, moist, compact						
3	1.0				SS-2	100	13	3 6 9 6	15	
4										
5		1.5		Brown Sandy Silt, trace Gravel, moist, very loose	SS-3	100	20	4 2 2 4	4	
6	2.0									
7		2.3		Brown Sandy Silt, moist, very loose	SS-4	100	24	1 1 1 1	2	
8										
9										
10	3.0	3.0		**SILTY SAND** - Brown and grey (layered) Silty Sand, moist, very loose	SS-5	100	32	0 0 0 0	0	▼ WL - 3.3 m 7/27/2015
11										
12										
13	4.0									
14										
15		4.6		Moist to wet, compact	SS-6	100	21	5 4 7 9	11	
16	5.0									
17		5.2		Very loose						
18										
19										
20	6.0									
21					SS-7	100	23	1 1 2 1	3	
22		6.7		END OF BOREHOLE						
23	7.0									
24										
25										
26	8.0									
27										
28										
29	9.0									

Shear test (Cu) △ Field
Sensitivity (S) □ Lab
○ Water content (%)
W_P W_l Atterberg limits (%)
× "N" Value (blows / 0.3 m) ◆ RQD ◎ CONE

10 20 30 40 50 60 70 80 90

BOREHOLE LOG GEOTECH 11103905-01, 15-09-15, BOREHOLE LOGS.GPJ GEOLOGIC.GDT 10/20/15

REFERENCE No.: 11103905-01 ENCLOSURE No.: A-2

BOREHOLE No.: BH-2

ELEVATION: 100.0 m

BOREHOLE REPORT

Page: 1 of 1

CLIENT: MMM Group

PROJECT: Boundary Road Swing Bridge

LOGGED BY: P. Hynes DATE: July 28, 2015

DRILLING COMPANY: Walker Drilling METHOD: Truck-mount Drill Rig

NOTES: Elevation based on Geodetic Survey of Canada BM No. 3193 next to control panel (243.7413 m)

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) 10 20 30 40 50 60 70 80 90	COMMENTS
		0.0		GROUND SURFACE							
		0.1		**ASPHALT** (75 mm)	AS-1		2			○	
		0.2		**FILL** - Brown Gravelly Sand, moist, compact							
				Brown Silty Sand, trace Gravel, moist, compact				9			
	1.0				SS-2	25	9	5	10	⊗ ✕	
								5			
								6			
		1.5		Loose				4			
								4			
	2.0				SS-3	75	17	4	8	✕ ○	
								4			
								4			
											▼ WL - 2.9 m 7/28/2015
	3.0	3.0		**SILTY SAND** - Grey and black (layered) Silty Sand, wet, very loose	SS-4	100	32	2	4	✕ ○	
								2			
								2			
								2			
	4.0										
		4.6		Grey Silty Sand, moist to wet, compact				4			
								4			
	5.0				SS-5	100	27	4	8	✕ ○	SS-5: 0% Gravel 69% Sand 31% Silt and Clay 24% between 5 and 75 µm
								4			
								4			
	6.0	6.1		Compact				5			
								6			
					SS-6	100	23	6	12	✕ ○	
		6.7		END OF BOREHOLE				6			
	7.0										
	8.0										
	9.0										

BOREHOLE LOG GEOTECH 11103905-01, 15-09-15, BOREHOLE LOGS.GPJ GEOLOGIC.GDT 10/20/15

REFERENCE No.: 11103905-01 ENCLOSURE No.: A-3

BOREHOLE No.: BH-3
ELEVATION: 100.0 m

BOREHOLE REPORT

Page: 1 of 1

CLIENT: MMM Group
PROJECT: Boundary Road Swing Bridge
LOGGED BY: P. Hynes DATE: July 28, 2015
DRILLING COMPANY: Walker Drilling METHOD: Truck-mount Drill Rig
NOTES: Elevation based on Geodetic Survey of Canada BM No. 3193 next to control panel (243.7413 m)

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		**WOOD BRIDGE DECK**							
	1.0										
	2.0										
		2.4		**WATER** (Talbot River)							▼ WL - 2.4 m 7/28/2015
	3.0										
	4.0										SS-2: 19% Gravel 28% Sand 53% Silt and Clay 46% between 5 and 75 µm
	5.0										
	6.0										*Steel casing dropped during first SPT interval (approximately 150 mm), therefore first interval was approximately 300 mm)
	7.0										
		7.9		**SANDY SILT** - Black Sandy Silt, with Gravel, trace ORGANICS, occasional Cobbles, wet	SS-1	100	13	22* 10 6 9	16		Borehole termined at practical refusal for advancement of spoon (presence of boulder inferred but not confirmed)
	8.0										
	9.0				SS-2	100	19	6 6 50=4"	100+		
		9.1		END OF BOREHOLE							

BOREHOLE LOG GEOTECH 11103905-01, 15-09-15, BOREHOLE LOGS.GPJ GEOLOGIC.GDT 10/20/15

REFERENCE No.: 11103905-01 ENCLOSURE No.: A-4

BOREHOLE No.: BH-4
ELEVATION: 99.6 m

BOREHOLE REPORT

Page: 1 of 2

CLIENT: MMM Group
PROJECT: Boundary Road Swing Bridge
LOGGED BY: P. Hynes DATE: July 27, 2015
DRILLING COMPANY: Walker Drilling METHOD: Truck-mount Drill Rig
NOTES: Elevation based on Geodetic Survey of Canada BM No. 3193 next to control panel (243.7413 m)

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	COMMENTS
		0.0		GROUND SURFACE						
		0.1		**ASPHALT** (75 mm)						
1		0.2		**FILL** - Brown Gravelly Sand, moist, compact with Silt	SS-1	75	5	13 10 10 4	20	
2		0.8		Brown Silty Sand, with Gravel, moist, compact						
3	1.0				SS-2	13	3	3 3 7 6	10	
4										
5		1.7		Brown Sand and Silt, moist, compact						
6					SS-3	75	18	8 6 6 5	12	
7	2.0									
8		2.4		Brown to grey Sandy Silt, moist to wet, loose						
9					SS-4	75	20	3 4 3 3	7	▼ WL - 2.7 m 7/27/2015
10	3.0	3.0		Very loose						
11					SS-5	75	21	1 1 2 2	3	
12										
13	4.0									
14										
15										
16					SS-6	75	25	1 1 1 2	2	
17	5.0									
18										
19										
20	6.0	6.1		Grey Silty Sand, moist to wet, loose						
21					SS-7	100	23	0 0 0 0	0	
22										
23	7.0									
24										
25		7.6		Wet, compact						
26	8.0				SS-8	100	18	6 10 18 18	28	SS-8: 0% Gravel 71% Sand 29% Silt and Clay 24% between 5 and 75 µm
27										
28										
29	9.0									

Shear test (Cu) △ Field
Sensitivity (S) □ Lab
○ Water content (%)
W_p W_l Atterberg limits (%)
× "N" Value (blows / 0.3 m)
◆ RQD
◎ CONE

10 20 30 40 50 60 70 80 90

BOREHOLE LOG GEOTECH 11103905-01, 15-09-15, BOREHOLE LOGS.GPJ GEOLOGIC.GDT 10/20/15

REFERENCE No.: 11103905-01 ENCLOSURE No.: A-4

BOREHOLE No.: BH-4

ELEVATION: 99.6 m

BOREHOLE REPORT

Page: 2 of 2

CLIENT: MMM Group

PROJECT: Boundary Road Swing Bridge

LOGGED BY: P. Hynes DATE: July 27, 2015

DRILLING COMPANY: Walker Drilling METHOD: Truck-mount Drill Rig

NOTES: Elevation based on Geodetic Survey of Canada BM No. 3193 next to control panel (243.7413 m)

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	
		9.1		Trace Shells	SS-9	100	18	5 5 5	10	× ○	
	10.0										
		10.7		Grey Silty Sand, wet, very dense	SS-10	100	17	7 19 35	54	○ ×	
	11.0										
	12.0										
		12.2		Light grey							
	13.0										
					SS-11	100	16	16 26 50=6"	76	○ ×	
	14.0	14.2		END OF BOREHOLE							
	15.0										
	16.0										
	17.0										
	18.0										

BOREHOLE LOG GEOTECH 11103905-01, 15-09-15, BOREHOLE LOGS.GPJ GEOLOGIC.GDT 10/20/15

REFERENCE No.: 11103905-01 ENCLOSURE No.: A-5

BOREHOLE No.: BH-5

ELEVATION: 99.6 m

BOREHOLE REPORT

Page: 1 of 1

CLIENT: MMM Group

PROJECT: Boundary Road Swing Bridge

LOGGED BY: P. Hynes DATE: July 27, 2015

DRILLING COMPANY: Walker Drilling METHOD: Truck-mount Drill Rig

NOTES: Elevation based on Geodetic Survey of Canada BM No. 3193 next to control panel (243.7413 m)

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
		0.0		GROUND SURFACE					
		0.1		**ASPHALT** (75 mm)					
1		0.2		**FILL** - Brown Gravelly Sand, moist, compact	SS-1	100	14	14 10 8 12	18
2		0.8		Brown to reddish brown Silty Sand, with Gravel, moist, compact				10	
3	1.0				SS-2	100	14	10 10 9	20
4				Brown Sandy Silt, moist, compact					
5		1.5		Brown to grey Silt and Sand, moist, loose				3	
6					SS-3	100	20	2 2 2	4
7	2.0								
8		2.3		Brown				4	
9					SS-4	25	21	2 2 2	4
10	3.0	3.0		**SILTY SAND** - Grey and black (layered) Silty Sand, trace WOOD/ROOTS, moist to wet, very loose				2	
11					SS-5	100	26	2 2 2	4
12									
13	4.0								
14									
15		4.6		Grey and black (layered) Silty Sand, , moist to wet, loose				3	
16					SS-6	100	30	4 4 3	8
17	5.0	5.0		Grey					
18									
19									
20	6.0							4	
21					SS-7	100	33	5 5 4	10
22		6.7		END OF BOREHOLE					
23	7.0								
24									
25									
26	8.0								
27									
28									
29	9.0								

Shear test (Cu) △ Field
Sensitivity (S) □ Lab
○ Water content (%)
W_P W_l Atterberg limits (%)
× "N" Value (blows / 0.3 m) ◆ RQD ◎ CONE

10 20 30 40 50 60 70 80 90

COMMENTS

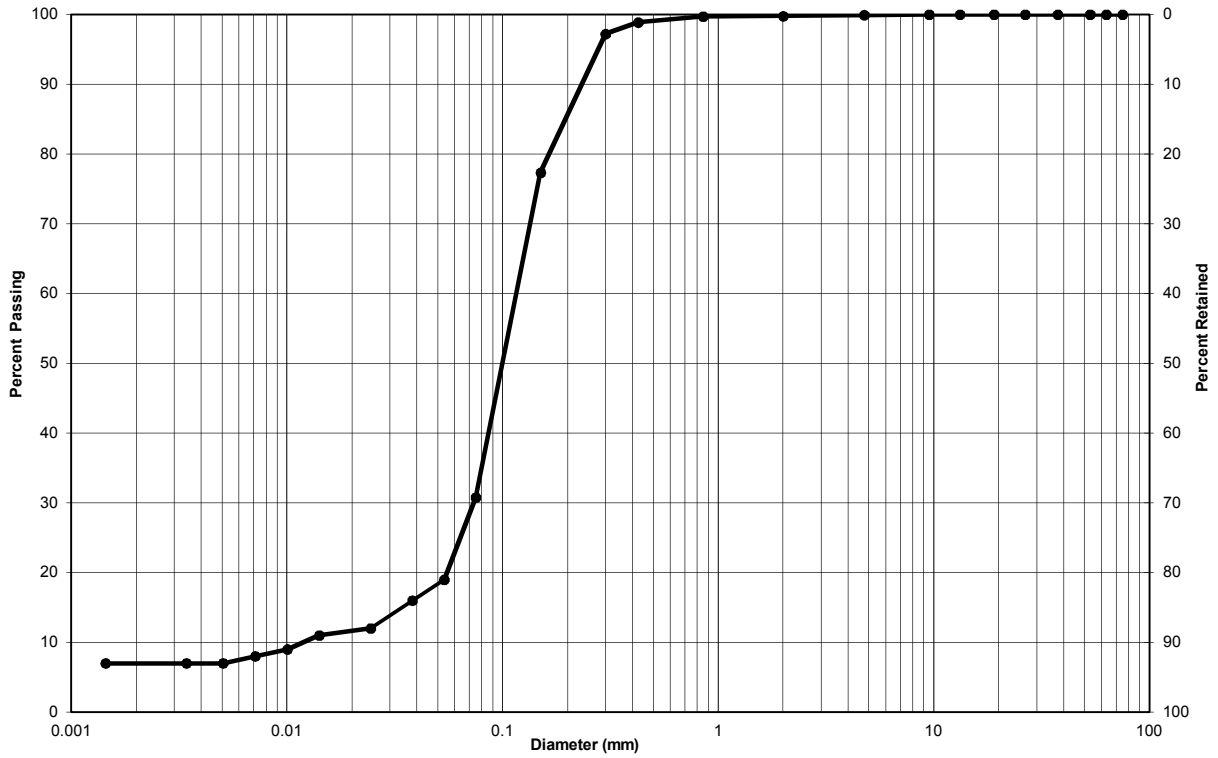
Caving of borehole encountered at approximately 0.9 mbeg. Groundwater seepage and accumulation was present beneath cave, but depth not able to be measured.

BOREHOLE LOG GEOTECH 11103905-01, 15-09-15, BOREHOLE LOGS.GPJ GEOLOGIC.GDT 10/20/15

Appendix B
Physical Laboratory Data

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

Client:	MMM Group	**Lab no.:**	SS-15-70
Project/Site:	Boundary Road Bridge	**Project no.:**	11103905-01
Borehole no.:	BH2	Sample no.:	SS5
Depth:	4.6 to 5.2 mbeg	Enclosure:	B-1



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

Soil Description	Gravel	Sand	Clay & Silt
BH2 SS5	0	69	31

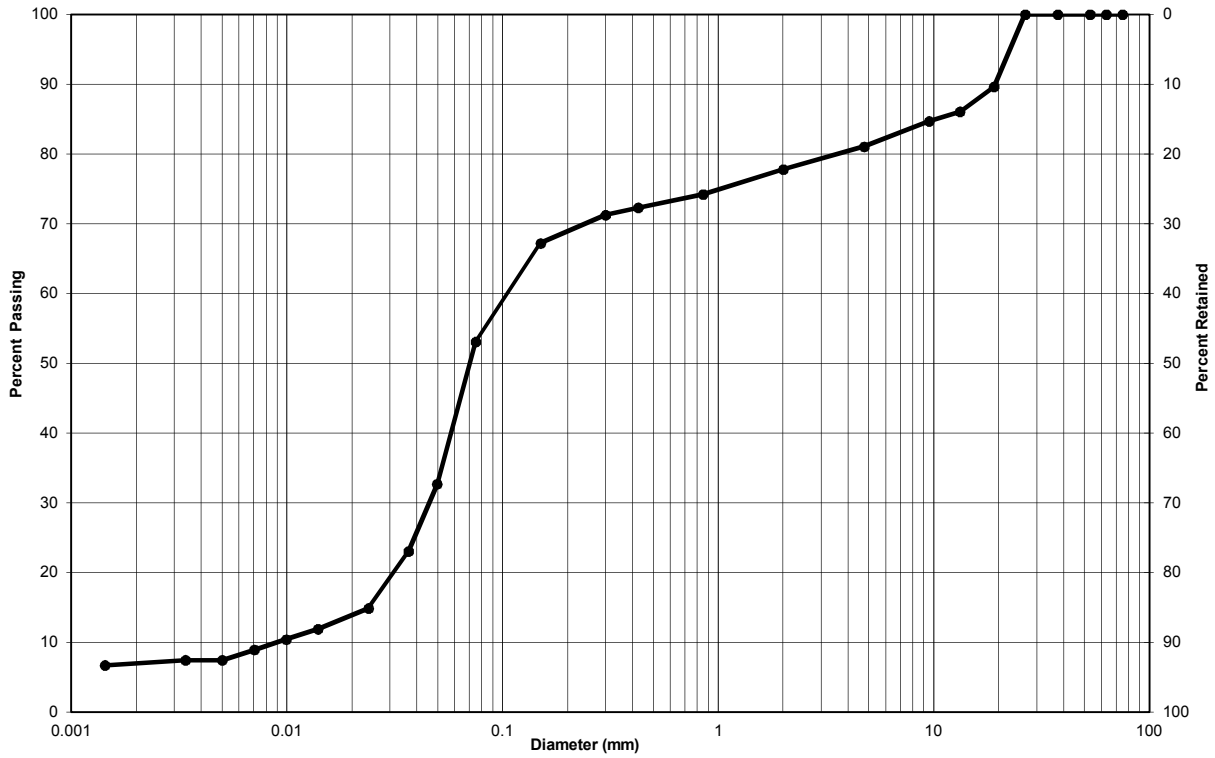
Remarks:

Performed by:		**Date:**	August 6, 2015
Verified by:		**Date:**	August 6, 2015

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

Client:	MMM Group	**Lab no.:**	SS-15-70
Project/Site:	Boundary Road Bridge	**Project no.:**	11103905-01

Borehole no.:	BH3	Sample no.:	SS2
Depth:	8.7 to 9.1 mbeg	Enclosure:	B-2



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

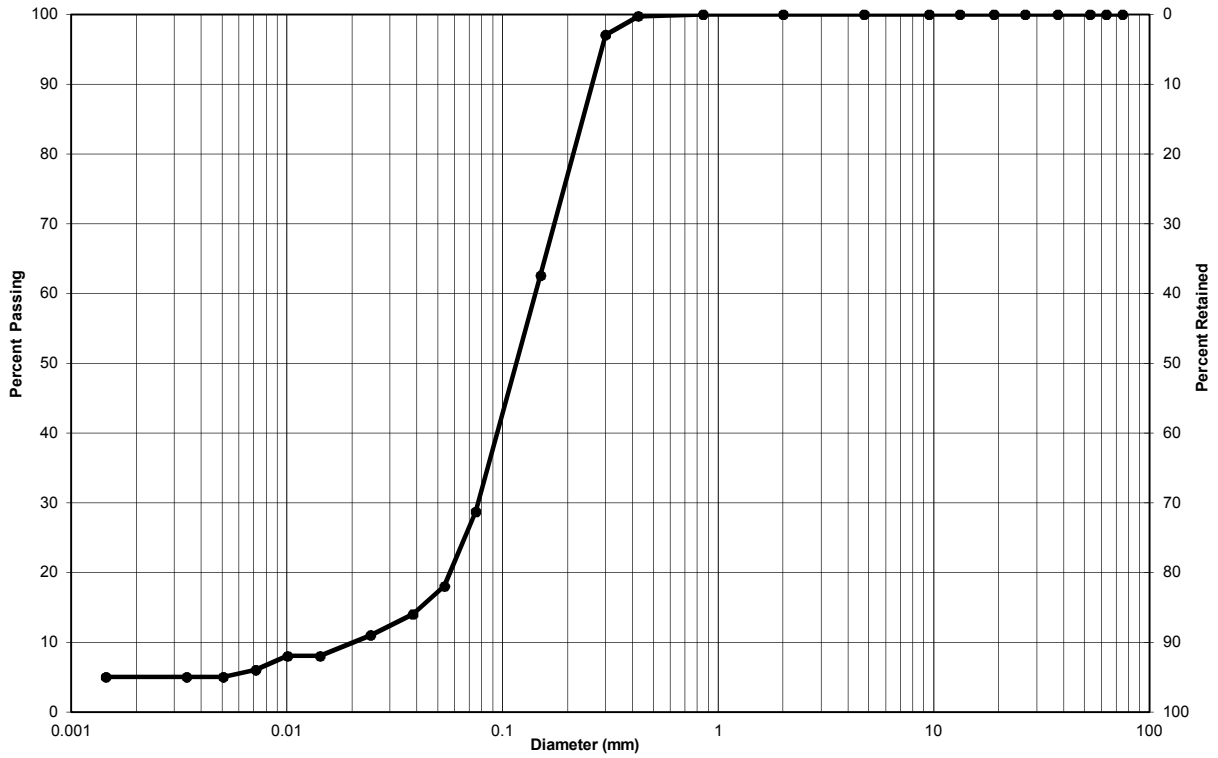
Soil Description	Gravel	Sand	Clay & Silt
BH3 SS2	19	28	53

Remarks:

Performed by:		**Date:**	August 6, 2015
Verified by:		**Date:**	August 6, 2015

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

Client:	MMM Group	**Lab no.:**	SS-15-70
Project/Site:	Boundary Road Bridge	**Project no.:**	11103905-01
Borehole no.:	BH4	Sample no.:	SS8
Depth:	7.6 to 8.2 mbeg	Enclosure:	B-3



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

Soil Description	Gravel	Sand	Clay & Silt
BH4 SS8	0	71	29

Remarks:

Performed by:		**Date:**	August 6, 2015
Verified by:		**Date:**	August 6, 2015