FOUNDATION INVESTIGATION AND DESIGN REPORT
DETAIL DESIGN
MINDEMOYA LAKE BRIDGE AND DAM REPLACEMENT
HIGHWAY 542, MANITOULIN ISLAND
G.W.P. 5460-04-00, SITE 49-023

Geocres Number: 41G-8

Report to

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PART A: FACTUAL INFORMATION

1 INTRODUCTION

This report presents the factual findings obtained from a foundation investigation conducted for the proposed replacement of the bridge and dam located on Highway 542 at the south end of Mindemoya Lake. The existing structure consists of a combined dam and bridge at the outlet of Mindemoya Lake to Mindemoya River.

A preliminary foundation investigation was carried out for this project by Thurber in August 2006, and the factual data from that investigation has been incorporated into the current assignment.

The purpose of the investigation was to explore the subsurface conditions at the site and, based on the data obtained, to provide a borehole location plan, borehole logs, stratigraphic profile and a written description of the subsurface conditions. A model of the subsurface conditions was developed to describe the geotechnical conditions influencing design and construction of the foundations and approach embankments for the proposed replacement bridge and dam.

Thurber carried out the investigation as a sub-consultant to McCormick Rankin Corporation, under the Ministry of Transportation Ontario (MTO) Agreement Number 5004-E-0056.

2 SITE DESCRIPTION

The bridge and dam site lies at the south end of Mindemoya Lake on Highway 542, approximately 6 km west of the Town of Mindemoya on Manitoulin Island. It lies in the Township of Central Manitoulin, District of Manitoulin.

The general site area is located within the physiographic region referred to as Manitoulin Island. The island is part of the Niagara cuesta, the rim of a large dolomitic saucer underlying the Michigan basin. It is characterized by a dolostone bedrock plain, gradually rising out of Lake Huron along the south side of the island and terminating in successive step cliffs along the centre and north sides of the island.

Mindemoya Lake and the study site itself are located within a broad lowland between areas of bedrock plain, formed by infilling of a north-south trending bedrock channel with stratified deposits of clay, sand and silt during submergence of the island by glacial Lake Algonquin.

Highway 542 forms the south boundary of Mindemoya Lake, with the roadway embankment constructed approximately 1 to 2 m above adjacent grade to create an earth dam. The lake is relatively shallow upstream of the structure (approximately 0.5 m) and the downstream river was approximately 0.3 m deep at the time of the investigation. Vegetation in the ditches along the downstream side of the dam indicates wet conditions and probable seepage through the dam.

Photographs of the site are provided in Appendix C. The existing outlet structure at Mindemoya River consists of an integrated stop log control structure and concrete deck bridge. The existing bridge deck has a span of 6.1 m and width of 6.0 m. The lands to the south of Highway 542 comprise relatively flat farmland. Brush and trees have reclaimed much of the property west of Mindemoya River.

3 SITE INVESTIGATION AND FIELD TESTING

Thurber carried out site investigation and field testing for the detailed design phase of this project during the period July 12 to August 10, 2007. The fieldwork for the preliminary investigation was carried out from August 21 to 27, 2006. In total, 27 boreholes were drilled and sampled at the locations of the proposed bridge, dam control structure, approaches and embankments.

The approximate locations of the boreholes are shown on the attached Borehole Locations and Soil Strata Drawings in Appendix D. The locations and depths of the boreholes were as follows:

Table 3.1 – Borehole Details

Location	Study Phase	Number of Boreholes	Borehole Numbers	Depth of Boreholes (m)
Proposed Bridge Abutments	Detail	4	07-M6, 07-M7, 07-M14, 07-M15	30.2 to 37.2
Proposed Control Structure	Preliminary	3	06-M1, 06-M3, 06-M4	35.1 o 37.7
	Detail	3	07-M1, 07-M3, 07-M4	34.7 to 35.1
Structure Approaches	Detail	4	07-M2, 07-M5, 07-M11, 07-M12	15.8 to 20.4
Existing and Proposed Embankments	Preliminary	9	06-M7 to 06-M15	13.0 to 33.4
	Detail	4	07-M8, 07-M9, 07-M10, 07-M13	15.7 to 15.8

The borehole depths in Table 3.1 include recovery of an approximate 3 m length of rock core at four locations.

Thurber positioned the boreholes in the field relative to the centreline of Highway 542 and the existing bridge structure. The coordinates and ground surface elevations at the boreholes were subsequently established by MRC. The coordinates and elevations of the boreholes are given on the Borehole Locations and Soil Strata Drawing and on the individual Record of Borehole Sheets in Appendix A.

A layer of rock fill surrounded by silt fence was placed in Mindemoya Lake and on the east bank of Mindemoya River to form platforms for drilling of boreholes 06-M01, 07-M1, 07-M7 and 07-M15. The rock fill was removed following completion of drilling.

A combination of hollow stem auger and rotary drilling techniques was used to advance the boreholes. Samples were obtained using a split spoon sampler in conjunction with Standard Penetration Tests (SPT). Where soft to firm cohesive soils were encountered, the undrained shear strength was evaluated using the MTO shear vane, and thin wall tube samples were recovered. The boreholes were supplemented by dynamic cone penetration testing. Bedrock cores were recovered using NQ coring equipment.

A member of Thurber's engineering staff supervised the drilling and sampling operations on a full time basis. The inspector logged the soil and groundwater conditions encountered in the boreholes, and collected, labelled and arranged for transport of the samples to Thurber's laboratory.

Standpipe piezometers and monitoring wells were installed in and adjacent to selected boreholes to monitor groundwater levels and conduct field permeability testing. The completion details of the piezometers and wells are presented in Table C1 of Appendix C.

The boreholes without piezometers were grouted upon completion, and the piezometers and monitoring wells were subsequently decommissioned in accordance with the abandonment requirements of MOE Reg. 903.

Field permeability (slug) testing was carried out in six monitoring wells installed in or adjacent to boreholes 07-M3, 07-M4 and 07-M6. The tests were carried out in general accordance with ASTM D 4044-96. The results are presented in Appendix C.

4 LABORATORY TESTING

All recovered soil samples were subjected to visual identification and to natural moisture content determination. The results of this testing are shown on the Record of Borehole sheets in Appendix A.

Selected samples were subjected to gradation analysis (sieve and hydrometer) and Atterberg Limits testing. A thin wall tube sample of silty clay from borehole 07-M1 was selected for one-dimensional consolidation testing. The results are shown on the Record of Borehole sheets in Appendix A and on the charts in Appendix B.

The rock core descriptions were confirmed in the laboratory and Point Load Tests were conducted to assess the compressive strength of the rock.

5 DESCRIPTION OF SUBSURFACE CONDITIONS

5.1 General

Reference is made to the Record of Borehole sheets in Appendix A and to the Borehole Locations and Soil Strata Drawings in Appendix D. An overall description of the stratigraphy based on the conditions encountered in the boreholes is given in the following paragraphs. However, the factual data presented in the borehole logs takes precedence over this general description and interpretation of the site conditions.

The soil stratigraphy encountered at this site generally consists of existing road embankment fill and/or relatively thin layers of topsoil, sand or silt, overlying a layer of soft to stiff silty clay, underlain by a silt stratum and a thick deposit of sand. The sand overlies bedrock.

More detailed descriptions of the individual strata are presented below.

It is noted that a 0.6 to 1.2 m thick layer of rockfill was placed to form a drilling platform at boreholes 06-M1, 07-M1, 07-M7 and 07-M15. In the description below, depths at these locations are referenced to the top of the rockfill, which has since been removed.

5.2 Proposed Bridge Location

Boreholes 07-M6, 07-M7, 07-M14 and 07-M15 were drilled at the proposed bridge abutments. Boreholes 07-M11 and 07-M12 were drilled at the approaches.

5.2.1 Topsoil

A 150 to 275 mm thick layer of topsoil was encountered surficially at the west abutment and both approaches. Topsoil was not encountered in the boreholes at the east abutment situated within the riverbank. The topsoil thickness may vary between and beyond the borehole locations and the data is not intended for the purpose of estimating quantities.

5.2.2 Upper Silt and Sand Layers

Layers of silt and sand were encountered below the topsoil at the west abutment and both approaches. These deposits comprised sand, trace silt, to silt, trace sand, and contained trace rootlets, topsoil, wood fibres, and locally shells. The colour varied between dark brown, brown and grey.

SPT N-values obtained in these deposits ranged from 4 to 13 blows/0.3 m, indicating a loose to compact condition.

The natural moisture content of recovered samples ranged from 19 to 39%, with one sample at 4%.

The total thickness of the sand/silt layers was 1.1 to 1.2 m, with the base at 1.4 m depth (elevation 195.4 to 195.6 m).

5.2.3 Silty Clay

A layer of silty clay was encountered below the sand/silt at the west abutment and approaches, and immediately below the rockfill drilling platform at the east abutment.

Based on SPT values of 2 to 15 blows/0.3 m, the consistency of the clay is soft to stiff. The undrained shear strength of the clay, assessed by in situ vane testing, ranged from 36 to 80 kPa (firm to stiff).

The natural moisture content of the silty clay ranged from 21 to 36%.

The results of laboratory tests carried out on five samples were as follows:

Gravel %	0
Sand %	0 to 1
Silt %	65 to 76
Clay %	23 to 34
Liquid Limit	29 to 38
Plastic Limit	17 to 20

The results of these tests indicate that the silty clay is a CL to CI soil (low to medium plasticity).

The grain size distribution curves for the samples tested are shown in Figures 07-B3 and 07-B4, Appendix B. The Atterberg Limits are plotted on Figures 07-B15 and 07-B16.

The clay layer ranged in thickness from 1.4 to 4.7 m. The depth to the base of the clay layer ranged from 2.2 to 6.1 m (elevation 190.9 to 193.9 m).

5.2.4 Silt

The clay was underlain by a layer of silt at all borehole locations. The silt contained trace to some clay, trace sand and was described as grey and wet. The bottom 3.2 m of this unit, below 8.4 m depth, at the north end of the east abutment (BH07-M7) was described as clayey silt to silty clay.

SPT N-values obtained in the silt ranged from 4 to 33 blows/0.3 m, indicating a loose to dense condition.

The natural moisture content of recovered samples ranged from 17 to 28%.

The results of laboratory tests carried out on eight samples were as follows:

Gravel %	0 to 1
Sand %	0 to 5
Silt %	77 to 85
Clay %	13 to 23

The grain size distribution curves for the samples tested are shown in Figures 07-B6 to 07-B8, Appendix B.

The silt unit ranged in thickness from 4.5 to 9.4 m. The depth to the base of the silt ranged from 9.1 to 11.9 m (elevation 183.6 to 187.7 m).

5.2.5 Sand

Sand was encountered below the silt unit in all boreholes. The sand varied from trace silt content to silty, and contained trace gravel and occasional silt inclusions. It was described as grey and wet.

SPT N-values obtained in the sand typically ranged from 20 to 49 blows/0.3 m, indicating a compact to dense condition. Isolated values of 10 and 56 blows/0.3 m were also obtained.

The natural moisture content of recovered samples ranged from 14 to 29%.

The results of laboratory tests carried out on eleven samples were as follows:

Gravel %	0 to 3
Sand %	59 to 95
Silt & Clay %	4 to 41

The grain size distribution curves for the samples tested are shown in Figures 07-B10 to 07-B12, Appendix B. The percentage of silt and clay size particles in two samples (37 and 41%) may reflect the presence of silt inclusions in the samples tested.

The sand extended to auger refusal or top of bedrock at depths of 30.2 to 34.1 m (elevation 162.9 to 165.0 m), indicating a deposit thickness of 18.6 to 23.7 m. The approach boreholes were terminated in sand at 15.8 m depth.

5.2.6 Bedrock and/or Refusal

Auger refusal was encountered on bedrock, probable bedrock, and a possible boulder at the depths and elevations listed in Table 5.1.

Table 5.1 – Depth to Bedrock and/or Refusal

Location	Borehole	Bedrock and/or Refusal		Comment
		Depth (m)	Elevation (m)	
West Abutment North End	07-M6	34.1	162.9	Bedrock proven by coring
West Abutment South End	07-M14	33.8	163.0	Probable bedrock
East Abutment North End	07-M7	30.2	165.0	Probable boulder above the bedrock surface
East Abutment South End	07-M15	32.0	163.4	Bedrock proven by coring

The bedrock recovered in the core samples consists of dolostone. The rock is described as fresh, thinly bedded, and brown to grey.

The core recovery was 100%. The measured RQD values in the full core runs ranged from 90 to 100%, indicating an excellent quality rock. The Fracture Index was 0 except for a single value of 3 fractures in the top 0.3 m of one core.

Based on Point Load Testing, the unconfined compressive strength of the bedrock was estimated to range from about 125 to 155 MPa. Based on these strength values and the classification system given in the Canadian Foundation Engineering Manual, the rock is classified as very strong.

5.2.7 Groundwater

The initial and final groundwater depths and elevations measured in the boreholes and piezometers are shown in Table 5.2.

Table 5.2 – Groundwater Depths and Elevations

Location	Borehole	Tip Depth (m)	Date	Water Level (m)	
				Depth	Elevation
West Approach	07-M11	15.2	18-Jul-07	2.0	194.8
			20-Jul-07	2.0	194.8
			17-Aug-07	2.1	194.7
			28-Aug-07	2.3	194.5
West Abutment North End	07-M6	7.6	18-Jul-07	2.3	194.7
			20-Jul-07	2.0	195.0
			17-Aug-07	2.2	194.8
			28-Aug-07	2.6	194.4
		12.5	18-Jul-07	1.9	195.1
			20-Jul-07	1.8	195.2
			17-Aug-07	1.9	195.1
			28-Aug-07	2.4	194.6
West Abutment South End	07-M14	7.6	18-Jul-07	2.1	194.7
			20-Jul-07	2.1	194.7
			17-Aug-07	2.0	194.8
			28-Aug-07	1.8	195.0
East Abutment North End	07-M7	7.6	20-Jul-07	1.4	193.8
			17-Aug-07	0.7	194.5
			28-Aug-07	1.0	194.2
East Abutment South End	07-M15	16.8	17-Aug-07	0.6	194.8
			28-Aug-07	1.4	194.0

The above water levels reflect the piezometric head at the level of the piezometer tips at the time of the investigation. The measurements are short-term observations and seasonal fluctuations of the groundwater level are to be expected.

5.3 Proposed Control Structure Location

Boreholes 06-M1, 06-M3, 06-M4, 07-M1, 07-M3 and 07-M4 were drilled at the proposed control structure. Boreholes 07-M2 and 07-M5 were drilled at the approaches.

5.3.1 Pavement and Existing Embankment Fill

A 25 to 50 mm thick layer of asphalt, appearing to comprise surface treatment, was encountered in the five boreholes drilled through the existing Highway 542 pavement.

The existing embankment fill consists primarily of sand. The sand contains variable amounts of silt (trace silt to silty), gravel (trace gravel to gravely), organics, wood fibres, and cobbles and boulders. It is described as moist becoming wet with depth, and brown, locally dark brown and grey.

SPT N-values obtained in the fill ranged from 3 blows/0.3 m to 50 blows/0.15 m penetration, indicating a very loose to very dense condition. The wide variation in recorded N-values may reflect hydraulic disturbance as well as the presence of cobbles and boulders in the fill.

The natural moisture content of recovered samples ranged from 2 to 39%.

The results of laboratory tests carried out on two samples were as follows:

Gravel %	1 to 15
Sand %	56 to 70
Silt & Clay %	15 to 43

The grain size distribution curves for the samples tested are shown in Figures B1 and 07-B1, Appendix B.

The depth to the base of the fill ranged from 1.8 to 4.0 m (elevation 194.0 to 196.1 m).

5.3.2 Upper Silt and Sand Layers

A sand layer was encountered below the rockfill pad placed in the lake. The sand contained trace organics, wood fibres, and shells, and was described as grey and wet. SPT N-values of 2 to 9 blows/0.3 m indicate a loose to very loose condition. Moisture contents of 19 to 56% were measured in the recovered samples.

The lakebed sand layer was 1.2 and 1.7 m thick. The base of this layer was at elevation 194.6 and 194.9 m.

A 0.4 m thick layer of sandy silt was encountered below the embankment fill at the east approach. This layer was described as loose, wet and grey. A moisture content of 18% was measured in one sample. The base of this layer was at elevation 195.7 m.

5.3.3 Silty Clay

A layer of silty clay was encountered below the embankment fill, sand and silt at all locations. The clay was described as grey and moist to wet.

Based on SPT values of 2 to 14 blows/0.3 m, the consistency of the clay is soft to stiff. The undrained shear strength of the clay, assessed by in situ vane testing, ranged from 32 to 64 kPa (firm to stiff).

The natural moisture content of the silty clay ranged from 21 to 38%.

The results of laboratory tests carried out on nine samples were as follows:

Gravel %	0 to 1
Sand %	0 to 6
Silt %	56 to 76
Clay %	23 to 43
Liquid Limit	18 to 35
Plastic Limit	7 to 20

The results of these tests indicate that the silty clay is a CL to CI soil (low to medium plasticity).

The grain size distribution curves for the samples tested are shown in Figures B3, 07-B2 and 07-B3, Appendix B. The Atterberg Limits are plotted on Figures B13 and 07-B14.

The results of consolidation testing conducted on a sample of the silty clay are included in Appendix B and summarized below.

Borehole	Depth (m)	w_o (%)	γ (kN/m^3)	e_o	p_o' (kPa)	p_c' (kPa)	OCR	C_c	C_r
07-M1	3.0-3.6	31	18.9	0.86	30	200	6.7	0.29	0.04

The clay layer ranged in thickness from 2.1 to 4.9 m. The depth to the base of the clay layer ranged from 6.0 to 7.3 m (elevation 190.3 to 192.0 m).

5.3.4 Silt

The clay was underlain by silt at all borehole locations. The silt contained trace to some clay, trace to some sand and was described as grey and wet.

SPT N-values obtained in the silt typically ranged from 1 to 29 blows/0.3 m, indicating a very loose to compact condition. Four values of 33 to 61 blows/0.3 m were obtained, indicating localized dense to very dense zones.

The natural moisture content of recovered samples ranged from 16 to 32%.

The results of laboratory tests carried out on nine samples were as follows:

Gravel %	0
Sand %	1 to 6
Silt %	82 to 90
Clay %	6 to 15

The grain size distribution curves for the samples tested are shown in Figures B6, 07-B5 and 07-B6, Appendix B.

The silt unit ranged in thickness from 4.9 to 8.8 m. The depth to the base of the silt ranged from 11.7 to 14.8 m (elevation 183.1 to 186.2 m).

5.3.5 Sand

Sand was encountered below the silt unit in all boreholes. The sand contained trace to some silt and occasional gravel and cobbles. It was described as brown to grey and wet.

SPT N-values obtained in the sand ranged from 8 blows/0.3 m to 100 blows/.125 m penetration, indicating a loose to very dense condition. An isolated value of 1 blow per 0.3 m probably resulted from hydraulic disturbance.

The natural moisture content of recovered samples ranged from 14 to 26%.

The results of laboratory tests carried out on twelve samples were as follows:

Gravel %	0
Sand %	80 to 97
Silt & Clay %	3 to 20

The grain size distribution curves for the samples tested are shown in Figures B9, B10, 07-B9 and 07-B10, Appendix B. The results of three additional samples from this unit, not included in the percentages listed above, indicate the presence of sand and silt layers and occasional gravel or cobbles within the sand.

The sand typically extended to auger refusal at depths of 34.7 to 35.2 m (elevation 162.6 to 163.2 m), indicating a deposit thickness of 21.8 to 23.2 m. However, the sand was interrupted by a silty clay layer at one location (BH07-M3) and was underlain by silt at 27.4 m depth (elevation 169.5 m) at another location (BH06-M1). The approach boreholes were terminated in sand at 20.4 m depth.

5.3.6 Localized Silt, Silt Till and Silty Clay Layers

At the northwest corner of the proposed structure location (BH06-M1), the sand was underlain by silt overlying silt till. The silt contained some sand and was described as grey a wet. SPT N-values of 18 and 24 blows/0.3 m obtained in the silt indicate a compact condition. Moisture contents of 17 and 21% were measured in two recovered samples. The base of this layer was at elevation 163.2 m.

The underlying silt till contained some sand and gravel and occasional limestone fragments. An N-value of 52 blows/0.3 m indicates a very dense condition. A moisture content of 11% was measured in this deposit. The till extended to auger refusal at 34.6 m depth (elevation 162.3 m).

A 5.2 m thick layer of silty clay was encountered within the sand at the west side of the structure location (BH07-M3) between depths of 27.6 and 32.8 m (elevation 170.4 and 165.2 m). This layer was hard (N-values of 30 blows/0.3 m and 66 blows/0.275 m). Natural moisture contents of 26 and 12% were measured.

5.3.7 Bedrock and/or Refusal

Auger refusal was encountered on bedrock and probable bedrock at the depths and elevations listed in Table 5.3.

Table 5.3 – Depth to Bedrock and/or Refusal

Location	Borehole	Bedrock and/or Refusal		Comment
		Depth (m)	Elevation (m)	
Northwest Corner	06-M1	34.6	162.3	Bedrock proven by coring
West Central Side	07-M3	34.8	163.2	Probable bedrock
Southwest Corner	06-M3	35.1	163.0	Probable bedrock
Northeast Corner	07-M1	34.7	162.6	Probable bedrock
East Central Side	07-M4	35.1	162.9	Probable bedrock
Southeast Corner	06-M4	35.2	162.8	Bedrock proven by coring

The bedrock recovered in the core samples consists of dolostone. The rock is described as fresh, thinly to medium bedded, and light brown to grey or dark brown. The core recovery was 100% in three core runs and 78% in the initial run in borehole 06-M04 where cobbles or very weathered rock was encountered in the first 275 mm of core. The measured RQD values in the full core runs ranged from 98 to 100%, indicating an excellent quality rock. The Fracture Index was generally 0 to 1, with single values of 2 and 4 fractures/0.3 m.

Based on Point Load Testing, the unconfined compressive strength of the bedrock was estimated to range from about 122 to 169 MPa. Based on these strength values and the classification system given in the Canadian Foundation Engineering Manual, the rock is classified as very strong.

5.3.8 Groundwater

The initial and final groundwater depths and elevations measured in the boreholes and piezometers are shown in Table 5.4.

Table 5.4 – Groundwater Depths and Elevations

Location	Borehole	Tip Depth (m)	Date	Water Level (m)	
				Depth	Elevation
West Central Side	07-M3	2.3	17-Aug-07	1.3	196.7
			29-Aug-07	1.3	196.7
		4.6	17-Aug-07	1.3	196.7
			28-Aug-07	1.3	196.7
		7.6	17-Aug-07	2.5	195.5
			28-Aug-07	2.2	195.8
Southwest Corner	06-M3	35.1	27-Aug-06	3.5	194.6
			31-Aug-06	3.6	194.5
East Central Side	07-M4	2.2	17-Aug-07	1.2	196.8
			29-Aug-07	1.3	196.7
Southeast Corner	06-M4	37.7	27-Aug-06	3.3	194.7
			31-Aug-06	3.5	194.5
			18-Jul-07	3.2	194.8

The above water levels reflect the piezometric head at the level of the piezometer tips at the time of the investigation. The measurements are short-term observations and seasonal fluctuations of the groundwater level are to be expected. The groundwater levels will fluctuate in conjunction with the water level in the lake, which was near elevation 197 m at the time of the fieldwork.

5.4 Existing and Proposed Embankments

Boreholes 06-M7 to 06-M15, 07-M8 to 07-M10, and 07-M13 were drilled along the existing and proposed embankments.

5.4.1 Pavement and Existing Embankment Fill

A 25 mm thick layer of asphalt, appearing to comprise surface treatment, was encountered in two boreholes drilled through the existing Highway 542 alignment.

The existing embankment fill encountered in the embankment boreholes consists of sand, sand and gravel, and silty sand. The fill contains organics, wood fibres, and cobbles and boulders. It is described as moist and brown, locally dark brown.

SPT N-values obtained in the fill typically ranged from 2 to 21 blows/0.3 m, indicating a very loose to compact condition. Two values of 40 blows/0.3 m and 50 blows/0.125 m penetration were obtained in gravel and rock fragments, respectively.

The natural moisture content of recovered samples ranged from 2 to 22%, with one sample at 45%.

The results of laboratory tests carried out on two samples were as follows:

Gravel %	5 to 22
Sand %	67 to 80
Silt & Clay %	11 to 15

The grain size distribution curves for the samples tested are shown in Figure B1, Appendix B.

The depth to the base of the fill ranged from 0.9 to 2.3 m (elevation 195.5 to 197.0 m).

5.4.2 Topsoil and Peat

A topsoil layer was encountered surficially at five locations along the new embankment location. The topsoil layer was 50 to 500 mm thick. The topsoil thickness may vary between and beyond the borehole locations and the data is not intended for the purpose of estimating quantities.

A peat layer was encountered surficially at one location (BH07-M8) and below existing embankment fill at another location (BH06-M8) west of the bridge. The surficial and buried peat layers were 300 and 100 mm thick, respectively, with a base elevation of 196.0 m. Moisture contents of 60 and 65% were measured in the peat.

A peat layer was also encountered within the upper silt unit near the west limit of new embankment (BH06-M7). The buried peat layer was 0.9 m thick, extending from 4.3 to 5.2 m depth (elevation 193.5 to 192.6 m). A moisture content of 198% was measured in one sample from this layer.

5.4.3 Upper Silt and Sand Layers

Layers of silt, sandy silt, silty sand and sand were encountered below the fill, peat and topsoil at all but two locations (BH06-M15 and 07-M13). These deposits were typically described as moist to wet and grey, locally brown to dark brown.

SPT N-values obtained in the silt and sand deposits ranged from 1 to 8 blows/0.3 m, indicating a loose to very loose condition.

The natural moisture content of recovered samples ranged from 17 to 39%.

The results of laboratory tests carried out on three samples were as follows:

Gravel %	0
Sand %	5 to 36
Silt %	59 to 87
Clay %	5 to 10

The grain size distribution curves for the samples tested are shown in Figure B2, Appendix B.

The total thickness of the sand/silt layers was 0.1 to 2.8 m, with the base at 0.8 to 4.3 m depth (elevation 193.4 to 195.6 m). At one location at the west end of the study area (BH06-M7), the silt deposit was encountered between 2.3 and 6.1 m depth (elevation 195.5 to 191.7 m) but contains a peat layer between 4.3 and 5.2 m depth.

5.4.4 Silty Clay

A layer of silty clay was encountered below the embankment fill, topsoil, sand and silt at all locations. The clay was described as grey and moist to wet.

Based on SPT values of 0 to 16 blows/0.3 m, the consistency of the clay is very soft to very stiff. The undrained shear strength of the clay, assessed by two in situ vane tests, was 56 and 60 kPa (stiff).

The natural moisture content of the silty clay ranged from 19 to 38%.

The results of laboratory tests carried out on 15 samples were as follows:

Gravel %	0
Sand %	0 to 1
Silt %	53 to 79
Clay %	21 to 46
Liquid Limit	18 to 37 (typically 32 to 36)
Plastic Limit	7 to 21 (typically 17 to 21)

The results of these tests indicate that the silty clay is a CL to CI soil (low to medium plasticity).

The grain size distribution curves for the samples tested are shown in Figures B3 to B5, 07-B3 and 07-B4, Appendix B. The Atterberg Limits are plotted on Figures B13 to B15, 07-B15 and 07-B16.

The clay layer generally ranged in thickness from 1.5 to 4.2 m, increasing to 7.9 m at the east limit of investigation (BH06-M15). The depth to the base of the clay layer ranged from 3.5 to 9.4 m (elevation 188.4 to 193.2 m).

5.4.5 Silt

The clay was underlain by silt at all borehole locations. The silt contained trace to some clay, trace to some sand and was described as grey and wet.

SPT N-values obtained in the silt typically ranged from 1 to 26 blows/0.3 m, indicating a very loose to compact condition.

The natural moisture content of recovered samples ranged from 17 to 30%, typically 17 to 23%.

The results of laboratory tests carried out on 15 samples were as follows:

Gravel %	0
Sand %	1 to 16
Silt %	73 to 91
Clay %	8 to 14

The grain size distribution curves for the samples tested are shown in Figures B6 to B8 and Figures 07-B6 to 07-B8, Appendix B.

The silt unit ranged in thickness from 3.6 to 12.2 m. The depth to the base of the silt ranged from 7.6 to 17.8 m (elevation 180.1 to 189.3 m). One borehole (BH06-M14) was terminated in the silt at 20.1 m depth (elevation 177.6 m).

5.4.6 Sand

Sand was encountered below the silt unit in all but four boreholes (BH06-M7, 06-M14, 06-M15 and 07-M13). The sand contained trace to some silt and occasional gravel and cobbles. It was described as grey and wet.

SPT N-values obtained in the sand ranged from 10 to 42 blows/0.3 m, indicating a compact to dense condition. Values of 74 and 120 blows/0.3 m (very dense) were obtained on single occasions. An isolated value of 2 blows per 0.3 m probably resulted from hydraulic disturbance.

The natural moisture content of recovered samples ranged from 15 to 26%.

The results of laboratory tests carried out on twelve samples were as follows:

Gravel %	0
Sand %	62 to 96
Silt & Clay %	4 to 38

The grain size distribution curves for the samples tested are shown in Figures B10, B11, 07-B10 and 07-B11, Appendix B. The results from one sample, not included in the percentages listed above, indicate the presence of sand and silt layers within the sand.

The sand extended to auger refusal at depths of 33.4 and 32.6 m (elevation 163.2 and 164.1 m) in two boreholes, indicating a deposit thickness of 22.7 and 16.4 m. The remaining boreholes were terminated in the sand at 15.7 to 20.4 m depth.

5.4.7 Localized Clayey Silt, and Silty Clay to Clayey Silt Till

At two locations (BH06-M7 and 07-M13), the non-cohesive silt was underlain by clayey silt. The silt contained trace sand (2 to 4%) and 19 to 23% clay in three samples tested (Figures B6 and 07-B8). SPT N-values of 8 to 18 blows/0.3 m obtained in the clayey silt indicate a stiff to very stiff consistency. Moisture contents of 19 to 30% were measured. The base of this layer was not encountered within the exploration depths of 20.1 and 15.8 m (elevation 177.7 and 180.7 m).

A deposit of till-like silty clay to clayey silt was encountered below the silty clay layer at the east limit of the study area (BH06-M15). This unit was firm to hard, with N-values of 4 and 39 blows/0.3 m recorded. A grain size distribution curve is included in Figure B5. Auger refusal was encountered in this deposit at 13.0 m depth (elevation 184.8 m).

5.4.8 Bedrock and/or Refusal

Auger refusal was encountered on probable bedrock or boulders at the depths and elevations listed in Table 5.5.

Table 5.5 – Depth to Bedrock and/or Refusal

Location	Borehole	Bedrock and/or Refusal		Comment
		Depth (m)	Elevation (m)	
West Embankment	06-M10	33.4	163.2	Probable bedrock
East Embankment	06-M13	32.6	164.1	Probable bedrock
East Embankment	06-M15	13.0	184.8	Probable boulder, possible bedrock

5.4.9 Groundwater

The initial and final groundwater depths and elevations measured in the boreholes and piezometers are shown in Table 5.6.

Table 5.6 – Groundwater Depths and Elevations

Location	Borehole	Tip Depth (m)	Date	Water Level (m)	
				Depth	Elevation
West Embankment	06-M9	20.1	27-Aug-06	3.1	194.6
			31-Aug-06	3.1	194.6
West Embankment	06-M10	32.0	26-Aug-06	2.1	194.5
			27-Aug-06	1.9	194.7
			31-Aug-06	2.1	194.5
			18-Jul-07	1.7	194.9
			20-Jul-07	1.7	194.9
			28-Aug-07	1.9	194.7
East Embankment	06-M13	32.6	27-Aug-06	2.9	193.8
			31-Aug-06	2.9	193.8
			18-Jul-07	1.8	194.9
			20-Jul-07	1.8	194.9
			28-Aug-07	1.8	194.9
East Embankment	06-M14	20.1	27-Aug-06	3.0	194.7
			31-Aug-06	2.8	194.9
			18-Jul-07	1.6	196.1
			20-Jul-07	1.6	196.1
			28-Aug-07	1.8	195.9

The above water levels reflect the piezometric head at the level of the piezometer tips at the time of the investigation. The measurements are short-term observations and seasonal fluctuations of the groundwater level are to be expected. The groundwater levels will fluctuate in conjunction with the water level in the lake, which was near elevation 197 m at the time of the fieldwork.

Artesian pressure to 1.5 m above the ground surface was encountered while drilling at about 25 m depth in borehole 06-M10. The pressure dissipated during continued drilling. Slight artesian pressure was also noted near 9 m depth in borehole 06-M13.

5.5 Field Permeability Testing

Field permeability (slug) testing was carried out in six monitoring wells installed in or adjacent to the existing dam embankment to evaluate the in situ hydraulic conductivity of the embankment and foundation soils. The results of these tests are presented in Appendix C and summarized in Table 5.7. For comparison, the average hydraulic conductivity of the various deposits was also estimated based on Hazen's formula and the grain size distribution curves.

Table 5.7 – Results of Hydraulic Conductivity Tests

Material Type	Monitoring Well	Estimated Hydraulic Conductivity (cm/s)	
		In Situ Test	Hazen's Formula
Embankment Fill	07-M3-2	3×10^{-4}	10^{-3}
	07-M4-2	4×10^{-4}	10^{-3}
Silty Clay	07-M3-5	7×10^{-6}	10^{-6}
	07-M3-8	1×10^{-5}	10^{-6}
Silt	07-M6-8	2×10^{-5}	10^{-5}
Sand	07-M6-12	1×10^{-4}	10^{-2}

The discrepancy in predicted and measured hydraulic conductivity may be attributed to variations in properties within the same deposits, inherent inaccuracies in the test method, and installation of the well infiltration zone (sand filter) partially within two different stratigraphic units.

6 MISCELLANEOUS

McCormick Rankin Corporation determined the co-ordinates and ground elevations at the boreholes following completion of the site investigation.

George Downing Estate Drilling Ltd. supplied and operated the drilling and sampling equipment. Full time supervision of the field activities, including obtaining utility clearances, was carried out by Mr. George Azzopardi and Mr. Stephane Loranger of Thurber.

Supervision of the field program, interpretation of the field data, and preparation of the report was performed by Mr. Murray Anderson, P.Eng. The report was reviewed by Mr. Alastair Gorman, P.Eng., and by Dr. P.K. Chatterji, Ph.D., a Designated Principal Contact for MTO Foundations Projects.

Thurber Engineering Ltd.
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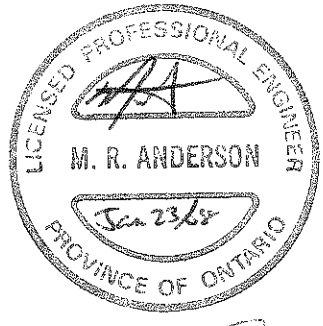
Senior Geotechnical Engineer



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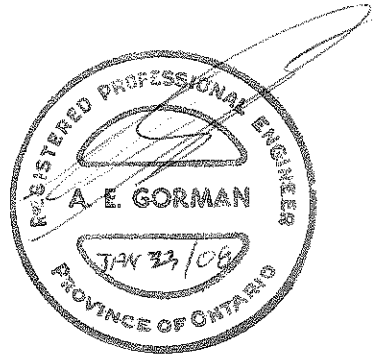

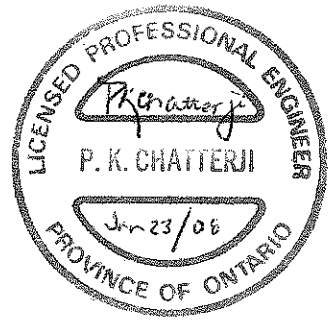

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Review Principal

FOUNDATION INVESTIGATION AND DESIGN REPORT
DETAIL DESIGN
MINDEMOYA LAKE BRIDGE AND DAM REPLACEMENT
HIGHWAY 542, MANITOULIN ISLAND
G.W.P. 5460-04-00, SITE 49-023

Geocres Number: 41G-8

PART B: ENGINEERING DISCUSSION AND RECOMMENDATIONS

7 INTRODUCTION

This report presents interpretation of the geotechnical data in the factual report and presents geotechnical design recommendations to assist selection and design of the foundation system and approach embankments for the proposed bridge and dam replacement.

Highway 542 forms the south boundary of Mindemoya Lake, with the roadway embankment constructed approximately 1 to 2 m above adjacent grade to create an earth dam. The existing outlet structure from Mindemoya Lake to Mindemoya River consists of an integrated bridge and stop log control structure. The existing concrete bridge deck has a span of 6.1 m and width of 6.0 m.

The existing bridge and control structure will be replaced with separate structures. The new bridge alignment will be constructed approximately 17 m south of the existing bridge alignment, and the new control structure will be shifted slightly north of the existing alignment.

The new bridge will have a single span of 18.3 m and a width of 12.4 m. Integral abutments are under consideration. Finished road grade over the structure will be at about Elevation 198.0. At the west abutment, the original ground lies at about Elevation 196.5 to 197.0 m, resulting in an approach fill approximately 1.0 to 1.5 m high. At the east abutment, the original ground lies near Elevation 194.0 to 194.5 m, resulting in an approach fill approximately 3.5 to 4.0 m high.

The new control structure will have base dimensions of about 17.8 m (parallel to embankment) by 8 m (in direction of water flow). It will have a top at Elevation 199.0 m, a channel base near Elevation 195.0 m, and be founded near elevation 193.0 m. The channel width will total 12.3 m including a weir, stop logs and sluice gate structure.

The discussion and recommendations presented in this report are based on our understanding of the project and on the factual data obtained in the course of the investigation. The scope of the investigation does not include assessment of the performance and integrity of the existing earth dam.

8 BRIDGE STRUCTURE

8.1 Foundation Alternatives

Foundation alternatives are presented in the following sections together with the corresponding geotechnical design parameters. A foundation scheme preferred from a foundations perspective is recommended.

A comparison of the technical advantages and disadvantages of alternative foundation schemes is presented in Table C2 of Appendix C. Initial consideration was given to spread footings on native soil or engineered fill, driven steel H-piles, and caissons (drilled shafts).

Based on the results of the exploratory boreholes, the subsurface stratigraphy consists of existing road embankment fill and/or relatively thin layers of topsoil, sand or silt, underlain by a 1.4 to 4.7 m thick layer of soft to stiff silty clay. The silty clay is then underlain by a silt unit, which overlies a thick deposit of sand. Bedrock/probable bedrock was contacted below the sand deposit at depths of 32.0 to 34.1 m (elevation 162.9 to 163.4 m).

8.2 Spread Footings

8.2.1 Spread Footings on Native Soil

The near surface soil consists of loose to very loose silts and sands overlying soft to stiff silty clay. The native soil is considered unsuitable for support of spread footings due to the relatively low bearing resistance available, the potential magnitude of settlement, and the risk of scour on bridge footings located downstream of the dam. Accordingly spread footings founded on native soil are not recommended.

8.2.2 Spread Footings on Engineered Fill

Construction of spread footings on engineered fill is not recommended in view of the potential for settlement in the underlying native soils, and construction concerns related to placement of engineered fill at the site. Placement of a fill pad to carry the foundation loads would require a relatively large and deep excavation within close proximity to the existing dam embankment, and may impact the hydraulic functioning of dam. Therefore engineered fill construction is not recommended.

8.3 Driven Steel Piles

The geotechnical conditions encountered at this site are considered suitable for driven steel H-pile foundations. The piles must be driven to bedrock and are expected to encounter refusal on bedrock near elevation 162.9 to 163.4 m.

Design of the piles should be carried out on the basis of the axial geotechnical resistances given in Table 8.1. The SLS condition will not govern for piles bearing on bedrock.

Table 8.1 – Pile Geotechnical Resistance

Pile Section	Factored ULS Resistance (kN)	Estimated Pile Tip Elevation
HP 310 X 110	2,000	162.9 to 163.4
HP 360 X 132	2,400	162.9 to 163.4

The structural resistance of the pile must be checked by the structural designer.

The tip elevations are presented for estimating purposes only and may vary along the abutment locations. The actual pile tip elevations will be controlled as described in Section 8.2.1 Pile Installation.

The tips of all piles should be fitted with H-section rock points from an approved manufacturer such as Titus Steel (Standard H-point), Pruyn Points or approved equivalent. Rock points are recommended for setting the piles on bedrock and tip protection if cobbles or boulders are encountered above the bedrock.

8.3.1 Pile Installation

Pile installation should be in accordance with Special Provision No. 903S01. The foundation drawing should include the note "Piles to be driven to bedrock".

The Contract Documents should contain a NSSP alerting the Bidders to the presence of cobbles and boulders in the sands just above bedrock, the possibility of some piles meeting refusal on a large boulder, and the need to terminate driving before the pile is damaged by overdriving. Suggested text for a NSSP on Pile Installation should contain the following:

"The soil overlying the bedrock contains cobbles and boulders. The presence of cobbles and boulders will potentially have an impact on the installation of driven piles at the site. Some possible impacts that must be taken into consideration include, but are not necessarily limited to:

- *The pile tips must be protected through the use of rock points*
- *The cobbles and boulders may impede the driving of the piles resulting in more arduous driving to reach bedrock*
- *Some piles may meet refusal on boulders that are large enough not to be dislodged or broken by the pile driving*
- *As a result of the presence of boulders, piles may meet refusal at varying depths"*

To facilitate pile installation, embankment fill through which piles will be driven must not contain oversize material, i.e. no particles exceeding 75 mm in size.

A preconstruction condition survey of the existing dam should be carried out prior to commencement of pile driving. Vibration monitoring should be carried out during pile installation to limit potential impacts on the existing structure. The dam condition should be carefully monitored for signs of disturbance by vibrations throughout the construction period.

8.3.2 Downdrag

Downdrag forces will develop along the length of pile embedded in the silty clay and the overlying native soil and fill due to increased approach embankment loads. For design purposes, an unfactored downdrag force of 125 kN per pile is recommended to evaluate the impact of downdrag.

In accordance with Section 6.8.4 of the CHBDC, the factored downdrag load should be added to the factored permanent loads to assess the effects of downdrag. A check should be performed to confirm that the factored permanent plus downdrag loads do not exceed the factored below-ground structural resistance of the pile at the neutral plane. As per the CHBDC, live loads and downdrag loads are not combined.

The factored structural resistance of the pile (factored for structural design and below-ground design) to be used in the downdrag check are:

HP 310 X 110	2,800 kN
HP 360 X 132	3,400 kN

8.3.3 Lateral Resistance of Piles

Considering the loose to very loose and soft to firm condition of the deposits surrounding the upper portion of the piles, it is recommended that batter piles be installed to resist lateral loads (for conventional abutments). If integral abutment design is planned, the upper 3 m of pile length is expected to lie within loose sand/silt and soft to firm silty clay which may provide sufficient flexibility.

The lateral resistance of the piles may be calculated using a value for the coefficient of horizontal subgrade reaction (k_s) and ultimate lateral resistance (p_{ult}) as follows:

$k_s = n_h . z / D$ (kN/m^3)

$p_{ult} = 3 . \gamma . z . K_p$ (kPa)

where

z	=	depth of embedment of pile in metres
D	=	pile width in metres
n_h	=	coefficient of horizontal subgrade reaction (Table 8.2)
γ	=	bulk unit weight (Table 8.2)
K_p	=	passive earth pressure coefficient (Table 8.2)

The above equations and recommended parameters may be used to analyze the interaction between a pile and the surrounding soil. The lateral pressures obtained from the analysis should not exceed the ultimate lateral resistance.

The spring constant, K, for analysis may be obtained by the expression, $K = k_s \times L \times D$ (kN/m), where k_s is the coefficient of horizontal subgrade reaction (kN/m^3), D is the pile width (m) and L is the length (m) of the pile segment or element used in the analysis. The ultimate lateral resistance, P_{ult}, may be obtained from the expression, $P_{ult} = p_{ult} \times L \times D$.

Table 8.2 – Parameters for Lateral Pile Resistance

Location	Elevation	Soil	n_h (kN/m^3)	K_p	Unit Weight* (kN/m^3)
West Abutment	194 to 191	Clay	1,200	2.7	9
	191 to 185	Silt	2,000	3.0	10
	185 to Rock	Sand	6,000	3.4	10
East Abutment	194 to 192	Clay	1,200	2.7	9
	192 to 184	Silt	2,000	3.0	10
	184 to Rock	Sand	6,000	3.4	10

*Buoyant unit weight below the water table.

The total horizontal passive resistance of a single pile should not exceed the following values:

Table 8.3 – Maximum Horizontal Passive Resistance of Piles

Pile	Maximum Passive Resistance	
	Factored ULS	SLS
HP 310X110	120 kN	50 kN
HP360X132	160 kN	60 kN

The modulus of subgrade reaction may have to be reduced, based on the pile spacing. The reduction factors to be used for a pile group oriented perpendicular or parallel to the direction of loading are provided in Table 8.4. Intermediate values may be obtained by linear interpolation.

Table 8.4 – Subgrade Reaction Reduction Factors for Pile Spacing

Condition	Pile Spacing, Centre to Centre*	Reduction Factor
Pile group oriented ***perpendicular*** to direction of loading	4D	1.0
	1D	0.5
Pile group oriented ***parallel*** to direction of loading	8D	1.0
	6D	0.7
	4D	0.4
	3D	0.25

* where D is the width of pile

8.4 Caissons

The use of augered caissons is not recommended in view of the relatively large depth to suitable bearing material (bedrock at 32 to 34 m depth) and the anticipated difficulties with constructing caissons at this site. Constructing caissons would require use of a liner socketed into rock and/or slurry methods to control groundwater, support the sidewalls of the shaft, and prevent heave in the base while augering in the saturated non-cohesive deposits.

8.5 Recommended Foundation

From a geotechnical perspective, the recommended foundation system for both abutments at this site is steel H-piles driven to bedrock.

8.6 Abutment Type

From a geotechnical perspective, the subsurface conditions at this site are considered to be suitable for the construction of conventional, semi-integral or integral abutments. The recommended foundation system of H-piles makes integral abutments a feasible option.

The integral abutment design requires that the piles possess flexibility in the upper 3 m of the pile length. At this site, the upper 3 m of the pile length will be installed in loose to very loose silt and sand or soft to stiff clay, which in its original state would provide sufficient flexibility. However, if the upper 3 m of the piles lies in compacted fill or if the native soil becomes compacted by the construction processes, the required flexibility may be compromised. Accordingly, to provide the required flexibility in the piles, the upper 3 m of the piles should be surrounded by a 600 mm diameter CSP filled with sand (for a "true abutment" supported on piles) or by concentric CSPs in accordance with standard integral abutment design procedures (for a "false abutment").

Backfill sand placed in the CSP should meet the gradation shown in Table 8.5 and must be placed after pile driving to minimize the potential for densification.

Table 8.5 – Integral Abutment Sand Grading

MTO Sieve Designation		Percentage Passing
2 mm	#10	100%
600 μm	#30	80%-100%
425 μm	#40	40%-80%
250 μm	#60	5%-25%
150 μm	#100	0%-6%

8.7 Frost and Scour Protection

The depth of earth cover required to provide frost protection for footings and pile caps at this site is 1.7 m. It is possible to reduce the thickness of earth cover by the substitution of synthetic insulation.

Scour protection must be provided for footings and pile caps, particularly if bridge foundations are located in areas of high flow velocity downstream of the control structure. Design of the scour and erosion protection measures must consider hydrologic and hydraulic concerns and should be carried out by specialists experienced in these fields.

8.8 Excavation and Dewatering

The preliminary General Arrangement drawings indicate that excavation for construction of the bridge abutments and pile caps will extend to approximate elevation 194 m. The borehole data indicates that the excavation will take place within surficial silts and sands and the underlying silty clay. Water levels measured in the piezometers typically ranged from about elevation 194 to 195 m.

All excavations must be carried out in accordance with the Occupational Health and Safety Act (OHSA) and in accordance with Special Provision 902S01. For the purposes of the OHSA, the native soils at this site may be classified as Type 3 soils above the water table and Type 4 soils below the water table. Excavation below the groundwater level is not recommended without prior dewatering. Provided dewatering is carried out as described below, temporary excavations may be sloped at 1H:1V.

The design of the groundwater control system is the responsibility of the Contractor. However, suitable systems that might be considered include pumping from filtered sumps for nominal penetration below the groundwater level or the use of a sheeted excavation.

Depending on the geometry of cut and proximity to the Mindemoya River, measures to prevent stream flow from entering the excavation, such as steel sheet piling along the river channel, may be required. The design must take into account the maximum flow potentially to occur during construction.

Excavations penetrating the clay layer and into the underlying silt should be avoided unless the groundwater level is first depressed below the deepest excavation level to a sufficient depth to maintain a stable base.

The Contract Documents should alert the Contractor to the requirement to maintain a stable excavation and that any shoring system should be designed by a shoring specialist, taking account of the need to control groundwater and prevent basal instability within the excavation.

8.9 Backfill To Bridge Abutments

Granular backfill is recommended adjacent to the bridge abutments. The backfill to the abutment walls should be in accordance with OPSS 902 as amended by Special Provision 902S01. Granular backfill should be placed to the extents shown in OPSD 3501.000.

Compaction equipment to be used adjacent to retaining structures should be restricted in accordance with SSP 105S10.

The design of the abutment should incorporate a subdrain as shown in OPSD 3501.000.

8.10 New Embankments

The maximum height of the immediate approaches to the new bridge will be approximately 3.5 to 4.0 m. The new highway embankments will generally be less than 2 m high. Embankments of this height, constructed using granular fill and founded on the native

silt/sand and firm to stiff silty clay, are expected to have an adequate factor of safety against slope instability for sideslopes constructed at 2H:1V.

Foundation settlements under the new embankment loads are expected to be less than 25 mm including both immediate settlement of the sands and silts, and long-term consolidation settlement of the silty clay layer.

In general, embankment construction should be in accordance with OPSS 206, as amended by Special Provision "Amendment to OPSS 206, December 1993", dated November 2002.

All topsoil and organic soils should be stripped from the footprint of the approach fills, with the exception of the existing dam embankment slope. Particular attention should be paid to existing ditches to remove all softened material.

In the existing condition, Highway 542 runs on a 1 to 2 m high embankment that is also the earth dam retaining Mindemoya Lake. Evidence of seepage was observed on the downstream side of the embankment. The scope of the current investigation does not include assessment of this seepage or the integrity of the earth dam, and it is understood that there is no design requirement to improve the water retaining capability of the dam, i.e. no requirement for incorporating measures to decrease the existing seepage. However, construction of the new road embankment must not have a negative impact on the integrity or functionality of the existing earth dam.

Embankment widening and new embankment construction downstream of the existing alignment must therefore incorporate design details that maintain the drainage of the downstream toe of the existing dam. To this effect, the following measures are recommended:

1. Any excavation into the existing dam embankment fill or side slopes must be avoided. No earth moving or construction equipment should be permitted on the downstream slope of the existing dam.
2. Close cut clearing should be carried out on the existing embankment slope where new embankment fill will be placed. The contract documents should clearly indicate that grubbing and stripping of topsoil is not permitted on the existing embankment and side slopes.
3. The existing embankment slope should not be benched prior to placement of new fill.
4. New ditches should not be cut into the embankment for drainage of the new pavement granulars. Where full-depth ditches are not provided, a subdrain should be installed along the toe of the downstream slope of the existing embankment, following the bottom of the existing ditch. Details of subdrain installation are provided in the Pavement Design Report for the project.

5. The new embankment fill should consist entirely of well-graded Granular B Type III material, with no more than 5 per cent passing the 75 μm sieve, to permit continued drainage of the existing embankment fill.

Earth fill embankment slopes must be provided with erosion protection in accordance with OPSS 572.

9 DAM CONTROL STRUCTURE

9.1 Foundation Alternatives

The discussion and recommendations regarding alternative foundation schemes presented for the bridge structure are applicable to the control structure. However, an additional foundation type comprising a large raft may be considered for a lightly loaded control structure, and is preferred to avoid potential development of a void/seepage path below the base of a rigidly supported structure. Design procedures for a raft foundation and steel H-piles driven to bedrock are discussed in the following sections.

9.2 Raft Foundation

The preliminary raft design calls for base dimensions of approximately 17.8 by 8.0 m and a founding level near elevation 193.0 m. The new structure will be positioned partially within and partially north of the area currently subjected to existing embankment loading.

The design requires a maximum allowable bearing pressure of 90 kPa at the downstream end of the structure. The base load will be applied eccentrically however, reflecting design high water and ice loads, and the applied pressure at the upstream side will be substantially less than this maximum value.

The borehole information indicates that the foundation soil below elevation 193 consists of 1.0 to 2.7 m of soft to stiff (typically firm) silty clay overlying loose to dense (typically loose to compact) silt.

An allowable bearing capacity of 90 kPa is considered suitable for working stress design (WSD) of a concrete raft foundation founded on the silty clay and silt at elevation 193.0 m. For Limit States Design, a factored bearing resistance at ULS of 200 kPa and a bearing resistance at SLS of 90 kPa are recommended.

Total and differential settlements of the raft, designed on the basis of the WSD capacity and SLS resistance values given above, are not expected to exceed 25 mm. This value takes into account the following conditions:

- The raft will be eccentrically loaded with a lower imposed pressure at the upstream end than at the downstream end;
- The downstream end of the structure will be constructed over an area currently subjected to the existing embankment load, whereas the upstream end will be positioned north of the existing embankment;

- Additional fill will be placed for embankment widening on the north side of the existing embankment, and existing embankment fill will be removed from the south side to form a wider outlet channel;
- Consequently, the eccentric loading from the raft will be offset by the stress changes due to embankment reconfiguration, resulting in reduced differential settlement between the upstream and downstream ends of the structure.

For analysis of base slab design, the following values of the modulus of subgrade reaction are recommended:

Soft to stiff silty clay	15 – 20 MPa/m
Loose to compact silt	10 – 15 MPa/m

The depth of earth cover required to provide frost protection for the raft foundation at this site is 1.7 m.

Installation of cut-off walls below the control structure is recommended to control seepage and prevent piping below the base of the structure. The most practical method of providing the cut-off walls is to install a steel sheet pile cofferdam to facilitate temporary excavation support and dewatering during construction as well as permanent seepage control. Recommendations in this regard are presented in a subsequent section of the report.

The lateral resistance of the foundation founded on soft to stiff silty clay may be computed using an unfactored friction coefficient of 0.35. This is an "ultimate" value and requires a degree of sliding movement to occur to fully mobilize the resistance.

The raft design must also be checked for resistance to buoyancy.

9.3 Driven Steel Piles

The geotechnical conditions encountered at this site are considered suitable for driven steel H-pile foundations. The piles must be driven to bedrock and are expected to encounter refusal on bedrock near elevation 162.3 to 163.2 m.

Design of pile foundations to support the dam control structure should be carried out as previously discussed for the bridge foundations. For Working Stress Design (WSD), an allowable pile capacity of 1,400 kN and an unfactored downdrag force of 125 kN per pile are recommended for HP 310X110 piles driven to bedrock.

If pile foundations are employed and additional embankment loads are imposed adjacent to the dam, the potential exists for settlement of the subgrade and adjacent approach fill relative to the control structure. This could leave a void along the base of the structure and a consequent seepage path. Accordingly, piles are not the recommended foundation type for this structure.

9.4 Excavation And Dewatering

The preliminary General Arrangement drawings for the new control structure indicate that the new structure will be positioned partially within the existing dam embankment and extend some 5 m beyond the north edge of the existing bridge deck, into Mindemoya Lake. The base will be founded near elevation 193 m.

The top of the existing embankment is near elevation 198 m, the lake level is typically near elevation 197 m, and the present lake bed appears to have accumulated sediment up to elevation 196 to 196.5 m. Therefore excavation is expected to extend approximately 5 m below the top of existing embankment, 4 m below the lake water level, and 3.0 to 3.5 m below the lake bottom.

Construction of the new structure and plunge pool will require installation of an enclosure and dewatering system to maintain the excavation in an unwatered condition. Diversion of river flow from the excavation area must also be provided. One available system of enclosure and dewatering would involve driving a sheet pile cofferdam around the excavation area.

The sheeting should be driven to sufficient depth to prevent heave of the excavation base and limit seepage into the excavation. The tip elevation and other requirements of the sheeting recommended for temporary and permanent seepage control under the structure are discussed in the next section.

The design of the temporary enclosure and dewatering system that may be required is normally the responsibility of the Contractor. For this site however, the sheeting is an integral part of the control structure design and must be left in place to serve as permanent seepage control under the new structure. Therefore the requirements presented in the next section must be specified as a minimum. The Contractor should satisfy himself that the enclosure design is adequate for his proposed excavation and dewatering procedures.

It must be recognized that there may be difficulties in obtaining a watertight seal within seams of the driven sheeting. Seepage water entering the cofferdam should be collected and removed from the work area.

The design of the cofferdam in or beside the lake must take into account the maximum lake level likely to occur during construction.

Excavation procedures used during construction of the new control structure must carefully consider the integrity of the existing earth dam both during and following completion of site work. Excavation, shoring and control of lake water and groundwater must be carried out using methods which preclude development of seepage channels through the dam.

Installation procedures must not damage the existing control structure before the shoring and dewatering works are operative. Close monitoring of the existing control structure for signs of increased seepage or movement should be enacted during the work.

Bidders must be alerted to the fact that cobbles, boulders and possibly rock fill or other obstructions are present within the existing dam embankment and may be buried below lakebed sediments. Further, the subsurface configuration of the existing bridge, control structure and any previous construction relics has not been defined. Pre-drilling or removal of obstructions may be required prior to installation of the sheeting.

All excavations must be carried out in accordance with the Occupational Health and Safety Act (OHSA) and in accordance with Special Provision 902S01. For the purposes of the OHSA, the native soils at this site may be classified as Type 3 soils above the water table and Type 4 soils below the water table. Excavation below the lake and groundwater levels is not recommended without prior dewatering.

9.5 Seepage Control

Control structure design must include measures to prevent seepage and piping below the base and adjacent to the walls of the structure.

The site is underlain by an apparently continuous layer of silty clay, and the existence of Lake Mindemoya is probably due, in part, to the existence of this aquitard. However, the clay layer is relatively thin and its continuity, in both the pre-existing condition and following potential impacts of construction, cannot be ensured. The clay is underlain by silt of higher permeability and high susceptibility to piping.

For this reason, it is recommended that cut-off walls be provided below the base of the structure to increase the length of seepage path and reduce the potential for development of piping. The most practical method of providing the cut-off walls is to install a steel sheet pile enclosure to facilitate both temporary excavation shoring/dewatering and permanent seepage control.

Seepage analysis was carried out to determine the depth of sheeting required for seepage control. Based on the subsurface conditions encountered in the boreholes and the results of the seepage analysis, it is recommended that the permanent sheet pile cut-off walls extend to elevation 184.0 m.

The top of the sheet piling should be cut off just below the final ground surface or above the high water level as applicable, and/or be incorporated into the control structure design. Any space between the base of the control structure and the sheet pile wall should be backfilled with mass concrete. The sheeting should be anchored into the concrete.

The sheet pile section selected for the permanent cut-off walls should be appropriately oversized to account for potential section loss due to corrosion during the design life of the structure.

Backfilling above the concrete slab within the sheeting enclosure should be carried out using OPS Granular B Type III material.

To increase the length of seepage path through the embankment on both sides of the control structure and to reduce the potential for development of piping adjacent to the side

walls of the sheet piling enclosure, it is recommended that a lateral sheet pile cut-off be installed on both sides of the enclosure. The lateral cut-off should be connected to the sheeting near the middle of the enclosure wall and extend 5.0 m from the perimeter of the enclosure, parallel to the embankment. The lateral cut-off sheet piles should also be driven to elevation 184.0 m.

Normally the design of the temporary enclosure and dewatering system is the responsibility of the Contractor. For this site however, the sheeting is an integral part of the control structure design and must be left in place to serve as permanent seepage control under the new structure. Therefore the above requirements for tip depth, lateral cut-off, sheet pile section, and backfill must be specified in the Contract.

The scope of the current investigation does not include analysis of the integrity and performance of the existing earth dam beyond the control structure. Seepage will continue to occur beyond the lateral cut-off. It is understood that there is no design requirement to decrease the existing seepage and improve the water retaining capability of the dam.

In addition to the cut-off walls, it is recommended that the base of the plunge pool on the downstream side of the structure include a graded granular filter designed to permit drainage of underseepage while preventing migration of fines and potential piping through the subgrade. The base of the pool should be excavated to elevation 193 m to remove the majority of the clay layer thickness, and then a filter comprising the following should be placed:

- A geotextile filter fabric placed on the exposed base.
- A fine filter comprising a 300 mm thick layer of sand conforming to the OPS gradation specification for Mortar Sand.
- A coarse filter comprising a 300 mm thick layer of gravel conforming to the OPS gradation specification for Granular O.
- Erosion protection comprising rip-rap conforming to OPS specifications.

9.6 Embankment Widening

Modifications to the existing dam embankment will be limited to the area immediately adjacent to the new control structure. A grade raise from elevation 198 to elevation 199 m and a widening of about 4 m into the lake are proposed.

New embankment slopes on the lake side of the dam should be inclined no steeper than 3H:1V and be provided with rock protection for erosion prevention.

Foundation settlement due to additional fill placement is expected to be less than 25 mm. Comments regarding settlement of the embankment and control structure were presented previously.

10 LATERAL EARTH PRESSURES

Earth pressures acting on the bridge structure may be assumed to be triangular and to be governed by the characteristics of the abutment backfill. For a fully drained condition, the pressures should be computed in accordance with the CHBDC but generally are given by the expression:

$p_h = K^*(\gamma h + q)$

Where:

p_h = horizontal pressure on the wall at depth h (kPa)

K = earth pressure coefficient (see below)

γ = unit weight of retained soil (see table below)

h = depth below top of fill where pressure is computed (m)

q = value of any surcharge (kPa)

Earth pressure coefficients for backfill to the abutment wall are dependent on the material used as backfill. Typical values are shown in Table 13.1.

Table 13.1 – Earth Pressure Coefficient (K)

Condition	Earth Pressure Coefficient (K)			
	OPSS Granular A or OPSS Granular B Type II $\phi = 35°, \gamma = 22.8$ kN/m^3		OPSS Granular B Type I or Type III $\phi = 32°, \gamma = 21.2$ kN/m^3	
	Horizontal Surface Behind Wall	Sloping Surface Behind Wall (2H:1V)	Horizontal Surface Behind Wall	Sloping Surface Behind Wall (2H:1V)
Active (Unrestrained Wall)	0.27	0.40*	0.31	0.47*
At rest (Restrained Wall)	0.43	-	0.47	-
Passive (Movement Towards Soil Mass)	3.7	-	3.3	-

* For wing walls.

In conventional design, the use of a material with a high friction angle and low active pressure coefficient (e.g. Granular A, Granular B Type II) might be preferred as it results in lower earth pressures acting on the wall. In the case of integral abutments, material with a lower passive pressure coefficient (e.g. Granular B Type I) might be preferred as it results in lower forces acting on the ballast wall as the wall moves toward the soil mass.

In accordance with Clause 6.9.3 of the CHBDC, a compaction surcharge should be added. The magnitude should be 12 kPa at the top of fill and decreasing to 0 kPa at a depth of 2.0 m for Granular B Type I or 1.7 m for Granular A or Granular B Type II.

11 SEISMIC CONSIDERATIONS

The following seismic parameters should be used for design:

- Velocity Related Seismic Zone 0
- Zonal Velocity Ratio 0.00
- Acceleration Related Seismic Zone 0
- Zonal Acceleration Ratio 0.00
- Peak Horizontal Acceleration 0.021

Based on these parameters, seismic design is not an issue at this site.

The Soil Profile Type at this site has been classified as Type III. Thus, according to Table 4.4.6.1 of the CHBDC, a Site Coefficient "S" of 1.5 should be used.

The potential for liquefaction of the foundation soils has been assessed using the Seed and Idriss (1971) method[1]. Using this method, it was determined that the foundation soils are not in danger of liquefaction.

12 CONSTRUCTION CONCERNS

Potential construction concerns include, but are not necessarily limited to:

- Excavation procedures used during construction of the new dam and bridge must carefully consider the integrity of the existing dam both during and following completion of site work. Excavation, shoring and control of lake water and groundwater must be carried out using methods which preclude development of seepage channels through the dam or damage to the existing control structure.
- Excavation within the lake and existing embankment for control structure construction will require shoring of the excavation walls and control of lake water and groundwater. Installation of a cofferdam comprising a driven steel sheet pile enclosure should be suitable.
- The possibility of encountering cobbles, boulders or other obstructions during installation of sheet piling. Removal of these obstructions in the existing embankment fill may be required.
- The possibility of bridge foundation piles encountering cobbles and boulders in the soils above the bedrock or reaching refusal on large boulders.
- Erosion and sedimentation control while maintaining streamflow.

Proper workmanship and quality control is critical to the successful performance of the control structure as part of the earth dam. Therefore in addition to the services provided by the QVE, an

[1] Seed, H.B. and Idriss, I.M. 1971, "Simplified Procedure for Evaluating Soil Liquefaction Potential" *Journal of Soil Mechanics and Foundations Division,* ASCE, Vol. 101, No. SM9, September, pp. 1249 – 1273.

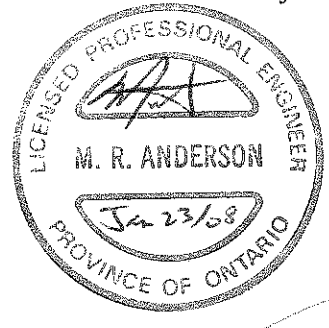
allowance should be made for periodic inspection and monitoring of construction by the design team. Items for inspection and monitoring should include as a minimum:

- Monitoring and inspection of the performance of the existing embankment and control structure during driving of sheet piles.
- Inspection of the foundation soil at the base of the control structure prior to placement of concrete.
- Review of the Contractor's method of site preparation for embankment widening and construction adjacent to the existing earth dam.

13 CLOSURE

Engineering analysis and preparation of the foundation design report was conducted by Mr. Murray Anderson, P.Eng. The report was reviewed by Mr. Alastair Gorman, P.Eng., and by Dr. P.K. Chatterji, Ph.D., a Designated Principal Contact for MTO Foundations Projects.

Thurber Engineering Ltd.
Murray R. Anderson, P.Eng., M.Eng.
Senior Geotechnical Engineer



Alastair E. Gorman, P.Eng., M.Sc.
Project Manager

P.K. Chatterji, P.Eng., Ph.D.
Review Principal

Appendix A

Record of Borehole Sheets

SYMBOLS, ABBREVIATIONS AND TERMS USED ON RECORDS OF BOREHOLES

1. TEXTURAL CLASSIFICATION OF SOILS

CLASSIFICATION	PARTICLE SIZE	VISUAL IDENTIFICATION
Boulders	Greater than 200mm	same
Cobbles	75 to 200mm	same
Gravel	4.75 to 75mm	5 to 75mm
Sand	0.075 to 4.75mm	Not visible particles to 5mm
Silt	0.002 to 0.075mm	Non-plastic particles, not visible to the naked eye
Clay	Less than 0.002mm	Plastic particles, not visible to the naked eye

2. COARSE GRAIN SOIL DESCRIPTION (50% greater than 0.075mm)

TERMINOLOGY	PROPORTION
Trace or Occasional	Less than 10%
Some	10 to 20%
Adjective (e.g. silty or sandy)	20 to 35%
And (e.g. sand and gravel)	35 to 50%

3. TERMS DESCRIBING CONSISTENCY (COHESIVE SOILS ONLY)

DESCRIPTIVE TERM	UNDRAINED SHEAR STRENGTH (kPa)	APPROXIMATE SPT[(1)] 'N' VALUE
Very Soft	12 or less	Less than 2
Soft	12 to 25	2 to 4
Firm	25 to 50	4 to 8
Stiff	50 to 100	8 to 15
Very Stiff	100 to 200	15 to 30
Hard	Greater than 200	Greater than 30

NOTE: Hierarchy of Soil Strength Prediction

1) Laboratory Triaxial Testing
2) Field Insitu Vane Testing
3) Laboratory Vane Testing
4) SPT value
5) Pocket Penetrometer

4. TERMS DESCRIBING DENSITY (COHESIONLESS SOILS ONLY)

DESCRIPTIVE TERM	SPT "N" VALUE
Very Loose	Less than 4
Loose	4 to 10
Compact	10 to 30
Dense	30 to 50
Very Dense	Greater than 50

5. LEGEND FOR RECORDS OF BOREHOLES

SYMBOLS AND ABBREVIATIONS FOR SAMPLE TYPE

SS Split Spoon Sample WS Wash Sample AS Auger (Grab) Sample
TW Thin Wall Shelby Tube Sample TP Thin Wall Piston Sample
PH Sampler Advanced by Hydraulic Pressure PM Sampler Advanced by Manual Pressure
WH Sampler Advanced by Self Static Weight RC Rock Core SC Soil Core

$$\text{Sensitivity} = \frac{\text{Undisturbed Shear Strength}}{\text{Remoulded Shear Strength}}$$

$\blacktriangledown$ Water Level

C_{pen} Shear Strength Determination by Pocket Penetrometer

(1) SPT 'N' Value Standard Penetration Test 'N' Value – refers to the number of blows from a 63.5kg hammer free falling a height of 0.76m to advance a standard 50 mm outside diameter split spoon sampler for 0.3 m depth into undisturbed ground.

(2) DCPT Dynamic Cone Penetration Test – Continuous penetration of a 50 mm outside diameter, 60° conical steel point attached to "A" size rods driven by a 63.5 kg hammer free falling a height of 0.76 m. The resistance to cone penetration is the number of hammer blows required for each 0.3 m advance of the conical point into undisturbed ground.

UNIFIED SOILS CLASSIFICATION

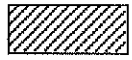
MAJOR DIVISIONS		GROUP SYMBOL	TYPICAL DESCRIPTION
COARSE GRAINED SOILS	GRAVEL AND GRAVELLY SOILS	GW	Well-graded gravels or gravel-sand mixtures, little or no fines.
		GP	Poorly-graded gravels or gravel-sand mixtures, little or no fines.
		GM	Silty gravels, gravel-sand-silt mixtures.
		GC	Clayey gravels, gravel-sand-clay mixtures.
	SAND AND SANDY SOILS	SW	Well-graded sands or gravelly sands, little or no fines.
		SP	Poorly-graded sands or gravelly sands, little or no fines.
		SM	Silty sands, sand-silt mixtures.
		SC	Clayey sands, sand-clay mixtures.
FINE GRAINED SOILS	SILTS AND CLAYS $W_L < 50\%$	ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity.
		CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays. ($W_L < 30\%$).
		CI	Inorganic clays of medium plasticity, silty clays. ($30\% < W_L < 50\%$).
		OL	Organic silts and organic silty-clays of low plasticity.
	SILTS AND CLAYS $W_L > 50\%$	MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts.
		CH	Inorganic clays of high plasticity, fat clays.
		OH	Organic clays of medium to high plasticity, organic silts.
HIGHLY ORGANIC SOILS		Pt	Peat and other highly organic soils.
CLAY SHALE			
SANDSTONE			
SILTSTONE			
CLAYSTONE			
COAL			

EXPLANATION OF ROCK LOGGING TERMS

ROCK WEATHERING CLASSIFICATION

Fresh (FR)	No visible signs of weathering.
Fresh Jointed (FJ)	Weathering limited to the surface of major discontinuities.
Slightly Weathered (SW)	Penetrative weathering developed on open discontinuity surfaces, but only slight weathering of rock material.
Moderately Weathered (MW)	Weathering extends throughout the rock mass, but the rock material is not friable.
Highly Weathered (HW)	Weathering extends throughout the rock mass and the rock is partly friable.
Completely Weathered (CW)	Rock is wholly decomposed and in a friable condition, but the rock texture and structure are preserved.

SYMBOLS


CLAYSTONE


SILTSTONE


SANDSTONE


COAL


Bedrock (general)

DISCONTINUITY SPACING

Bedding	Bedding Plane Spacing
Very thickly bedded	Greater than 2m
Thickly bedded	0.6 to 2m
Medium bedded	0.2 to 0.6m
Thinly bedded	60mm to 0.2m
Very thinly bedded	20 to 60mm
Laminated	6 to 20mm
Thinly Laminated	Less than 6mm

TERMS

Total Core Recovery: (TCR)	Core recovered as a percentage of total core run length.
Solid Core Recovery: (SCR)	Percent Ratio of solid core of full cylindrical shape recovered. Expressed with respect to the total length of core run.
Rock Quality Designation: (RQD)	Total length of sound core recovered in pieces 0.1m in length or larger as a percentage of total core run length.
Uniaxial Compressive Strength (UCS)	Axial stress required to break the specimen
Fracture Index: (FI)	Frequency of natural fractures per 0.3m of core run.

STRENGTH CLASSIFICATION

Rock Strength	Approximate Uniaxial Compressive Strength (MPa)	(psi)	Field Estimation of Hardness*
Extremely Strong	Greater than 250	Greater than 36,000	Specimen can only be chipped with a geological hammer
Very Strong	100-250	15,000 to 36,000	Requires many blows of geological hammer to break
Strong	50-100	7,500 to 15,000	Requires more than one blow of geological hammer to break
Medium Strong	25.0 to 50.0	3,500 to 7,500	Breaks under single blow of geological hammer.
Weak	5.0 to 25.0	750 to 3,500	Can be peeled by a pocket knife with difficulty
Very Weak	1.0 to 5.0	150 to 750	Can be peeled by a pocket knife, crumbles under firm blows of geological pick.
Extremely Weak (Rock)	0.25 to 1.0	35 to 150	Indented by thumbnail

THURBER

Ministry of Transportation
Ontario

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RECORD OF BOREHOLE No 07-M01 1 OF 4 METRIC

G.W.P. 5460-04-00 LOCATION Mindemoya Lake Bridge and Dam N9876.66 E9181.24 ORIGINATED BY GA

HWY 542 BOREHOLE TYPE Hollow Stem Augers/NW Casing COMPILED BY WM

DATUM Geodetic DATE 2007-07-17 - 2007-07-17 CHECKED BY MRA

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
197.3	Rockfill Platform										
0.0	**ROCKFILL** (drilling platform)					▼	197				
196.1							196				
1.2	**SAND**, fine to coarse grained, trace to some silt, with organics, trace shells, trace wood fibres Loose Grey Wet		1	SS	9				o		
194.9							195				
2.4	Silty **CLAY**, trace sand Firm to soft Grey Wet		2	SS	5				o		
			1	TW			194				0 1 56 43
							193	3.6			
			3	SS	4				o		0 1 76 23
							192	3.2			
			4	SS	4		191		o		
190.3											
7.0	**SILT**, trace to some clay, trace sand Compact to dense Grey Wet						190				
			5	SS	11				o		
			6	SS	12		189		o		0 3 82 15
							188				

Continued Next Page

$+^3$, $\times^3$: Numbers refer to Sensitivity

$\frac{20}{15}\oplus\frac{5}{10}$ (%) STRAIN AT FAILURE

ONTMT4S 5198-MINDEMOYA.GPJ 08/1/18

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 07-M01 2 OF 4 METRIC

G.W.P. 5460-04-00 LOCATION Mindemoya Lake Bridge and Dam N9876.66 E9181.24 ORIGINATED BY GA

HWY 542 BOREHOLE TYPE Hollow Stem Augers/NW Casing COMPILED BY WM

DATUM Geodetic DATE 2007-07-17 - 2007-07-17 CHECKED BY MRA

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page		7	SS	29		187		○		
			8	SS	33		186		○		
185.1											
12.2	**SAND**, fine to medium grained, trace silt Compact to dense Grey Wet		9	SS	21		185		○		0 97 3 (SI+CL)
	occasional gravel at 13.7 to 14.4m						184				
			10	SS	22		183		○		
							182				
			11	SS	31		181		○		
							180				
							179				
			12	SS	36		178		○		

Continued Next Page

+ ³ . × ³ : Numbers refer to Sensitivity

(%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 07-M01 3 OF 4 METRIC

G.W.P. 5460-04-00 LOCATION Mindemoya Lake Bridge and Dam N9876.66 E9181.24 ORIGINATED BY GA

HWY 542 BOREHOLE TYPE Hollow Stem Augers/NW Casing COMPILED BY WM

DATUM Geodetic DATE 2007-07-17 - 2007-07-17 CHECKED BY MRA

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P — NATURAL MOISTURE CONTENT w — LIQUID LIMIT w_L / WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
	Continued From Previous Page						177				
							176				
			13	SS	26		175				
							174				
							173				
			14	SS	35		172				
							171				
							170				
			15	SS	42		169				0 97 3 (SI+CL)
							168				

Continued Next Page

$+^3$, $\times^3$: Numbers refer to Sensitivity

20 / 15 5 / 10 (%) STRAIN AT FAILURE

ONTMT4S 5198.GPJ 11/2/07

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 07-M01 4 OF 4 METRIC

G.W.P. 5460-04-00 LOCATION Mindemoya Lake Bridge and Dam N9876.66 E9181.24 ORIGINATED BY GA

HWY 542 BOREHOLE TYPE Hollow Stem Augers/NW Casing COMPILED BY WM

DATUM Geodetic DATE 2007-07-17 - 2007-07-17 CHECKED BY MRA

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P NATURAL MOISTURE CONTENT w LIQUID LIMIT w_L WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
	Continued From Previous Page										
	occasional gravel at 29.9 to 31.1m						167				
			16	SS	32		166		○		
							165				
							164				
	cobble or large gravel at 34.1m						163				
162.6											
34.7	END OF BOREHOLE AT 34.7m. AUGER REFUSAL AT 34.7m ON PROBABLE BEDROCK. BOREHOLE OPEN TO 34.7m AND WATER LEVEL AT 0.9m. BOREHOLE BACKFILLED WITH BENTONITE TO 1.2m AND ROCKFILLTO SURFACE.										

+ ^{3}, × ^{3}: Numbers refer to Sensitivity

15 (20 10 5) {%} STRAIN AT FAILURE

ONTMT4S 5198.GPJ 11/2/07

Ministry of Transportation
Ontario

RECORD OF BOREHOLE No 07-M02 1 OF 3 METRIC

G.W.P. 5460-04-00 LOCATION Mindemoya Lake Bridge and Dam N9872.33 E9152.51 ORIGINATED BY SLL
HWY 542 BOREHOLE TYPE Hollow Stem Augers/NW Casing COMPILED BY WM
DATUM Geodetic DATE 2007-09-08 - 2007-09-08 CHECKED BY MRA

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: o UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
197.9	Ground Surface										
0.0 / 197.3	Gravelly **SAND** Brown Moist (FILL)										
0.6 / 195.9	**COBBLES** AND **BOULDERS** in a sand matrix (FILL)						197				
2.0 / 194.8	**SAND**, trace to some silt, trace wood fragments and seashells Very loose Brown Wet (FILL)		1	SS	3		196				
3.1 / 191.8	Silty **CLAY**, trace sand, occasional limestone fragment Stiff to soft Grey Moist to wet		2	SS	14		195				0 6 57 37
	Boulder (200mm)		3	SS	41		194				Sampler striking boulder. Switched to NW Casing and tricone to penetrate.
6.1	**SILT**, trace to some clay, trace sand Very loose to compact Grey Wet		4	SS	2		193				
			5	SS	17		192				
			6	SS	7		191				0 1 88 11
							190				
							189				
							188				

Continued Next Page

$+^3$, $\times^3$: Numbers refer to Sensitivity

20 / 15 5 / 10 (%) STRAIN AT FAILURE

ONTMT4S 5198-MINDEMOYA.GPJ 08/1/18

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THURBER

RECORD OF BOREHOLE No 07-M02 2 OF 3 METRIC

G.W.P. 5460-04-00 LOCATION Mindemoya Lake Bridge and Dam N9872.33 E9152.51 ORIGINATED BY SLL
HWY 542 BOREHOLE TYPE Hollow Stem Augers/NW Casing COMPILED BY WM
DATUM Geodetic DATE 2007-08-09 - 2007-08-09 CHECKED BY MRA

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	trace sand seams, dense		7	SS	43		187		○		
186.2											
11.7	**SAND**, trace silt Very Dense Grey Wet		8	SS	50/.125		186		○		
			9	SS	62		185		○		0 94 6 (SI+CL)
			10	SS	82		184		○		
			11	SS	49		183		○		
	becoming Compact						182				
							181				
							180				
							179		○		
							178				

Continued Next Page

$+^3$, $\times^3$: Numbers refer to Sensitivity

(%) STRAIN AT FAILURE

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RECORD OF BOREHOLE No 07-M02 3 OF 3 METRIC

G.W.P. 5460-04-00 LOCATION Mindemoya Lake Bridge and Dam N9872.33 E9152.51 ORIGINATED BY SLL

HWY 542 BOREHOLE TYPE Hollow Stem Augers/NW Casing COMPILED BY WM

DATUM Geodetic DATE 2007-08-09 - 2007-08-09 CHECKED BY MRA

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100	PLASTIC LIMIT w_P	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w_L	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa: o UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE; 20 40 60 80 100	WATER CONTENT (%) 20 40 60				GR SA SI CL
	Continued From Previous Page												
177.5			12	SS	28								
20.4	END OF BOREHOLE AT 20.4m. BOREHOLE GROUTED WITH BENTONITE TO 0.15m THEN ASPHALT PATCH TO SURFACE.						177						

$+^3$, $\times^3$ Numbers refer to Sensitivity

20 / 15 5 / 10 (%) STRAIN AT FAILURE

ONTMT4S 5198.GPJ 11/2/07

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RECORD OF BOREHOLE No 07-M03 1 OF 4 METRIC

G.W.P. 5460-04-00 LOCATION Mindemoya Lake Bridge and Dam N9868.79 E9166.69 ORIGINATED BY SLL
HWY 542 BOREHOLE TYPE Hollow Stem Augers/NW Casing COMPILED BY WM
DATUM Geodetic DATE 2007-10-08 - 2007-10-08 CHECKED BY MRA

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
198.0	Road Surface						198				
0.0	**ASPHALT:** (40mm)										
	Gravelly **SAND**, some silt Brown Moist (FILL)										
197.2							197				
0.8	**COBBLES** and **BOULDERS** in a sand matrix (FILL)					MW07-M3-5 MW07-M3-2					
196.6											
1.4	**SAND**, some silt to silty, with wood fragments Loose Brown Wet (FILL)		1	SS	8		196		o		1 56 42 1
						MW07-M3-8					
			2	SS	9				o		
195.0							195				
3.0	Silty **CLAY**, trace sand, trace gravel Stiff to soft Grey Wet		3	SS	10				o o		
			4	SS	5		194		⊢		1 3 63 33
			5	SS	4				o		
			1	TW			193		o		
			6	SS	2		192		o		
190.7							191				
7.3	**SILT**, some clay, trace sand, with clay seams Loose to compact Grey Wet		7	SS	7		190		o		
			8	SS	8		189		o		0 4 85 11

Continued Next Page

+ ^{3}, × ^{3}: Numbers refer to Sensitivity

(%) STRAIN AT FAILURE

ONTMT4S 5198-MINDEMOYA.GPJ 08/1/18

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RECORD OF BOREHOLE No 07-M03 2 OF 4 METRIC

G.W.P. 5460-04-00 LOCATION Mindemoya Lake Bridge and Dam N9868.79 E9166.69 ORIGINATED BY SLL

HWY 542 BOREHOLE TYPE Hollow Stem Augers/NW Casing COMPILED BY WM

DATUM Geodetic DATE 2007-08-10 - 2007-08-10 CHECKED BY MRA

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page						188				
			9	SS	18		187		○		
185.8							186				
12.2	**SAND**, trace silt Very Dense Grey Wet		10	SS	50/.125		185		○		
			11	SS	50/.125		184		○		
			12	SS	56		183		○		0 92 8 (SI+CL)
							182				
							181				
							180				
			13	SS	53		179		○		

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+ 3 . × 3 : Numbers refer to Sensitivity

15 20 10 5 (%) STRAIN AT FAILURE

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RECORD OF BOREHOLE No 07-M03 3 OF 4 METRIC

G.W.P. 5460-04-00 LOCATION Mindemoya Lake Bridge and Dam N9868.79 E9166.69 ORIGINATED BY SLL

HWY 542 BOREHOLE TYPE Hollow Stem Augers/NW Casing COMPILED BY WM

DATUM Geodetic DATE 2007-08-10 - 2007-08-10 CHECKED BY MRA

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page						178				
							177				
			14	SS	47				○		
							176				
							175				
							174				
			15	SS	76				○		
							173				
							172				
							171				
170.4											
27.6	Silty **CLAY**, trace sand, with sand seams Hard Grey Moist		16	SS	30		170		○ w_P ⊢ w_L		0 9 63 28
							169				

Continued Next Page

+ 3 , × 3 : Numbers refer to Sensitivity

15 (20/10) 5 (%) STRAIN AT FAILURE

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RECORD OF BOREHOLE No 07-M03 4 OF 4 METRIC

G.W.P. 5460-04-00 LOCATION Mindemoya Lake Bridge and Dam N9868.79 E9166.69 ORIGINATED BY SLL

HWY 542 BOREHOLE TYPE Hollow Stem Augers/NW Casing COMPILED BY WM

DATUM Geodetic DATE 2007-10-08 - 2007-10-08 CHECKED BY MRA

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: o UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page						168				
			17	SS	66/ 275				o		
							167				
							166				
165.2											
32.8	**SAND**, trace to some silt, trace gravel, trace limestone fragments Very Dense Grey Wet						165				
			18	SS	50/ .100				o		
163.2							164				
34.8	END OF BOREHOLE AT 34.8m. AUGER REFUSAL AT 34.8m ON PROBABLE BEDROCK BOREHOLE GROUTED WITH BENTONITE TO 0.15m, THEN ASPHALT PATCH TO SURFACE. INSTALLED MONITORING WELLS 07-M3-2, 07-M3-5 AND 07-M3-8 IN SEPARATE HOLES. REFER TO SKETCH FOR DETAILS. WATER LEVEL READINGS: DATE DEPTH(m) ELEV.(m) MW 07-M3-2 2007-08-17 1.29 196.74 2007-08-29 1.34 196.69 MW 07-M3-5 2007-08-17 1.35 196.68 2007-08-28 1.26 196.77 MW 07-M3-8 2007-08-17 2.49 195.54 2007-08-28 2.22 195.81										

$+^3$, $\times^3$: Numbers refer to Sensitivity

$\frac{20}{15}\oplus\frac{5}{10}$ (%) STRAIN AT FAILURE

ONTMT4S 5198-MINDEMOYA.GPJ 15/11/07

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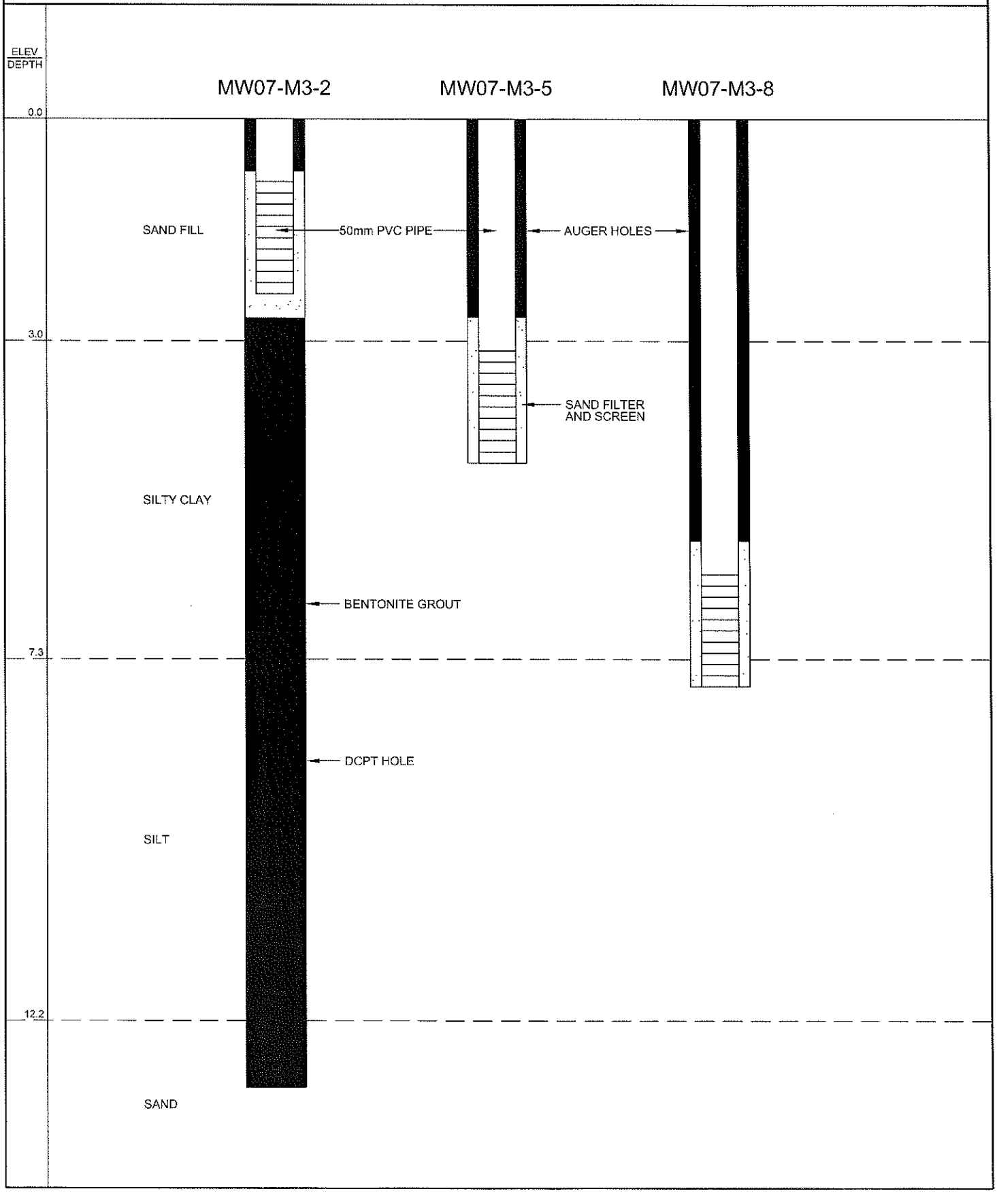
MONITORING WELL DETAIL No 07-M03

1 OF 1

METRIC

G.W.P.	5460-04-00	LOCATION	Mindemoya Lake Bridge and Dam N9868.79 E9166.69	ORIGINATED BY	SLL
HWY	542	BOREHOLE TYPE	Hollow Stem Augers/NW Casing	COMPILED BY	WM
DATUM	Geodetic	DATE	2007-08-10 - 2007-08-10	CHECKED BY	MRA



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RECORD OF BOREHOLE No 07-M04 1 OF 4 METRIC

G.W.P. 5460-04-00 LOCATION Mindemoya Lake Bridge and Dam N9876.32 E9181.62 ORIGINATED BY SLL
HWY 542 BOREHOLE TYPE Hollow Stem Augers COMPILED BY WM
DATUM Geodetic DATE 2007-08-08 - 2007-10-08 CHECKED BY MRA

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
198.0	Road Surface						198				
0.0	**ASPHALT:** (25mm)										
	Gravelly **SAND**, some silt, occasional cobbles Very Dense Brown Moist (FILL)		1	AS							
			1	SS	50/.150		197				
	with wood fragments Grey Wet		2	SS	48		196				
195.6											
2.4	Silty **CLAY**, trace sand Firm to stiff Grey Moist to wet		3	SS	4		195				
			4	SS	13						
			5	SS	5		194				0 1 60 39
			1	TW			193	4.5			
			6	SS	2		192				
190.7							191	2.8			
7.3	**SILT**, trace to some clay, trace sand Loose to compact Grey Wet		7	SS	19		190				
			8	SS	5		189				

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+³, ×³: Numbers refer to Sensitivity

20 / 15 5 / 10 (%) STRAIN AT FAILURE

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RECORD OF BOREHOLE No 07-M04 2 OF 4 METRIC

G.W.P. 5460-04-00 LOCATION Mindemoya Lake Bridge and Dam N9876.32 E9181.62 ORIGINATED BY SLL

HWY 542 BOREHOLE TYPE Hollow Stem Augers COMPILED BY WM

DATUM Geodetic DATE 2007-08-08 - 2007-08-10 CHECKED BY MRA

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (20 40 60 80 100): ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page						188				
			9	SS	27		187				0 6 88 6
							186				
	Dense		10	SS	45						
184.8							185				
13.2	**SAND**, trace to some silt Compact to very dense Brown Wet		11	SS	29		184				
							183				
			12	SS	48						0 90 10 (SI+CL)
							182				
							181				
							180				
			13	SS	35						
							179				

Continued Next Page

+ ³, × ³ Numbers refer to Sensitivity

20 / 15 5 / 10 (%) STRAIN AT FAILURE

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RECORD OF BOREHOLE No 07-M04 3 OF 4 METRIC

G.W.P. 5460-04-00 LOCATION Mindemoya Lake Bridge and Dam N9876.32 E9181.62 ORIGINATED BY SLL

HWY 542 BOREHOLE TYPE Hollow Stem Augers COMPILED BY WM

DATUM Geodetic DATE 2007-08-08 - 2007-08-10 CHECKED BY MRA

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: o UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page						178				
							177				
			14	SS	29				o		
							176				
							175				
							174				
	Grey		15	SS	77				o		
							173				
							172				
							171				
			16	SS	30				o		0 94 6 (SI+CL)
							170				
							169				

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$+^3$, $\times^3$: Numbers refer to Sensitivity

$15 \oplus^{20}_{10} 5$ (%) STRAIN AT FAILURE

ONTMT4S 5198.GPJ 11/2/07

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THURBER

RECORD OF BOREHOLE No 07-M04 4 OF 4 METRIC

G.W.P. 5460-04-00 LOCATION Mindemoya Lake Bridge and Dam N9876.32 E9181.62 ORIGINATED BY SLL

HWY 542 BOREHOLE TYPE Hollow Stem Augers COMPILED BY WM

DATUM Geodetic DATE 2007-08-08 - 2007-10-08 CHECKED BY MRA

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page						168				
	occasional cobbles		17	SS	100/.175		167				
							166				
							165				
			18	SS	100/.125		164		o		
162.9							163				
35.1	END OF BOREHOLE AT 35.1m. AUGER REFUSAL AT 35.1m ON PROBABLE BEDROCK. BOREHOLE BACKFILLED WITH BENTONITE TO 0.15m, THEN ASPHALT PATCH TO SURFACE. INSTALLED MONITORING WELL 07-M4-2 IN DCPT HOLE.										

WATER LEVEL READINGS:

DATE	DEPTH(m)	ELEV.(m)
2007-08-17	1.23	196.77
2007-08-29	1.32	196.68

$+^3$, $\times^3$: Numbers refer to Sensitivity

(%) STRAIN AT FAILURE

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RECORD OF BOREHOLE No 07-M05 1 OF 3 METRIC

G.W.P. 5460-04-00 LOCATION Mindemoya Lake Bridge and Dam N9867.95 E9195.58 ORIGINATED BY SLL
HWY 542 BOREHOLE TYPE Hollow Stem Augers COMPILED BY WM
DATUM Geodetic DATE 2007-09-08 - 07/0/90/7 CHECKED BY MRA

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
197.9	Road Surface										
0.0 / 0.1	**ASPHALT:** (50mm)										
	SAND, some gravel, occasional cobbles and boulders Brown Moist (FILL)						197				
196.1			1	SS	6						
1.8	Sandy **SILT**						196				
195.7	Loose Grey										
2.2	Wet										
	Silty **CLAY**, with silty sand seams Soft to Stiff Grey Moist to Wet		2	SS	4		195				
			3	SS	12						
			4	SS	4		194				
			5	SS	3		193				0 0 70 30
			6	SS	2						
191.9							192				
6.0	**SILT**, trace to some clay, trace sand Very loose to very dense Grey Wet		7	SS	1						
							191				
			8	SS	17		190				
							189				
			9	SS	23						0 1 86 13
							188				

Continued Next Page

+³, ×³: Numbers refer to Sensitivity

15 (20, 10, 5) (%) STRAIN AT FAILURE

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RECORD OF BOREHOLE No 07-M05 2 OF 3 METRIC

G.W.P. 5460-04-00 LOCATION Mindemoya Lake Bridge and Dam N9867.95 E9195.58 ORIGINATED BY SLL

HWY 542 BOREHOLE TYPE Hollow Stem Augers COMPILED BY WM

DATUM Geodetic DATE 2007-08-09 - 07/0/90/7 CHECKED BY MRA

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
			10	SS	61		187		○		
							186				
			11	SS	9				○		
							185				
			12	SS	3		184		○		0 1 90 9
183.1											
14.8	**SAND**, trace silt Compact to dense Grey Wet		13	SS	23		183		○		
							182				
							181				
							180				
			14	SS	39				○		
							179				
							178				

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+ ³, × ³ : Numbers refer to Sensitivity

$\frac{20}{15 \oplus 5}$ (%) STRAIN AT FAILURE
10

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RECORD OF BOREHOLE No 07-M05 3 OF 3 METRIC

G.W.P. 5460-04-00 LOCATION Mindemoya Lake Bridge and Dam N9867.95 E9195.58 ORIGINATED BY SLL

HWY 542 BOREHOLE TYPE Hollow Stem Augers COMPILED BY WM

DATUM Geodetic DATE 2007-08-09 - 07/0/90/7 CHECKED BY MRA

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: O UNCONFINED + FIELD VANE; ● QUICK TRIAXIAL × LAB VANE; 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L; WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
	Continued From Previous Page										
177.5			15	SS	28				o		0 90 10 (SI+CL)
20.4	END OF BOREHOLE AT 20.4m. BOREHOLE GROUTED WITH BENTONITE TO 0.15m, THEN ASPHALT PATCH TO SURFACE.						177				

$+^3$, $\times^3$ Numbers refer to Sensitivity

$\oplus^{20}_{15\ 10\ 5}$ (%) STRAIN AT FAILURE

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RECORD OF BOREHOLE No 07-M06 1 OF 5 METRIC

G.W.P. 5460-04-00 LOCATION Mindemoya Lake Bridge and Dam N9857.86 E9158.58 ORIGINATED BY GA

HWY 542 BOREHOLE TYPE Hollow Stem Augers/NQ Coring COMPILED BY WM

DATUM Geodetic DATE 2007-07-16 - 2007-07-17 CHECKED BY MRA

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
197.0	Ground Surface						197				
0.0 / 196.7	**TOPSOIL:** (275mm)										
0.3	**SAND**, trace silt, trace rootlets, trace wood fibres Loose Grey Wet		1	SS	4				o		
			2	SS	4		196		o		
195.6											
1.4	Silty **CLAY**, trace sand Stiff to soft Grey Wet		3	SS	8				o		
			4	SS	7	▼ ▼	195	MW07-6-12 MW07-6-8	o		
			5	SS	15		194		o		0 1 76 23
							193	3.5 +			
			6	SS	2				o		
190.9							192	3.6 +			
6.1	**SILT**, trace to some clay, trace sand Loose to dense Grey Wet		7	SS	7		191		o		
							190				
			8	SS	11		189		o		
			9	SS	9		188		o		0 1 84 15

Continued Next Page

+ ^{3}, × ^{3}: Numbers refer to Sensitivity

$\frac{20}{15 \oplus 5}$ (%) STRAIN AT FAILURE
10

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THURBER

RECORD OF BOREHOLE No 07-M06 2 OF 5 METRIC

G.W.P. 5460-04-00 LOCATION Mindemoya Lake Bridge and Dam N9857.86 E9158.58 ORIGINATED BY GA

HWY 542 BOREHOLE TYPE Hollow Stem Augers/NQ Coring COMPILED BY WM

DATUM Geodetic DATE 2007-07-16 - 2007-07-17 CHECKED BY MRA

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (o UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	Dense		10	SS	32		187		o		
185.4							186				
11.6	**SAND**, fine to medium grained, trace silt Dense to compact Grey Wet		11	SS	44		185		o		0 92 8 (SI+CL)
			12	SS	40		184		o		
	Silty from 14.6 to 16.2m		13	SS	30		183		o		
	trace gravel at 15.5m		14	SS	24		182		o		
	trace gravel at 19.2m		15	SS	38		181		o		
							180				
							179				
							178				

Continued Next Page

$+^3$, $\times^3$: Numbers refer to Sensitivity

(%) STRAIN AT FAILURE

ONTMT4S 5198.GPJ 11/2/07

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 07-M06 3 OF 5 METRIC

G.W.P. 5460-04-00 LOCATION Mindemoya Lake Bridge and Dam N9857.86 E9158.58 ORIGINATED BY GA

HWY 542 BOREHOLE TYPE Hollow Stem Augers/NQ Coring COMPILED BY WM

DATUM Geodetic DATE 2007-07-16 - 2007-07-17 CHECKED BY MRA

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
	Continued From Previous Page						177				
							176				
							175				
			16	SS	34				○		0 93 7 (SI+CL)
							174				
							173				
							172				
			17	SS	42				○		
	trace gravel at 26.8 to 27.7m						171				
							170				
							169				
			18	SS	32				○		
							168				

Continued Next Page

$+^{3}$, $\times^{3}$: Numbers refer to Sensitivity

$\frac{20}{15 \oplus 5}$ (%) STRAIN AT FAILURE
10

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 07-M06 4 OF 5 METRIC

G.W.P. 5460-04-00 LOCATION Mindemoya Lake Bridge and Dam N9857.86 E9158.58 ORIGINATED BY GA
HWY 542 BOREHOLE TYPE Hollow Stem Augers/NQ Coring COMPILED BY WM
DATUM Geodetic DATE 2007-07-16 - 2007-07-17 CHECKED BY MRA

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (20 40 60 80 100): ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	clay seam at 29.9m						167				
							166				
			19	SS	31				o		
							165				
							164				
162.9							163			FI	
34.1	Brown to grey, fresh, thinly bedded, strong to very strong **DOLOSTONE**		1	RUN						3	RUN 1# TCR=100%, SCR=87%, RQD=90%, UCS=125MPa
							162			0	
										0	
										0	
										0	RUN 2# TCR=100%, SCR=100%, RQD=100%, UCS=127MPa
			2	RUN			161			0	
										0	
										0	
159.8							160			0	
37.2	END OF BOREHOLE AT 37.2m. BOREHOLE OPEN TO 37.2m AND WATER LEVEL AT 3.7m ON COMPLETION. Piezometer installation consists of 50mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. INSTALLED MONITORING WELL 07-6-8 IN SEPARATE AUGER HOLE. REFER TO SKETCH. WATER LEVEL READINGS: DATE DEPTH(m) ELEV.(m) MW 07-6-8 2007-07-18 2.25 194.73 2007-07-20 2.00 194.98 2007-08-17 2.21 194.77 2007-08-28 2.56 194.42 MW 07-6-12 2007-07-18 1.89 195.09 2007-07-20 1.81 195.17										

Continued Next Page

+ ³, × ³ Numbers refer to Sensitivity (20 / 15 5 / 10) (%) STRAIN AT FAILURE

ONTMT4S 5198-MINDEMOYA.GPJ 15/11/07

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 07-M06 5 OF 5 METRIC

G.W.P. 5460-04-00 LOCATION Mindemoya Lake Bridge and Dam N9857.86 E9158.58 ORIGINATED BY GA

HWY 542 BOREHOLE TYPE Hollow Stem Augers/NQ Coring COMPILED BY WM

DATUM Geodetic DATE 2007-07-16 - 2007-07-17 CHECKED BY MRA

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa o UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
	Continued From Previous Page										
	2007-08-17 1.92 195.06										
	2007-08-28 2.36 194.62										

$+^3$, $\times^3$: Numbers refer to Sensitivity

$\overset{20}{15}\oplus\overset{5}{10}$ (%) STRAIN AT FAILURE

ONTMT4S 5198.GPJ 11/2/07

Ministry of Transportation
Ontario

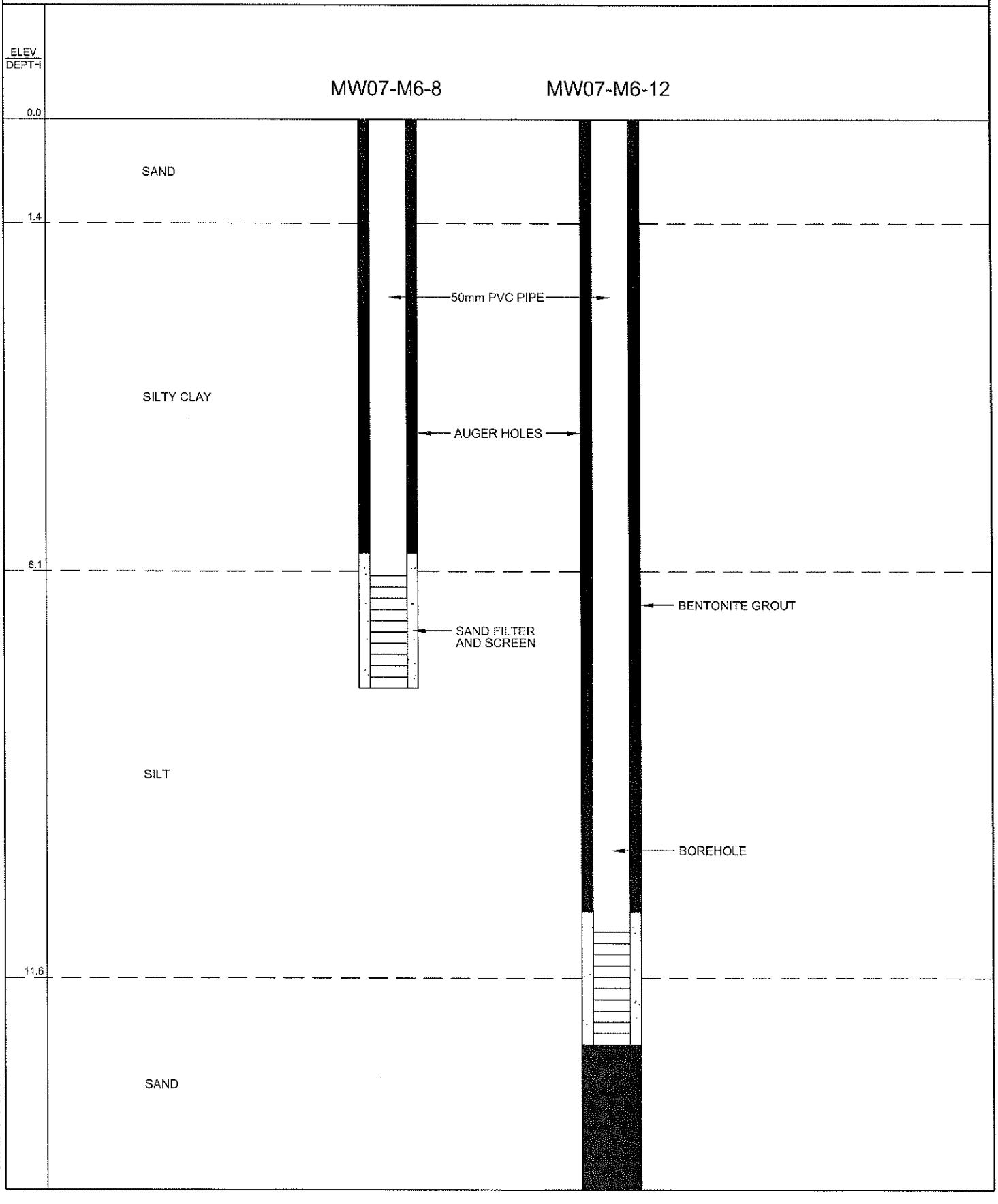
THURBER

MONITORING WELL DETAIL No 07-M06

1 OF 1

METRIC

G.W.P.	5460-04-00	LOCATION	Mindemoya Lake Bridge and Dam N9857.86 E9158.58	ORIGINATED BY	GA
HWY	542	BOREHOLE TYPE	Hollow Stem Augers/NQ Coring	COMPILED BY	WM
DATUM	Geodetic	DATE	2007-07-16 - 2007-07-17	CHECKED BY	MRA



ONTMT4S 5198.GPJ 11/2/07

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 07-M07 1 OF 4 METRIC

G.W.P. 5460-04-00 LOCATION Mindemoya Lake Bridge and Dam N9853.87 E9181.08 ORIGINATED BY GA

HWY 542 BOREHOLE TYPE Hollow Stem Augers COMPILED BY WM

DATUM Geodetic DATE 2007-07-18 - 2007-07-19 CHECKED BY MRA

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
195.2	Ground Surface										
0.0	**ROCKFILL** (drilling platform)						195				
194.4											
0.8	Silty **CLAY** Firm to soft Grey Wet		1	SS	6		194				
			2	SS	2						0 0 70 30
193.0							193				
2.2	**SILT**, trace clay to clayey, trace sand Loose to compact Grey Wet		3	SS	4						
			4	SS	8		192				
			5	SS	16		191				
			6	SS	8		190				0 2 83 15
			7	SS	12		189				
186.8							188				
8.4	Clayey **SILT** to silty **CLAY**, trace sand Stiff Grey Wet		8	SS	11		187				
							186				

Continued Next Page

+ ³ , × ³ : Numbers refer to Sensitivity

20 / 15 5 / 10 (%) STRAIN AT FAILURE

ONTMT4S 5198-MINDEMOYA.GPJ 08/1/18

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 07-M07 2 OF 4 METRIC

G.W.P. 5460-04-00 LOCATION Mindemoya Lake Bridge and Dam N9853.87 E9181.08 ORIGINATED BY GA
HWY 542 BOREHOLE TYPE Hollow Stem Augers COMPILED BY WM
DATUM Geodetic DATE 2007-07-18 - 2007-07-19 CHECKED BY MRA

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
	Continued From Previous Page		9	SS	10		185		○		0 0 77 23
183.6							184				
11.6	**SAND**, fine to medium grained, trace to some silt, trace gravel, occasional silt inclusions Compact to dense Grey Wet		10	SS	32		183		○		
			11	SS	36		182		○		
			12	SS	27		181		○		
			13	SS	23		180				3 82 15 (SI+CL)
							179		○		
							178				
							177				
			14	SS	28		176		○		

Continued Next Page

$+^3$, $\times^3$ Numbers refer to Sensitivity

20
15 ⊕ 5 (%) STRAIN AT FAILURE
10

ONTMT4S 5198.GPJ 11/2/07

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 07-M07 3 OF 4 METRIC

G.W.P. 5460-04-00 LOCATION Mindemoya Lake Bridge and Dam N9853.87 E9181.08 ORIGINATED BY GA

HWY 542 BOREHOLE TYPE Hollow Stem Augers COMPILED BY WM

DATUM Geodetic DATE 2007-07-18 - 2007-07-19 CHECKED BY MRA

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
	Continued From Previous Page						175				
							174				
							173				
			15	SS	36				o		
							172				
							171				
							170				
			16	SS	36				o		
							169				
							168				
							167				
			17	SS	44				o		
							166				

Continued Next Page

$+^{3}$, $\times^{3}$: Numbers refer to Sensitivity

20
15 ⊕ 5
10 (%) STRAIN AT FAILURE

ONTMT4S 5198.GPJ 11/2/07

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 07-M07 4 OF 4 METRIC

G.W.P. 5460-04-00 LOCATION Mindemoya Lake Bridge and Dam N9853.87 E9181.08 ORIGINATED BY GA

HWY 542 BOREHOLE TYPE Hollow Stem Augers COMPILED BY WM

DATUM Geodetic DATE 2007-07-18 - 2007-07-19 CHECKED BY MRA

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
165.0	Continued From Previous Page										
30.2	END OF BOREHOLE AT 30.2m. AUGER REFUSAL AT 30.2m ON POSSIBLE BOULDER OR BEDROCK. BOREHOLE OPEN TO 30.2m AND WATER LEVEL AT 0.9m UPON COMPLETION. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH(m) ELEV.(m) 2007-07-20 1.37 193.86 2007-08-17 0.68 194.55 2007-08-28 1.02 194.21						165				

$+^3$, $\times^3$: Numbers refer to Sensitivity

20 / 15 5 / 10 (%) STRAIN AT FAILURE

ONTMT4S 5198.GPJ 11/2/07

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 07-M08 1 OF 2 METRIC

G.W.P. 5460-04-00 LOCATION Mindemoya Lake Bridge and Dam N9893.23 E8995.38 ORIGINATED BY GA

HWY 542 BOREHOLE TYPE Hollow Stem Augers COMPILED BY WM

DATUM Geodetic DATE 2007-07-13 - 2007-07-13 CHECKED BY MRA

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
196.3	Ground Surface								
0.0 / 196.0	**PEAT** Dark brown		1	SS	6		196		
0.3	**SILT**, trace sand, trace rootlets Loose Grey Damp to wet		2	SS	6		195		
194.8									
1.5	Silty **CLAY** Stiff to firm Grey Moist to wet		3	SS	13		194		0 0 56 44
			4	SS	14				
			5	SS	5		193		
192.3									
4.0	**SILT**, trace clay, trace to some sand, occasional clay seams Compact to loose Grey Wet		6	SS	12		192		
			7	SS	26		191		
							190		0 12 79 9
			8	SS	18		189		
							188		
			9	SS	14		187		

DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100

SHEAR STRENGTH kPa
○ UNCONFINED + FIELD VANE
● QUICK TRIAXIAL × LAB VANE
20 40 60 80 100

PLASTIC LIMIT w_P NATURAL MOISTURE CONTENT w LIQUID LIMIT w_L
WATER CONTENT (%) 20 40 60

Continued Next Page

+ ³, × ³: Numbers refer to Sensitivity

20 / 15 5 / 10 (%) STRAIN AT FAILURE

ONTMT4S 5198-MINDEMOYA.GPJ 08/1/18

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 07-M08 2 OF 2 METRIC

G.W.P. 5460-04-00 LOCATION Mindemoya Lake Bridge and Dam N9893.23 E8995.38 ORIGINATED BY GA

HWY 542 BOREHOLE TYPE Hollow Stem Augers COMPILED BY WM

DATUM Geodetic DATE 2007-07-13 - 2007-07-13 CHECKED BY MRA

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
	Continued From Previous Page						186				
			10	SS	8				○		
							185				
			11	SS	3		184		○		0 7 85 8
182.9											
13.4	**SAND**, fine grained, trace silt Compact to very dense Grey Wet		12	SS	18		183		○		
							182				
180.6			13	SS	74		181		○		
15.7	END OF BOREHOLE AT 15.7m. BOREHOLE OPEN TO 15.2m AND WATER LEVEL AT 1.8m UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE TO SURFACE.										

$+^3$ $\times^3$ Numbers refer to Sensitivity

$\frac{20}{15 \oplus 5}$ (%) STRAIN AT FAILURE
10

ONTMT4S 5198.GPJ 11/2/07

Ministry of Transportation
Ontario

RECORD OF BOREHOLE No 07-M09 1 OF 2 METRIC

G.W.P. 5460-04-00 LOCATION Mindemoya Lake Bridge and Dam N9877.56 E9042.05 ORIGINATED BY GA
HWY 542 BOREHOLE TYPE Hollow Stem Augers COMPILED BY WM
DATUM Geodetic DATE 2007-07-13 - 2007-07-13 CHECKED BY MRA

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
196.4	Ground Surface								
0.0	**TOPSOIL:** (150mm)								
0.2	Sandy **SILT**, occasional rootlets Loose Brown		1	SS	8		196		
195.6	Moist								
0.8	Silty **CLAY**, trace sand Stiff to firm Grey Moist to wet		2	SS	9		195		
			3	SS	11				
			4	SS	8		194		0 1 59 40
192.9			5	SS	4		193		
3.5	**SILT**, trace to some clay, trace sand Loose to compact Grey Wet		6	SS	15		192		
			7	SS	13		191		
			8	SS	8		190		0 1 86 13
			9	SS	17		189		
							188		
							187		

DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100
SHEAR STRENGTH kPa
○ UNCONFINED + FIELD VANE
● QUICK TRIAXIAL × LAB VANE
20 40 60 80 100

PLASTIC LIMIT w_P NATURAL MOISTURE CONTENT w LIQUID LIMIT w_L
WATER CONTENT (%) 20 40 60

Continued Next Page

$+^3$ $\times^3$ Numbers refer to Sensitivity

20
15 5
10
(%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 07-M09 2 OF 2 METRIC

G.W.P. 5460-04-00 LOCATION Mindemoya Lake Bridge and Dam N9877.56 E9042.05 ORIGINATED BY GA

HWY 542 BOREHOLE TYPE Hollow Stem Augers COMPILED BY WM

DATUM Geodetic DATE 2007-07-13 - 2007-07-13 CHECKED BY MRA

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (o UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
			10	SS	10		186		o		
							185				
184.2											
12.2	**SAND**, fine to medium grained, trace to some silt Compact to dense Grey Wet		11	SS	42		184		o		0 92 8 (SI+CL)
			12	SS	20		183		o		
							182				
180.6			13	SS	32		181		o		0 87 13 (SI+CL)
15.8	END OF BOREHOLE AT 15.8m. BOREHOLE OPEN TO 15.8m AND WATER LEVEL AT 4.1m UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE TO SURFACE.										

$+^3$, $\times^3$: Numbers refer to Sensitivity

$\frac{20}{15}\oplus\frac{5}{10}$ (%) STRAIN AT FAILURE

ONTMT4S 5198.GPJ 11/2/07

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 07-M10 1 OF 2 METRIC

G.W.P. 5460-04-00 LOCATION Mindemoya Lake Bridge and Dam N9863.56 E9084.88 ORIGINATED BY GA

HWY 542 BOREHOLE TYPE Hollow Stem Augers COMPILED BY WM

DATUM Geodetic DATE 2007-07-13 - 2007-07-14 CHECKED BY MRA

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
196.9	Ground Surface										
0.0	**TOPSOIL:** (150mm)										
0.2	**SILT**, trace sand, occasional rootlets Loose Dark Brown to Brown		1	SS	8						
196.3											
0.6	Silty **SAND**, trace rootlets Loose to very dense Brown Moist to wet		2	SS	4		196				
			3	SS	2		195				
194.7											
2.2	Silty **CLAY** Firm Grey Wet		4	SS	4						0 0 64 36
			5	SS	5		194				
193.2											
3.7	**SILT**, trace clay, trace sand Compact to loose Grey Wet						193				
			6	SS	15		192				
			7	SS	6		191				
							190				
189.3											
7.6	**SAND**, fine to medium grained, trace silt Compact Grey Wet		8	SS	10		189				
			9	SS	18		188				0 96 4 (SI+CL)
							187				

Continued Next Page

$+^3$, $\times^3$: Numbers refer to Sensitivity

20 15 5 10 (%) STRAIN AT FAILURE

ONTMT4S 5198-MINDEMOYA.GPJ 08/1/18

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 07-M10 2 OF 2 METRIC

G.W.P. 5460-04-00 LOCATION Mindemoya Lake Bridge and Dam N9863.56 E9084.88 ORIGINATED BY GA

HWY 542 BOREHOLE TYPE Hollow Stem Augers COMPILED BY WM

DATUM Geodetic DATE 2007-07-13 - 2007-07-14 CHECKED BY MRA

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	occasional silt inclusions		10	SS	26		186				
			11	SS	17		185				
			12	SS	15		184				
			13	SS	34		183				
181.1							182				0 62 38 (SI+CL)
15.8	END OF BOREHOLE AT 15.8m. BOREHOLE OPEN TO 15.2m AND WATER LEVEL AT 2.3m ON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE TO SURFACE.										

$+^3$, $\times^3$: Numbers refer to Sensitivity

20 / 15 5 / 10 (%) STRAIN AT FAILURE

ONTM14S 5198.GPJ 11/2/07

Ministry of Transportation
Ontario

RECORD OF BOREHOLE No 07-M11 1 OF 2 METRIC

G.W.P. 5460-04-00 LOCATION Mindemoya Lake Bridge and Dam N9849.13 E9136.60 ORIGINATED BY GA
HWY 542 BOREHOLE TYPE Hollow Stem Augers COMPILED BY WM
DATUM Geodetic DATE 2007-07-15 - 2007-07-15 CHECKED BY MRA

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (O UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
196.8	Ground Surface										
0.0	**TOPSOIL:** (200mm)										
0.2	**SAND**, trace silt, mixed with topsoil, occasional rootlets, shells and wood fibres Loose to compact Brown to grey Moist to wet		1	SS	10						
			2	SS	9		196				
195.4											
1.4	Silty **CLAY**, trace sand Stiff Grey Moist to wet		3	SS	12		195				
			4	SS	13	▼					0 1 65 34
			5	SS	8		194				
192.2							193	3.3			
4.6	**SILT**, trace to some clay, trace sand Compact to dense Grey Wet		6	SS	11		192				
			7	SS	27		191				0 4 81 15
			8	SS	33		190				
187.7							189				
9.1	**SAND**, fine to medium grained, trace silt Compact to dense Grey Wet		9	SS	10		188				
							187				

Continued Next Page

+ ³, × ³: Numbers refer to Sensitivity

(%) STRAIN AT FAILURE

ONTMT4S 5198-MINDEMOYA.GPJ 08/1/18

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 07-M11 2 OF 2 METRIC

G.W.P. 5460-04-00 LOCATION Mindemoya Lake Bridge and Dam N9849.13 E9136.60 ORIGINATED BY GA

HWY 542 BOREHOLE TYPE Hollow Stem Augers COMPILED BY WM

DATUM Geodetic DATE 2007-07-15 - 2007-07-15 CHECKED BY MRA

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
			10	SS	40		186		○		
			11	SS	21		185		○		0 94 6 (SI+CL)
			12	SS	49		184		○		
181.0			13	SS	33		183		○		
							182				
15.8	END OF BOREHOLE AT 15.8m. BOREHOLE OPEN TO 15.2m AND WATER LEVEL AT 1.7m ON COMPLETION. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen.						181				

WATER LEVEL READINGS:

DATE	DEPTH(m)	ELEV.(m)
2007-07-18	1.97	194.82
2007-07-20	1.96	194.83
2007-08-17	2.09	194.70
2007-08-28	2.31	194.48

$+^{3}$, $\times^{3}$ Numbers refer to Sensitivity

$15\text{-}\frac{20}{10}\text{-}5$ (%) STRAIN AT FAILURE

ONTMT4S 5198.GPJ 11/2/07

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Ontario

THURBER

RECORD OF BOREHOLE No 07-M12 1 OF 2 METRIC

G.W.P. 5460-04-00 LOCATION Mindemoya Lake Bridge and Dam N9839.73 E9198.99 ORIGINATED BY GA

HWY 542 BOREHOLE TYPE Hollow Stem Augers COMPILED BY WM

DATUM Geodetic DATE 2007-12-07 - 2007-12-07 CHECKED BY MRA

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
196.9	Ground Surface										
0.0 / 196.6	**TOPSOIL:** (250mm)										
0.3 / 196.2	**SILT**, trace sand, trace rootlets Compact Brown		1	SS	13				○		
0.7	Dry										
	Silty **SAND** Compact Brown		2	SS	12		196		○		
195.5	Moist										
1.4	Silty **CLAY**, trace sand Firm to stiff Brown to grey Moist to wet		3	SS	7		195		○		
			4	SS	8				⊣		0 1 67 32
193.9							194				
3.0	**SILT**, trace to some clay, trace sand Loose to compact Grey Wet		5	SS	5				○		
							193				
			6	SS	6		192		○		0 1 85 14
							191				
			7	SS	11				○		
							190				
			8	SS	16		189		○		
							188				
			9	SS	8				○		
							187				

Continued Next Page

$+^3$, $\times^3$: Numbers refer to Sensitivity

20 / 15 5 / 10 (%) STRAIN AT FAILURE

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Ontario

THURBER

RECORD OF BOREHOLE No 07-M12 2 OF 2 METRIC

G.W.P. 5460-04-00 LOCATION Mindemoya Lake Bridge and Dam N9839.73 E9198.99 ORIGINATED BY GA

HWY 542 BOREHOLE TYPE Hollow Stem Augers COMPILED BY WM

DATUM Geodetic DATE 2007-07-12 - 2007-07-12 CHECKED BY MRA

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
185.0			10	SS	6		186				
11.9	**SAND**, fine to medium grained, trace to some silt Compact to dense Grey Wet		11	SS	20		185				
			12	SS	42		184				0 82 18 (SI+CL)
181.1			13	SS	36		183				
15.8	END OF BOREHOLE AT 15.8m. BOREHOLE OPEN TO 15.8m AND WATER LEVEL AT 3.0m ON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE TO SURFACE.						182				

$+^3$, $\times^3$: Numbers refer to Sensitivity

20 / 15 5 / 10 (%) STRAIN AT FAILURE

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Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 07-M13 1 OF 2 METRIC

G.W.P. 5460-04-00 LOCATION Mindemoya Lake Bridge and Dam N9833.74 E9246.39 ORIGINATED BY GA
HWY 542 BOREHOLE TYPE Hollow Stem Augers COMPILED BY WM
DATUM Geodetic DATE 2007-12-07 - 2007-12-07 CHECKED BY MRA

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
196.5	Ground Surface										
0.0	**TOPSOIL:** (150mm)										
0.2	Silty **CLAY**, trace sand, occasional rootlets Very stiff to firm Brown to grey Moist to wet		1	SS	11		196				
			2	SS	16		195				
			3	SS	11		194				
			4	SS	11		193				
192.8			5	SS	7						0 1 68 31
3.7	**SILT**, trace to some clay, trace sand Compact Grey Wet		6	SS	13		192				
			7	SS	23		191				
			8	SS	14		190				
187.8							189				0 4 84 12
8.7	Clayey **SILT**, trace sand Stiff to very stiff Grey		9	SS	16		188				
							187				0 4 73 23

Continued Next Page

+ ³, × ³: Numbers refer to Sensitivity

20 / 15 5 / 10 (%) STRAIN AT FAILURE

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Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 07-M13 2 OF 2 METRIC

G.W.P. 5460-04-00 LOCATION Mindemoya Lake Bridge and Dam N9833.74 E9246.39 ORIGINATED BY GA

HWY 542 BOREHOLE TYPE Hollow Stem Augers COMPILED BY WM

DATUM Geodetic DATE 2007-07-12 - 2007-07-12 CHECKED BY MRA

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
	Continued From Previous Page						186				
			10	SS	8				○		
							185				
			11	SS	12				○		
							184				
							183				
			12	SS	18				○		0 3 78 19
							182				
180.7			13	S	14		181		○		
15.8	END OF BOREHOLE AT 15.8m. BOREHOLE OPEN TO 15.8m AND WATER LEVEL AT 2.7m ON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE TO SURFACE.										

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$+^{3}$ $\times^{3}$ Numbers refer to Sensitivity

$15 \oplus^{20}_{10} 5$ (%) STRAIN AT FAILURE

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THURBER

RECORD OF BOREHOLE No 07-M14 1 OF 4 METRIC

G.W.P. 5460-04-00 LOCATION Mindemoya Lake Bridge and Dam N9844.84 E9154.49 ORIGINATED BY GA

HWY 542 BOREHOLE TYPE Hollow Stem Augers COMPILED BY WM

DATUM Geodetic DATE 2007-07-15 - 2007-07-15 CHECKED BY MRA

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
196.8	Ground Surface								
0.0	**TOPSOIL:** (150mm)								
0.2	**SILT**, trace sand, occasional rootlets Loose Dark Brown to Brown		1	SS	9				
196.1	Dry								
0.7	**SAND**, trace silt, occasional rootlets, occasional wood fibres Compact Brown		2	SS	11				
195.4	Damp								
1.4	Silty **CLAY**, trace sand Stiff to firm Grey Wet		3	SS	8				
			4	SS	6				0 1 67 32
193.8									
3.0	**SILT**, trace to some clay, trace sand Compact Grey Wet		5	SS	12				
			6	SS	14				
			7	SS	12				1 2 78 19
			8	SS	11				
			9	SS	12				

DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100

SHEAR STRENGTH kPa
○ UNCONFINED + FIELD VANE
● QUICK TRIAXIAL × LAB VANE
20 40 60 80 100

PLASTIC LIMIT w_P NATURAL MOISTURE CONTENT w LIQUID LIMIT w_L
WATER CONTENT (%) 20 40 60

ELEVATION SCALE: 196 195 194 193 192 191 190 189 188 187

Continued Next Page

$+^3$ $\times^3$ Numbers refer to Sensitivity

20 15 10 5 (%) STRAIN AT FAILURE

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THURBER

RECORD OF BOREHOLE No 07-M14 2 OF 4 METRIC

G.W.P. 5460-04-00 LOCATION Mindemoya Lake Bridge and Dam N9844.84 E9154.49 ORIGINATED BY GA

HWY 542 BOREHOLE TYPE Hollow Stem Augers COMPILED BY WM

DATUM Geodetic DATE 2007-07-15 - 2007-07-15 CHECKED BY MRA

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page							
186.7								
10.1	**SAND**, fine to medium grained, trace silt to silty, occasional silt inclusions Compact to dense Grey Wet		10	SS	26			
			11	SS	45			0 59 41 (SI+CL)
			12	SS	49			
			13	SS	38			
			14	SS	38			0 83 17 (SI+CL)
			15	SS	56			

DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100

SHEAR STRENGTH kPa
○ UNCONFINED + FIELD VANE
● QUICK TRIAXIAL × LAB VANE
20 40 60 80 100

PLASTIC LIMIT w_P NATURAL MOISTURE CONTENT w LIQUID LIMIT w_L
WATER CONTENT (%) 20 40 60

ELEVATION SCALE 186 185 184 183 182 181 180 179 178 177

Continued Next Page

$+^3$, $\times^3$: Numbers refer to Sensitivity

15 20 10 5 (%) STRAIN AT FAILURE

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THURBER

RECORD OF BOREHOLE No 07-M14 3 OF 4 METRIC

G.W.P. 5460-04-00 LOCATION Mindemoya Lake Bridge and Dam N9844.84 E9154.49 ORIGINATED BY GA

HWY 542 BOREHOLE TYPE Hollow Stem Augers COMPILED BY WM

DATUM Geodetic DATE 2007-07-15 - 2007-07-15 CHECKED BY MRA

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
	Continued From Previous Page										
	gravelly seam at 20.7m						176				
							175				
			16	SS	34				○		
	occasional large gravel at 22.9 to 24.4m						174				
							173				
							172				
			17	SS	29				○		
	occasional gravel at 25.9 to 27.4m						171				
							170				
							169				
			18	SS	33				○		0 63 37 (SI+CL)
							168				
							167				

Continued Next Page

+ 3 , × 3 Numbers refer to Sensitivity

20 / 15 ⊕ 5 / 10 (%) STRAIN AT FAILURE

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THURBER

RECORD OF BOREHOLE No 07-M14 4 OF 4 METRIC

G.W.P. 5460-04-00 LOCATION Mindemoya Lake Bridge and Dam N9844.84 E9154.49 ORIGINATED BY GA

HWY 542 BOREHOLE TYPE Hollow Stem Augers COMPILED BY WM

DATUM Geodetic DATE 2007-07-15 - 2007-07-15 CHECKED BY MRA

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	clay seam at 29.9m						166				
			19	SS	34		165		○		
							164				
163.0											
33.8	END OF BOREHOLE AT 33.8m. AUGER REFUSAL AT 33.8m ON PROBABLE BEDROCK. BOREHOLE OPEN TO 33.8m AND WATER LEVEL AT 3.4m UPON COMPLETION. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH(m) ELEV.(m) 2007-07-18 2.08 194.72 2007-07-20 2.08 194.72 2007-08-17 2.01 194.79 2007-08-28 1.83 194.97										

$+^3$, $\times^3$: Numbers refer to Sensitivity

$15 \overset{20}{\oplus} 5$ $\underset{10}{}$ (%) STRAIN AT FAILURE

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Ontario

THURBER

RECORD OF BOREHOLE No 07-M15 1 OF 4 METRIC

G.W.P. 5460-04-00 LOCATION Mindemoya Lake Bridge and Dam N9841.29 E9181.37 ORIGINATED BY GA

HWY 542 BOREHOLE TYPE Hollow Stem Augers/NQ Coring COMPILED BY WM

DATUM Geodetic DATE 2007-07-19 - 2007-07-20 CHECKED BY MRA

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
195.4	Rockfill Platform										
0.0	**ROCKFILL** (drilling platform)						195				
194.2											
1.2	Silty **CLAY** Firm Grey Wet		1	SS	5		194		○		
			2	SS	4		193		○		
192.4											
3.0	**SILT**, trace sand, trace to some clay Loose to compact Grey Wet		3	SS	4		192		○		0 1 83 16
			4	SS	12		191		○		
			5	SS	11		190		○		
			6	SS	9		189		○		
			7	SS	8		188		○		1 5 81 13
							187				
							186				

Continued Next Page

+ ³, × ³: Numbers refer to Sensitivity

20 / 15 5 / 10 (%) STRAIN AT FAILURE

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THURBER

RECORD OF BOREHOLE No 07-M15 2 OF 4 METRIC

G.W.P. 5460-04-00 LOCATION Mindemoya Lake Bridge and Dam N9841.29 E9181.37 ORIGINATED BY GA
HWY 542 BOREHOLE TYPE Hollow Stem Augers/NQ Coring COMPILED BY WM
DATUM Geodetic DATE 2007-07-19 - 2007-07-20 CHECKED BY MRA

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	Compact		8	SS	15		185				
184.4											
11.0	**SAND**, fine to medium grained, trace to some silt, occasional silt inclusions Compact to dense Grey Wet		9	SS	32		184				0 75 25 (SI+CL)
			10	SS	25		183				
			11	SS	40		182				
	occasional gravel at 15.2 to 15.9m		12	SS	37		181				0 95 5 (SI+CL)
			13	SS	27		180				
							179				
							178				
							177				
							176				

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+ ^{3}, × ^{3} : Numbers refer to Sensitivity

(%) STRAIN AT FAILURE

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THURBER

RECORD OF BOREHOLE No 07-M15 3 OF 4 METRIC

G.W.P. 5460-04-00 LOCATION Mindemoya Lake Bridge and Dam N9841.29 E9181.37 ORIGINATED BY GA

HWY 542 BOREHOLE TYPE Hollow Stem Augers/NQ Coring COMPILED BY WM

DATUM Geodetic DATE 2007-07-19 - 2007-07-20 CHECKED BY MRA

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
	Continued From Previous Page										
							175				
							174				
			14	SS	41		173		○		
							172				
							171				
			15	SS	31		170		○		2 94 4 (SI+CL)
							169				
							168				
			16	SS	38		167		○		
							166				

Continued Next Page

$+^3$ $\times^3$ Numbers refer to Sensitivity

$\frac{20}{15 \oplus 5}$ (%) STRAIN AT FAILURE
10

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Ontario

THURBER

RECORD OF BOREHOLE No 07-M15 4 OF 4 METRIC

G.W.P. 5460-04-00 LOCATION Mindemoya Lake Bridge and Dam N9841.29 E9181.37 ORIGINATED BY GA

HWY 542 BOREHOLE TYPE Hollow Stem Augers/NQ Coring COMPILED BY WM

DATUM Geodetic DATE 2007-07-19 - 2007-07-20 CHECKED BY MRA

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	cobble (100mm)						165				
							164				
163.4										FI	
32.0	Grey to brown, fresh, thinly bedded, strong to very strong **DOLOSTONE**		1	RUN			163			0	RUN 1# TCR=100%, SCR=100%, RQD=100%, UCS=155MPa
										0	
										0	
										0	
							162			0	
			2	RUN						0	RUN 2# TCR=100%, SCR=100%, RQD=100%, UCS=140MPa
										0	
										0	
							161			0	
160.3										0	
35.1	END OF BOREHOLE AT 35.1m. BOREHOLE OPEN TO 35.1m AND WATER LEVEL AT 1.1m ON COMPLETION. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen.										

WATER LEVEL READINGS:

DATE	DEPTH(m)	ELEV.(m)
2007-08-17	0.57	194.78
2007-08-28	1.35	194.00

+ ³, × ³: Numbers refer to Sensitivity

20 / 15 ⊕ 5 / 10 (%) STRAIN AT FAILURE

ONTMT4S 5198-MINDEMOYA.GPJ 15/11/07

Record of Borehole Sheets

from Preliminary Investigation

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 06-M01 1 OF 4 METRIC

G.W.P. 5460-04-00 LOCATION Mindemoya Lake Bridge and Dam N9878.4 E9169.6 ORIGINATED BY GA

HWY 542 BOREHOLE TYPE Hollow Stem Augers/NW Casing COMPILED BY WM

DATUM Geodetic DATE 2006-08-27 - 2006-08-27 CHECKED BY MA

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
196.9	Rockfill Platform										
0.0 196.3	**ROCK FILL** (drilling platform)										
0.6	**SAND**, occasional wood fibres Very Loose Grey Wet		1	SS	2		196				
			2	SS	2		195				
194.6											
2.3	Silty **CLAY**, trace sand Firm to Soft Grey Wet (CL-ML)		3	SS	7		194				
			4	SS	2		193	2.3			0 1 61 38
			5	SS	2		192				
190.8							191				
6.1	**SILT**, trace sand Very Loose to Compact Grey Wet (ML-NP)		6	SS	2		190				
			7	SS	10		189				0 3 90 7
			8	SS	12		188				
							187				

Continued Next Page

+ ³, × ³: Numbers refer to Sensitivity

(%) STRAIN AT FAILURE

ONTMT4S 5198-MINDEMOYA.GPJ 08/1/18

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 06-M01 2 OF 4 METRIC

G.W.P. 5460-04-00 LOCATION Mindemoya Lake Bridge and Dam N9878.4 E9169.6 ORIGINATED BY GA

HWY 542 BOREHOLE TYPE Hollow Stem Augers/NW Casing COMPILED BY WM

DATUM Geodetic DATE 2006-08-27 - 2006-08-27 CHECKED BY MA

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (20 40 60 80 100): o UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	Continued from previous page										
			9	SS	11		186		o		
184.7							185				
12.2	**SAND**, fine to medium grained, trace silt Compact Grey Wet		10	SS	14		184		o		
			11	SS	29		183		o		0 90 10 (SI+CL)
			12	SS	21		182		o		
							181				
							180				
							179				
			13	SS	25		178		o		
							177				

Continued Next Page

$+^{3}$, $\times^{3}$ Numbers refer to Sensitivity

$\frac{20}{15}\oplus\frac{5}{10}$ (%) STRAIN AT FAILURE

ONTMT4S 5198.GPJ 11/2/07

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 06-M01 3 OF 4 METRIC

G.W.P. 5460-04-00 LOCATION Mindemoya Lake Bridge and Dam N9878.4 E9169.6 ORIGINATED BY GA

HWY 542 BOREHOLE TYPE Hollow Stem Augers/NW Casing COMPILED BY WM

DATUM Geodetic DATE 2006-08-27 - 2006-08-27 CHECKED BY MA

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
	Continued From Previous Page										
	Continued from previous page						176				
			14	SS	19		175		○		0 94 6 (SI+CL)
							174				
							173				
			15	SS	28		172		○		
							171				
169.5							170				
27.4	**SILT**, some sand Compact Grey Wet		16	SS	18		169		○		0 21 66 13
							168				
							167				

Continued Next Page

+ ³, × ³: Numbers refer to Sensitivity

20 / 15 5 / 10 (%) STRAIN AT FAILURE

ONTMT4S 5198.GPJ 11/2/07

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 06-M01 4 OF 4 METRIC

G.W.P. 5460-04-00 LOCATION Mindemoya Lake Bridge and Dam N9878.4 E9169.6 ORIGINATED BY GA

HWY 542 BOREHOLE TYPE Hollow Stem Augers/NW Casing COMPILED BY WM

DATUM Geodetic DATE 2006-08-27 - 2006-08-27 CHECKED BY MA

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	Continued from previous page										
			17	SS	24		166	○			
							165				
							164				
163.2											
33.7	**SILT**, some sand, some gravel, occasional limestone fragments Very Dense Grey Wet (TILL)		18	SS	52		163	○			
162.3										FI	
34.6	Light brown and grey, fresh, thinly to medium bedded, very strong, **DOLOSTONE** Horizontal joints at 35.10 and 35.46 m		1	RUN			162			0 1 1 0	Run #1 TCR=100% SCR=100% RQD=100% UCS=169MPa
							161			0	
	Horizontal joints at 36.62, 36.78, 37.09 and 37.19 m		2	RUN			160			0 1 1 2	Run #2 TCR=100% SCR=100% RQD=100% UCS=157MPa
159.3										0	
37.6	END OF BOREHOLE AT 37.64 m. BOREHOLE OPEN AND WATER LEVEL AT 0.61 m ON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE.										

$+^3$, $\times^3$: Numbers refer to Sensitivity

20 / 15 ⊕ 5 / 10 (%) STRAIN AT FAILURE

ONTMT4S 5198-MINDEMOYA.GPJ 15/11/07

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 06-M03 1 OF 4 METRIC

G.W.P. 5460-04-00 LOCATION Mindemoya Lake Bridge and Dam N9865.0 E9166.1 ORIGINATED BY KH

HWY 542 BOREHOLE TYPE Hollow Stem Augers/NW Casing COMPILED BY WM

DATUM Geodetic DATE 2006-08-24 - 2006-08-24 CHECKED BY MA

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
198.1	Road Surface						198				
0.0	**ASPHALT**: (25 mm)		1	GS							
	SAND, some gravel, some silt, occasional wood and rock fragments, trace organics Compact to Dense Brown Moist (FILL)		1	SS	29		197				
			2	SS	38		196				
	Loose		3	SS	5						
195.4							195				
2.7	Silty **CLAY**, trace sand Soft Grey Wet		4	SS	3	▼					
			5	SS	2		194				0 1 74 25
192.0							193				
6.1	**SILT**, some sand Very Loose to Loose Grey Wet		6	SS	1		192				
			7	SS	8		191				0 1 89 10
			8	SS	3		190				
							189				

Continued Next Page

+ ^{3}, × ^{3} : Numbers refer to Sensitivity

(%) STRAIN AT FAILURE

ONTMT4S 5198-MINDEMOYA.GPJ 08/1/18

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 06-M03 2 OF 4 METRIC

G.W.P. 5460-04-00 LOCATION Mindemoya Lake Bridge and Dam N9865.0 E9166.1 ORIGINATED BY KH
HWY 542 BOREHOLE TYPE Hollow Stem Augers/NW Casing COMPILED BY WM
DATUM Geodetic DATE 2006-08-24 - 2006-08-24 CHECKED BY MA

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	Continued from previous page										
			9	SS	3						
186.2											
11.9	**SAND**, fine to medium grained, trace silt Dense to Compact Grey Wet		10	SS	30						
			11	SS	39						0 92 8 (SI+CL)
			12	SS	25						
			13	SS	15						

Continued Next Page

+^{3} ×^{3} Numbers refer to Sensitivity

(%) STRAIN AT FAILURE

ONTMT4S 5198.GPJ 11/2/07

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 06-M03 3 OF 4 METRIC

G.W.P. 5460-04-00 LOCATION Mindemoya Lake Bridge and Dam N9865.0 E9166.1 ORIGINATED BY KH

HWY 542 BOREHOLE TYPE Hollow Stem Augers/NW Casing COMPILED BY WM

DATUM Geodetic DATE 2006-08-24 - 2006-08-24 CHECKED BY MA

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
	Continued From Previous Page										
	Continued from previous page						178				
			14	SS	15		177				
							176				
							175				
			15	SS	22		174				0 92 8 (SI+CL)
							173				
							172				
			16	SS	27		171				
	Occasional silt layer						170				
	some silt, trace gravel, occasional limestone fragments						169				

Continued Next Page

$+^3$, $\times^3$: Numbers refer to Sensitivity

20 / 15 5 / 10 {%} STRAIN AT FAILURE

ONTMT4S 5198.GPJ 11/2/07

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 06-M03 4 OF 4 METRIC

G.W.P. 5460-04-00 LOCATION Mindemoya Lake Bridge and Dam N9865.0 E9166.1 ORIGINATED BY KH

HWY 542 BOREHOLE TYPE Hollow Stem Augers/NW Casing COMPILED BY WM

DATUM Geodetic DATE 2006-08-24 - 2006-08-24 CHECKED BY MA

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	Continued from previous page						168				
			17	SS	25				○		16 65 19 (SI+CL)
							167				
							166				
							165				
			18	SS	44				○		
163.0							164				
35.1	END OF BOREHOLE AT 35.10 m. AUGER REFUSAL AT 35.10m ON PROBABLE BEDROCK. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen.										

WATER LEVEL READINGS:

DATE	DEPTH(m)	ELEV.(m)
2006-08-27	3.46	194.6
2006-08-31	3.56	194.5

$+^3$, $\times^3$: Numbers refer to Sensitivity

20 / 15 ⊕ 5 / 10 (%) STRAIN AT FAILURE

ONTMT4S 5198.GPJ 11/2/07

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 06-M04 1 OF 4 METRIC

G.W.P. 5460-04-00 LOCATION Mindemoya Lake Bridge and Dam N9863.6 E9180.7 ORIGINATED BY KH

HWY 542 BOREHOLE TYPE Hollow Stem Augers/NW Casing COMPILED BY WM

DATUM Geodetic DATE 2006-08-22 - 2006-08-23 CHECKED BY MA

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
198.0	Road Surface										
0.0	**ASPHALT**: (25 mm)						198				
	SAND, some gravel, some silt Compact Brown Moist (FILL)		1	GS							
			1	SS	11		197				15 70 15 (SI+CL)
196.6											
1.4	**SAND**, some silt to silty, trace gravel, trace organics, occasional wood fragments Compact to Loose Dark Brown Moist to Wet (FILL)		2	SS	28		196				
			3	SS	14						
			4	SS	5	▼	195				
194.0											
4.0	Silty **CLAY**, trace sand Soft Grey		5	SS	2		194				0 2 67 31
191.9							193				
6.1	**SILT**, trace sand, trace clay Grey Wet		6	SS	2		192				
			7	SS	10		191				
			8	SS	2		190				
							189				

Continued Next Page

+ ³, × ³ Numbers refer to Sensitivity

20 / 15 ⊕ 5 / 10 (%) STRAIN AT FAILURE

ONTMT4S 5198-MINDEMOYA.GPJ 08/1/18

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 06-M04 2 OF 4 METRIC

G.W.P. 5460-04-00 LOCATION Mindemoya Lake Bridge and Dam N9863.6 E9180.7 ORIGINATED BY KH

HWY 542 BOREHOLE TYPE Hollow Stem Augers/NW Casing COMPILED BY WM

DATUM Geodetic DATE 2006-08-22 - 2006-08-23 CHECKED BY MA

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	Continued from previous page						188				
			9	SS	6		187				0 2 89 9
							186				
			10	SS	3						
184.9							185				
13.1	SAND, fine to medium grained, trace to some silt Loose to Compact Brown Wet		11	SS	1		184				
			12	SS	12		183				0 92 8 (SI+CL)
							182				
			13	SS	18						
	with layers of reddish brown sand and silt from 17.4m to 18.9m						181				
			14	SS	8		180				0 49 47 4
							179				
			15	SS	12						

Continued Next Page

+ ^{3}, × ^{3} : Numbers refer to Sensitivity

$\frac{20}{15}\oplus\frac{5}{10}$ (%) STRAIN AT FAILURE

ONTMT4S 5198.GPJ 11/2/07

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 06-M04 3 OF 4 METRIC

G.W.P. 5460-04-00 LOCATION Mindemoya Lake Bridge and Dam N9863.6 E9180.7 ORIGINATED BY KH

HWY 542 BOREHOLE TYPE Hollow Stem Augers/NW Casing COMPILED BY WM

DATUM Geodetic DATE 2006-08-22 - 2006-08-23 CHECKED BY MA

SOIL PROFILE			SAMPLES								
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	Continued from previous page						178				
							177				
			16	SS	17						
							176				
			17	SS	13						
							175				
	Grey						174				
			18	SS	28						
							173				
							172				
							171				
			19	SS	16						
							170				
							169				

Continued Next Page

$+^3$, $\times^3$: Numbers refer to Sensitivity

(%) STRAIN AT FAILURE

ONTMT4S 5198.GPJ 11/2/07

Ministry of Transportation
Ontario

RECORD OF BOREHOLE No 06-M04 4 OF 4 METRIC

G.W.P. 5460-04-00 LOCATION Mindemoya Lake Bridge and Dam N9863.6 E9180.7 ORIGINATED BY KH
HWY 542 BOREHOLE TYPE Hollow Stem Augers/NW Casing COMPILED BY WM
DATUM Geodetic DATE 2006-08-22 - 2006-08-23 CHECKED BY MA

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	Continued from previous page						168				
			20	SS	34				○		0 80 20 (SI+CL)
							167				
							166				
							165				
	with cobbles		21	SS	38				○		
							164				
162.8	Possible cobbles or weathered rock.						163				
35.2	Dark brown, fresh, thinly bedded, very strong, DOLOSTONE		1	RUN			162				Run #1 -no recovery in top 275mm; probable cobbles or weathered rock TCR=78% SCR=78% RQD=78% UCS=122MPa Run #2 TCR=100% SCR=100% RQD=98% UCS=151MPa
			2	RUN			161				
160.3											
37.7	END OF BOREHOLE AT 37.74 m. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen.										

WATER LEVEL READINGS:

DATE	DEPTH(m)	ELEV.(m)
2006-08-27	3.31	194.7
2006-08-31	3.55	194.5
2007-07-18	3.25	194.8

$+^3$, $\times^3$: Numbers refer to Sensitivity

20 / 15 5 / 10 (%) STRAIN AT FAILURE

ONTMT4S 5198-MINDEMOYA.GPJ 15/11/07

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 06-M07 1 OF 3 METRIC

G.W.P. 5460-04-00 LOCATION Mindemoya Lake Bridge and Dam N9963.0 E8870.2 ORIGINATED BY KH

HWY 542 BOREHOLE TYPE Hollow Stem Augers/NW Casing COMPILED BY WM

DATUM Geodetic DATE 2006-08-27 - 2006-08-27 CHECKED BY MA

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
197.8	Road Surface										
0.0	**ASPHALT**: (25 mm)										
	SAND, some gravel, some silt, trace organics Compact Brown Moist (FILL)		1	SS	20				○		
			2	SS	16		197		○		
196.3											
1.5	Silty **SAND**, trace gravel, trace organics, occasional wood pieces Very Loose Dark Brown Moist (FILL)		3	SS	2		196		○		
195.5											
2.3	**SILT**, trace clay, trace sand Very Loose Grey Moist to Wet		4	SS	1		195		○		
			5	SS	2				○		
193.5							194				
4.3	**PEAT**, amorphous, trace clay Very Soft Brown to Black Moist		6	SS	1		193		○ 19		
192.6											
5.2	**SILT**, trace sand, trace clay Very Loose Grey Wet		7	SS	2		192		○		
191.7											
6.1	Silty **CLAY** Very Soft Grey Wet		8	SS	1		191		○		0 0 57 43
189.6							190				
8.2	**SILT**, trace sand, trace clay Loose to Compact Grey Wet		9	SS	5		189		○		
							188				

Continued Next Page

+ ^{3}, × ^{3}: Numbers refer to Sensitivity

20 / 15 5 / 10 (%) STRAIN AT FAILURE

ONTMT4S 5198-MINDEMOYA.GPJ 08/1/18

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 06-M07 2 OF 3 METRIC

G.W.P. 5460-04-00 LOCATION Mindemoya Lake Bridge and Dam N9963.0 E8870.2 ORIGINATED BY KH

HWY 542 BOREHOLE TYPE Hollow Stem Augers/NW Casing COMPILED BY WM

DATUM Geodetic DATE 2006-08-27 - 2006-08-27 CHECKED BY MA

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	Continued from previous page										
			10	SS	9		187		○		
			11	SS	23		186		○		0 1 91 8
			12	SS	14		185		○		
			13	SS	20		184		○		
181.3							183				
16.5	Clayey SILT, trace sand Stiff Grey Wet		14	SS	14		182		○		0 2 77 21
			15	SS	10		181		○		
							180				
							179				
							178				

Continued Next Page

+ ³ , × ³ : Numbers refer to Sensitivity

20 / 15 ⊕ 5 / 10 (%) STRAIN AT FAILURE

ONTMT4S 5198.GPJ 11/2/07

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 06-M07 3 OF 3 METRIC

G.W.P. 5460-04-00 LOCATION Mindemoya Lake Bridge and Dam N9963.0 E8870.2 ORIGINATED BY KH

HWY 542 BOREHOLE TYPE Hollow Stem Augers/NW Casing COMPILED BY WM

DATUM Geodetic DATE 2006-08-27 - 2006-08-27 CHECKED BY MA

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (O UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, X LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
177.7	Continued From Previous Page										
20.1	END OF SAMPLED BOREHOLE AT 20.12 m.						177				
171.3											
26.5	END OF DCPT AT 26.52 m. BOREHOLE BACKFILLED WITH BENTONITE AND PATCHED WITH ASPHALT AT SURFACE.										

$+^3$, $\times^3$: Numbers refer to Sensitivity

(%) STRAIN AT FAILURE

ONTMT4S 5198.GPJ 11/2/07

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 06-M08 1 OF 4 METRIC

G.W.P. 5460-04-00 LOCATION Mindemoya Lake Bridge and Dam N9923.5 E8961.3 ORIGINATED BY KH

HWY 542 BOREHOLE TYPE Hollow Stem Augers/NW Casing COMPILED BY WM

DATUM Geodetic DATE 2006-08-27 - 2006-08-27 CHECKED BY MA

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
198.0	Shoulder Surface						198				
0.0	**SAND and GRAVEL**, trace silt, trace organics Dense to Loose Brown Moist (FILL)		1	SS	40				○		
			2	SS	5		197		○		
196.1			3	SS	4				○		
196.0	**PEAT**						196				
2.0	**SILT**, trace sand, trace clay Loose to Very Loose Grey Moist		4	SS	2				○		
			5	SS	4		195		○		0 8 82 10
193.7							194				
4.3	Silty **CLAY** Firm to Very Soft Grey Moist to Wet		6	SS	4				○		
			7	SS	1		193		⊖		0 1 53 46
			8	SS	4		192		○		
189.5							191				
8.5	**SILT**, trace clay, trace sand Loose to Very Loose Grey Wet		9	SS	5		190		○		
							189				

Continued Next Page

+ ^{3}, × ^{3}: Numbers refer to Sensitivity

20 / 15 ⊕ 5 / 10 (%) STRAIN AT FAILURE

ONTMT4S 5198-MINDEMOYA.GPJ 08/1/18

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 06-M08 2 OF 4 METRIC

G.W.P. 5460-04-00 LOCATION Mindemoya Lake Bridge and Dam N9923.5 E8961.3 ORIGINATED BY KH
HWY 542 BOREHOLE TYPE Hollow Stem Augers/NW Casing COMPILED BY WM
DATUM Geodetic DATE 2006-08-27 - 2006-08-27 CHECKED BY MA

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	Continued from previous page						188				
			10	SS	1				○		
							187				
			11	SS	1				○		
							186				
							185				
			12	SS	1				○		0 7 82 11
							184				
			13	SS	1		183		○		
							182				
			14	SS	2				○		
							181				
180.2											
17.8	**SAND**, fine grained, trace silt Compact Grey Wet						180				
							179				
			15	SS	21				○		0 91 9

Continued Next Page

$+^3$, $\times^3$: Numbers refer to Sensitivity

$\frac{20}{15 \oplus 5}$ (%) STRAIN AT FAILURE
10

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Ontario

THURBER

RECORD OF BOREHOLE No 06-M08 3 OF 4 METRIC

G.W.P. 5460-04-00 LOCATION Mindemoya Lake Bridge and Dam N9923.5 E8961.3 ORIGINATED BY KH
HWY 542 BOREHOLE TYPE Hollow Stem Augers/NW Casing COMPILED BY WM
DATUM Geodetic DATE 2006-08-27 - 2006-08-27 CHECKED BY MA

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL (SI+CL)
177.9	Continued From Previous Page						178				
20.1	END OF SAMPLED BOREHOLE AT 20.12 m.										

Continued Next Page

+ ^{3}, × ^{3}: Numbers refer to Sensitivity

15 20 10 5 {%} STRAIN AT FAILURE

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 06-M08 4 OF 4 METRIC

G.W.P. 5460-04-00 LOCATION Mindemoya Lake Bridge and Dam N9923.5 E8961.3 ORIGINATED BY KH
HWY 542 BOREHOLE TYPE Hollow Stem Augers/NW Casing COMPILED BY WM
DATUM Geodetic DATE 2006-08-27 - 2006-08-27 CHECKED BY MA

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P — NATURAL MOISTURE CONTENT w — LIQUID LIMIT w_L / WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
	Continued From Previous Page										
166.6											
31.4	END OF DCPT AT 31.39 m. BOREHOLE BACKFILLED WITH BENTONITE AND PATCHED WITH ASPHALT AT SURFACE.										

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+ ^{3}, × ^{3}: Numbers refer to Sensitivity

15 (20/10) 5 (%) STRAIN AT FAILURE

Ministry of Transportation
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RECORD OF BOREHOLE No 06-M09 1 OF 3 METRIC

G.W.P. 5460-04-00 LOCATION Mindemoya Lake Bridge and Dam N9914.2 E9012.9 ORIGINATED BY KH
HWY 542 BOREHOLE TYPE Hollow Stem Augers/NW Casing COMPILED BY WM
DATUM Geodetic DATE 2006-08-26 - 2006-08-26 CHECKED BY MA

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
197.7	Shoulder Surface										
0.0	**SAND**, some gravel, some silt, trace organics Compact Brown Moist (FILL)		1	SS	16				o		
			2	SS	12		197		o		5 80 15 (SI+CL)
196.2											
1.5	**SILT**, trace sand, trace clay Loose to Very Loose Grey Moist to Wet		3	SS	6		196		o		
			4	SS	3				o		0 5 87 8
			5	SS	1	▼	195		o		
193.4							194				
4.3	Silty **CLAY**, trace sand Soft Grey Wet		6	SS	2		193		o		
			7	SS	1		192	+ 1.6	o		
			8	SS	1		191		o		0 1 66 33
189.2							190				
8.5	**SILT**, trace sand, trace clay Compact Grey Wet		9	SS	11		189		o		
							188				

Continued Next Page

+ ³, × ³ : Numbers refer to Sensitivity

20 / 15 5 / 10 (%) STRAIN AT FAILURE

ONTMT4S 5198-MINDEMOYA.GPJ 08/1/18

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 06-M09 2 OF 3 METRIC

G.W.P. 5460-04-00 LOCATION Mindemoya Lake Bridge and Dam N9914.2 E9012.9 ORIGINATED BY KH
HWY 542 BOREHOLE TYPE Hollow Stem Augers/NW Casing COMPILED BY WM
DATUM Geodetic DATE 2006-08-26 - 2006-08-26 CHECKED BY MA

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	Continued from previous page										
			10	SS	10		187				
							186				
			11	SS	24						0 2 88 10
							185				
183.9			12	SS	17		184				
13.8	**SAND**, fine grained, some silt Compact Grey Wet										
			13	SS	25		183				
							182				
			14	SS	15		181				0 81 19 (SI+CL)
							180				
							179				
			15	SS	23		178				

Continued Next Page

$+^3$, $\times^3$: Numbers refer to Sensitivity

(%) STRAIN AT FAILURE

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THURBER

RECORD OF BOREHOLE No 06-M09 3 OF 3 METRIC

G.W.P. 5460-04-00 LOCATION Mindemoya Lake Bridge and Dam N9914.2 E9012.9 ORIGINATED BY KH

HWY 542 BOREHOLE TYPE Hollow Stem Augers/NW Casing COMPILED BY WM

DATUM Geodetic DATE 2006-08-26 - 2006-08-26 CHECKED BY MA

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100	PLASTIC LIMIT w_P	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w_L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	WATER CONTENT (%) 20 40 60			kN/m^3	GR SA SI CL
177.6	Continued From Previous Page												
20.1	END OF BOREHOLE AT 20.12 m. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen.												
	WATER LEVEL READINGS: DATE DEPTH(m) ELEV.(m) 2006-08-27 3.08 194.7 2006-08-31 3.10 194.6						177						

$+^3$, $\times^3$: Numbers refer to Sensitivity

$^{20}_{15}\oplus^{5}_{10}$ (%) STRAIN AT FAILURE

ONTMT4S 5198.GPJ 11/2/07

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Ontario

RECORD OF BOREHOLE No 06-M10 1 OF 4 METRIC

G.W.P. 5460-04-00 LOCATION Mindemoya Lake Bridge and Dam N9888.0 E9051.4 ORIGINATED BY GA
HWY 542 BOREHOLE TYPE Hollow Stem Augers/NW Casing COMPILED BY WM
DATUM Geodetic DATE 2006-08-23 - 2006-08-24 CHECKED BY MA

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE) 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
196.6	Ground Surface										
0.0	**TOPSOIL**: (50 mm)										
0.0	**SILT**, trace sand, trace rootlets, organic odour Very Soft to Soft Dark Brown Damp		1	SS	3		196				
196.0											
0.6	Sandy **SILT**, occasional iron oxide staining Loose Grey Wet		2	SS	4						
195.1							195				
1.5	Silty **CLAY** Firm to Stiff Grey Damp to Wet		3	SS	7						
			4	SS	11		194				
			5	SS	7						0 0 55 45
							193	3.3			
			6	SS	4		192				
191.1											
5.5	**SILT**, trace to some sand, trace clay Loose to Compact Grey Wet		7	SS	13		191				
							190				
			8	SS	9		189				0 2 87 11
							188				
			9	SS	10		187				

Continued Next Page

+ ³, × ³: Numbers refer to Sensitivity

20 / 15 5 / 10 (%) STRAIN AT FAILURE

ONTMT4S 5198-MINDEMOYA.GPJ 08/1/18

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 06-M10 2 OF 4 METRIC

G.W.P. 5460-04-00 LOCATION Mindemoya Lake Bridge and Dam N9888.0 E9051.4 ORIGINATED BY GA

HWY 542 BOREHOLE TYPE Hollow Stem Augers/NW Casing COMPILED BY WM

DATUM Geodetic DATE 2006-08-23 - 2006-08-24 CHECKED BY MA

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page							20 40 60 80 100	20 40 60		
185.9	Continued from previous page										
10.7	**SAND**, fine grained, trace silt Compact Grey Wet		10	SS	15		186				
			11	SS	21		185				0 91 9 (SI+CL)
			12	SS	17		184				
			13	SS	10		183				
			14	SS	20		182				
							181				
							180				
							179				
							178				
							177				

Continued Next Page

$+^{3}$ $\times^{3}$: Numbers refer to Sensitivity

(%) STRAIN AT FAILURE

ONTMT4S 5198.GPJ 11/2/07

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Ontario

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RECORD OF BOREHOLE No 06-M10 3 OF 4 METRIC

G.W.P. 5460-04-00 LOCATION Mindemoya Lake Bridge and Dam N9888.0 E9051.4 ORIGINATED BY GA

HWY 542 BOREHOLE TYPE Hollow Stem Augers/NW Casing COMPILED BY WM

DATUM Geodetic DATE 2006-08-23 - 2006-08-24 CHECKED BY MA

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	Continued from previous page						176				
			15	SS	16		175		○		
							174				
							173				
	with layers of silt and sand from 24.4m to 27.4m		16	SS	15		172		○		0 43 50 7
											Artesian pressure to 1.5m above ground surface in casing.
	Dense						171				
							170				
			17	SS	39		169		○		
							168				
							167				

Continued Next Page

+ ³, × ³: Numbers refer to Sensitivity

(%) STRAIN AT FAILURE

ONTMT4S 5198.GPJ 11/2/07

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 06-M10 4 OF 4 METRIC

G.W.P. 5460-04-00 LOCATION Mindemoya Lake Bridge and Dam N9888.0 E9051.4 ORIGINATED BY GA

HWY 542 BOREHOLE TYPE Hollow Stem Augers/NW Casing COMPILED BY WM

DATUM Geodetic DATE 2006-08-23 - 2006-08-24 CHECKED BY MA

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	Continued from previous page		18	SS	33		166		○		0 72 28 (SI+CL)
							165				
	occasional limestone fragments						164				
163.2			19	SS	140				○		
33.4	AUGER REFUSAL AT 33.38 m ON PROBABLE BEDROCK OR BOULDERS. WATER LEVEL AT 3.05 m UPON COMPLETION. Piezometer installation consists of 25mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. END OF BOREHOLE AT 33.38 m.										

WATER LEVEL READINGS:

DATE	DEPTH(m)	ELEV.(m)
2006-08-26	2.10	194.5
2006-08-27	1.89	194.7
2006-08-31	2.10	194.5
2007-07-18	1.73	194.9
2007-07-20	1.70	194.9
2007-08-28	1.88	194.7

$+^3$, $\times^3$ Numbers refer to Sensitivity

$\frac{20}{15}\oplus\frac{5}{10}$ {%} STRAIN AT FAILURE

ONTMT4S 5198.GPJ 11/2/07

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 06-M11 1 OF 3 METRIC

G.W.P. 5460-04-00 LOCATION Mindemoya Lake Bridge and Dam N9874.6 E9107.3 ORIGINATED BY GA

HWY 542 BOREHOLE TYPE Hollow Stem Augers/NW Casing COMPILED BY WM

DATUM Geodetic DATE 2006-08-23 - 2006-08-23 CHECKED BY MA

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa: ○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
197.9	Road Surface										
0.0	**ASPHALT**: (25 mm)										
	SAND, trace gravel, trace silt Compact Brown Dry		1	SS	20				○		
197.0	(FILL)						197				
0.9	Sandy **SILT**, trace organics, occasional wood fibres Loose to Very Loose Dark Brown to Grey Moist to Wet		2	SS	6				○		
			3	SS	7		196		○		0 36 59 5
			4	SS	1				○		
194.9							195				
3.0	Silty **CLAY**, trace sand Very Soft Grey Wet		5	SS	2				○		
							194				
			6	SS	2		193		⊢●		0 1 65 34
192.4											
5.5	**SILT**, some sand, trace clay Compact to Very Loose Grey Wet						192				
			7	SS	10				○		
							191				
			8	SS	3		190		○		0 16 73 11
188.8							189				
9.1	**SAND**, fine grained, trace to some silt Compact Grey Wet		9	SS	22				○		
							188				

Continued Next Page

+ ³, × ³: Numbers refer to Sensitivity

20 / 15 5 / 10 (%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 06-M11 2 OF 3 METRIC

G.W.P. 5460-04-00 LOCATION Mindemoya Lake Bridge and Dam N9874.6 E9107.3 ORIGINATED BY GA
HWY 542 BOREHOLE TYPE Hollow Stem Augers/NW Casing COMPILED BY WM
DATUM Geodetic DATE 2006-08-23 - 2006-08-23 CHECKED BY MA

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	Continued from previous page										
			10	SS	15		187		○		
							186				
			11	SS	22				○		
							185				
			12	SS	22		184		○		
							183				
			13	SS	28				○		0 84 16 (SI+CL)
							182				
	fine to medium grained Dense		14	SS	30		181		○		
							180				
							179				
							178				

Continued Next Page

$+^3$, $\times^3$: Numbers refer to Sensitivity

$\frac{20}{15}\oplus\frac{5}{10}$ (%) STRAIN AT FAILURE

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RECORD OF BOREHOLE No 06-M11 3 OF 3 METRIC

G.W.P. 5460-04-00 LOCATION Mindemoya Lake Bridge and Dam N9874.6 E9107.3 ORIGINATED BY GA
HWY 542 BOREHOLE TYPE Hollow Stem Augers/NW Casing COMPILED BY WM
DATUM Geodetic DATE 2006-08-23 - 2006-08-23 CHECKED BY MA

SOIL PROFILE ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: o UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
177.5	Continued From Previous Page		15	SS	35				o		
20.4	END OF BOREHOLE AT 20.42 m. BOREHOLE OPEN TO 19.81 m AND WATER LEVEL AT 5.18 m. BOREHOLE BACKFILLED WITH BENTONITE AND PATCHED WITH ASPHALT AT SURFACE.						177				

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+ ³, × ³ Numbers refer to Sensitivity

(%) STRAIN AT FAILURE

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RECORD OF BOREHOLE No 06-M12 1 OF 3 METRIC

G.W.P. 5460-04-00 LOCATION Mindemoya Lake Bridge and Dam N9866.0 E9239.5 ORIGINATED BY KH
HWY 542 BOREHOLE TYPE Hollow Stem Augers/NW Casing COMPILED BY WM
DATUM Geodetic DATE 2006-08-26 - 2006-08-26 CHECKED BY MA

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
197.8	Shoulder Surface										
0.0	**SAND and GRAVEL**, trace silt, trace organics Compact Brown Moist (FILL)		1	SS	21				○		
			2	SS	15		197		○		
196.3											
1.5	**SILT**, trace clay, trace sand, trace organics Very Loose Grey Moist		3	SS	3		196		○		
195.5											
2.3	Silty **CLAY**, trace sand Soft to Firm Grey Moist		4	SS	2		195		○		
			5	SS	6				⊢○⊣		0 1 54 45
							194				
			6	SS	3		193		○		
192.3											
5.5	**SILT**, trace sand, trace to some clay Loose to Compact Grey		7	SS	4		192		○		
							191				
			8	SS	8		190				
							189				
			9	SS	4				○		
							188				

Continued Next Page

+ ^{3}, × ^{3}: Numbers refer to Sensitivity

15 20 10 5 (%) STRAIN AT FAILURE

ONTMT4S 5198-MINDEMOYA.GPJ 08/1/18

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 06-M12 2 OF 3 METRIC

G.W.P. 5460-04-00 LOCATION Mindemoya Lake Bridge and Dam N9866.0 E9239.5 ORIGINATED BY KH
HWY 542 BOREHOLE TYPE Hollow Stem Augers/NW Casing COMPILED BY WM
DATUM Geodetic DATE 2006-08-26 - 2006-08-26 CHECKED BY MA

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
	Continued From Previous Page										
	Continued from previous page										
			10	SS	10		187				0 4 82 14
							186				
			11	SS	6						
							185				
			12	SS	11		184				
							183				
			13	SS	2						0 1 86 13
							182				
			14	SS	16		181				
180.1											
17.7	**SAND**, fine to medium grained Compact Grey Wet						180				
							179				
			15	SS	15		178				

Continued Next Page

$+^3$, $\times^3$: Numbers refer to Sensitivity

20 / 15 ⊕ 5 / 10 (%) STRAIN AT FAILURE

ONTMT4S 5198.GPJ 11/2/07

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 06-M12 3 OF 3 METRIC

G.W.P. 5460-04-00 LOCATION Mindemoya Lake Bridge and Dam N9866.0 E9239.5 ORIGINATED BY KH

HWY 542 BOREHOLE TYPE Hollow Stem Augers/NW Casing COMPILED BY WM

DATUM Geodetic DATE 2006-08-26 - 2006-08-26 CHECKED BY MA

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa o UNCONFINED + FIELD VANE • QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
177.7	Continued From Previous Page										
20.1	END OF BOREHOLE AT 20.12 m. BOREHOLE BACKFILLED WITH BENTONITE.						177				

$+^3$, $\times^3$: Numbers refer to Sensitivity

15 20 10 5 (%) STRAIN AT FAILURE

ONTMT4S 5198.GPJ 11/2/07

Ministry of Transportation
Ontario

RECORD OF BOREHOLE No 06-M13 1 OF 4 METRIC

G.W.P. 5460-04-00 LOCATION Mindemoya Lake Bridge and Dam N9847.6 E9296.2 ORIGINATED BY GA
HWY 542 BOREHOLE TYPE Hollow Stem Augers/NW Casing COMPILED BY WM
DATUM Geodetic DATE 2006-08-25 - 2006-08-26 CHECKED BY MA

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
196.7	Ground Surface										
0.0 196.2	**TOPSOIL** Dark Brown		1	SS	7						
0.5 195.2	Silty **SAND**, fine grained Loose Grey Damp		2	SS	8						
1.5	Silty **CLAY** Stiff Grey Wet		3	SS	11		195				
			4	SS	8						
			5	SS	8						0 0 64 36
191.2	Soft		6	SS	2						
5.5	**SILT**, trace sand, trace clay Very Loose to Loose Grey Wet		7	SS	1						
			8	SS	2						0 2 90 8
			9	SS	2						Slight artesian pressure

Continued Next Page

+ ³, × ³: Numbers refer to Sensitivity

(%) STRAIN AT FAILURE

ONTMT4S 5198-MINDEMOYA.GPJ 08/1/18

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 06-M13 2 OF 4 METRIC

G.W.P. 5460-04-00 LOCATION Mindemoya Lake Bridge and Dam N9847.6 E9296.2 ORIGINATED BY GA
HWY 542 BOREHOLE TYPE Hollow Stem Augers/NW Casing COMPILED BY WM
DATUM Geodetic DATE 2006-08-25 - 2006-08-26 CHECKED BY MA

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	Continued from previous page		10	SS	7						
			11	SS	7						
			12	SS	1						0 3 88 9
			13	SS	2						
180.5											
16.2	**SAND**, fine grained, trace silt Compact Grey Wet		14	SS	11						0 91 9 (SI+CL)
	with layers of soft clayey silt from 19.1m to 21.3m		15	SS	2						

ELEVATION SCALE: 186, 185, 184, 183, 182, 181, 180, 179, 178, 177

Continued Next Page

+ 3 × 3 Numbers refer to Sensitivity

15 20 10 5 (%) STRAIN AT FAILURE

ONTMT4S 5198.GPJ 11/2/07

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 06-M13 3 OF 4 METRIC

G.W.P. 5460-04-00 LOCATION Mindemoya Lake Bridge and Dam N9847.6 E9296.2 ORIGINATED BY GA

HWY 542 BOREHOLE TYPE Hollow Stem Augers/NW Casing COMPILED BY WM

DATUM Geodetic DATE 2006-08-25 - 2006-08-26 CHECKED BY MA

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
	Continued From Previous Page										
	Continued from previous page						176				
							175				
			16	SS	24		174				
							173				
							172				
			17	SS	23		171				0 71 29 (SI+CL)
							170				
							169				
	compact to dense		18	SS	33		168				
							167				

Continued Next Page

$+^3$, $\times^3$: Numbers refer to Sensitivity

(%) STRAIN AT FAILURE

ONTMT4S 5198.GPJ 11/2/07

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 06-M13 4 OF 4 METRIC

G.W.P. 5460-04-00 LOCATION Mindemoya Lake Bridge and Dam N9847.6 E9296.2 ORIGINATED BY GA

HWY 542 BOREHOLE TYPE Hollow Stem Augers/NW Casing COMPILED BY WM

DATUM Geodetic DATE 2006-08-25 - 2006-08-26 CHECKED BY MA

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	Continued from previous page						166				
			19	SS	29		165				
164.1											
32.6	END OF BOREHOLE AT 32.61 m. AUGER REFUSAL AT 32.61 m ON PROBABLE BEDROCK OR BOULDERS. BOREHOLE OPEN TO 32.61 m AND WATER LEVEL AT 3.51 m UPON COMPLETION. Piezometer installation consists of 25mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH(m) ELEV.(m) 2006-08-27 2.93 193.7 2006-08-31 2.89 193.8 2007-07-18 1.84 194.9 2007-07-20 1.78 195.0 2007-08-28 1.76 195.0										

$+^3$, $\times^3$: Numbers refer to Sensitivity

$^{20}_{15}\oplus^{5}_{10}$ (%) STRAIN AT FAILURE

ONTMT4S 5198.GPJ 11/2/07

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 06-M14 1 OF 3 METRIC

G.W.P. 5460-04-00 LOCATION Mindemoya Lake Bridge and Dam N9854.2 E9342.9 ORIGINATED BY KH
HWY 542 BOREHOLE TYPE Hollow Stem Augers/NW Casing COMPILED BY WM
DATUM Geodetic DATE 2006-08-25 - 2006-08-25 CHECKED BY MA

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
197.7	Shoulder Surface										
0.0	**SAND**, some gravel, some silt, trace organics Compact to Loose Brown Moist (FILL)		1	SS	14				○		22 67 11 (SI+CL)
			2	SS	4		197		○		
	Topsoil layer from 1.27m to 1.37 m										
195.7			3	SS	3		196		○		
198.8											
2.1	**SILT**, trace sand Very Loose Grey Moist		4	SS	5		195		○		
	Silty **CLAY** Firm to Very Soft Grey Moist to Wet		5	SS	4				⊢○		0 0 62 38
			6	SS	3		194		○		
			7	SS	2		193		○		
			8	SS	0		192		⊢○		0 0 71 29
189.2							191				
8.5	**SILT**, trace sand, trace clay Very Loose to Loose Grey Wet		9	SS	4		190		○		
							189				
							188				

Continued Next Page

+ ³, × ³: Numbers refer to Sensitivity

20 / 15 5 / 10 (%) STRAIN AT FAILURE

ONTMT4S 5198-MINDEMOYA.GPJ 08/1/18

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 06-M14 2 OF 3 METRIC

G.W.P. 5460-04-00 LOCATION Mindemoya Lake Bridge and Dam N9854.2 E9342.9 ORIGINATED BY KH
HWY 542 BOREHOLE TYPE Hollow Stem Augers/NW Casing COMPILED BY WM
DATUM Geodetic DATE 2006-08-25 - 2006-08-25 CHECKED BY MA

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P NATURAL MOISTURE CONTENT w LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
	Continued From Previous Page										
	Continued from previous page										
			10	SS	3		187				
			11	SS	4		186				0 10 83 7
			12	SS	3		185				
			13	SS	1		184				
			14	SS	1		183				
							182				
							181				
							180				
							179				
	occasional cobbles		15	SS	1		178				
	Continued Next Page										

$+^3$, $\times^3$: Numbers refer to Sensitivity

20 / 15 ⊕ 5 / 10 (%) STRAIN AT FAILURE

ONTMT4S 5198.GPJ 11/2/07

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 06-M14 3 OF 3 METRIC

G.W.P. 5460-04-00 LOCATION Mindemoya Lake Bridge and Dam N9854.2 E9342.9 ORIGINATED BY KH

HWY 542 BOREHOLE TYPE Hollow Stem Augers/NW Casing COMPILED BY WM

DATUM Geodetic DATE 2006-08-25 - 2006-08-25 CHECKED BY MA

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE; ● QUICK TRIAXIAL × LAB VANE; 20 40 60 80 100	WATER CONTENT (%) 20 40 60		GR SA SI CL
177.6	Continued From Previous Page										
20.1	END OF BOREHOLE AT 20.12 m. Piezometer installation consists of 25mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen.						177				

WATER LEVEL READINGS:

DATE	DEPTH(m)	ELEV.(m)
2006-08-27	3.01	194.7
2006-08-31	2.83	194.9
2007-07-18	1.63	196.1
2007-07-20	1.58	196.2
2007-08-28	1.83	196.0

+ ^{3}, × ^{3}: Numbers refer to Sensitivity

15-20-5-10 (%) STRAIN AT FAILURE

ONTMT4S 5198.GPJ 11/2/07

Ministry of Transportation
Ontario

RECORD OF BOREHOLE No 06-M15 1 OF 2 METRIC

G.W.P. 5460-04-00 LOCATION Mindemoya Lake Bridge and Dam N9865.5 E9443.1 ORIGINATED BY KH
HWY 542 BOREHOLE TYPE Hollow Stem Augers/NW Casing COMPILED BY WM
DATUM Geodetic DATE 2006-08-25 - 2006-08-25 CHECKED BY MA

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
197.8	Shoulder Surface										
0.0	**SAND and GRAVEL**, trace organics, occasional rock fragments Compact Brown Moist (FILL)		1	SS	20						
	Numerous cobbles/rock fragments		2	SS	50/.125		197				
196.3											
1.5	Silty **CLAY** Soft to Firm Grey Moist		3	SS	3		196				
			4	SS	3						0 0 55 45
			5	SS	6		195				
							194				
			6	SS	4		193				
			7	SS	3		192				
							191				
			8	SS	2		190				0 0 78 22
							189				
188.4			9	SS	6						
9.4	Silty **CLAY** to clayey **SILT**, some sand, trace gravel Firm						188				

Continued Next Page

$+^3$, $\times^3$ Numbers refer to Sensitivity

(%) STRAIN AT FAILURE

ONTMT4S 5198-MINDEMOYA.GPJ 08/1/18

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 06-M15 2 OF 2 METRIC

G.W.P. 5460-04-00 LOCATION Mindemoya Lake Bridge and Dam N9865.5 E9443.1 ORIGINATED BY KH
HWY 542 BOREHOLE TYPE Hollow Stem Augers/NW Casing COMPILED BY WM
DATUM Geodetic DATE 2006-08-25 - 2006-08-25 CHECKED BY MA

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
	Continued From Previous Page										
	Grey Wet (TILL-LIKE)										
			10	SS	4		187		⊢●⊣		0 24 52 24
							186				
	Hard occasional limestone fragments		11	SS	39				○		
184.8							185				
13.0	END OF BOREHOLE AT 12.95 m. AUGER REFUSAL AT 12.95 m ON PROBABLE BEDROCK OR BOULDERS. BOREHOLE BACKFILLED WITH BENTONITE.										

+ ^{3}, × ^{3} Numbers refer to Sensitivity

20
15 ⊕ 5 (%) STRAIN AT FAILURE
10

ONTMT4S 5198.GPJ 11/2/07

Appendix B

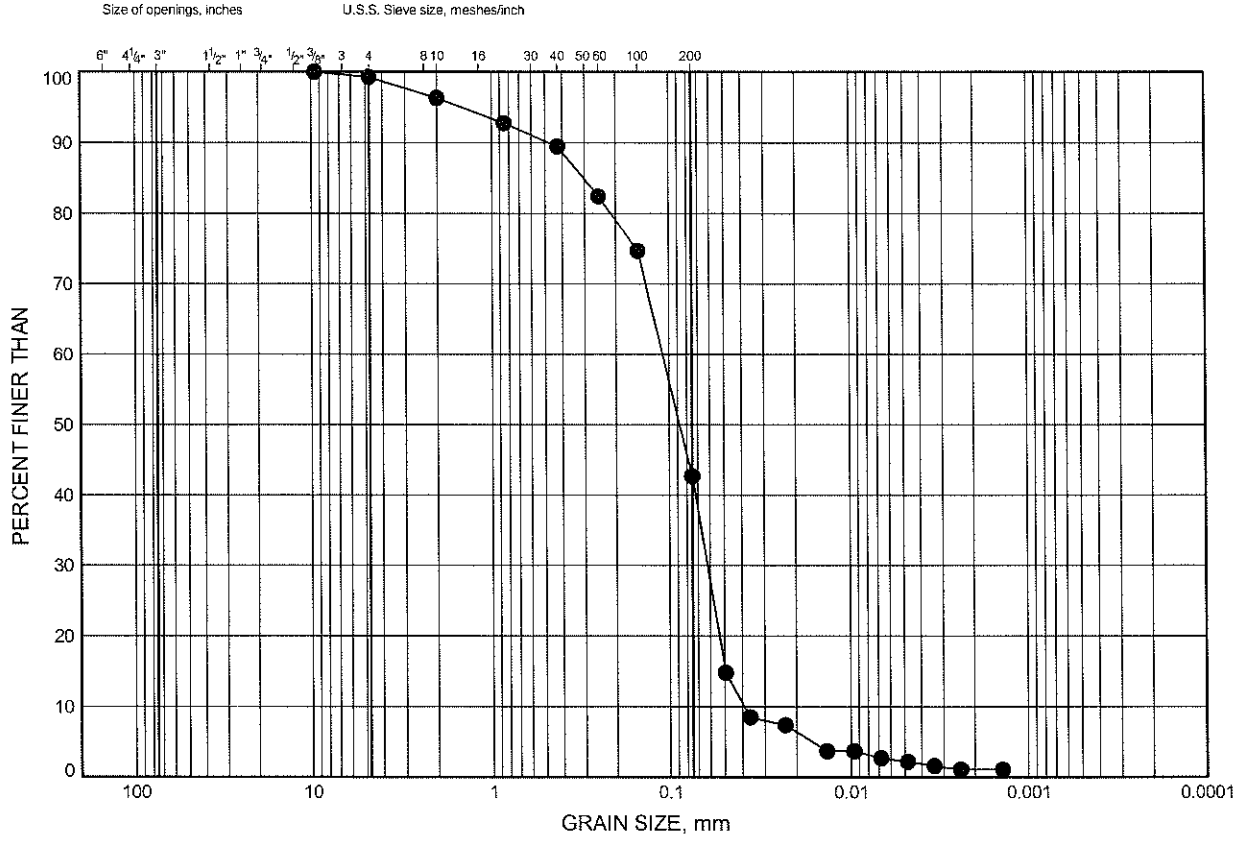
Laboratory Test Results

Mindemoya Lake Bridge and Dam Replacement

GRAIN SIZE DISTRIBUTION

FIGURE 07-B1

FILL



COBBLE SIZE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT and CLAY
	GRAVEL		SAND			FINE GRAINED

SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	07-M03	1.83	196.17

Date November 2007

Project 5460-04-00

THURBER

Prep'd MFA

Chkd. MRA

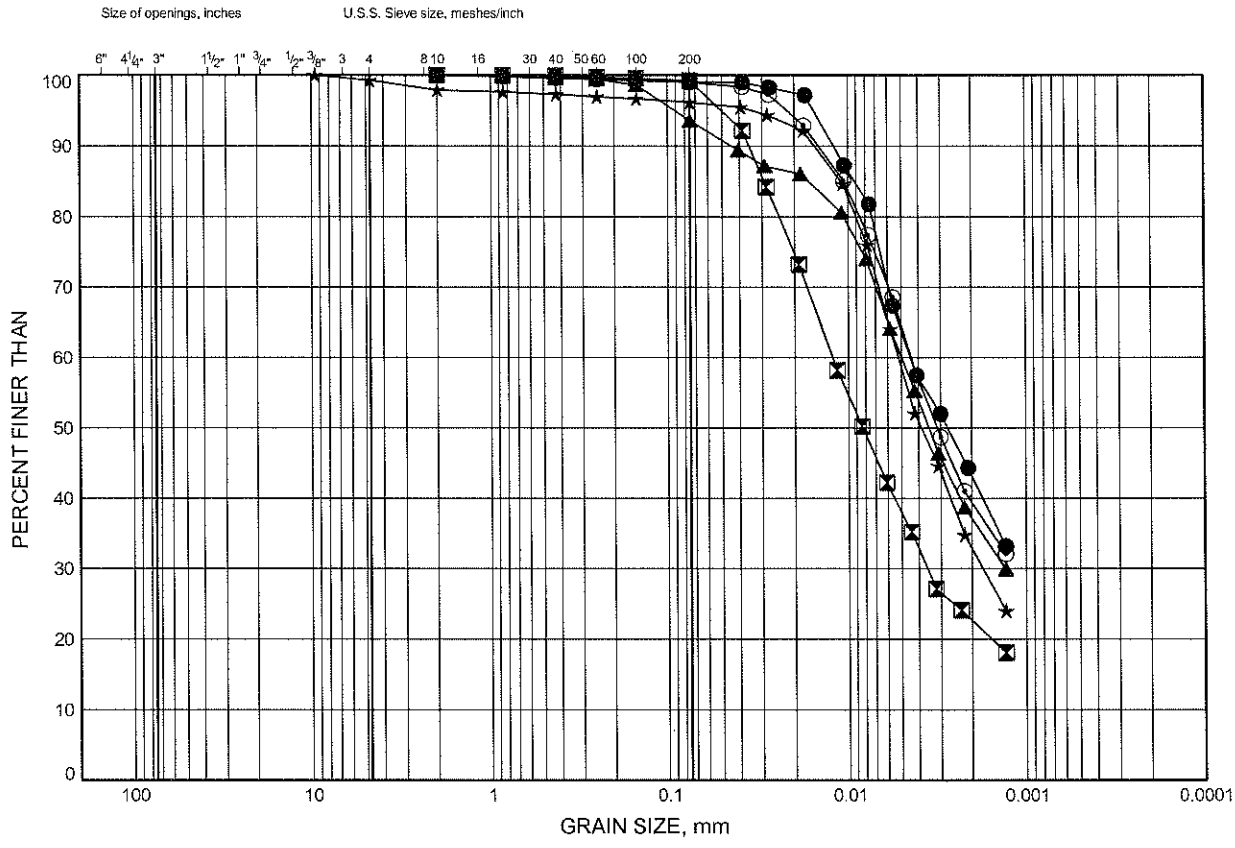
THURBGSD 5198.GPJ 11/7/07

Mindemoya Lake Bridge and Dam Replacement

GRAIN SIZE DISTRIBUTION

FIGURE 07-B2

SILTY CLAY



COBBLE SIZE	GRAVEL		SAND			SILT and CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	FINE GRAINED

SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	07-M1	3.33	193.97
⊠	07-M1	4.88	192.42
▲	07-M2	3.33	194.57
★	07-M3	4.11	193.89
⊙	07-M4	4.11	193.89

Date October 2007

Project 5460-04-00

THURBER

Prep'd MFA

Chkd. MRA

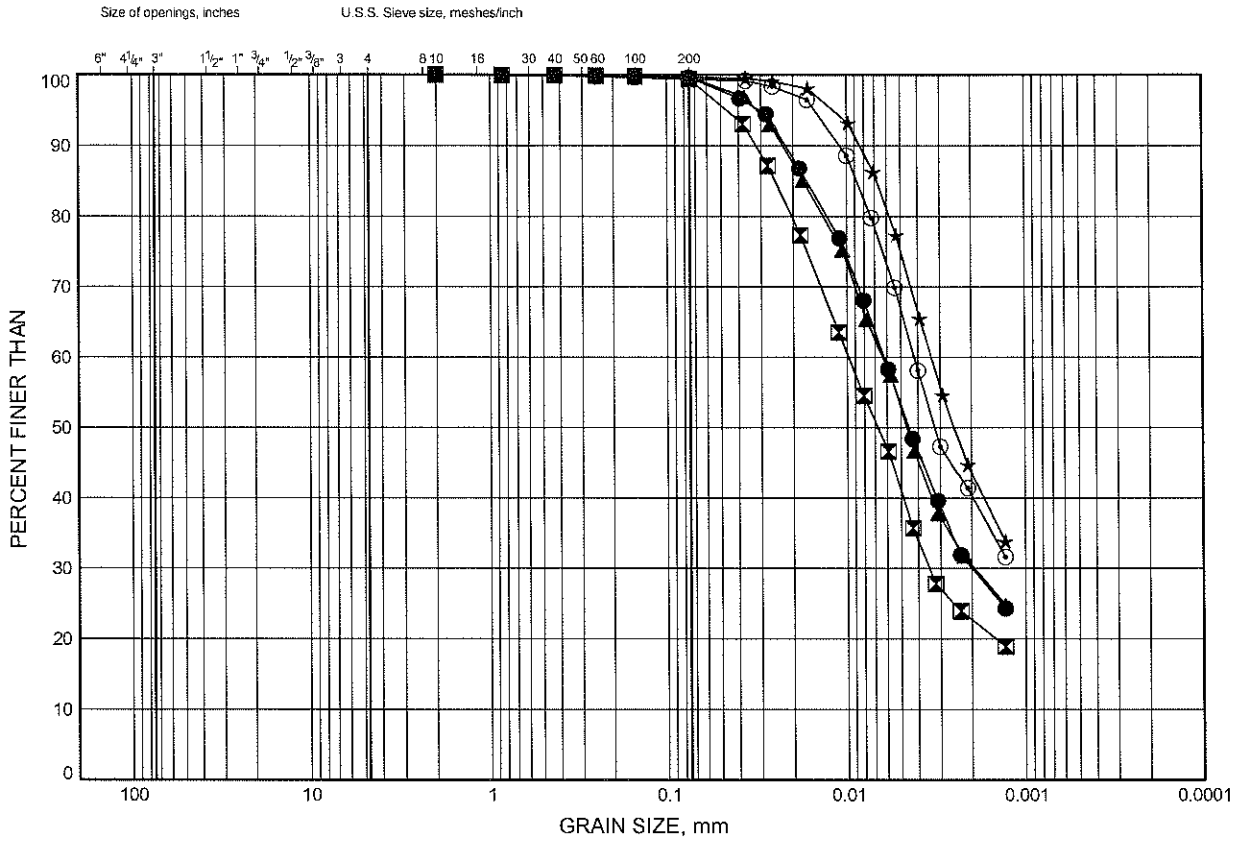
THURBGSD 5198.GPJ 10/22/07

Mindemoya Lake Bridge and Dam Replacement

GRAIN SIZE DISTRIBUTION

FIGURE 07-B3

SILTY CLAY



COBBLE SIZE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT and CLAY
	GRAVEL		SAND			FINE GRAINED

SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	07-M5	4.88	193.02
⊠	07-M6	3.35	193.65
▲	07-M7	1.83	193.37
★	07-M8	1.83	194.47
⊙	07-M9	2.59	193.81

Date October 2007

Project 5460-04-00

THURBER

Prep'd MFA

Chkd. MRA

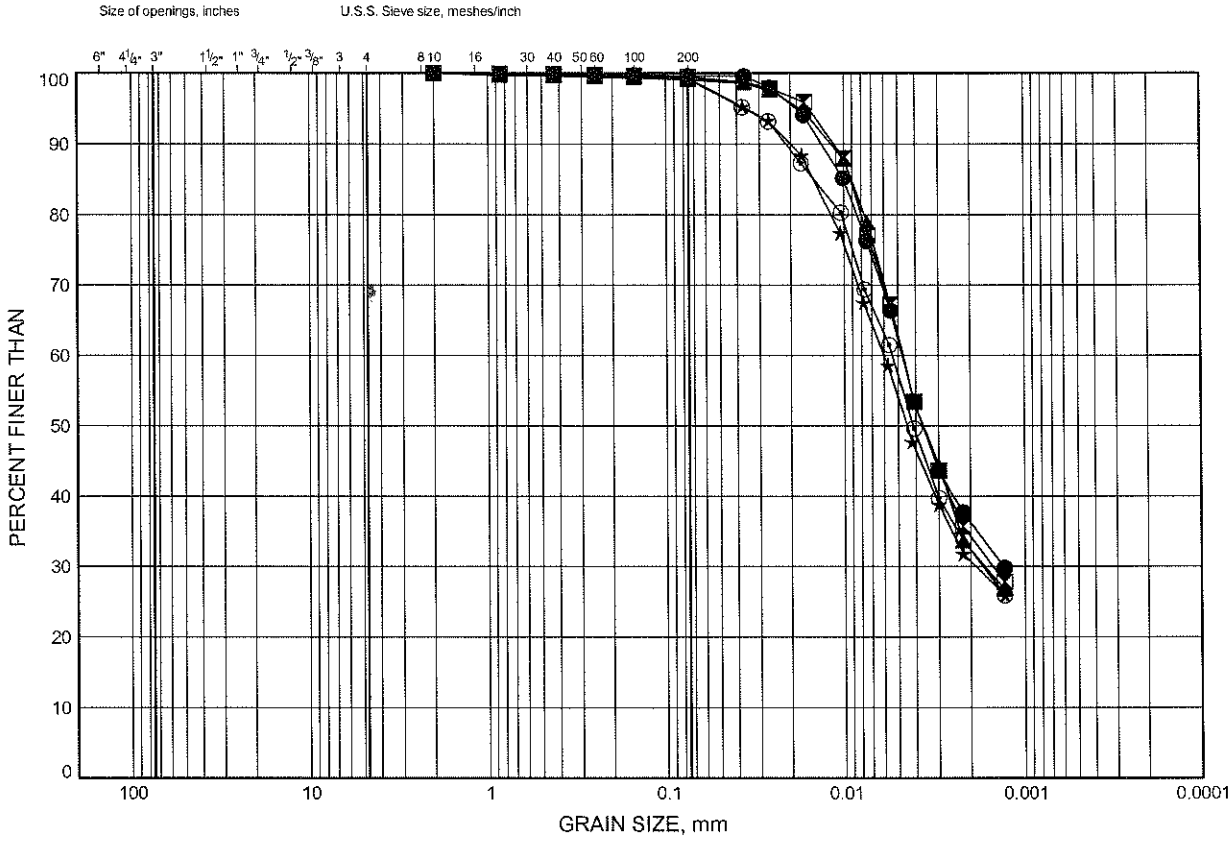
THURBGSD 5198.GPJ 10/22/07

Mindemoya Lake Bridge and Dam Replacement

GRAIN SIZE DISTRIBUTION

FIGURE 07-B4

SILTY CLAY



COBBLE SIZE	GRAVEL		SAND			FINE GRAINED
	COARSE	FINE	COARSE	MEDIUM	FINE	SILT and CLAY

SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	07-M10	2.59	194.31
⊠	07-M11	2.59	194.21
▲	07-M12	2.59	194.31
★	07-M13	3.35	193.15
⊙	07-M14	2.59	194.21

Date October 2007

Project 5460-04-00

THURBER

Prep'd MFA

Chkd. MRA

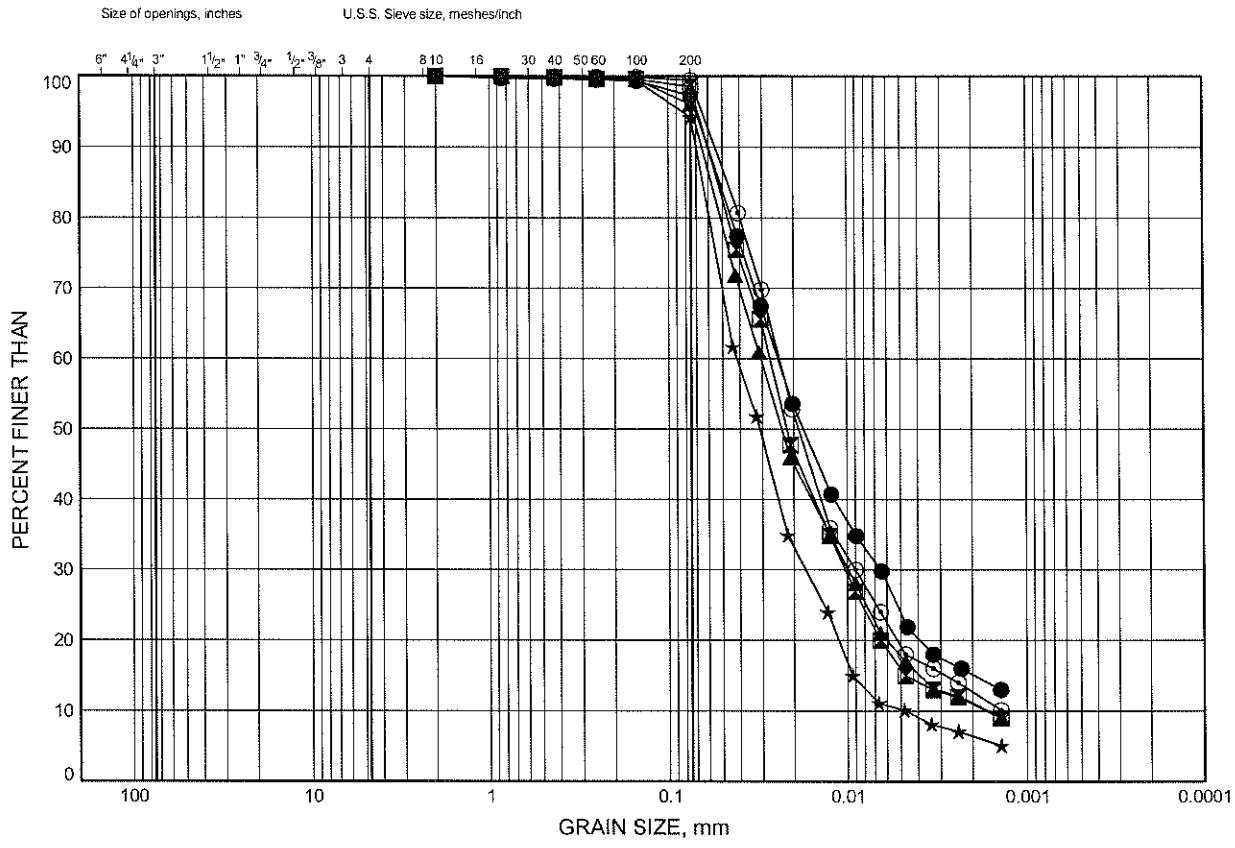
THURBGSD 5198.GPJ 10/22/07

Mindemoya Lake Bridge and Dam Replacement

GRAIN SIZE DISTRIBUTION

FIGURE 07-B5

SILT TO CLAYEY SILT



COBBLE SIZE	GRAVEL		SAND			SILT and CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	FINE GRAINED

SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	07-M1	8.53	188.77
⊠	07-M2	9.45	188.45
▲	07-M3	9.45	188.55
★	07-M4	10.97	187.03
⊙	07-M5	9.45	188.45

Date October 2007

Project 5460-04-00

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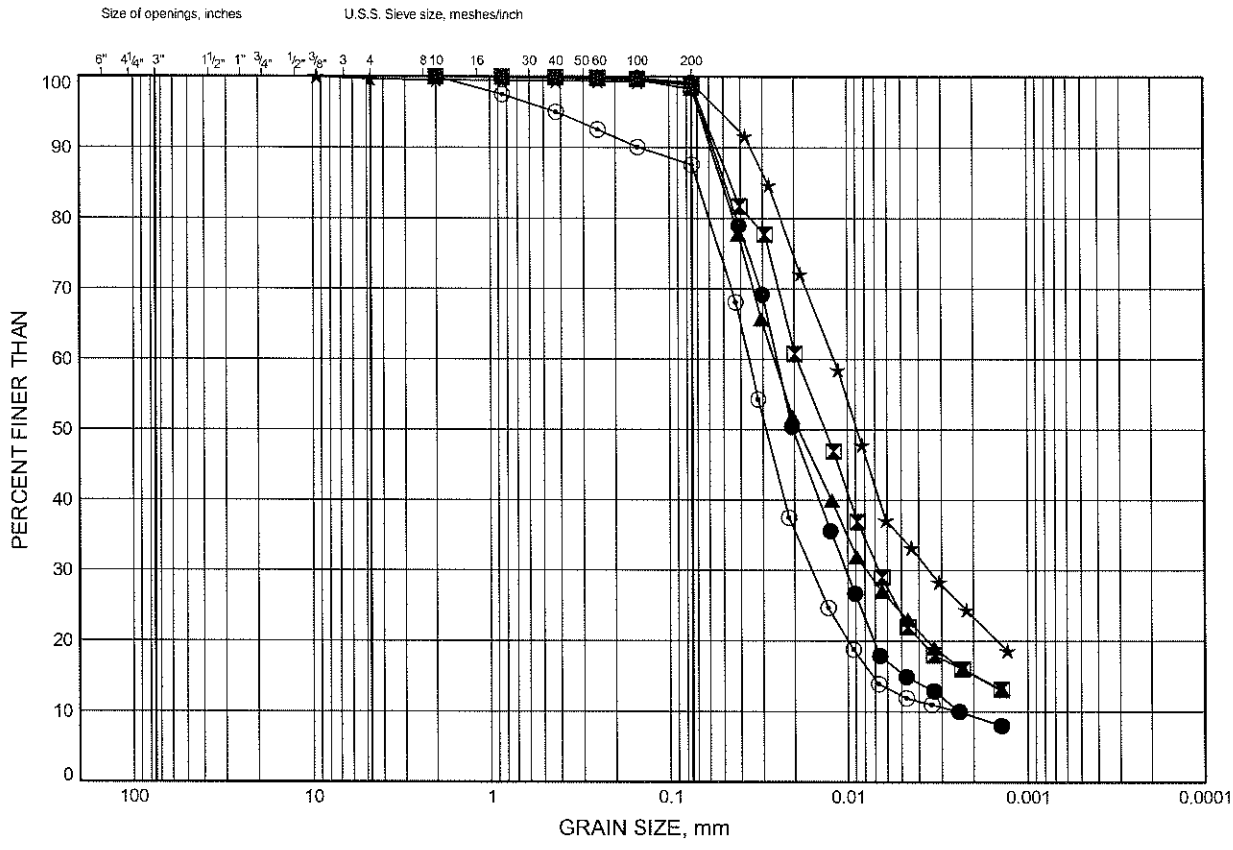
THURBGSD 5198.GPJ 10/22/07

Mindemoya Lake Bridge and Dam Replacement

GRAIN SIZE DISTRIBUTION

FIGURE 07-B6

SILT TO CLAYEY SILT



COBBLE SIZE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT and CLAY
	GRAVEL		SAND			FINE GRAINED

SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	07-M5	14.02	183.88
⊠	07-M6	8.84	188.16
▲	07-M7	6.40	188.80
★	07-M7	10.36	184.84
⊙	07-M8	6.40	189.90

Date October 2007

Project 5460-04-00

THURBER

Prep'd MFA

Chkd. MRA

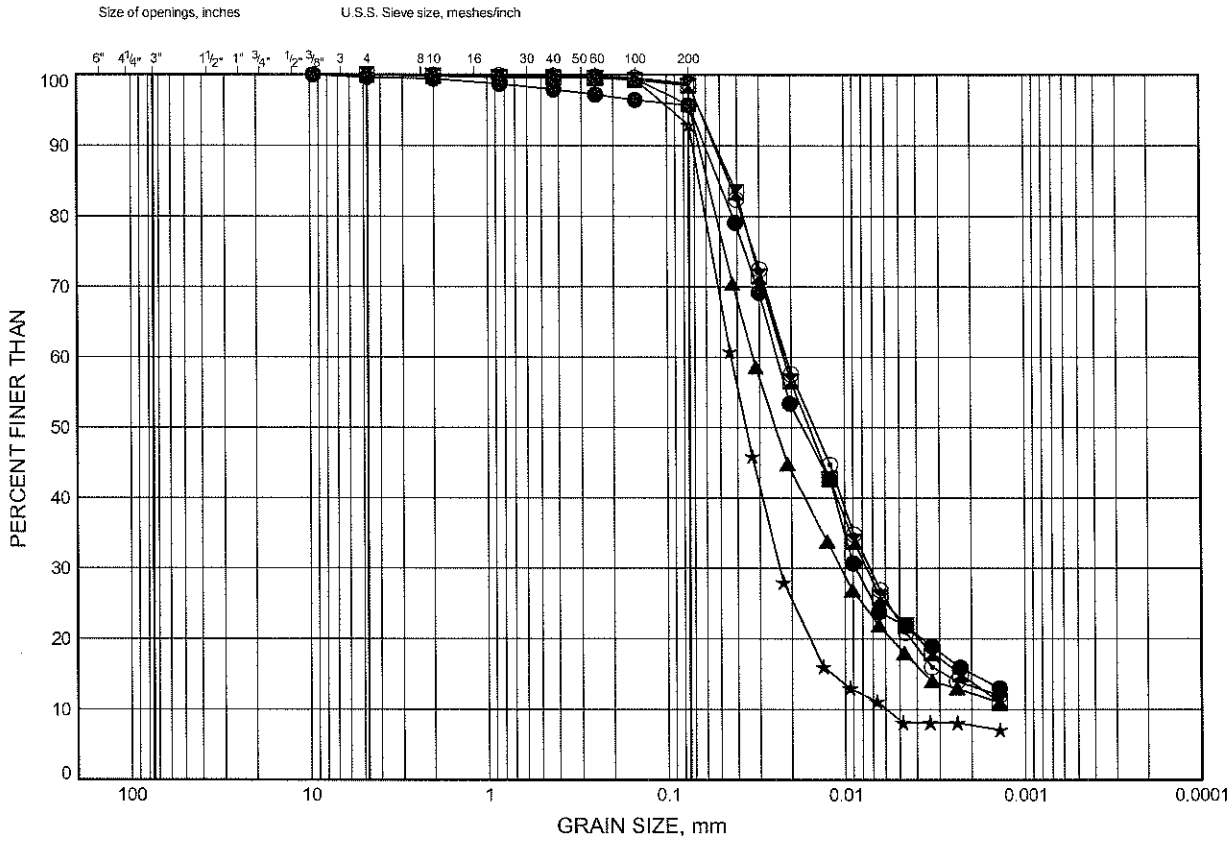
THURBGSD 5198.GPJ 10/22/07

Mindemoya Lake Bridge and Dam Replacement

GRAIN SIZE DISTRIBUTION

FIGURE 07-B7

SILT TO CLAYEY SILT



COBBLE SIZE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT and CLAY
	GRAVEL		SAND			FINE GRAINED

SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	07-M11	6.40	190.40
⊠	07-M12	4.88	192.02
▲	07-M13	7.92	188.58
★	07-M8	12.50	183.80
⊙	07-M9	7.92	188.48

Date October 2007

Project 5460-04-00

THURBER

Prep'd MFA

Chkd. MRA

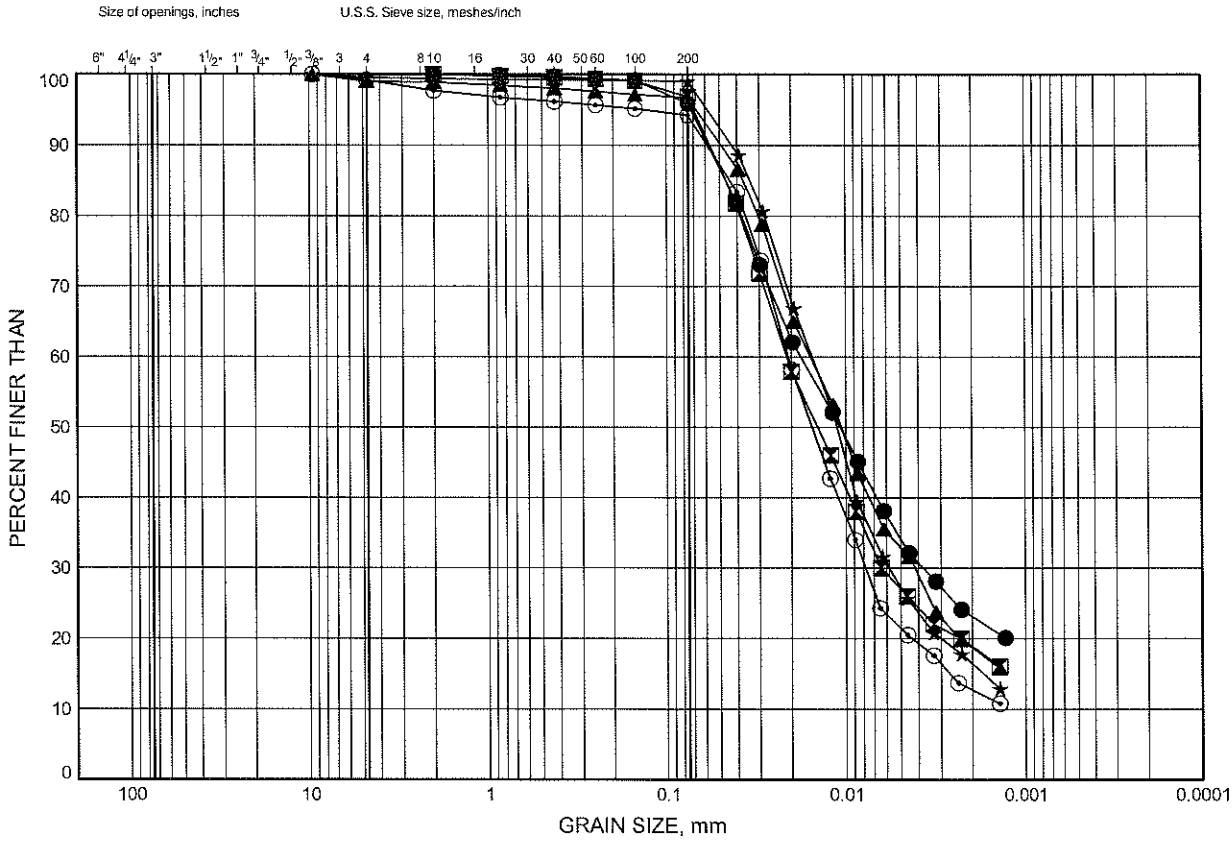
THURBGSD 5198.GPJ 10/22/07

Mindemoya Lake Bridge and Dam Replacement

GRAIN SIZE DISTRIBUTION

FIGURE 07-B8

SILT TO CLAYEY SILT



COBBLE SIZE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT and CLAY
	GRAVEL		SAND			FINE GRAINED

SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	07-M13	9.45	187.05
⊠	07-M13	14.02	182.48
▲	07-M14	6.40	190.40
★	07-M15	3.35	192.05
⊙	07-M15	8.84	186.56

Date October 2007

Project 5460-04-00

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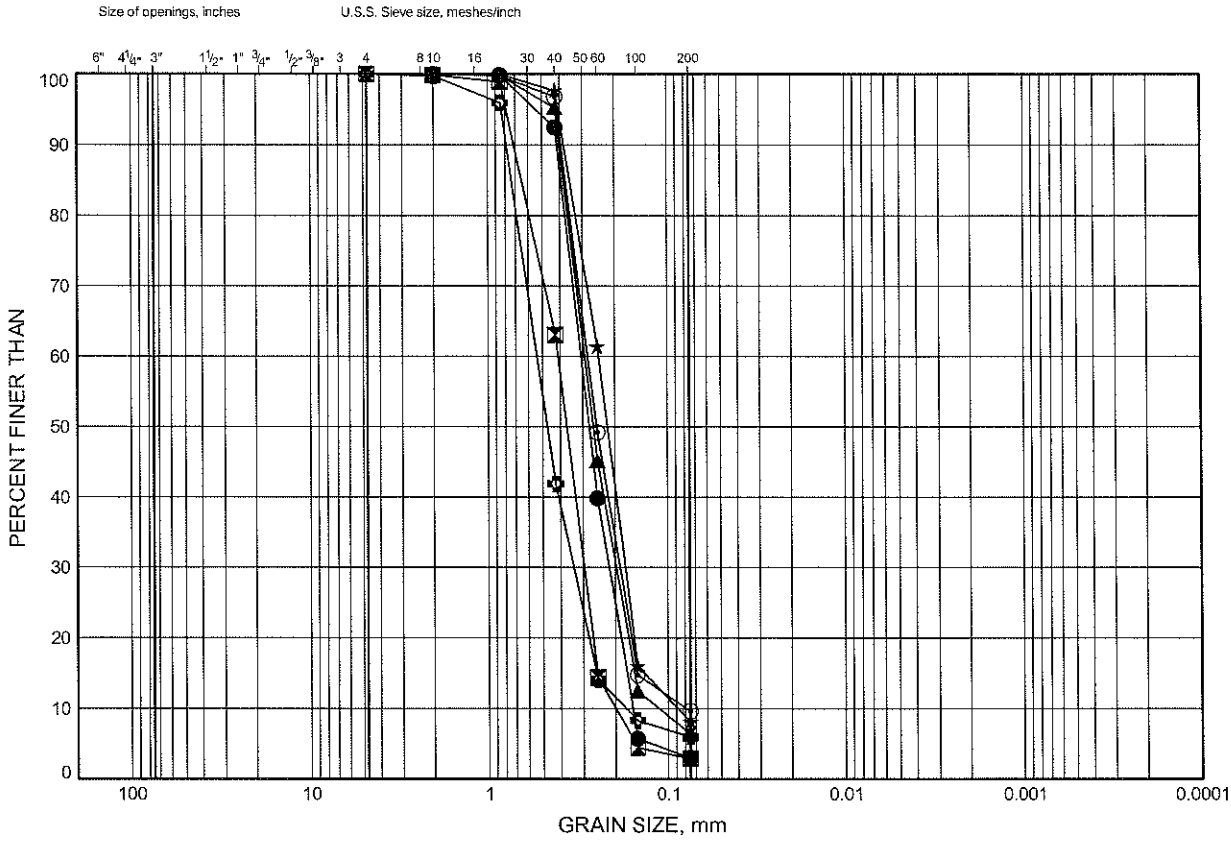
THURBGSD 5198.GPJ 10/22/07

Mindemoya Lake Bridge and Dam Replacement

GRAIN SIZE DISTRIBUTION

FIGURE 07-B9

SAND



COBBLE SIZE	GRAVEL		SAND			SILT and CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	FINE GRAINED

SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	07-M1	13.11	184.19
⧓	07-M1	28.35	168.95
▲	07-M2	14.02	183.88
★	07-M3	15.54	182.46
⊙	07-M4	15.54	182.46
✿	07-M4	27.74	170.26

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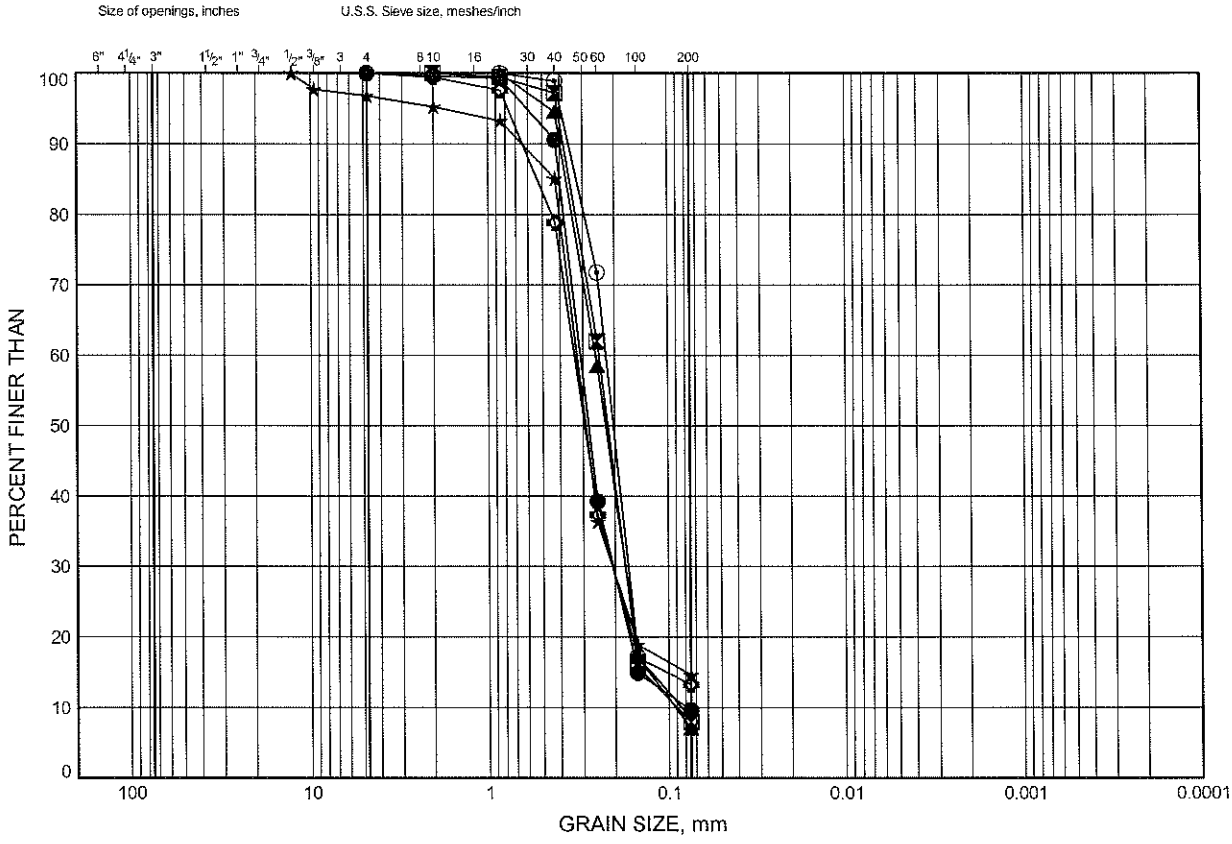
Mindemoya Lake Bridge and Dam Replacement

GRAIN SIZE DISTRIBUTION

FIGURE 07-B10

SAND



COBBLE SIZE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT and CLAY
	GRAVEL		SAND			FINE GRAINED

SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	07-M5	20.12	177.78
⧓	07-M6	11.89	185.11
▲	07-M6	22.56	174.44
★	07-M7	16.46	178.74
⊙	07-M9	12.50	183.90
✿	07-M9	15.54	180.86

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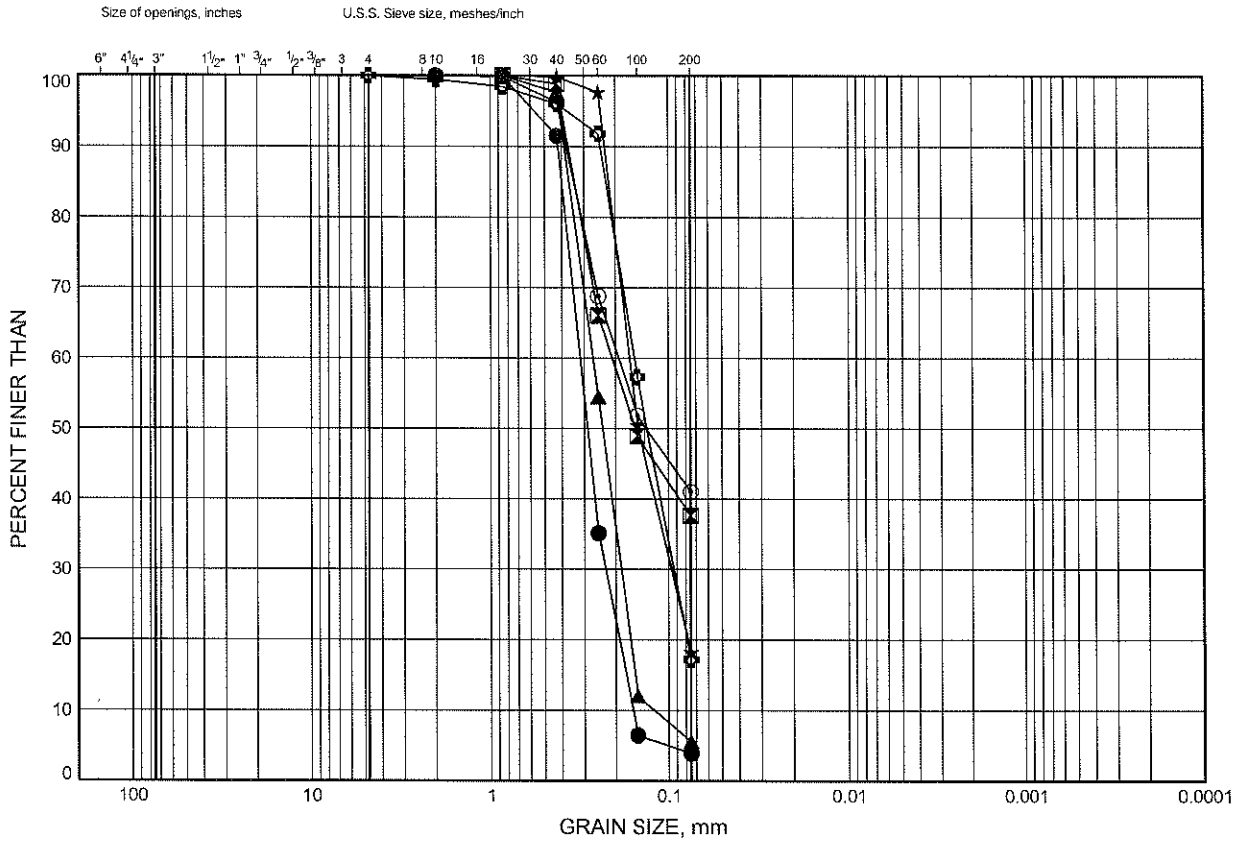
Mindemoya Lake Bridge and Dam Replacement

GRAIN SIZE DISTRIBUTION

FIGURE 07-B11

SAND



COBBLE SIZE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT and CLAY
	GRAVEL		SAND			FINE GRAINED

SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	07-M10	9.45	187.45
⊠	07-M10	15.54	181.36
▲	07-M11	12.50	184.30
★	07-M12	14.02	182.88
⊙	07-M14	11.89	184.91
⌬	07-M14	16.46	180.34

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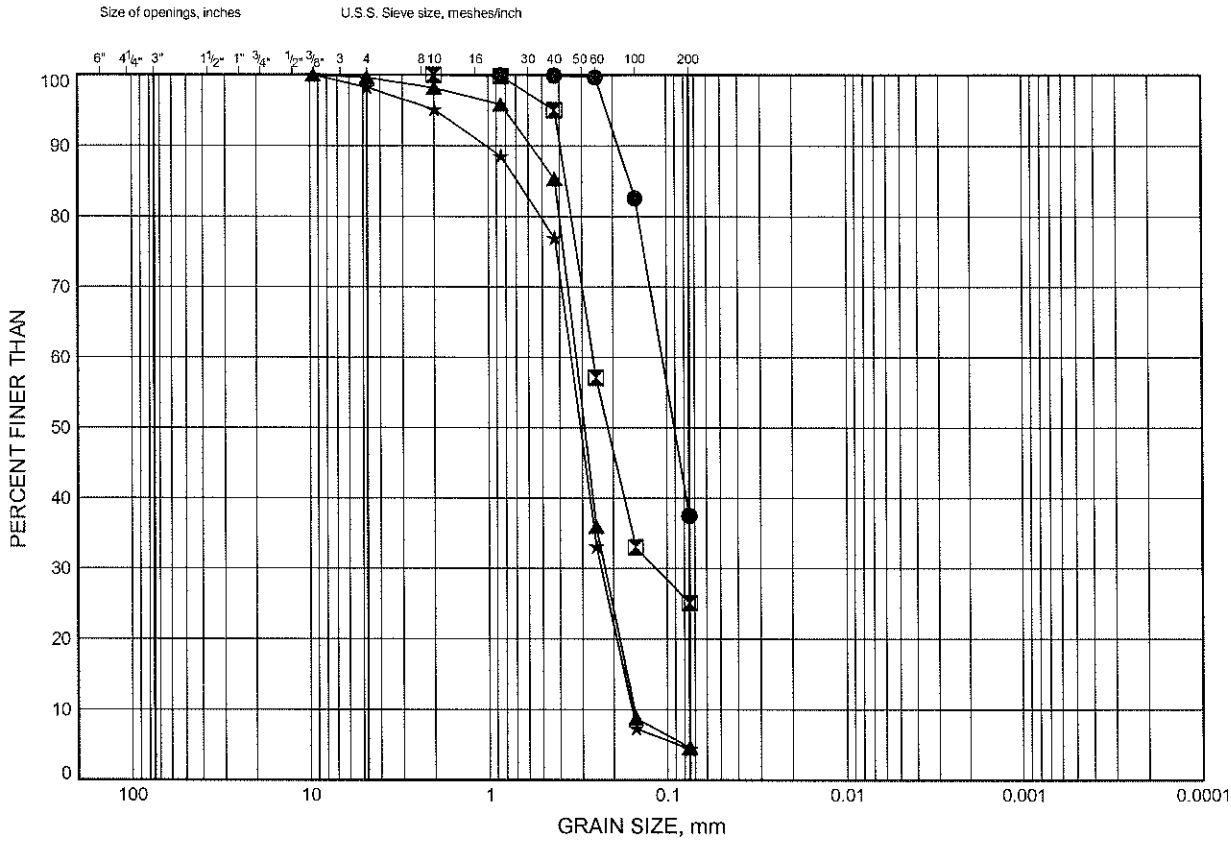
Mindemoya Lake Bridge and Dam Replacement

GRAIN SIZE DISTRIBUTION

FIGURE 07-B12

SAND



COBBLE SIZE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT and CLAY
	GRAVEL		SAND			FINE GRAINED

SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	07-M14	28.65	168.15
⊠	07-M15	11.89	183.51
▲	07-M15	16.46	178.94
★	07-M15	25.60	169.80

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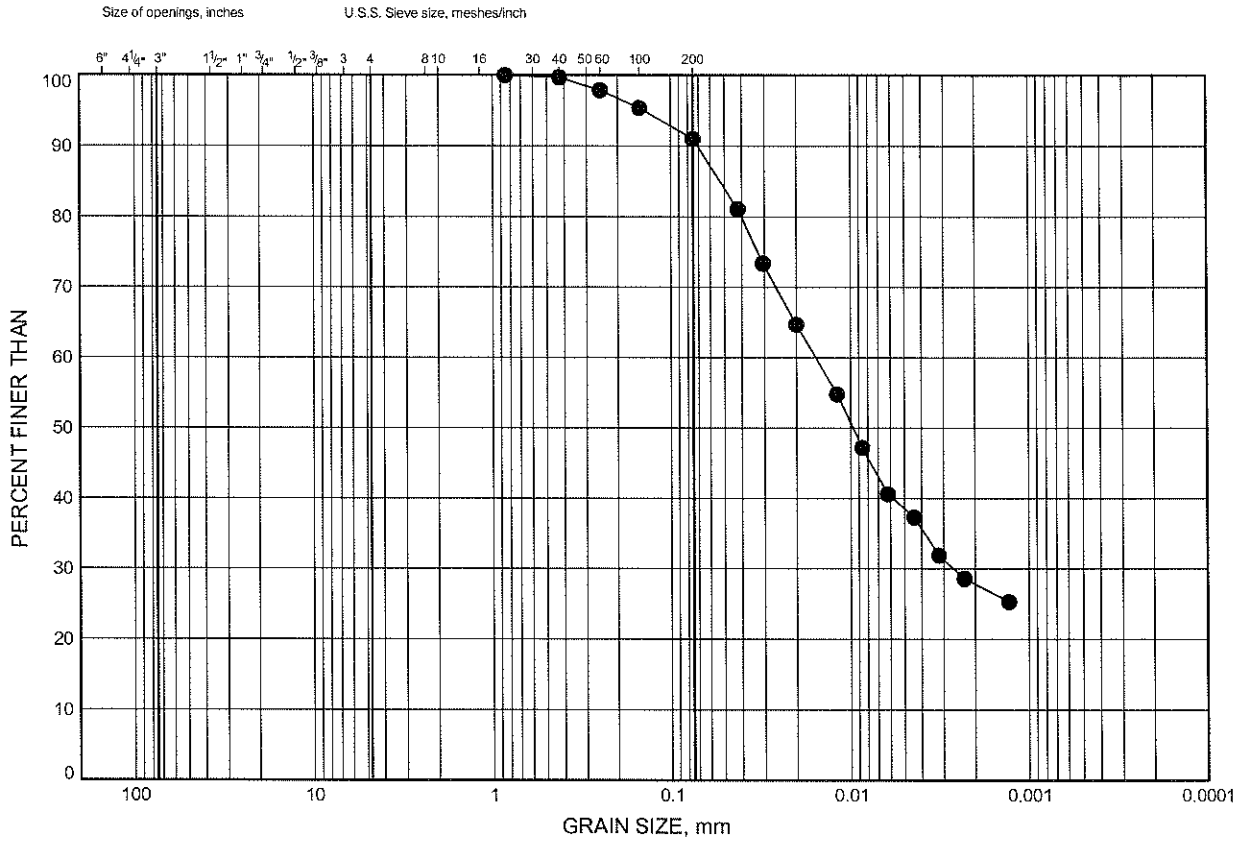
Mindemoya Lake Bridge and Dam Replacement

GRAIN SIZE DISTRIBUTION

FIGURE 07-B13

LOWER SILTY CLAY



COBBLE SIZE	GRAVEL		SAND			SILT and CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	FINE GRAINED

SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	07-M3	27.81	170.19

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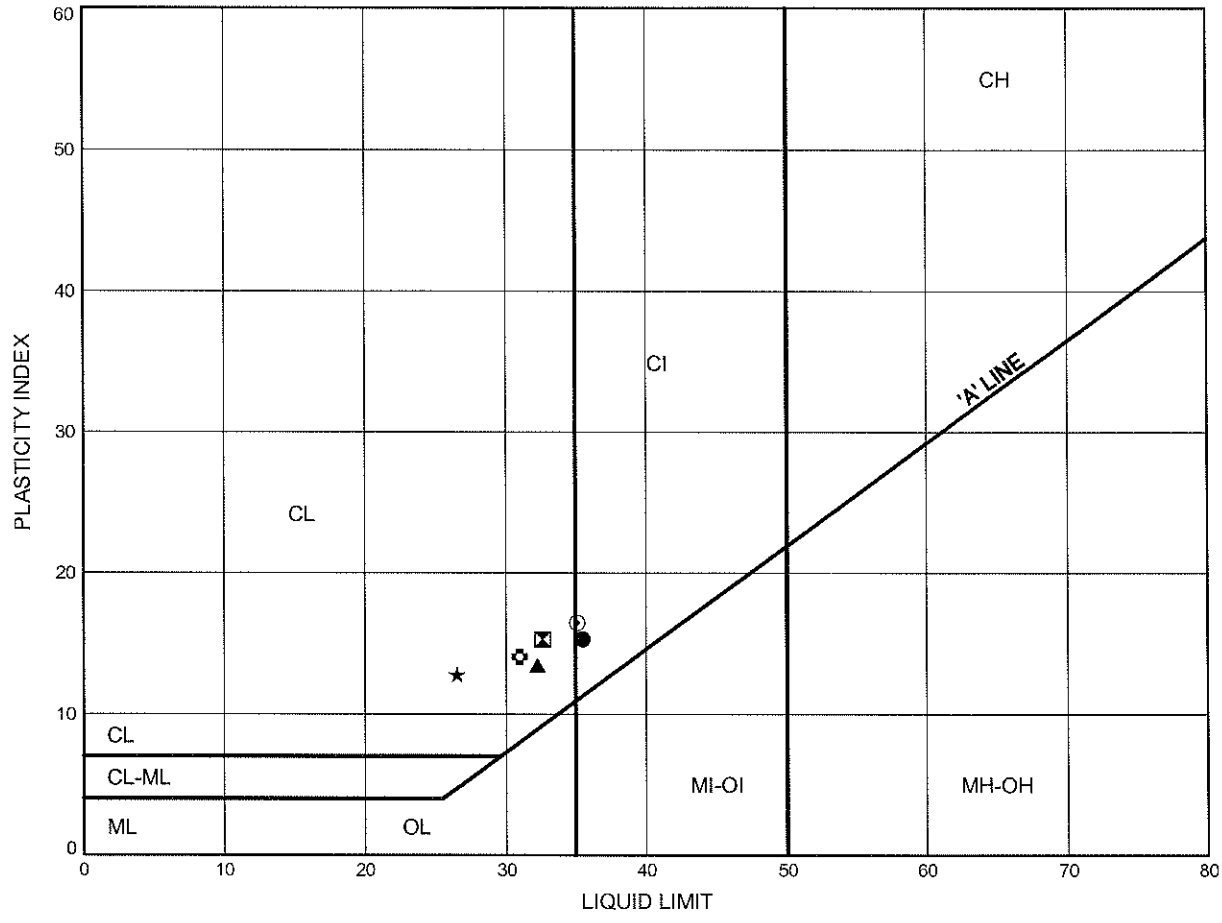
Mindemoya Lake Bridge and Dam Replacement

ATTERBERG LIMITS TEST RESULTS

FIGURE 07-B14

SILTY CLAY



SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	07-M01	3.33	193.97
⊠	07-M02	3.33	194.57
▲	07-M03	4.11	193.89
★	07-M03	27.81	170.19
⊙	07-M04	4.11	193.89
✿	07-M05	4.88	193.02

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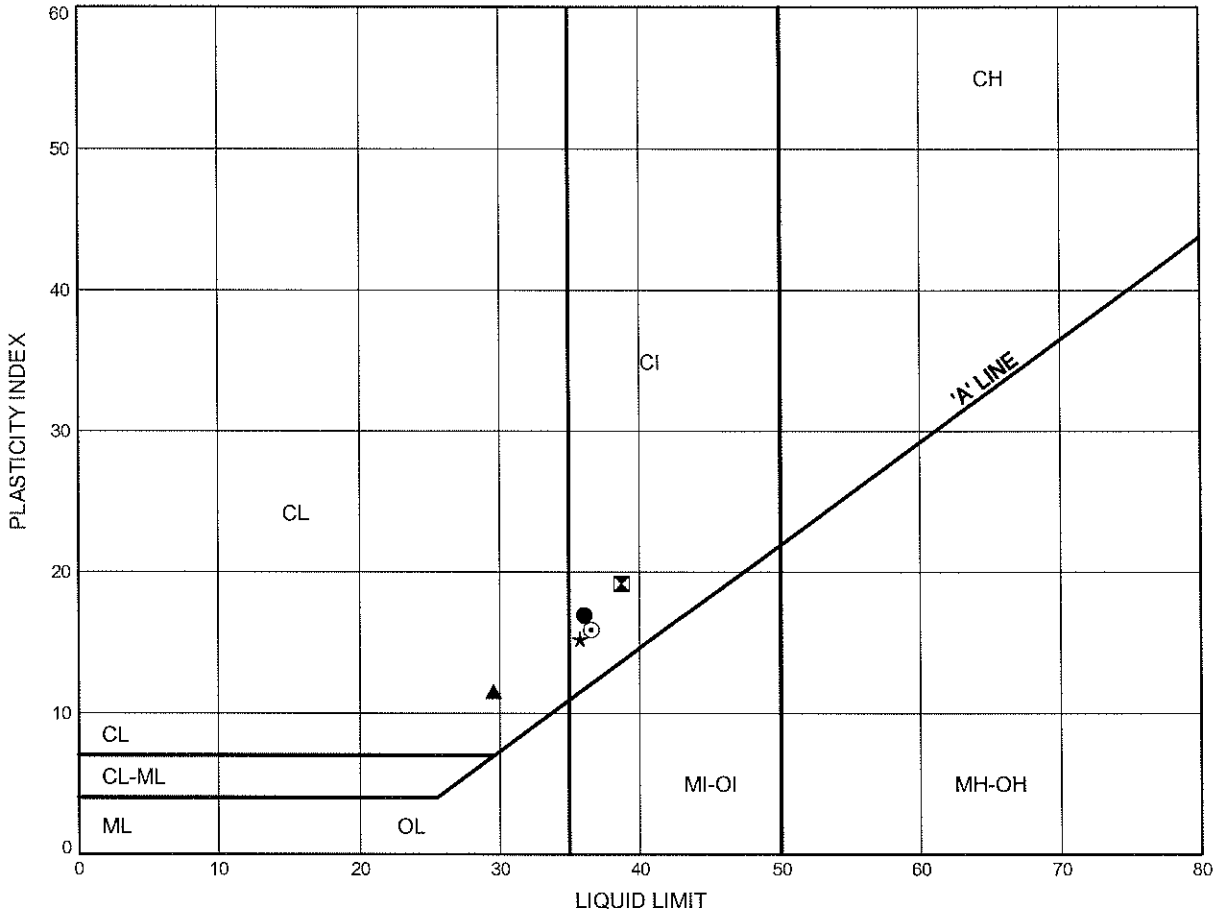
THURBALT 5198.GPJ 11/2/07

Mindemoya Lake Bridge and Dam Replacement

ATTERBERG LIMITS TEST RESULTS

FIGURE 07-B15

SILTY CLAY



SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	07-M10	2.59	194.31
⊠	07-M11	2.59	194.21
▲	07-M7	1.83	193.37
★	07-M8	1.83	194.47
⊙	07-M9	2.59	193.81

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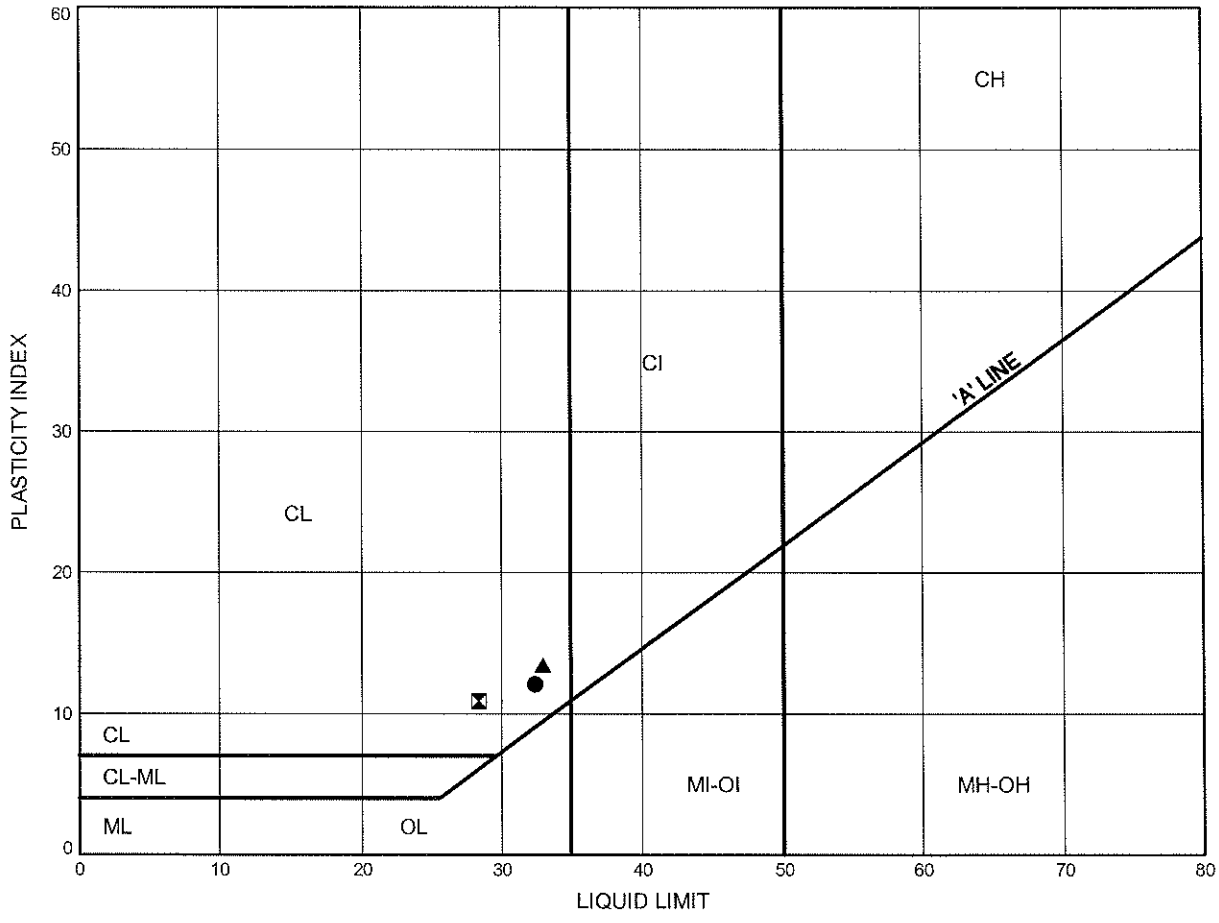
Mindemoya Lake Bridge and Dam Replacement

ATTERBERG LIMITS TEST RESULTS

FIGURE 07-B16

SILTY CLAY



SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	07-M12	2.59	194.31
⊠	07-M13	3.35	193.15
▲	07-M14	2.59	194.21

Date October 2007

Project 5460-04-00

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Chkd. MRA

THURBALT 5198.GPJ 10/22/07

Consolidation Test Report

CLIENT:	**McCormick Rankin Corporation**	FILE NUMBER:	18-45-1 / 19-1351-98
PROJECT:	Mindemoya Bridge and Dam Replacement	REPORT DATE:	11-Oct-07

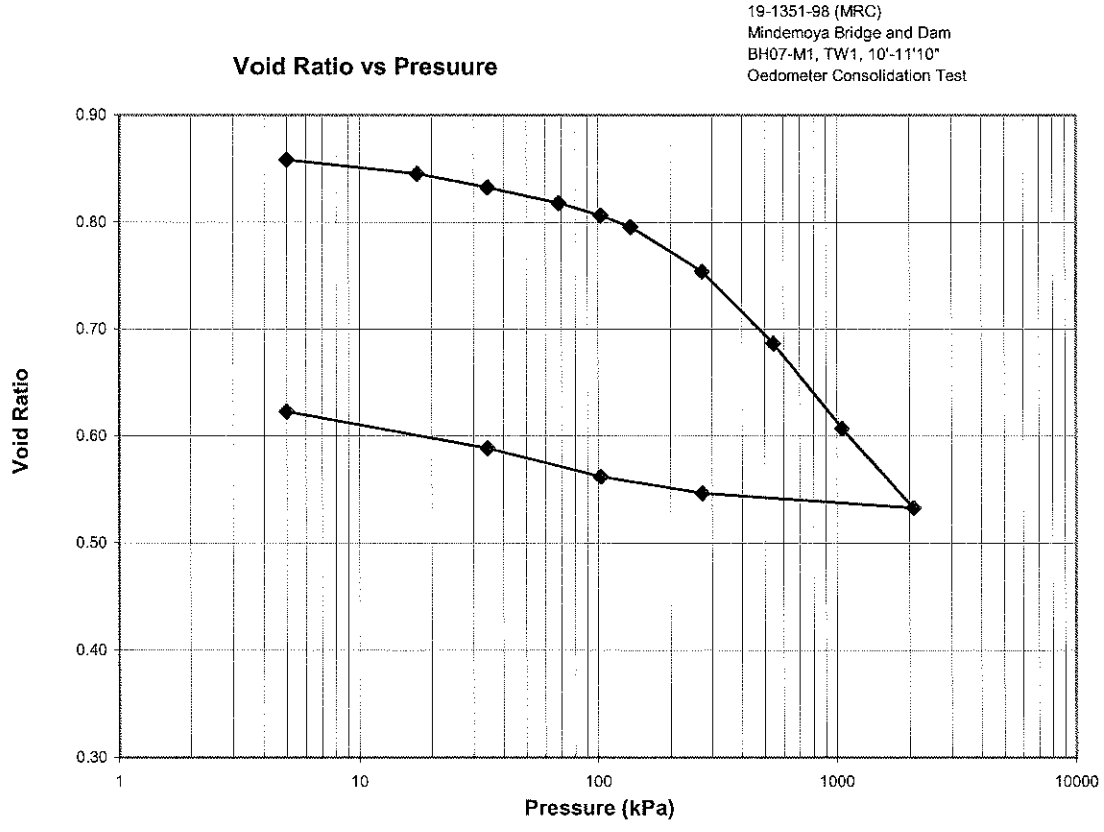
TEST DATES: September 20, 2007 - October 3, 2007

SAMPLE: BH07-M1, TW1, 10'-11'10"
Silty Clay, grey, plastic, (CI), Lab Vane: 20 - 37 kPa (Soft)
Grain Size: 43% Clay & 56 % Silt

PROCEDURE: Tested in accordance with Standard Test Method for One-Dimensional Consolidation Properties of Soils, ASTM D 2435-04, method B

	Start of Test	End of Test
Wet Dens. (kg/m^3)	1931.9	2119.6
Dry Dens. (kg/m^3)	1480.7	1681.7
Moisture Cont. (%)	30.5	26.0
Void Ratio	0.857	0.635
Saturation (%)	97.8	

Note: A Specific Gravity of 2.75 was assumed for the void ratio and saturation calculations



TEST DONE BY: WM/EA
REVIEWED BY: JPL

Consolidation Test Report

Mindemoya Bridge and Dam Replacement
18-45-1 / 19-1351-98 BH07-M1, TW1, 10'-11'10"

TRIMMING: The Specimen was manually trimmed to the size of consolidation ring, then mounted in a fixed ring consolidometer

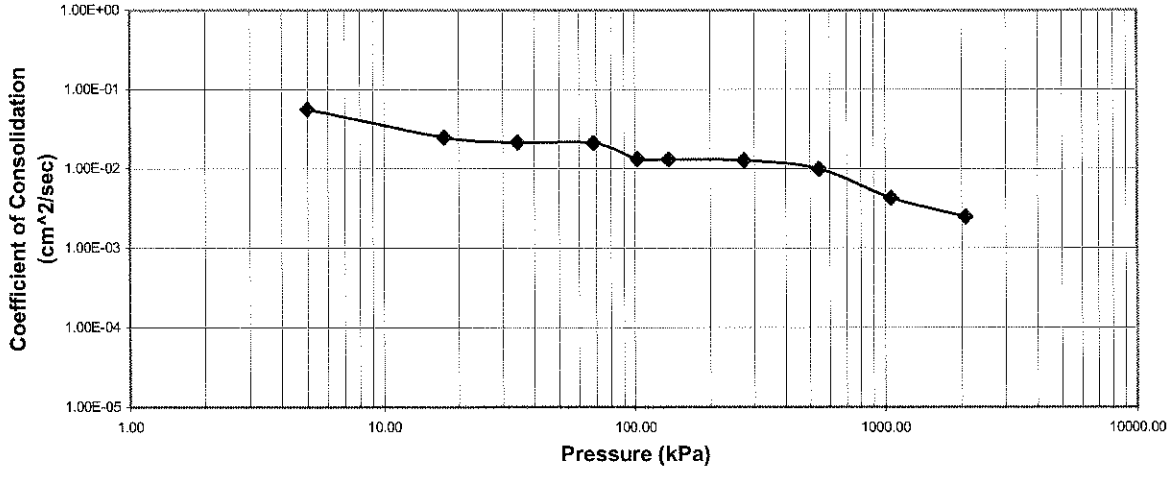
LOADING: A seating load of 5 kPa was applied and the consolidometer was flooded with distilled water. Sample was monitored to ensure no swelling effect occurred before the start of the test. Subsequent loads were applied and the duration of each load step was 24 hrs.

CALCULATIONS: Coefficients of Consolidation were calculated by the square root time method.

Pressure (kPa)	Corr. Hgt (mm)	Avg. Hgt. (mm)	T90 (min)	Cv (cm^2/sec)	Void Ratio	mv (m^2/kN)	k (cm/s)
0.00	19.850	19.850			0.857		
5.00	19.858	19.854	0.25	5.57E-02	0.858	5.50E-04	3.00E-06
17.50	19.722	19.790	0.56	2.47E-02	0.845	4.04E-04	9.78E-07
34.46	19.586	19.654	0.64	2.13E-02	0.833	2.31E-04	4.82E-07
68.42	19.430	19.508	0.64	2.10E-02	0.818	1.82E-04	3.74E-07
102.82	19.306	19.368	1.00	1.33E-02	0.806	1.70E-04	2.21E-07
136.78	19.192	19.249	1.00	1.31E-02	0.796	1.65E-04	2.12E-07
273.12	18.745	18.968	1.00	1.27E-02	0.754	1.33E-04	1.66E-07
545.39	18.025	18.385	1.21	9.87E-03	0.687	8.38E-05	8.10E-08
1057.63	17.173	17.599	2.56	4.27E-03	0.607	3.90E-05	1.63E-08
2080.12	16.381	16.777	4.00	2.49E-03	0.533	4.04E-06	9.85E-10
273.12	16.526	16.850			0.546		
102.82	16.694	16.610			0.562		
34.46	16.975	16.835			0.588		
5.00	17.341	17.158			0.623		

Coefficient of Consoildation vs Pressure

19-1351-98 (MRC)
Mindemoya Bridge and Dam
BH07-M1, TW1, 10'-11'10"
Oedometer Consolidation Test



Notes: Cv and k calculated using t_{90} values

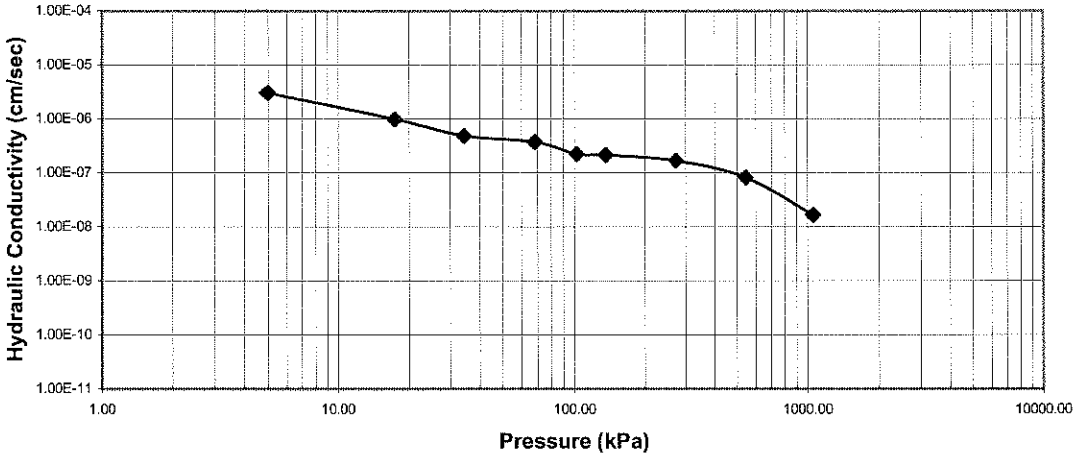
TEST DONE BY: WM/EA
REVIEWED BY: JPL

Consolidation Test Report

Mindemoya Bridge and Dam Replacement
18-45-1 / 19-1351-98 BH07-M1, TW1, 10'-11'10"

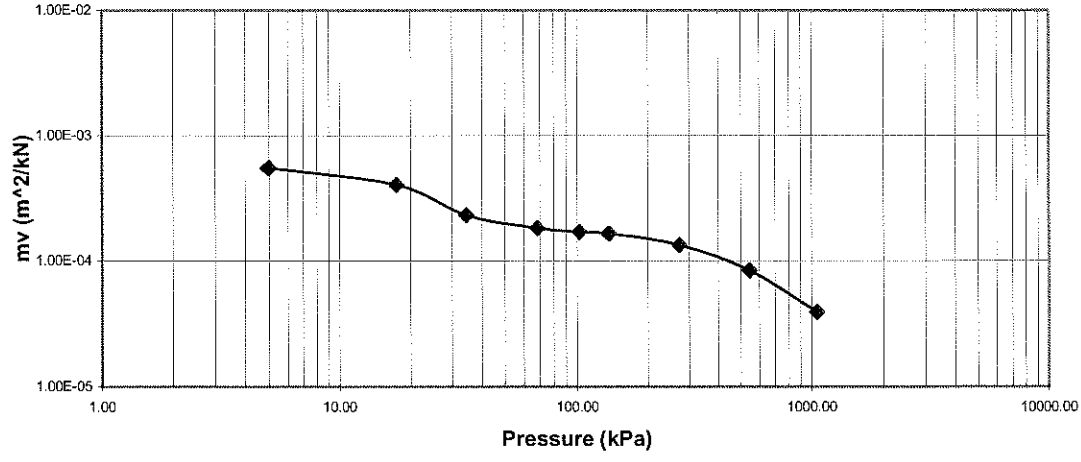
Hydraulic Conductivity vs Pressure

19-1351-98 (MRC)
Mindemoya Bridge and Dam
BH07-M1, TW1, 10'-11'10"
Oedometer Consolidation Test



mv vs Pressure

19-1351-98 (MRC)
Mindemoya Bridge and Dam
BH07-M1, TW1, 10'-11'10"
Oedometer Consolidation Test



TEST DONE BY: WM/EA
REVIEWED BY: JPL

Laboratory Test Results

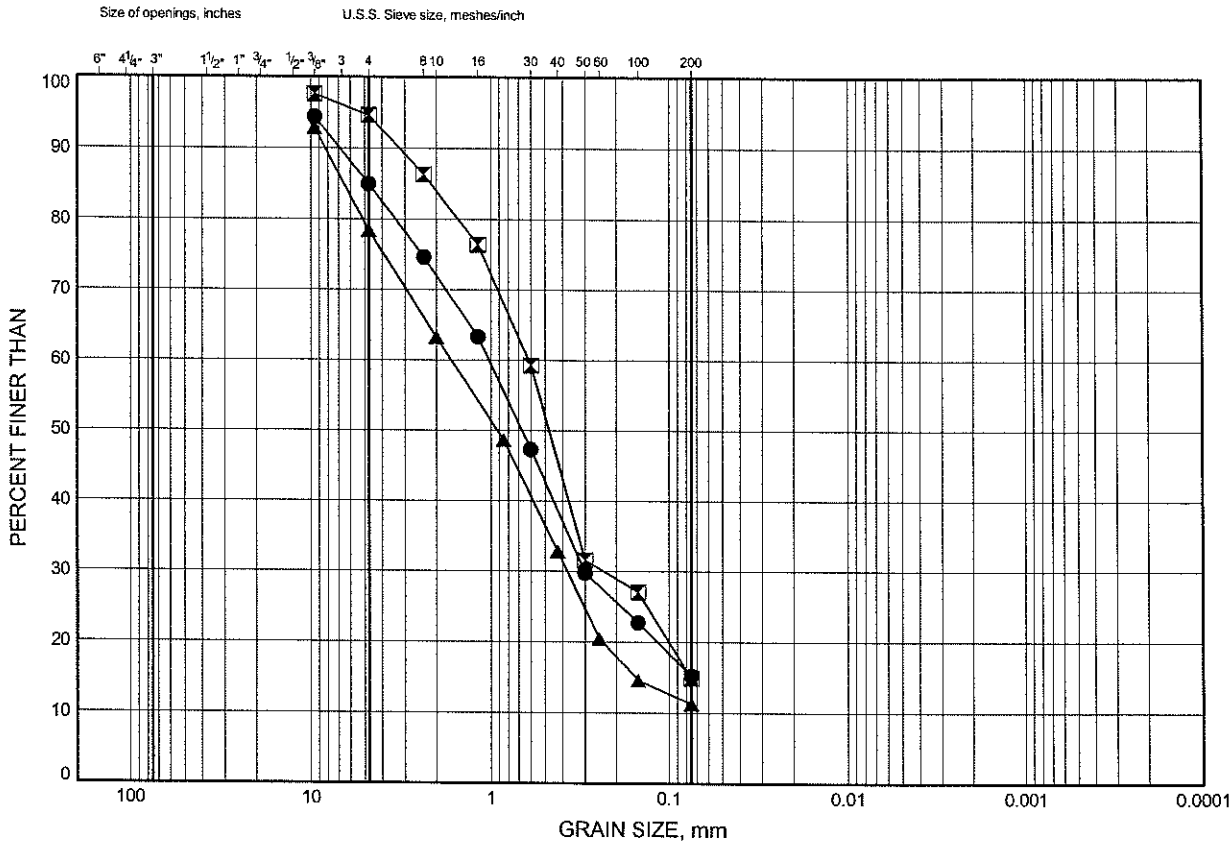
from Preliminary Investigation

Mindemoya Lake Bridge and Dam

GRAIN SIZE DISTRIBUTION

FIGURE B1

SAND FILL



COBBLE SIZE	GRAVEL		SAND			SILT and CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	FINE GRAINED

SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	06-M04	1.07	196.93
⊠	06-M09	1.07	196.63
▲	06-M14	0.30	197.39

Date December 2006

Project 5460-04-00

THURBER

Prep'd MFA

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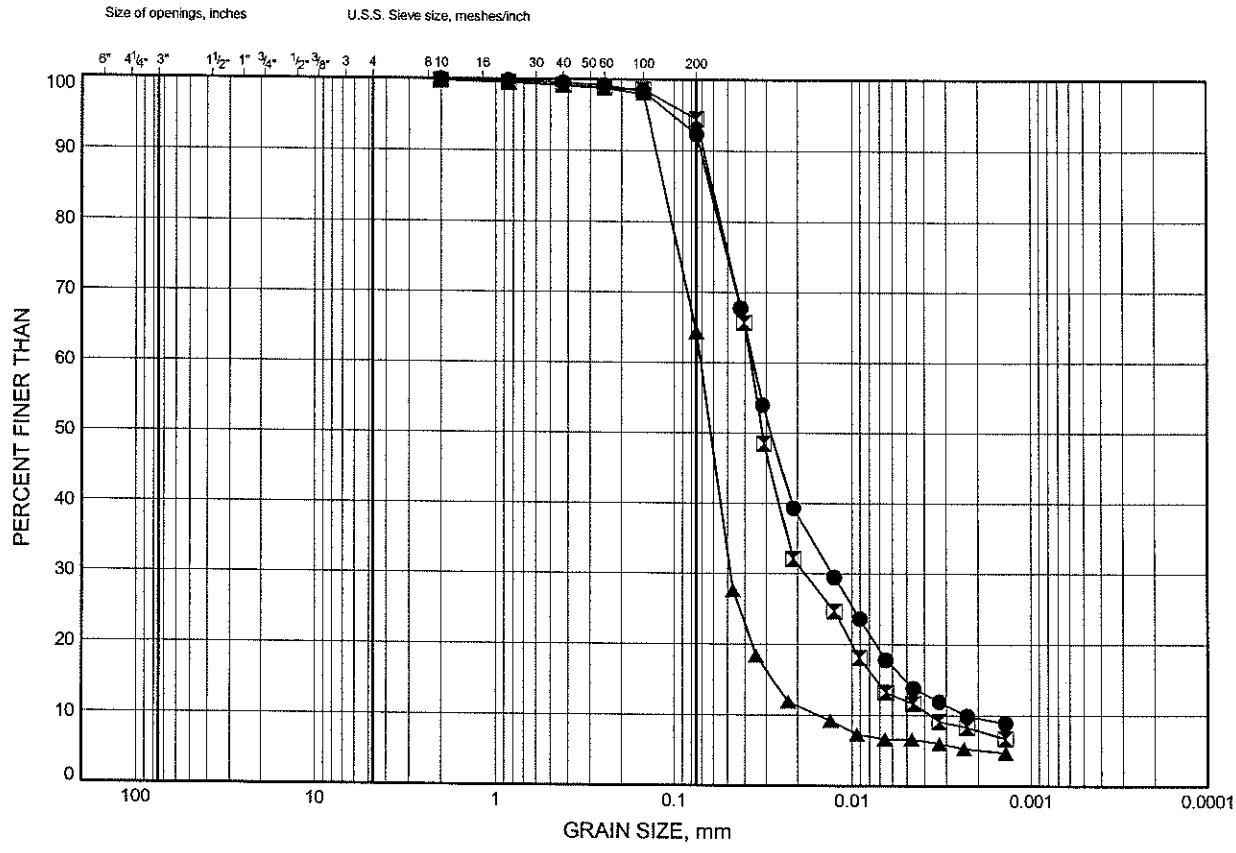
THURBGSD 5198.GPJ 05/12/06

Mindemoya Lake Bridge and Dam

GRAIN SIZE DISTRIBUTION

FIGURE B2

SURFICIAL SILT TO SANDY SILT



COBBLE SIZE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT and CLAY
	GRAVEL		SAND			FINE GRAINED

SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	06-M08	3.35	194.65
⧓	06-M09	2.59	195.11
▲	06-M11	1.83	196.07

Date December 2006

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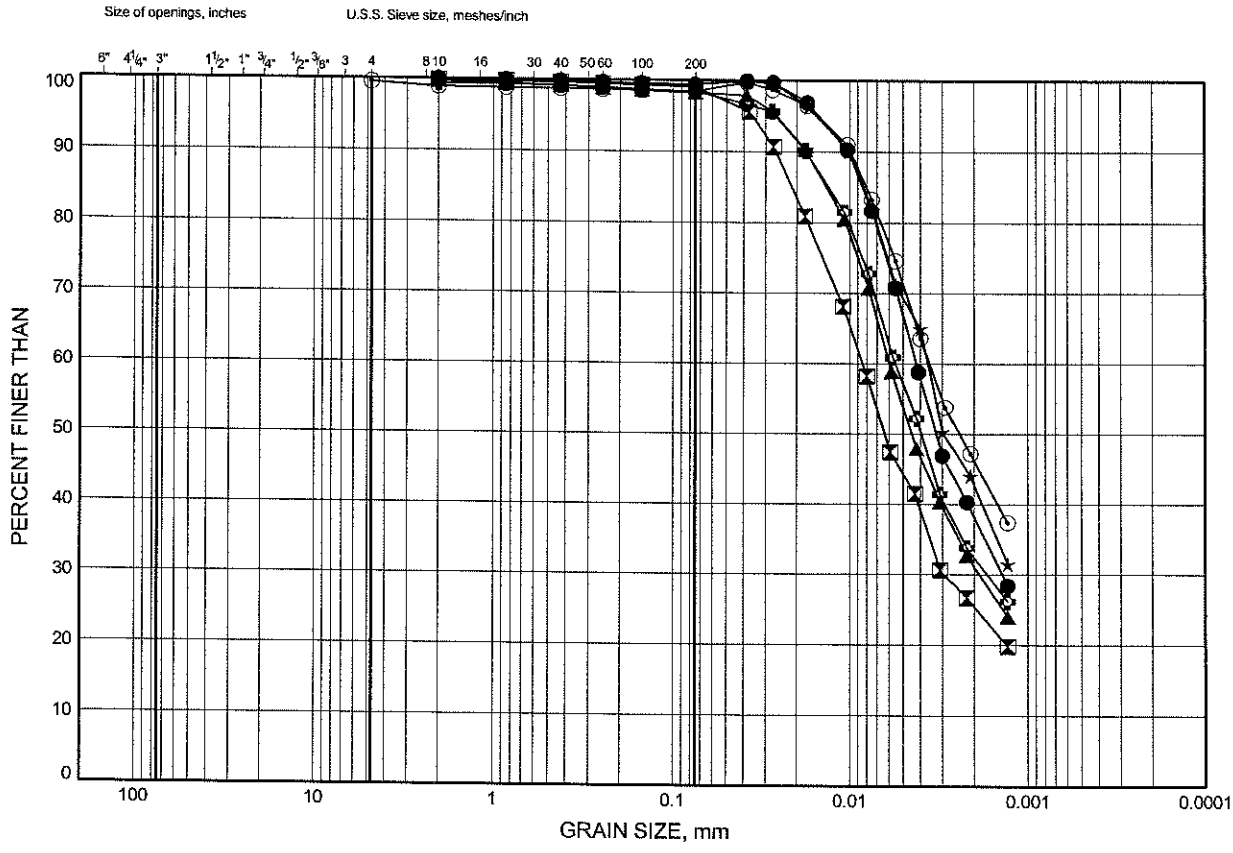
Mindemoya Lake Bridge and Dam

GRAIN SIZE DISTRIBUTION

FIGURE B3

SILTY CLAY



COBBLE SIZE	GRAVEL		SAND			SILT and CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	FINE GRAINED

SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	06-M01	3.35	193.55
⧓	06-M03	4.88	193.22
▲	06-M04	4.88	193.12
★	06-M07	7.62	190.18
⊙	06-M08	6.10	191.91
✿	06-M09	7.62	190.08

Date December 2006

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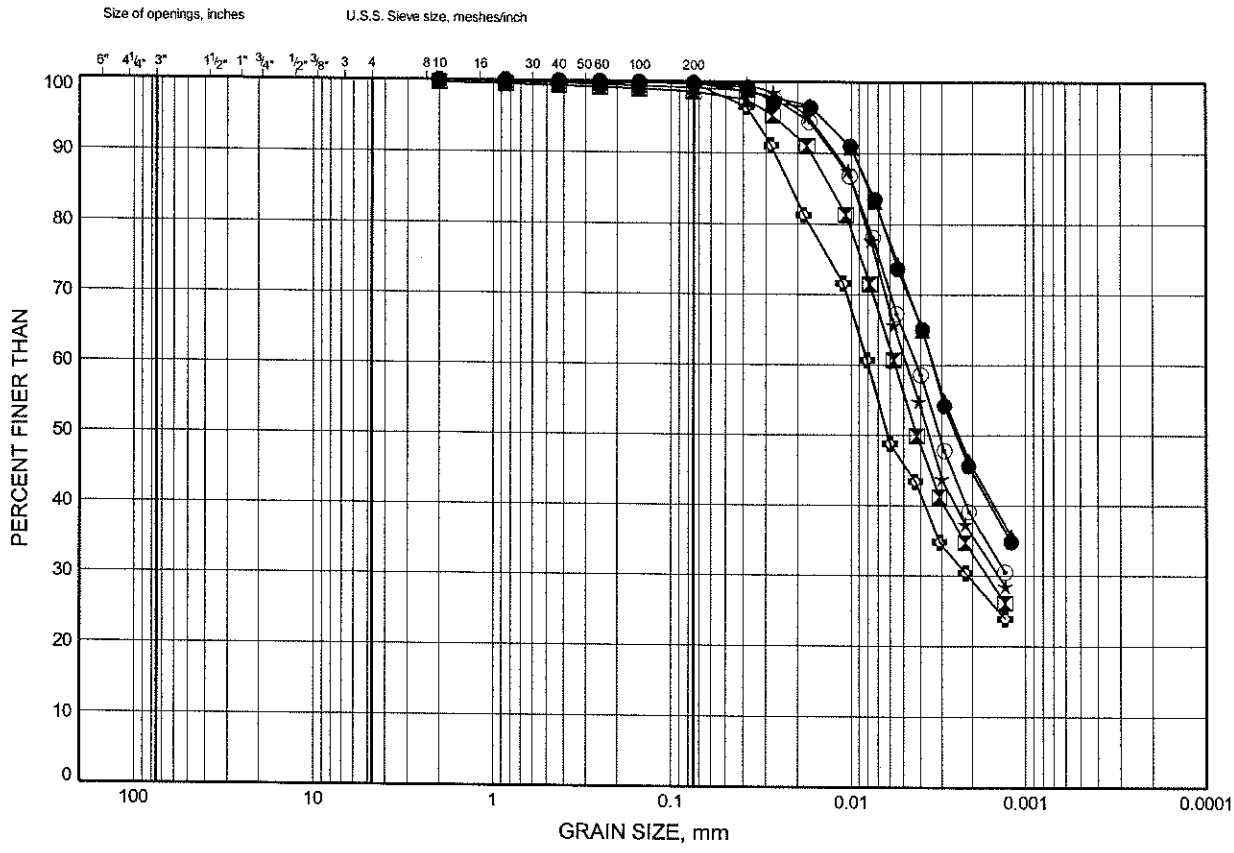
Mindemoya Lake Bridge and Dam

GRAIN SIZE DISTRIBUTION

FIGURE B4

SILTY CLAY



COBBLE SIZE	GRAVEL		SAND			SILT and CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	FINE GRAINED

SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	06-M10	3.35	193.25
⊠	06-M11	4.88	193.02
▲	06-M12	3.35	194.45
★	06-M13	3.35	193.35
⊙	06-M14	3.35	194.35
✿	06-M14	7.62	190.08

Date December 2006

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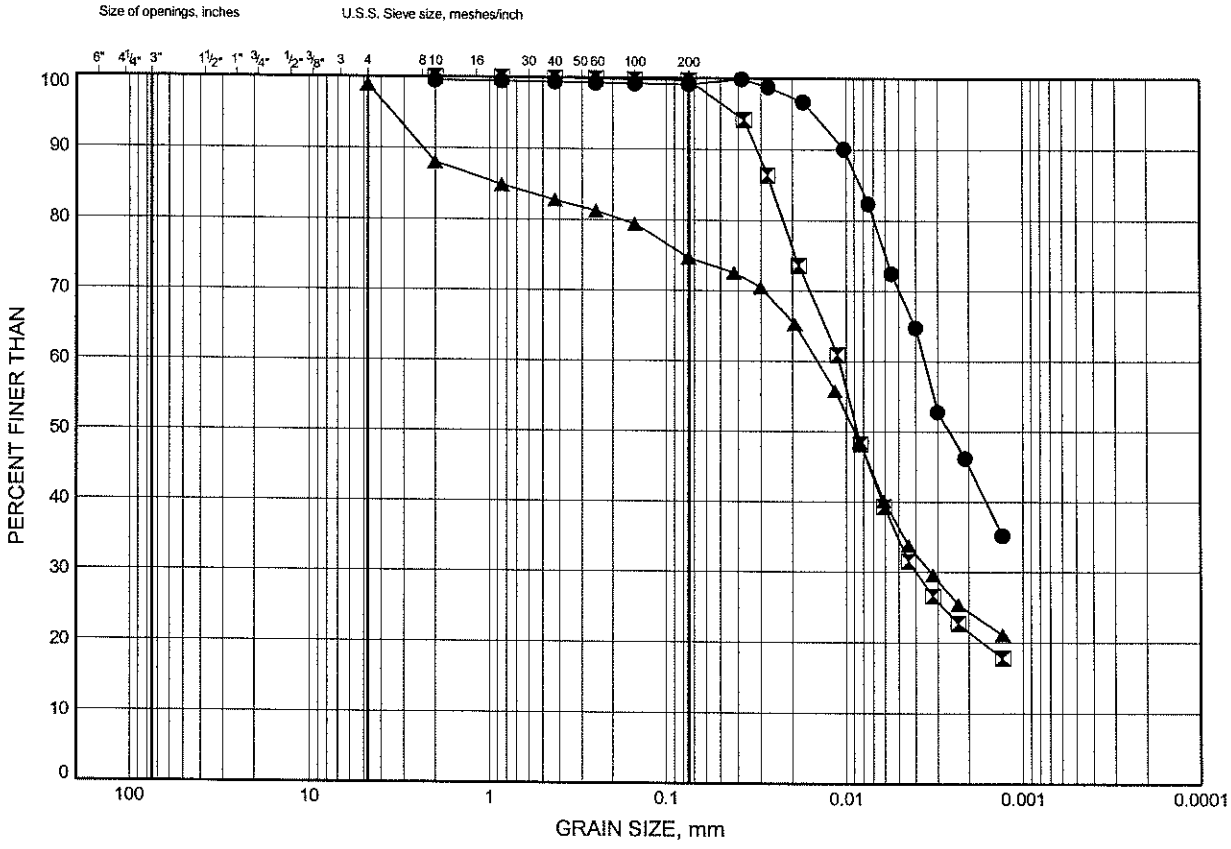
Mindemoya Lake Bridge and Dam

GRAIN SIZE DISTRIBUTION

FIGURE B5

SILTY CLAY



COBBLE SIZE	GRAVEL		SAND			SILT and CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	FINE GRAINED

SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	06-M15	2.59	195.21
⧓	06-M15	7.62	190.18
▲	06-M15	10.67	187.13

Date December 2006

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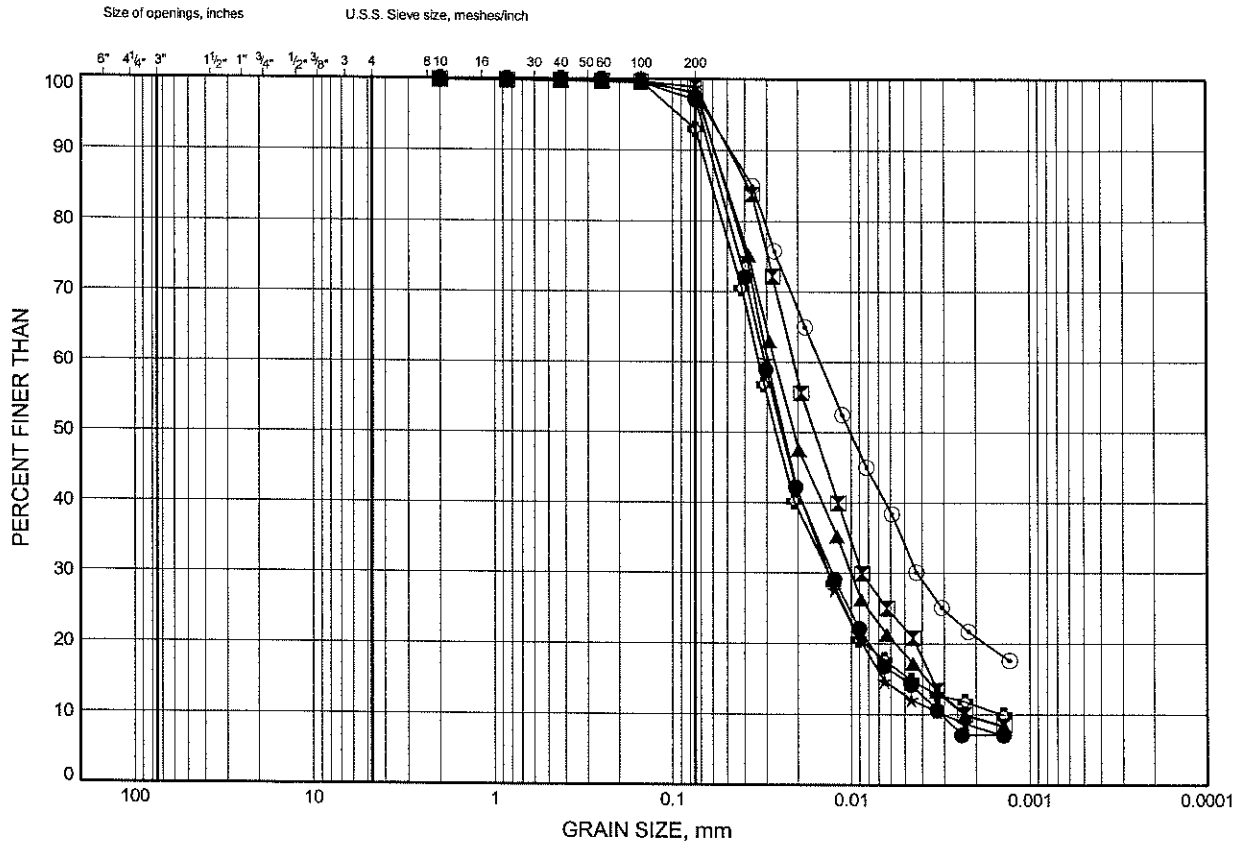
Mindemoya Lake Bridge and Dam

GRAIN SIZE DISTRIBUTION

FIGURE B6

SILT



COBBLE SIZE	GRAVEL		SAND			SILT and CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	FINE GRAINED

SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	06-M01	7.92	188.98
⊠	06-M03	7.62	190.48
▲	06-M04	10.97	187.03
★	06-M07	12.19	185.61
⊙	06-M07	16.76	181.04
✿	06-M08	13.72	184.29

Date December 2006

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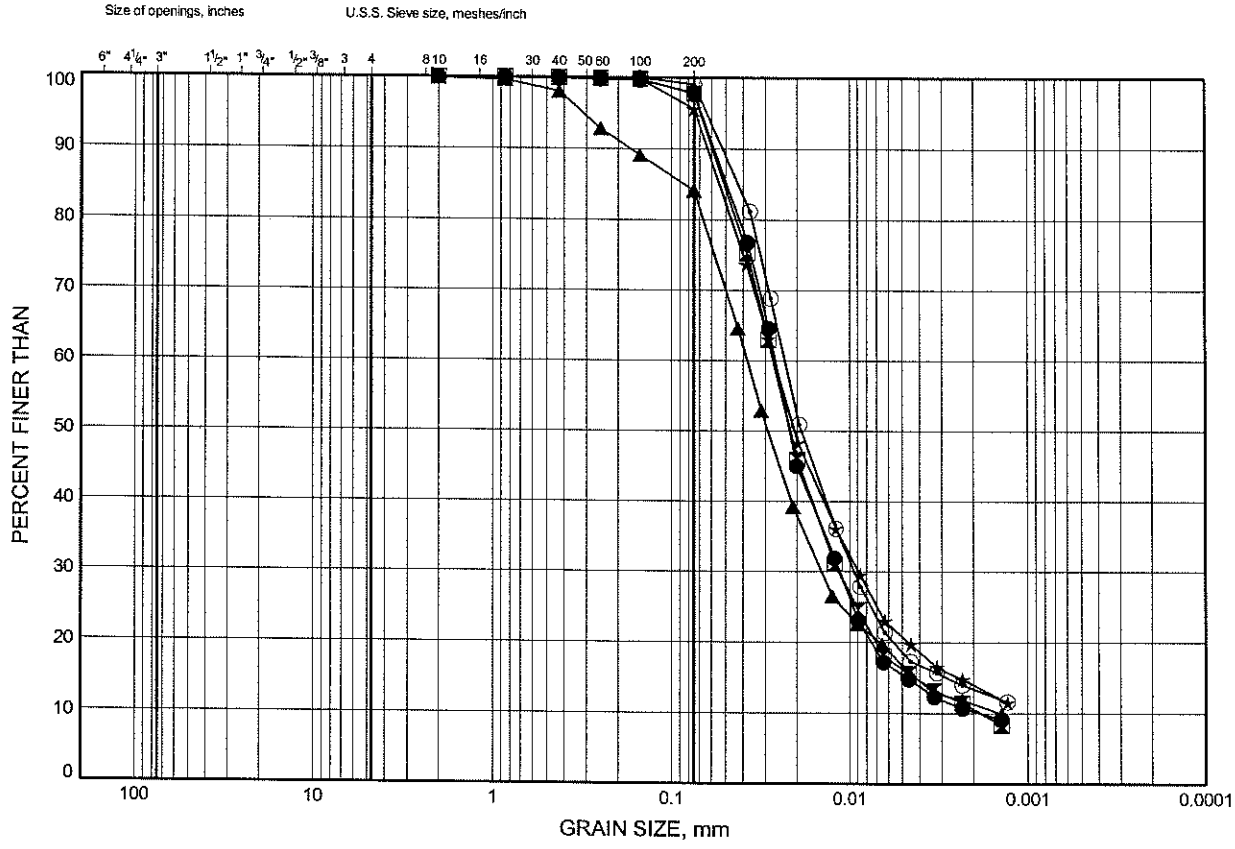
Mindemoya Lake Bridge and Dam

GRAIN SIZE DISTRIBUTION

FIGURE B7

SILT



COBBLE SIZE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT and CLAY
	GRAVEL		SAND			FINE GRAINED

SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	06-M09	12.19	185.51
⊠	06-M10	7.92	188.67
▲	06-M11	7.92	189.98
★	06-M12	10.67	187.13
⊙	06-M12	15.24	182.56

Date December 2006

Project 5460-04-00

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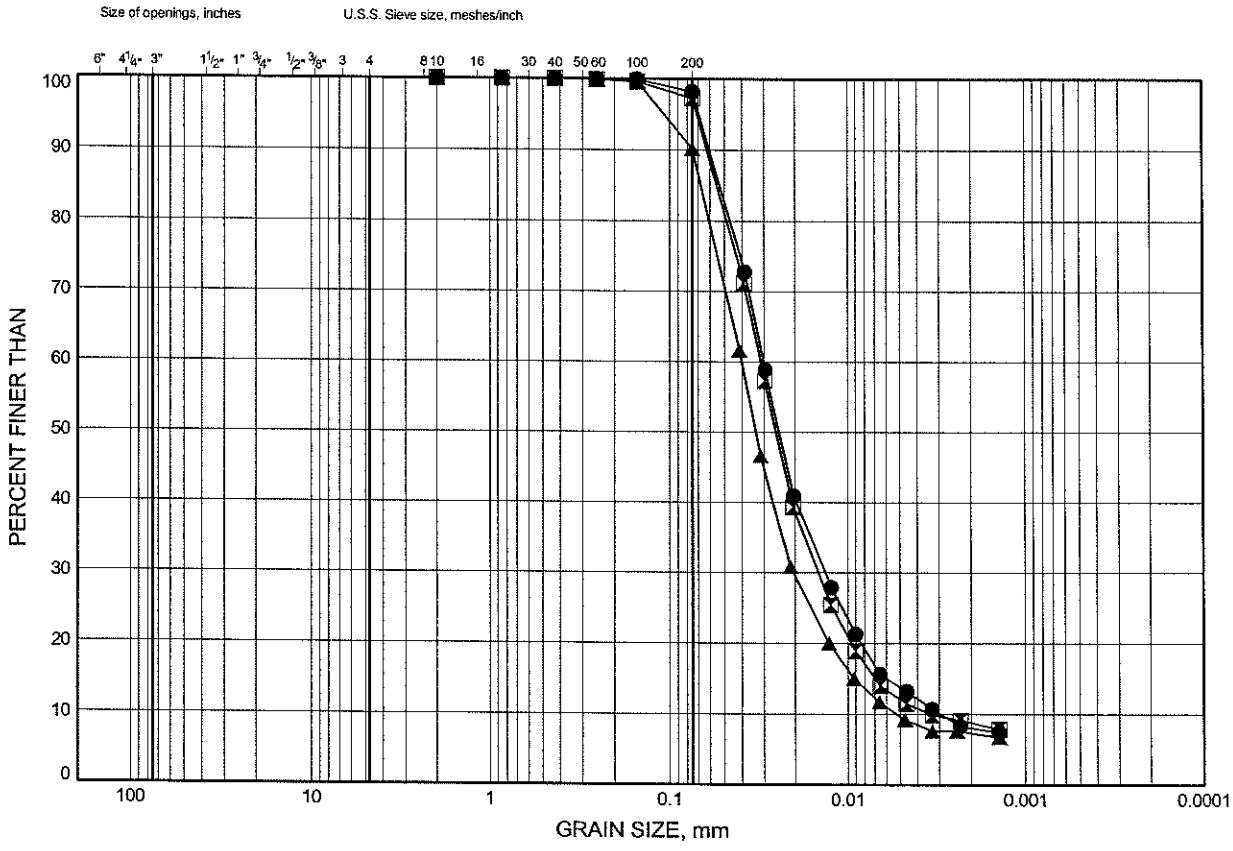
Mindemoya Lake Bridge and Dam

GRAIN SIZE DISTRIBUTION

FIGURE B8

SILT



COBBLE SIZE	GRAVEL		SAND			SILT and CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	FINE GRAINED

SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	06-M13	7.32	189.38
⧓	06-M13	13.41	183.29
▲	06-M14	12.19	185.51

Date December 2006

Project 5460-04-00

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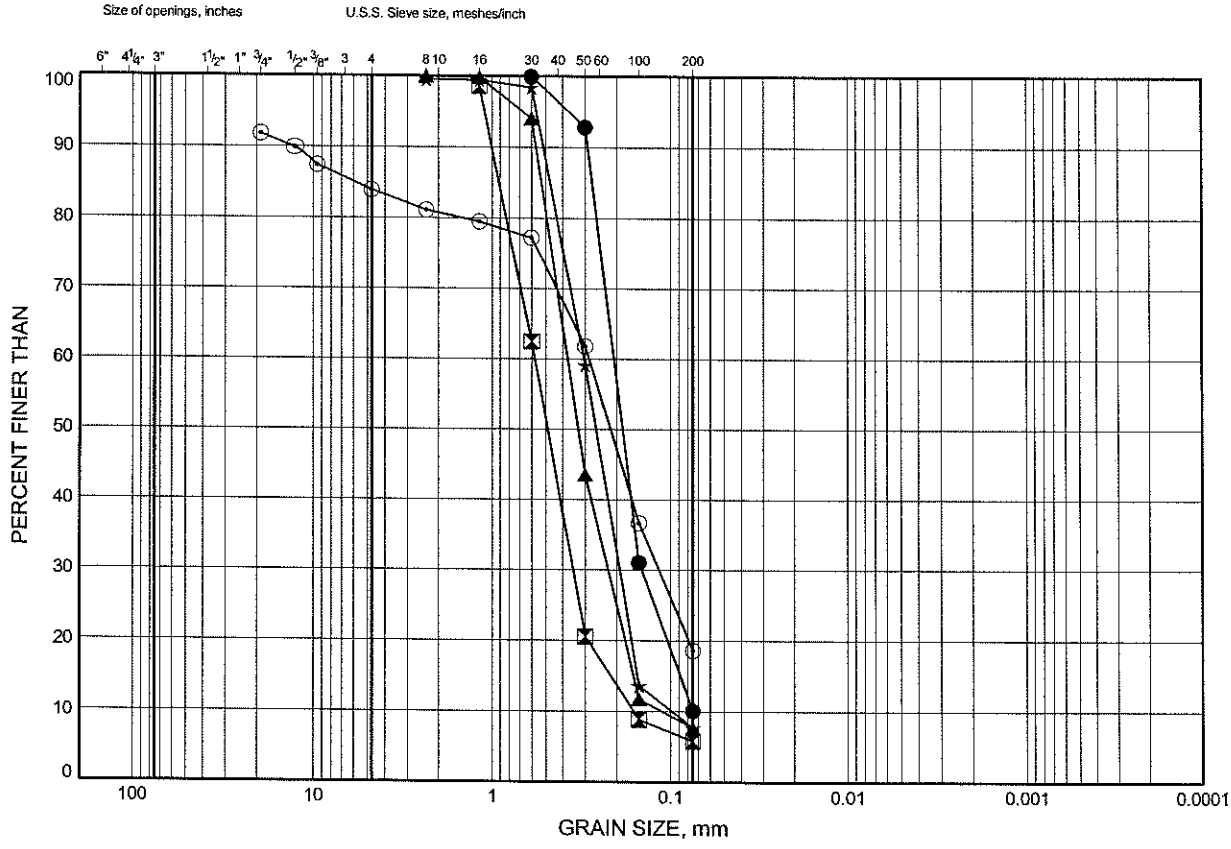
Mindemoya Lake Bridge and Dam

GRAIN SIZE DISTRIBUTION

FIGURE B9

SAND



COBBLE SIZE	GRAVEL		SAND			SILT and CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	FINE GRAINED

SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	06-M01	14.02	182.88
⊠	06-M01	21.64	175.26
▲	06-M03	13.72	184.38
★	06-M03	24.38	173.71
⊙	06-M03	30.48	167.62

Date December 2006

Project 5460-04-00

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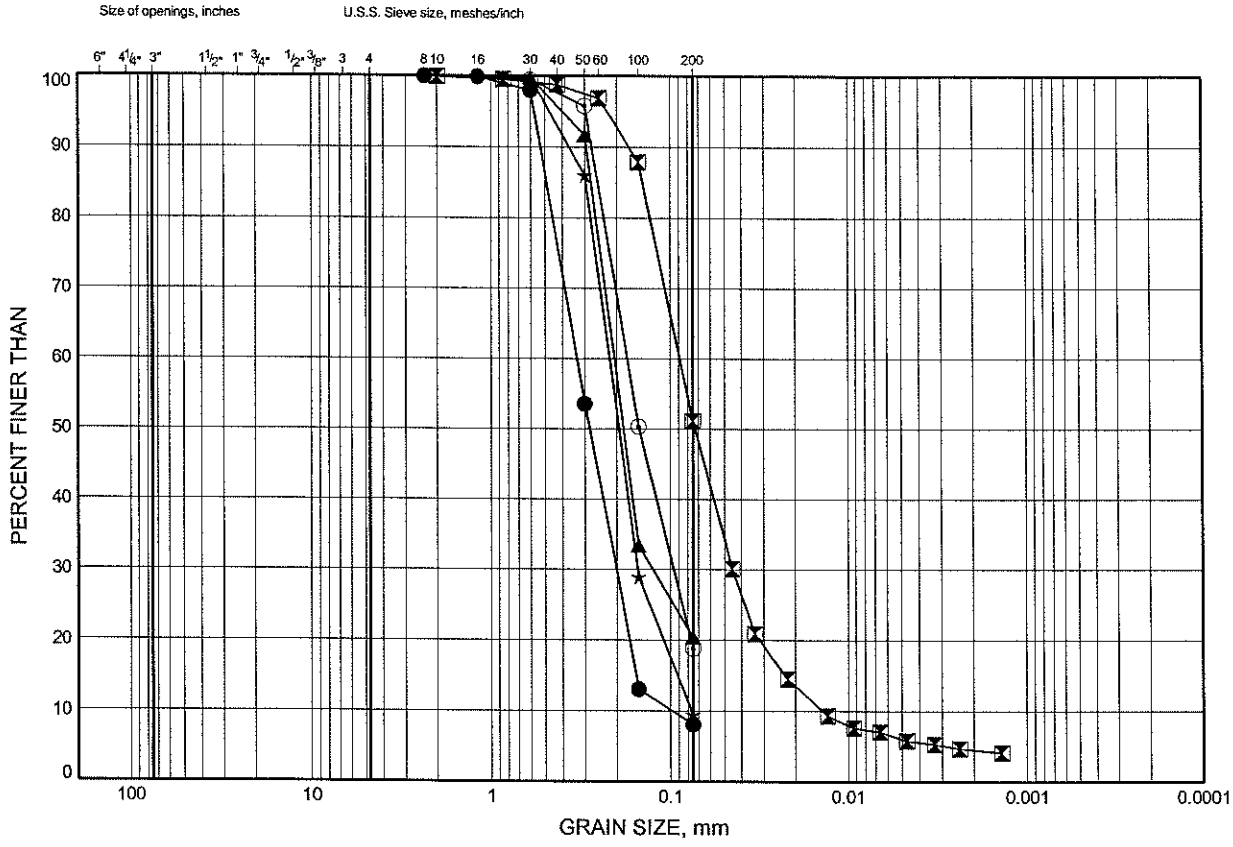
THURB/GSD 5198.GPJ 05/12/06

Mindemoya Lake Bridge and Dam

GRAIN SIZE DISTRIBUTION

FIGURE B10

SAND TO SAND AND SILT



COBBLE SIZE	GRAVEL		SAND			SILT and CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	FINE GRAINED

SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	06-M04	15.24	182.76
⧓	06-M04	18.29	179.71
▲	06-M04	30.48	167.52
★	06-M08	19.81	178.19
⊙	06-M09	16.76	180.94

Date December 2006

Project 5460-04-00

THURBER

Prep'd MFA

Chkd. MRA

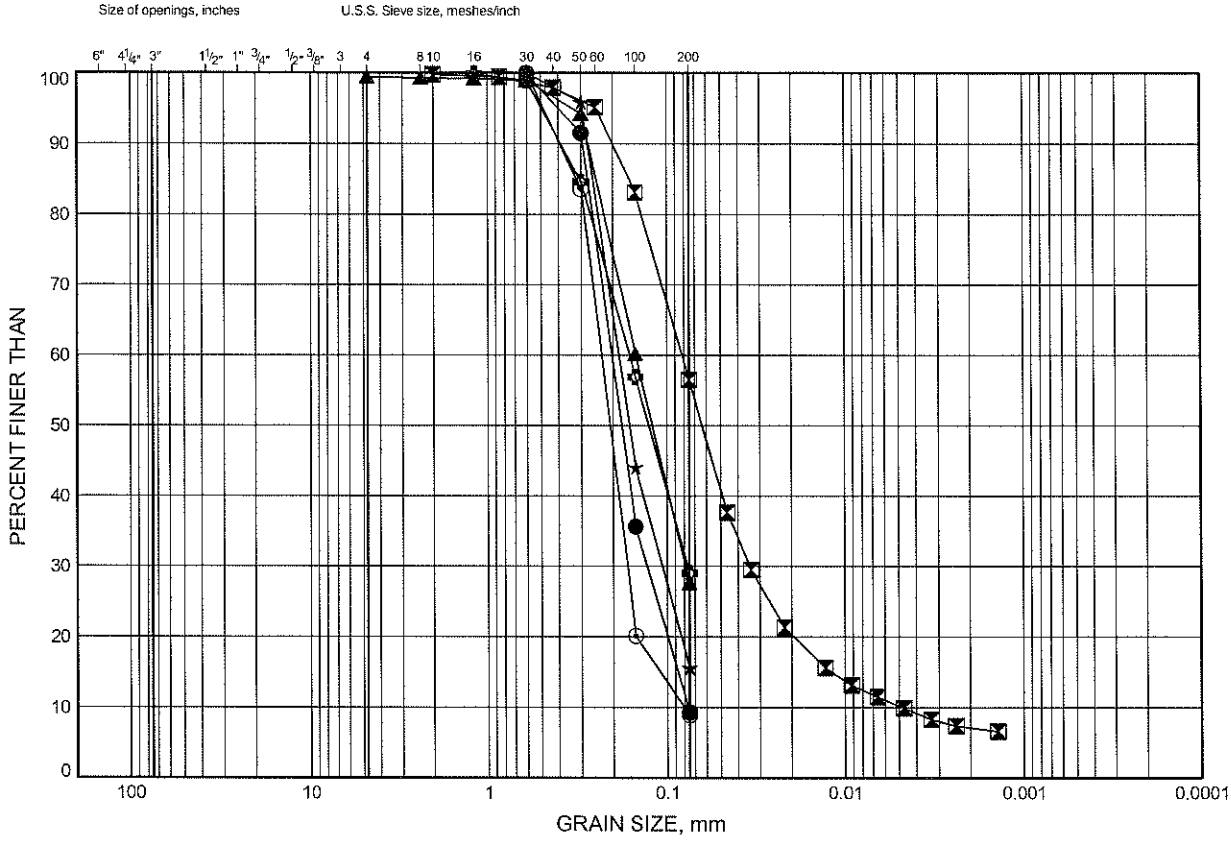
THURBGSD 5198.GPJ 05/12/06

Beatty Creek Bridge Replacement

GRAIN SIZE DISTRIBUTION

FIGURE B11

SAND TO SAND AND SILT



COBBLE SIZE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT and CLAY
	GRAVEL		SAND			FINE GRAINED

SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	06-M10	12.50	184.10
⊠	06-M10	24.69	171.91
▲	06-M10	30.18	166.42
★	06-M11	15.54	182.36
⊙	06-M13	16.46	180.24
✿	06-M13	25.60	171.10

Date November 2007

Project 5460-04-00

THURBER

Prep'd MFA

Chkd. MRA

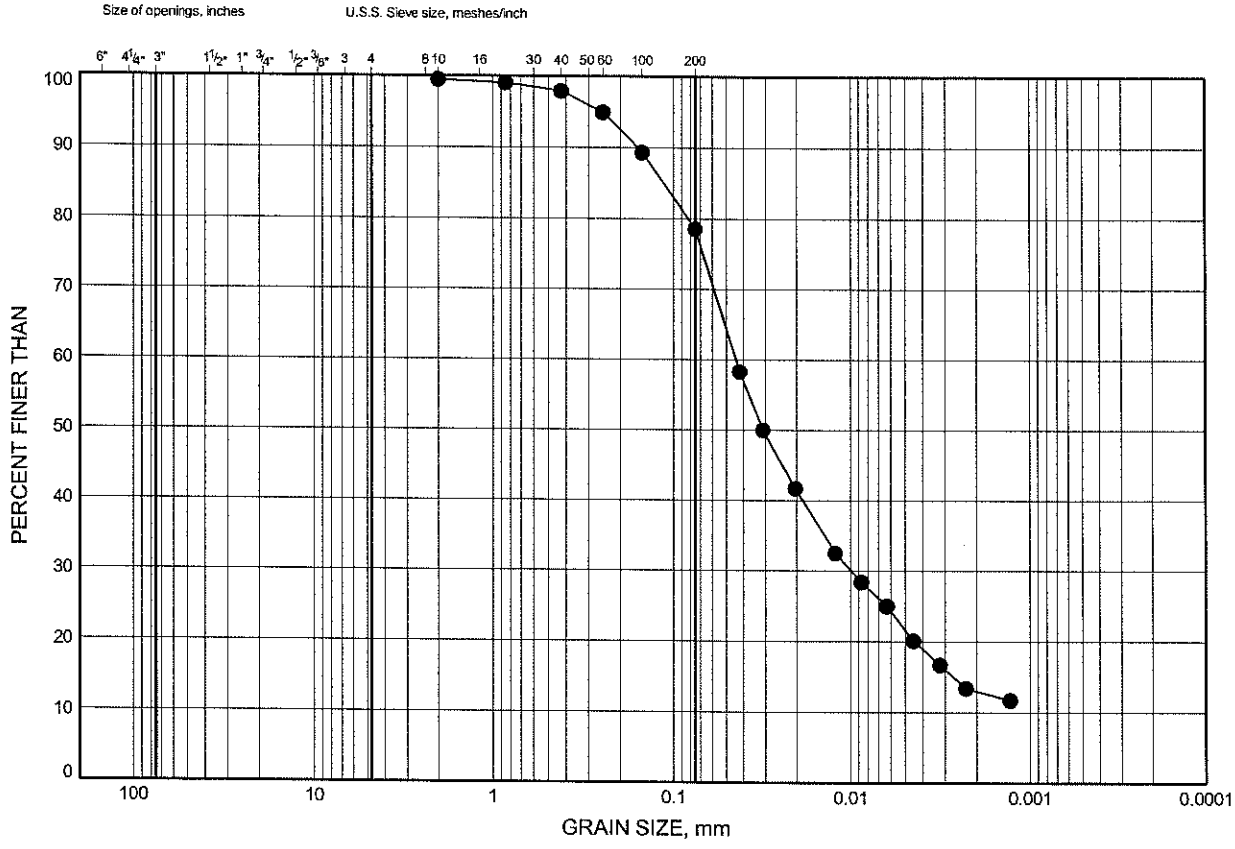
THURBGSD 5198.GPJ 11/2/07

Mindemoya Lake Bridge and Dam

GRAIN SIZE DISTRIBUTION

FIGURE B12

LOWER SILT



COBBLE SIZE	GRAVEL		SAND			SILT and CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	FINE GRAINED

SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	06-M01	27.74	169.16

Date December 2006

Project 5460-04-00

THURBER

Prep'd MFA

Chkd. MRA

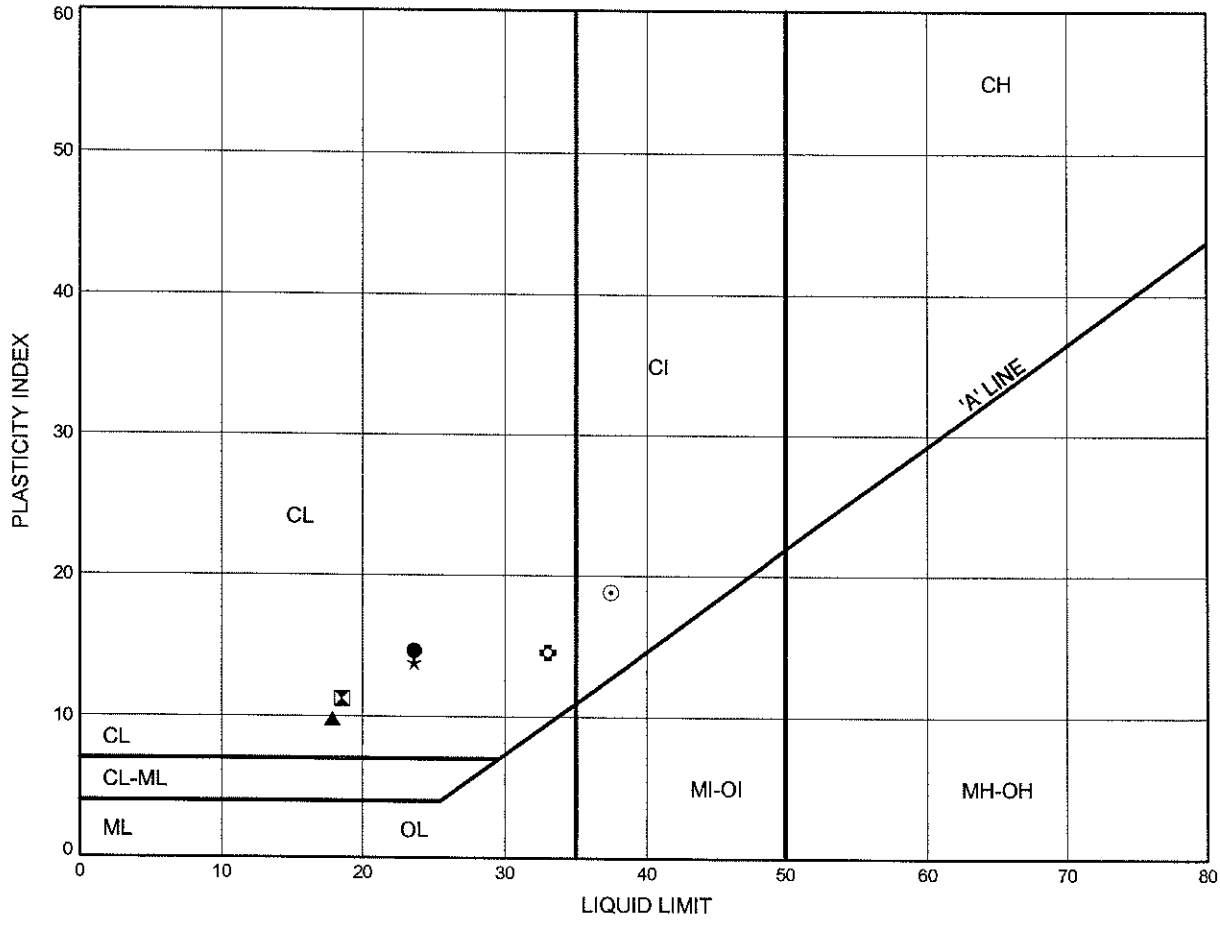
THURBGSD 5198.GPJ 05/12/06

Mindemoya Lake Bridge and Dam

ATTERBERG LIMITS TEST RESULTS

FIGURE B13

SILTY CLAY



SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	06-M01	3.35	193.55
⊠	06-M03	4.88	193.22
▲	06-M04	4.88	193.12
★	06-M07	7.62	190.18
⊙	06-M08	6.10	191.91
✿	06-M09	7.62	190.08

Date December 2006

Project 5460-04-00

THURBER

Prep'd MFA

Chkd. MRA

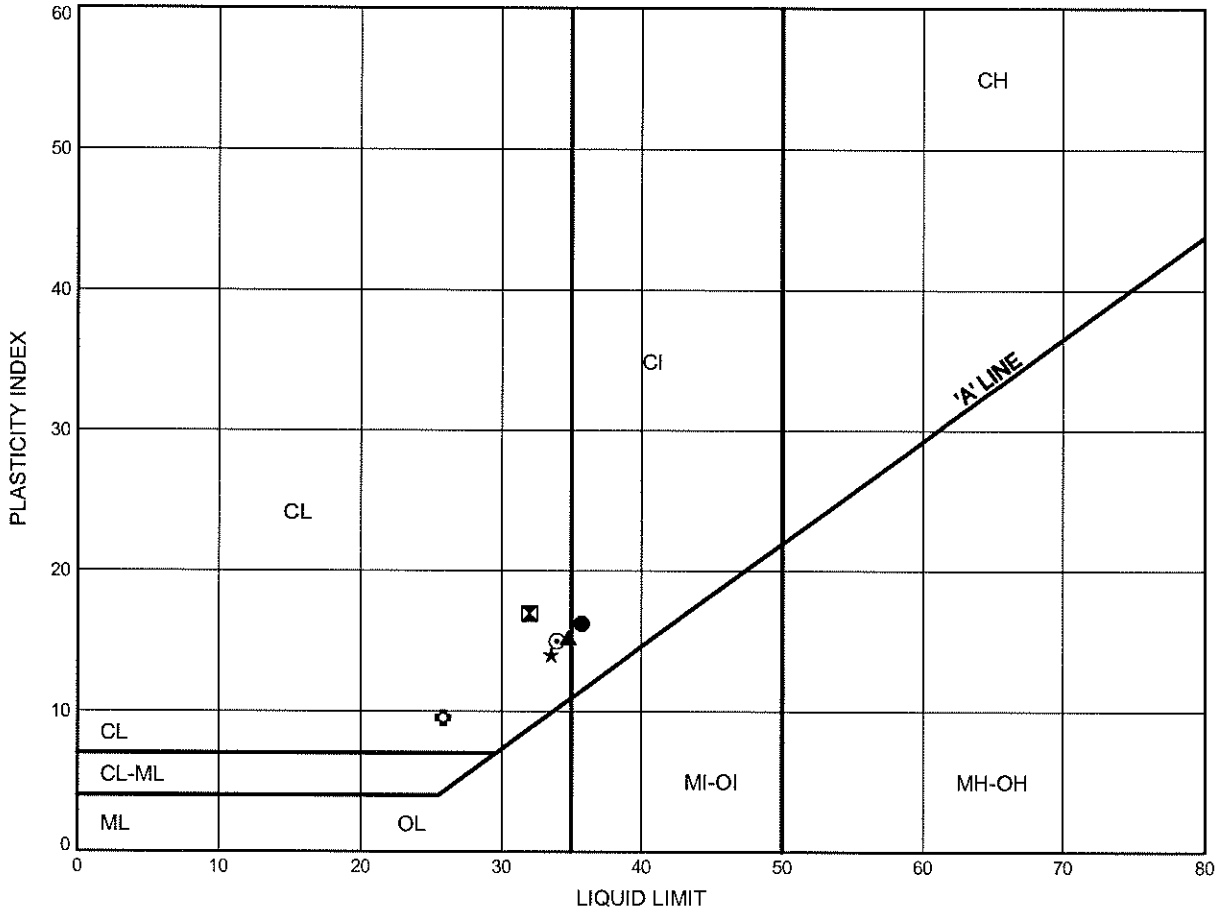
THURBALT 5198.GPJ 05/12/06

Mindemoya Lake Bridge and Dam

ATTERBERG LIMITS TEST RESULTS

FIGURE B14

SILTY CLAY



SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	06-M10	3.35	193.25
⊠	06-M11	4.88	193.02
▲	06-M12	3.35	194.45
★	06-M13	3.35	193.35
⊙	06-M14	3.35	194.35
✿	06-M14	7.62	190.08

Date November 2007

Project 5460-04-00

THURBER

Prep'd MFA

Chkd. MRA

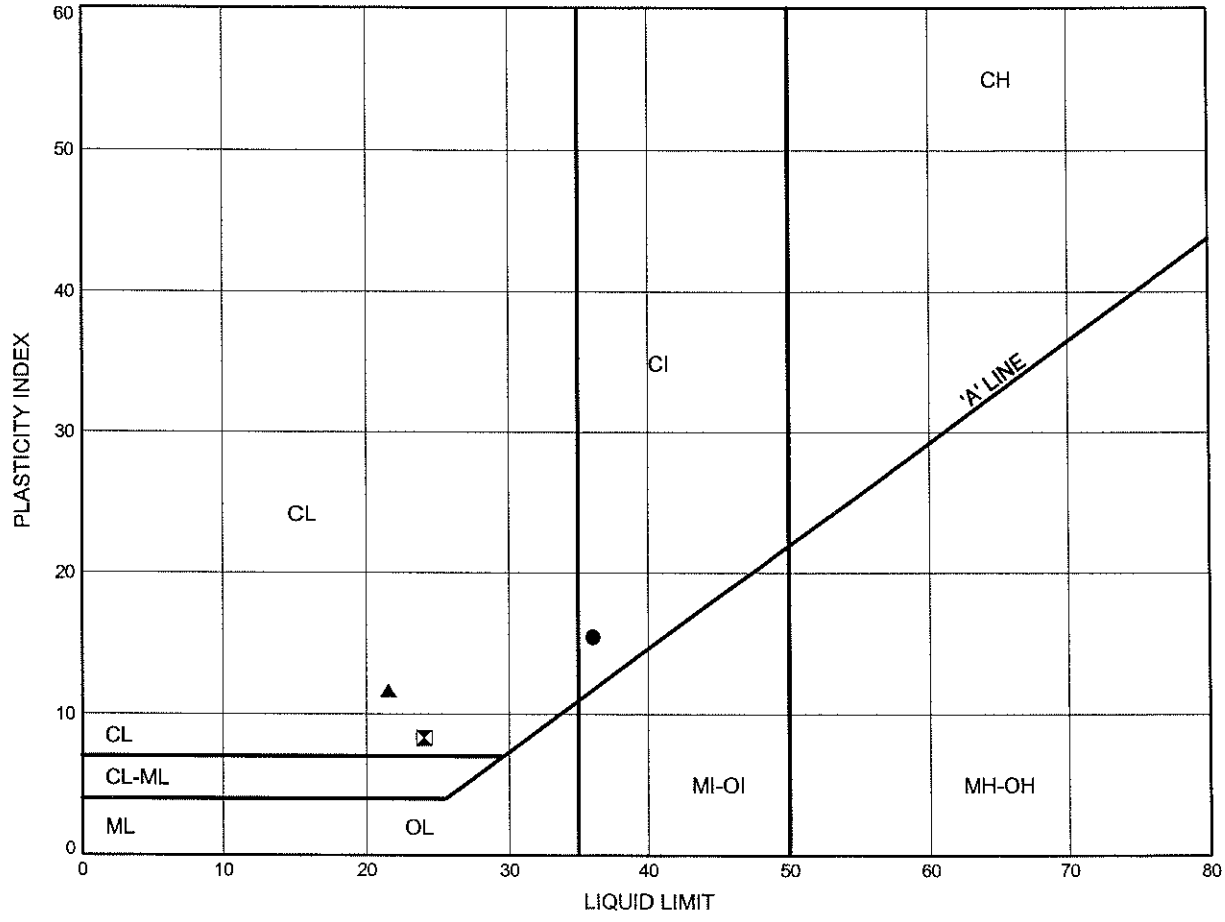
THURBALT 5198-MINDEMOYA.GPJ 15/11/07

Mindemoya Lake Bridge and Dam

ATTERBERG LIMITS TEST RESULTS

FIGURE B15

SILTY CLAY



SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	06-M15	2.59	195.21
⊠	06-M15	7.62	190.18
▲	06-M15	10.67	187.13

Date December 2006

Project 5460-04-00

THURBER

Prep'd MFA

Chkd. MRA

THURBALT 5198.GPJ 05/12/06

Appendix C

Photographs, Figures and Tables

Photograph 1: Existing dam control structure and pool (July 2006).

Photograph 2: Mindemoya River and pool (September 2007).

Photograph 3: Lake side of Highway 542 bridge, looking west (September 2007).

Photograph 4: Lake side of existing Highway 542 bridge, looking east (September 2007).

TABLE C1 – PIEZOMETER AND MONITORING WELL DETAILS

Location	Tip Position (m)		Completion Details
	Depth	Elevation	
BH06-M03	35.1	163.0	Sand filter and screen from 35.1 to 32.9 m, bentonite seal to 31.7 m, grout to 4.6 m, bentonite to surface.
BH06-M04	37.7	160.3	Sand filter and screen from 37.7 to 35.4 m, bentonite seal to 34.7, grout to 2.7 m, bentonite to surface.
BH06-M09	20.1	177.6	Sand filter and screen from 20.1 to 17.7 m, bentonite seal to 14.9 m, grout to 3.0 m, bentonite to surface.
BH06-M10	32.0	164.6	Sand filter and screen from 32.0 to 30.2 m, bentonite seal to 29.6 m, grout to 5.5 m, bentonite to surface.
BH06-M13	32.6	164.1	Sand filter and screen from 32.6 to 30.8 m, bentonite seal to 29.9 m, grout to 4.6 m, bentonite to surface.
BH06-M14	20.1	177.6	Sand filter and screen from 20.1 to 17.7 m, bentonite seal to 16.8 m, grout to 2.1 m, bentonite to surface.
BH07-M3	2.3	195.7	Bentonite from 13.1 to 3.0 m, bentonite seal to 2.7 m, sand filter and screen from 2.7 to 0.7 m, bentonite seal to 0.4 m, cement to 0.2 m, sand to 0.1 m, asphalt to surface.
	4.6	193.4	Sand filter and screen from 4.6 to 2.7 m, bentonite seal to 1.9 m, grout to 0.9 m, bentonite seal to 0.3 m, sand to 0.15 m, asphalt to surface.
	7.6	190.4	Sand filter and screen from 7.6 to 5.7 m, bentonite seal to 4.9 m, grout to 0.9 m, bentonite seal to 0.3 m, cement to 0.15 m, sand to 0.08 m, asphalt to surface.
BH07-M4	2.2	195.8	Grout from 13.2 to 3.0 m, bentonite seal to 2.5 m, sand filter and screen from 2.5 to 0.6 m, bentonite seal to 0.25 m, cement to 0.1 m, sand to 0.05 m, asphalt to surface.
BH07-M6	7.6	189.4	Sand filter and screen from 7.6 to 5.8 m, bentonite seal to 4.9 m, grout to 0.9 m, bentonite to surface.
	12.5	184.5	Grout from 37.2 to 13.1 m, bentonite seal to 12.5 m, sand filter and screen from 12.5 to 10.7 m, bentonite seal to 9.8 m, grout to 0.9 m, bentonite to surface.
BH07-M7	7.6	187.6	Grout from 30.2 to 8.5 m, bentonite seal to 7.6 m, sand filter and screen from 7.6 to 5.8 m, bentonite seal to 4.9 m, grout to 0.9 m, bentonite to surface
BH07-M11	15.2	181.6	Sand filter and screen from 15.2 to 13.4 m, bentonite seal to 12.2 m, grout to 0.9 m, bentonite to surface
BH07-M14	7.6	189.2	Grout from 33.8 to 8.5 m, bentonite seal to 7.6 m, sand filter and screen from 7.6 to 5.8 m, bentonite seal to 4.9 m, grout to 0.9 m, bentonite to surface
BH07-M15	16.8	178.6	Grout from 35.1 to 18.3 m, bentonite seal to 16.8 m, sand filter and screen from 16.8 to 14.9 m, bentonite seal to 14.0 m, grout to 0.9 m, bentonite to surface

TABLE C2: COMPARISON OF FOUNDATION ALTERNATIVES

Footings on Native Soil	Footings on Engineered Fill	Driven Piles	Caissons
Advantages: i. Ease of construction. ii. Allows choice of semi-integral or conventional abutment. iii. Lower cost than deep foundations. *Disadvantages:* i. Low geotechnical resistance available on native soil at this site. ii. Potential for post-construction settlement. iii. May require increased bridge span and/or increased abutment height. iv. Excavation within existing dam embankment fill below lake and groundwater level. **NOT RECOMMENDED**	*Advantages:* i. Would permit use of higher geotechnical resistance than is available on the native soil. ii. Allows choice of semi-integral or conventional abutment. iii. Allows use of perched abutments. iv. Lower cost than deep foundations. *Disadvantages:* i. Cost of constructing engineered fill. v. Potential for post-construction settlement. vi. May require increased bridge span and/or increased abutment height. ii. Excavation within existing dam embankment fill below lake and groundwater level. **NOT RECOMMENDED**	*Advantages:* i. Piles will develop high geotechnical resistance if driven to refusal on bedrock. ii. Construction of piles could continue in freezing weather. iii. Allows choice of integral, semi-integral or conventional abutment design. iv. Readily installed. v. Bridge span can be minimized. *Disadvantages:* i. Higher unit costs than footings. ii. Possibility that cobbles and boulders or rockfill may be encountered in existing embankment fill or native soil above bedrock. **RECOMMENDED**	*Advantages:* i. High resistance is available for caissons founded on bedrock. ii. Construction of caissons could continue in freezing weather. iii. Choice of semi-integral or conventional abutment design. *Disadvantages:* i. Significant depth to bedrock bearing stratum. ii. Steel liner will be required to support caisson excavation sidewalls and reduce seepage into caisson excavation below groundwater level. iii. Possibility of boulders or rockfill being encountered during augering. iv. Difficulty excluding seepage and flow of soil under rim of liner. **NOT RECOMMENDED**

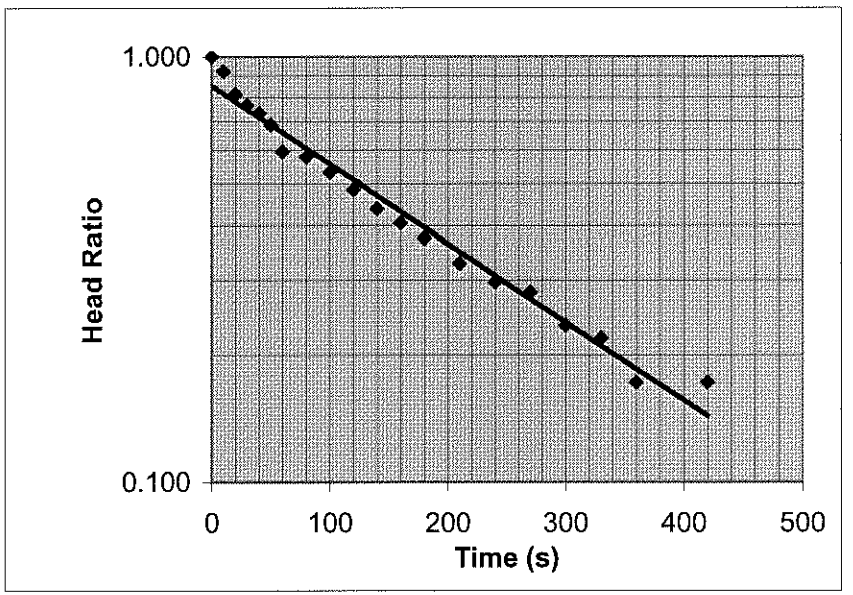
Determination of Hydraulic Conductivity from a Piezometer (Hvorslev Time-Lag Method)

Instructions:
Enter field data in blue cells
Determine Time lag from graph and enter in green cell
Hydraulic Conductivity Calculated in pink cell

Project Number:	19-1351-98
Borehole Number:	07-M3-2
Date of Test:	29-Aug-07
Technician:	GA
Static Water Level Depth:	1.34 m
Well Depth:	2.7 m
Height of Water in Well (H):	1.36 m

Test Data

Time (sec.)	Depth to Water (m)	Height of Water in Well (h)	Head Ratio (H-h/H-ho)
0	0.70	2.00	1.000
10	0.75	1.95	0.922
20	0.82	1.88	0.813
30	0.85	1.85	0.766
40	0.87	1.83	0.734
50	0.90	1.80	0.688
60	0.96	1.74	0.594
80	0.97	1.73	0.578
100	1.00	1.70	0.531
120	1.03	1.67	0.484
140	1.06	1.64	0.438
160	1.08	1.62	0.406
180	1.10	1.60	0.375
210	1.13	1.57	0.328
240	1.15	1.55	0.297
270	1.16	1.54	0.281
300	1.19	1.51	0.234
330	1.20	1.50	0.219
360	1.23	1.47	0.172
420	1.23	1.47	0.172



Input Data

d=Inside Diameter of Piezometer	0.05 m
D=Diameter of Borehole	0.06 m
L=Length of Screen	2 m
To=Basic Time Lag (from graph) (time at head ratio = 0.37)	190 s

Calculation

Hydraulic Conductivity (K) = 3.45E-06 m/s

Assumptions:
L/R >4
Well diameter is constant

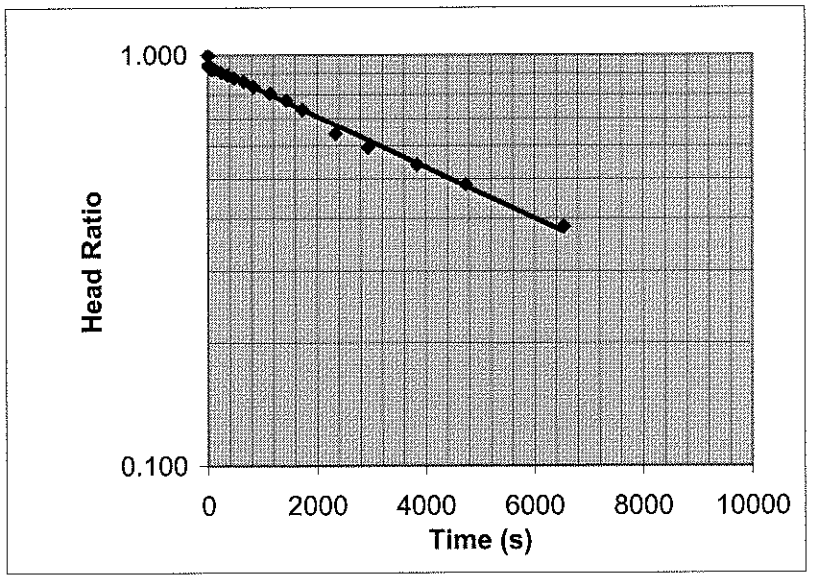
Determination of Hydraulic Conductivity from a Piezometer (Hvorslev Time-Lag Method)

Instructions:
Enter field data in blue cells
Determine Time lag from graph and enter in green cell
Hydraulic Conductivity Calculated in pink cell

Project Number:	19-1351-98
Borehole Number:	07-M3-5
Date of Test:	28-Aug-07
Technician:	GA
Static Water Level Depth:	1.26 m
Well Depth:	4.6 m
Height of Water in Well (H):	3.34 m

Test Data

Time (sec.)	Depth to Water (m)	Height of Water in Well (h)	Head Ratio (H-h/H-ho)
0	2.54	2.06	1.000
10	2.47	2.13	0.945
20	2.46	2.14	0.938
30	2.45	2.15	0.930
45	2.45	2.15	0.930
60	2.44	2.16	0.922
90	2.44	2.16	0.922
120	2.44	2.16	0.922
240	2.42	2.18	0.906
360	2.40	2.20	0.891
480	2.38	2.22	0.875
660	2.36	2.24	0.859
840	2.33	2.27	0.836
1140	2.29	2.31	0.805
1440	2.25	2.35	0.773
1740	2.20	2.40	0.734
2340	2.08	2.52	0.641
2940	2.02	2.58	0.594
3840	1.95	2.65	0.539
4740	1.88	2.72	0.484
6540	1.75	2.85	0.383



Input Data

d=Inside Diameter of Piezometer	0.05 m
D=Diameter of Borehole	0.2 m
L=Length of Screen	1.9 m
To=Basic Time Lag (from graph) (time at head ratio = 0.37)	6600 s

Calculation

Hydraulic Conductivity (K) = 7.34E-08 m/s

Assumptions:
L/R >4
Well diameter is constant

Determination of Hydraulic Conductivity from a Piezometer (Hvorslev Time-Lag Method)

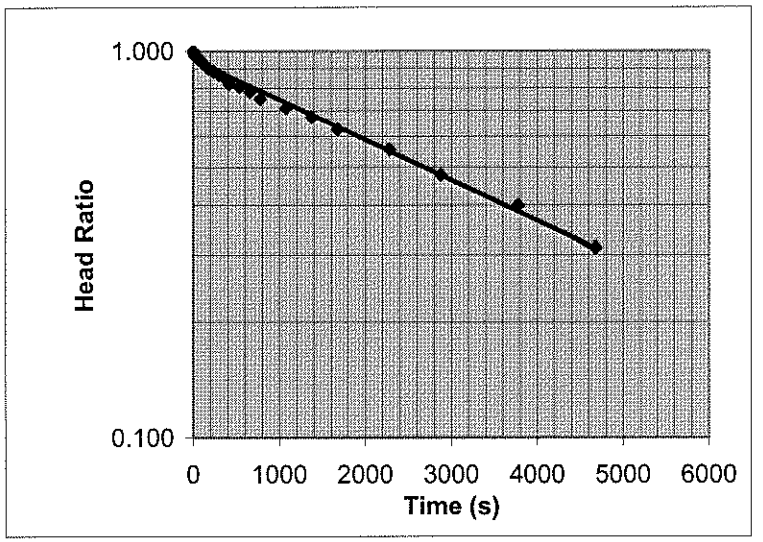
Instructions:
Enter field data in blue cells
Determine Time lag from graph and enter in green cell
Hydraulic Conductivity Calculated in pink cell

Project Number:	19-1351-98
Borehole Number:	07-M3-8
Date of Test:	28-Aug-07
Technician:	GA

Static Water Level Depth:	2.22 m
Well Depth:	7.6 m
Height of Water in Well (H):	5.38 m

Test Data

Time (sec.)	Depth to Water (m)	Height of Water in Well (h)	Head Ratio (H-h/H-ho)
0	0.94	6.66	1.000
10	0.95	6.65	0.992
20	0.97	6.63	0.977
30	0.98	6.62	0.969
40	0.99	6.61	0.961
60	1.00	6.60	0.953
90	1.01	6.59	0.945
120	1.03	6.57	0.930
150	1.05	6.55	0.914
180	1.07	6.53	0.898
240	1.09	6.51	0.883
300	1.11	6.49	0.867
360	1.13	6.47	0.852
420	1.17	6.43	0.820
540	1.19	6.41	0.805
660	1.22	6.38	0.781
780	1.26	6.34	0.750
1080	1.31	6.29	0.711
1380	1.36	6.24	0.672
1680	1.42	6.18	0.625
2280	1.51	6.09	0.555
2880	1.61	5.99	0.477
3780	1.71	5.89	0.398
4680	1.82	5.78	0.313



Input Data

d=Inside Diameter of Piezometer	0.05 m
D=Diameter of Borehole	0.2 m
L=Length of Screen	1.9 m
To=Basic Time Lag (from graph) (time at head ratio = 0.37)	4000 s

Calculation

Hydraulic Conductivity (K) = 1.21E-07 m/s

Assumptions:
L/R >4
Well diameter is constant

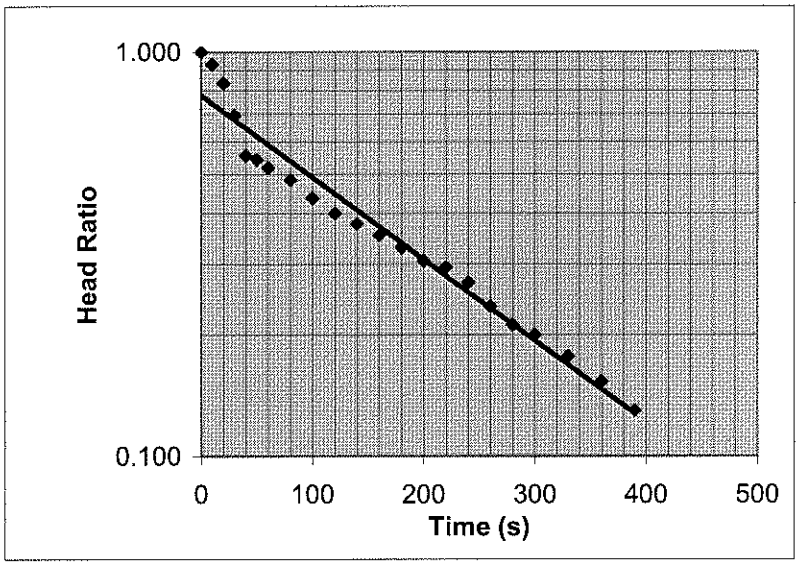
Determination of Hydraulic Conductivity from a Piezometer (Hvorslev Time-Lag Method)

Instructions:
Enter field data in blue cells
Determine Time lag from graph and enter in green cell
Hydraulic Conductivity Calculated in pink cell

Project Number:	19-1351-98
Borehole Number:	07-M4-2
Date of Test:	29-Aug-07
Technician:	GA
Static Water Level Depth:	1.32 m
Well Depth:	2.5 m
Height of Water in Well (H):	1.18 m

Test Data

Time (sec.)	Depth to Water (m)	Height of Water in Well (h)	Head Ratio (H-h/H-ho)
0	0.47	2.03	1.000
10	0.53	1.97	0.929
20	0.61	1.89	0.835
30	0.73	1.77	0.694
40	0.85	1.65	0.553
50	0.86	1.64	0.541
60	0.88	1.62	0.518
80	0.91	1.59	0.482
100	0.95	1.55	0.435
120	0.98	1.52	0.400
140	1.00	1.50	0.376
160	1.02	1.48	0.353
180	1.04	1.46	0.329
200	1.06	1.44	0.306
220	1.07	1.43	0.294
240	1.09	1.41	0.271
260	1.12	1.38	0.235
280	1.14	1.36	0.212
300	1.15	1.35	0.200
330	1.17	1.33	0.176
360	1.19	1.31	0.153
390	1.21	1.29	0.129



Input Data

d=Inside Diameter of Piezometer	0.05 m
D=Diameter of Borehole	0.06 m
L=Length of Screen	2 m
To=Basic Time Lag (from graph) (time at head ratio = 0.37)	160 s

Calculation

Hydraulic Conductivity (K) = 4.10E-06 m/s

Assumptions:
L/R >4
Well diameter is constant

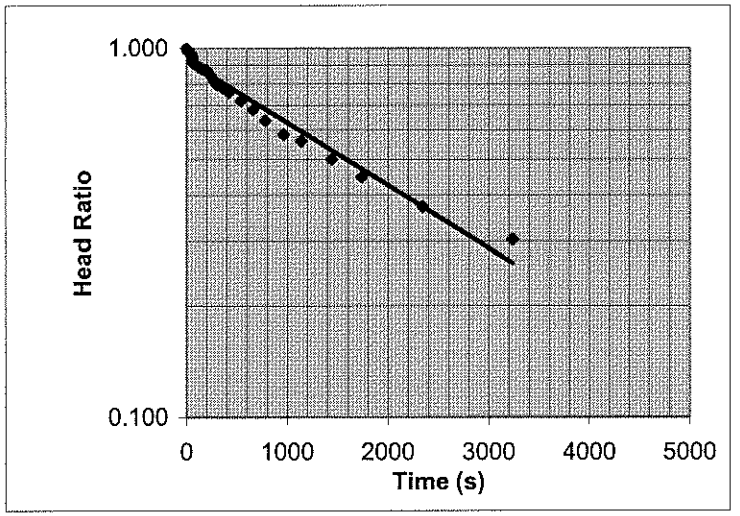
Determination of Hydraulic Conductivity from a Piezometer (Hvorslev Time-Lag Method)

Instructions:
Enter field data in blue cells
Determine Time lag from graph and enter in green cell
Hydraulic Conductivity Calculated in pink cell

Project Number:	19-1351-98
Borehole Number:	07-M6-8
Date of Test:	28-Aug-07
Technician:	GA
Static Water Level Depth:	3.05 m
Well Depth:	7.6 m
Height of Water in Well (H):	4.55 m

Test Data

Time (sec.)	Depth to Water (m)	Height of Water in Well (h)	Head Ratio (H-h/H-ho)
0	1.73	5.87	1.000
10	1.74	5.86	0.992
20	1.76	5.84	0.977
25	1.77	5.83	0.970
50	1.78	5.82	0.962
60	1.80	5.80	0.947
70	1.85	5.75	0.909
90	1.85	5.75	0.909
120	1.88	5.72	0.886
150	1.89	5.71	0.879
180	1.90	5.70	0.871
210	1.91	5.69	0.864
240	1.94	5.66	0.841
270	1.97	5.63	0.818
300	2.00	5.60	0.795
360	2.02	5.58	0.780
420	2.05	5.55	0.758
540	2.10	5.50	0.720
660	2.15	5.45	0.682
780	2.21	5.39	0.636
960	2.28	5.32	0.583
1140	2.31	5.29	0.561
1440	2.39	5.21	0.500
1740	2.46	5.14	0.447
2340	2.56	5.04	0.371
3240	2.65	4.95	0.303



Input Data

d=Inside Diameter of Piezometer	0.05 m
D=Diameter of Borehole	0.2 m
L=Length of Screen	1.8 m
To=Basic Time Lag (from graph) (time at head ratio = 0.37)	2400 s

Calculation

Hydraulic Conductivity (K) = 2.09E-07 m/s

Assumptions:
L/R >4
Well diameter is constant

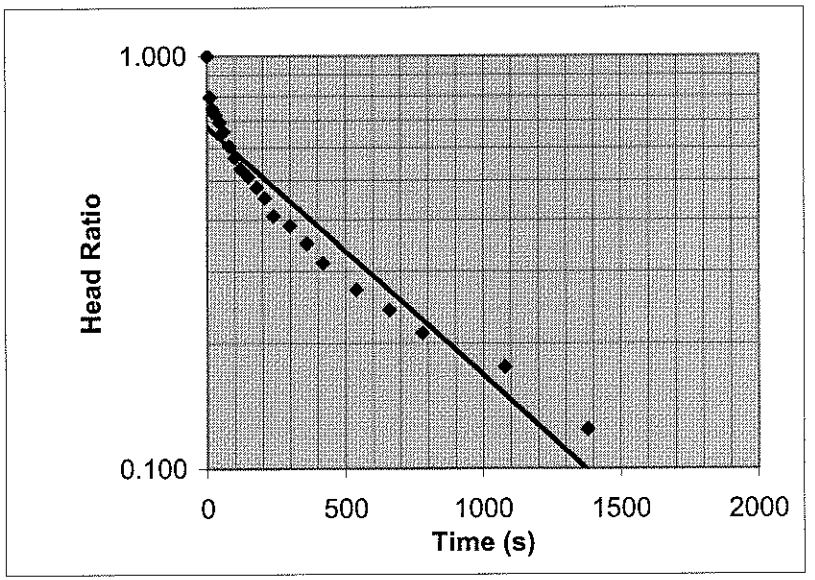
Determination of Hydraulic Conductivity from a Piezometer (Hvorslev Time-Lag Method)

Instructions:
Enter field data in blue cells
Determine Time lag from graph and enter in green cell
Hydraulic Conductivity Calculated in pink cell

Project Number:	19-1351-98
Borehole Number:	07-M6-12
Date of Test:	28-Aug-07
Technician:	GA
Static Water Level Depth:	3.48 m
Well Depth:	12.5 m
Height of Water in Well (H):	9.02 m

Test Data

Time (sec.)	Depth to Water (m)	Height of Water in Well (h)	Head Ratio (H-h/H-ho)
0	2.11	10.39	1.000
10	2.39	10.11	0.796
20	2.46	10.04	0.745
30	2.49	10.01	0.723
45	2.53	9.97	0.693
60	2.58	9.92	0.657
80	2.65	9.85	0.606
100	2.70	9.80	0.569
120	2.75	9.75	0.533
150	2.78	9.72	0.511
180	2.82	9.68	0.482
210	2.86	9.64	0.453
240	2.92	9.58	0.409
300	2.95	9.55	0.387
360	3.00	9.50	0.350
420	3.05	9.45	0.314
540	3.11	9.39	0.270
660	3.15	9.35	0.241
780	3.19	9.31	0.212
1080	3.24	9.26	0.175
1380	3.31	9.19	0.124



Input Data

d=Inside Diameter of Piezometer	0.05 m
D=Diameter of Borehole	0.2 m
L=Length of Screen	1.8 m
To=Basic Time Lag (from graph) (time at head ratio = 0.37)	450 s

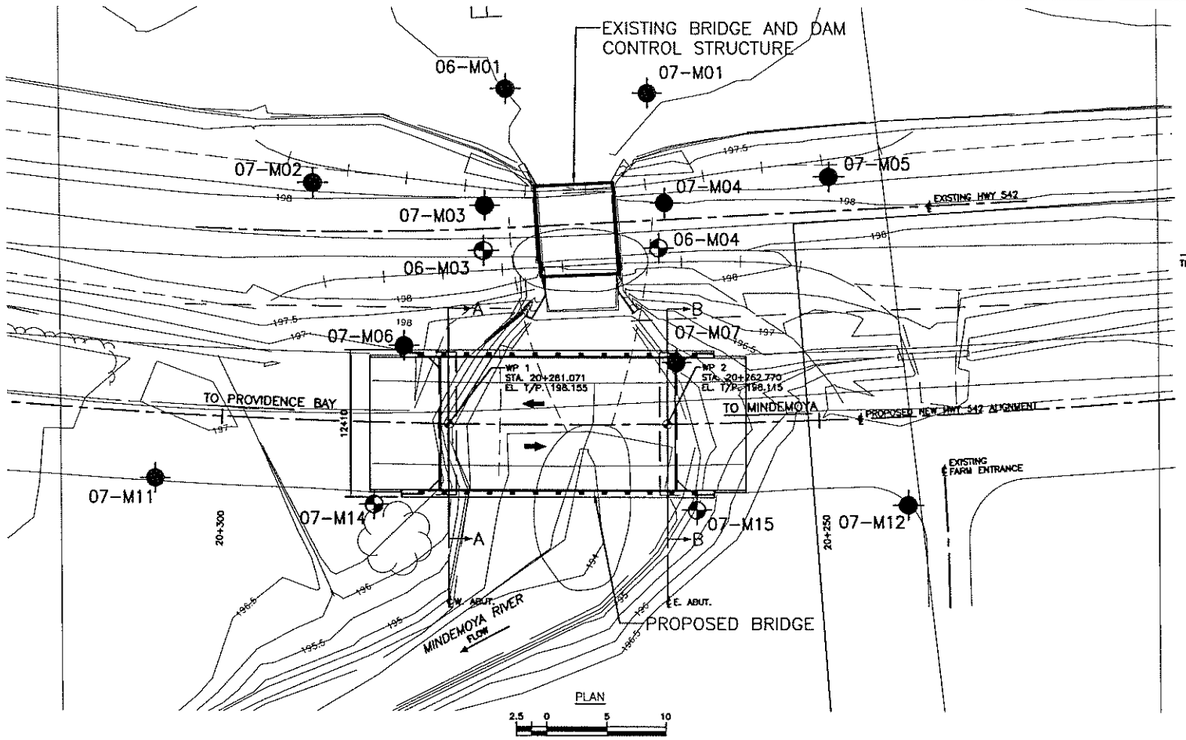
Calculation

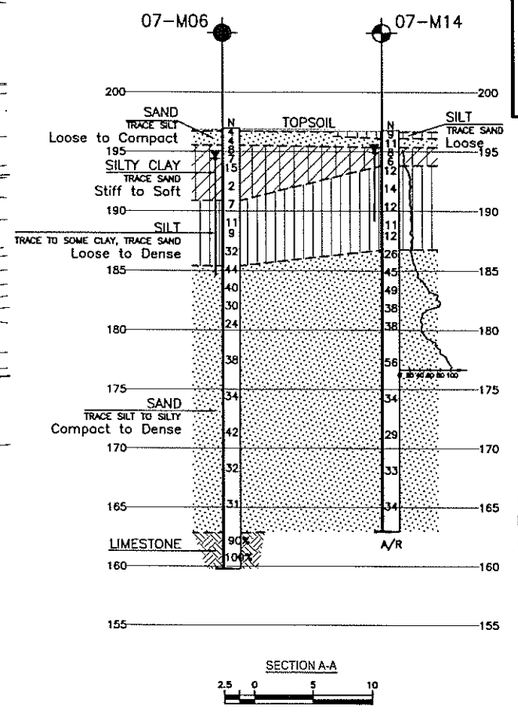
Hydraulic Conductivity (K) = 1.12E-06 m/s

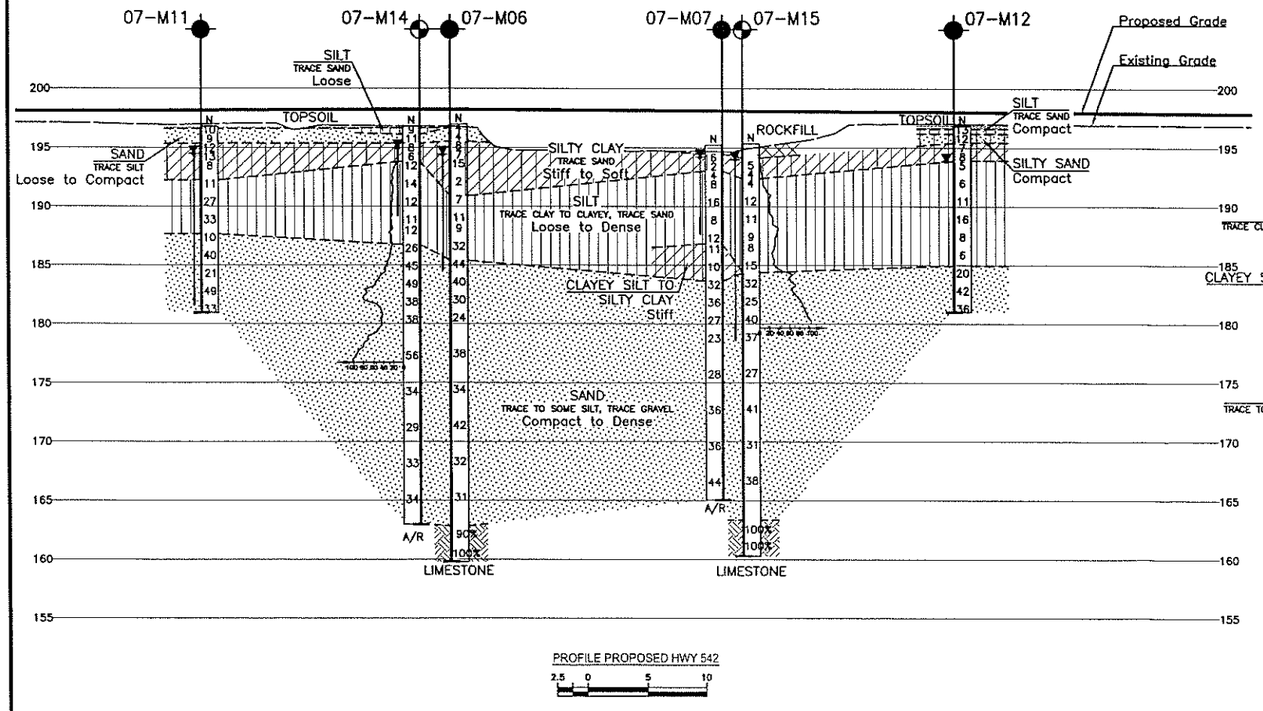
Assumptions:
L/R >4
Well diameter is constant

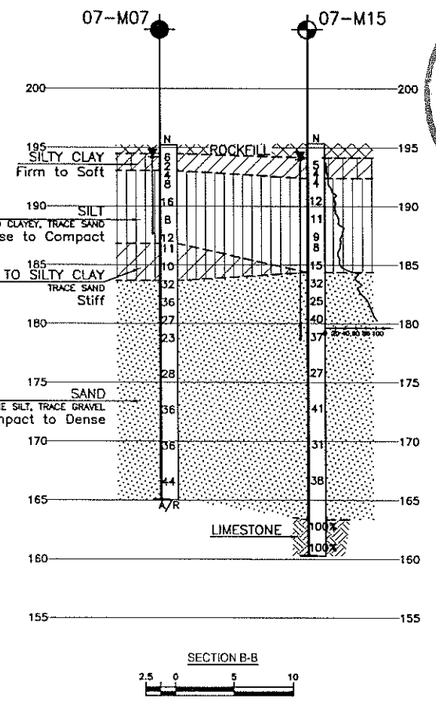
Appendix D

Borehole Locations and Soil Strata Drawings









METRIC

DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN

LICENSED PROFESSIONAL ENGINEER
M. R. ANDERSON
Jan 23/08
PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER
P. K. CHATTERJI
Jan 23/08
PROVINCE OF ONTARIO

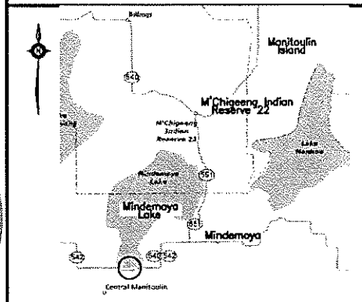
CONT No
GWP No.5460-04-00

SHEET

HIGHWAY 542
MINDEMOYA LAKE BRIDGE REPLACEMENT
BOREHOLE LOCATIONS AND SOIL STRATA

McCORMICK RANKIN CORPORATION

THURBER ENGINEERING LTD.
GEOTECHNICAL • ENVIRONMENTAL • MATERIALS



KEYPLAN

LEGEND

	Borehole
	Borehole and Cone
N	Blows /0.3m (Std Pen Test, 475J/blow)
CONE	Blows /0.3m (60° Cone, 475J/blow)
PH	Pressure, Hydraulic
	Water Level
	Head Artesian Water
	Piezometer
90%	Rock Quality Designation (RQD)
A/R	Auger Refusal

NO	ELEVATION	NORTHING	EASTING
07-M01	197.3	9876.7	9181.2
07-M02	197.9	9872.3	9152.5
07-M03	198.0	9868.8	9166.7
07-M04	198.0	9867.3	9181.6
07-M05	197.9	9868.0	9195.6
07-M06	197.0	9857.9	9158.6
07-M07	195.2	9853.9	9181.1
07-M11	196.8	9849.1	9136.6
07-M12	196.9	9839.7	9199.0
07-M14	196.8	9844.8	9154.5
07-M15	195.4	9841.3	9181.4
06-M01	196.9	9878.4	9169.6
06-M03	198.1	9865.0	9166.1
06-M04	198.0	9863.6	9180.7

-NOTES-

1) The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.
2) This drawing is for subsurface information only. Surface details and features are for conceptual illustration.

GEOCRES No. 41G-8

DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING

REVISIONS	DATE	BY	DESCRIPTION

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CREATED: JULY 06
MODIFIED:

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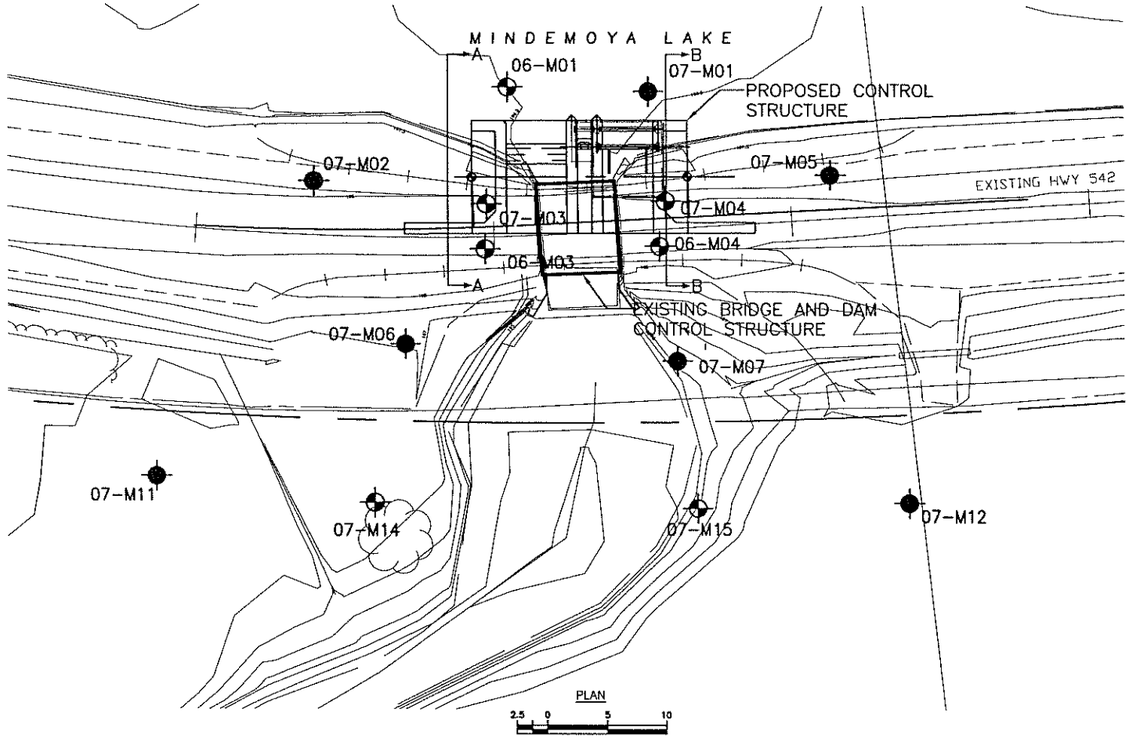
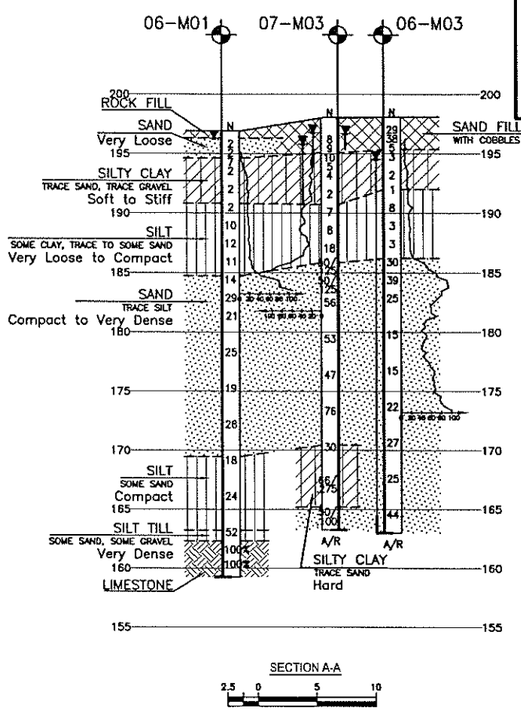
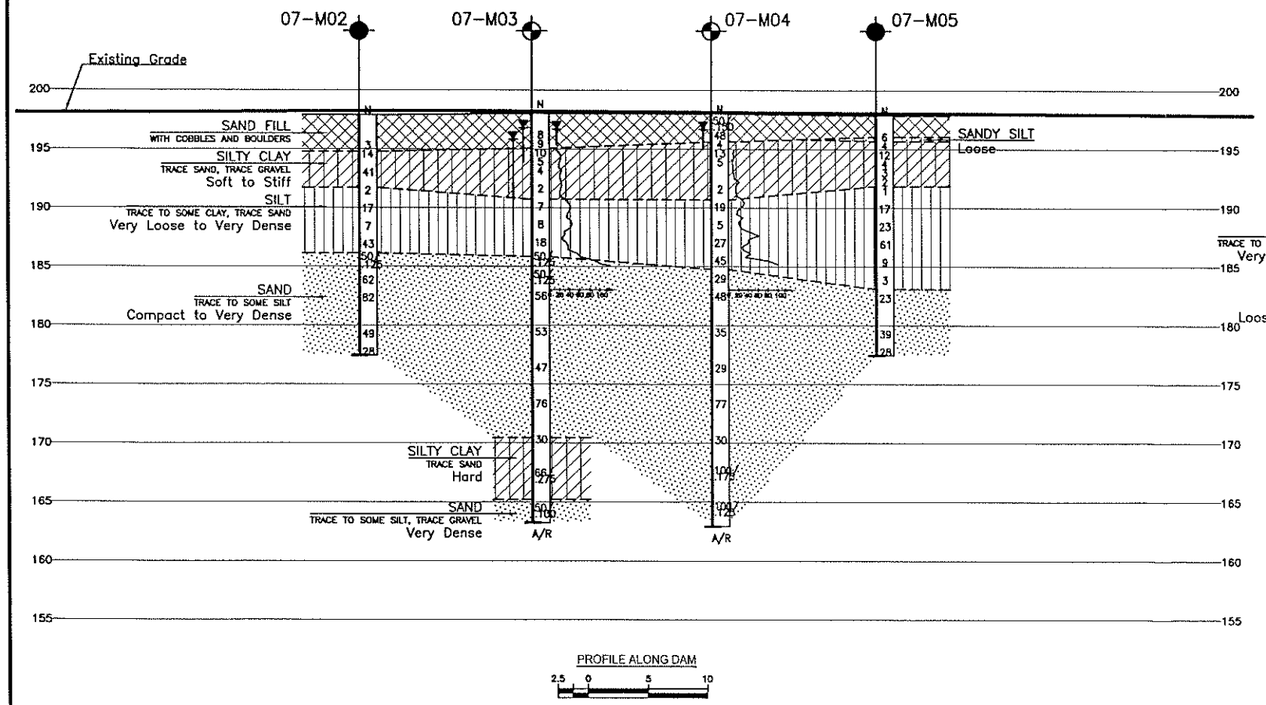
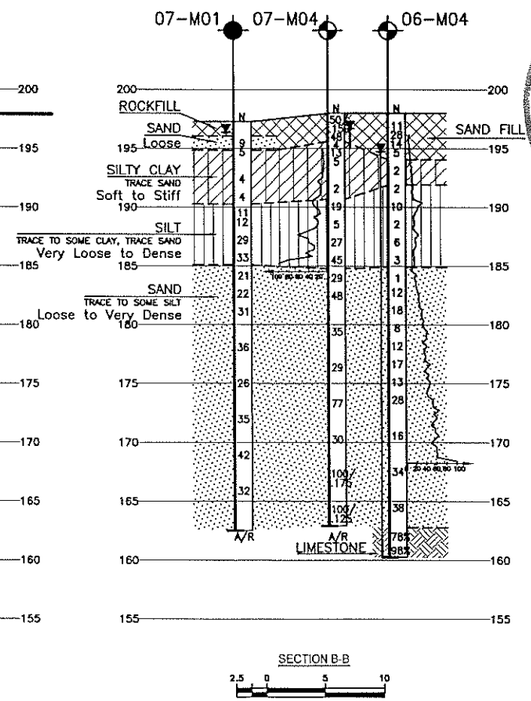
PLOTDATE: Jan 18, 2008 - 2:12pm

MINISTRY OF TRANSPORTATION, ONTARIO
PLOT SCALE 1:1
05-05
MI-A-707









DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING

METRIC

DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN

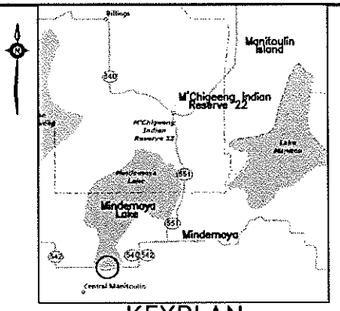
CONT No
GWP No.5460–04–00

SHEET

HIGHWAY 542
MINDEMOYA LAKE DAM
REPLACEMENT
BOREHOLE LOCATIONS AND SOIL STRATA

McCORMICK RANKIN CORPORATION

THURBER ENGINEERING LTD.



KEYPLAN

LICENSED PROFESSIONAL ENGINEER
M. R. ANDERSON
Jan 23/08
PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER
P. K. CHATTERJI
Jan 23/08
PROVINCE OF ONTARIO

LEGEND

	Borehole
	Borehole and Cone
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	Water Level
	Head Artesian Water
	Piezometer
90%	Rock Quality Designation (RQD)
A/R	Auger Refusal

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07–M15	195.4	9841.3	9181.4
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GEOCRES No. 41G-8

REVISIONS		
DATE	BY	DESCRIPTION

DESIGN	MRA	CHK	PKC	CODE		LOAD	DATE OCT 2007
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PLOT SCALE 1:1 | PW-0-707 | 98-26 | MINISTRY OF TRANSPORTATION, ONTARIO

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PLOTDATE: Jan 18, 2008 – 2:22pm

METRIC

DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN

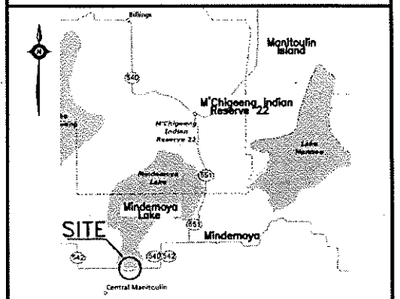
CONT No
GWP No.5460-04-00

SHEET

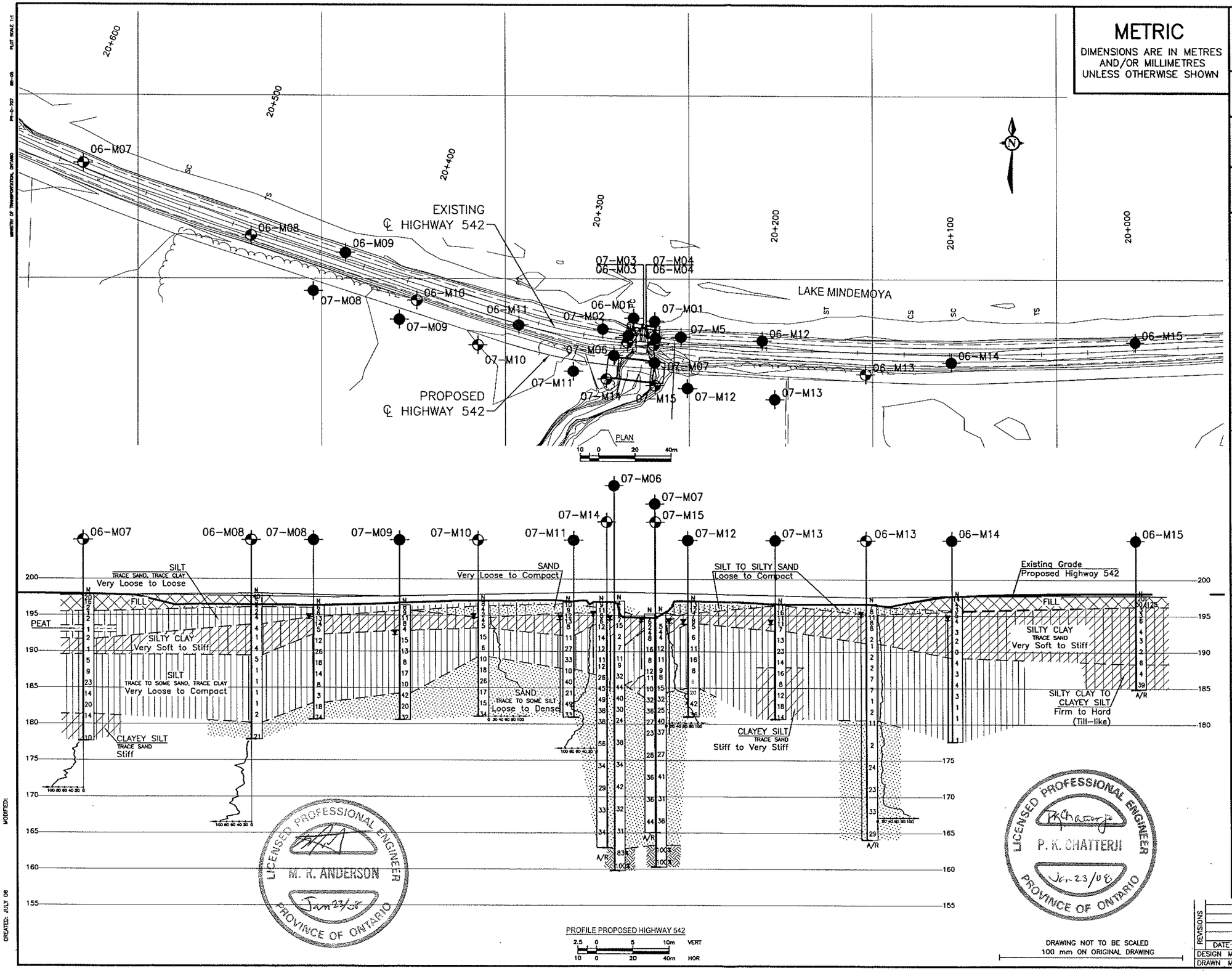
HIGHWAY 542
MINDEMOYA LAKE BRIDGE AND DAM
BOREHOLE LOCATIONS AND SOIL STRATA

McCORMICK RANKIN CORPORATION

THURBER ENGINEERING LTD.



KEYPLAN



LEGEND

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	Borehole and Cone
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07-M06	197.0	9857.9	9158.6
07-M07	195.2	9853.9	9181.1
07-M08	196.3	9893.2	8995.4
07-M09	196.4	9877.6	9042.1
07-M10	196.9	9863.6	9084.9
07-M11	196.8	9849.1	9136.6
07-M12	196.9	9839.7	9199.0
07-M13	196.5	9833.7	9246.4
07-M14	196.8	9844.8	9154.5
07-M15	195.4	9841.3	9181.4
06-M07	197.8	9963.0	8870.2
06-M08	198.0	9923.5	8961.3
06-M13	196.7	9847.6	9296.2
06-M14	197.7	9854.2	9342.9
06-M15	197.8	9865.5	9443.1

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REVISIONS		
DATE:	BY	DESCRIPTION

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