FOUNDATION INVESTIGATION AND DESIGN REPORT
NAISCOOT LAKE BRIDGE – SBL STRUCTURE
HIGHWAY 69 FOUR-LANING
FROM THE SOUTH JUNCTION OF HIGHWAY 529, NORTHERLY 15 KM
G.W.P 5076-06-00, W.P. 5198-06-01, SITE NO. 44-449/2

Geocres Number: 41 H-93

Report to

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PART 1: FACTUAL INFORMATION

1 INTRODUCTION

This report presents the factual findings obtained from a foundation investigation conducted at the location of the proposed bridge carrying Highway 69 southbound lanes (SBL) over Naiscoot Lake. The proposed bridge is part of the four-laning of Highway 69 from the south junction of Highway 69 and Highway 529 northerly for 15 km.

The purpose of this investigation was to explore the subsurface conditions at the site and, based on the data obtained, to provide a borehole location plan, records of boreholes, stratigraphic profile and cross-sections, laboratory test results and written descriptions of the subsurface conditions. A model of the subsurface conditions was developed from the data obtained in the course of the investigation.

Thurber carried out the investigation as a sub-consultant to MMM Group Limited (MMM), under the Ministry of Transportation Ontario (MTO) Agreement Number 5006-E-0030.

2 SITE DESCRIPTION

The site of the proposed structure is located approximately 3.9 km north of the intersection of Highway 529 and Highway 69. The proposed structure lies approximately 45 m east of the existing structure that carries Highway 69 over Naiscoot Lake. The new structure at this location will carry Highway 69 SBL over Naiscoot Lake as well as Flicker Trail (located on the south shore) and Teal Trail (located on the north shore).

At the location of the proposed Naiscoot Lake SBL structure the lake is approximately 115 m wide. The water level in the lake was measured at Elevation 182.07 in August 2010.

The south lake shore slope is approximately 11 m high and the north lake shore slope is approximately 15 m high. The lake shore slopes are generally well treed, with grass and shrubs along the river banks and in the open areas. In places, bedrock is exposed at surface at the lake shore. Site Photos are included in Appendix F

The lands surrounding the site are generally undeveloped forested land with open swamps. Bedrock outcroppings, ridges and small creeks/water bodies are visible along the existing Highway 69 corridor.

The site lies within the physiographic region known as the Georgian Bay Fringe, which covers Parry Sound and Muskoka. The region is characterized by very shallow overburden and bare rock knobs and ridges. Bedrock is exposed in many areas and intermittent swamps were filled in when glacial lake Algonquin inundated the area. The overburden materials consist of sand, silt and clay. Recent organic deposits of peat and muck occur in abundance in the bedrock hollows and valleys.

The area is underlain by strongly foliated and highly to moderately deformed rocks of Precambrian age of the following types:

- Gneisses of metasedimentary origin.
- Migmatitic rocks and gneisses.
- Felsic igneous rocks (tonalite, granodiorite, monzonite, granite, syenite, derived gneisses).
- Tectonite unit (tectonites, various gneisses).

3 SITE INVESTIGATION AND FIELD TESTING

The site investigation and field testing for this project was carried out in two phases. The first phase was carried out from January 13 to 28, 2010 and the second phase was carried out from August 10 to 18, 2010.

Phase 1 of the site investigation consisted of drilling and sampling a total of 24 boreholes located at the proposed foundation elements of the Naiscoot Lake SBL structure that are located on land (South Abutment, Pier 1, Pier 3, and North Abutment). These boreholes are identified as BH10-01 to 06, BH10-13 to 18, BH10-25 to 30 and BH10-37 to 42.

Phase 2 of the site investigation consisted of drilling and sampling 12 boreholes located at the approximate location of Pier 2 of the Naiscoot Lake SBL structure, which is located in the lake. These boreholes are identified as NL10-01 to NL10-12.

Borehole advancement within the overburden on land generally ranged from 0 m to 1.5 m where the drill rig encountered refusal, while borehole advancement within the lake bed deposits generally ranged from 0.6 m to 3.4 m below the top of the lake bed prior to refusal. Bedrock outcrops and very shallow bedrock (less than 0.1 m depth) were noted at the locations of Boreholes BH10-02, BH10-16, BH10-18, BH10-27, and BH10-30. Twelve boreholes from Phase

1 and 6 boreholes from Phase 2 were advanced 2.8 to 3.4 m into bedrock by NQ or NQ2" size diamond coring.

The approximate borehole locations are shown on the drawing entitled "Borehole Locations and Soil Strata Drawing" included in Appendix E.

Prior to drilling, the borehole locations were marked in the field and all necessary utility clearances were obtained. At this site, utility location included the use of a dive team to locate the submerged Bell cable crossing the site and to attach buoys to it for future reference.

Access to the borehole locations on land proved to be difficult due to terrain and, as a result, a light tripod drill rig powered by a Hilti electric drill was mobilized. This equipment was adequate in view of the shallow overburden existing at this site. Similarly, accessing the borehole locations in Naiscoot Lake was difficult since travel from the local marina was obstructed by the existing highway bridge and loading from the lake shore would have involved unacceptable impacts on the lake shore. Accordingly, a small barge was mobilized and fitted with a light tripod drill powered by a Hilti DD-250. Soil samples were obtained using a split spoon sampler and bedrock coring was carried out in selected boreholes.

The drilling and sampling operations were supervised on a full time basis by a member of Thurber's technical staff. The supervisor logged the boreholes and processed the recovered soil and rock samples for transport to Thurber's laboratory for further examination and testing.

All rock cores were logged, and the Total Core Recovery (TCR), Rock Quality Designation (RQD) and the Fracture Indices (FI) were determined.

Groundwater conditions in the open boreholes were observed throughout the drilling operations. Four standpipe piezometers consisting of 25 mm PVC pipe with slotted screens were installed and enclosed in filter sand to permit longer term groundwater level monitoring. One piezometer was installed at the proposed location of each foundation element located on land. The locations and completion details of the piezometers are summarized in Table 3.1.

Table 3.1 – Borehole Completion Details

SBL Foundation Element	Borehole	Piezometer Tip Depth/ Elevation (m)	Completion Details
South Abutment	BH10-01	None installed	Borehole backfilled with cuttings to surface.
	BH10-02	None installed	Borehole backfilled with cuttings to surface.
	BH10-03	None installed	Borehole backfilled with bentonite to surface.
	BH10-04	3.2 / 186.5	Sand from 3.2 m to 1.3 m, bentonite from 1.3 m to surface.
	BH10-05	None installed	Borehole backfilled with bentonite to surface.
	BH10-06	None installed	Borehole backfilled with cuttings to surface.
Pier #1	BH10-13	3.6 / 181.8	Sand from 3.6 m to 1.5 m, bentonite from 1.5 m to surface.

SBL Foundation Element	Borehole	Piezometer Tip Depth/ Elevation (m)	Completion Details
	BH10-14	None installed	Borehole backfilled with bentonite to surface.
	BH10-15	None installed	Borehole backfilled with cuttings to surface.
	BH10-16	None installed	Bedrock at surface.
	BH10-17	None installed	Borehole backfilled with cuttings to surface.
	BH10-18	None installed	Borehole backfilled with bentonite to surface.
Pier #2	NL10-01	None installed	Borehole backfilled with bentonite to 6.1 m. Slough to lake bed surface.
	NL10-02	None installed	Slough to lake bed surface.
	NL10-03	None installed	Slough to lake bed surface.
	NL10-04	None installed	Borehole backfilled with bentonite to 5.2 m. Slough to lake bed surface.
	NL10-05	None installed	Slough to lake bed surface.
	NL10-06	None installed	Borehole backfilled with bentonite to 4.8 m. Slough to lake bed surface.
	NL10-07	None installed	Borehole backfilled with bentonite to 5.5 m. Slough to lake bed surface.
	NL10-08	None installed	Slough to lake bed surface.
	NL10-09	None installed	Borehole backfilled with bentonite to 5.2 m. Slough to lake bed surface.
	NL10-10	None installed	Slough to lake bed surface.
	NL10-11	None installed	Slough to lake bed surface.
	NL10-12	None installed	Borehole backfilled with bentonite to 4.3 m. Slough to lake bed surface.
Pier #3	BH10-25	3.9 / 180.0	Sand from 3.9 m to 2.1 m, bentonite from 2.1 m to surface.
	BH10-26	None installed	Borehole backfilled with cuttings to surface.
	BH10-27	None installed	Borehole backfilled with cuttings to surface.
	BH10-28	None installed	Borehole backfilled with cuttings to surface.
	BH10-29	None installed	Borehole backfilled with bentonite to surface.
	BH10-30	None installed	Borehole backfilled with bentonite to surface.
North Abutment	BH10-37	None installed	Borehole backfilled with cuttings to surface.
	BH10-38	4.1 / 189.4	Sand from 4.1 m to 2.3 m, bentonite from 2.3 m to surface.
	BH10-39	None installed	Borehole backfilled with bentonite to surface.
	BH10-40	None installed	Borehole backfilled with bentonite to surface.
	BH10-41	None installed	Borehole backfilled with cuttings to surface.
	BH10-42	None installed	Borehole backfilled with cuttings to surface.

4 LABORATORY TESTING

All recovered soil samples were subjected to Visual Identification (VI) and rock samples to geological logging. Moisture content determinations were carried out on all soil samples. Selected samples were also subjected to grain size distribution analyses (sieve and hydrometer) and Atterberg Limits testing where appropriate. The results of this testing program are summarized on the Record of Borehole sheets included in Appendix A and on the figures presented in Appendix B.

Point load tests were carried out in the laboratory on selected samples of intact bedrock to assist in evaluation of the compressive strength of the bedrock. The results of the point load tests performed on the rock core samples are summarized on the Record of Borehole sheets in Appendix A. The estimated UCS value recorded on the Record of Borehole sheets is the average value per core run.

5 DESCRIPTION OF SUBSURFACE CONDITIONS

Reference is made to the Record of Borehole sheets in Appendix A. Details of the encountered soil and rock stratigraphy are presented in these sheets and on the "Borehole Locations and Soil Strata" drawing in Appendix E. An overall description of the stratigraphy is given in the following paragraphs. However, the factual data presented in the Record of Borehole Sheets governs any interpretation of the site conditions.

In general terms, the overburden encountered in the boreholes drilled on land at this site consists of peat and/or thin layers of native sand overlying granitic gneiss bedrock. In one borehole a thin layer of cobbles and/or boulders was encountered below the sand, overlying bedrock. As well, in some locations bedrock was exposed at the surface. In the boreholes drilled in Naiscoot Lake, the lake bed deposits typically consist of very soft to soft silty clay to clayey silt, overlying sandy silt to silty sand overlying bedrock.

5.1 Overburden (Boreholes Drilled on Land)

5.1.1 Peat

Peat was encountered at surface in 20 of the 24 boreholes that were drilled on land for the SBL structure. In these boreholes the thickness of the peat ranged from 30 mm to 450 mm. The natural moisture content of the peat typically ranged from greater than 100% to over 350%. Lower moisture contents were measured for some peat samples and can likely be attributed to lower organic content.

It should be noted that the peat thickness may vary between and beyond the borehole locations and this data is not intended for the purpose of estimating quantities.

5.1.2 Sand

Of the 24 boreholes drilled on land for the SBL structure, sand was encountered at surface in 1 borehole and below a thin layer of peat in 8 boreholes. The sand was generally brown containing trace silt, occasional organics and rootlets, and trace gravel in some boreholes. Occasional cobbles and/ boulders were also encountered within the sand layer.

The thickness of the sand layer ranged from 0.1 to 1.4 m. The elevation of the bottom of the sand layer varied from Elevation 183.4 m to Elevation 195.1 m.

SPT N-values recorded in the sand layer generally ranged from 5 to 19 blows per 0.3 m penetration, indicating a loose to compact relative density. Several SPT N-values of 50 blows for less than 0.3 m penetration were also recorded in the sand layer. However, these values were typically recorded on cobbles or boulders or just above refusal and are not necessarily representative of the relative density of the sand.

The measured moisture contents of samples collected from the sand layer typically ranged from 10 to 50%. Higher moisture content values were measured for some sand samples, which can likely be attributed to higher organic content.

5.1.3 Cobbles and Boulders

A thin layer of cobbles and/or boulders was encounter in 1 borehole (BH10-25) below the sand layer and overlying bedrock. The thickness of the layer of cobbles and boulders at this location was 0.4 m and the bottom of this layer was recorded at Elevation 183.1 m.

5.2 Lake Bed Deposits (Boreholes Drilled in Naiscoot Lake)

5.2.1 Silty Clay to Clayey Silt

A layer of silty clay to clayey silt was encountered from the surface of the lake bed in 11 of the 12 boreholes drilled in Naiscoot Lake at the proposed location of Pier 2. The thickness of this layer ranged from 0.5 m to 1.4 m and the underside elevation of this layer ranged from Elevation 176.8 m to Elevation 177.9 m.

Very few SPT N-values were recorded in the silty clay to clayey silt layer as the split spoon sampler typically sank to the bottom of this layer, indicating a very soft consistency. An SPT N-value of 13 blows per 0.3 m penetration was recorded at one location (NL10-09), indicating a stiff consistency. A few SPT N-values of 50 blows for less than 0.3 m penetration were also recorded in this layer; however these high N-values were noted just above bedrock or refusal.

Selected samples of the silty clay to clayey silt underwent gradation and Atterberg Limits testing. The results of these tests are presented on the Record of Borehole sheets included in Appendix A and in Figures B1 and B3 of Appendix B. The test results are summarized below.

Soil Particles	(%)
Gravel	0 to 3
Sand	1 to 10
Silt	44 to 81
Clay	10 to 55

Index Property	(%)
Liquid Limit	41
Plastic Limit	18

5.2.2 Sandy Silt to Silty Sand

A layer of sandy silt to silty sand containing trace gravel and occasional cobbles was encountered below the silty clay to clayey silt layer in 9 boreholes and at the surface of the lake bed in one borehole. The thickness of the sandy silt to silty sand layer ranges from 0.2 m to 2.1 m, with the elevation of the bottom of this layer ranging from Elevation 175.0 m to Elevation 177.7 m.

SPT N-values recorded in the sandy silt to silty sandy layers ranged from 4 blows per 0.3 m penetration to 50 blows for less than 0.3 m penetration. This range in N-values indicates a loose to very dense relative density. Some N-values of 50 blows for less than 0.3 m penetration were recorded just above refusal or bedrock.

This moisture content of the sandy silt to silty sand samples typically ranged from 8 to 22%.

Selected samples of the sandy silt to silty sand were submitted for laboratory gradation testing. The results of these tests are presented on the Record of Borehole sheets in Appendix A and are summarized below. The grain size distribution curves for these samples are presented in Appendix B.

Soil Particle	Percentage (%)
Gravel	2 to 7
Sand	29 to 56
Silt	33 to 64
Clay	4 to 5

5.3 Bedrock

The overburden soils described above are underlain by granitic gneiss bedrock. The bedrock is slightly weathered to fresh. Occasional mechanical breaks as well as sub-horizontal and sub-vertical fractures were observed in the rock cores. Quartz veins were also noted in several cores.

Bedrock was encountered directly below a thin layer of peat in 12 of the 24 boreholes drilled on land. Bedrock was exposed at surface at the following three borehole locations; BH10-16, BH10-18, and BH10-30.

Bedrock was encountered at various depths and it was proved by coring in 3 boreholes near the location of each proposed foundation element on land (4) and in 6 boreholes near the location of Pier 2. Table 5.3 summarizes depths and elevations to the top of bedrock in the boreholes. Where coring was not carried out, bedrock was inferred from auger refusal.

Table 5.3 – Depths and Elevations of Top of Bedrock

SBL Foundation Element	Borehole	Bedrock Depth Below Ground Surface (m)	Bedrock Elevation (m)
SBL South Abutment	BH10-01	0.1	191.5
	BH10-02	0.02	191.4
	BH10-03	0.1	191.1*
	BH10-04	0.2	189.5*
	BH10-05	0.1	189.8*
	BH10-06	0.1	190.7
SBL Pier 1	BH10-13	0.5	185.0*
	BH10-14	1.5	183.8*
	BH10-15	0.6	185.7
	BH10-16	0.0	185.2
	BH10-17	0.4	184.1
	BH10-18	0.0	184.9*
SBL Pier 2	NL10-01	3.4**	175.0*
	NL10-02	2.2**	175.8
	NL10-03	0.8**	177.0
	NL10-04	0.6**	176.8*
	NL10-05	2.4**	176.2
	NL10-06	1.1**	177.3*
	NL10-07	1.9**	176.3*
	NL10-08	1.4**	176.5
	NL10-09	1.9**	176.9*
	NL10-10	1.5**	177.0
	NL10-11	0.7**	177.7
	NL10-12	0.6**	177.5*
SBL Pier 3	BH10-25	0.9	183.1*
	BH10-26	0.2	183.7
	BH10-27	0.02	184.0
	BH10-28	0.2	185.8
	BH10-29	0.4	186.3*
	BH10-30	0.0	187.2*

SBL Foundation Element	Borehole	Bedrock Depth Below Ground Surface (m)	Bedrock Elevation (m)
SBL North Abutment	BH10-37	0.2	192.6
	BH10-38	1.0	192.4*
	BH10-39	0.1	194.0*
	BH10-40	1.3	193.4*
	BH10-41	0.2	195.1
	BH10-42	1.1	195.1

* Bedrock proved by coring techniques.
** Depth to bedrock measured from the surface of the lake bed.

Total core recovery (TCR) in the bedrock ranged from 60% to 100%, though was typically 100%. The RQD values typically ranged from 75% to 100% indicating good to excellent rock quality. For 8 core runs the RQD value was less than 75%, typically ranging from 50% to 71% which indicates a fair rock quality. An RQD of 0% was also noted for Borehole NL10-09 Run 3.

The Fracture Index (FI) of the rock core, expressed as fractures per 0.3 m of core, generally ranged from 0 to 5 in most cores. In some cores the FI was greater than 5, though the FI was never greater than 10.

Based on Point Load tests performed in the laboratory, the estimated uniaxial compressive strength of the selected rock cores ranges from 77 MPa to 231 MPa, indicating a strong to very strong rock. These estimated rock strength values are interpreted from point load tests that were conducted on rock cores recovered from the boreholes. The average UCS value per core run is recorded on the Record of Borehole Sheets included in Appendix A.

5.4 Water Levels

Water levels were observed in the boreholes during and upon completion of drilling. One standpipe piezometer was installed at each foundation element during Phase 1 of the investigation to monitor water levels after completion of drilling. The water levels as measured in the piezometers are summarized in Table 5.4.

Table 5.4 – Water Level Measurements

SBL Foundation Element	Borehole	Date	Water Level (m)	
			Depth	Elevation
South Abutment	BH10-04	28-Jan-10	0.0*	189.7
Pier #1	BH10-13	28-Jan-10	1.1	184.4
Pier #3	BH10-25	28-Jan-10	1.5	182.4
North Abutment	BH10-38	28-Jan-10	1.4	192.1

*Frozen at surface

The piezometric readings taken at the South Abutment, Pier #1, Pier #3, and North Abutment in January 2010 indicate that the groundwater levels range from Elevation 182.4 m to 192.1 m. The groundwater elevations are typically higher at the proposed abutments, located at the top of the lake shore slopes.

The water level in Naiscoot Lake was measured at Elevation 182.07 m in August 2010, during Phase 2 of the field investigation.

The above values are short-term readings and seasonal fluctuations of the groundwater level are to be expected. In particular, the groundwater level may be at a higher elevation after the spring snowmelt or after periods of heavy rainfall.

6 MISCELLANEOUS

Borehole locations were selected by Thurber Engineering Ltd. Surveyors from MMM Group Limited staked these locations in the field, confirmed the co-ordinates and recorded the corresponding ground surface elevations.

Thurber obtained utility clearances for the borehole locations prior to drilling.

OGS Drilling Inc. of Almonte, Ontario supplied and operated the portable coring equipment used to drill and core all of the boreholes, during Phase 1 and Phase 2, at this site.

Phase 1 field work was supervised on a full time basis by Mr. George Azzopardi and Phase 2 field work was supervised by Mr. Stephane Loranger, C.E.T., both of Thurber. Overall planning and supervision of the field program was conducted by Mr. Tony Harte, M.Sc. Interpretation of the data and preparation of the report was carried out by Mrs. L. Blaine, E.I.T. and Mr. Alastair E. Gorman, P.Eng.

The report was reviewed by Dr. P.K. Chatterji, P.Eng., a Designated Principal Contact for MTO Foundations Projects.

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PART 2: ENGINEERING DISCUSSION AND RECOMMENDATIONS

7 GENERAL

This report presents interpretation of the geotechnical data in the factual report and presents geotechnical design recommendations to assist the design team to select and design a suitable foundation system and approach embankment for the proposed Highway 69 Naiscoot Lake Bridge SBL structure.

Based on the preliminary General Arrangement (GA) drawing provided by MMM Group Limited, a four-span structure supported on two abutments and three piers is proposed. The total length of the structure will be 201 m, with 35 m between the south abutment and Pier 1, 54 m between Pier 1 and Pier 2, 77 m between Pier 2 and Pier 3, and 35 m between Pier 3 and the north abutment. The proposed structure will be approximately 14 m wide. The proposed finished grade at the structure will vary from Elevation 196.9 m at the south abutment to Elevation 198.4 m at the north abutment.

At the south abutment, the finished grade will be at approximately Elevation 196.9 m and the existing ground is at approximately Elevation 190.2 m therefore the approach embankment will be up to 6.7 m high relative to the existing ground. Below the approach embankment, the existing forward slope down to the lake level will be cut into for the new Flicker Trail and will follow the original ground below Flicker Trail.

At the north abutment, the finished grade will be at about Elevation 198.4 and the existing ground is at approximately Elevation 193.8 m therefore the approach embankment will be up to 4.6 m high relative to the existing ground. The existing forward slope, below the approach embankment will be cut into for the new Teal Trail and then follow the original ground below Teal Trail.

The discussion and recommendations presented in this report are based on the information provided by MMM Group Ltd. and on the factual data obtained in the course of the investigations.

8 STRUCTURE FOUNDATIONS

In general terms, the overburden encountered at this site consists of peat and/or thin layers of sand. In Naiscoot Lake the lake bed deposits consist of layers of silty clay to clayey silt and sandy silt to silty sandy. Granitic gneiss bedrock was encountered below the overburden, generally at depths ranging from 0 to 1.5 m. Granitic gneiss bedrock was also encountered below the lake bed deposits, generally at depths of 0.6 to 3.4 m, relative to the surface of the lake bed.

The piezometric readings measured at the foundation elements for the SBL structure indicate that the groundwater levels range from Elevations 182.4 m to 192.1 m.

The water level measured at Naiscoot Lake was at Elevation 182.07 in August 2010.

Initial consideration was given to the following foundation types:

- Spread footings on native soils
- Spread footings on bedrock
- Socketted H-piles
- Drilled shafts
- Driven steel H-piles

A comparison of the foundation alternatives based on advantages and disadvantages of each one is included in Appendix C.

8.1 Spread Footings on Native Soils

Spread footings founded on native soils are not a feasible foundation option at this site due to the presence of bedrock at very shallow depth, generally 0.0 m to 1.5 m below ground surface at the foundation elements located on land (South Abutment, Pier 1, Pier 3, and North Abutment). Founding on native soil in the lake bed is not considered to be a viable option due to the soft soil conditions and issues related to underwater construction.

8.2 Spread Footings on Bedrock

Based on the subsurface stratigraphy encountered at this site, spread footings founded on bedrock are feasible for the support of the proposed structure.

Spread footings bearing on undisturbed bedrock at or below elevations presented in Table 8.1 may be designed as follows:

- Factored geotechnical resistance of 2,000 kPa at Ultimate Limit States (ULS)
- The SLS condition will not govern design of footings founded on bedrock

The ULS resistance was selected taking account of the sloping nature of the bedrock. This resistance value is for vertical, concentric loads. Where eccentric or inclined loads are applied, the resistance used in design must be reduced in accordance with the CHBDC Clause 6.7.3 and Clause 6.7.4.

Prior to constructing the footing, if the slope of the bedrock surface exceeds 5%, the rock must be excavated to the minimum extent necessary to prepare a bearing surface with a slope no greater than 5%. It is recommended that this be determined during design and be shown on the Contract Drawings in order to be biddable.

If, during construction, it is found that the prepared bedrock surface lies below the specified founding elevation, then the area must be brought up to founding elevation using concrete fill of the same class as the footing.

Comments related to the applicability of spread footings at specific foundations elements are presented below.

8.2.1 South Abutment

At the south abutment the elevation of the top of bedrock varies from 189.5 to 191.5 m, with a mean value of 190.7 m.

Two possible approaches to preparation of the bearing surface are:

1. Prepare a level surface in the bedrock at Elevation 189.4 m.
2. Adopt a founding elevation around Elevation 191.5 m and stipulate that the low areas must be made up using concrete fill. Low areas must be levelled to within a 5% slope prior to placing concrete.

However, the GA indicates that bedrock must be removed in order to develop sufficient length of abutment stem. Accordingly, the founding elevation may be specified on the basis of the required elevation from a structural perspective.

Assuming a founding elevation in the vicinity of elevation 188, the footing will be approximately 6 m above the recorded lake level and thus there are not any anticipated problems related to constructing this foundation in the dry.

The forward edge of this footing must be at least 3.0 m behind the crest of the excavation formed for the Flicker Trail.

8.2.2 Pier 1

At Pier 1, the elevation of the top of bedrock varies from 183.8 to 185.7 m, with a mean value of 184.8 m.

Two possible approaches to preparation of the bearing surface are:

1. Prepare a level surface in the bedrock at Elevation 183.7 m.
2. Adopt a founding elevation around Elevation 185.7 m and stipulate that the low areas must be made up using concrete fill. Low areas must be levelled to within a 5% slope prior to placing concrete.

The lower of these founding elevations is 1.6 m above the recorded lake level. Therefore, depending on the lake level at the time of construction, it is possible that a base at the lower elevation will be under water. The presence of water will not cause deterioration of the bedrock at this site, but provisions must be made for unwatering prior to placing concrete.

Adopting a higher founding elevation, e.g. 185.7, would reduce the risk of the actual footing base being inundated. However, the concrete fill required in this case must also be placed in the dry, necessitating provisions for unwatering.

8.2.3 Pier 2

Pier 2 will be constructed in Naiscoot Lake. Construction in this location will require the use of a cofferdam and will require the excavation of the overburden from within the cofferdam to expose the underlying bedrock. The construction methodology must allow for complete removal of all overburden from within the cofferdam and for the placement of concrete on bare bedrock. This may require a combination of excavation methods, such as clam shell followed by air-lift for the final cleaning.

The bedrock elevation across the area investigated for Pier 2 varies from 175.0 to 177.7 m, with a mean value of 176.7 m. The elevation of the top of the overburden (lake bottom) ranges from 177.4 to 178.8 m, with a mean value of 178.2 m.

Apart from a veneer of cohesionless soil on top of the bedrock, the overburden soils are identified as very soft to soft clay.

When considering possible cofferdam schemes, it can be assumed that steel sheet piles can be driven through the overburden readily but that they will not penetrate into the bedrock.

Two possible consequences include:

1. Toe support cannot be obtained by driving the sheet piles into bedrock. Thus, toe support must be provided by some other means, such as multiple levels of walers and bracing or by pinning the tips of the sheet piles to the bedrock.
2. It will not be possible to achieve a tight seal between lower edge of a steel cofferdam and the bedrock. One consequence of this lack of seal will be a need to maintain a positive head of water inside the cofferdam at all times in order to reduce the risk of water flowing in below the bottom edge of the cofferdam and carrying soil in with it.

8.2.4 Pier 3

At Pier 3, the elevation of the top of bedrock varies from 183.1 to 187.2 m, with a mean value of 185.0 m.

Two possible approaches to preparation of the bearing surface are:

1. Prepare a level surface in the bedrock at Elevation 183.0 m.
2. Adopt a founding elevation around Elevation 187.2 m and stipulate that the low areas must be made up using concrete fill. Low areas must be levelled to within a 5% slope prior to placing concrete.

The lower of these founding elevations is 0.9 m above the recorded lake level. Therefore, depending on the lake level at the time of construction, it is possible that a base at the lower elevation will be under water. The presence of water will not cause deterioration of the bedrock at this site, but provisions must be made for unwatering prior to placing concrete.

Adopting a higher founding elevation, e.g. 187.2, would reduce the risk of the actual footing base being inundated. However, the concrete fill required in this case must also be placed in the dry, necessitating provisions for unwatering.

8.2.5 North Abutment

At the north abutment the elevation of the top of bedrock varies from 192.4 to 195.1 m, with a mean value of 193.8 m.

Two possible approaches to preparation of the bearing surface are:

1. Prepare a level surface in the bedrock at Elevation 192.3 m.
2. Adopt a founding elevation around Elevation 195.1 m and stipulate that the low areas must be made up using mass concrete. Low areas must be levelled to within a 5% slope prior to placing concrete.

However, the GA indicates that bedrock must be removed in order to develop sufficient length of abutment stem. Accordingly, the founding elevation may be specified on the basis of the required elevation from a structural perspective.

Assuming a founding elevation in the vicinity of elevation 190, the footing will be approximately 8 m above the recorded lake level and thus there are not any anticipated problems related to constructing this foundation in the dry.

The forward edge of this footing must be at least 3.0 m behind the crest of the excavation formed for the Teal Trail

Table 8.1 – Highest Permitted Founding Elevations

Foundation Element	Borehole	Top of Bedrock	
		Depth below existing ground surface (m)	Founding Elevation
South Abutment	BH10-01	0.1	191.5
	BH10-02	0.02	191.4
	BH10-03	0.1	191.1
	BH10-04	0.2	189.5
	BH10-05	0.1	189.8
	BH10-06	0.1	190.7
Pier 1	BH10-13	0.5	185.0
	BH10-14	1.5	183.8
	BH10-15	0.6	185.7
	BH10-16	0.0	185.2
	BH10-17	0.4	184.1
	BH10-18	0.0	184.9
Pier 2	NL10-01	3.4*	175.0
	NL10-02	2.2*	175.8
	NL10-03	0.8*	177.0
	NL10-04	0.6*	176.8
	NL10-05	2.4*	176.2
	NL10-06	1.1*	177.3
	NL10-07	1.9*	176.3
	NL10-08	1.4*	176.5
	NL10-09	1.9*	176.9
	NL10-10	1.5*	177.0

Foundation Element	Borehole	Top of Bedrock	
		Depth below existing ground surface (m)	Founding Elevation
	NL10-11	0.7*	177.7
	NL10-12	0.6*	177.5
Pier 3	BH10-25	0.9	183.1
	BH10-26	0.2	183.7
	BH10-27	0.02	184.0
	BH10-28	0.2	185.8
	BH10-29	0.4	186.3
	BH10-30	0.0	187.2
North Abutment	BH10-37	0.2	192.6
	BH10-38	1.0	192.4
	BH10-39	0.1	194.0
	BH10-40	1.3	193.4
	BH10-41	0.2	195.1
	BH10-42	1.1	195.1

* Depth to bedrock measured from the surface of the lake bed.

8.2.6 Lateral Resistance on Bedrock

Initial calculations of the horizontal resistance may be carried out using a value of 0.7 for the ultimate friction factor of concrete poured on rock.

If the frictional component is insufficient, the horizontal resistance may be increased by dowelling the footing into the rock mass. Dowels are considered to be comparatively short steel bars that may be assumed to provide only shear resistance. If vertical resistance in tension is required, rock anchors must be included in the design.

The dowel will fail geotechnically when the ultimate lateral resistance of the rock or grout is exceeded. Using lower bound values for the strength of the rock, an ultimate horizontal resistance of 2.6 MN may be assumed for a 50 mm steel dowel embedded 2,500 mm into the rock. The depth of embedment is measured below the bedrock surface.

The shearing resistance of the selected dowel must be checked structurally.

8.2.1 Uplift of Footings on Bedrock

Uplift forces on footings founded on bedrock may be resisted by steel dowels grouted in to the bedrock.

The dowels may be designed on the basis of a bond strength of 1,500 kPa between the grout and the bedrock, assuming that the minimum compressive strength of the grout is 30 Mpa. This is the ultimate resistance and a load factor of 0.4 must be applied, giving a factored ULS resistance of 600 kPa.

The installation of the dowels must be carried out in accordance with the special provision for Dowels into Rock. The text of the SP is included in Appendix D and includes blank fields that must be completed by the designer before it is included in the Contract Package.

8.3 Socketted H-Piles

H-piles grouted into sockets drilled into the bedrock are considered to be technically feasible for Pier 2 of the SB Naiscoot Lake bridge. This system is not considered to be applicable to the other foundation elements due to the presence of bedrock essentially at the ground surface.

If an HP 310 X 110 pile is used, design can be carried out on the basis of a factored ULS resistance of 2,000 kN per pile. The SLS condition will not govern for a pile grouted into bedrock.

A possible construction sequence is:

i. Drill a cased hole of suitable size, e.g. 900 mm, to bedrock and advance far enough into bedrock to achieve a seal

ii. Advance a 750 mm diameter hole, but not the casing, a further 1 m into bedrock or the depth dictated by structural considerations.

iii. Flush the hole clean

iv. Place the pile in contact with bedrock at the bottom of the hole and brace it in position

v. Grout at least the lower 1.0 m of the pile in bedrock with 30 MPa grout

vi. From a geotechnical perspective, it is only necessary to ensure that the piles are grouted into the bedrock. However, since installation will take place through the water column and through very soft soil, consideration should be given to leaving the outer casing in place permanently.

One possible method of installation would be to use a duplex drilling system that advances a steel casing as the hole is being drilled. The method of advance can be left to the Contractor, provided the resulting cased holes meets the requirements. However, systems that could be considered include rotary drilling with roller bits or a down the hole hammer (DTH) system with simultaneous casing advance.

This foundation system will require a pile cap and that, in turn, will require that the piles be installed inside a cofferdam. After pile installation, a plug of tremie concrete should be placed inside the cofferdam to permit unwatering of the cofferdam and construction of the pile cap in the dry. Prior to pile driving, any soil above the level of the underside of the tremie plug should be excavated, though this does not appear to be necessary at this location.

The soil that will lie in the base of the cofferdam is very soft and may fail under the weight of the wet concrete if it is allowed to build up under the tremie discharge. To mitigate this problem, it is recommended that the contract specify construction of a two stage tremie plug. In the first stage, the concrete thickness should be limited to 0.5 m and the Contractor must be instructed to keep the tremie discharge pipe moving across the area of the cofferdam so that the wet concrete does not build up in one area. This initial layer must be allowed to harden, following which the second layer of the plug may be placed.

An alternative approach at this site would be to construct a floating cofferdam with sleeves through which the piles would be installed.

8.4 Drilled Shafts

Support of Pier 2 on drilled shafts is considered to be technically feasible at this site. An advantage of this system is that it could eliminate the need for a cofferdam, if the shafts can be continued up to the pier cap with no pile cap.

At the foundation level, this shaft might typically be in the order of 1.5 m in diameter and must be advanced into the bedrock to develop the required geotechnical resistance.

It is recommended that the geotechnical resistance be based on adhesion between the concrete shaft and the bedrock. At this site, the recommended value of adhesion for SLS design is 5% of the compressive strength of the concrete used in the shaft. Thus, if 30 MPa concrete is used, the vale for shaft adhesion is 1,500 kPa. Higher values of adhesion can be used if higher strength concrete is specified for the foundation. For the ULS condition, an adhesion 20% higher than the SLS value can be used, i.e. 1,800 kPa in this example.

Using the 1,500 kPa adhesion and a 1.5 diameter shaft, the geotechnical resistance developed per metre length of shaft is 7,000 kN.

The top 1 m of penetration into the bedrock must be ignored in resistance calculations to allow for the variations in the bedrock surface and possible, localized, surface fracturing.

8.5 Driven Piles

Driven piles are not considered to be a feasible foundation system for this bridge. Except at Pier 2, the bedrock is too shallow to permit the use of driven piles. At Pier 2, the overburden is too weak to provide lateral restraint of piles driven to end bearing on the bedrock.

8.6 Abutment Design Considerations

The ground conditions at this site are considered suitable for conventional or semi-integral abutment design.

8.7 Recommended Foundation

From a geotechnical perspective, based on the subsurface conditions and taking account of the relative costs, the recommended foundation type for this site is spread footings bearing on bedrock.

8.8 Frost Cover

The design depth of frost penetration at this site is 1.8 m.

However, frost penetration is not an issue for footings bearing on bedrock or concrete fill placed on bedrock.

9 EXCAVATION

Minor excavation of overburden soils (native sand) and peat removal will be required at this site. Peat is generally 30 mm to 450 mm thick and the layers of sand with occasional cobbles and/or boulders range from 0.1 to 1.4 m in thickness. Rock excavation will be required for the foundation elements of the SBL structure as well as for Flicker Trail and Teal Trail which pass under the bridge along the south and north shore, respectively.

9.1 Earth Excavation

The thickness of overburden at the SB Structure site is a maximum of 1.5 m.

If earth excavation is required, it must be carried out in accordance with the Occupational Health and Safety Act (OHSA). For the purposes of the OHSA, the native soils within the probable depth of excavation at this site may be classed as Type 3 soils above water level and Type 4 below water level.

The excavation and backfilling for foundations must be carried out in accordance with SP 902S01.

9.2 Rock Excavation

Minor rock excavation may be required at the foundation locations in order to prepare the founding surface. Rock excavation will also be required to achieve the proposed grade of Flicker Trail and Teal Trail, which pass under the bridge structure.

At Flicker Trail and Teal Trail, blasting may be employed to create the necessary bench in the bedrock.

At the footing locations, where only a shallow depth of excavation is required, it is strongly recommended that blasting be avoided and that excavation be carried out using pneumatic breakers, or other methods that will avoid disturbing the bedrock below the founding elevation.

The Special Provision (SP) governing the use of explosives must be included in the contract. The text of the SP is included in Appendix D.

The design of the blast and removal procedures should be the responsibility of the Contractor. However, it is important that his procedures incorporate methods of reducing damage to the founding surfaces or to any adjacent structures. Such methods may include, though not necessarily be limited to, line drilling, pre-splitting and cushion blasting.

10 UNWATERING

Groundwater may enter foundation excavations at this site in the form of seepage from the bedrock and from the shallow overburden. The volume of water is expected to be low and the bedrock bearing surface will not be degraded by the presence of water.

At the abutments, unwatering requirements are expected to consist of provision to drain the seepage water away from the bearing surface to allow concrete to be placed in dry conditions.

The unwatering requirements at Pier 1 and Pier 3 include the drainage requirement set out above. At these two locations, there is the added risk of inundation if the lake level is above the founding level at the time of construction. The Contractor must be advised of this risk and it is recommended that the Contract contain a requirement for him to provide protection against lake levels up to a specified elevation. The appropriate lake elevation for design of the protection must be assessed by a hydrologist.

The design of the unwatering system must remain the responsibility of the Contractor.

11 COFFERDAM

Where a cofferdam is required, e.g. for the construction of Pier 2, the design of the cofferdam must be carried out by the Contractor. However, when assessing the feasibility and constructability of the cofferdam, the following points must be kept in mind:

1. It will not be possible to drive the sheet piles into the bedrock.
2. The overburden soils are very soft to soft and may not be relied on to provide toe support for the cofferdam.
3. Alternate methods of providing toe support must be considered. These could include drilling a dowel into the bedrock at each sheeting pan in order to pin the sheet in place, or else constructing multiple levels of walers and advancing the lower walers down the sheeting as the excavation proceeds.

It will not be possible to construct a watertight cofferdam using sheet piles. Accordingly, if a spread footing bearing on bedrock is designed, steps must be taken to guard against soil being carried into the cofferdam enclosure by water flow around the tips of the sheet piles. One way of achieving this is to maintain a positive head of water inside the cofferdam at all stages of excavation and cleaning. The positive head must be maintained until the bedrock surface has been cleaned and a plug of tremie concrete has been placed and allowed to set.

12 APPROACH EMBANKMENTS

The immediate approach embankments will be in order of 4.6 to 6.7 m high. The foundation for the embankments will be bedrock or shallow overburden, maximum thickness 1.5 m based on the borehole data, overlying bedrock.

No settlement or stability issues exist for the planned approach embankments.

Earth fill embankments may be constructed with side slopes no steeper than 2H:1V.

Rock fill embankments may be constructed with side slopes no steeper than 1.25H:1V. The width of the rock fill platform must satisfy the requirements of the most recent Northeastern Region Policy on rock fill.

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

13 BACKFILL TO ABUTMENTS

Backfill to the abutment should be granular material.

In the case of a conventional abutment, granular backfill is recommended but rock backfill can be permitted. A NSSP is required to specify grading limits for the rock fill.

In all cases where the approach embankment consists of rock fill and granular backfill to the abutment wall is used, the granular backfill must consist of OPSS Granular "B" Type II.

The backfill to the abutment walls must be in accordance with OPSS 902 as amended by Special Provision 902S01. Granular backfill must be placed to the extents shown in OPSD 3101.150, and rock backfill must be placed to the extents shown in OPSD 3101.200. All granular material should meet the requirements of SP 110F13 Amendment to OPSS 1010, March 1993.

Compaction equipment to be used adjacent to the abutment walls must be restricted in accordance with SP 105S10.

The design of the abutment must incorporate a subdrain as shown in OPSD 3101.150 or OPSD 3101.200, as applicable.

14 EARTH PRESSURE

Earth pressures acting on the 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 table 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)

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.

Earth pressure coefficients for backfill to the abutment wall are dependent on the material used as backfill. Typical values are shown in Table 14.1.

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.

The coefficients in Table 14.1 are "ultimate" values and require certain movements for the respective conditions to be mobilized. The values to use in design can be estimated from Figure C6.9.1 (a) in the Commentary to the Canadian Highway Bridge Design Code.

Table 14.1 – 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 $\phi = 32°, \gamma = 21.2$ kN/m^3		Rock Fill (Limited to 300 mm size) $\phi = 42°, \gamma = 19$ kN/m^3	
	Horizontal Surface Behind Wall	Sloping Surface Behind Wall (2H:1V)	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	0.48*	0.2	0.28*
At rest (Restrained Wall)	0.43	-	0.47	-	0.33	-
Passive (Movement Towards Soil Mass)	3.7	-	3.3	-	5.0	-

* For wing walls.

15 SEISMIC CONSIDERATIONS

15.1 Seismic Design Parameters

The site is treated as lying in Seismic Zone 1. The following seismic parameters should be used for design:

- Velocity Related Seismic Zone 1
- Zonal Velocity Ratio 0.05
- Acceleration Related Seismic Zone 1
- Zonal Acceleration Ratio 0.05
- Peak Horizontal Acceleration 0.08

The soil profile type at this site has been classified as Type I. Therefore, according to Table 4.4.6.1 of the CHBDC, a Site Coefficient "S" (ground motion amplification factor) of 1.0 should be used in seismic design.

15.2 Liquefaction Potential

The foundation soils at the abutments are not in danger of liquefaction under earthquake loading.

15.3 Retaining Wall Dynamic Earth Pressures

In accordance with Clause 4.6.4 of the CHBDC, retaining structures should be designed using active (K_{AE}) and passive (K_{PE}) earth pressure coefficients that incorporate the effects of earthquake loading.

For the design of retaining walls, the coefficients of horizontal earth pressure in Table 15.1 may be used:

Table 15.1 – Earth Pressure Coefficient for Earthquake Loading

Earth Pressure Coefficient (K) for Earthquake Loading						
	Granular A or Granular B Type II $\phi = 35°$; $\gamma = 22.8$ kN/m³		OPSS Granular B Type I $\phi = 32°$; $\gamma = 21.2$ kN/m³		Rock Fill $\phi = 42°$; $\gamma = 19.0$ kN/m³	
Wall Condition	Horizontal Surface Behind Wall	Sloping Surface Behind Wall (2H:1V)	Horizontal Surface Behind Wall	Sloping Surface Behind Wall (2H:1V)	Horizontal Surface Behind Wall	Sloping Surface Behind Wall (2H:1V)
Active (K_{AE})*	0.3	0.47	0.34	0.58	0.22	0.31
Passive (K_{PE})	3.6	-	3.2	-	4.9	-
At Rest (K_{OE})**	0.53	-	0.57	-	0.43	-

* After Mononobe and Okabe, passive case assumes a horizontal surface in front of the wall.
** After Woods

16 CONSTRUCTION CONCERNS

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

16.1 Variations in the elevation of the bedrock surface.

The surface of the bedrock has been shown in the investigation to be variable. Since the elevation of the bedrock surface was only established at discrete points, it is possible that higher or lower elevations will be encountered during construction. Also, the slope of the bedrock is expected to be locally steeper than that depicted by joining the elevations established at the boreholes.

The bedrock elevation variability may lead to difficulty sealing out groundwater at the toe of a sheet pile enclosure.

16.2 Control of groundwater and surface water.

If the lake level is abnormally high, the excavation for Piers 1 and 3 may require cofferdams and unwatering.

17 CLOSURE

Engineering analysis and preparation of the report were carried out by Mr. Alastair E. Gorman, P.Eng.

The report was reviewed by Dr. P.K. Chatterji, P.Eng., a Designated Principal Contact for MTO Foundations Projects.

Thurber Engineering Ltd.

Alastair E. Gorman, P.Eng.
Senior Foundations Engineer

Report reviewed by:
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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

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

▼ 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

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Ontario

THURBER

RECORD OF BOREHOLE No BH10-01

METRIC

W.P. 5076-06-00
LOCATION N 5 056 457.0 E 234 744.7
ORIGINATED BY GA

HWY 69
BOREHOLE TYPE Tripod/Hilti
COMPILED BY MFA

DATUM Geodetic
DATE 2010.01.14 - 2010.01.14
CHECKED BY LRB

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, × 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
191.6	GROUND SURFACE										
0.0	**PEAT** (100 mm)		1	SS	50/100						
0.1	END OF BOREHOLE AT 0.1 m UPON REFUSAL ON PROBABLE BEDROCK. BOREHOLE OPEN AND DRY TO 0.1 m.										

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

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

Ministry of Transportation Ontario

THURBER

RECORD OF BOREHOLE No BH10-02

METRIC

W.P.	5076-06-00	LOCATION	N 5 056 458.1 E 234 749.8	ORIGINATED BY	GA
HWY	69	BOREHOLE TYPE	Tripod/Hilti	COMPILED BY	MFA
DATUM	Geodetic	DATE	2010.01.14 - 2010.01.14	CHECKED BY	LRB

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, 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
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
191.4	GROUND SURFACE										
0.0	**PEAT** (30 mm)		1	SS	50/.025						
	END OF BOREHOLE AT 0.03 m UPON REFUSAL ON PROBABLE BEDROCK. BOREHOLE OPEN AND DRY TO 0.03 m.										

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

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

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BH10-03

METRIC

W.P. 5076-06-00 LOCATION N 5 056 459.2 E 234 754.6 ORIGINATED BY GA
HWY 69 BOREHOLE TYPE Tripod/Hilti COMPILED BY MFA
DATUM Geodetic DATE 2010.01.15 - 2010.01.15 CHECKED BY LRB

ELEV / DEPTH	DESCRIPTION	SAMPLE NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
191.2	GROUND SURFACE							
0.0	**PEAT** (100 mm)	1	SS	50/ .100			FI	
0.1	**BEDROCK**, granitic gneiss, fresh, coarse grained, strong to very strong, black/pink/white. Occasional mechanical breaks.	1	RUN		∇ (water level)	191	0, 0	RUN #1 TCR=100% SCR=100% RQD=100% UCS=112MPa
		2	RUN			190	0, 0, 0, 0	RUN #2 TCR=100% SCR=100% RQD=100% UCS=85MPa
	Highly broken zone at 2.23 to 2.46m. Biotite seam at 2.23 to 2.46m.	3	RUN			189	0, >5	RUN #3 TCR=100% SCR=88% RQD=65% UCS=217MPa
188.3 / 2.9	END OF BOREHOLE AT 2.9 m. BOREHOLE OPEN TO 2.9 m AND WATER LEVEL AT 1.0 m UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO SURFACE.						0	

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
GR SA SI CL

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

Ministry of Transportation Ontario

THURBER

RECORD OF BOREHOLE No BH10-04

METRIC

W.P. 5076-06-00	LOCATION N 5 056 461.8 E 234 743.5	ORIGINATED BY GA
HWY 69	BOREHOLE TYPE Tripod/Hilti	COMPILED BY MFA
DATUM Geodetic	DATE 2010.01.14 - 2010.01.14	CHECKED BY LRB

ELEV / DEPTH	DESCRIPTION	NUMBER	TYPE	"N" VALUES	ELEVATION SCALE	UNIT WEIGHT kN/m³ / FI	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
189.7	GROUND SURFACE						
0.0	**PEAT** (200 mm)	1	SS	50/.150			
0.2	**BEDROCK**, granitic gneiss, fresh, coarse grained, very strong, pink/white/black. Occasional mechanical breaks.	1	RUN		189	0, 0, 0, 0	RUN #1 TCR=100% SCR=100% RQD=100% UCS=211MPa
		2	RUN		188	0, 0, 0, 0	RUN #2 TCR=100% SCR=100% RQD=100% UCS=103MPa
186.5	Horizontal joint at 2.87m.	3	RUN		187	0, 1	RUN #3 TCR=100% SCR=100% RQD=100% UCS=109MPa
3.2	END OF BOREHOLE AT 3.2 m.					0	

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

END OF BOREHOLE AT 3.2 m.
BOREHOLE OPEN TO 3.2 m AND WATER LEVEL AT 1.6 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)
2010.01.28	0.0*	189.7

*Frozen at surface.

+³, ×³: Numbers refer to Sensitivity

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

Ministry of Transportation Ontario

THURBER

RECORD OF BOREHOLE No BH10-05

METRIC

W.P. 5076-06-00	LOCATION N 5 056 463.0 E 234 748.6		ORIGINATED BY GA
HWY 69	BOREHOLE TYPE Tripod/Hilti		COMPILED BY MFA
DATUM Geodetic	DATE 2010.01.14 - 2010.01.15		CHECKED BY LRB

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	UNIT WEIGHT γ kN/m³ (FI)	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
189.9	GROUND SURFACE								
0.0	**PEAT** (100 mm)		1	SS	50/.125			FI	
189.8 / 0.1	**BEDROCK**, granitic gneiss, fresh, coarse grained, very strong, black/pink. Occasional mechanical breaks.		1	RUN			189	0, 0, 0, 1	RUN #1 TCR=100% SCR=100% RQD=91% UCS=130MPa
	Sub-horizontal joint at 1.24m.								
	Horizontal joints at 1.62, 1.65, 2.03 and 2.13m.		2	RUN		∇	188	0, 2, 1, 1	RUN #2 TCR=100% SCR=98% RQD=92% UCS=116MPa
			3	RUN			187	0, 0	RUN #3 TCR=100% SCR=100% RQD=100% UCS=201MPa
186.8 / 3.2	END OF BOREHOLE AT 3.2 m. BOREHOLE OPEN TO 3.2 m AND WATER LEVEL AT 1.5 m UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO SURFACE.								

Plot headers: 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)

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

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

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BH10-06

METRIC

W.P.	5076-06-00	LOCATION	N 5 056 464.1 E 234 753.5	ORIGINATED BY	GA
HWY	69	BOREHOLE TYPE	Tripod/Hilti	COMPILED BY	MFA
DATUM	Geodetic	DATE	2010.01.14 - 2010.01.14	CHECKED BY	LRB

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/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
190.8	GROUND SURFACE										
0.0 / 0.1	**PEAT** (50 mm)		1	SS	50/ .050						
	END OF BOREHOLE AT 0.05 m UPON REFUSAL ON PROBABLE BEDROCK. BOREHOLE OPEN AND DRY TO 0.05 m.										

ONTMT4S 6121(NAISCOOT LAKE).GPJ 5/3/12

+ 3, × 3: Numbers refer to Sensitivity

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

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BH10-13

METRIC

W.P. 5076-06-00 | LOCATION N 5 056 490.9 E 234 736.6 | ORIGINATED BY GA

HWY 69 | BOREHOLE TYPE Tripod/Hilti | COMPILED BY MFA

DATUM Geodetic | DATE 2010.01.13 - 2010.01.13 | CHECKED BY LRB

ELEV / DEPTH	DESCRIPTION	SAMPLE NUMBER	TYPE	"N" VALUES	NATURAL MOISTURE CONTENT	UNIT WEIGHT (FI)	REMARKS
185.5	GROUND SURFACE						
0.0	**SAND**, trace silt, occasional organics Compact Brown Damp	1	SS	11	o	FI	
185.0 / 0.5	**BEDROCK**, granitic gneiss, fresh, coarse grained, very strong, dark grey/black, occasional red streaks. Horizontal joints at 0.53 and 0.66m. Occasional mechanical breaks. Horizontal joints at 1.14 and 1.19m.	1	RUN			0, 1	RUN #1 TCR=100% SCR=100% RQD=100% UCS=116MPa
		2	RUN			0, 2, 0	RUN #2 TCR=100% SCR=100% RQD=96% UCS=143MPa
	Occasional banding at 2.44 to 3.05m.	3	RUN			0, 0, 0, 0	RUN #3 TCR=100% SCR=100% RQD=100% UCS=170MPa
181.8 / 3.6		4	RUN			0, 0	RUN #4 TCR=100% SCR=100% RQD=100% UCS=173MPa

Elevation scale: 185, 184, 183, 182

END OF BOREHOLE AT 3.6 m.
BOREHOLE OPEN AND DRY TO 3.6 m.
Piezometer installation consists of 25mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen.
WATER LEVEL READINGS:

DATE	DEPTH (m)	ELEV. (m)
2010.01.28	1.1	184.4

+ 3, × 3: Numbers refer to Sensitivity

(%) STRAIN AT FAILURE

Ministry of Transportation Ontario

THURBER

RECORD OF BOREHOLE No BH10-14

METRIC

W.P. 5076-06-00	LOCATION N 5 056 492.2 E 234 741.7		ORIGINATED BY GA
HWY 69	BOREHOLE TYPE Tripod/Hilti		COMPILED BY MFA
DATUM Geodetic	DATE 2010.01.13 - 2010.01.13		CHECKED BY LRB

ELEV DEPTH	DESCRIPTION	SAMPLE NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	WATER CONTENT (%)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
185.3	GROUND SURFACE								
0.0 / 0.1	**PEAT** (50mm)								
	SAND, trace silt, occasional rootlets Loose Brown Damp Cobble from 0.69 to 0.76 m	1	SS	5		185			
		2	SS	50 / 0.03			o		
					▽				
183.8 / 1.5		3	SS	50 / 0.1		184	o	FI	
	BEDROCK, granitic gneiss, fresh, coarse grained, strong to very strong, grey/black, occasional banding Occasional mechanical breaks.	1	RUN					0 0 0	RUN #1 TCR=100% SCR=100% RQD=100% UCS=141MPa
	Horizontal joint at 2.49m.					183		1 0 0	RUN #2 TCR=100% SCR=100% RQD=94% UCS=92MPa
	Horizontal joints at 3.43, 3.48 and 3.71m.	2	RUN			182		1 2	
180.9 / 4.4		3	RUN			181		0	RUN #3 TCR=100% SCR=100% RQD=100% UCS=135MPa
	END OF BOREHOLE AT 4.4 m. BOREHOLE OPEN TO 4.4 m AND WATER LEVEL AT 1.2 m UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO SURFACE.								

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

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

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BH10-15

METRIC

W.P.	5076-06-00	LOCATION	N 5 056 493.3 E 234 746.3	ORIGINATED BY	GA
HWY	69	BOREHOLE TYPE	Tripod/Hilti	COMPILED BY	MFA
DATUM	Geodetic	DATE	2010.01.14 - 2010.01.14	CHECKED BY	LRB

ELEV DEPTH	SOIL PROFILE 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 (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
186.3	GROUND SURFACE										
0.0 0.1	**PEAT** (50mm)										
185.7 0.6	**SAND**, trace silt, occasional rootlets Compact Brown Damp		1	SS	15		186		o (approx. 23)		
	END OF BOREHOLE AT 0.6 m UPON AUGER REFUSAL ON PROBABLE BEDROCK. BOREHOLE OPEN AND DRY TO 0.6 m. BOREHOLE BACKFILLED WITH CUTTINGS TO SURFACE.										

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

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

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BH10-16

METRIC

W.P.	5076-06-00	LOCATION	N 5 056 495.8 E 234 735.4	ORIGINATED BY	GA
HWY	69	BOREHOLE TYPE	Tripod/Hilti	COMPILED BY	MFA
DATUM	Geodetic	DATE	2010.01.13 - 2010.01.13	CHECKED BY	LRB

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/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
185.2	GROUND SURFACE										
0.0	**BEDROCK AT SURFACE**										

+ ³, × ³ : Numbers refer to Sensitivity

15-⊕-5 (20 above, 10 below) (%) STRAIN AT FAILURE

ONTMT4S 6121(NAISCOOT LAKE).GPJ 5/3/12

RECORD OF BOREHOLE No BH10-17

METRIC

W.P.	5076-06-00	LOCATION	N 5 056 497.1 E 234 740.5	ORIGINATED BY	GA
HWY	69	BOREHOLE TYPE	Tripod/Hilti	COMPILED BY	MFA
DATUM	Geodetic	DATE	2010.01.13 - 2010.01.13	CHECKED BY	LRB

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)	WATER CONTENT (%) (PLASTIC LIMIT w_P, NATURAL MOISTURE CONTENT w, LIQUID LIMIT w_L) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
184.5	GROUND SURFACE										
0.0	**PEAT** (100 mm)										
0.1 / 184.1	**SAND**, trace silt, occasional rootlets Loose Brown Damp		1	SS	50/ .075				o (~45)		
0.4	END OF BOREHOLE AT 0.4 m UPON REFUSAL ON PROBABLE BEDROCK. BOREHOLE OPEN AND DRY TO 0.4 m. BOREHOLE BACKFILLED WITH CUTTINGS TO SURFACE.										

+3, ×3: Numbers refer to Sensitivity

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

RECORD OF BOREHOLE No BH10-18

METRIC

W.P. 5076-06-00	LOCATION N 5 056 498.2 E 234 745.3	ORIGINATED BY GA
HWY 69	BOREHOLE TYPE Tripod/Hilti	COMPILED BY MFA
DATUM Geodetic	DATE 2010.01.14 - 2010.01.14	CHECKED BY LRB

ELEV DEPTH	DESCRIPTION	SAMPLE NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	FI	REMARKS & GRAIN SIZE DISTRIBUTION (%)
184.9	GROUND SURFACE							
0.0	**BEDROCK**, granitic gneiss, fresh, coarse grained, very strong, black/pink with occasional banding Occasional mechanical breaks. Horizontal joint at 0.61m. Sub-horizontal joints at 0.66 and 0.97m.	1	RUN		▽	184	0, 0, 2, 1	RUN #1 TCR=100% SCR=100% RQD=96% UCS=145MPa
	Horizontal joint at 1.37m.	2	RUN			183	1, 0, 0, 0	RUN #2 TCR=100% SCR=100% RQD=100% UCS=195MPa
182.0 2.9	END OF BOREHOLE AT 2.9 m. BOREHOLE OPEN TO 2.9 m AND WATER LEVEL AT 0.9 m UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO SURFACE.	3	RUN				0, 0	RUN #3 TCR=100% SCR=100% RQD=100% UCS=163MPa

Column headings: 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; GR SA SI CL

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

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BH10-25

METRIC

W.P. 5076-06-00
HWY 69
DATUM Geodetic

LOCATION N 5 056 616.6 E 234 701.0
BOREHOLE TYPE Tripod/Hilti
DATE 2010.01.20 - 2010.01.20

ORIGINATED BY GA
COMPILED BY MFA
CHECKED BY LRB

ELEV DEPTH	DESCRIPTION	SAMPLE NUMBER	TYPE	"N" VALUES	ELEVATION SCALE	UNIT WEIGHT kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
183.9	GROUND SURFACE						
0.0 / 0.1	**PEAT** (50 mm)						
183.4 / 0.5	**SAND**, trace silt, trace gravel, occasional rootlets, Loose, Brown, Damp	1	SS	8		FI	
183.1 / 0.9	**BOULDERS** and **COBBLES**				183	>4	
	BEDROCK, granitic gneiss, fresh, coarse grained, very strong, black/white/salmon. Occasional mechanical breaks. Sub-horizontal joint at 0.97 and 1.07m. Horizontal joints at 1.12 and 1.14m. Highly broken zone at 1.91 to 2.06m.	1	RUN			0, 0, 0	RUN #1 TCR=100% SCR=100% RQD=88% UCS=123MPa
		2	RUN		182	5, 0, 0	RUN #2 TCR=100% SCR=90% RQD=88% UCS=131MPa
180.0 / 3.9		3	RUN		181	0, 0, 0, 0	RUN #3 TCR=100% SCR=100% RQD=100% UCS=157MPa

Column headings: SOIL PROFILE; SAMPLES; GROUND WATER CONDITIONS; 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; GR SA SI CL.

END OF BOREHOLE AT 3.9 m.
BOREHOLE OPEN TO 3.9 m AND WATER LEVEL AT 0.7 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)
2010.01.28	1.5	182.4

ONTMT4S 6121(NAISCOOT LAKE).GPJ 5/3/12

+³, ×³: Numbers refer to Sensitivity

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

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BH10-26

METRIC

W.P. 5076-06-00
LOCATION N 5 056 618.2 E 234 706.0
ORIGINATED BY GA
HWY 69
BOREHOLE TYPE Tripod/Hilti
COMPILED BY MFA
DATUM Geodetic
DATE 2010.01.20 - 2010.01.20
CHECKED BY LRB

ELEV DEPTH	SOIL PROFILE 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
183.9	GROUND SURFACE										
0.0	**PEAT** (200 mm)		1	SS	50/ .000						
0.2	END OF BOREHOLE AT 0.2 m UPON REFUSAL ON PROBABLE BEDROCK OR BOULDER. BOREHOLE OPEN AND DRY TO 0.2 m.										

ONTMT4S 6121(NAISCOOT LAKE).GPJ 5/3/12

+ ³, × ³ : Numbers refer to Sensitivity

15-⊕-5 (20 above, 10 below) (%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BH10-27

METRIC

W.P.	5076-06-00	LOCATION	N 5 056 619.8 E 234 710.7	ORIGINATED BY	GA
HWY	69	BOREHOLE TYPE	Tripod/Hilti	COMPILED BY	MFA
DATUM	Geodetic	DATE	2010.01.20 - 2010.01.20	CHECKED BY	LRB

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/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
184.0	GROUND SURFACE										
0.0	**PEAT** (30 mm)		1	SS	50/.025						
	END OF BOREHOLE AT 0.03 m UPON REFUSAL ON PROBABLE BEDROCK OR BOULDER.										

+ ³, × ³ : Numbers refer to Sensitivity

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

ONTMT4S 6121(NAISCOOT LAKE).GPJ 5/3/12

Ministry of Transportation Ontario

THURBER

RECORD OF BOREHOLE No BH10-28

METRIC

W.P.	5076-06-00	LOCATION	N 5 056 621.3 E 234 699.4	ORIGINATED BY	GA
HWY	69	BOREHOLE TYPE	Tripod/Hilti	COMPILED BY	MFA
DATUM	Geodetic	DATE	2010.01.20 - 2010.01.20	CHECKED BY	LRB

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/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
186.0	GROUND SURFACE										
0.0	**PEAT** (200 mm)		1	SS	50/ .150		186				
0.2	END OF BOREHOLE AT 0.2 m UPON REFUSAL ON PROBABLE BEDROCK OR BOULDER. BOREHOLE OPEN AND DRY TO 0.2 m										

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

Ministry of Transportation Ontario

THURBER

RECORD OF BOREHOLE No BH10-29

METRIC

W.P. 5076-06-00 | LOCATION N 5 056 622.9 E 234 704.4 | ORIGINATED BY GA

HWY 69 | BOREHOLE TYPE Tripod/Hilti | COMPILED BY MFA

DATUM Geodetic | DATE 2010.01.20 - 2010.01.25 | CHECKED BY LRB

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	WATER CONTENT (%)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
186.7	GROUND SURFACE									
0.0	**PEAT**		1	SS	50/100			o	FI	
186.3 / 0.4	**BEDROCK**, granitic gneiss, fresh, coarse grained, very strong, white/black/salmon, with quartz seams. Highly broken zones at 0.51 to 0.61, and 1.24 to 1.37m. Quartz seam from 0.89 to 2.41m		1	RUN			186		4, 0, 0	RUN #1 TCR=100% SCR=82% RQD=76% UCS=108MPa
	Occasional mechanical breaks. Horizontal joints at 1.68, 1.73, 1.78, 1.83, 2.06, and 2.23m.		2	RUN		▽	185		>5, 0, 4	RUN #2 TCR=100% SCR=80% RQD=59% UCS=161MPa
	Highly broken zone at 2.72 to 3.02m.		3	RUN			184		3, >5, 0, 0	RUN #3 TCR=100% SCR=71% RQD=71% UCS=102MPa
183.2 / 3.5	END OF BOREHOLE AT 3.5 m. BOREHOLE OPEN TO 3.5 m AND WATER LEVEL AT 1.4 m UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO SURFACE.									

Column header details: 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; GR SA SI CL

$+^3, \times^3$: Numbers refer to Sensitivity   15-⊕-5 (20 / 10) (%) STRAIN AT FAILURE

Ministry of Transportation Ontario

THURBER

RECORD OF BOREHOLE No BH10-30

METRIC

W.P.	5076-06-00	LOCATION	N 5 056 624.5 E 234 709.2	ORIGINATED BY	GA
HWY	69	BOREHOLE TYPE	Tripod/Hilti	COMPILED BY	MFA
DATUM	Geodetic	DATE	2010.01.25 - 2010.01.26	CHECKED BY	LRB

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	UNIT WEIGHT γ kN/m³ (FI)	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
187.2	GROUND SURFACE								
0.0	**BEDROCK**, granitic gneiss, fresh, coarse grained, very strong, black/white/salmon. Occasional mechanical breaks.		1	RUN		∇	187	0, 0, 0	RUN #1 TCR=100% SCR=100% RQD=100% UCS=170MPa
			2	RUN			186	0, 0, 0	RUN #2 TCR=100% SCR=100% RQD=100% UCS=201MPa
	Quartz from 2.03 to 2.64m.		3	RUN			185	0, 0, 0	RUN #3 TCR=100% SCR=100% RQD=100% UCS=196MPa
184.2 / 2.9	END OF BOREHOLE AT 2.9 m. BOREHOLE OPEN TO 2.9 m AND WATER LEVEL AT 0.7 m UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO SURFACE.							0	

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

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

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

Ministry of Transportation Ontario

THURBER

RECORD OF BOREHOLE No BH10-37

METRIC

W.P.	5076-06-00	LOCATION	N 5 056 649.7 E 234 689.9	ORIGINATED BY	GA
HWY	69	BOREHOLE TYPE	Tripod/Hilti	COMPILED BY	MFA
DATUM	Geodetic	DATE	2010.01.18 - 2010.01.18	CHECKED BY	LRB

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, 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/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
192.8	GROUND SURFACE										
0.0	**PEAT** (200 mm)		1	SS	50/.075				o (approx. 40)		
0.2	END OF BOREHOLE AT 0.2 m UPON REFUSAL ON PROBABLE BEDROCK OR BOULDER. BOREHOLE OPEN AND DRY TO 0.2 m. BOREHOLE BACKFILLED WITH CUTTINGS TO SURFACE.										

+ 3, × 3: Numbers refer to Sensitivity

15 ⊕ 5 (20 above, 10 below) (%) STRAIN AT FAILURE

THURBER

RECORD OF BOREHOLE No BH10-38

METRIC

W.P. 5076-06-00	LOCATION N 5 056 651.4 E 234 694.8		ORIGINATED BY GA
HWY 69	BOREHOLE TYPE Tripod/Hilti		COMPILED BY MFA
DATUM Geodetic	DATE 2010.01.18 - 2010.01.19		CHECKED BY LRB

ELEV / DEPTH	DESCRIPTION	SAMPLE NUMBER	TYPE	"N" VALUES	ELEVATION SCALE	UNIT WEIGHT kN/m3	REMARKS & GRAIN SIZE DISTRIBUTION (%)
193.5	GROUND SURFACE						
0.0 / 193.0	**PEAT** (450mm)	1	SS	19			
0.5 / 192.4	**SAND**, trace silt, trace gravel, occasional rootlets. Compact. Dark Brown to Brown. Occasional cobbles				193	FI	
1.0	**BEDROCK**, granitic gneiss, fresh, medium to coarse grained, very strong, dark grey/black/white. Occasional mechanical breaks. Horizontal joint at 1.09m.	1	RUN		192	1, 0, 0, 0, 0	RUN #1 TCR=100% SCR=100% RQD=80% UCS=114MPa
	Vertical joint at 2.64 to 3.00m.	2	RUN		191	0, 1, 1	RUN #2 TCR=100% SCR=100% RQD=100% UCS=167MPa
189.4		3	RUN		190	0, 0, 0	RUN #3 TCR=100% SCR=100% RQD=100% UCS=108MPa
4.1	END OF BOREHOLE AT 4.1 m. BOREHOLE OPEN TO 4.1 m AND WATER LEVEL AT 0.9 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)
2010.01.28	1.4	192.1

Chart headings: 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; GR SA SI CL.

$+^3, \times^3$: Numbers refer to Sensitivity   15-5 / 20 / 10 (%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BH10-39

METRIC

W.P. 5076-06-00 | LOCATION N 5 056 653.0 E 234 699.5 | ORIGINATED BY GA

HWY 69 | BOREHOLE TYPE Tripod/Hilti | COMPILED BY MFA

DATUM Geodetic | DATE 2010.01.19 - 2010.01.19 | CHECKED BY LRB

ELEV DEPTH	SOIL PROFILE DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa	WATER CONTENT (%)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
194.1	GROUND SURFACE										
0.0	**PEAT** (100 mm)		1	SS	50/ 100		194		o	FI	
0.1	**BEDROCK**, granitic gneiss, fresh, medium to coarse grained, strong to very strong, black/white/salmon. Occasional mechanical breaks. Horizontal joints at 0.79 and 0.81mm.		1	RUN		∇				0, 2, 0	RUN #1 TCR=100% SCR=97% RQD=97% UCS=98MPa
			2	RUN			193			0, 0, 0	RUN #2 TCR=100% SCR=100% RQD=100% UCS=216MPa
	Biotite seam at 2.62 to 2.69m.		3	RUN			192			0, 0, 0	RUN #3 TCR=100% SCR=100% RQD=100% UCS=162MPa
191.0 3.0	END OF BOREHOLE AT 3.0 m. BOREHOLE OPEN TO 3.0 m AND WATER LEVEL AT 0.6 m UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO SURFACE.									0	

Legend: DCPT plot scale 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

$+^3$, $\times^3$: Numbers refer to Sensitivity — 20 / 15 ⊕ 5 / 10 (%) STRAIN AT FAILURE

Ministry of Transportation Ontario

THURBER

RECORD OF BOREHOLE No BH10-40

METRIC

W.P.	5076-06-00	LOCATION	N 5 056 654.4 E 234 688.2	ORIGINATED BY	GA
HWY	69	BOREHOLE TYPE	Tripod/Hilti	COMPILED BY	MFA
DATUM	Geodetic	DATE	2010.01.18 - 2010.01.18	CHECKED BY	LRB

ELEV / DEPTH	SOIL PROFILE DESCRIPTION	STRAT PLOT	SAMPLE NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	UNIT WEIGHT (kN/m³)	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
194.6	GROUND SURFACE								
0.0	**PEAT** (100 mm)								
0.1	**SAND**, trace silt, occasional rootlets Loose to Compact Brown Wet Boulder at 0.7m (100mm)		1	SS	7				
			2	SS	50/ .075	∇	194		
193.4 / 1.3	**BEDROCK**, granitic gneiss, fresh, coarse grained, strong to very strong, dark grey/black/white/salmon Occasional mechanical breaks. Horizontal joints at 1.32 and 1.37m.		3	SS	50/ .050			FI 2	
			1	RUN			193	0 0 0	RUN #1 TCR=100% SCR=100% RQD=91% UCS=142MPa
			2	RUN			192	0 0 0 0	RUN #2 TCR=100% SCR=100% RQD=100% UCS=114MPa
190.5			3	RUN			191	0 0	RUN #3 TCR=100% SCR=100% RQD=100% UCS=77MPa
4.2	END OF BOREHOLE AT 4.2 m. BOREHOLE OPEN TO 4.2 m AND WATER LEVEL AT 0.8 m UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO SURFACE.								

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

+³, ×³: Numbers refer to Sensitivity

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

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BH10-41

METRIC

W.P. 5076-06-00	LOCATION N 5 056 656.1 E 234 693.2	ORIGINATED BY GA
HWY 69	BOREHOLE TYPE Tripod/Hilti	COMPILED BY MFA
DATUM Geodetic	DATE 2010.01.18 - 2010.01.18	CHECKED BY LRB

ELEV DEPTH	DESCRIPTION	STRAT PLOT	SAMPLE NUMBER	SAMPLE 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
195.3	GROUND SURFACE										
0.0	**PEAT** (100mm)		1	SS	50/.075				>>○		
0.1 0.2	**SAND**, trace silt, occasional rootlets Loose Brown Moist										
	END OF BOREHOLE AT 0.2 m UPON REFUSAL ON PROBABLE BEDROCK OR BOULDER. BOREHOLE OPEN AND DRY TO 0.2 m. BOREHOLE BACKFILLED WITH CUTTINGS TO SURFACE.										

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

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

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BH10-42

METRIC

W.P. 5076-06-00	LOCATION N 5 056 657.7 E 234 697.9		ORIGINATED BY GA
HWY 69	BOREHOLE TYPE Tripod/Hilti		COMPILED BY MFA
DATUM Geodetic	DATE 2010.01.19 - 2010.01.19		CHECKED BY LRB

ELEV DEPTH	SOIL PROFILE 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
196.2	GROUND SURFACE										
0.0	**PEAT** (100 mm)										
0.1	**SAND**, trace silt, occasional rootlets, organic odour Loose to Compact Brown to Dark Brown Damp to Moist		1	SS	7		196		○		
			2	SS	15				○		
195.1 1.1	END OF BOREHOLE AT 1.1 m UPON REFUSAL ON PROBABLE BEDROCK. BOREHOLE OPEN AND DRY TO 1.1 m. BOREHOLE BACKFILLED WITH CUTTINGS TO SURFACE.										

+³, ×³: Numbers refer to Sensitivity

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

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No NL10-01

METRIC

W.P. 5076-06-00 | LOCATION N 5 056 544.5 E 234 724.1 | ORIGINATED BY SLL
HWY 69 | BOREHOLE TYPE BW Casing - Split Spoon/AQ Core | COMPILED BY LRB
DATUM Geodetic | DATE 2010.08.10 - 2010.08.11 | CHECKED BY AEG

ELEV / DEPTH	DESCRIPTION	NUMBER	TYPE	"N" VALUES	ELEVATION SCALE	FI	REMARKS
182.1	LAKE SURFACE						
0.0	**WATER**				182		
178.4 / 3.7	Silty **CLAY** Soft to firm Grey				178		
177.1 / 5.0	Silty **SAND**, trace gravel, occasional cobbles Dense to very dense Grey Moist	1	SS	34	177		
		2	SS	50 / 0.075	176		
175.0 / 7.1	**BEDROCK**, granitic gneiss, very strong Sub-horizontal joints at 7.2, 7.3, 7.4, 7.5, and 7.7 m	1	RUN		175	2, 2	RUN #1 TCR=100% SCR=100% RQD=88% UCS=158.4MPa
		2	RUN		174	2, 5, 2, 3	RUN #2 TCR=100% SCR=95% RQD=68% UCS=136.9MPa
	Vertical joint from 8.89 to 8.94 m Quartz vein from 9.04 to 9.14 m	3	RUN		173	1, 1, 1	RUN #3 TCR=100% SCR=100% RQD=100% UCS=168.3MPa

Column headings: 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/m³; REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL

Continued Next Page

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

ONTMT4S 6121(NAISCOOT LAKE).GPJ 5/3/12

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No NL10-01

METRIC

W.P. 5076-06-00 LOCATION N 5 056 544.5 E 234 724.1 ORIGINATED BY SLL

HWY 69 BOREHOLE TYPE BW Casing - Split Spoon/AQ Core COMPILED BY LRB

DATUM Geodetic DATE 2010.08.10 - 2010.08.11 CHECKED BY AEG

SOIL PROFILE: ELEV / DEPTH	SOIL PROFILE: 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										
171.9							172			2	
10.2	END OF BOREHOLE AT 10.2 m. BOREHOLE BACKFILLED WITH BENTONITE TO 6.1 m.										

ONTMT4S 6121(NAISCOOT LAKE).GPJ 5/3/12

+ 3, × 3: Numbers refer to Sensitivity

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

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No NL10-02

METRIC

W.P. 5076-06-00
LOCATION N 5 056 548.1 E 234 722.6
ORIGINATED BY SLL

HWY 69
BOREHOLE TYPE BW Casing - Split Spoon/AQ Core
COMPILED BY LRB

DATUM Geodetic
DATE 2010.08.13 - 2010.08.13
CHECKED BY AEG

ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION / SHEAR STRENGTH kPa	WATER CONTENT (%)	UNIT WEIGHT γ kN/m³	GR	SA	SI	CL
182.1	LAKE SURFACE													
0.0	**WATER**						182, 181, 180, 179							
178.0 / 4.1	Silty **CLAY** Very soft Grey		1	GS			178		○ (approx. 62)					
177.0 / 5.1	Silty **SAND**, trace gravel Very dense Grey Moist		2	SS	63		177		○ (approx. 10)		7	56	33	4
			~~3~~	~~SS~~			176							
175.8 / 6.3	END OF BOREHOLE AT 6.3 m UPON REFUSAL ON PROBABLE BEDROCK.													

Plot legend: 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; REMARKS & GRAIN SIZE DISTRIBUTION (%)

+³, ×³: Numbers refer to Sensitivity   15-⊕-5 (20 above, 10 below) (%) STRAIN AT FAILURE

Ministry of Transportation Ontario

THURBER

RECORD OF BOREHOLE No NL10-03

METRIC

W.P. 5076-06-00	LOCATION N 5 056 550.8 E 234 722.8	ORIGINATED BY SLL
HWY 69	BOREHOLE TYPE BW Casing - Split Spoon/AQ Core	COMPILED BY LRB
DATUM Geodetic	DATE 2010.08.13 - 2010.08.13	CHECKED BY AEG

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	WATER CONTENT (%)	UNIT WEIGHT kN/m³	GR	SA	SI	CL
182.1	LAKE SURFACE												
0.0	**WATER**						182 / 181 / 180 / 179 / 178						
177.8 / 4.3	**SILT**, some clay, trace sand Very loose Grey Wet												
177.0			1	SS	50 / 0.05			○		3	6	81	10
5.1	END OF BOREHOLE AT 5.1 m UPON REFUSAL ON PROBABLE BEDROCK.												

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

REMARKS & GRAIN SIZE DISTRIBUTION (%)

+³, ×³: Numbers refer to Sensitivity

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

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No NL10-04

METRIC

W.P. 5076-06-00	LOCATION N 5 056 552.9 E 234 721.4	ORIGINATED BY SLL
HWY 69	BOREHOLE TYPE BW Casing - Split Spoon/AQ Core	COMPILED BY LRB
DATUM Geodetic	DATE 2010.08.11 - 2010.08.11	CHECKED BY AEG

ELEV / DEPTH (m)	DESCRIPTION	SAMPLE NUMBER	TYPE	"N" VALUES	ELEVATION SCALE	NATURAL MOISTURE CONTENT (%)	UNIT WEIGHT / FI	REMARKS
182.1	LAKE SURFACE							
0.0	**WATER**				182–178			
177.4 / 4.7	Silty **CLAY**, trace sand, trace organics. Very soft. Grey	1	GS		177	~40		
176.8 / 5.3		2	SS	50 / 0.05			FI	
	BEDROCK, granitic gneiss, fresh, strong	1	RUN				3, 2	RUN #1 TCR=100% SCR=100% RQD=63%
		2	RUN		176		0, 0, 1	RUN #2 TCR=100% SCR=100% RQD=100%
		3	RUN		175, 174		0, 0, 3, 2, 0	RUN #3 TCR=100% SCR=100% RQD=96%
173.8 / 8.3	END OF BOREHOLE AT 8.3 m. BOREHOLE BACKFILLED WITH BENTONITE TO 5.2m.							

Column headings: SOIL PROFILE; SAMPLES; GROUND WATER CONDITIONS; 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

+³, ×³: Numbers refer to Sensitivity

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

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No NL10-05

METRIC

W.P. 5076-06-00	LOCATION N 5 056 544.7 E 234 727.2	ORIGINATED BY SLL	
HWY 69	BOREHOLE TYPE BW Casing - Split Spoon/AQ Core	COMPILED BY LRB	
DATUM Geodetic	DATE 2010.08.13 - 2010.08.13	CHECKED BY AEG	

ELEV / DEPTH	DESCRIPTION	NUMBER	TYPE	"N" VALUES	WATER CONTENT (%)	GR	SA	SI	CL
182.1	LAKE SURFACE								
0.0	**WATER**								
178.6 / 3.5	Silty **CLAY**, Very soft, Grey, (CI)	1	GS			0	1	44	55
177.6 / 4.5	Sandy **SILT**, trace gravel, Loose, Grey, Moist	2	SS	7					
176.9 / 5.2	Silty **SAND**, trace gravel, occasional cobbles, Very dense, Grey, Moist	3	SS	50 / 0.1					
176.2 / 5.9	**BEDROCK**								
176.0 / 6.1	END OF BOREHOLE AT 6.1 m.								

Column headings: SOIL PROFILE; SAMPLES; STRAT PLOT; GROUND WATER CONDITIONS; ELEVATION SCALE (182, 181, 180, 179, 178, 177); 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

+³, ×³: Numbers refer to Sensitivity

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

Ministry of Transportation Ontario

THURBER

RECORD OF BOREHOLE No NL10-06

METRIC

W.P. 5076-06-00 — LOCATION N 5 056 548.7 E 234 726.4 — ORIGINATED BY SLL

HWY 69 — BOREHOLE TYPE BW Casing - Split Spoon/AQ Core — COMPILED BY LRB

DATUM Geodetic — DATE 2010.08.12 - 2010.08.12 — CHECKED BY AEG

ELEV / DEPTH	DESCRIPTION	SAMPLE NUMBER	TYPE	"N" VALUES	WATER CONTENT (%)	UNIT WEIGHT (FI)	REMARKS & GRAIN SIZE DISTRIBUTION (%)
182.1	LAKE SURFACE						
0.0	**WATER**						
178.4 / 3.7	Silty **CLAY**, Very soft, Grey	1	GS		(plotted)		
177.5 / 4.6	Sandy **SILT**, trace gravel, Very dense, Grey, Moist to wet	2	SS	50 / 0.08	(plotted)	FI	
177.3 / 4.8	**BEDROCK**, granitic gneiss, fresh, very strong. Sub-vertical joints at 5.41 to 5.43 m, 6.12 to 6.15 m, 6.25 to 6.32 m, and 6.45 to 6.48 m	1	RUN			3, 1, 0, 0, 4	RUN #1 TCR=100% SCR=98% RQD=87% UCS=128.5MPa
		2	RUN			1, 3	RUN #2 TCR=100% SCR=100% RQD=79% UCS=193.0MPa
	Quartz veins at 7.67 to 7.72 m and 7.92 to 8.08 m	3	RUN			2, 2, 1, 1	RUN #3 TCR=100% SCR=100% RQD=100% UCS=187.0MPa
174.0 / 8.1	END OF BOREHOLE AT 8.1 m. BOREHOLE BACKFILLED WITH BENTONITE TO 4.8m.						

Elevation scale: 182, 181, 180, 179, 178, 177, 176, 175

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 kN/m³ — GR SA SI CL

$+^3, \times^3$: Numbers refer to Sensitivity — 15-20-5-10 (%) STRAIN AT FAILURE

Ministry of Transportation Ontario

THURBER

RECORD OF BOREHOLE No NL10-07

METRIC

W.P. 5076-06-00 | LOCATION N 5 056 551.6 E 234 726.1 | ORIGINATED BY SLL

HWY 69 | BOREHOLE TYPE BW Casing - Split Spoon/AQ Core | COMPILED BY LRB

DATUM Geodetic | DATE 2010.08.12 - 2010.08.12 | CHECKED BY AEG

ELEV / DEPTH	DESCRIPTION	SAMPLE NUMBER	TYPE	"N" VALUES	ELEVATION SCALE	WATER CONTENT (%)	UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)
182.1	LAKE SURFACE							
0.0	**WATER**				182, 181, 180, 179			
178.1 / 3.9	Silty **CLAY**, Very soft, Grey	1	GS		178	~38		
177.4 / 4.7	Silty **SAND**, trace gravel, Very dense, Grey, Moist	2	SS	66	177	~10		
176.3 / 5.8	Occasional cobbles; **BEDROCK**, granitic gneiss, very strong	1	RUN		176		FI 1, 0	RUN #1 TCR=100% SCR=100% RQD=100% UCS=221.9MPa
		2	RUN		175		1, 2, 0	RUN #2 TCR=100% SCR=100% RQD=98% UCS=218.0MPa
	Sub-vertical joint at 7.54 to 7.62 m and 7.87 to 7.92 m	3	RUN		174		3, 1, 2, 2, 5	RUN #3 TCR=100% SCR=100% RQD=67% UCS=118.1MPa
173.2 / 8.9	END OF BOREHOLE AT 8.9 m. BOREHOLE BACKFILLED WITH BENTONITE TO 5.5m.							

Legend: 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; GR SA SI CL

$+^3, \times^3$: Numbers refer to Sensitivity; 15-20-5-10: (%) STRAIN AT FAILURE

Ministry of Transportation Ontario

THURBER

RECORD OF BOREHOLE No NL10-08

METRIC

W.P. 5076-06-00	LOCATION N 5 056 553.5 E 234 726.1		ORIGINATED BY SLL
HWY 69	BOREHOLE TYPE BW Casing - Split Spoon/AQ Core		COMPILED BY LRB
DATUM Geodetic	DATE 2010.08.13 - 2010.08.13		CHECKED BY AEG

ELEV DEPTH	DESCRIPTION	SAMPLE NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	WATER CONTENT (%)	UNIT WEIGHT (kN/m³)	GR	SA	SI	CL
182.1	LAKE SURFACE										
0.0	**WATER**										
178.0 4.1	Silty **CLAY** Very soft Grey	1	GS			~45					
177.4 4.7	Silty **SAND**, trace gravel Very dense Grey Moist	2	SS	56		~12		5	53	37	5
176.5 5.5	Probable **BEDROCK**										
176.4 5.7	END OF HOLE AT 5.7 m.										

Plot headings: 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); ELEVATION SCALE 182, 181, 180, 179, 178, 177; REMARKS & GRAIN SIZE DISTRIBUTION (%).

+ ³, × ³: Numbers refer to Sensitivity

15 ⊕ 5 (20 above, 10 below): (%) STRAIN AT FAILURE

ONTMT4S 6121(NAISCOOT LAKE).GPJ 5/3/12

Ministry of Transportation Ontario

THURBER

RECORD OF BOREHOLE No NL10-09

METRIC

W.P. 5076-06-00	LOCATION N 5 056 544.4 E 234 730.8	ORIGINATED BY	SLL
HWY 69	BOREHOLE TYPE BW Casing - Split Spoon/AQ Core	COMPILED BY	LRB
DATUM Geodetic	DATE 2010.08.10 - 2010.08.10	CHECKED BY	AEG

ELEV / DEPTH	DESCRIPTION	SAMPLE NUMBER	TYPE	"N" VALUES	UNIT WEIGHT (FI)	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
182.1	LAKE SURFACE					
0.0	**WATER**					
178.8 / 3.3	Silty **CLAY**, Very soft to firm, Grey	1	SS	13		
177.4 / 4.7	Silty **SAND**, trace gravel, Compact to dense, Grey, Moist				FI	
176.9 / 5.2	**BEDROCK**, granitic gneiss, fresh, very strong	1	RUN		2, 1	RUN #1 TCR=100% SCR=100% RQD=80% UCS=124.8MPa
		2	RUN		3, 4, 3	RUN #2 TCR=100% SCR=100% RQD=50% UCS=131.9MPa
	Vertical joints at 6.61 to 6.93 m and 7.09 to 7.42 m	3	RUN		2	RUN #3 TCR=100% SCR=0% RQD=0%
		4	RUN		6, 1	RUN #4 TCR=100% SCR=60% RQD=43%
		5	RUN		6, 2, 0	RUN #5 TCR=100% SCR=88% RQD=88% UCS=192MPa
173.6 / 8.5	END OF BOREHOLE AT 8.5 m. BOREHOLE BACKFILLED WITH BENTONITE TO 5.2 m.					

Column headings: SOIL PROFILE; STRAT PLOT; SAMPLES; GROUND WATER CONDITIONS; ELEVATION SCALE (182, 181, 180, 179, 178, 177, 176, 175, 174); 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

+ ³, × ³ : Numbers refer to Sensitivity

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

Ministry of Transportation Ontario

THURBER

RECORD OF BOREHOLE No NL10-10

METRIC

W.P. 5076-06-00	LOCATION N 5 056 549.9 E 234 729.9	ORIGINATED BY SLL
HWY 69	BOREHOLE TYPE BW Casing - Split Spoon/AQ Core	COMPILED BY LRB
DATUM Geodetic	DATE 2010.08.14 - 2010.08.14	CHECKED BY AEG

ELEV / DEPTH	DESCRIPTION	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	WATER CONTENT (%)	UNIT WEIGHT kN/m³	GR	SA	SI	CL
182.1	LAKE SURFACE											
0.0	**WATER**					182						
178.5 / 3.6	Silty **CLAY**, Very Soft, Grey	1	GS									
177.9 / 4.2	Sandy **SILT**, trace clay, Loose, Grey, Moist to wet	2	SS	4					2	29	65	4
177.0 / 5.1	END OF BOREHOLE AT 5.1 m UPON AUGER REFUSAL ON PROBABLE BEDROCK.											

Column headings: SOIL PROFILE; SAMPLES; STRAT PLOT; 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/m³; REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL.

Elevation scale: 182, 181, 180, 179, 178

+³, ×³: Numbers refer to Sensitivity

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

Ministry of Transportation Ontario

THURBER

RECORD OF BOREHOLE No NL10-11

METRIC

W.P. 5076-06-00 | LOCATION N 5 056 552.3 E 234 729.5 | ORIGINATED BY SLL

HWY 69 | BOREHOLE TYPE BW Casing - Split Spoon/AQ Core | COMPILED BY LRB

DATUM Geodetic | DATE 2010.08.14 - 2010.08.14 | CHECKED BY AEG

ELEV / DEPTH	DESCRIPTION	SAMPLE NUMBER	TYPE	"N" VALUES	ELEVATION SCALE	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
182.1	LAKE SURFACE					
0.0	**WATER**				182, 181, 180, 179	
178.4 / 3.7	**SILT**, some clay, some sand; Very loose; Grey; Wet	1	GS		178	0 10 78 12
177.9 / 4.2		2	SS			
177.7 / 4.4	Silty **SAND**, trace gravel; Loose to compact; Grey; Moist to wet					
	END OF BOREHOLE AT 4.4 m UPON REFUSAL ON PROBABLE BEDROCK.					

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

+³, ×³: Numbers refer to Sensitivity

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

Ministry of Transportation Ontario

THURBER

RECORD OF BOREHOLE No NL10-12

METRIC

W.P. 5076-06-00 LOCATION N 5 056 554.6 E 234 728.7 ORIGINATED BY SLL

HWY 69 BOREHOLE TYPE BW Casing - Split Spoon/AQ Core COMPILED BY LRB

DATUM Geodetic DATE 2010.08.11 - 2010.08.12 CHECKED BY AEG

ELEV / DEPTH	DESCRIPTION	SAMPLE NUMBER	TYPE	"N" VALUES	NATURAL MOISTURE CONTENT (WATER CONTENT %)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
182.1	LAKE SURFACE						
0.0	**WATER**						
178.2 / 3.9	Sandy **SILT**, some clay Very loose to dense Grey Wet	1	SS	50 / 0.15	o (approx. 25)		
177.5 / 4.5	**BEDROCK**, granitic gneiss, fresh, very strong Vertical joint at 4.62 to 4.70 m	1	RUN			FI 5 1 2	RUN #1 TCR=100% SCR=93% RQD=85% UCS=231.2MPa
		2	RUN			2 2 2	RUN #2 TCR=100% SCR=100% RQD=92% UCS=180.5MPa
		3	RUN			2 1 3 1 1	RUN #3 TCR=100% SCR=100% RQD=90% UCS=155.2MPa
174.3 / 7.7	END OF BOREHOLE AT 7.7 m. BOREHOLE BACKFILLED WITH BENTONITE TO 4.3m.						

Elevation scale: 182, 181, 180, 179, 178, 177, 176, 175

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

+ ³, × ³ : Numbers refer to Sensitivity

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

Appendix B

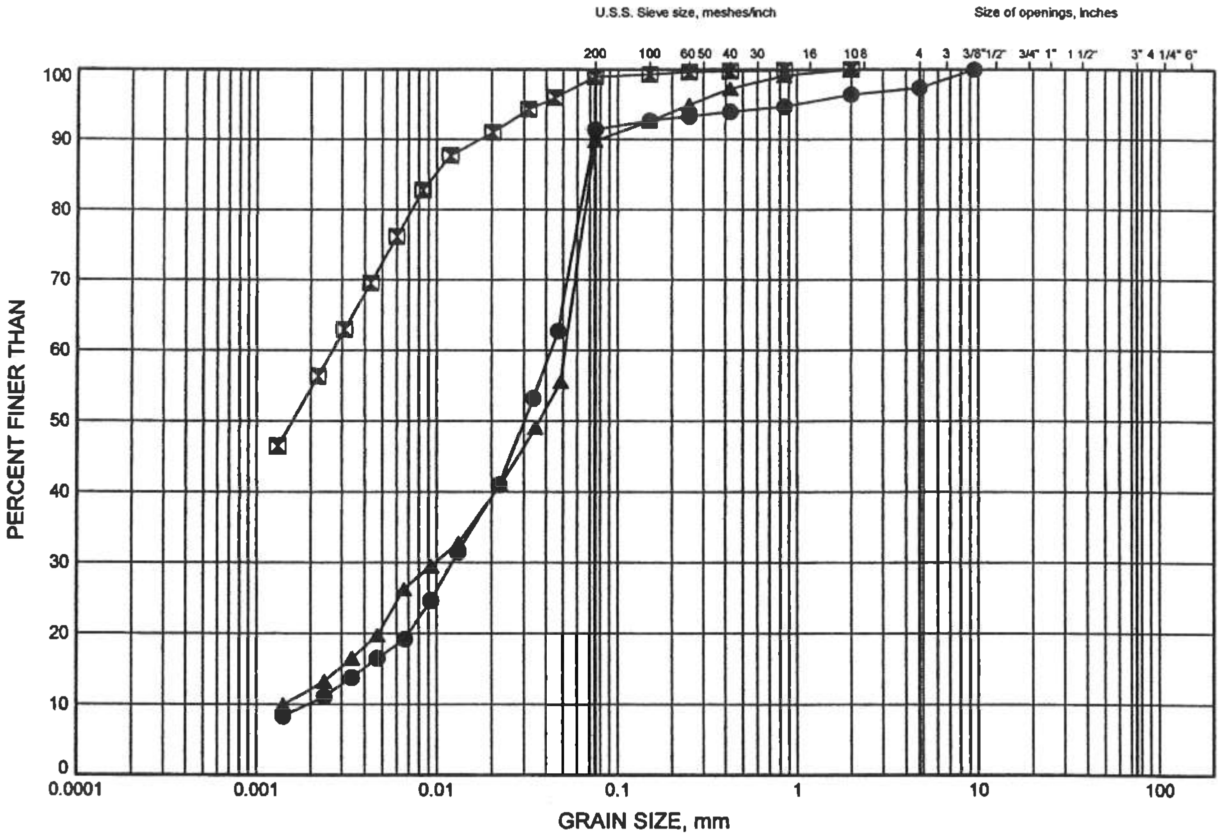
Laboratory Test Results

Hwy 69 Four-Laning North of Hwy 529

GRAIN SIZE DISTRIBUTION

FIGURE B1

Silty Clay to Clayey Silt



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	NL10-03	5.03	177.06
⊠	NL10-05	3.89	178.23
▲	NL10-11	3.96	178.13

W.P.# 5076-06-00

Prepared By LRB

Checked By AEG

THURBER

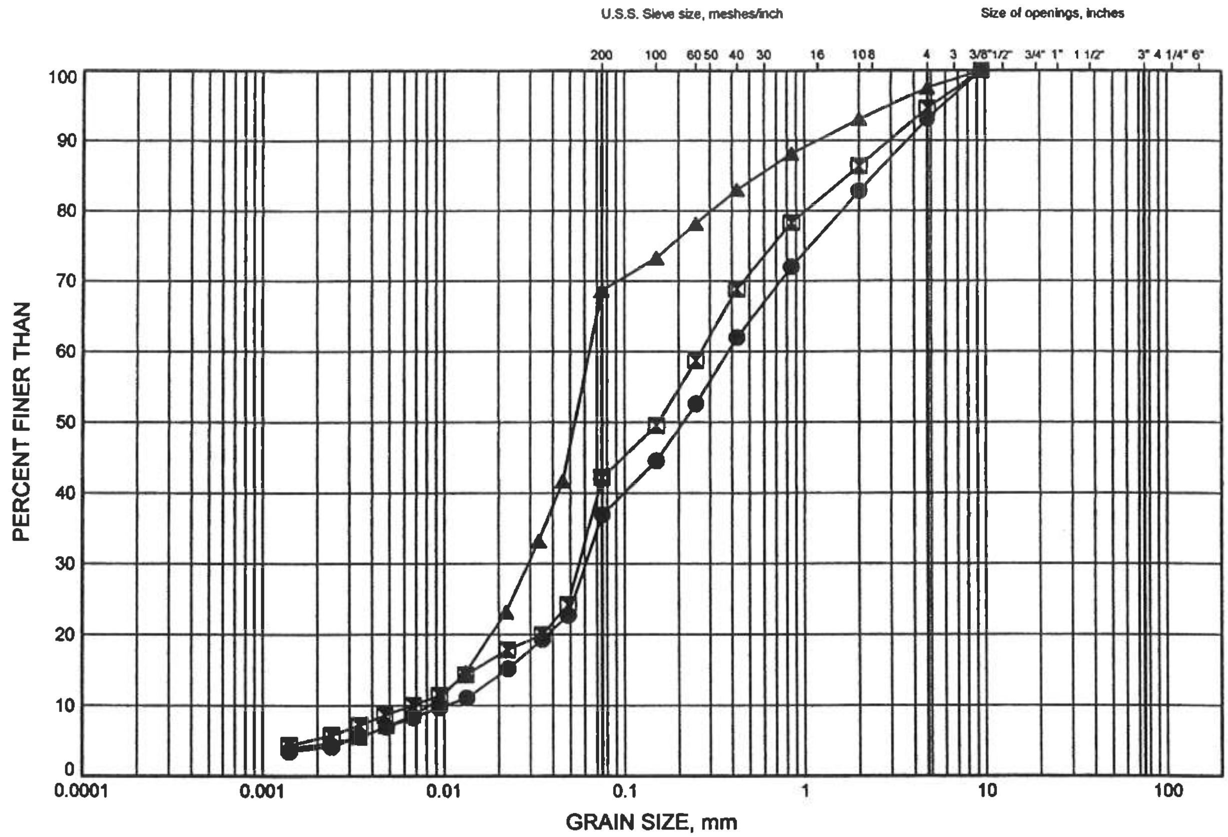
GRAIN SIZE DISTRIBUTION - THURBER 6121(NAISCOOT LAKE) PEAT.GPJ 9/14/10

Hwy 69 Four-Laning North of Hwy 529

GRAIN SIZE DISTRIBUTION

FIGURE B2

Sandy Silt to Silty Sand



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	NL10-02	5.31	176.81
⊠	NL10-08	5.23	176.86
▲	NL10-10	4.44	177.64

W.P.# 5076-06-00

Prepared By LRB

Checked By AEG

THURBER

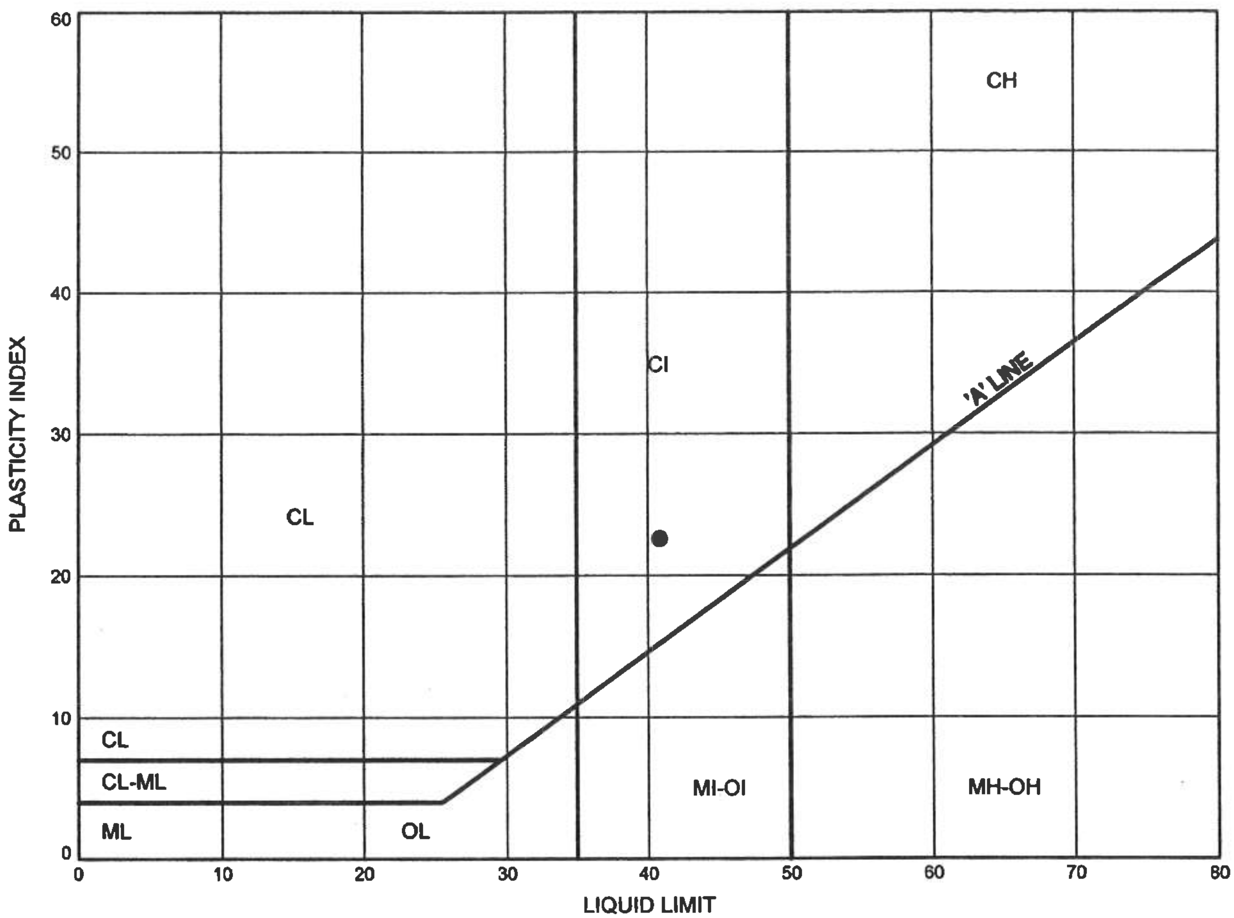
GRAIN SIZE DISTRIBUTION - THURBER 6121(NAISCOOT LAKE) PEAT.GPJ 9/14/10

Hwy 69 Four-Laning North of Hwy 529

ATTERBERG LIMITS TEST RESULTS

FIGURE B3

Silty Clay to Clayey Silt



SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	NL10-05	3.89	178.23

THURBALT 6121(NAISCOOT LAKE) PEAT.GPJ 9/14/10

Date September 2010

Project 5076-06-00

THURBER

Prep'd LRB

Chkd. AEG

TABLE 1 - Point Load Test Results

NAISCOOT LAKE BRIDGE - SBL

HWY 69 FOUR-LANING

FROM THE SOUTH JUNCTION OF HIGHWAY 69 AND HIGHWAY 529, NORTHERLY 15 KM

BH10-03	DEPTH			FORCE	AXIAL /	DIAMETER	LENGTH		CONCLUSIONS	
	FT.	IN.	METERS	(kN)	DIAMETRIC	(mm)	(mm)	UCS (Mpa)		
RUN # 1	1	2	0.36	11.8	D	50.38	-	111.96		
RUN # 2	4	9	1.45	9.0	D	50.51	-	85.05		
RUN # 3	9	1	2.77	23.0	D	50.62	-	216.62		
										AVERAGE
									RUN #1:	112
									RUN #2:	85
									RUN #3:	217

BH10-04	DEPTH			FORCE	AXIAL /	DIAMETER	LENGTH		CONCLUSIONS	
	FT.	IN.	METERS	(kN)	DIAMETRIC	(mm)	(mm)	UCS (Mpa)		
RUN # 1	1	6	0.46	22.8	D	51.21	-	210.92		
RUN # 2	5	3	1.60	11.2	D	51.31	-	103.30		
RUN # 3	9	8	2.95	11.8	D	51.40	-	108.53		
										AVERAGE
									RUN #1:	211
									RUN #2:	103
									RUN #3:	109

BH10-05	DEPTH			FORCE	AXIAL /	DIAMETER	LENGTH		CONCLUSIONS	
	FT.	IN.	METERS	(kN)	DIAMETRIC	(mm)	(mm)	UCS (Mpa)		
RUN # 1	1	4	0.41	14.0	D	51.04	-	130.18		
RUN # 2	6	3	1.91	12.8	D	51.95	-	115.80		
RUN # 3	9	1	2.77	22.2	D	52.06	-	200.19		
										AVERAGE
									RUN #1:	130
									RUN #2:	116
									RUN #3:	200

BH10-13	DEPTH			FORCE	AXIAL /	DIAMETER	LENGTH		CONCLUSIONS	
	FT.	IN.	METERS	(kN)	DIAMETRIC	(mm)	(mm)	UCS (Mpa)		
RUN # 1	2	0	0.61	11.3	D	47.71	-	116.66		
RUN # 2	5	7	1.70	15.1	D	50.53	-	142.61		
RUN # 3	8	9	2.67	18.1	D	50.83	-	169.38		
RUN # 4	11	0	3.35	18.5	D	50.79	-	173.34		
										AVERAGE
									RUN #1:	117
									RUN #2:	143
									RUN #3:	169
									RUN #4:	173

TABLE 1 - Point Load Test Results

NAISCOOT LAKE BRIDGE - SBL

HWY 69 FOUR-LANING

FROM THE SOUTH JUNCTION OF HIGHWAY 69 AND HIGHWAY 529, NORTHERLY 15 KM

BH10-14	DEPTH			FORCE	AXIAL /	DIAMETER	LENGTH		CONCLUSIONS	
	FT.	IN.	METERS	(kN)	DIAMETRIC	(mm)	(mm)	UCS (Mpa)		
RUN # 1	7	5	2.26	15.0	D	50.63	-	141.23		
RUN # 2	11	2	3.40	9.8	D	50.93	-	91.43		
RUN # 3	14	2	4.32	14.4	D	50.91	-	134.43		
										AVERAGE
									RUN #1:	141
									RUN #2:	91
									RUN #3:	134

BH10-18	DEPTH			FORCE	AXIAL /	DIAMETER	LENGTH		CONCLUSIONS	
	FT.	IN.	METERS	(kN)	DIAMETRIC	(mm)	(mm)	UCS (Mpa)		
RUN # 1	2	7	0.79	15.7	D	51.21	-	145.24		
RUN # 2	6	9	2.06	21.0	D	51.18	-	194.44		
RUN # 3	9	2	2.79	17.6	D	51.22	-	162.76		
										AVERAGE
									RUN #1:	145
									RUN #2:	194
									RUN #3:	163

BH10-25	DEPTH			FORCE	AXIAL /	DIAMETER	LENGTH		CONCLUSIONS	
	FT.	IN.	METERS	(kN)	DIAMETRIC	(mm)	(mm)	UCS (Mpa)		
RUN # 1	5	3	1.60	13.1	D	50.70	-	123.08		
RUN # 2	7	7	2.31	13.9	D	50.72	-	130.52		
RUN # 3	12	2	3.71	16.8	D	50.89	-	156.93		
										AVERAGE
									RUN #1:	123
									RUN #2:	131
									RUN #3:	157

BH10-29	DEPTH			FORCE	AXIAL /	DIAMETER	LENGTH		CONCLUSIONS	
	FT.	IN.	METERS	(kN)	DIAMETRIC	(mm)	(mm)	UCS (Mpa)		
RUN # 1	3	6	1.07	11.5	D	50.69	82.45	108.08		
RUN # 2	7	8	2.34	2.0	D	50.84	140.79	18.71		
Retest # 2	5	2	1.57	15.2	D	50.80	166.00	142.37		
RUN # 3	9	5	2.87	10.8	D	50.59	120.82	101.81		
										AVERAGE
									RUN #1:	108
									RUN #2:	81
									RUN #3:	102

TABLE 1 - Point Load Test Results

NAISCOOT LAKE BRIDGE - SBL

HWY 69 FOUR-LANING

FROM THE SOUTH JUNCTION OF HIGHWAY 69 AND HIGHWAY 529, NORTHERLY 15 KM

BH10-30	DEPTH			FORCE	AXIAL /	DIAMETER	LENGTH		CONCLUSIONS	
	FT.	IN.	METERS	(kN)	DIAMETRIC	(mm)	(mm)	UCS (Mpa)		
RUN # 1	2	10	0.86	18.2	D	50.96	112.07	169.64		
RUN # 2	6	5	1.96	6.0	D	51.08	119.04	55.72		
Retest # 2	6	0	1.83	15.5	D	50.80	89.52	145.18		
RUN # 3	7	11	2.41	20.9	D	50.78	101.03	195.88		
										AVERAGE
									RUN #1:	170
									RUN #2:	100
									RUN #3:	196

BH10-38	DEPTH			FORCE	AXIAL /	DIAMETER	LENGTH		CONCLUSIONS	
	FT.	IN.	METERS	(kN)	DIAMETRIC	(mm)	(mm)	UCS (Mpa)		
RUN # 1	5	5	1.65	12.1	D	50.56	-	114.17		
RUN # 2	8	3	2.51	17.8	D	50.72	-	167.13		
RUN # 3	12	5	3.78	11.5	D	50.61	-	108.34		
										AVERAGE
									RUN #1:	114
									RUN #2:	167
									RUN #3:	108

BH10-39	DEPTH			FORCE	AXIAL /	DIAMETER	LENGTH		CONCLUSIONS	
	FT.	IN.	METERS	(kN)	DIAMETRIC	(mm)	(mm)	UCS (Mpa)		
RUN # 1	2	11	0.89	10.4	D	50.67	-	97.80		
RUN # 2	5	3	1.60	23.0	D	50.68	-	216.22		
RUN # 3	9	2	2.79	17.2	D	50.67	-	161.75		
										AVERAGE
									RUN #1:	98
									RUN #2:	216
									RUN #3:	162

BH10-40	DEPTH			FORCE	AXIAL /	DIAMETER	LENGTH		CONCLUSIONS	
	FT.	IN.	METERS	(kN)	DIAMETRIC	(mm)	(mm)	UCS (Mpa)		
RUN # 1	6	11	2.11	15.0	D	50.51	-	141.75		
RUN # 2	9	3	2.82	12.1	D	50.57	-	114.14		
RUN # 3	12	10	3.91	4.2	D	50.61	-	39.57		
Retest #3	12	9	3.89	12.1	D	50.59	-	114.07		
										AVERAGE
									RUN #1:	142
									RUN #2:	114
									RUN #3:	77

TABLE 1 - Point Load Test Results

NAISCOOT LAKE BRIDGE - SBL

HWY 69 FOUR-LANING

FROM THE SOUTH JUNCTION OF HIGHWAY 69 AND HIGHWAY 529, NORTHERLY 15 KM

NL10-01	DEPTH			FORCE	AXIAL /	DIAMETER	LENGTH			
	FT.	IN.	METERS	(kN)	DIAMETRIC	(mm)	(mm)	UCS (Mpa)	CONCLUSIONS	
RUN #1	23	7	7.19	15.0	D	47.5	111.5	155.81		
	24	8	7.52	15.5	D	47.5	162.0	161.01		
RUN #2	26	4	8.03	17.0	A	47.5	57.0	127.19		
	27	7	8.41	18.5	A	47.5	79.5	106.95		
	27	10	8.48	17.0	D	47.5	153.5	176.59		
RUN #3	29	4	8.94	18.0	A	47.5	61.0	127.77		
	30	8	9.35	19.5	D	47.5	89.0	202.56		
	32	1	9.78	16.0	D	47.5	192.0	166.20		
	32	10	10.01	17.0	D	47.5	150.0	176.59		
										AVERAGE
									RUN #1:	158
									RUN #2:	137
									RUN #3:	168

NL10-06	DEPTH			FORCE	AXIAL /	DIAMETER	LENGTH			
	FT.	IN.	METERS	(kN)	DIAMETRIC	(mm)	(mm)	UCS (Mpa)	CONCLUSIONS	
RUN #1	15	9	4.80	21.5	A	47.8	96.0	106.90		
	16	8	5.08	23.0	D	47.8	302.5	236.75		
	17	9	5.41	20.0	A	47.8	300.5	41.07		
	20	4	6.20	18.5	A	47.8	62.0	129.09		
RUN #2	20	9	6.32	19.0	D	47.8	130.0	195.58		
	22	1	6.73	18.5	D	47.8	180.0	190.43		
RUN #3	23	3	7.09	19.5	D	47.8	230.0	200.72		
	24	6	7.47	20.0	D	47.8	145.5	205.87		
	26	2	7.98	15.0	D	47.8	102.0	154.40		
										AVERAGE
									RUN #1:	128
									RUN #2:	193
									RUN #3:	187

NL10-07	DEPTH			FORCE	AXIAL /	DIAMETER	LENGTH			
	FT.	IN.	METERS	(kN)	DIAMETRIC	(mm)	(mm)	UCS (Mpa)	CONCLUSIONS	
RUN #1	19	4	5.89	21.0	D	47.0	185.0	221.89		
RUN #2	21	9	6.63	20.5	D	47.0	235.5	216.61		
	22	7	6.88	22.4	D	47.0	280.0	236.69		
	24	1	7.34	19.0	D	47.0	180.5	200.76		
RUN #3	25	1	7.65	17.0	D	47.0	156.0	179.63		
	26	7	8.10	15.0	A	47.0	70.0	96.52		
	27	8	8.43	16.5	A	47.0	86.0	90.52		
	28	6	8.69	20.0	A	47.0	90.0	105.92		
										AVERAGE
									RUN #1:	222
									RUN #2:	218
									RUN #3:	118

TABLE 1 - Point Load Test Results

NAISCOOT LAKE BRIDGE - SBL
HWY 69 FOUR-LANING
FROM THE SOUTH JUNCTION OF HIGHWAY 69 AND HIGHWAY 529, NORTHERLY 15 KM

NL10-09	DEPTH			FORCE	AXIAL /	DIAMETER	LENGTH		CONCLUSIONS	
	FT.	IN.	METERS	(kN)	DIAMETRIC	(mm)	(mm)	UCS (Mpa)		
RUN #1	17	2	5.23	16.0	A	47.6	54.0	124.66		
RUN #2	19	0	5.79	21.5	D	47.6	109.0	222.75		
	20	4	6.20	12.5	A	47.6	72.0	77.93		
	21	6	6.55	17.5	A	47.6	86.5	94.64		
RUN #5	24	3	7.39	19.0	D	47.6	280.0	196.85		
	25	9	7.85	19.5	D	47.6	231.0	202.03		
	27	0	8.23	17.0	D	47.6	291.0	176.13		
										AVERAGE
									RUN #1:	125
									RUN #2:	132
									RUN #5:	192

NL10-12	DEPTH			FORCE	AXIAL /	DIAMETER	LENGTH		CONCLUSIONS	
	FT.	IN.	METERS	(kN)	DIAMETRIC	(mm)	(mm)	UCS (Mpa)		
RUN #1	16	3	4.95	23.0	D	47.5	158.0	239.07		
	17	5	5.31	21.5	D	47.5	146.0	223.48		
RUN #2	18	7	5.66	11.0	A	47.5	72.0	68.69		
	19	5	5.92	21.0	D	47.5	221.0	218.28		
	20	8	6.30	24.5	D	47.5	130.0	254.66		
RUN #3	21	5	6.53	20.0	D	47.5	104.0	207.89		
	23	1	7.04	18.0	D	47.5	136.0	187.10		
	24	2	7.37	17.0	A	47.5	69.0	109.72		
	25	5	7.75	19.0	A	47.5	74.0	116.15		
										AVERAGE
									RUN #1:	231
									RUN #2:	181
									RUN #3:	155

Appendix C

Foundation Comparison

COMPARISON OF FOUNDATION ALTERNATIVES FOR EACH FOUNDATION ELEMENT

Footing on Native Soil	**Footings on Bedrock**	**Drilled Piles** ***Considered only for Pier 2)***	**Drilled Shafts** ***Considered only for Pier 2)***
Advantages: i. Economical to install. ii. Ease of construction ***Disadvantages:*** i. Soil conditions encountered at this site are considered unsuitable. ii. Not suitable for integral abutment design.	***Advantages:*** i. High values of geotechnical resistance are available on the bedrock. ii. Conventional construction iii. Lower cost than deep foundations ***Disadvantages:*** i. Stepped footing may be required ii. High cost of excavation of bedrock. iii. In the case of Pier 2, there will be the high cost of cofferdam and construction below the lake level. iv. Mass concrete fill required to create a level founding surface. v. Some groundwater drainage may be required.	***Advantages:*** i. High geotechnical resistance available for units founded on bedrock. i. ***(Considered only for Pier 2)***. ***Disadvantages:*** i. Possibly higher unit cost compared to other foundation options such as footings ii. Difficulties in obtaining seal below the liner to pour concrete in dry conditions FEASIBLE BUT NOT RECOMMENDED	***Advantages:*** ii. High geotechnical resistance available for units founded on bedrock. iii. May be used to eliminate the need for a cofferdam . ***Disadvantages:*** iii. Higher unit cost compared to other foundation options such as footings or driven piles. iv. Difficulties in obtaining seal below the liner to pour concrete in dry conditions v. Potential difficulty in unwatering, cleaning and inspecting bases.
NOT RECOMMENDED/NOT VIABLE	**RECOMMENDED**	**FEASIBLE AT ABUTMENTS**	**NOT RECOMMENDED**

Appendix D

List of SPs and OPSS, and Suggested Text for Selected NSSP

1. List of Special Provisions and OPSS Documents Referenced in this Report

- OPSS 902 as modified by SP 902S01 (June 2006).
- OPSS 572
- OPSD 3101.150,
- OPSD 3101.200.
- SP 110F13 Amendment to OPSS 1010, March 1993.
- SP 105S10.

2. Suggested text for a NSSP on Dewatering

Excavations at the abutments will penetrate below the groundwater level.

The soils overlying the bedrock at this site are predominantly cohesionless and will be readily disturbed by unbalanced water heads or by flow of water.

The Contractor shall design, install and operate systems that shall:

1. Unwater the excavations
2. Control the flow of groundwater and surface water into the excavations
3. Prevent the disturbance of the base of the excavation
4. Prevent the sloughing of soil into the excavations.

1\. The selection and design of suitable unwatering and shoring systems shall remain the responsibility of the Contractor.

3. Suggested text for pile driving

Steel H-piles driven at this site must be founded on bedrock. All driven piles shall be fitted with cast steel, H-section rock points from an approved manufacturer such as Titus Steel (Standard H-point) or approved equivalent. Piles placed in rock sockets shall not be fitted with rock points.

NSP 98 Northeastern

REQUIREMENTS FOR BLASTING

1. GENERAL

1.1 The Contractor shall comply with OPSS 120 unless otherwise noted in the Contract.

1.2 For the purpose of work related to blasting, a Blasting Consultant is defined as: A Professional Engineer licensed to practice in the Province of Ontario with a minimum of five years (5) experience related to blasting.

The Blasting Consultant shall be retained by the Contractor and shall be independent of the Contractor and any subcontractor doing blasting work. The Blasting Consultant shall be required to complete the specified monitoring of vibration levels and provide a report detailing the vibration levels and copies of the recorded ground vibration documents to the Contractor and the Contract Administrator immediately following each blast and prior to the next blast.

1.3 All blasting shall be designed and carried out in a manner, such that no damage occurs to the buildings or equipment.

1.4 Under no circumstances will the Contractor blast within the vicinity of any TransCanada Pipelines, Union Gas Pipelines, Ontario Hydro lines and Bell Fibre optics lines without a representative from TransCanada Pipelines, Ontario Hydro or Bell Canada on site.

The Contractor shall notify the following appropriate representative 72 hours in advance of blasting.

<u>* Fill - in as appropriate for the project</u>

Hydro One Networks Inc.
45 Sarjeant Drive
Box 6700
Barrie, ON
L4M 5N5

Attn: Arthur Conlon
Telephone : (888) 238-2398
Fax: (705) 746-7293

Bell Canada
9 High Street
Huntsville, ON
P1H 1P2

Attn: Timothy Beachy
Telephone: (705) 789-9638
Fax: (705) 789-6223

The Contractor shall notify the following appropriate representative 10 days in advance of blasting.

<u>* Fill - in as appropriate for the project</u>

TransCanada Pipelines Ltd.
801 Seventh Avenue S.W.
P.O. Box 2535, Station M
Calgary, Alberta

T2P 2N6

Attn: Elio Ramos
Telephone: (403) 261-8256
<u>and</u> Ron Marsh
(705) 840-7454

Union Gas Limited
P.O. Box 3040
36 Charles Street East
North Bay, ON
P1B 8K7

Attn: Jeff Peroff
Telephone: (705) 475-7923
Fax: (866) 252-2012

2.0 DESIGN AND SUBMISSION REQUIREMENTS

2.1 Section 120.04.02 b) iii is deleted and replaced with:

A letter signed by the Contractor certifying that a pre-blast survey has been carried out in accordance with the Pre-Blast Survey subsection. A copy of the pre-blast survey shall be provided to the Contract Administrator.

3.0 EQUIPMENT

3.1 Section 120.06.02 is amended by the addition of the following:

The transducer used to measure ground vibration levels shall be coupled to the ground by either pinning or burying.

4.0 CONSTRUCTION

4.1 The last bullet (c) of Section 120.07.03 is deleted and replaced with the following:

(c) Clear quality 35 mm photographs and/or DVD videos, and written report necessary for proper recording of areas of concern and condition of the property. Photographs and DVDs shall be clearly labeled as to location.

4.2 Section 120.07.03 is amended by the addition of the following:

The contractor will be supplied with a "Permission to Enter For Pre-Blast and Post-Blast Inspection" form that the contractor shall use to record the permission to carry out an inspection.

4.3 Section 120.07.05.02 is amended by the addition of the following:

TransCanada Pipelines has requirements in addition to Table 1. When providing vibration monitoring within 100m of the TransCanada pipeline, the Contractor shall ensure that the following vibration limits in the vicinity of the pipeline are measured and are met:

- Vibrations are to be controlled to a maximum peak particle velocity of 50mm/s above the pipeline.
- Should any two consecutive seismographic readings fall between 50 and 80mm/s the pipeline is to be exposed and monitored to ensure that a third reading taken on the pipe falls below 50mm/s.
- should any seismographic reading taken below the pipe fall above 80mm/s or taken on the pipe fall above 50mm/s the loading pattern should be adjusted to fall below these limits.
- Delays shall be designed to prevent double readings.

When blasting is within 100m of the TransCanada pipeline, a TransCanada representative and /or blasting consultant may be present to monitor vibrations and any other effects on the pipeline.

5.0 RESPONSIBILITY

This special provision in no way intends to remove any of the responsibility for a safe blast from the Blasting Contractor.

6.0 BASIS OF PAYMENT

Compensation for the Contractor to provide blast monitoring and schedule his operations in accordance with these requirements, including all equipment, labour and materials, shall be deemed to be included in the contract bid price for the various tender items.

Note to designer:

Confirm with the Contracts Office whether the minimum distance for the Pre-Blast Survey should be increased.

1.0 DOWELS INTO ROCK – Item No.

Special Provision

CONSTRUCTION SPECIFICATION FOR THE SUPPLY, INSTALLATION AND TESTING OF DOWELS INTO ROCK FOR PIER FOOTINGS

1.0 SCOPE

The work for the above noted tender item shall be in accordance with OPSS 904, including all Special Provisions, except as extended herein. This document specifies additional requirements for the supply, installation and testing of Dowels into Rock for the pier footing.

2.0 REFERENCES

This Special Provision refers to the following standards, specifications, or publications:

ASTM International

D1143M Standard Test Methods for Deep Foundations Under Static Axial Compressive Load

3.0 DEFINITIONS

For the purpose of this Special Provision, the following definitions apply:

Dowels into Rock: reinforcing steel bar and non-shrink grout.

Design Engineer: An Engineer who has a minimum of five (5) years experience in all aspects associated with the installation of Dowels into Rock, including drilling, grouting and doweling work. The Design Engineer shall be retained by the Contractor to design various components for the installation and testing for the Dowels into Rock.

Quality Verification Engineer: An Engineer who has a minimum of five (5) years experience in all aspects associated with the installation of Dowels into Rock, including drilling, grouting and doweling work. The Quality Verification Engineer shall be retained by the Contractor to ensure conformance with the contract documents and issue certificate(s) of conformance.

4.0 DESIGN AND SUBMISSION REQUIREMENTS

4.01 Working Drawings

Working Drawings shall consist of drawings, testing and installation records, procedures and reports, and work plans.

The Contractor shall submit Working Drawings to the Contract Administrator as follows:

a) All Working Drawings that include drawing, testing and installation procedures and reports, and work plans shall be sealed and signed by the Design Engineer.

b) All Working Drawings that include testing and installation results and reports shall be signed and sealed by the Quality Verification Engineer.

Upon completion of testing or installation and testing for each component, the Contractor shall submit to the Contract Administrator a Certificate of Conformance sealed and signed by a Quality Verification Engineer. The Certificate shall state that the work has been carried out in conformance with the Working Drawings and in general conformance with the contract documents.

Working Drawings consisting of testing an installation records and reports shall be submitted four days after completion of testing and installation. All other Working Drawings shall be submitted two weeks prior to construction.

Working Drawings to be submitted include the following with further details outlined in the remainder of this specification:

a) Design calculations, specifications and shop drawings covering all aspects of fabrication, installation and acceptance testing of Dowels into Rock.

b) Test results verifying the 28 day strength of non-shrink grout.

c) The method for constructing of the holes, maintaining the holes, and placing reinforcing steel bars, grout and other materials in the holes, including casing sizes, bit sizes and tremie grouting methods.

d) The procedures to verify hole length. Records of measurements that verify the hole length.

e) Records of all drilling procedures, rock conditions encountered, and installation times.

f) Test procedures for Dowels into Rock.

g) Drawings and design calculations for a suitable reaction system for the applied test loads.

h) Records of vertical and horizontal movements of the reaction system, and elongation of the reinforcing steel bar.

i) Drawings and details for reference system arrangement.

j) Current calibration curves shall be provided for all gauges.

k) Complete test records for all tests including plots of dowel movement versus dowel load, dowel load versus time, and dowel movement versus time.

l) Remedial measures for unacceptable stressing results.

5.0 MATERIALS

5.01 Non-Shrink Grout

The non-shrink grout shall be an approved product from the MTO's Pre-Qualified Products List.

5.02 Anti-Washout Agent

The anti-washout agent shall be used with the non-shrink grout for the Dowels into Rock. The anti-washout agent shall be one of the following proprietary products:

1) Sikament 100 SC Anti-Washout Admixture
Sika Canada Inc.
6915 Davand Drive
Mississauga, ON, L5T 1L5
Toll Free Phone: 800-933-7452

2) Rheomac UW 450 Anti-Washout Admixture
BASF Construction Chemicals Canada Ltd (Master Builders)
1800 Clark Blvd
Brampton, ON, L6T 4M7
Toll Free Phone: 416-520-1392

5.03 Manufacturer Information

The Contractor shall provide the following information from the manufacturer for non-shrink grout and anti-washout agent:

a) Data sheets for the non-shrink grout and anti-washout agent,

b) Technical information that proves that the non-shrink grout and anti-washout agent are compatible, and

c) installation procedures

6.0 EQUIPMENT

All equipment for the installation of the Dowels into Rock shall be suitable for the intended purposes and capable of working on the site under the prevailing access and clearance conditions.

The equipment shall not cause damage to the reinforcing steel bars.

7.0 CONSTRUCTION

7.01 Instructions to Contractor

These instructions are to be read in conjunction with the Contract Drawings.

A total of 2 test Dowels into Rock are required for the Dowels into Rock at the pier.

Dowels into rock at the pier shall be installed into sound bedrock to the specified embedment depth.

7.02 Responsibilities of the Contractor

The Contractor shall prove the allowable bond stress by tests of the Dowels into Rock on non-production Dowels into Rock.

The Contractor shall supply equipment, materials and skilled personnel to install production Dowels into Rock and conduct the specified acceptance tests. It shall be the responsibility of the Contractor to constantly monitor the acceptance tests, maintain specified test loads and record test measurements as specified by the Contract Administrator.

The Contractor is responsible for materials and workmanship. Any remedial measures, required because of defects in materials or workmanship, shall be completed by the Contractor at no cost to the Owner.

The Contractor shall submit 4 copies of all Working Drawings to the Contract Administrator as outlined in Section 4.0.

7.03 Subsurface Conditions

Rock and groundwater conditions are described in the Foundation Investigation Report for this Contract.

7.04 Construction of Holes

The sides and end of the hole shall not be disturbed. The Contractor shall submit Working Drawings to the Contract Administrator that include the method for constructing of the holes, maintaining the holes, and placing reinforcing steel bar, grout and other materials in the holes. All excavated material shall be removed from the site.

The hole diameters and hole length for this project are as specified on the Contract Drawings. Prior to commencing drilling operations, the Contractor shall submit Working Drawings to the Contract Administrator outlining devised procedures to verify hole length. The Contractor shall submit Working Drawings that include drilling operations records to the Contract Administrator that include the above noted records.

At all times, the Contractor shall keep a record of all drilling procedures, rock conditions encountered, and installation times. The Contractor shall submit Working Drawings to the Contract Administrator that include the above noted records.

7.05 Installation of Reinforcing Steel Bar

Reinforcing steel bar shall be installed in strict accordance with the Contract Drawings and installation procedures.

Centering devices shall be provided to ensure that the reinforcing steel bar is located centrally in the hole.

Dowels into Rock at the pier shall be installed into sound bedrock.

Reinforcing steel bar shall be installed after the dowel hole has been filled with non-shrink grout.

7.06 Grout and Anti-Washout Agent

The non-shrink grout shall entirely fill the annular space between the reinforcing steel bar and side for the dowel hole.

The placement of grout for the test Dowels into Rock shall be identical to the production Dowels into Rock.

Anti-washout agent shall be used in accordance with the specifications of the manufacturer.

Non-shrink grout shall be placed into the dowel hole using tremie placement methods.

8.0 QUALITY ASSURANCE

All work for the installation of Dowels into Rock shall be inspected by the Quality Verification Engineer.

8.01 Qualifications

8.01.01 Qualifications of Staff from Contractor or Sub-Contractor Completing Work for the Dowels into Rock

All work shall be performed under the direction of personnel experienced with all aspects associated with the installation of Dowels into Rock. Such experience shall have been obtained within the preceding five (5) years on projects of similar nature and scope to the work required for this project.

8.01.02 Qualifications of the Quality Verification Engineer

A resume of the work experience of the Quality Verification Engineer shall be submitted to the Contract Administrator for record purposes. The Quality Verification Engineer shall be a Professional Engineer licensed in the Province of Ontario having a minimum of five years of experience on projects of similar nature and scope to the work required for this project.

8.01.03 Qualifications of the Design Engineer

A resume of the work experience of the Design Engineer shall be submitted to the Contract Administrator for record purposes. The Design Engineer shall be a Professional Engineer licensed in the Province of Ontario having a minimum of five years of experience of projects of similar nature and scope to the work required for this project.

8.02 Testing Requirements

All work for the testing of Dowels into Rock shall be inspected by the Quality Verification Engineer.

8.02.01 General Testing Requirements

Refer to the attached Instructions to Contractor and the Contract Drawings for specific test details.

The Contractor shall install the number of Dowels into Rock specified in the contract documents for testing purposes. The purpose of the testing the Dowels into Rock is to prove the adequacy of the proposed anchor configuration and installation procedures under the site conditions, and to provide design parameters.

The equipment, labour and materials for test dowels shall be identical to Dowels into Rock at the pier. The Dowels into Rock for testing shall be __M dowels grouted into ___ mm diameter holes filled with an approved non-shrink grout with a minimum ____ mm embedment into sound bedrock.

The Contractor shall submit Working Drawings that include proposed procedures for testing of the Dowels into Rock to the Contract Administrator. Such testing shall be executed in strict accordance with the proposed procedures of the Contractor.

The Quality Verification Engineer shall supervise the testing of the Dowels into Rock. The Contractor will notify the Contract Administrator of the testing schedule at least 10 days prior to commencement of the testing program. Testing for Dowels into Rock shall be conducted concurrently, as scheduled by the Contract Administrator. The tests shall normally be conducted between 8:00 hrs and 20:00 hrs from Monday to Friday, unless otherwise directed by the Contract Administrator.

The Contractor shall supply materials and skilled personnel to conduct the tests for the Dowels into Rock. The equipment and materials shall be capable of stressing the Dowels into Rock to the specified loads. It shall be the responsibility of the Contractor to constantly monitor the test, maintain specified test loads and to record test measurements as specified by the Quality Verification Engineer.

The test site shall be restored to its pre-test condition. Reinforcing steel bars used in tests shall be cut down 25 mm below the top of the sound bedrock.

8.02.02 Testing Location

The Contractor shall remove all loose rock down to sound bedrock at the test location.

The test Dowels into Rock shall be constructed at locations specified by the Contract Administrator.

If site conditions dictate, changes to the test locations will be considered. The Contractor shall provide the Contract Administrator at least 2 days notice in writing of this operation.

8.02.03 Testing Equipment

The dowels into rock will be carried out generally in accordance with the prevailing requirements of ASTM International D1143M superseded where applicable by the procedures specified in this document.

The Contractor shall submit Working Drawings for a suitable reaction system for the applied test loads to the Contract Administrator. Jacks must be secured with chains to provide adequate protection for the personnel in the event of breakage of the reinforcing steel bar or stressing system.

The Contractor shall submit Working Drawings for the reference system arrangement to the Contract Administrator. All reference beams shall be as follows:

The beams shall be independently supported with the support firmly embedded in the ground.

The testing device shall not apply compression to the bedrock surrounding the test for the Dowels into Rock, within a circle concentric with the dowel hole and a diameter equal to 4.0 m.

Reference beams shall be sufficiently rigid to support instrumentation such that variations in readings do not occur.

The Contractor shall construct suitable enclosures to provide complete protection for equipment and instruments from variations in the weather conditions and disturbances during the test program. These provisions must meet the approval of the Quality Verification Engineer and will include that the test enclosures must be weather-proof and provide a consistent temperature in order to eliminate temperature variations that could affect instrumentation.

8.02.04 Testing for Dowels Into Rock, and Report

At all times, the Contractor shall keep records of vertical and horizontal movements of the reaction system, elongation of reinforcing steel bar, and the record of test enclosure temperature. The movements shall be recorded with respect to an independent fixed reference point. The Contractor shall submit Working Drawings that include the above noted records to the Contract Administrator.

Dial gauges shall have at least a 76.2 mm (3.0 in.) travel. Longer gauge stems or sufficient gauge blocks shall be provided to allow for greater travel if required. Gauges shall have precision of at least 0.025 mm (0.0001 in.). The dial gauges shall be placed on smooth bearing surfaces mounted perpendicular to the direction of movement. All gauges, scales or reference points attached to the test anchor shall be mounted so as to prevent movement relative to the test anchor during the test. The Contractor shall submit Working Drawings that include details for current calibration and curves for all gauges to the Contract Administrator.

Jacks used for reinforcing steel bars shall have a minimum ram dimension of 152.6 mm (6.0 in.). The Contractor shall submit Working Drawings that include details for current calibration and curves for all gauges to the Contract Administrator.

Requirements for Clauses 5.4.1 to 5.4.4 shall be repeated as required at different testing locations.

8.02.05 Testing Loading

The testing procedures shall safely load test the Dowels into Rock in tension at a rate of approximately 100kN per minute to the test load of ____ kN. The load shall be increased by an additional 50 kN beyond this level as directed by the Quality Verification Engineer.

Each load shall be maintained for a minimum time of 15 minutes and until the rate of displacement is not greater than 0.25 mm (0.01 inches) per hour.

8.03 Acceptance Criteria

The following acceptance criteria apply:

a) The testing of dowels shall be carried out in advance of the instalment of Dowels into Rock at the pier footing.

b) Tests for Dowels into Rock shall have a capacity of at least ____ kN. The Quality Verification Engineer shall report on the acceptance of the tests for Dowels into Rock. The Quality Verification Engineer shall report on the testing of the Dowels into Rock including recommendations for increasing embedment depth, if necessary.

9.0 MEASUREMENT FOR PAYMENT

For measurement purposes, a count shall be made of the number of dowels installed.

10.0 BASIS OF PAYMENT

Payment at the contract unit price for the above tender item shall include full compensation for all labour, equipment, and materials to do the work. No additional payment will be made for tests for Dowels into Rock which are deemed as included as part of the work for the above noted item.

Appendix E

Drawing
Borehole Locations and Soil Strata

METRIC

DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN

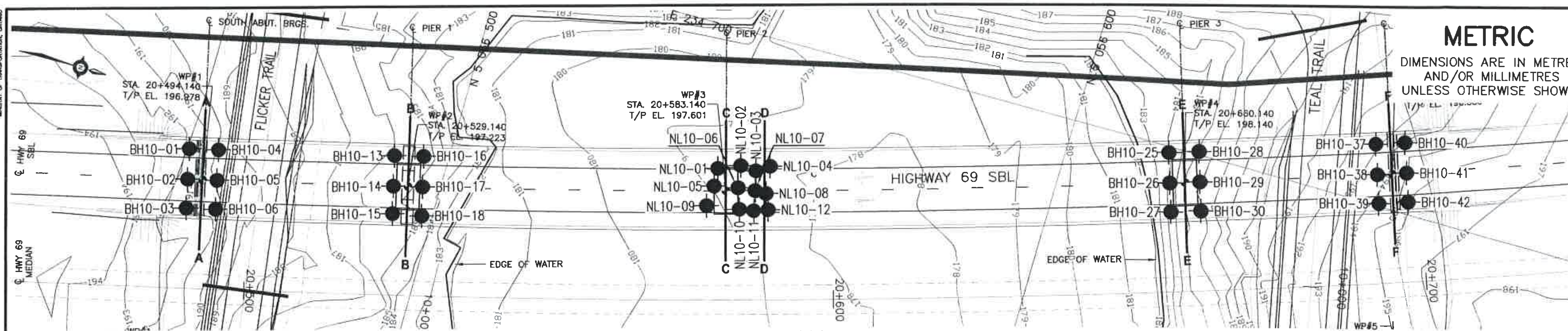
CONT No
WP No 5076-06-00

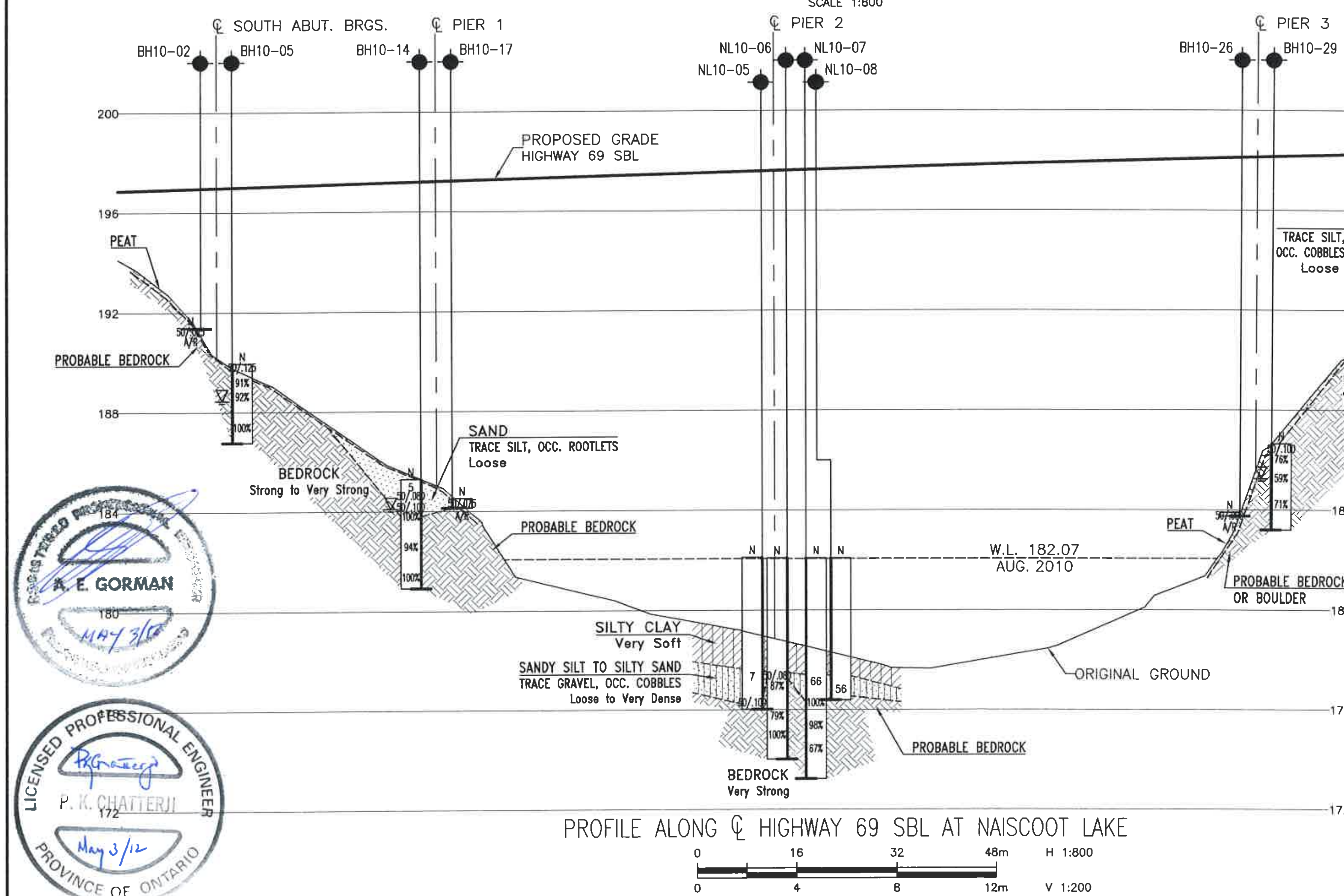
HIGHWAY 69 FOUR-LANING
NAISCOOT LAKE BRIDGE
SOUTHBOUND LANES
BOREHOLE LOCATIONS AND SOIL STRATA

SHEET

MMM GROUP

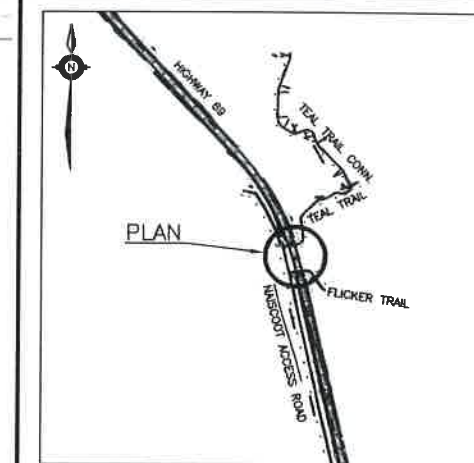
THURBER ENGINEERING LTD.





PROFILE ALONG ℄ HIGHWAY 69 SBL AT NAISCOOT LAKE

H 1:800
V 1:200



KEYPLAN

LEGEND

⊕	Borehole
⊕	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
BH10-29	186.7	5 056 623.0	234 704.4
BH10-30	187.2	5 056 624.5	234 709.2
BH10-37	192.8	5 056 649.6	234 689.9
BH10-38	193.5	5 056 651.4	234 694.8
BH10-39	194.1	5 056 653.0	234 699.5
BH10-40	194.6	5 056 654.4	234 688.2
BH10-41	195.3	5 056 656.1	234 693.2
BH10-42	196.2	5 056 657.7	234 697.9
NL10-01	182.1	5 056 544.5	234 724.1
NL10-02	182.1	5 056 548.1	234 722.6
NL10-03	182.1	5 056 550.8	234 722.8
NL10-04	182.1	5 056 552.9	234 721.4
NL10-05	182.1	5 056 544.7	234 727.2
NL10-06	182.1	5 056 548.7	234 726.4
NL10-07	182.1	5 056 551.6	234 726.1
NL10-08	182.1	5 056 553.5	234 726.1
NL10-09	182.1	5 056 544.4	234 730.8
NL10-10	182.1	5 056 549.9	234 729.9
NL10-11	182.1	5 056 552.3	234 729.5
NL10-12	182.1	5 056 554.6	234 728.7

NO	ELEVATION	NORTHING	EASTING
BH10-01	191.6	5 056 457.0	234 744.7
BH10-02	191.4	5 056 458.1	234 749.8
BH10-03	191.2	5 056 459.2	234 754.6
BH10-04	189.7	5 056 461.8	234 743.5
BH10-05	190.0	5 056 463.0	234 748.6
BH10-06	190.8	5 056 464.1	234 753.5
BH10-13	185.5	5 056 490.9	234 736.6
BH10-14	185.3	5 056 492.2	234 741.7
BH10-15	186.3	5 056 493.3	234 746.3
BH10-16	185.2	5 056 495.8	234 735.4
BH10-17	184.5	5 056 497.1	234 740.5
BH10-18	184.9	5 056 498.2	234 745.3
BH10-25	183.9	5 056 616.6	234 701.0
BH10-26	183.9	5 056 618.2	234 706.0
BH10-27	184.0	5 056 619.8	234 710.7
BH10-28	186.0	5 056 621.3	234 699.4

-NOTES-

1) The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.
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GEOCRES No. 41H-93

REVISIONS	DATE	BY	DESCRIPTION
DESIGN LRB	CHK AEG	CODE	LOAD	DATE MAY 2012
DRAWN MFA	CHK PKC	SITE	STRUCT	DWG 1

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PLOTDATE: May 03, 2012 - 2:56pm

METRIC

DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN

CONT No

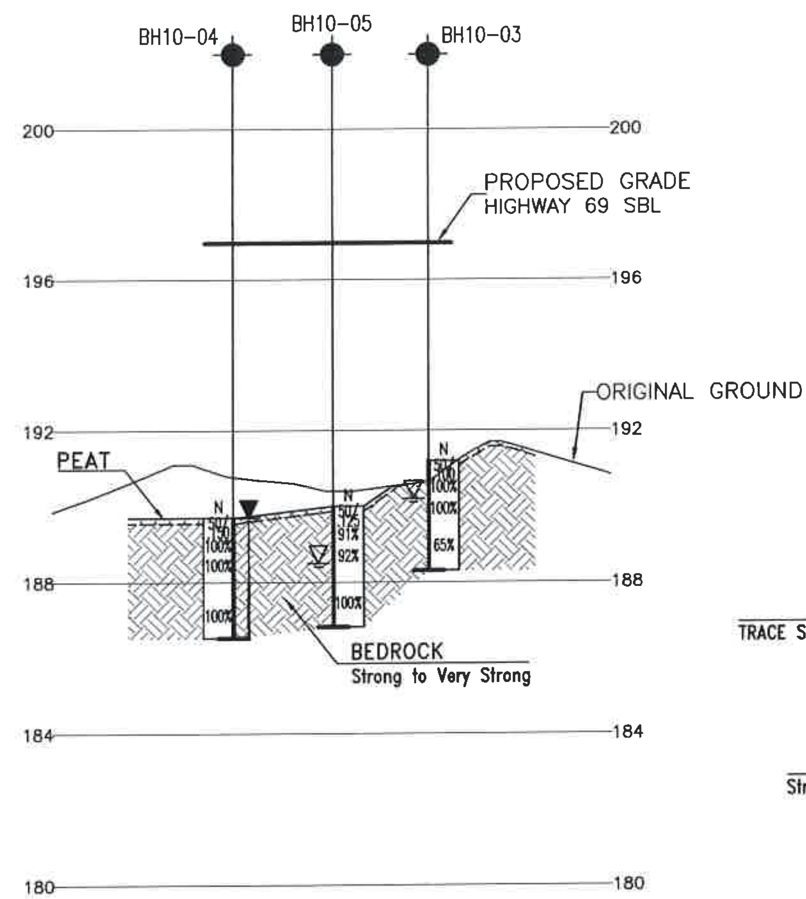
WP No 5076-06-00

HIGHWAY 69 FOUR-LANING
NAISCOOT LAKE BRIDGE
SOUTHBOUND LANES
BOREHOLE LOCATIONS AND SOIL STRATA

SHEET

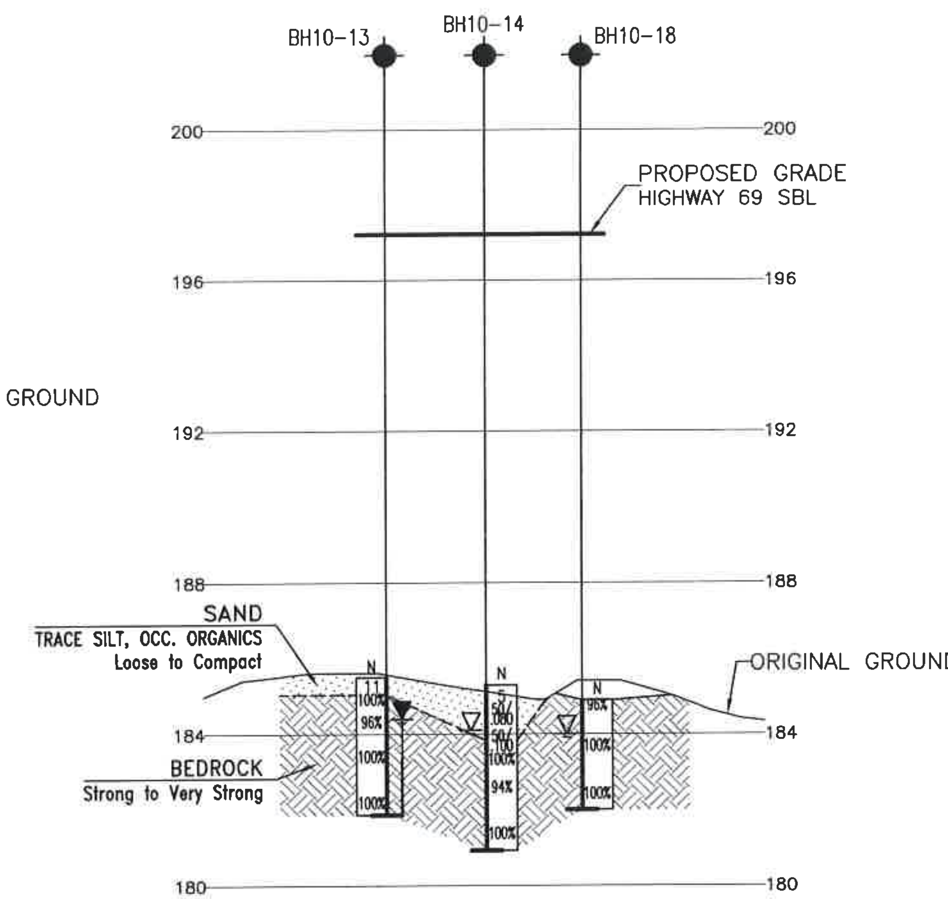
MMM GROUP

THURBER ENGINEERING LTD.



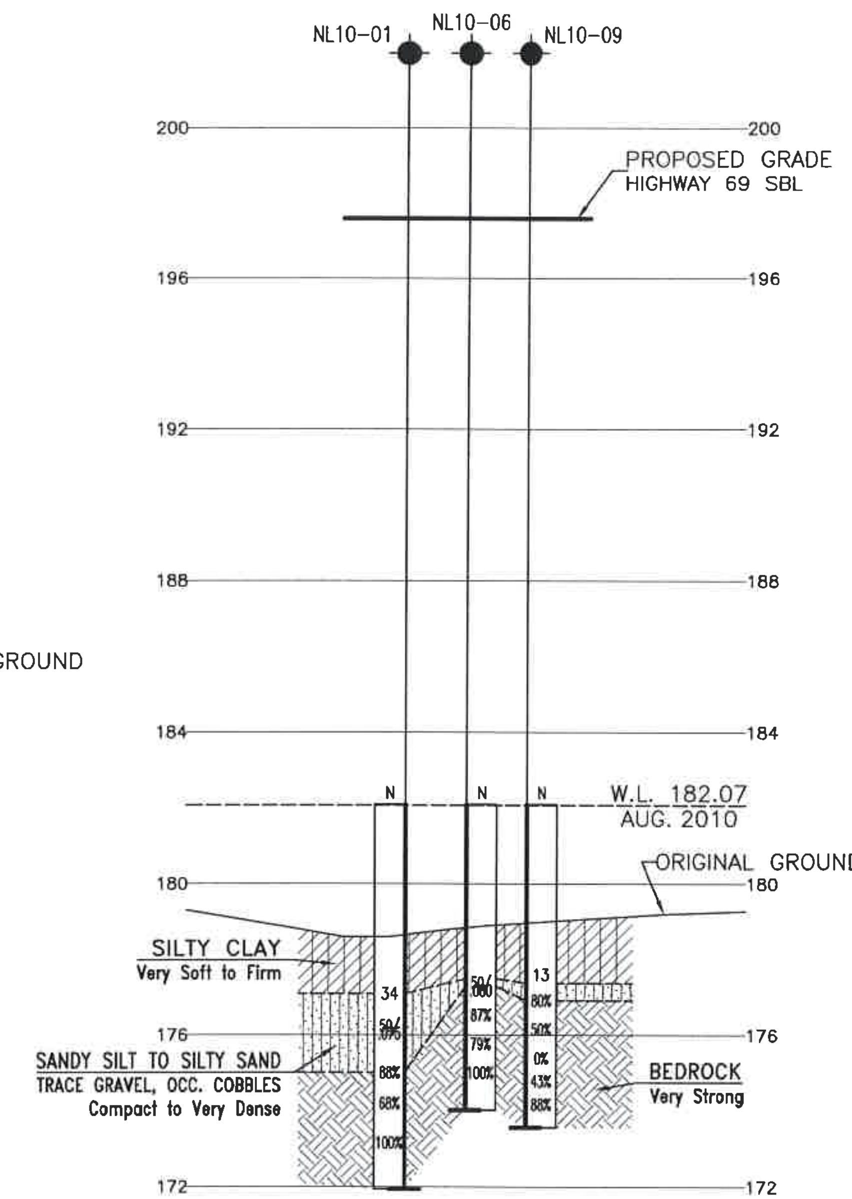
SECTION A-A
S. ABUT. HWY 69 SBL AT NAISCOOT LAKE

0 8 16 24m H 1:400
0 4 8 12m V 1:200



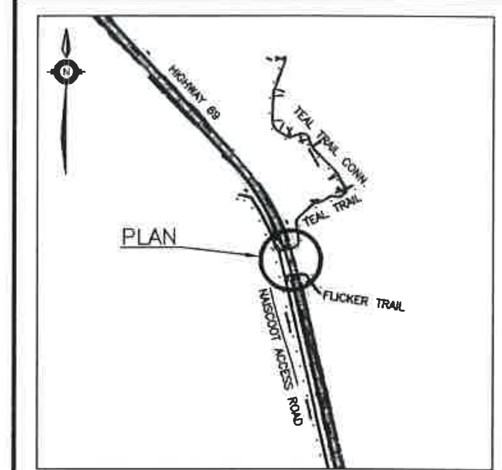
SECTION B-B
PIER 1 HWY 69 SBL AT NAISCOOT LAKE

0 8 16 24m H 1:400
0 4 8 12m V 1:200



SECTION C-C
PIER 2 HWY 69 SBL AT NAISCOOT LAKE

0 8 16 24m H 1:400
0 4 8 12m V 1:200



KEYPLAN

L E G E N D

	Borehole
	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
BH10-01	191.6	5 056 457.0	234 744.7
BH10-02	191.4	5 056 458.1	234 749.8
BH10-03	191.2	5 056 459.2	234 754.6
BH10-04	189.7	5 056 461.8	234 743.5
BH10-05	190.0	5 056 463.0	234 748.6
BH10-06	190.8	5 056 464.1	234 753.5
BH10-13	185.5	5 056 490.9	234 736.6
BH10-14	185.3	5 056 492.2	234 741.7
BH10-15	186.3	5 056 493.3	234 746.3
BH10-16	185.2	5 056 495.8	234 735.4
BH10-17	184.5	5 056 497.1	234 740.5
BH10-18	184.9	5 056 498.2	234 745.3
BH10-25	183.9	5 056 616.6	234 701.0
BH10-26	183.9	5 056 618.2	234 706.0
BH10-27	184.0	5 056 619.8	234 710.7
BH10-28	186.0	5 056 621.3	234 699.4

NO	ELEVATION	NORTHING	EASTING
BH10-29	186.7	5 056 623.0	234 704.4
BH10-30	187.2	5 056 624.5	234 709.2
BH10-37	192.8	5 056 649.6	234 689.9
BH10-38	193.5	5 056 651.4	234 694.8
BH10-39	194.1	5 056 653.0	234 699.5
BH10-40	194.6	5 056 654.4	234 688.2
BH10-41	195.3	5 056 656.1	234 693.2
BH10-42	196.2	5 056 657.7	234 697.9
NL10-01	182.1	5 056 544.5	234 724.1
NL10-02	182.1	5 056 548.1	234 722.6
NL10-03	182.1	5 056 550.8	234 722.8
NL10-04	182.1	5 056 552.9	234 721.4
NL10-05	182.1	5 056 544.7	234 727.2
NL10-06	182.1	5 056 548.7	234 726.4
NL10-07	182.1	5 056 551.6	234 726.1
NL10-08	182.1	5 056 553.5	234 726.1
NL10-09	182.1	5 056 544.4	234 730.8
NL10-10	182.1	5 056 549.9	234 729.9
NL10-11	182.1	5 056 552.3	234 729.5
NL10-12	182.1	5 056 554.6	234 728.7

REGISTERED PROFESSIONAL GEOSCIENTIST
A. E. GORMAN
MAY 3/12

LICENSED PROFESSIONAL ENGINEER
P. K. CHATTERJI
May 3/12
PROVINCE OF ONTARIO

-NOTES-

1) The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.
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GEOCRES No. 41H-93

REVISIONS | DATE | BY | DESCRIPTION

DESIGN LRB | CHK AEG | CODE | LOAD | DATE MAY 2012
DRAWN MFA | CHK PKC | SITE | STRUCT | DWG 2

FILENAME: H:\Drafting\19\5181\21\ted8121-NaiscootLake.dwg
PLOTDATE: May 03, 2012 - 3:06pm

METRIC

DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN

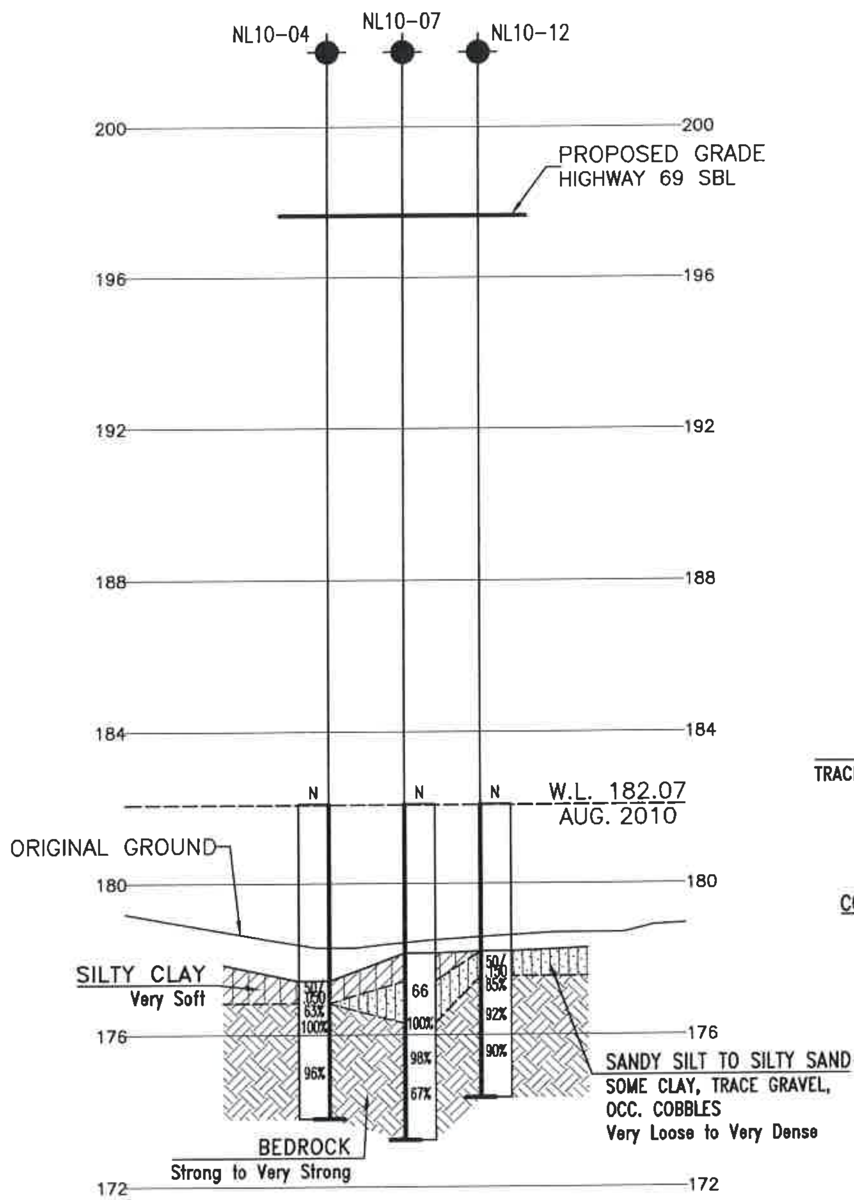
CONT No
WP No 5076-06-00

HIGHWAY 69 FOUR-LANING
NAISCOOT LAKE BRIDGE
SOUTHBOUND LANES
BOREHOLE LOCATIONS AND SOIL STRATA

SHEET

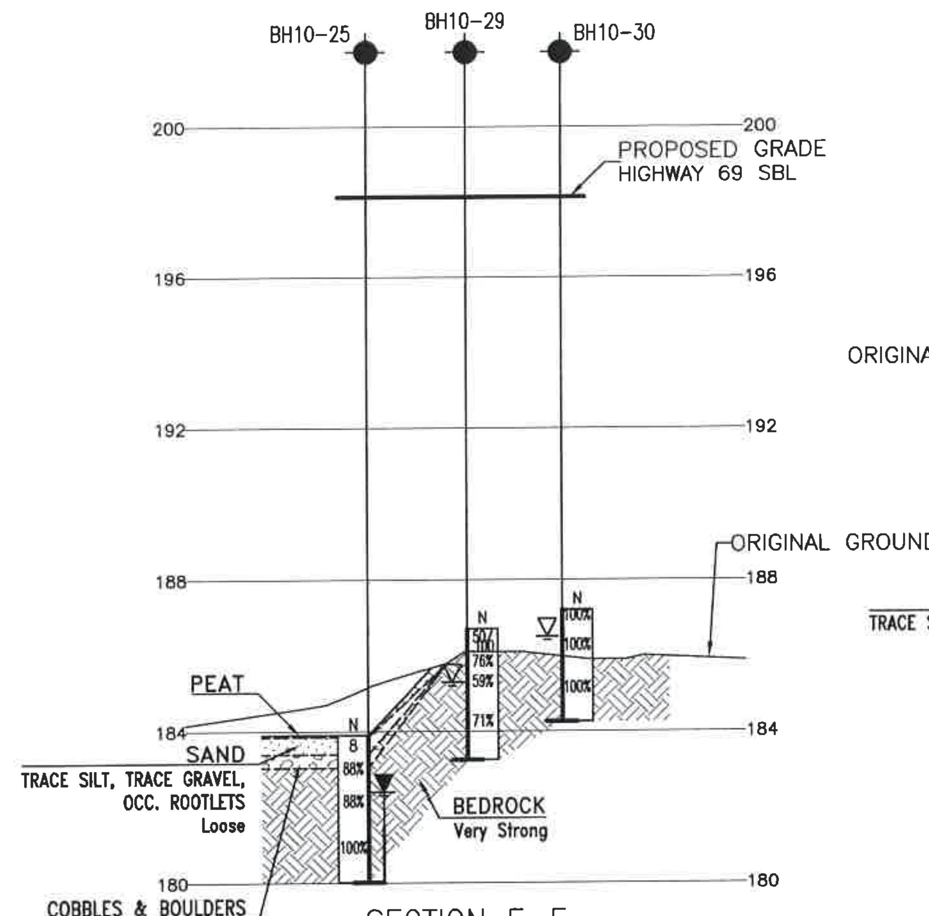
MMM GROUP

THURBER ENGINEERING LTD.



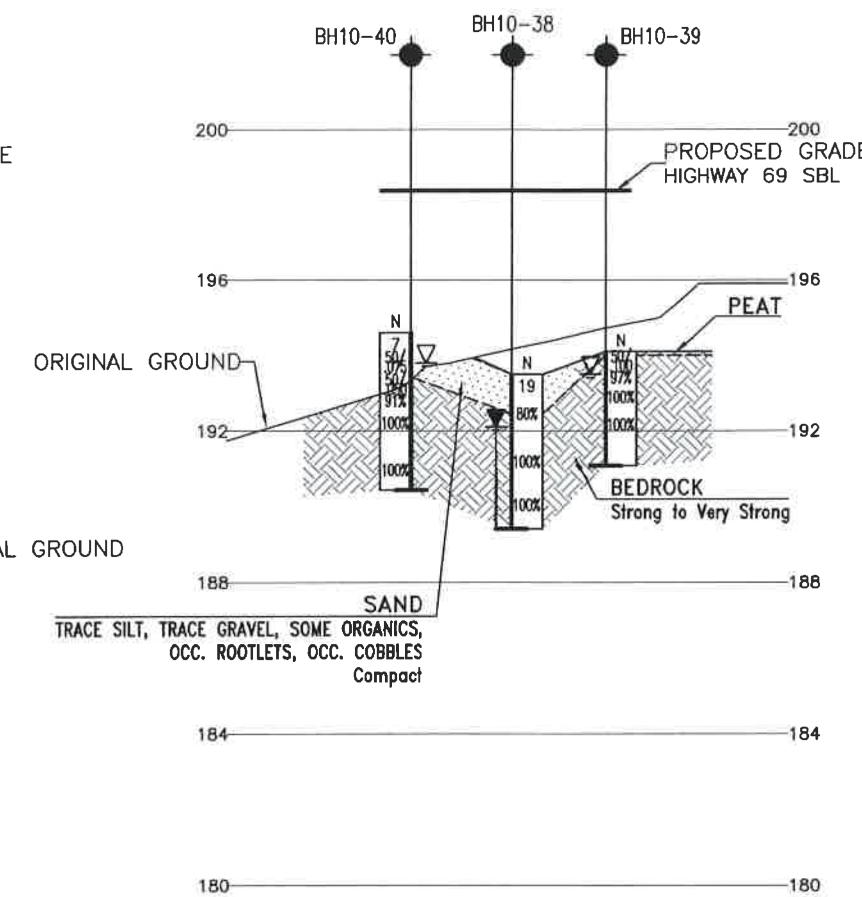
SECTION D-D
PIER 2 HWY 69 SBL AT NAISCOOT LAKE

H 1:400 (0, 8, 16, 24m)
V 1:200 (0, 4, 8, 12m)



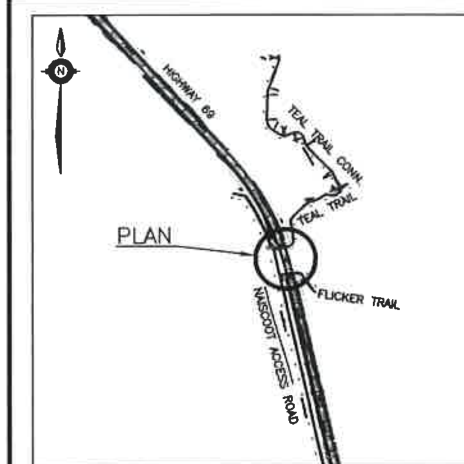
SECTION E-E
PIER 3 HWY 69 SBL AT NAISCOOT LAKE

H 1:400 (0, 8, 16, 24m)
V 1:200 (0, 4, 8, 12m)



SECTION F-F
N. ABUT. HWY 69 SBL AT NAISCOOT LAKE

H 1:400 (0, 8, 16, 24m)
V 1:200 (0, 4, 8, 12m)



KEYPLAN

LEGEND

(symbol)	Borehole
(symbol)	Cone
N	Blows /0.3m (Std Pen Test, 475J/blow)
CONE	Blows /0.3m (60° Cone, 475J/blow)
PH	Pressure, Hydraulic
(symbol)	Water Level
(symbol)	Head Artesian Water
(symbol)	Piezometer
90%	Rock Quality Designation (RQD)
A/R	Auger Refusal

NO	ELEVATION	NORTHING	EASTING
BH10-29	186.7	5 056 623.0	234 704.4
BH10-30	187.2	5 056 624.5	234 709.2
BH10-37	192.8	5 056 649.6	234 689.9
BH10-38	193.5	5 056 651.4	234 694.8
BH10-39	194.1	5 056 653.0	234 699.5
BH10-40	194.6	5 056 654.4	234 688.2
BH10-41	195.3	5 056 656.1	234 693.2
BH10-42	196.2	5 056 657.7	234 697.9
NL10-01	182.1	5 056 544.5	234 724.1
NL10-02	182.1	5 056 548.1	234 722.6
NL10-03	182.1	5 056 550.8	234 722.8
NL10-04	182.1	5 056 552.9	234 721.4
NL10-05	182.1	5 056 544.7	234 727.2
NL10-06	182.1	5 056 548.7	234 726.4
NL10-07	182.1	5 056 551.6	234 726.1
NL10-08	182.1	5 056 553.5	234 726.1
NL10-09	182.1	5 056 544.4	234 730.8
NL10-10	182.1	5 056 549.9	234 729.9
NL10-11	182.1	5 056 552.3	234 729.5
NL10-12	182.1	5 056 554.6	234 728.7

NO	ELEVATION	NORTHING	EASTING
BH10-01	191.6	5 056 457.0	234 744.7
BH10-02	191.4	5 056 458.1	234 749.8
BH10-03	191.2	5 056 459.2	234 754.6
BH10-04	189.7	5 056 461.8	234 743.5
BH10-05	190.0	5 056 463.0	234 748.6
BH10-06	190.8	5 056 464.1	234 753.5
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BH10-14	185.3	5 056 492.2	234 741.7
BH10-15	186.3	5 056 493.3	234 746.3
BH10-16	185.2	5 056 495.8	234 735.4
BH10-17	184.5	5 056 497.1	234 740.5
BH10-18	184.9	5 056 498.2	234 745.3
BH10-25	183.9	5 056 616.6	234 701.0
BH10-26	183.9	5 056 618.2	234 706.0
BH10-27	184.0	5 056 619.8	234 710.7
BH10-28	186.0	5 056 621.3	234 699.4

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GEOCRES No. 41H-93

LICENSED PROFESSIONAL ENGINEER
P. K. CHATTERJI
May 3/12
PROVINCE OF ONTARIO

A. E. GORMAN
MAY 3/12

REVISIONS	DATE	BY	DESCRIPTION

DESIGN LRB	CHK AEG	CODE	LOAD	DATE MAY 2012	
DRAWN MFA	CHK PKC	SITE	STRUCT	DWG 3	

Appendix F

Site Photographs

Photo 1. Naiscoot Lake north shore from existing Highway 69

Photo 2. Looking Naiscoot Lake south shore from existing Highway