FOUNDATION INVESTIGATION REPORT
MAKAMI RIVER BRIDGE WIDENING
Highway 144, Site No.: 46N-228
G.W.P. 123-88-00, W.P. 123-88-02
District 53, New Liskeard

Geocres Number: 41P-45

Report to

McCormick Rankin Corporation

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August 10, 2010
File: 19-1351-154

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PART 1: FACTUAL INFORMATION

1. INTRODUCTION

This report presents the factual findings obtained from a foundation investigation conducted at the site of a proposed bridge widening north west of Gogama, Ontario. The existing structure carries Highway 144 over the Makami River.

The purpose of the investigation was to explore the subsurface conditions at the site, and based on the data obtained, to provide a borehole location plan, records of boreholes, a stratigraphic profile, laboratory test results and a written description 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 McCormick Rankin Corporation, under the Ministry of Transportation Ontario (MTO) Agreement Number 5007-E-0066.

2. SITE DESCRIPTION

The site of the investigation is the crossing of Highway 144 over the Makami River, approximately 3 km north west of Gogama, Ontario and 0.5 km west of Highway 661. At present, the highway crosses the Makami River on a three- span structure with two piers supported on piles.

At the site, the river channel is approximately 30 m wide. The surrounding area is relatively flat and heavily treed, as illustrated in Photo 1 in Appendix D, and there is no development in the immediate vicinity of the bridge. Photo 2 in Appendix D shows the existing bridge viewed from the upstream, east side.

Physiographically, the site lies within the Canadian Shield, characterized by Pre-Cambrian igneous and metamorphic bedrock. Locally, however, the bedrock is mantled by deposits of sand and gravel.

3. SITE INVESTIGATION AND FIELD TESTING

The site investigation and field testing for this project was carried out between March 23 and March 27, 2010. A total of seven boreholes numbered 10-01, 10-01A, 10-02, 10-02A, 10-03, 10-03A and 10-04, were advanced to depths ranging from 10.2 m to 13.8 m below the existing highway grade.

Boreholes 10-01, 10-01A and 10-04 were drilled behind the existing west and east abutments, respectively. Boreholes 10-02, 10-02A, 10-03 and 10-03A were drilled at the piers in order to investigate the foundation soils underlying the proposed deck widening to the north. The approximate locations of the boreholes are shown on the attached Borehole Locations and Soil Strata Drawing in Appendix C.

The drilling was carried out from the highway using a CME75 truck-mounted drill rig with hollow stem augers and HW casing/NQ coring equipment. Samples were obtained at selected intervals using a split spoon sampler in conjunction with Standard Penetration Testing (SPT) in the overburden soils.

Boreholes 10-01, 10-01A and 10-04 were drilled through the embankment fill and the native soils to a depth between 7.3 m and 10.7 m where granitic bedrock was encountered.

Boreholes 10-02, 10-02A, 10-03 and 10-03A were drilled through the bridge deck and into the native soils to a depth between 8.9 m and 10.1 m below the bridge deck where granitic bedrock was encountered.

All seven boreholes were advanced approximately 3 m into bedrock by NQ size diamond coring techniques.

Groundwater conditions in the open boreholes were observed throughout the drilling operations. Standpipe piezometers consisting of 19 mm PVC pipe with a slotted screen were installed in boreholes 10-01 and 10-04. The locations and completion details of the piezometers are shown in Table 3.1. The boreholes in which no piezometers were installed were grouted with bentonite. Grouting was carried out in general accordance with the requirements of MOE Reg. 903 (as amended by Reg. 372/07). The borehole completion details are shown in Table 3.1.

Table 3.1 – Borehole Completion Details

Location	Details	
	Piezometer Tip Depth/ Elevation (m)	Completion Details
10-01	7.6/345.5	Bentonite seal from 10.7 m to 7.6 m, Piezometer with 1.5 m slotted screen installed with sand filter to 5.7 m, bentonite seal from 5.7 m to 0.1 m. Flushmount cover installed.
10-01A	None installed	Backfilled with bentonite to 0.2 m. Asphalt from 0.2 m to surface.
10-02	None installed	Backfilled with bentonite to 5.8 m. Bridge deck filled with 0.3 m of concrete.
10-02A	None installed	Backfilled with bentonite to 5.5 m. Bridge deck filled with 0.3 m of concrete.
10-03	None installed	Backfilled with bentonite to 5.2 m. Bridge deck filled with 0.3 m of concrete.
10-03A	None installed	Backfilled with bentonite to 5.8 m. Bridge deck filled with 0.3 m of concrete.
10-04	10.7/342.3	Bentonite seal from 13.6 m to 10.7 m, Piezometer with 1.5 m slotted screen installed with sand filter to 8.7 m, bentonite seal from 8.7 m to 0.1 m. Asphalt from 0.1 m to surface. Flushmount cover installed.

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.

4. LABORATORY TESTING

The recovered soil samples were subjected to Visual Identification (VI) and to natural moisture content determination. The results of this testing are shown on the Record of Borehole sheets in Appendix A. Selected samples were also subjected to gradation analysis and the results of this testing program are shown on the Record of Borehole sheets in Appendix A and on the figures contained in Appendix B. Point load testing was conducted on selected portions of the rock cores. Uniaxial compressive strength (UCS) of the cores was assessed from the point load test results. The assessed UCS values are shown on the borehole logs and in Appendix B.

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 this Appendix and on the "Borehole Locations and Soil Strata" drawing in Appendix C. Soil stratigraphy along the existing bridge alignment for the boreholes drilled in 1964 is presented 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.

The stratigraphy encountered in the three boreholes drilled through the highway consisted of pavement over gravelly sand fill, overlying native gravelly sand and sandy gravel. The overburden soils are underlain by granite bedrock.

The stratigraphy encountered in the boreholes drilled through the bridge deck consisted of native gravelly sand and sandy gravel overlying granitic bedrock.

5.1 Asphalt

At boreholes 10-01, 10-01A and 10-04, 100 mm of asphalt was encountered at the surface. The asphalt thickness may vary in other areas of the site.

5.2 Fill

In boreholes 10-01, 10-01A and 10-04, the asphalt is underlain by 3.6 m to 5.4 m of sand fill. The fill has SPT values generally ranging from 12 to 29 blows for 0.3 m penetration, indicating compact conditions. Occasional values of 8 and 32 blows for 0.3 m penetration indicate loose or dense layers, respectively. The fill is described as sand, trace gravel to gravelly, trace silt and clay, brown and dry to moist, with moisture contents ranging from 1% to 9%.

The underside of the fill lies at a depth of 3.7 m (Elevation 349.3) near the east abutment and 4.6 m to 5.5 m (Elevation 348.5 to 347.6) near the west abutment.

The gradations of the fill in the embankment are shown in Appendix B. The results of laboratory tests carried out are summarized below:

Soil Particles	(%)
Gravel	17 to 27
Sand	67 to 74
Silt & Clay	5 to 9

5.3 Gravelly Sand

A layer of gravelly sand with cobbles and boulders was encountered below the riverbed in boreholes 10-02, 10-02A, 10-03, 10-03A and below the fill in borehole 10-04. The sand is described as gravelly, trace silt, occasional cobbles and boulders, brown and wet and with moisture contents ranging from 9% to 19%.

The SPT values recorded range from 4 to 86 blows for 0.3 m penetration, indicating loose to very dense conditions.

The underside of the gravelly sand layer lies at a depth of 0.8 m to 2.9 m below the riverbed (Elevation 344.7 to 346.4) and 7.2 m below the highway grade (Elevation 345.8).

The gradations of the fill in the embankment are shown in Appendix B. The results of laboratory tests carried out are summarized below:

Soil Particles	(%)
Gravel	3 to 40
Sand	56 to 95
Silt & Clay	1 to 7

5.4 Sandy Gravel

Underlying the highway embankment fill and the gravelly sand layer, a layer of sandy gravel was encountered in all boreholes. This layer is present just above the bedrock. The thickness of the layer ranges from 1.0 m to 3.5 m with underside elevations ranging from 342.3 to 345.8. The sandy gravel contains trace silt and some cobbles and boulders and is brown and wet, with measured moisture content between 2% to 18%.

SPT values recorded in the sand and gravel deposit ranged from 74 to greater than 50 blows for 0.03 m penetration, indicating very dense conditions.

The gradations of the sandy gravel deposit are shown in Appendix B. The results of laboratory tests carried out are summarized below:

Soil Particles	(%)
Gravel	46 to 60
Sand	34 to 48
Silt & Clay	6 to 7

5.5 Bedrock

The overburden soils described above are underlain by granitic bedrock which was proved by coring at all boreholes. Table 5.1 summarizes the bedrock depth and the elevations to the top of bedrock.

Table 5.1 – Depth to Bedrock at Borehole Locations

Location	Depth to Bedrock (m)	Top of Bedrock Elevation
BH 10-01	7.6	345.5
BH 10-01A	7.3	345.8
BH 10-02	9.6	343.5
BH 10-02A	9.4	343.6
BH 10-03	10.1	342.9
BH 10-03A	8.9	344.1
BH 10-04	10.7	342.3

Total core recovery in the bedrock was 90 to 100% in all boreholes except for borehole 10-02 RUN #1 where a total core recovery of 47% was observed. Solid core recovery was 58 to 100% except for borehole 10-02 RUN #1 where a solid core recovery of 23% was noted. The RQD was 58 to 100% indicating fair to excellent rock quality except for borehole 10-02 RUN #1 where an RQD of 0% was observed. Point load tests are summarized in Appendix B. The UCS values assessed from the point load tests range from 128 to 264 MPa indicating a very strong rock.

5.6 Water Levels

Standpipe piezometers were installed in boreholes 10-01 and 10-04. Water levels were measured for the duration of the site work. The water level readings from the piezometers are presented in Table 5.2.

Based on these observations, local groundwater levels exist at Elevations 348.0 to 348.2, which is in good agreement with the river elevation of 348.1 at the time of the investigation. All groundwater observations at this site are short term and the levels are expected to fluctuate seasonally and after severe weather events and will be strongly influenced by the river level.

Table 5.2: Water Level Measurements

Date	BH 10-01 West Abutment	BH 10-04 East Abutment
	Depth/ Elev. (m)	Depth/ Elev. (m)
March 24, 2010	4.9/348.2	-
March 25, 2010	4.9/348.2	-
March 26, 2010	5.0/348.1	4.9/348.0
March 27, 2010	5.0/348.1	4.9/348.0

6. MISCELLANEOUS

Eastern Ontario Diamond Drilling Limited of Hawkesbury, Ontario supplied the drill rig and conducted the drilling, sampling and in-situ testing operations. A truck-mounted CME #75 drill rig was used for the duration of the investigation.

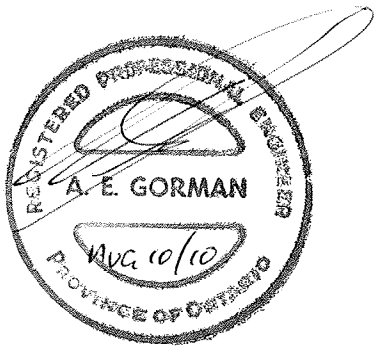
The drilling and sampling operations in the field were supervised on a full time basis by Mr. George Azzopardi of Thurber.

Mr. Alastair E. Gorman, P.Eng. directed the field operations and Mr. Lukasz Gilarski, Project Manager, prepared the report.

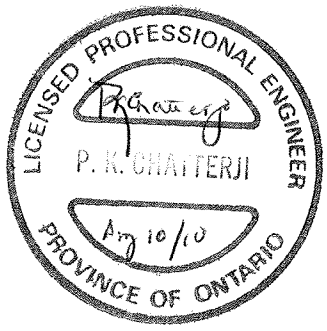
Dr. P.K. Chatterji, P.Eng., a Designated Principal Contact for MTO Foundations projects, reviewed the report.

THURBER ENGINEERING LTD.

Lukasz Gilarski, E.I.T.
Project Manager



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



P.K. Chatterji, P.Eng.,
Review Principal, Designated MTO Contact

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			

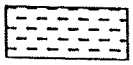
EXPLANATION OF ROCK LOGGING TERMS

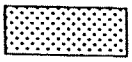
ROCK WEATHERING CLASSIFICATION

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

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Ministry of Transportation
Ontario

RECORD OF BOREHOLE No 10-01 1 OF 2 METRIC

G.W.P. 123-88-00 LOCATION N 5 285 258.4 E 249 407.9 ORIGINATED BY GA
HWY 144 - Bridge at Makami River BOREHOLE TYPE Hollow Stem Augers/NQ Coring COMPILED BY AN
DATUM GEODETIC DATE 2010-03-23 - 2010-03-23 CHECKED BY LPG

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) (20 40 60)	UNIT WEIGHT kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
353.1											
0.0	**ASPHALT**										
0.1	**SAND**, gravelly, occasional cobbles Loose to Dense Brown Dry (FILL)		1	SS	22		353		○		
			2	SS	24		352		○		
			3	SS	32				○		
			4	SS	8		351		○		
			5	SS	29		350		○		27 67 6 (SI+CL)
			6	SS	12	▼	349		○		
347.6							348				
5.5	Sandy **GRAVEL**, some cobbles and boulders, trace silt Very Dense Brown Wet		7	SS	74		347		○		60 34 7 (SI+CL)
345.5							346				
7.6	**GRANITE**, slightly weathered to fresh, coarse grained, very strong, occasional mechanical breaks Start coring at 7.6m Highly broken zone at 7.8m		1	RUN			345			FI 4 0 0 2	RUN 1# TCR=100%, SCR=95%, RQD=83%, UCS=232MPa
			2	RUN			344			0 0 0	RUN 2#

Continued Next Page

+ ³, × ³: Numbers refer to Sensitivity

20 15 5 10 (%) STRAIN AT FAILURE

ONTMT4S 1154.GPJ 10/5/27

Ministry of Transportation
Ontario

RECORD OF BOREHOLE No 10-01 2 OF 2 METRIC

G.W.P. 123-88-00 LOCATION N 5 285 258.4 E 249 407.9 ORIGINATED BY GA

HWY 144 - Bridge at Makami River BOREHOLE TYPE Hollow Stem Augers/NQ Coring COMPILED BY AN

DATUM GEODETIC DATE 2010-03-23 - 2010-03-23 CHECKED BY LPG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa 20 40 60 80 100 (○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
	Continued From Previous Page										GR SA SI CL
342.5	125mm sub-vertical joints at 10.0m						343			1 0	TCR=90%, SCR=90%, RQD=90%, UCS=214MPa
10.7	END OF BOREHOLE AT 10.7m. BOREHOLE OPEN TO 10.7m AND WATER LEVEL AT 5.2m. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) 24/03/2010 4.9 348.2 25/03/2010 4.9 348.2 26/03/2010 5.0 348.1 27/03/2010 5.0 348.1										

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

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

ONTMT4S 1154.GPJ 10/5/27

Ministry of Transportation
Ontario

RECORD OF BOREHOLE No 10-01A 1 OF 2 METRIC

G.W.P. 123-88-00 LOCATION N 5 285 257.9 E 249 414.2 ORIGINATED BY GA
HWY 144 - Bridge at Makami River BOREHOLE TYPE NW Casing/NQ Coring COMPILED BY AN
DATUM GEODETIC DATE 2010-03-26 - 2010-03-26 CHECKED BY LPG

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
353.1											
0.0	**ASPHALT**										
0.1	**SAND**, some gravel, trace silt and clay Compact Brown Dry (FILL)		1	SS	29		353				
			2	SS	22		352				
			3	SS	14						17 74 9 (SI+CL)
			4	SS	17		351				
			5	SS	29		350				
348.5							349				
4.6	Sandy **GRAVEL**, some cobbles and boulders, trace silt Very Dense Brown Wet		6	SS	50/ 0.150	▽					46 48 6 (SI+CL)
			7	SS	50/ 0.150		348				
345.8							347				
7.3	**GRANITE**, slightly weathered to fresh, coarse grained, very strong Start coring at 7.3m 125mm highly broken zone at 7.8m		1	RUN			346			FI 3 >5 0 0 0 0 0 0 0	RUN 1# TCR=100%, SCR=76%, RQD=72%, UCS=137MPa RUN 2# TCR=100%, SCR=100%, RQD=100%, UCS=183MPa
			2	RUN			345				
							344				

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+ ³, × ³: Numbers refer to Sensitivity

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

ONTMT4S 1154.GPJ 10/5/27

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 10-01A 2 OF 2 METRIC

G.W.P. 123-88-00 LOCATION N 5 285 257.9 E 249 414.2 ORIGINATED BY GA

HWY 144 - Bridge at Makami River BOREHOLE TYPE NW Casing/NQ Coring COMPILED BY AN

DATUM GEODETIC DATE 2010-03-26 - 2010-03-26 CHECKED BY LPG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
	Continued From Previous Page										
342.9											
10.2	END OF BOREHOLE AT 10.2m. BOREHOLE OPEN TO 10.2m AND WATER LEVEL AT 4.7m. BOREHOLE BACKFILLED WITH HOLEPLUG TO 0.2m, THEN ASPHALT TO SURFACE.						343				

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

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

ONTMT4S 1154.GPJ 10/5/27

Ministry of Transportation
Ontario

RECORD OF BOREHOLE No 10-02 1 OF 2 METRIC

G.W.P. 123-88-00 LOCATION N 5 285 242.1 E 249 417.9 ORIGINATED BY GA
HWY 144 - Bridge at Makami River BOREHOLE TYPE NW Casing/NQ Coring COMPILED BY AN
DATUM GEODETIC DATE 2010-03-24 - 2010-03-24 CHECKED BY LPG

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
353.1							353				
0.0 / 352.8	**CONCRETE** (Bridge Deck)										
0.3	**AIR**										
348.3						▽	348				
4.8 / 347.3	**WATER**										
5.8 / 346.4	Gravelly **SAND**, trace silt, occasional cobbles and boulders Very Dense Brown Wet		1	SS	66		347		○		34 61 5 (SI+CL)
6.6	Sandy **GRAVEL**, some cobbles and boulders, trace silt Very Dense Brown Wet		2	SS	50/ 0.025		346				
			3	SS	50/ 0.00		345				
343.5			4	SS	50/ 0.100		344		○		
9.6	**GRANITE**, fresh, coarse grained, very strong, occasional mechanical breaks									FI 4	

Continued Next Page

+ ³, × ³: Numbers refer to Sensitivity

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

ONTMT4S 1154.GPJ 10/5/27

Ministry of Transportation
Ontario

RECORD OF BOREHOLE No 10-02 2 OF 2 METRIC

G.W.P. 123-88-00 LOCATION N 5 285 242.1 E 249 417.9 ORIGINATED BY GA
HWY 144 - Bridge at Makami River BOREHOLE TYPE NW Casing/NQ Coring COMPILED BY AN
DATUM GEODETIC DATE 2010-03-24 - 2010-03-24 CHECKED BY LPG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						GR SA SI CL
	Continued From Previous Page										
	Start coring at 9.6m		1	RUN			343			2	
										1	RUN 1# TCR=47%, SCR=23%, RQD=0%, UCS=145MPa
							342				
			2	RUN						0	
										0	
										0	RUN 2# TCR=100%, SCR=100%, RQD=100%, UCS=187MPa
							341			0	
										0	
			3	RUN						0	RUN 3# TCR=100%,
339.8							340			0	
13.3	END OF BOREHOLE AT 13.3m. BOREHOLE OPEN TO 13.3m AND WATER LEVEL AT 4.8m. BOREHOLE BACKFILLED WITH GROUT TO 5.8m, THEN 0.3m OF CONCRETE FOR BRIDGE DECK.										SCR=100%, RQD=100%, UCS=256MPa

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

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

ONTMT4S 1154.GPJ 10/5/27

Ministry of Transportation
Ontario

RECORD OF BOREHOLE No 10-02A 1 OF 2 METRIC

G.W.P. 123-88-00 LOCATION N 5 285 241.4 E 249 423.3 ORIGINATED BY GA
HWY 144 - Bridge at Makami River BOREHOLE TYPE NW Casing/NQ Coring COMPILED BY AN
DATUM GEODETIC DATE 2010-03-26 - 2010-03-26 CHECKED BY LPG

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
353.1											
0.0 / 352.8	**CONCRETE** (Bridge Deck)						353				
0.3	**AIR**										
							352				
							351				
							350				
							349				
348.2						▽					
4.8 / 347.6	**WATER**						348				
5.5	Gravelly **SAND**, trace silt, occasional cobbles and boulders Loose to Very Dense Brown Wet		1	SS	4				○		29 64 7 (SI+CL)
			2	SS	44		347		○		
			3	SS	55		346				3 95 1 (SI+CL)
344.7							345				
8.4	Sandy **GRAVEL**, some cobbles and boulders, trace silt Very Dense Brown Wet		4	SS	50/ 0.025						
343.6							344			FI	
9.4	**GRANITE**, slightly weathered to fresh, coarse grained, very strong Start coring at 9.4m									>10	
										>10	

Continued Next Page

+ ³, × ³: Numbers refer to Sensitivity

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

ONTMT4S 1154.GPJ 10/5/27

Ministry of Transportation
Ontario

RECORD OF BOREHOLE No 10-02A 2 OF 2 METRIC

G.W.P. 123-88-00 LOCATION N 5 285 241.4 E 249 423.3 ORIGINATED BY GA
HWY 144 - Bridge at Makami River BOREHOLE TYPE NW Casing/NQ Coring COMPILED BY AN
DATUM GEODETIC DATE 2010-03-26 - 2010-03-26 CHECKED BY LPG

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (O UNCONFINED, + 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										
			1	RUN			343			0	RUN 1# TCR=100%, SCR=58%, RQD=58%, UCS=255MPa
										0	
										0	
							342			0	
			2	RUN						0	RUN 2# TCR=100%, SCR=100%, RQD=100%, UCS=247MPa
340.9							341			0	
12.2	END OF BOREHOLE AT 12.2m. BOREHOLE OPEN TO 12.2m AND WATER LEVEL AT 4.8m. BOREHOLE BACKFILLED WITH GROUT TO 4.8m, THEN 0.3m OF CONCRETE FOR BRIDGE DECK.										

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

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

ONTMT4S 1154.GPJ 10/5/27

Ministry of Transportation
Ontario

RECORD OF BOREHOLE No 10-03 1 OF 2 METRIC

G.W.P. 123-88-00 LOCATION N 5 285 228.8 E 249 425.3 ORIGINATED BY GA
HWY 144 - Bridge at Makami River BOREHOLE TYPE NW Casing/NQ Coring COMPILED BY AN
DATUM GEODETIC DATE 2010-03-24 - 2010-03-24 CHECKED BY LPG

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
353.0							353				
0.0 / 352.7	**CONCRETE** (Bridge Deck)										
0.3	**AIR**										
							352				
							351				
							350				
							349				
348.1						▽					
4.9 / 347.8	**WATER**						348				
5.2	Gravelly **SAND**, trace silt, occasional cobbles and boulders Loose to Very Dense Brown to Grey Wet		1	SS	4				○		40 56 3 (SI+CL)
			2	SS	86		347		○		
346.0											
7.0	Sandy **GRAVEL**, some cobbles and boulders, trace silt Very Dense Grey Wet 225mm boulder at 7.3m 75mm cobbles at 7.5m		3	SS	50/ 0.100		346		○		
							345				
			4	SS	50/ 0.025		344				

Continued Next Page

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

(%) STRAIN AT FAILURE

ONTMT4S 1154.GPJ 10/5/27

Ministry of Transportation
Ontario

RECORD OF BOREHOLE No 10-03 2 OF 2 METRIC

G.W.P. 123-88-00 LOCATION N 5 285 228.8 E 249 425.3 ORIGINATED BY GA
HWY 144 - Bridge at Makami River BOREHOLE TYPE NW Casing/NQ Coring COMPILED BY AN
DATUM GEODETIC DATE 2010-03-24 - 2010-03-24 CHECKED BY LPG

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
342.9	Continued From Previous Page						343				
10.1	**GRANITE**, fresh, coarse grained, very strong, occasional mechanical breaks Start coring at 10.1m Highly broken zone at 10.1m (150mm)		1	RUN			342			5 0 0 0 0 0 0 0	RUN 1# TCR=100%, SCR=90%, RQD=90%, UCS=222MPa
			2	RUN			341			0 0 0 0 0	RUN 2# TCR=100%, SCR=100%, RQD=100%, UCS=261MPa
			3	RUN			340			0 0	RUN 3# TCR=100%,
339.2											
13.8	END OF BOREHOLE AT 13.8m. BOREHOLE OPEN TO 13.8m AND WATER LEVEL AT 4.9m. BOREHOLE BACKFILLED WITH GROUT TO 5.2m, THEN 0.3m OF CONCRETE FOR BRIDGE DECK.										SCR=100%, RQD=100%, UCS=264MPa

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

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

ONTMT4S 1154.GPJ 10/5/27

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 10-03A 1 OF 2 METRIC

G.W.P. 123-88-00 LOCATION N 5 285 231.9 E 249 428.7 ORIGINATED BY GA
HWY 144 - Bridge at Makami River BOREHOLE TYPE NW Casing/NQ Coring COMPILED BY AN
DATUM GEODETIC DATE 2010-03-27 - 2010-03-27 CHECKED BY LPG

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
353.0							353				
0.0 / 352.7	**CONCRETE** (Bridge Deck)										
0.3	**AIR**										
							352				
							351				
							350				
							349				
348.1											
4.9	**WATER**					▽	348				
347.2											
5.8	Gravelly **SAND**, trace silt, occasional cobbles and boulders Compact to Very Dense Brown Wet		1	SS	25		347		o		
			2	SS	50		346		o		
345.5											
7.5	Sandy **GRAVEL**, some cobbles and boulders, trace silt Very Dense Grey Wet		3	SS	50/ 0.050		345		o		
344.1			4	SS	50/ 0.100				o	FI 0	
8.9	**GRANITE**, fresh, coarse grained, very strong, occasional mechanical breaks Start coring at 8.9m		1	RUN			344			0 0 0 0	RUN 1# TCR=100%, SCR=100%,

Continued Next Page

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

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

Ministry of Transportation
Ontario

RECORD OF BOREHOLE No 10-03A 2 OF 2 METRIC

G.W.P. 123-88-00 LOCATION N 5 285 231.9 E 249 428.7 ORIGINATED BY GA
HWY 144 - Bridge at Makami River BOREHOLE TYPE NW Casing/NQ Coring COMPILED BY AN
DATUM GEODETIC DATE 2010-03-27 - 2010-03-27 CHECKED BY LPG

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: O UNCONFINED + FIELD VANE, ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	50mm highly broken zone at 10.0m						343			0	RQD=100%, UCS=229MPa
										0	
										0	
			2	RUN			342			0	RUN 2# TCR=100%, SCR=100%, RQD=100%, UCS=215MPa
341.1										0	
11.9	END OF BOREHOLE AT 11.9m. BOREHOLE OPEN TO 11.9m AND WATER LEVEL AT 4.9m. BOREHOLE BACKFILLED WITH GROUT TO 5.8m, THEN 0.3m OF CONCRETE FOR BRIDGE DECK.										

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

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

ONTMT4S 1154.GPJ 10/5/27

Ministry of Transportation
Ontario

RECORD OF BOREHOLE No 10-04 1 OF 2 METRIC

G.W.P. 123-88-00 LOCATION N 5 285 215.9 E 249 437.6 ORIGINATED BY GA
HWY 144 - Bridge at Makami River BOREHOLE TYPE Hollow Stem Augers/NQ Coring COMPILED BY AN
DATUM GEODETIC DATE 2010-03-25 - 2010-03-25 CHECKED BY LPG

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
352.9							353				
0.0	**ASPHALT**										
0.1	Gravelly **SAND**, trace silt and clay Compact Brown Dry to Moist (FILL)		1	SS	26				o		
			2	SS	29		352		o		23 72 5 (SI+CL)
			3	SS	28		351		o		
			4	SS	16				o		
			5	SS	19		350		o		24 69 7 (SI+CL)
349.3											
3.7	Gravelly **SAND**, trace silt, occasional cobbles and boulders Compact to Very Dense Brown Wet		6	SS	24	▼	349		o		
			7	SS	74		348		o		
345.8							347				
7.2	Sandy **GRAVEL**, some cobbles and boulders, trace silt Very Dense Grey Wet		8	SS	50/ 0.00		346				
			9	SS	50/ 0.075		345				
							344				

Continued Next Page

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

(%) STRAIN AT FAILURE

ONTMT4S 1154.GPJ 10/5/27

Ministry of Transportation
Ontario

RECORD OF BOREHOLE No 10-04 2 OF 2 METRIC

G.W.P. 123-88-00 LOCATION N 5 285 215.9 E 249 437.6 ORIGINATED BY GA
HWY 144 - Bridge at Makami River BOREHOLE TYPE Hollow Stem Augers/NQ Coring COMPILED BY AN
DATUM GEODETIC DATE 2010-03-25 - 2010-03-25 CHECKED BY LPG

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa: O UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page						343				
342.3										FI	
10.7	**GRANITE**, slightly weathered to fresh, coarse grained, very strong Start coring at 10.7m		1	RUN			342			0 0 0 0	RUN 1# TCR=100%, SCR=100%, RQD=100%, UCS=128MPa
							341			0 0 0	
			2	RUN			340			0 0 0	RUN 2# TCR=100%, SCR=100%, RQD=100%, UCS=195MPa
339.4											
13.6	END OF BOREHOLE AT 13.6m. BOREHOLE OPEN TO 13.5m AND WATER LEVEL AT 4.9m. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) 26/03/2010 4.9 348.0 27/03/2010 4.9 348.0										

+ ³, × ³: Numbers refer to Sensitivity

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

ONTMT4S 1154.GPJ 10/5/27

Appendix B

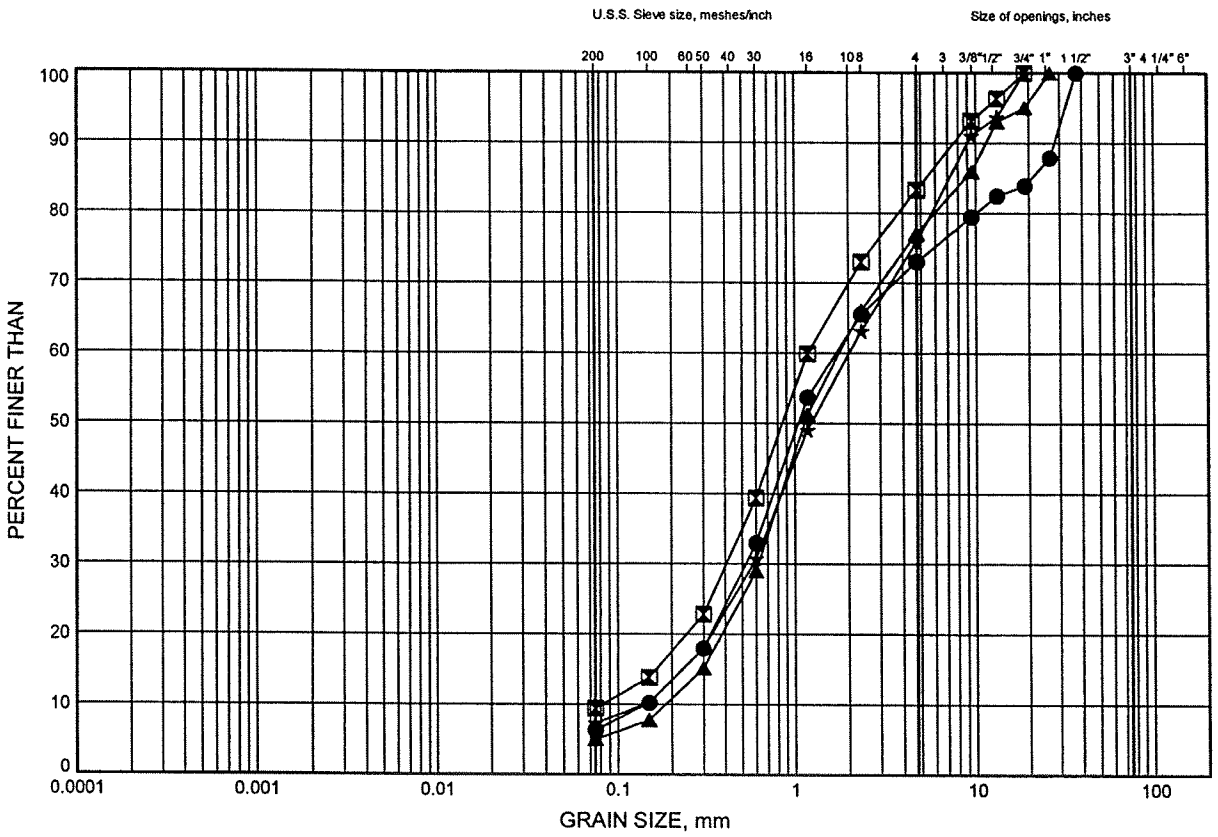
Laboratory Test Results

Hwy 144 Bridge at Makami River

GRAIN SIZE DISTRIBUTION

FIGURE 1

SAND, Some Gravel to Gravelly FILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	10-01	3.35	349.77
⊠	10-01A	1.83	351.29
▲	10-04	1.07	351.85
★	10-04	3.35	349.57

W.P.# 123-88-00
Prepared By AN
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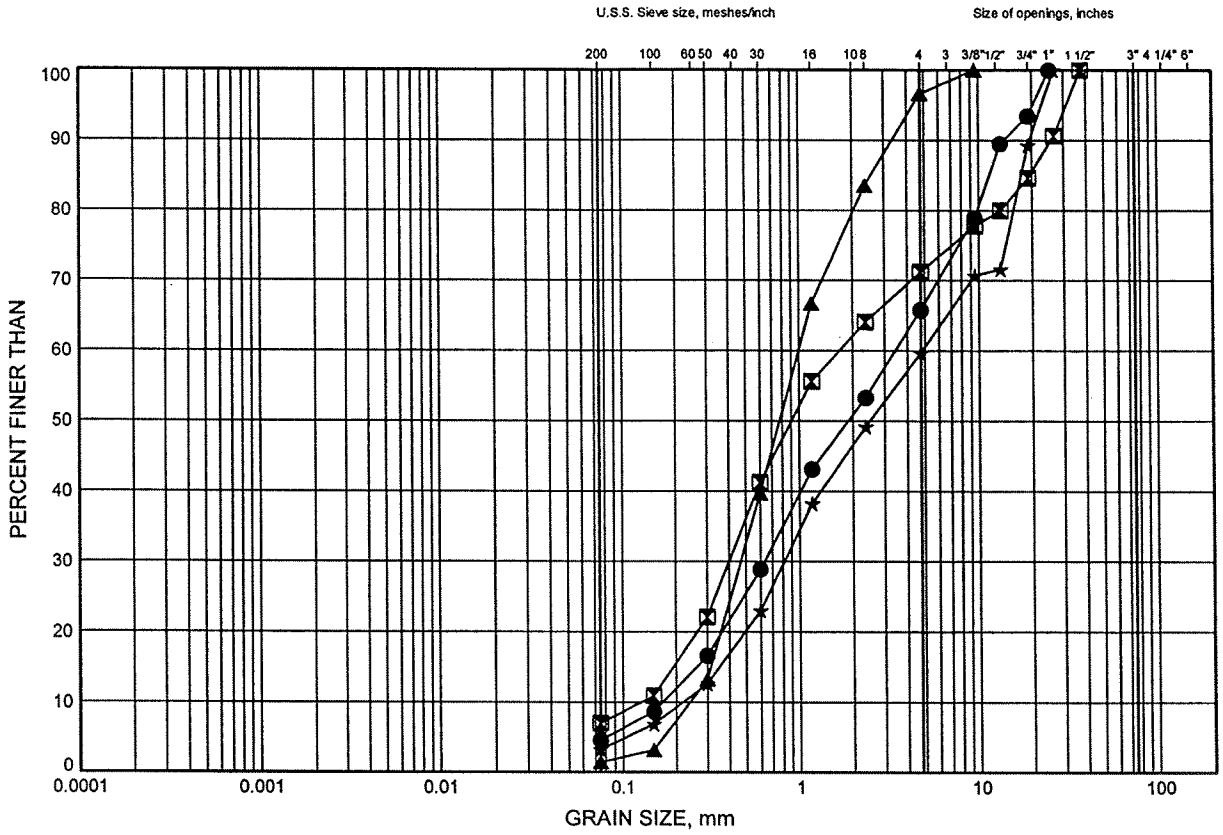
GRAIN SIZE DISTRIBUTION - THURBER 1154.GPJ 5/31/10

Hwy 144 Bridge at Makami River

GRAIN SIZE DISTRIBUTION

FIGURE 2

Gravelly SAND



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	10-02	6.10	346.97
⊠	10-02A	5.79	347.26
▲	10-02A	7.92	345.13
★	10-03	5.49	347.50

W.P.# 123-88-00
Prepared By AN
Checked By LPG

THURBER

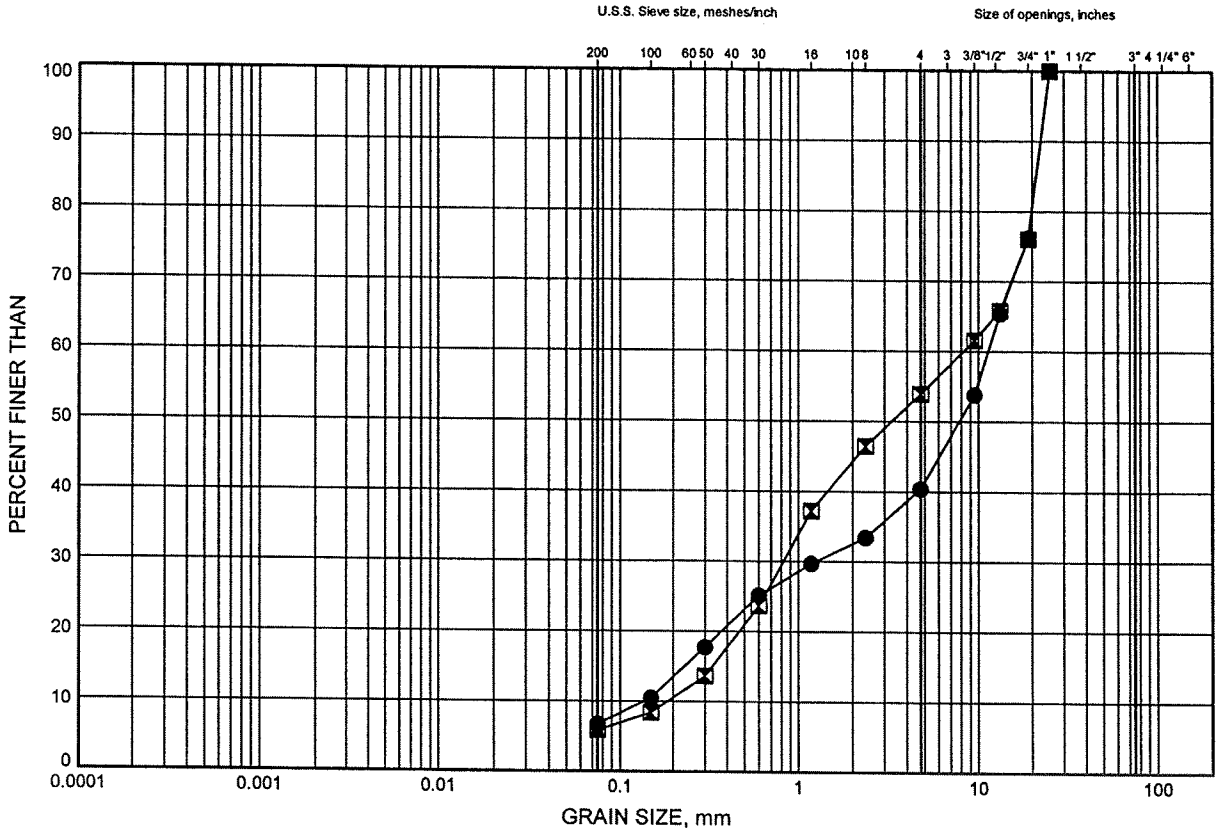
GRAIN SIZE DISTRIBUTION - THURBER 1154.GPJ 5/31/10

Hwy 144 Bridge at Makami River

GRAIN SIZE DISTRIBUTION

FIGURE 3

Sandy GRAVEL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	10-01	6.40	346.72
⊠	10-01A	4.88	348.24

W.P.# 123-88-00

Prepared By AN

Checked By LPG

THURBER

GRAIN SIZE DISTRIBUTION - THURBER 1154.GPJ 5/31/10

THURBER ENGINEERING LTD.

POINT LOAD TEST SHEET

Job No :	19-1351-154	**Client :**	MRC
Project Name :	Hwy 144 Bridge at Makami River	**Date Drilled :**	23/03/2010
BH No :	10-1	**Date Tested :**	29/3/2010
Core Size :	NQ	**Tester :**	JM

Test No.	Run No.	Depth (m)	Axial or Diametical	Force (kN)	Diameter (mm)	Length (mm)	UCS (MPa)	Rock Type	Notes
1	1	7.7	D	17.5	46.8	175.2	186.1	Granite	Very Strong
2	1	8.2	D	25.5	46.8	305.2	271.7	Granite	Extremely Strong
3	1	8.3	D	27.5	46.8	362.2	292.3	Granite	Extremely Strong
4	1	8.8	D	25.5	46.8	131.2	271.5	Granite	Extremely Strong
5	1	8.8	A	27.0	46.7	50.5	224.8	Granite	Extremely Strong
6	1	8.9	D	22.5	46.9	183.3	238.9	Granite	Extremely Strong
7	1	9.4	D	17.5	46.7	245.3	186.5	Granite	Very Strong
8	1	9.4	A	22.5	46.8	52.4	181.8	Granite	Very Strong
9	2	9.5	D	18.0	46.7	92.5	192.0	Granite	Very Strong
10	2	10.0	D	25.0	46.8	200.3	266.1	Granite	Extremely Strong
11	2	10.3	D	17.5	47.3	385.2	182.9	Granite	Very Strong
12	2	10.6	D	18.5	47.1	385.2	194.8	Granite	Very Strong
13	2	10.6	A	25.0	47.3	48.1	214.1	Granite	Extremely Strong
14	2	10.8	D	22.5	47.2	140.3	236.2	Granite	Extremely Strong

* It is ideal to perform axial test on core specimens with D/L ratio of 1.1 ± 0.1
Long pieces of core can be tested diametrically to produce suitable lengths for axial testing

* Diametral Test should have 0.7 x D on either side of test point.

THURBER ENGINEERING LTD.

POINT LOAD TEST SHEET

Job No :	19-1351-154	**Client :**	MRC
Project Name :	Hwy 144 Bridge at Makami River	**Date Drilled :**	26/3/2010
BH No :	10-1A	**Date Tested :**	29/3/2010
Core Size :	NQ	**Tester :**	WC

Test No.	Run No.	Depth (m)	Axial or Diametical	Force (kN)	Diameter (mm)	Length (mm)	UCS (MPa)	Rock Type	Notes
1	1	8.0	D	19.5	47.2	98.5	204.7	Granite	Extremely Strong
2	1	8.2	A	23.5	47.1	84.3	130.8	Granite	Very Strong
3	1	8.4	D	13.0	47.3	61.2	136.2	Granite	Very Strong
4	1	8.7	D	12.0	47.2	105.0	126.1	Granite	Extremely Strong
5	1	8.7	A	15.0	47.2	78.1	88.4	Granite	Strong
6	2	9.0	D	19.0	47.2	100.0	199.4	Granite	Very Strong
7	2	9.2	D	22.0	47.2	260.0	230.6	Granite	Extremely Strong
8	2	9.5	D	18.5	47.2	113.8	194.4	Granite	Very Strong
9	2	9.8	D	17.0	47.2	62.1	178.4	Granite	Very Strong
10	2	10.1	D	18.0	47.2	92.1	189.1	Granite	Very Strong
11	2	10.1	A	20.0	47.2	92.1	103.8	Granite	Very Strong

* It is ideal to perform axial test on core specimens with D/L ratio of 1.1 ± 0.1
Long pieces of core can be tested diametrically to produce suitable lengths for axial testing

* Diametral Test should have 0.7 x D on either side of test point.

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POINT LOAD TEST SHEET

Job No :	19-1351-154	**Client :**	MRC
Project Name :	Hwy 144 Bridge at Makami River	**Date Drilled :**	24/03/2010
BH No :	10-2	**Date Tested :**	29/3/2010
Core Size :	NQ	**Tester :**	WC

Test No.	Run No.	Depth (m)	Axial or Diametical	Force (kN)	Diameter (mm)	Length (mm)	UCS (MPa)	Rock Type	Notes
1	1	9.6	D	15.5	46.7	76.5	165.4	Granite	Very Strong
2	1	9.9	D	12.0	47.4	77.2	125.1	Granite	Very Strong
3	2	11.2	D	15.0	46.8	170.0	159.5	Granite	Very Strong
4	2	11.2	A	26.5	46.8	79.1	155.6	Granite	Very Strong
5	2	11.5	D	17.5	46.8	280.0	186.3	Granite	Very Strong
6	2	11.5	A	22.0	46.8	61.0	158.1	Granite	Very Strong
7	2	11.9	D	23.0	46.9	94.0	243.7	Granite	Extremely Strong
8	2	12.0	D	21.0	47.0	94.9	221.8	Granite	Extremely Strong
9	3	12.8	D	24.5	47.3	157.9	256.3	Granite	Extremely Strong
10	3	12.8	A	30.5	47.2	52.3	245.2	Granite	Extremely Strong
11	3	13.2	D	25.5	47.2	242.1	268.1	Granite	Extremely Strong

* It is ideal to perform axial test on core specimens with D/L ratio of 1.1 ± 0.1
Long pieces of core can be tested diametrically to produce suitable lengths for axial testing

* Diametral Test should have 0.7 x D on either side of test point.

THURBER ENGINEERING LTD.

POINT LOAD TEST SHEET

Job No :	19-1351-154	**Client :**	MRC
Project Name :	Hwy 144 Bridge at Makami River	**Date Drilled :**	26/3/2010
BH No :	10-2A	**Date Tested :**	29/3/2010
Core Size :	NQ	**Tester :**	JM

Test No.	Run No.	Depth (m)	Axial or Diametical	Force (kN)	Diameter (mm)	Length (mm)	UCS (MPa)	Rock Type	Notes
1	1	10.9	D	15.5	46.7	142.1	165.3	Granite	Very Strong
2	1	10.7	D	29.5	46.9	159.1	312.9	Granite	Extremely Strong
3	1	10.4	D	27.0	47.1	248.5	284.4	Granite	Extremely Strong
4	1	10.4	A	35.5	47.2	60.2	256.1	Granite	Extremely Strong
5	2	11.9	D	19.0	46.8	136.4	202.2	Granite	Extremely Strong
6	2	11.9	D	25.5	46.8	241.6	271.1	Granite	Extremely Strong
7	2	12.1	A	27.0	47.1	46.9	236.7	Granite	Extremely Strong
8	2	11.5	D	27.5	46.9	183.4	291.9	Granite	Extremely Strong
9	2	11.3	D	22.0	46.9	361.3	233.2	Granite	Extremely Strong

* It is ideal to perform axial test on core specimens with D/L ratio of 1.1 ± 0.1
Long pieces of core can be tested diametrically to produce suitable lengths for axial testing

* Diametral Test should have 0.7 x D on either side of test point.

THURBER ENGINEERING LTD.

GEOTECHNICAL · ENVIRONMENTAL · MATERIALS

POINT LOAD TEST SHEET

Job No :	19-1351-154	**Client :**	MRC
Project Name :	Hwy 144 Bridge at Makami River	**Date Drilled :**	24/03/2010
BH No :	10-3	**Date Tested :**	29/3/2010
Core Size :	NQ	**Tester :**	JM

Test No.	Run No.	Depth (m)	Axial or Diametical	Force (kN)	Diameter (mm)	Length (mm)	UCS (MPa)	Rock Type	Notes
1	1	10.2	D	21.5	46.9	152.9	227.9	Granite	Extremely Strong
2	1	10.7	D	22.5	46.9	282.3	238.9	Granite	Extremely Strong
3	1	10.9	A	28.0	46.8	52.9	224.6	Granite	Extremely Strong
4	1	10.9	D	26.5	47.0	230.5	280.3	Granite	Extremely Strong
5	1	11.3	D	27.0	46.7	241.1	288.4	Granite	Extremely Strong
6	1	11.6	D	14.5	46.7	151.7	154.7	Granite	Very Strong
7	1	11.6	A	19.5	46.8	62.0	138.4	Granite	Very Strong
8	2	11.7	D	27.5	46.8	182.4	292.4	Granite	Extremely Strong
9	2	11.9	D	25.5	46.8	190.3	271.6	Granite	Extremely Strong
10	2	12.5	D	23.5	46.9	1.2	249.3	Granite	Extremely Strong
11	2	12.6	D	20.5	46.7	127.0	218.6	Granite	Extremely Strong
12	2	13.1	D	25.5	46.8	295.4	271.2	Granite	Extremely Strong
13	3	13.6	D	26.0	46.7	182.4	277.2	Granite	Extremely Strong
14	3	13.7	A	31.0	46.8	46.0	277.2	Granite	Extremely Strong
15	3	13.7	D	22.5	46.8	178.6	239.0	Granite	Extremely Strong

* It is ideal to perform axial test on core specimens with D/L ratio of 1.1 ± 0.1
Long pieces of core can be tested diametrically to produce suitable lengths for axial testing

* Diametral Test should have 0.7 x D on either side of test point.

THURBER ENGINEERING LTD.

POINT LOAD TEST SHEET

Job No :	19-1351-154	**Client :**	MRC
Project Name :	Hwy 144 Bridge at Makami River	**Date Drilled :**	27/3/2010
BH No :	10-3A	**Date Tested :**	29/3/2010
Core Size :	NQ	**Tester :**	WC

Test No.	Run No.	Depth (m)	Axial or Diametical	Force (kN)	Diameter (mm)	Length (mm)	UCS (MPa)	Rock Type	Notes
1	1	9.0	D	16.5	47.5	121.0	171.3	Granite	Very Strong
2	1	9.0	A	25.0	47.5	62.7	173.7	Granite	Very Strong
3	1	9.2	D	22.0	47.7	101.0	226.9	Granite	Extremely Strong
4	1	9.6	D	22.5	47.5	74.7	233.9	Granite	Extremely Strong
5	1	1.0	D	27.5	47.4	61.1	286.4	Granite	Extremely Strong
6	1	10.2	D	27.0	47.5	210.0	280.8	Granite	Extremely Strong
7	2	10.4	A	28.0	48.0	73.2	171.3	Granite	Very Strong
8	2	10.7	D	23.0	47.6	79.8	238.3	Granite	Extremely Strong
9	2	11.1	D	23.5	47.8	230.0	241.8	Granite	Extremely Strong
10	2	11.3	D	24.0	47.5	125.0	249.6	Granite	Extremely Strong
11	2	11.3	A	41.0	47.5	77.1	242.8	Granite	Extremely Strong
12	2	11.7	D	20.0	47.9	67.9	205.5	Granite	Extremely Strong
13	2	11.7	A	24.5	47.9	67.9	159.1	Granite	Very Strong

* It is ideal to perform axial test on core specimens with D/L ratio of 1.1 ± 0.1
Long pieces of core can be tested diametrically to produce suitable lengths for axial testing

* Diametral Test should have 0.7 x D on either side of test point.

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POINT LOAD TEST SHEET

Job No :	19-1351-154	**Client :**	MRC
Project Name :	Hwy 144 Bridge at Makami River	**Date Drilled :**	25/3/2010
BH No :	10-4	**Date Tested :**	29/3/2010
Core Size :	NQ	**Tester :**	WC

Test No.	Run No.	Depth (m)	Axial or Diametical	Force (kN)	Diameter (mm)	Length (mm)	UCS (MPa)	Rock Type	Notes
1	1	10.8	D	15.0	47.0	316.0	158.6	Granite	Very Strong
2	1	11.1	D	13.0	47.3	92.5	135.9	Granite	Very Strong
3	1	11.4	D	7.5	47.2	260.0	78.7	Granite	Strong
4	1	11.4	A	18.0	47.2	48.7	152.9	Granite	Very Strong
5	1	11.7	D	8.0	47.4	160.0	83.5	Granite	Strong
6	1	12.0	D	14.0	47.3	82.1	146.7	Granite	Very Strong
7	1	12.0	A	17.0	47.3	51.9	137.4	Granite	Very Strong
8	2	12.3	D	14.0	47.4	120.0	146.2	Granite	Very Strong
9	2	12.5	D	14.0	47.3	210.0	146.5	Granite	Very Strong
10	2	12.8	D	16.5	47.3	230.0	172.7	Granite	Very Strong
11	2	12.8	A	20.0	47.3	56.4	151.5	Granite	Very Strong
12	2	12.9	D	15.5	47.3	120.0	162.1	Granite	Very Strong
13	2	13.1	D	23.5	47.2	146.3	246.6	Granite	Extremely Strong
14	2	13.1	A	32.5	47.3	51.1	265.6	Granite	Extremely Strong
15	2	13.5	D	25.5	47.2	229.7	267.8	Granite	Extremely Strong

* It is ideal to perform axial test on core specimens with D/L ratio of 1.1 ± 0.1
Long pieces of core can be tested diametrically to produce suitable lengths for axial testing

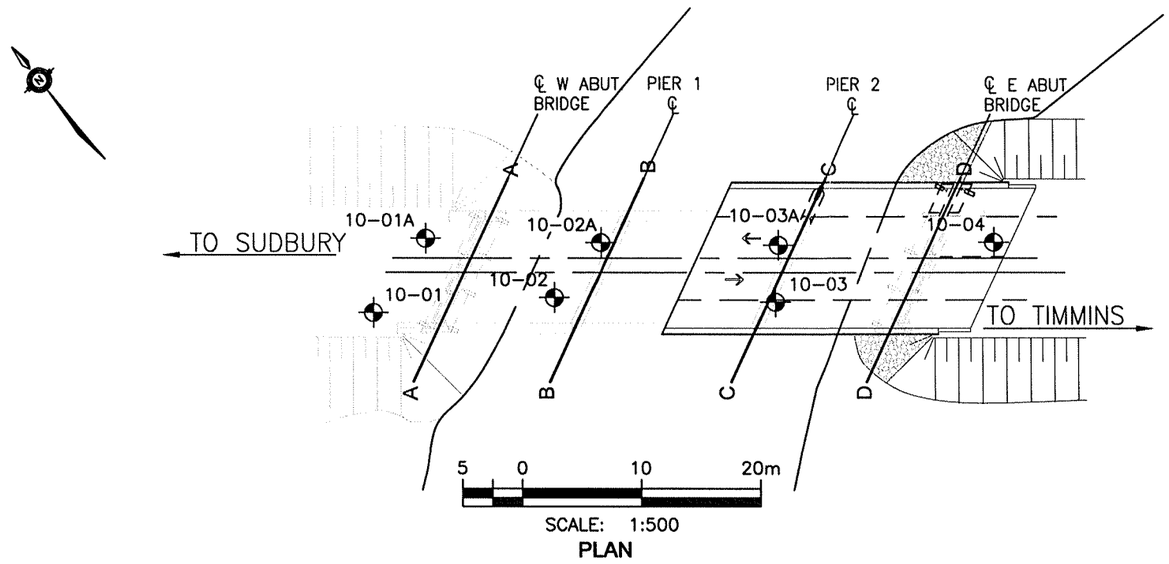
* Diametral Test should have 0.7 x D on either side of test point.

Appendix C

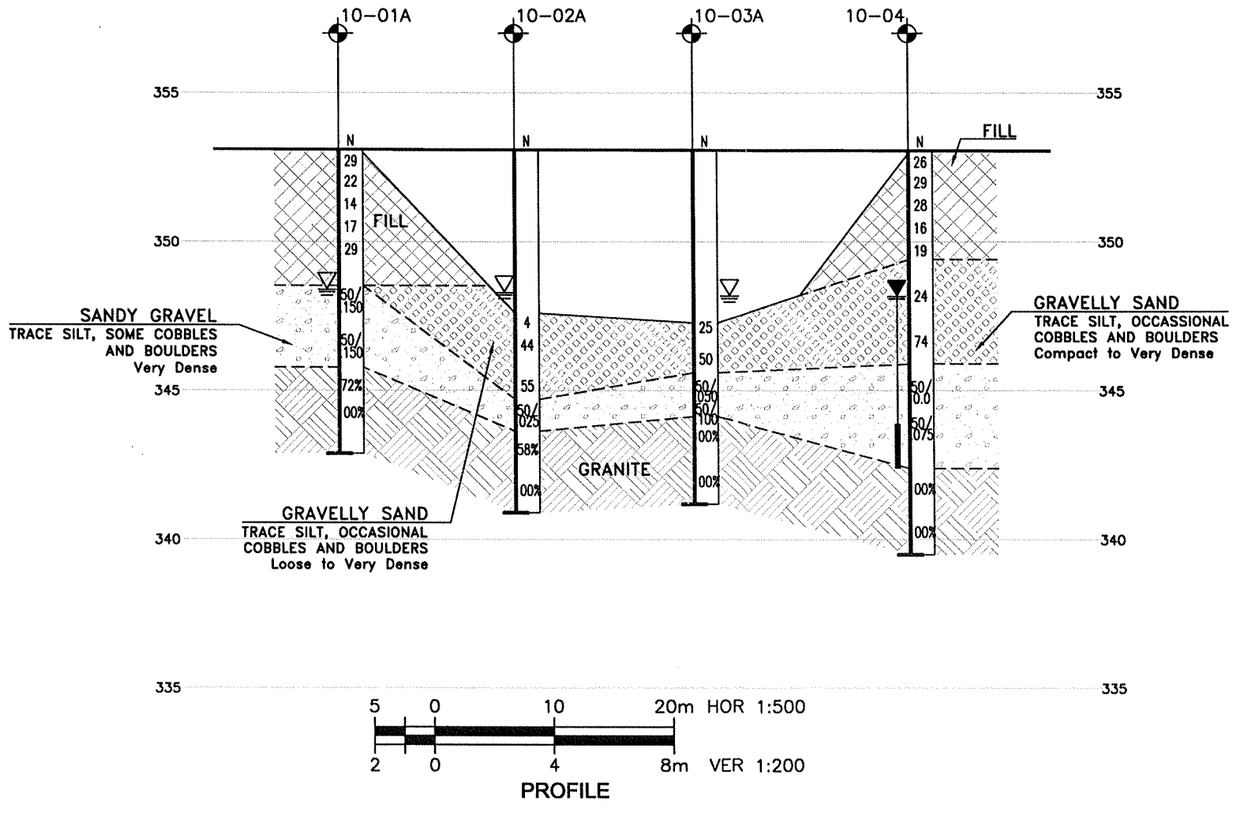
Drawing "Borehole Locations and Soil Strata"

METRIC

DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN



PLAN



PROFILE

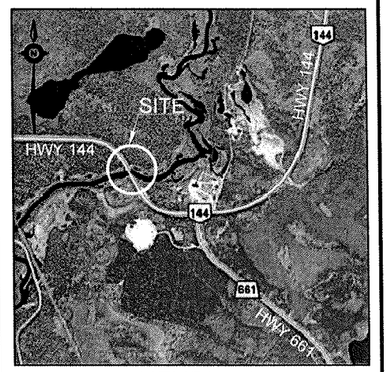
CONT No.
WP No 123-88-02

SHEET

MAKAMI RIVER BRIDGE REHABILITATION
BOREHOLE LOCATIONS AND SOIL STRATA

MMM GROUP

THURBER ENGINEERING LTD.
GEOTECHNICAL • ENVIRONMENTAL • MATERIALS



KEYPLAN

LEGEND

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

NO	ELEVATION	NORTHING	EASTING
10-01	353.1	5 285 258.4	294 407.9
10-01A	353.1	5 285 257.9	294 414.0
10-02	353.1	5 285 242.1	294 417.9
10-02A	353.1	5 285 241.4	294 423.3
10-03	353.0	5 285 228.8	294 425.3
10-03A	353.0	5 285 231.9	294 428.7
10-04	352.9	5 285 215.9	294 437.6

REGISTERED PROFESSIONAL ENGINEER
A. E. GORMAN
AUG 10/10
PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER
P. K. CHATTERJI
AUG 10/10
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.
2) This drawing is for subsurface information only. Surface details and features are for conceptual illustration.

GEOCRES No. 41P - 45

REVISIONS	DATE	BY	DESCRIPTION

DESIGN	LPG	CHK	PKC	CODE	CHBDC 2006	LOAD	CL-625-ONT
DRAWN	AN	CHK	AEG	SITE	46-228	STRUCT	DWG 2

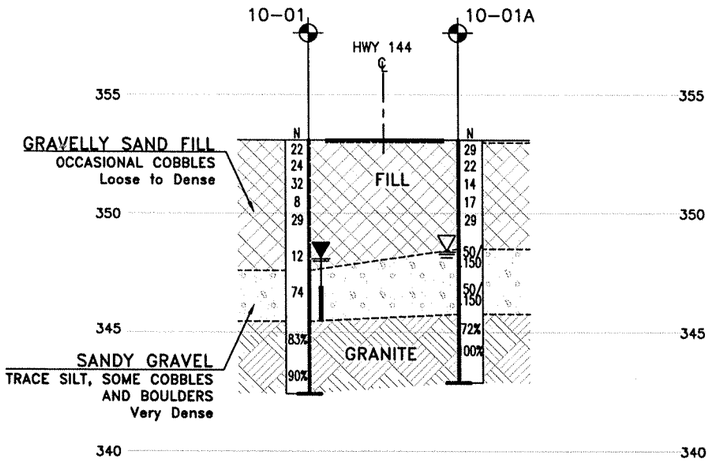
DATE AUG. 2010

FILENAME:
PLOTDATE:

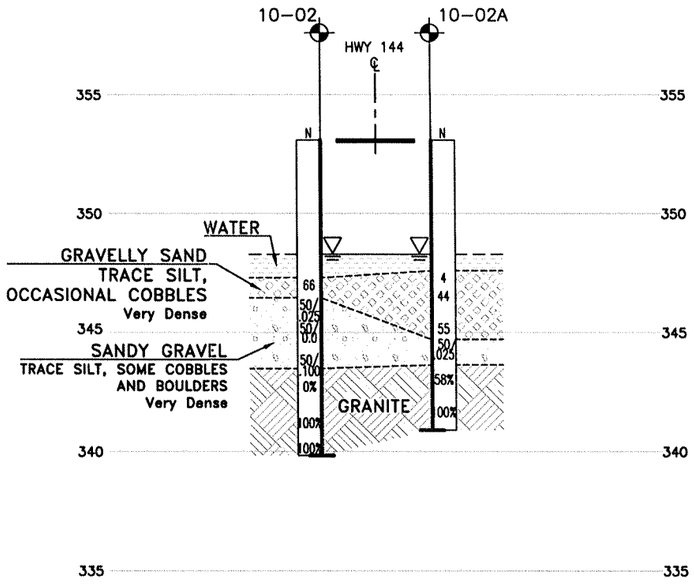
MINISTRY OF TRANSPORTATION, ONTARIO

METRIC

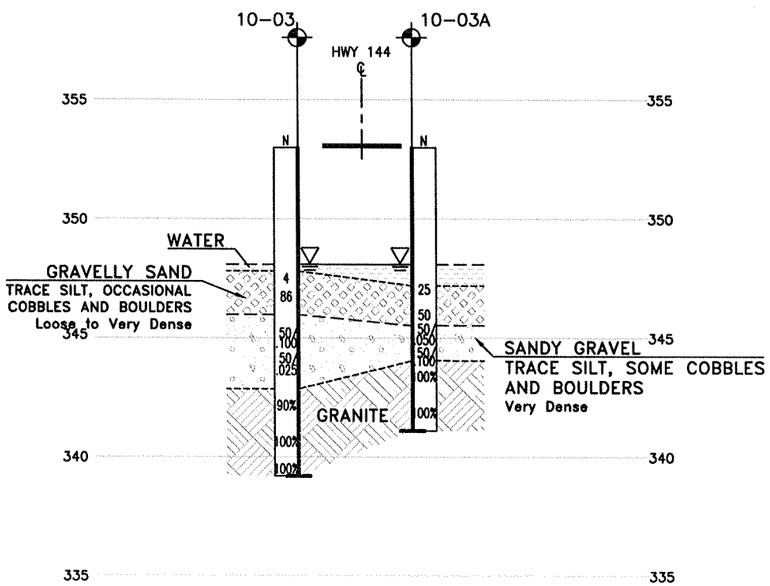
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN



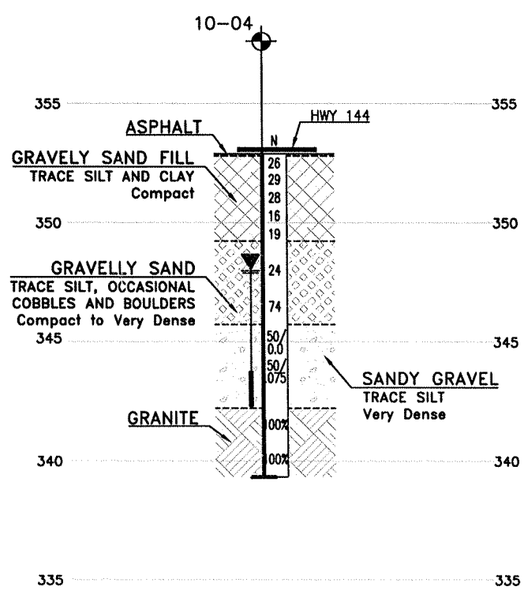
SECTION A-A



SECTION B-B



SECTION C-C



SECTION D-D

2 0 5 10m

SCALE: 1:250

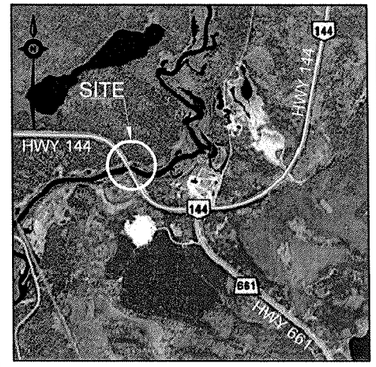
CONT No.
WP No 123-88-02

SHEET

MAKAMI RIVER BRIDGE REHABILITATION
BOREHOLE LOCATIONS AND SOIL STRATA

MMM GROUP

THURBER ENGINEERING LTD.
GEOTECHNICAL • ENVIRONMENTAL • MATERIALS



KEYPLAN

LEGEND

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

NO	ELEVATION	NORTHING	EASTING
10-01	353.1	5 285 258.4	294 407.9
10-01A	353.1	5 285 257.9	294 414.0
10-02	353.1	5 285 242.1	294 417.9
10-02A	353.1	5 285 241.4	294 423.3
10-03	353.0	5 285 228.8	294 425.3
10-03A	353.0	5 285 231.9	294 428.7
10-04	352.9	5 285 215.9	294 437.6

-NOTES-

1) The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.
2) This drawing is for subsurface information only. Surface details and features are for conceptual illustration.

GEOCRES No. 41P - 45

REVISIONS		
DATE	BY	DESCRIPTION

DESIGN	LPG	CHK	PKC	CODE	CHBDC 2006
DRAWN	AN	CHK	AEG	SITE	48-228
LOAD	CL-625-ONT	DATE	AUG. 2010		
STRUCT		DWG	3		

FILENAME:
PLOTDATE:

Appendix D

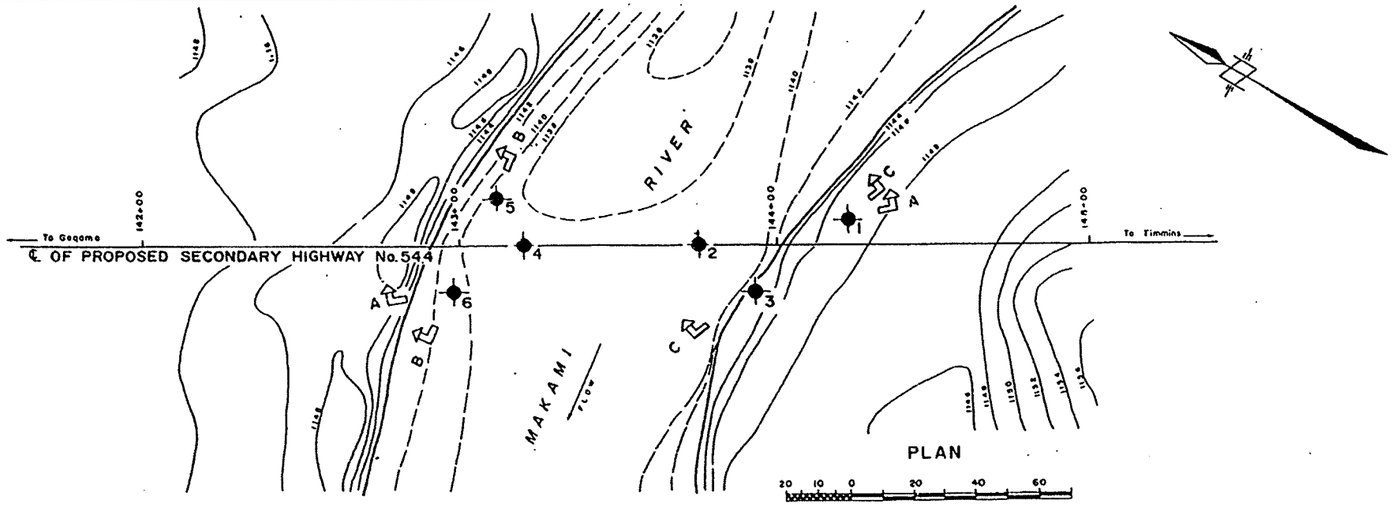
Site Photographs

Photo 1. General view of bridge site. (East Side Looking South)

Photo 2. North East Side of Bridge where widening will take place.

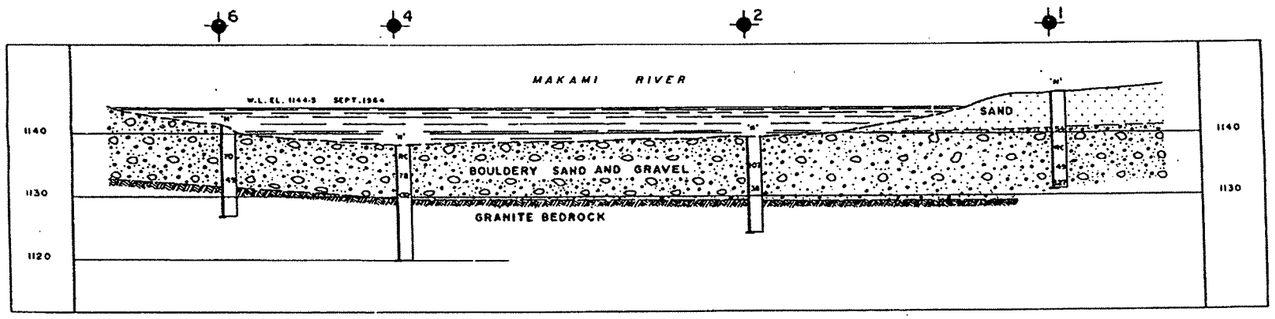
Appendix E

Soil Stratigraphy Along Existing Bridge Alignment

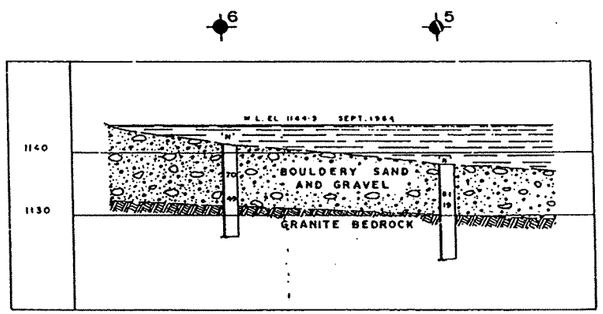


PLAN

SCALE IN FEET



SECTION A-A



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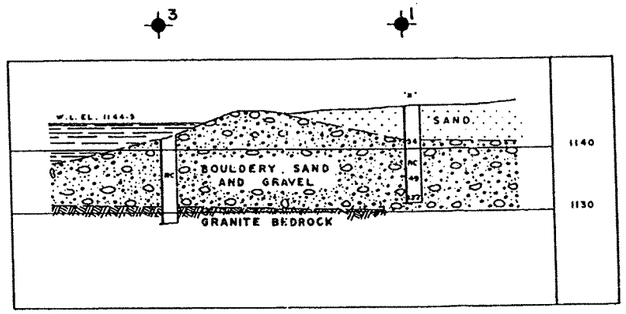

SECTION C-C

SCALE IN FEET

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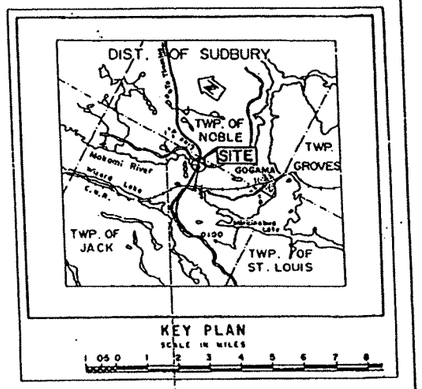

KEY PLAN

SCALE IN MILES

0 1 2 3 4 5 6 7 8

LEGEND

- Bore Hole
- Cone Penetration Hole
- Bore & Cone Penetration Hole
- Water Levels established at time of field investigation.

RC Rock core

NO.	ELEVATION	STATION	OFFSET
1	1146·6	144+23	8'LT.
2	1139·6	143+76	℄
3	1141·7	143+93	15'RT.
4	1138·7	143+20	℄
5	1138·1	143+12	15'LT.
6	1141·7	142+98	15'RT.

- NOTE -

The boundaries between soil strata have been established only at Bore Hole locations. Between Bore Holes the boundaries are assumed from geological evidence and may be subject to considerable error.

PRINT RECORD		
NO.	FOR	DATE

REVISIONS		
DATE	BY	DESCRIPTION

DEPARTMENT OF HIGHWAYS - ONTARIO

MATERIALS & RESEARCH DIVISION - FOUNDATION SECTION

PROPOSED CROSSING AT MAKAMI RIVER

KING'S HIGHWAY NO. 544 LINE 'A' DIST NO. 14

DISTRICT OF SUDBURY

TWP. JACK LOT ____ CON. ____

BOREHOLE LOCATION PLAN & SOIL STRATIGRAPHY

SUBM'D	CHECKED	W.P. NO.	M.B.R. DRAWING NO
DRAWN W.G.	CHECKED	JOB NO.	
DATE SEPT. 1964		SITE NO	BRIDGE DRAWING NO.
APPROVED		CONT. NO.	