FOUNDATION INVESTIGATION REPORT
STURGEON RIVER BRIDGE REPLACEMENT
HIGHWAY 11
GERALDTON COMMUNITY
DISTRICT OF THUNDER BAY, TOWNSHIP OF COLTER, ONTARIO

G.W.P. 6056-10-00, Site No. 48E-8

Geocres Number: 42H-13

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 site of a proposed replacement of the existing bridge structure which carries Highway 11 over Sturgeon River located approximately 18 km east of Jellicoe and 30 km west of Geraldton, in the District of Thunder Bay, Township of Colter, Ontario.

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 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 (MRC), under the Ministry of Transportation Ontario (MTO) Agreement Number 6010-E-0011.

In the preparation of this report and in addition to the boreholes drilled under the current assignment, reference has been made to information on subsurface conditions contained in a previous foundation report. The title of this report is listed as follows:

- Foundation Investigation and Design Report for Sturgeon River Bridge (18 km east of Jellicoe), W.P. 335-85-01, Site 48E-8, Hwy. 11, District 19, Thunder Bay, Contract No. 87-202, Geocres No. 42E-3, prepared by Engineering Materials Office, Foundation Design Section, dated June 27, 1986. (Reference 1).

2 SITE DESCRIPTION

The Sturgeon River Bridge is located on Highway 11 approximately 18 km east of Jellicoe and 30 km west of Geraldton, Ontario in the District of Thunder Bay, Township of Colter.

At present, the highway crosses the Sturgeon River on a three-span structure supported on two piers and two abutments. The span lengths are 12 m, 17 m and 12 m. The total length of the bridge is 41.0 m and the width is 10.9 m.

At this site, the Sturgeon River flows to the north. The river channel is approximately 25 m to 30 m wide and 1.0 m to 3.0 m deep at the bridge. The river is relatively fast-flowing at this site. Rock fill erosion protection is visible above the river level throughout the lower parts of the approach embankments.

The area surrounding the bridge site is gently to moderately rolling. The areas to east and west of the site are generally heavily treed. Camp 51 Road is located approximately 90 m east of the bridge. Rock outcrops are visible near the site.

Photographs in Appendix F show the general nature of the site.

The site is located on a morainal landform, which consist of thin till deposits over bedrock. The site lies within the physiographic region known as the Wabigoon Subprovince of the Superior Province of the Canadian Shield. The region is characterized by metasedimentary rocks. Locally, the bedrock is mantled by sand and silt till deposit. Rock knobs are associated with this terrain.

3 SITE INVESTIGATION AND FIELD TESTING

A site investigation and field testing for this project were carried out on July 26 and 27 and August 3 and 5, 2011 and consisted of drilling and sampling six boreholes (numbered STR-01 to STR-03 and STR-08 to STR-10).

Locations of Boreholes STR-01 to STR-03 and STR-08 to STR-10 were selected based on the bridge design information available at the time of the investigation, including the possibility of retaining the existing abutments. However, after the field investigation was completed, the design concept was finalized to a full bridge replacement. For a bridge span of 35.0 m, the drilled boreholes were not positioned at the foundation units of the new design. A second investigation, consisting of four boreholes (numbered STR-04 to STR-07) was conducted from September 26 to 28, 2012 to identify soil conditions and establish the bedrock elevation at the revised abutment locations.

All the boreholes were drilled through the highway embankment or the bridge deck in the area of the existing and proposed west and east approaches and abutments.

Boreholes STR-01 and STR-10 were drilled through the existing west and east approaches, respectively, and were both terminated at 4.9 m and 6.4 m (elevations 337.2 and 335.8).

Boreholes STR-02 to STR-05 were drilled near the existing and proposed west abutments to depths ranging from 4.1 m to 8.7 m (elevations 333.4 to 338.0).

Boreholes STR-06 to STR-09 were drilled at the location of the existing and proposed east abutments and were terminated at depths ranging from 6.8 m to 12.7 m (elevations 329.5 to 335.4).

Bedrock was proved in Boreholes STR-03 to STR-08 by NQ size diamond coring. Boreholes STR-03 to STR-08 were advanced 2.8 m to 4.4 m into bedrock.

A Dynamic Cone Penetration Tests (DCPTs) was conducted adjacent to Borehole STR-09 to supplement the data collected from the borehole. The DCPT was terminated at 7.1 m depth (elevation 335.1), upon refusal on probable bedrock.

Records of Boreholes 1 to 4 drilled during the previous investigation (Reference 1) and their respective laboratory test results are enclosed in Appendix C.

The approximate locations of the boreholes are shown on the attached Borehole Locations and Soil Strata Drawing in Appendix G.

The borehole locations were marked in the field and utility clearances were obtained prior to drilling.

The drilling was carried out from the highway grade using both CME 75 and CME 55 truck-mounted drill rigs. Hollow stem augers, NW casing and tricone were used to advance the boreholes through the overburden deposits and NQ coring methods were used to advance boreholes through the bedrock. Overburden samples were obtained at selected intervals using a split spoon sampler in conjunction with Standard Penetration Testing (SPT).

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.

Two standpipe piezometers consisting of 19 mm PVC pipe with slotted screen and enclosed in filter sand were installed at this site to permit longer term groundwater level monitoring. The boreholes were backfilled with bentonite holeplug in general accordance with O.Reg. 903 upon completion. The location and completion details of the piezometer and boreholes are presented in Table 3.1.

Table 3.1 – Borehole Abandonment Details

Location	Borehole	Piezometer Tip Depth/ Elevation (m)	Abandonment Details
West Approach	STR-01	None installed	Borehole backfilled with bentonite holeplug to 0.9 m, sand and gravel to 0.6 m, concrete to 0.15 m then asphalt to surface.
West Abutment	STR-02	None installed	Borehole backfilled with bentonite holeplug to 0.9 m, sand and gravel to 0.6 m, concrete to 0.15 m, then asphalt to surface.
	STR-03	8.5/333.6	Sand from 8.5 m to 6.7 m, bentonite holeplug form 6.7 m to 2.0 m, sand from 2.0 m to 0.4 m, then asphalt to surface.
	STR-04	None installed	Boreholes backfilled with bentonite holeplug to ground surface. Bridge deck backfilled with 0.28 m of concrete, then asphalt to highway surface.
	STR-05	None installed	
East Abutment	STR-06	None installed	
	STR-07	None installed	
	STR-08	11.0 / 331.2	Sand from 11.0 m to 9.1 m, bentonite holeplug from 9.1 m to 1.8 m, sand from 1.8 m to 0.4 m, then asphalt to surface.
	STR-09	None installed	Borehole backfilled with bentonite holeplug to 1.5 m, sand and gravel from 1.5 m to 0.45 m, concrete to 0.15 m, then asphalt to surface.
East Approach	STR-10	None installed	Borehole backfilled with bentonite holeplug to 0.9 m, sand and gravel from 0.9 m to 0.15 m, asphalt to surface.

Piezometers have been decommissioned in accordance with O. Reg. 903 in September 2012.

4 LABORATORY TESTING

The recovered soil samples were subjected to Visual Identification (VI) and to natural moisture content determination. Selected samples were also subjected to grain size distribution analyses (sieve and hydrometer). The results of this testing program are summarized on the Record of Borehole sheets in Appendix A and shown on the figures contained in Appendix B.

Point load tests were carried out on selected samples of intact bedrock upon arrival at the laboratory to assist in evaluation of the compressive strength of the bedrock. Results of point load tests on the rock core samples are included in Appendix B and on the Record of Borehole sheets in Appendix A.

5 DESCRIPTION OF SUBSURFACE CONDITIONS

Reference is made to the Record of Borehole sheets in Appendix A. Details of the encountered soil stratigraphy are presented in these sheets and on the "Borehole Locations and Soil Strata" drawing in Appendix G. 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. It must be recognized that soil conditions may vary between and beyond borehole locations.

In general terms, the stratigraphy encountered at this site consists of pavement structure overlying granular embankment fill. A layer of sandy silt with organics was encountered below the fill at the west approach. On the east side of the river, native sand and silt till was contacted below the granular fill. A layer of cobbles and boulders was contacted below the granular fill at the west abutment and below the sand and silt till at the east abutment. Grey metasedimentary bedrock as well as auger refusal on probable bedrock were encountered below the fill, the native sand and silt till and layer of cobbles and boulders at depths ranging from 2.7 m to 9.4 m (elevations 332.8 to 338.0).

More detailed descriptions of the individual strata are presented below.

5.1 Pavement Structure

Pavement structure was encountered in all the boreholes, which were drilled through the existing Highway 11 roadway at this site. Boreholes STR-01 and STR-10 revealed a 150-mm thick layer of asphalt overlying granular fill.

Boreholes STR-02 to STR-09, drilled through the approach slab, revealed 75 mm to 150 mm of asphalt over 225 mm to 275 mm of concrete. Granular fill was encountered below the concrete.

5.2 Sand and Sand and Gravel Fill

Two distinctive layers of road base and embankment fill were encountered below the asphalt pavement in the boreholes:

- Brown to dark brown sand and gravel containing trace to some silt and clay, occasional cobbles and occasional organics.
- Brown sand containing trace gravel to gravelly, some silt and clay and occasional organics.

A layer of organics, approximately 200 mm thick, was encountered within the fill at 0.9 m depth (elevation341.3) in Borehole STR-10.

The thickness of the granular fill ranged from 1.9 m to 3.9 m.

The depth to the base of the granular fill ranged from 1.9 m to 4.3 m (elevations 337.2 to 338.6).

SPT 'N' values recorded in the sand/sand and gravel fill ranged from 4 to 25 blows for 0.3 m penetration, indicating a loose to compact relative density. Higher SPT 'N' values of 33 to 54 blows per 0.3 m of penetration and 50 blows per 0.1 m of penetration, indicating a dense to very dense relative density, were measured in Boreholes STR-04, STR-05, STR-06, STR-08 and STR-10 near elevations 338.0 to 339.0, which may indicate the presence of cobbles within the fill. In 1986, two test pits excavated by MTO revealed numerous cobbles and boulders within the sand fills (see Reference 1). It must be recognized that embankment fills are heterogeneous and may contain obstructions such as cobbles, boulders and rockfill.

The moisture content of samples of the sand/sand and gravel fill generally ranged from 3% to 26%. A moisture content of 37% was measured in Borehole STR-09 near elevation 339.0. A moisture content of 164% was measured in the organic layer encountered in Borehole STR-10.

Grain size distribution curves for sand fill and sand and gravel fill samples are presented on the Record of Borehole sheets and on Figures B1 and B2 of Appendix B..

The results of the laboratory tests are summarized as follows:

Soil Particles	Percentage (%) Sand to Gravelly Sand Fill	Percentage (%) Sand and Gravel Fill
Gravel	1 to 26	44
Sand	60 to 88	41
Silt and Clay	11 to 19	15

5.3 Sandy silt with organics

A layer of dark brown to black sandy silt with organics was encountered below the sand fill at 3.5 m depth (elevation 338.6) in Borehole STR-01, which was drilled at the west approach.

The thickness of the sandy silt with organics was 1.4 m.

The depth to the base of this layer was 4.9 m (elevation 337.2). Borehole STR-01 was terminated, below this layer, at 4.9 m depth, upon auger refusal on probable bedrock or boulder.

An SPT 'N' value of 13 blows for 0.3 m penetration, indicating a compact relative density was recorded in the sandy silt with organics.

The moisture content of samples of the sandy silt with organics ranged from 11% to 31%.

5.4 Sand and Silt Till

Native brown to grey sand and silt till containing trace to some clay, trace gravel and occasional cobbles was contacted in Boreholes STR-06 to STR-10, drilled near the east abutment and east approach. Cobbles and boulders were encountered below the sand and silt till near elevation 334.3 in Borehole STR-07.

The thickness of the sand and silt till ranged from 2.3 m to 3.9 m.

In Boreholes STR-06 to STR-08, the depths to the base of the sand and silt till layer ranged from 5.1 m to 8.2 m (elevations 333.9 to 334.3). Boreholes STR-09 and STR-10 were terminated upon refusal on probable bedrock or boulders, encountered below the sand and silt till, at 6.8 m and 6.4 m depth (elevations 335.4 and 335.8).

SPT 'N' values recorded in the sand and silt till layer ranged from 6 to 61 blows per 0.3 m of penetration, indicating loose to very dense relative density. Higher SPT 'N' values of 50 to 100 blows per 0.075 m of penetration, indicating a very dense relative density were measured near the base of the sand and silt till layer in Boreholes STR-06, STR-08 and STR-10, and in Borehole STR-07 where cobbles and boulders were encountered.

The moisture contents of the sand and silt till samples ranged from 7% to 21%.

Three samples of the sand and silt till were selected for gradation analysis and the results are summarized below. These results are also presented on the Record of Borehole sheets in Appendix A and on Figure B3 of Appendix B.

Soil Particles	Percentage (%)
Gravel	0 to 8
Sand	37 to 38
Silt	35 to 45
Clay	18 to 19

Glacial tills inherently contain cobbles and boulders.

5.5 Cobbles and Boulders

A layer of cobbles and boulders with some sand was contacted below the approach embankment fill at 3.9 m, 2.1 m and 2.8 m depth (elevations 338.2, 337.9 and 337.2) in Boreholes STR-03, STR-04 and STR-05 drilled at the west abutment. The thickness of this layer varies from 0.2 m to 1.7 m. A 1.5-m thick layer of cobbles and boulders was encountered at 5.1 m depth (elevation 334.3) in Borehole STR-07, drilled at the east

abutment. The layers of cobbles and boulders were encountered immediately above the bedrock. Coring through the cobbles and boulders was required to advance these boreholes.

In Boreholes STR-03, STR-04 and STR-05, drilled at the west abutment, the depths to the base of the cobbles and boulders were 5.6 m, 2.7 m and 3.0 m (elevations 336.5, 337.3 and 337.0), respectively. At the east abutment, in Borehole STR-07, the depth to the base of the cobbles and boulders was 6.6 m (elevation 332.8).

An SPT 'N' value of 100 blows for 0.2 m of penetration was recorded in this layer in Borehole STR-03.

Based on depths to refusal and elevations of top of bedrock encountered in adjacent boreholes, it is possible that a layer of cobbles and boulders exists immediately above the bedrock in Boreholes STR-02, STR-09 and STR-10.

5.6 Bedrock and Auger Refusal

The overburden soils described above are underlain by metasedimentary bedrock. The bedrock was grey with occasional white bands. Occasional mechanical breaks and horizontal joints were noted throughout the bedrock cores.

Bedrock was proved by coring in Boreholes STR-03 to STR-08. Boreholes STR-01, STR-02, STR-09 and STR-10 were terminated upon auger refusal on probable bedrock or boulders. Table 5.1 summarizes depths and elevations to the top of bedrock and auger refusal from the present investigation and the 1986 investigation (Boreholes 1 to 4).

Table 5.1 – Depths and Elevations of Top of Bedrock and Auger Refusal on Probable Bedrock or Boulders

Foundation Element	Borehole	Top of Bedrock/Auger Refusal on probable bedrock or boulders	
		Depth (m)	Elevation (m)
West Approach	STR-01	4.9	337.2
	3	5.2	336.8
West abutment	STR-02	4.1	338.0
	STR-03	5.6*	336.5*
	STR-04	2.7*	337.3*
	STR-05	3.0*	337.0*
	4	4.7	337.4
East abutment	STR-06	5.4*	334.3*
	STR-07	6.6*	332.8*
	STR-08	8.2*	333.9*
	STR-09	6.8	335.4
	2	6.4	335.7
East Approach	STR-10	6.4	335.8
	1	6.6	335.5

*Bedrock proved by coring

Core recovery in the bedrock was 100%. The RQD values ranged from 0% to 94%, indicating very poor to excellent rock quality. An RQD of 40% was measured in Borehole STR-04, Run 1, indicating a poor rock quality. RQD values of 0% were noted in Boreholes STR-08 Run 1, STR-06 Runs 1 to 4 and STR-07 Run 1 and 4. The rock quality of the upper 3.0 m of rock at the east abutment appears to be of very poor quality.

The Fracture Index (FI) of the rock, expressed as fractures per 0.3 m of core, ranged from 0 to 8. FI greater than 10 was noted in Borehole STR-06.

The estimated unconfined compressive strength of the rock cores (average per Run) generally ranged from 77 MPa to 255 MPa, indicating a strong to very strong rock. Low unconfined compressive strengths ranging from 26 MPa to 38 MPa, indicating a weak to medium strong rock, were estimated in Boreholes STR-03 and STR-08. These estimated rock strength values are interpreted from point load tests that were conducted on rock cores recovered from the boreholes. A summary of the Point Load Test Results are presented in Appendix B.

5.7 Water Levels

Water levels were monitored in the open boreholes during and upon completion of drilling. Two standpipe piezometers were installed in Boreholes STR-03 and STR-08 to

monitor water levels after completion of drilling. The water levels measured in the piezometer and open boreholes are summarized in Table 5.2.

Table 5.2 – Water Level Measurements

Foundation Unit	Borehole	Date	Water Level (m)		Comments
			Depth	Elevation	
West Approach	STR-01	July 27, 2011	3.7	338.4	Open borehole
West Abutment	STR-02	July 27, 2011	3.4	338.7	Open borehole
	STR-03	August 5, 2011 November 28, 2011	3.9 4.6	338.2 337.5	Open borehole In piezometer
East Abutment	STR-06	September 27, 2012	1.9	337.8	Open borehole
	STR-08	November 28, 2011	4.1	338.0	In piezometer
	STR-09	July 26, 2011	5.9	336.3	Open borehole

Piezometric readings indicate that the water level is near elevations 337.5 to 338.0.

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.

Preliminary GA drawing indicates that water level in the Sturgeon River was near Elevation 338.1 in April, 2011.

5.8 Data from previous investigation, 1986 (Reference 1)

Boreholes 1 to 4 were drilled at this site during the previous investigation conducted in 1986. Data from the 1986 investigation revealed that the subsurface soils conditions are consistent with the data obtained by Thurber. The 1986 boreholes were advanced though the embankment fill and into the underlying native materials. The subsurface conditions encountered were as follows:

- A 100-mm thick layer of asphalt was encountered surficially in the boreholes.
- Below the asphalt, sand fill containing silt, gravel and numerous cobbles and boulders was contacted. Augering through the fill was difficult due to the presence of boulders. The thickness of the fill varied from 2.7 m to 2.9 m. Two test pits completed on either side of the existing structure revealed the presence of numerous cobbles and boulders. The boulders were up to 0.5 m in diameter. Boulders and cobbles were also surficially observed on the river banks.
- A 0.6-m thick layer of organics was encountered below the fill in Borehole 2, drilled at the east abutment.

- Native compact to very dense sand containing some silt, trace gravel and organics was contacted below the fill in Boreholes 1, 3 and 4 and below the organics in Borehole 2.
- Very stiff to hard glacial till consisting of, heterogeneous mixture of gravel, sand, silt and clay was encountered below the sand layer in Boreholes 1 and 2, drilled at the east abutment and east approach. The thickness of this layer was less than 3.0 m.
- Boreholes were terminated upon refusal to auger on probable bedrock, at depths ranging from 4.7 m to 6.6 m.
- Groundwater level was noted at elevation 338.3 in 1986.

6 MISCELLANEOUS

Borehole locations for the first stage of the investigation were selected and established in the field by Thurber Engineering Ltd. MMM Group Limited surveyed the borehole locations and provided the co-ordinates and the ground surface elevations.

For the second investigation, MRC provided plan drawings to obtain the co-ordinates and the ground surface elevations for the boreholes.

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

Eastern Ontario Diamond Drilling Ltd. from Hawkesbury, Ontario and TBT Engineering from Thunder Bay, Ontario supplied truck mounted CME 75 and CME 55 drill rigs and conducted the drilling, sampling and in-situ testing operations.

The drilling and sampling operations in the field were supervised on a full time basis by Mr. Jason Mei, Mr. Stephane Loranger, C.E.T. and Mr. Mark Farrant, P. Eng. of Thurber Engineering Ltd.

Routine laboratory testing was carried out by Thurber Engineering Ltd.

Overall planning and supervision of the field program was conducted by Mr. Mark Farrant, P. Eng.

Interpretation of the data and preparation of the report was carried out by Ms. R. Palomeque Reyna, P.Eng. and Mr. Murray Anderson, 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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Appendix A

Record of Borehole Sheets
(Present investigation)

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			

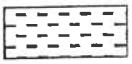
EXPLANATION OF ROCK LOGGING TERMS

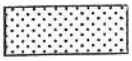
ROCK WEATHERING CLASSIFICATION

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

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No STR-01 1 OF 1 METRIC

W.P. 6056-10-00 LOCATION Sturgeon River Bridge N 5 506 736.8 E 282 728.1 ORIGINATED BY JM

HWY 11 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2011.07.27 - 2011.07.27 CHECKED BY MRA

SOIL PROFILE ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
342.1											
0.0	**ASPHALT:** (150mm)						342				
0.2	**SAND** and **GRAVEL**, trace silt Compact Brown Moist (FILL)		1	AS					○		
340.6			1	SS	19		341		○		
1.4	**SAND**, some gravel to gravelly, some silt and clay Compact to Loose Brown Moist (FILL) Occasional organics		2	SS	17				○		17 72 11 (SI+CL)
			3	SS	7		340		○		
338.6			4	SS	5		339		○		
3.5	Sandy **SILT**, with organics, trace gravel, occasional cobbles Compact Dark Brown to Black Moist		5	SS	13	▽			○		
337.2			6	SS	100/ 0.125		338		○		
4.9	END OF BOREHOLE AT 4.8m UPON AUGER REFUSAL ON PROBABLE BOULDER OR BEDROCK. BOREHOLE OPEN TO 4.8m AND WATER LEVEL AT 3.7m. BOREHOLE BACKFILLED WITH HOLEPLUG TO 0.9m, SAND AND GRAVEL TO 0.6m, CONCRETE TO 0.15m, THEN ASPHALT TO SURFACE.										

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

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

ONTMT4S 1197.GPJ 7/24/12

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No STR-02 1 OF 1 METRIC

W.P. 6056-10-00 LOCATION Sturgeon River Bridge N 5 506 737.3 E 282 735.3 ORIGINATED BY JM

HWY 11 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2011.07.27 - 2011.07.27 CHECKED BY MRA

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: O UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
342.1											
0.0	**ASPHALT:** (150mm)						342				
0.2 / 341.7	**CONCRETE:** (225mm)										
0.4	**SAND** and **GRAVEL** Compact Brown Moist (FILL)		1	AS					O		
340.6			1	SS	16		341		O		
1.5	**SAND**, some gravel to gravelly, some silt and clay Compact Brown Moist (FILL)		2	SS	16				O		
			3	SS	16		340		O		26 60 14 (SI+CL)
	Occasional organics		4	SS	25	▽	339		O		
338.0											
4.1	END OF BOREHOLE AT 4.1m UPON AUGER REFUSAL ON PROBABLE BOULDER OR BEDROCK. BOREHOLE OPEN TO 4.1m AND WATER LEVEL AT 3.4m. BOREHOLE BACKFILLED WITH HOLEPLUG TO 0.3m, SAND AND GRAVEL TO 0.6m, CONCRETE TO 0.15m, THEN ASPHALT TO SURFACE.										

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

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

ONTMT4S 1197.GPJ 7/24/12

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No STR-03 1 OF 2 METRIC

W.P. 6056-10-00 LOCATION Sturgeon River Bridge N 5 506 743.3 E 282 732.5 ORIGINATED BY SLL

HWY 11 BOREHOLE TYPE NQ Coring COMPILED BY AN

DATUM Geodetic DATE 2011.08.05 - 2011.08.05 CHECKED BY MRA

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
342.1											
0.0	**ASPHALT:** (150mm)										
0.2 / 341.7	**CONCRETE:** (250mm)										
0.4	**SAND** and **GRAVEL** Loose Brown Moist (FILL)		1	SS	6		342		○		
			2	SS	7		341		○		
			3	SS	6		340		○		
338.2			4	SS	5		339		○		
3.9	**COBBLES** and **BOULDERS**, some sand Very Dense Grey Wet Cored through cobbles and boulders at 4.6m		5	SS	100/ 0.200		338				
336.5							337			FI	
5.6	**BEDROCK**, metasedimentary, slightly to fresh weathered, grey with white bands, occasional sub-vertical and horizontal breaks Coring started at 5.6m		1	RUN			336			3 3 2	RUN #1 TCR=100% SCR=100% RQD=83% UCS=118MPa (Average)
	Quartz seam (50mm) at 6.7m						335			1 3 1	
			2	RUN			334			2 0 4	RUN #2 TCR=100% SCR=100% RQD=71% UCS=212MPa (Average)
333.4	Slightly to moderately weathered Sub-vertical joint (50mm) at 8.2m Sub-vertical joint at 8.3m, 8.4m and 8.5m									3	
8.7	END OF BOREHOLE AT 8.7m. WATER OBSERVED AT 3.9m DURING DRILLING. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS:										

Continued Next Page

+ ³, × ³ : Numbers refer to Sensitivity

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

ONTMT4S 1197.GPJ 7/24/12

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No STR-03 2 OF 2 METRIC

W.P. 6056-10-00 LOCATION Sturgeon River Bridge N 5 506 743.3 E 282 732.5 ORIGINATED BY SLL

HWY 11 BOREHOLE TYPE NQ Coring COMPILED BY AN

DATUM Geodetic DATE 2011.08.05 - 2011.08.05 CHECKED BY MRA

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	WATER CONTENT (%) 20 40 60		GR SA SI CL
	Continued From Previous Page										
	DATE DEPTH (m) ELEV. (m) Nov.28/11 4.6 337.5										

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

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

ONTMT4S 1197.GPJ 7/24/12

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No STR-04

1 OF 1

METRIC

W.P. 6056-10-00 LOCATION Sturgeon River Bridge N 5 506 738.2 E 282 742.0 ORIGINATED BY MEF

HWY 11 BOREHOLE TYPE NW Casing/Tricone COMPILED BY AN

DATUM Geodetic DATE 2012.09.27 - 2012.09.27 CHECKED BY MEF

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
342.1											
0.0	**ASPHALT:** (75mm)						342				
0.1 / 341.7	**CONCRETE:** (275mm)										
0.4	Air gap between underside of bridge deck and ground surface						341				
340.0	Rockfill and cobbles at surface						340				
2.1 / 339.1	**SAND** and **GRAVEL** (FILL)						339				
3.0	**SAND**, trace gravel, trace to some silt and clay Loose Grey to Brown Wet (FILL)		1	SS	4				○		
337.9	Very Dense		2	SS	50/ 0.100		338		○		1 88 11 (SI+CL)
4.2 / 337.3	Coring through **COBBLES** and **BOULDERS** from 4.2m									FI	
4.8	**BEDROCK**, metasedimentary, grey with white bands									2	RUN #1 TCR=100% SCR=95% RQD=40% UCS=153MPa (Average)
	Subvertical fractures from 5.2m to 5.3m and 5.7m to 6.2m		1	RUN			337			6 1	
	Subhorizontal fractures from 6.1m to 6.3m									5	
	Occasional quartz veins						336			2	
			2	RUN						1 1	RUN #2 TCR=100% SCR=98% RQD=78% UCS=168MPa (Average)
334.2							335			1 0 4	
7.9	END OF BOREHOLE AT 7.9m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO GROUND SURFACE, BRIDGE DECK BACKFILLED WITH CONCRETE TO 0.28m, THEN ASPHALT TO HIGHWAY SURFACE.										

+ ³, × ³: Numbers refer to Sensitivity

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

ONTMT4S 1197.GPJ 10/19/12

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No STR-05 1 OF 1 METRIC

W.P. 6056-10-00 LOCATION Sturgeon River Bridge N 5 506 744.1 E 282 740.2 ORIGINATED BY MEF

HWY 11 BOREHOLE TYPE Tricone/NW Casing/NQ Coring COMPILED BY AN

DATUM Geodetic DATE 2012.09.28 - 2012.09.28 CHECKED BY MEF

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
342.1											
0.0 / 0.1	**ASPHALT:** (75mm)										
341.7	**CONCRETE:** (275mm)						342				
0.4	Air gap between underside of bridge deck and ground surface										
							341				
340.0	Rockfill and cobbles at surface										
2.1	**SAND** and **GRAVEL**, occasional cobbles Dense Grey (FILL)						340				
			1	SS	43		339		○		
338.3											
3.8	**SAND**, trace gravel, trace to some silt and clay Very Dense to Dense Grey Wet (FILL)		2	SS	50/ 0.100		338		○		
337.2			3	SS	44				○		
4.9 / 337.0	Coring through **COBBLES** and **BOULDERS** at 4.9m									FI	RUN #1 TCR=100% SCR=100% RQD=75% UCS=95MPa (Average)
5.1	**BEDROCK**, metasedimentary, grey with white bands Cobbles zone (75mm) at 5.3m		1	RUN			337			5 >10 5	
							336			0 4 2	RUN #2 TCR=94% SCR=94% RQD=65% UCS=94MPa (Average)
			2	RUN			335			2 3 8	
334.2											
7.9	END OF BOREHOLE AT 7.9m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO GROUND SURFACE, BRIDGE DECK BACKFILLED WITH CONCRETE TO 0.28m, THEN ASPHALT TO HIGHWAY SURFACE.										

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

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

ONTMT4S 1197.GPJ 10/30/12

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No STR-06 1 OF 2 METRIC

W.P. 6056-10-00 LOCATION Sturgeon River Bridge N 5 506 741.8 E 282 776.1 ORIGINATED BY MEF

HWY 11 BOREHOLE TYPE Solid Stem Augers/NW Casing/Coring COMPILED BY AN

DATUM Geodetic DATE 2012.09.26 - 2012.09.27 CHECKED BY MEF

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
342.2											
0.0	**ASPHALT:** (75mm)						342				
0.1 / 341.8	**CONCRETE:** (275mm)										
0.4	Air gap between underside of bridge deck and ground surface										
							341				
339.7	Rockfill and cobbles at surface										
2.5	**SAND** and **GRAVEL** Compact (FILL)		1	SS	12		340				
338.5	Layer of topsoil (50mm)										
3.7	**SAND**, some gravel, trace to some silt and clay Dense Brown Moist		4	SS	33	▽	339		○		21 60 19 (SI+CL)
337.8 / 4.4	(FILL)										
	SAND and **SILT**, trace to some gravel, trace clay Very Dense Brown Wet (TILL) Compact Grey		2	SS	40		338		○		
			3	SS	14		337		○		
							336		○		
			5	SS	50/ 0.125		335		○		
334.3	Coring started at 7.9m									FI	
7.9	**BEDROCK**, metasedimentary, grey with white bands		1	RUN			334			>10	RUN #1 TCR=78% SCR=0% RQD=0%
										>10	
	Highly broken		2	RUN						>10	RUN #2 TCR=82% SCR=0% RQD=0%
										>10	
	Sand and silt seam at 9.4m						333			>10	
			3	RUN						>10	RUN #3 TCR=100%

Continued Next Page

+ 3, × 3 Numbers refer to Sensitivity

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

ONTMT4S 1197.GPJ 10/30/12

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No STR-06 2 OF 2 METRIC

W.P. 6056-10-00 LOCATION Sturgeon River Bridge N 5 506 741.8 E 282 776.1 ORIGINATED BY MEF
HWY 11 BOREHOLE TYPE Solid Stem Augers/NW Casing/Coring COMPILED BY AN
DATUM Geodetic DATE 2012.09.26 - 2012.09.27 CHECKED BY MEF

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
	Continued From Previous Page										
331.4	**BEDROCK**, metasedimentary, grey with while bands Sand and silt seam at 10.1m Highly broken		4	RUN			332			>10 >10	SCR=86% RQD=0% RUN #4 TCR=100% SCR=48% RQD=0%
10.8	END OF BOREHOLE AT 10.8m. WATER OBSERVED AT 1.9m BELOW GROUND SURFACE DURING DRILLING. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO GROUND SURFACE, BRIDGE DECK BACKFILLED WITH CONCRETE TO 0.28m, THEN ASPHALT TO HIGHWAY SURFACE.										

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

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

ONTMT4S 1197.GPJ 10/30/12

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No STR-07 1 OF 2 METRIC

W.P. 6056-10-00 LOCATION Sturgeon River Bridge N 5 506 747.8 E 282 775.6 ORIGINATED BY MEF

HWY 11 BOREHOLE TYPE Tricone/NW Casing/Coring COMPILED BY AN

DATUM Geodetic DATE 2012.09.28 - 2012.09.28 CHECKED BY MEF

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
342.2											
0.0	**ASPHALT:** (100mm)										
0.1 / 341.8	**CONCRETE:** (275mm)						342				
0.4	Air gap between underside of bridge deck and ground surface										
							341				
							340				
339.4	Rockfill and cobbles at surface										
2.8	**SAND** and **GRAVEL**, trace silt Compact to Loose Grey (FILL)		3	SS	11		339				
			1	SS	10		338				
337.2			2	SS	5				○		
5.0	**SAND** and **SILT**, trace gravel, some clay Dense Grey Wet (TILL)						337		○		
			4	SS	41		336		○		8 38 35 19
	Some cobbles and boulders (spoon bouncing, no recovery)		5	SS	50/ 0.050		335				
334.3											
7.9	Coring through **COBBLES** (25mm to 125mm in diameter) in a sand and silt matrix		1	RUN			334				
							333				
332.8										FI	
9.4	**BEDROCK**, metasedimentary, greenish grey with white bands, vertical and subvertical breaks		2	RUN						>10 >10	RUN #2 TCR=83% SCR=0% RQD=0%

Continued Next Page

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

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

ONTMT4S 1197.GPJ 10/30/12

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No STR-07 2 OF 2 METRIC

W.P. 6056-10-00 LOCATION Sturgeon River Bridge N 5 506 747.8 E 282 775.6 ORIGINATED BY MEF
HWY 11 BOREHOLE TYPE Tricone/NW Casing/Coring COMPILED BY AN
DATUM Geodetic DATE 2012.09.28 - 2012.09.28 CHECKED BY MEF

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	WATER CONTENT (%) 20 40 60	kN/m^3	GR SA SI CL
	Continued From Previous Page										
	BEDROCK, metasedimentary, greenish grey with white bands, vertical and subvertical breaks						332			>10	RUN #3 TCR=87% SCR=60% RQD=40% UCS=45MPa (Average)
			3	RUN						4	
										>10	
										>10	RUN #4 TCR=95% SCR=45% RQD=10% UCS=52MPa (Average)
							331			>10	
	Rubble zone: 75mm at 11.4m 100mm at 11.5m		4	RUN						>10	
										>10	
										>10	RUN #5 TCR=89% SCR=18% RQD=0%
329.5			5	RUN			330			>10	
12.7	END OF BOREHOLE AT 12.7m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO GROUND SURFACE, BRIDGE DECK BACKFILLED WITH CONCRETE TO 0.3m, THEN ASPHALT TO HIGHWAY SURFACE.										

ONTMT4S 1197.GPJ 10/30/12

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

20
15 ⊕ 5
10
(%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No STR-08 1 OF 2 METRIC

W.P. 6056-10-00 LOCATION Sturgeon River Bridge N 5 506 742.4 E 282 782 3 ORIGINATED BY SLL

HWY 11 BOREHOLE TYPE Hollow Stem Augers/NQ Coring COMPILED BY AN

DATUM Geodetic DATE 2011.08.03 - 2011.08.05 CHECKED BY MRA

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
342.1											
0.0	**ASPHALT:** (150mm)						342				
0.2 / 341.7	**CONCRETE:** (250mm)										
0.4	**SAND** and **GRAVEL**, some silt and clay Compact Brown Moist (FILL)		1	SS	18		341		○		
			2	SS	19		340		○		
			3	SS	6		339		○		
			4	SS	54		338		○		44 41 15 (SI+CL)
	Very Dense Dark Brown Moist to Wet					▼					
337.8											
4.3	**SAND** and **SILT**, some clay, trace gravel Loose Brown Moist (TILL)		5	SS	6		337		○		
			6	SS	61		336		○		
	Occasional cobbles						335				
	Very Dense		7	SS	100/ 0.075				○		
333.9							334			FI	
8.2	**BEDROCK**, metasedimentary, moderately to slightly weathered, grey with white bands, sub-vertical breaks Coring started at 8.2m		1	RUN						4 1 6	RUN #1 TCR=100% SCR=100% RQD=0% UCS=83MPa (Average)
	Sub-vertical joints at 8.3m, 8.4m Vertical joint (75mm) at 8.2m Horizontal joints (50mm) at 9.4m		2	RUN			333			4 4 7	RUN #2 TCR=100% SCR=79% RQD=58% UCS=63MPa (Average)

Continued Next Page

+ 3, × 3 : Numbers refer to Sensitivity

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

ONTMT4S 1197.GPJ 7/24/12

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No STR-08 2 OF 2 METRIC

W.P. 6056-10-00 LOCATION Sturgeon River Bridge N 5 506 742.4 E 282 782.3 ORIGINATED BY SLL

HWY 11 BOREHOLE TYPE Hollow Stem Augers/NQ Coring COMPILED BY AN

DATUM Geodetic DATE 2011.08.03 - 2011.08.05 CHECKED BY MRA

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (20 40 60 80 100): O UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	BEDROCK, metasedimentary, moderately to slightly weathered, grey with white bands, sub-vertical breaks Sub-vertical joints (25mm to 75mm) at 9.0m, 10.0m 100mm at 8.6m 100mm at 9.4m 225mm at 10.5m 250mm at 11.1m 275mm at 11.6m Rubble zone (25mm to 75mm) at 9.2m, 9.8m 175mm at 8.9m Mechanical breaks at 11.1m, 11.5m and 11.7m Silt infilling at 12.2m and 12.3m		3	RUN			332 331 330			0 1 1 0 1 2 0 2	RUN #3 TCR=100% SCR=100% RQD=94% UCS=109MPa (Average)
329.5 12.6	END OF BOREHOLE AT 12.6m. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) Nov.28/11 4.1 338.0										

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

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

ONTMT4S 1197.GPJ 7/24/12

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No STR-09 1 OF 1 METRIC

W.P. 6056-10-00 LOCATION Sturgeon River Bridge N 5 506 748.2 E 282 783.1 ORIGINATED BY JM

HWY 11 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2011.07.26 - 2011.07.26 CHECKED BY MRA

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
342.2											
0.0	**ASPHALT:** (150mm)										
0.2 / 341.8	**CONCRETE:** (225mm)										
0.4	**SAND**, trace gravel, some silt and clay Loose to Compact Brown Moist (FILL)		1	AS			342				
			1	SS	7						
			2	SS	4		341				
			3	SS	4		340				2 84 14 (SI+CL)
			4	SS	25		339				
338.1											
4.1	**SAND** and **SILT**, trace gravel, some clay Compact Brown Moist (TILL)		5	SS	15	▽	338				0 37 45 18
	Dense Grey		6	SS	32		337				
335.4							336				
6.8	END OF BOREHOLE AT 6.8m UPON AUGER REFUSAL ON PROBABLE BOULDER OR BEDROCK. BOREHOLE OPEN TO 6.8m AND WATER LEVEL AT 5.9m. BOREHOLE BACKFILLED WITH HOLEPLUG TO 1.5m, SAND AND GRAVEL TO 0.45m, CONCRETE TO 0.15m, THEN ASPHALT TO SURFACE.										

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

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

ONTMT4S 1197.GPJ 7/24/12

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No STR-10 1 OF 1 METRIC

W.P. 6056-10-00 LOCATION Sturgeon River Bridge N 5 506 748.8 E 282 787.9 ORIGINATED BY JM

HWY 11 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2011.07.26 - 2011.07.26 CHECKED BY MRA

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
342.2											
0.0	**ASPHALT:** (150mm)										
0.2	**SAND** and **GRAVEL**, trace silt Loose Brown Moist (FILL)		1	AS			342				
	Layer of organics at 0.9m (200mm)		1	SS	9						
			2	SS	8		341				
			3	SS	7		340				
	Occasional cobbles, occasional organics Dense		4	SS	53		339				
338.1											
4.1	**SAND** and **SILT**, some clay, trace gravel Compact Brown to Grey Moist (TILL)		5	SS	22		338				3 37 41 19
							337				
	Grey		6	SS	100/ 0.075		336				
335.8											
6.4	END OF BOREHOLE AT 6.4m UPON AUGER REFUSAL ON PROBABLE BEDROCK. BOREHOLE OPEN TO 6.4m AND DRY. BOREHOLE BACKFILLED WITH HOLEPLUG TO 0.9m, SAND AND GRAVEL TO 0.15m, THEN ASPHALT TO SURFACE.										

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

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

ONTMT4S 1197.GPJ 7/24/12

Appendix B

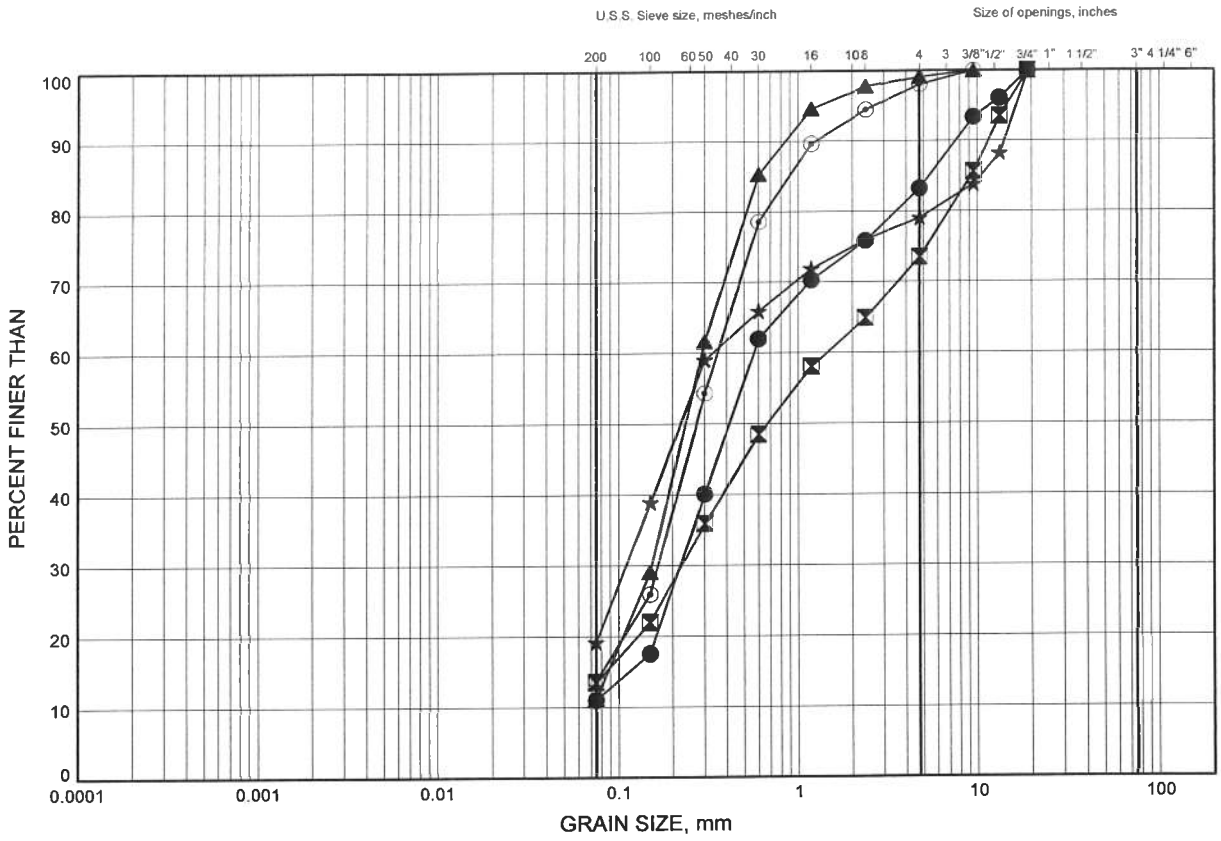
Laboratory Test Results
(Present investigation)

NWR 32 Rehabs

GRAIN SIZE DISTRIBUTION

FIGURE B1

SAND to GRAVELLY SAND FILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	STR-01	1.83	340.27
⊠	STR-02	2.59	339.51
▲	STR-04	4.01	338.09
★	STR-06	3.96	338.24
⊙	STR-09	2.59	339.61

Date October 2012

W.P.# 6056-10-00

THURBER

Prep'd AN

Chkd. RPR

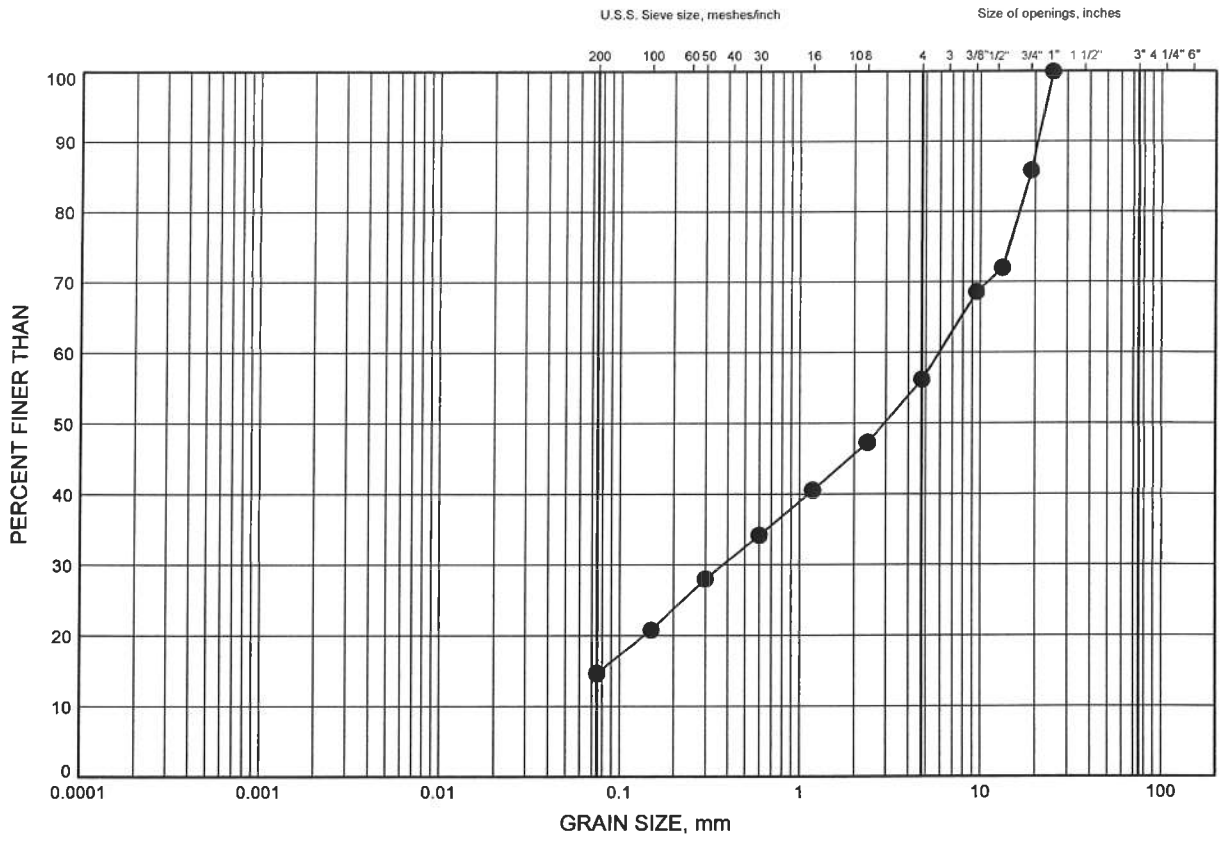
GRAIN SIZE DISTRIBUTION - THURBER 1197.GPJ 10/16/12

NWR 32 Rehabs

GRAIN SIZE DISTRIBUTION

FIGURE B2

SAND & GRAVEL FILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	STR-08	3.35	338.74

Date July 2012

W.P.# 6056-10-00

THURBER

Prep'd AN

Chkd. RPR

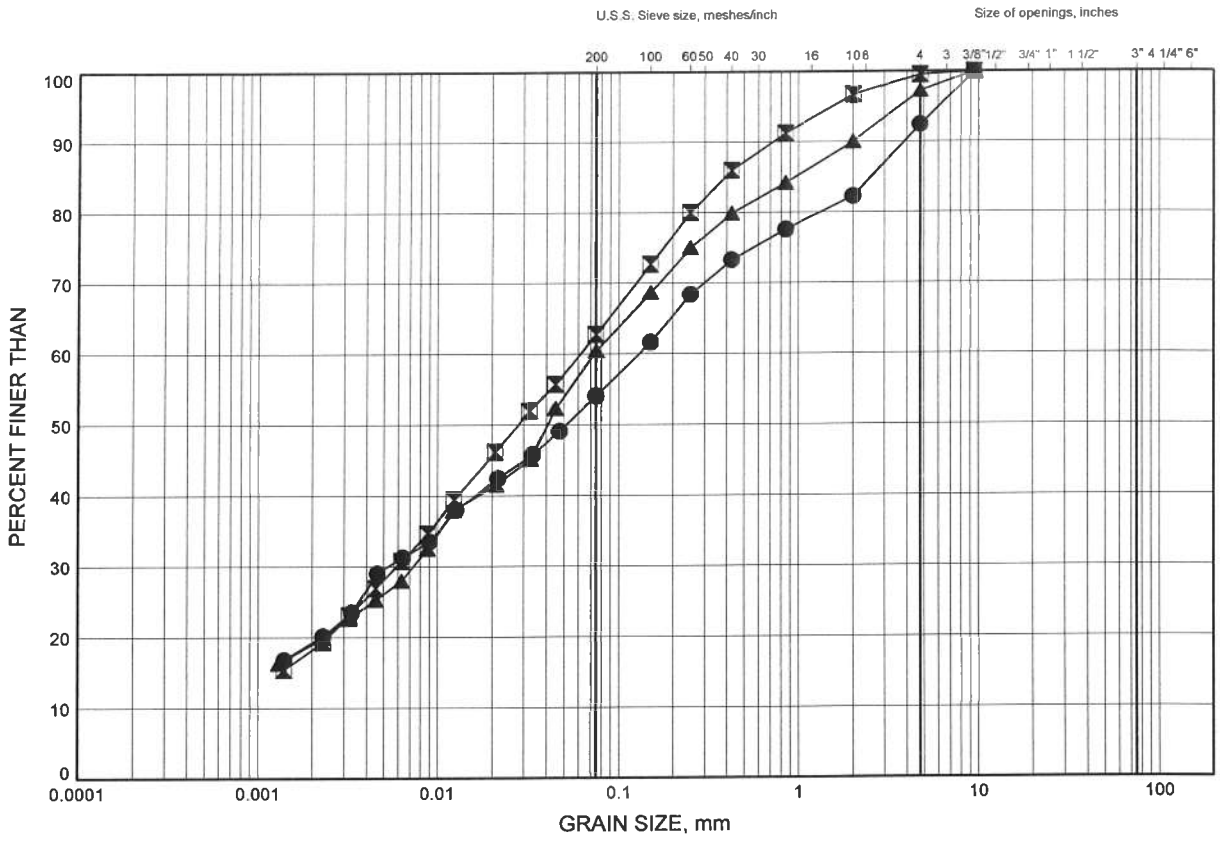
GRAIN SIZE DISTRIBUTION - THURBER 1197.GPJ 7/24/12

NWR 32 Rehabs

GRAIN SIZE DISTRIBUTION

FIGURE B3

SAND & SILT TILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	STR-07	6.40	335.80
⊠	STR-09	4.88	337.32
▲	STR-10	4.88	337.32

Date October 2012

W.P.# 6056-10-00

THURBER

Prep'd AN

Chkd. RPR

GRAIN SIZE DISTRIBUTION - THURBER 1197.GPJ 10/16/12

THURBER ENGINEERING LTD.
GEOTECHNICAL • ENVIRONMENTAL • MATERIALS

POINT LOAD TEST SHEET

Job No : 19-1351-197 **Client :** GENIVAR

Date Drilled : 8/5/2011

Project Name : Sturgeon River Bridge **Date Tested :** 9/8/2011

Core Size : NQ **BH No :** STR-03 **Tester :** DB

Test No.	Run No.	Depth (m)	Axial or Diametral	Force (kN)	Diameter (mm)	Length (mm)	UCS (MPa)	Rock Type	Notes
1	1	5.9	A	4.9	47.3	55.4	37.9	Metasedimentary	Medium Strong
2	1	6.5	D	4.3	47.2	55.4	44.9	Metasedimentary	Medium Strong
3	1	7.2	D	16.3	47.2	60.5	171.1	Metasedimentary	Very Strong
4	1	7.4	A	31.3	47.2	62.3	219.5	Metasedimentary	Very Strong
5	2	7.8	D	20.7	47.2	64.9	217.7	Metasedimentary	Very Strong
6	2	8.1	A	36.5	47.1	54.4	284.7	Metasedimentary	Extremely Strong
7	2	8.5	D	12.9	47.2	65.4	135.2	Metasedimentary	Very Strong
8									
9									
10									
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25									
26									
27									
28									
29									
30									

* 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 : 19-1351-197 **Client :** GENIVAR

Date Drilled : 9/28/2012

Project Name : Sturgeon River Bridge **Date Tested :** 11/1/2012

Core Size : NQ **BH No :** STR-04 **Tester :** RK

Test No.	Run No.	Depth (m)	Axial or Diametral	Force (kN)	Diameter (mm)	Length (mm)	UCS (MPa)	Rock Type	Notes
1	1	4.9	D	6.9	46.8	115.0	73.4	Metasedimentary	Strong
2	1	5.3	D	17.9	47.5	77.4	186.8	Metasedimentary	Very Strong
3	1	5.6	D	17.4	44.6	95.3	199.6	Metasedimentary	Very Strong
4	2	6.5	D	20.5	48.0	89.1	209.5	Metasedimentary	Very Strong
5	2	6.9	D	17.3	48.4	86.4	174.6	Metasedimentary	Very Strong
6	2	7.3	D	17.0	47.6	100.0	175.9	Metasedimentary	Very Strong
7	2	7.8	D	11.1	48.3	78.3	112.1	Metasedimentary	Very Strong
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28									
29									
30									

* 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 : 19-1351-197 **Client :** GENIVAR

Date Drilled : 9/28/2012

Project Name : Sturgeon River Bridge **Date Tested :** 11/1/2012

Core Size : NQ **BH No :** STR-05 **Tester :** RK

Test No.	Run No.	Depth (m)	Axial or Diametral	Force (kN)	Diameter (mm)	Length (mm)	UCS (MPa)	Rock Type	Notes
1	1	5.5	D	21.0	47.4	94.9	218.7	Metasedimentary	Very Strong
2	2	6.7	D	11.1	47.5	102.0	114.9	Metasedimentary	Very Strong
3	2	7.0	D	17.5	47.4	99.1	182.4	Metasedimentary	Very Strong
4	2	7.1	D	24.9	48.0	98.9	255.0	Metasedimentary	Extremely Strong
5	2	7.8	D	20.9	48.2	76.9	212.2	Metasedimentary	Very Strong
6									
7									
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27									
28									
29									
30									

* 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.
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POINT LOAD TEST SHEET

Job No : 19-1351-197 **Client :** GENIVAR

Date Drilled : 9/28/2012

Project Name : Sturgeon River Bridge **Date Tested :** 11/1/2012

Core Size : NQ **BH No :** STR-07 **Tester :** RK

Test No.	Run No.	Depth (m)	Axial or Diametral	Force (kN)	Diameter (mm)	Length (mm)	UCS (MPa)	Rock Type	Notes
1	3	10.2	D	10.8	46.8	93.4	115.1	Metasedimentary	Very Strong
2	4	11.9	D	14.3	46.9	99.1	151.8	Metasedimentary	Very Strong
3									
4									
5									
6									
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29									
30									

* 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.
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POINT LOAD TEST SHEET

Job No : 19-1351-197 **Client :** GENIVAR

Date Drilled : July 26 2011

Project Name : Sturgeon River Bridge **Date Tested :** 9/8/2011

Core Size : NQ **BH No :** STR-08 **Tester :** DB

Test No.	Run No.	Depth (m)	Axial or Diametral	Force (kN)	Diameter (mm)	Length (mm)	UCS (MPa)	Rock Type	Notes
1	1	8.4	A	7.3	47.2	33.5	83.2	Metasedimentary	Strong
2	2	8.6	A	4.5	47.2	51.6	36.6	Metasedimentary	Medium Strong
3	2	8.8	D	12.0	47.2	60.1	126.0	Metasedimentary	Very Strong
4	2	9.5	A	3.5	47.2	56.5	26.2	Metasedimentary	Medium Strong
5	3	10.4	A	13.6	47.3	57.1	102.4	Metasedimentary	Very Strong
6	3	10.5	D	12.7	47.3	61.0	133.3	Metasedimentary	Very Strong
7	3	10.9	A	11.5	47.2	54.3	90.2	Metasedimentary	Strong
8	3	12.0	D	8.0	47.2	62.7	83.5	Metasedimentary	Strong
9	3	12.5	A	16.6	47.2	51.1	135.9	Metasedimentary	Very Strong
10									
11									
12									
13									
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29									
30									

* 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

Record of Borehole Sheets and Laboratory Results (previous investigation)

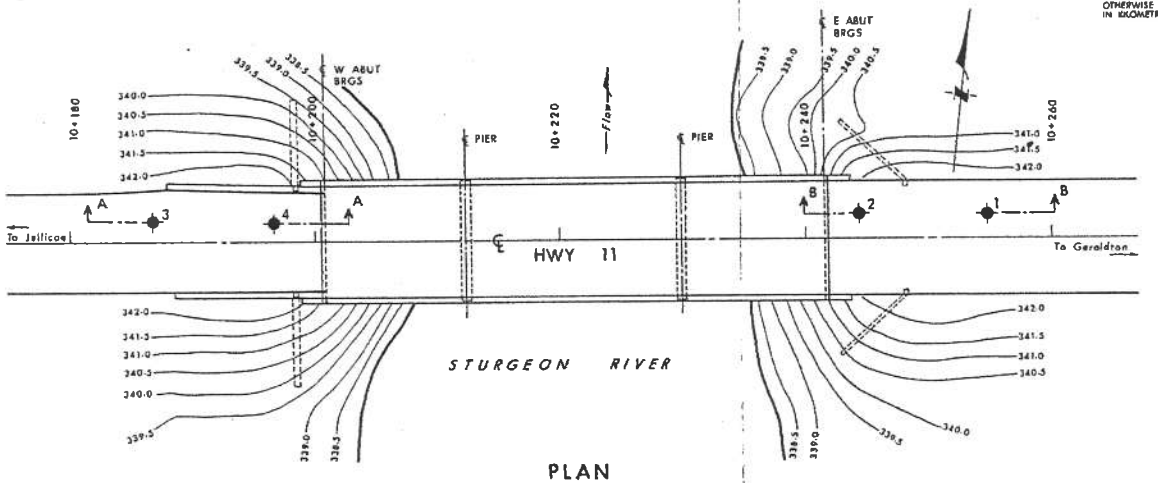
MINISTRY OF TRANSPORTATION AND COMMUNICATIONS, ONTARIO

METRIC
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN. STATIONS IN KILOMETRES + METRES.

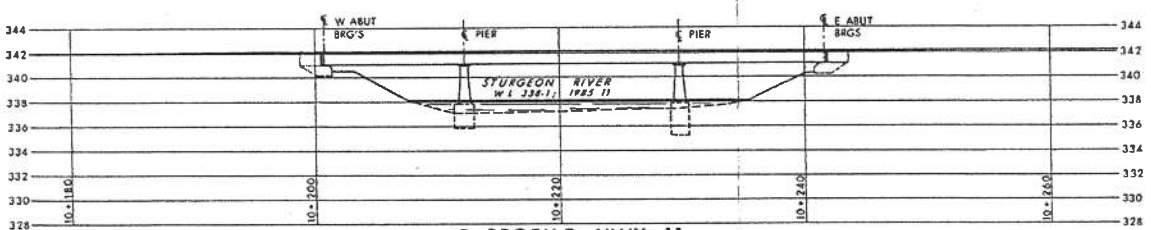
CONT No
WP No 335-85-01

SHEET

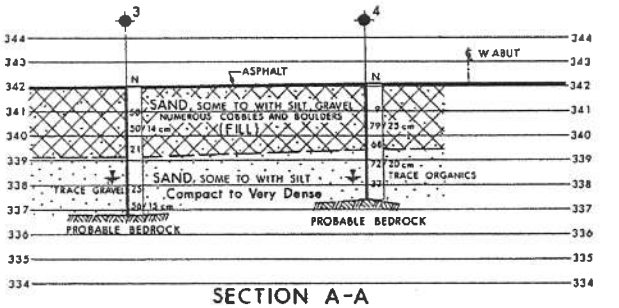
STURGEON RIVER BRIDGE ₩₱ 4
REHABILITATION
BORE HOLE LOCATIONS & SOIL STRATA



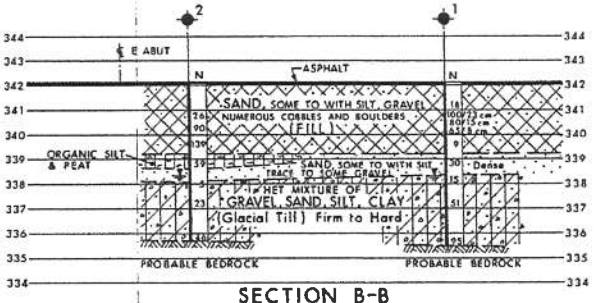
PLAN
SCALE
4m 2 0 4m



℄ PROFILE HWY 11
SCALE
4m 2 0 4m

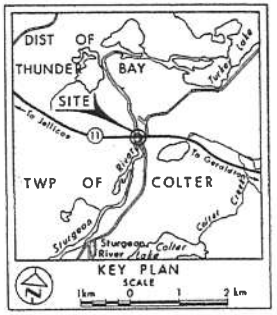


SECTION A-A



SECTION B-B

SCALE
2m 1 0 2m



LEGEND

- Bore Hole
- Dynamic Cone Penetration Test (Cone)
- Bore Hole & Cone
- N Blows/0.3m (Std Pen Test, 475 J/blow)
- CONE Blows/0.3m (60° Cone, 475 J/blow)
- W.L. at time of investigation 1986 04

No	ELEVATION	STATION	OFFSET
1	342.1	10+256.8	2.0m Lt
2	342.1	10+244.4	2.0m Lt
3	342.0	10+186.8	1.6m Lt
4	342.1	10+196.6	1.5m Lt

NOTE
The boundaries between soil strata have been established only at Bore Hole locations. Between Bore Holes the boundaries are assumed from geological evidence.

NOTE: The complete foundation investigation and design report for this project and other related documents may be examined at the Engineering Materials Office, Downsview. Information contained in this report and related documents is specifically excluded in accordance with the conditions of Section 102-2 of Form 100.

REV	DATE	BY	DESCRIPTION

Geocres No 42E-3

HWY No 11			DIST 19
SUBMD L P	CHECKED	DATE 1986 06 17	SITE 48E-8
DRAWN	CHECKED	APPROVED	DWG 3358501-A

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 1 METRIC

W P 335-85-01 LOCATION STA. 10 + 254.8; °/s 2.0 m Lt. ℄ Hwy. 11 ORIGINATED BY LP
DIST 19 HWY 11 BOREHOLE TYPE Hollow Stem Auger COMPILED BY LP
DATUM Geodetic DATE 86 04 22 CHECKED BY

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 (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT Wl — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
342.1	Pavement Surface						342				
0.0	Asphalt										
	Fill Sand, Some to with Silt, Gravel Numerous Cobbles and Boulders		1	SS	18		341				
			2	SS	100/23 cm						14 53 30 3
			3	SS	80/15 cm						
			4	SS	65/8 cm		340				
339.2			5	SS	9						28 47 23 2
2.9	Sand with Silt, Some Gravel						339				
338.4	Dense		6	SS	30						23 44 30 3
3.7	Heterogeneous Mixture Gravel, Sand, Silt, Clay (Glacial Till)		7	SS	15		338				18 29 40 13
	Very Stiff to Hard		8	SS	51		337				3 34 47 16
335.5			9	SS	95		336				9 35 43 13
6.6	End of Borehole Refusal to Auger, Probable Bedrock										

$+^3$, $\times^5$: Numbers refer to Sensitivity

20
15 ◇ S (%) STRAIN AT FAILURE
10

OFFICE REPORT ON SOIL EXPLORATION

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 2 METRIC

W P 335-85-01 LOCATION STA. 10 + 244.4; °/s 2.0 m Lt. ℄ Hwy. 11 ORIGINATED BY LP
DIST 19 HWY 11 BOREHOLE TYPE Hollow Stem Auger COMPILED BY LP
DATUM Geodetic DATE 86 04 22 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT Wl — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						GR SA SI CL
342.1	Pavement Surface						342				
0.0	Asphalt										
	Fill Sand, Some to with Silt, Gravel Numerous Cobbles and Boulders		1	SS	26		341				
			2	SS	90				○		18 45 35 2
339.2			3	SS	139		340				
2.9	Organics										
338.6	Silt and Peat		4	SS	59		339				56 %
3.5	Sand Some Silt, Trace Gravel										
338.1											
4.0	Heterogeneous Mixture of Gravel, Sand, Silt, Clay (Glacial Till) Firm to Hard		5	SS	5		338				7 36 48 9
			6	SS	23		337				
335.7			7	SS	46		336		○		6 35 45 14
6.4	End of Borehole Refusal to Auger, Probable Bedrock										

OFFICE REPORT ON SOIL EXPLORATION

+3, ×5 ; Numbers refer to Sensitivity

20
15 ◇ S (%) STRAIN AT FAILURE
10

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 3 METRIC

W P 335-85-01 LOCATION STA. 10 + 186.8; °/s 1.6 m Lt. ℄ Hwy. 11 ORIGINATED BY LP
DIST 19 HWY 11 BOREHOLE TYPE Hollow Stem Auger COMPILED BY LP
DATUM Geodetic DATE 86 04 23 CHECKED BY GP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT Wl / WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						GR SA SI CL
342.0	Pavement Surface										
0.0	Asphalt										
	Fill Sand Some to with Silt, Gravel Numerous Cobbles and Boulders		1	SS	50		341				
			2	SS	50/14 cm		340		○		19 67 13 1
339.1			3	SS	21						
2.9	Sand, Some Silt Trace Gravel					▼	339				
			4	SS	25		338		○		4 70 24 2
	Compact to Very Dense		5	SS	56/15 cm		337				
336.8											
5.2	End of Borehole Refusal to Auger, Probable Bedrock										

+3, ×5 : Numbers refer to Sensitivity

20
15 ◇ 5 (%) STRAIN AT FAILURE
10

OFFICE REPORT ON SOIL EXPLORATION

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 4 METRIC

W P 335-85-01 LOCATION STA. 10 + 196.6; °/s 1.5 m Lt. ℄ Hwy. 11 ORIGINATED BY LP

DIST 19 HWY 11 BOREHOLE TYPE Hollow Stem Auger COMPILED BY LP

DATUM Geodatic DATE 86 04 23 CHECKED BY

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 (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT W_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
342.1	Pavement Surface						342				
0.0	Asphalt										
	Fill										
	Sand, Some to with Silt, Gravel		1	SS	9		341		○		10 50 38 2
	Numerous Cobbles and Boulders		2	SS	79/25 cm						
339.4			3	SS	68		340		○		33 50 15 2
2.7	Sand, with Silt Trace Organics		4	SS	72/20 cm **		339				
			5	SS	32		338				
337.4	Dense to Very Dense		6	SS	*						
4.7	End of Borehole										

* Spoon Bouncing Probable Bedrock

** Spoon Bouncing on Boulder

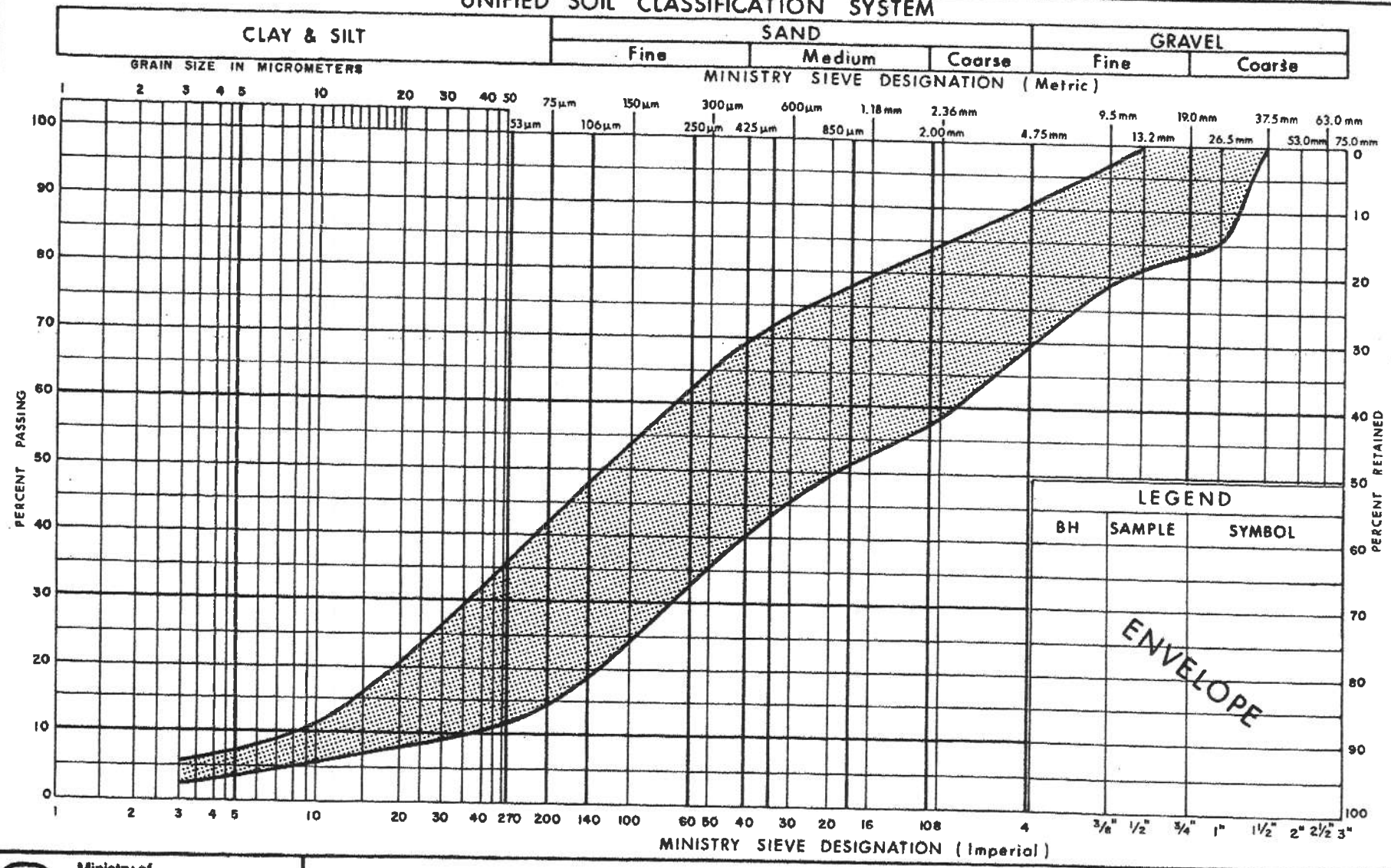
$+^3$, $\times^5$: Numbers refer to Sensitivity

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

OFFICE REPORT ON SOIL EXPLORATION

78 12 M

UNIFIED SOIL CLASSIFICATION SYSTEM



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Ontario

GRAIN SIZE DISTRIBUTION

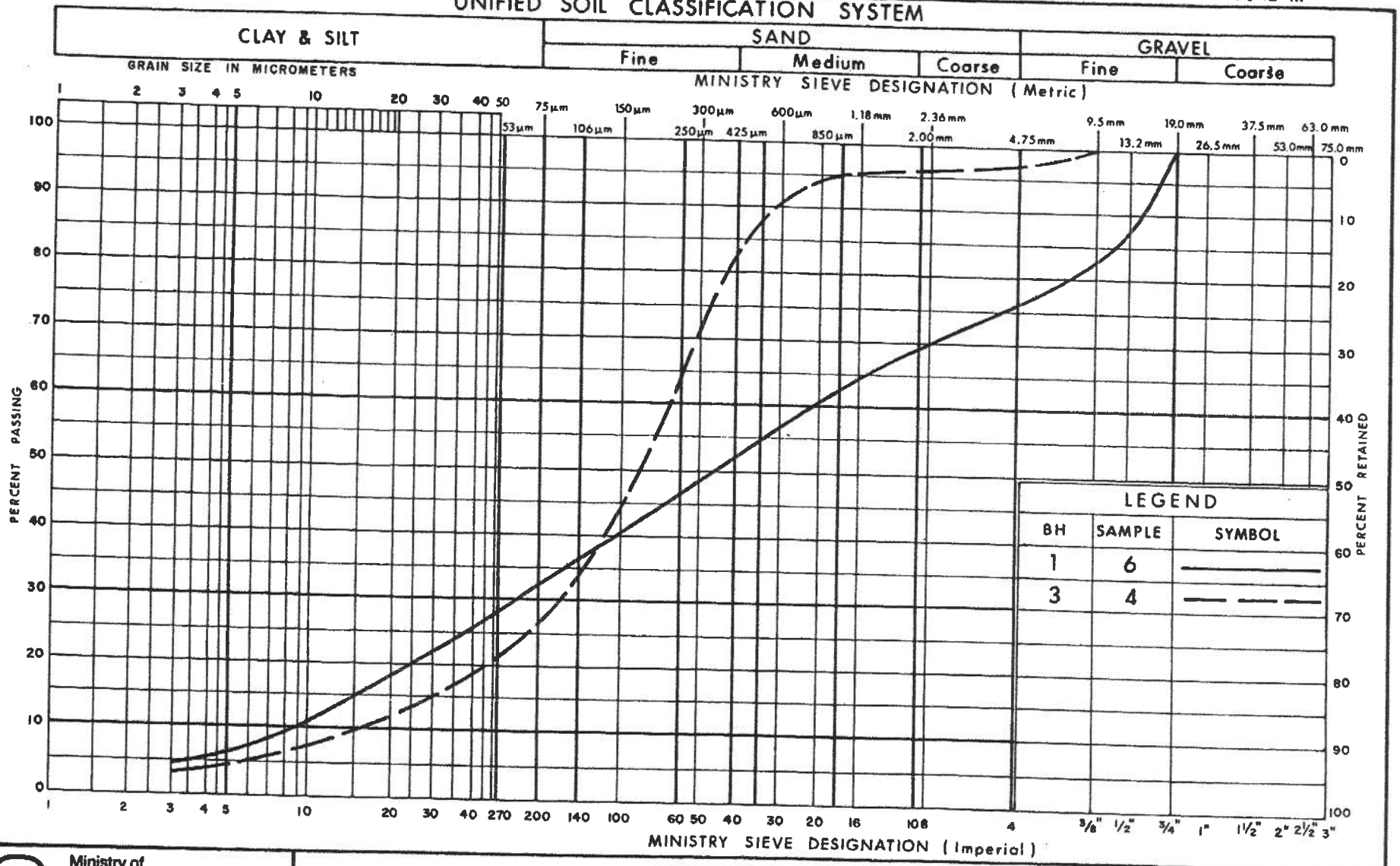
SAND, SOME TO WITH SILT, GRAVEL (FILL)
NUMEROUS COBBLES AND BOULDERS

FIG No 1
W P 335-85-01

10

78 12 M

UNIFIED SOIL CLASSIFICATION SYSTEM



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Ontario

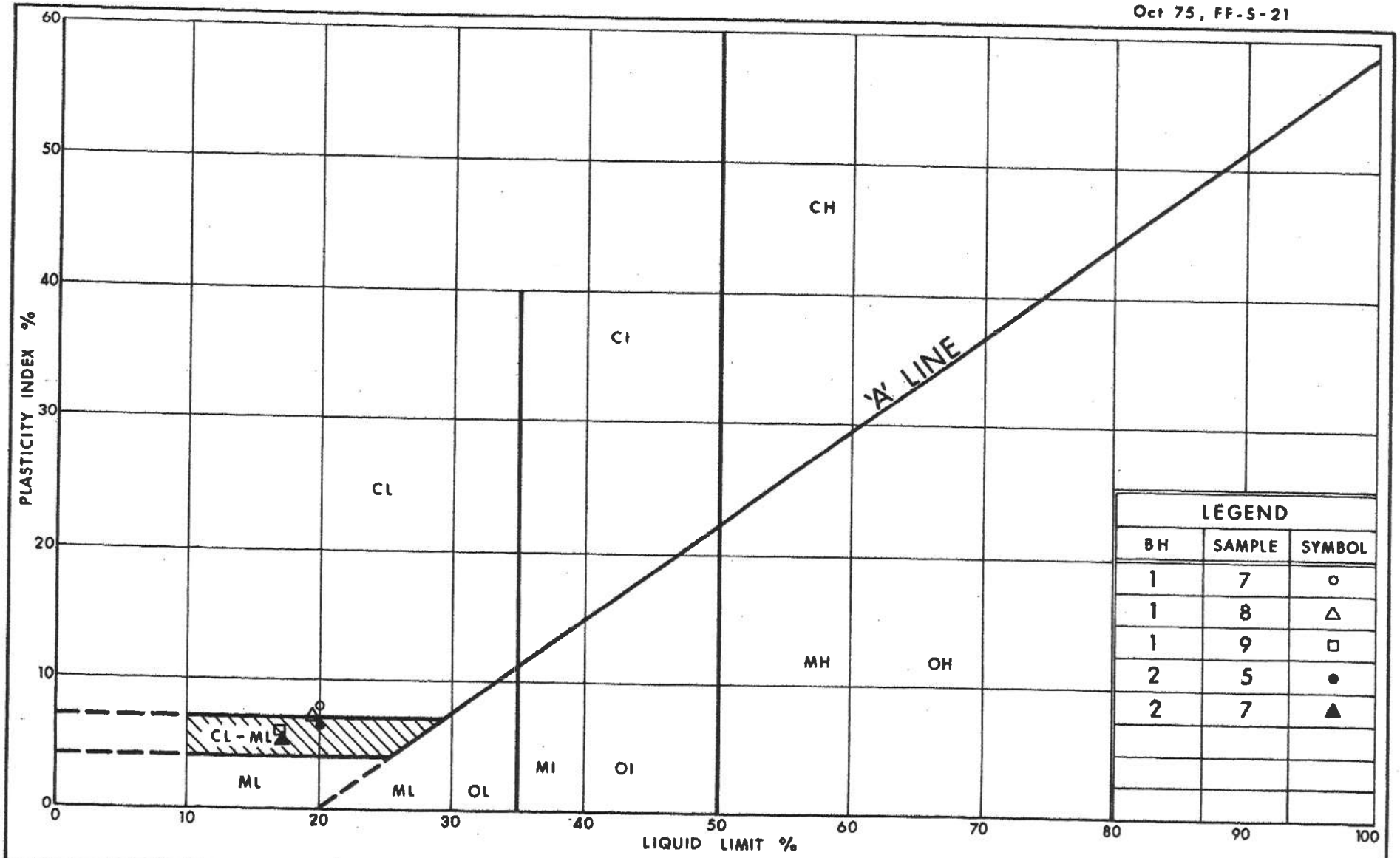
GRAIN SIZE DISTRIBUTION

SAND WITH SILT, TRACE TO WITH GRAVEL

FIG No 2

W P 335-85-01

Oct 75, FF-S-21



LEGEND		
BH	SAMPLE	SYMBOL
1	7	○
1	8	△
1	9	□
2	5	●
2	7	▲

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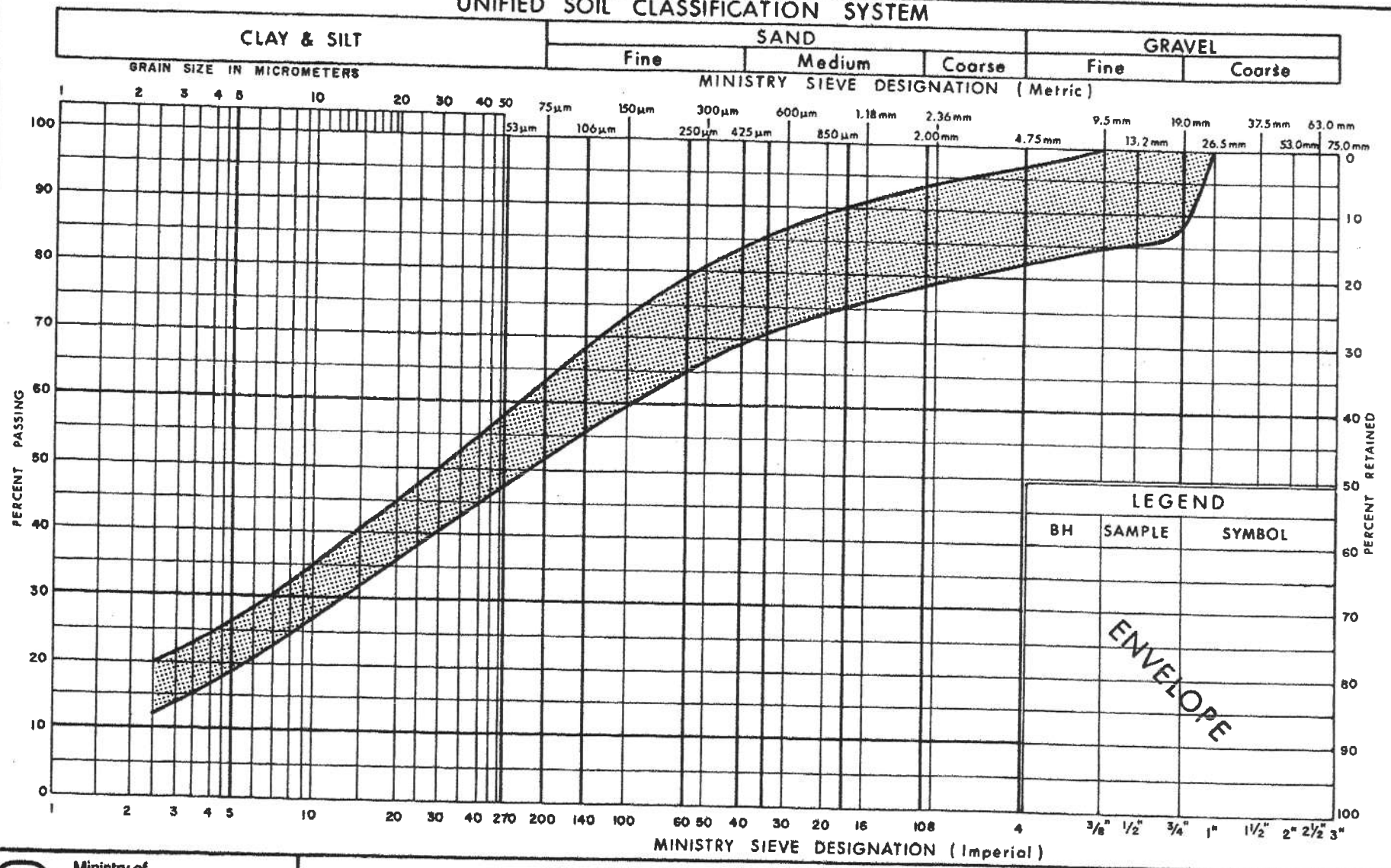
PLASTICITY CHART
HET MIXTURE OF
GRAVEL, SAND, SILT, CLAY (Glacial Till)

FIG No 3
W P 335-85-01

78 12 M

UNIFIED SOIL CLASSIFICATION SYSTEM



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Ontario

GRAIN SIZE DISTRIBUTION
HET MIXTURE OF
GRAVEL, SAND, SILT, CLAY (Glacial Till)

FIG No 4
W P 335-85-01

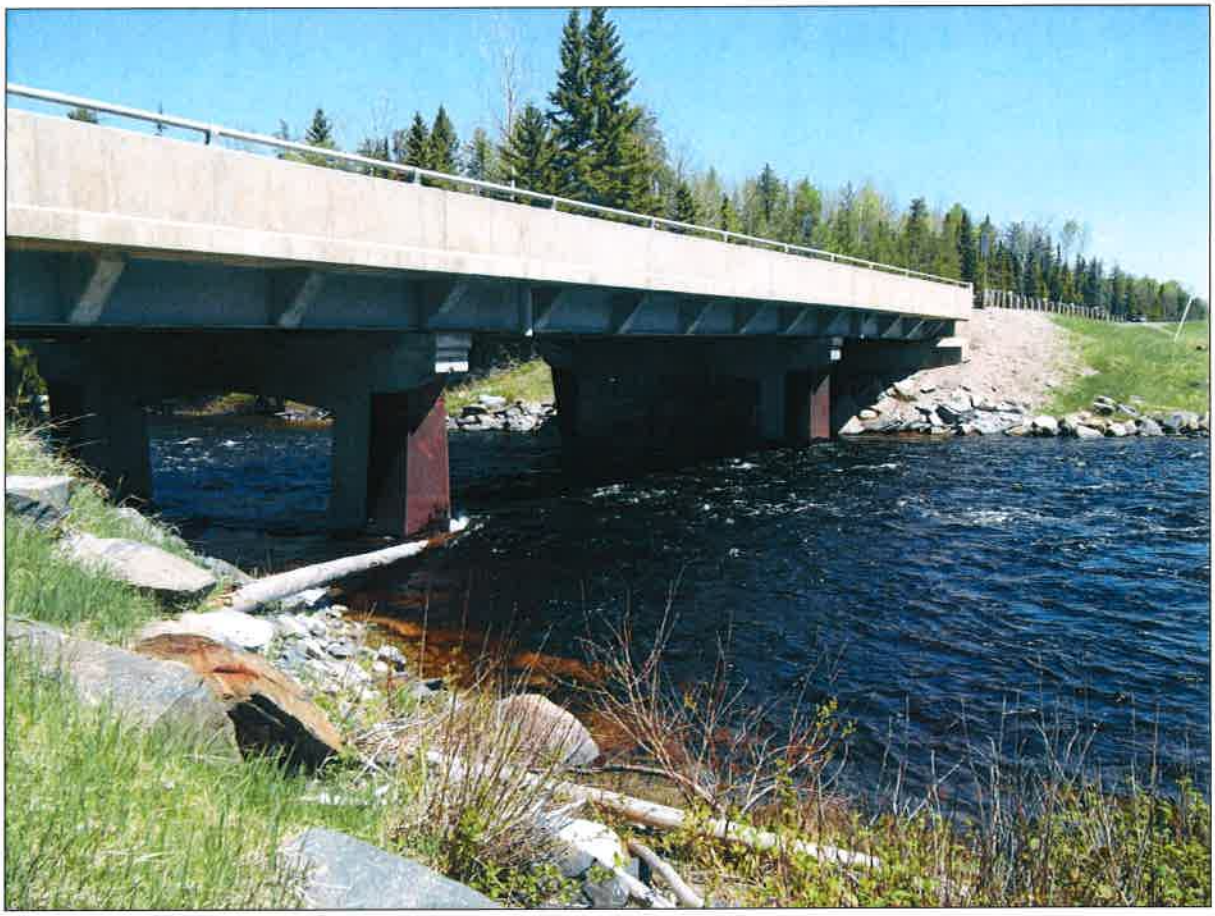
Appendix D

Site Photographs

Photograph 1– Highway 11 and Sturgeon River Bridge crossing

Photograph 2– Existing Highway 11 embankment

Photograph 3–Sturgeon River Bridge



Photograph 4–Sturgeon River Bridge

Photographs 5 and 6 –Sturgeon River south and north sides of the Highway 11

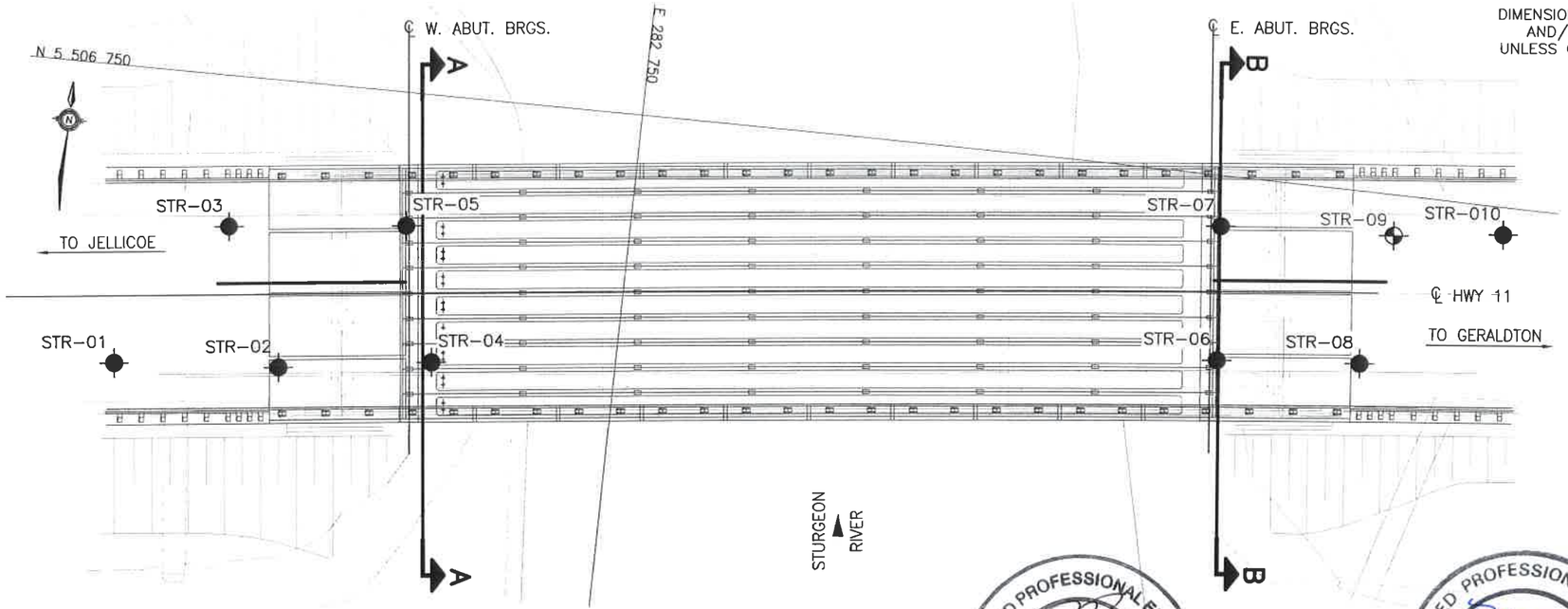
Appendix E

Drawing titled "Borehole Locations and Soil Strata"

MINISTRY OF TRANSPORTATION, ONTARIO

METRIC

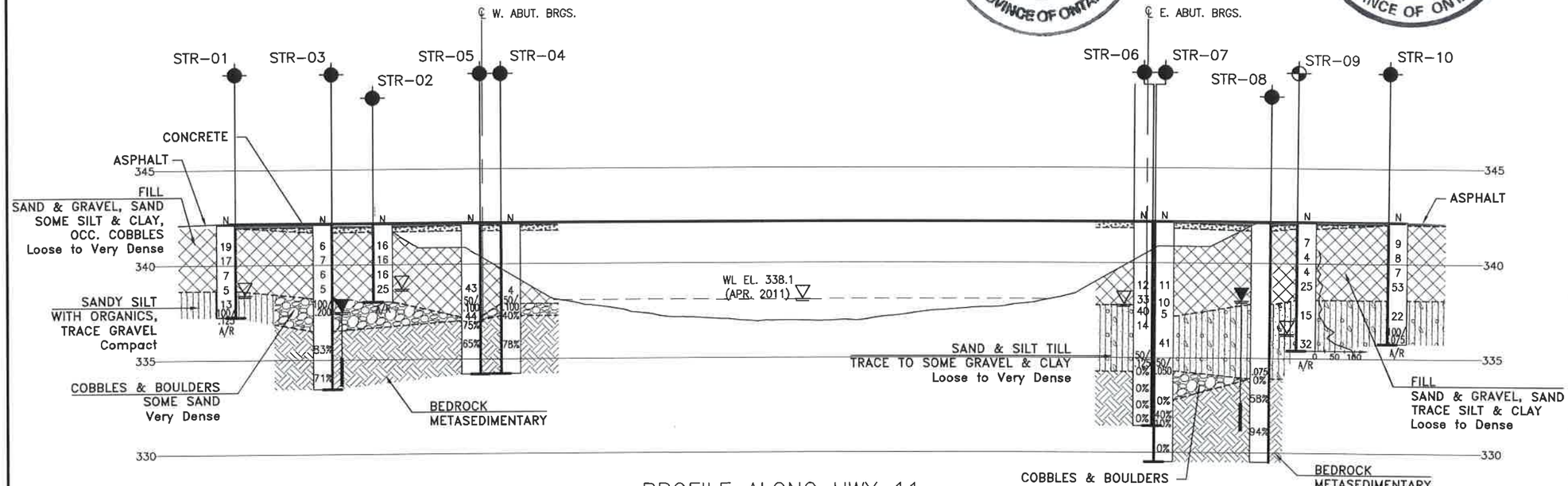
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN



PLAN

5 0 5 10m

SCALE 1:250



PROFILE ALONG HWY 11

5 0 5 10m

SCALE 1:250

LICENSED PROFESSIONAL ENGINEER
R. Palomeque Reyna
100083209
Oct 30/2012
PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER
P. K. CHATTERJI
Oct 30/2012
PROVINCE OF ONTARIO

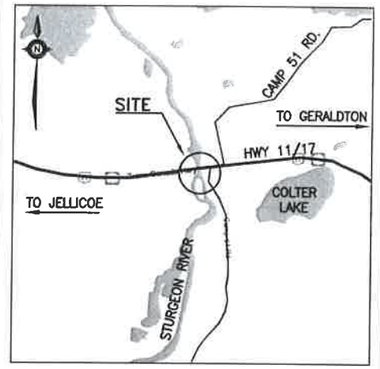
CONT No
WP No 6056-10-00

SHEET

HIGHWAY 11
STURGEON RIVER BRIDGE
BOREHOLE LOCATIONS AND SOIL STRATA

MRC McCORMICK RANKIN
A member of MMM GROUP

THURBER ENGINEERING LTD



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
STR-01	342.1	5 506 736.8	282 728.1
STR-02	342.1	5 506 737.3	282 735.3
STR-03	342.1	5 506 743.3	282 732.5
STR-04	342.1	5 506 738.2	282 742.0
STR-05	342.1	5 506 744.1	282 740.2
STR-06	342.2	5 506 741.8	282 776.1
STR-07	342.2	5 506 747.8	282 775.6
STR-08	342.1	5 506 742.4	282 782.3
STR-09	342.2	5 506 748.2	282 783.1
STR-10	342.2	5 506 748.8	282 787.9

-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. 42H-13

REVISIONS		
DATE	BY	DESCRIPTION

DESIGN	RPR	CHK RPR	CODE	LOAD	DATE OCT. 2012
DRAWN	AN	CHK PKC	SITE 48C-46	STRUCT	DWG 1

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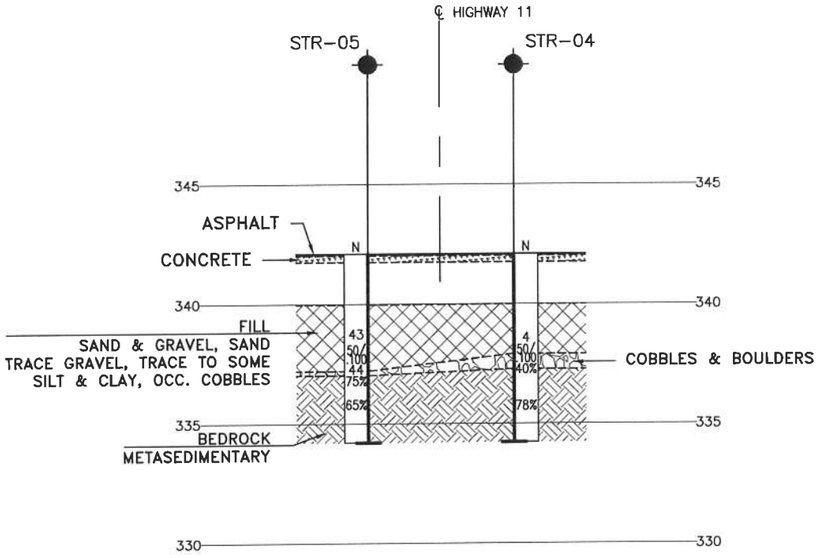
PLOTDATE: 10/25/2012 9:26 AM

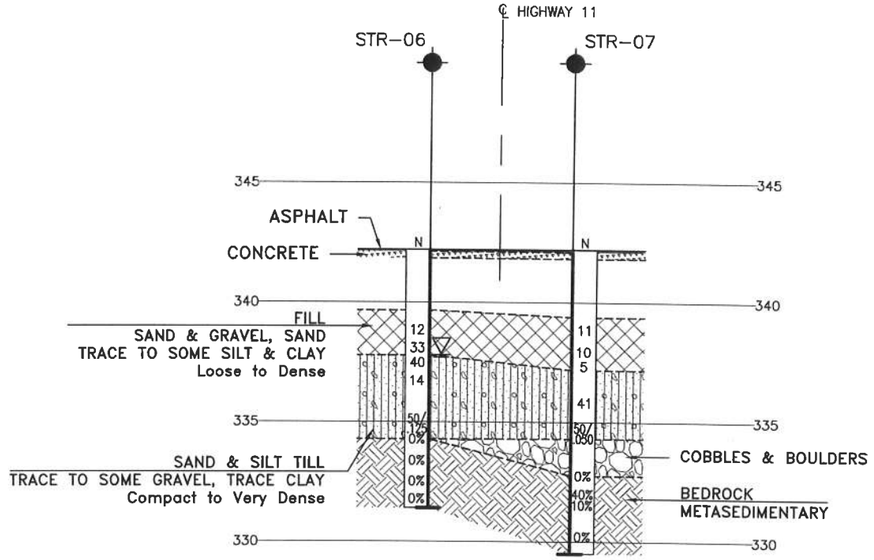
MINISTRY OF TRANSPORTATION, ONTARIO

METRIC

DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN



SECTION ALONG A–A



SECTION ALONG B–B

5 0 5 10m
SCALE 1:250

LICENSED PROFESSIONAL ENGINEER
R. Palomeque Reyna
100083209
Oct/30/12
PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER
P. K. CHATTERJI
Oct 30/2012
PROVINCE OF ONTARIO

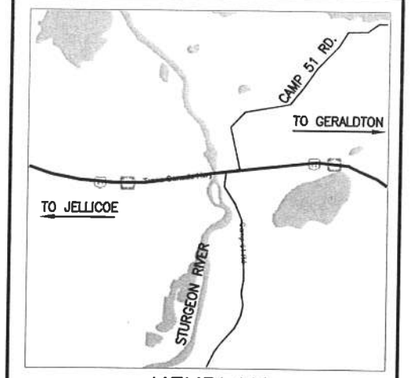
CONT No
WP No 6056–10–00

SHEET

HIGHWAY 11
STURGEON RIVER BRIDGE
BOREHOLE LOCATIONS AND SOIL STRATA

MRC McCORMICK RANKIN
A member of MMM GROUP

THURBER ENGINEERING LTD.



KEYPLAN

LEGEND

✦	Borehole
✦	Borehole and Cone
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CONE	Blows /0.3m (60° Cone, 475J/blow)
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⧗	Water Level
⧗	Head Artesian Water
▏	Piezometer
90%	Rock Quality Designation (RQD)
A/R	Auger Refusal

NO	ELEVATION	NORTHING	EASTING
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GEOCRES No. 42H-13

REVISIONS		
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