

**FOUNDATION INVESTIGATION REPORT
GRAND RIVER CROSSING SBL
HIGHWAY 8 WIDENING, KITCHENER
G.W.P. 277-97-00, SITE: 33-137S**

Geocres Number: 40P8-143

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 structure at Kitchener, Ontario. The proposed five-span structure will carry the southbound lanes (SBL) of the future widened Highway 8 across the Grand 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, 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 Morrison Hershfield, under the Ministry of Transportation Ontario (MTO) Agreement Number 3005-E-0035.

2 SITE DESCRIPTION

The site for the proposed new SBL crossing lies across the valley of the Grand River on the south side of the City of Kitchener and immediately west (downstream) of the existing structure carrying Highway 8 across the river. The existing Highway 8 spans the river channel, as well as the flood plain on the south side of the river, on a five-span structure.

At the site location, the river channel is approximately 60 m wide and the existing bridge spans a distance of approximately 190 m. The water level was measured to be approximately 1.5 m to 2.3 m deep at the locations of boreholes drilled in the river during the current investigation. The south shoreline of the river consists of a generally level floodplain with a gentle slope towards the river channel. The floodplain is mainly vegetated with grass, shrubs and some sparse trees. A gravel trail crosses beneath the existing structure between the south abutment and Pier 4 and continues eastwards and westwards from Highway 8, generally following the alignment of the Grand River. The north shoreline of the river consists of an approximately 18 m high cliff with an approximate slope of 2H : 1V. The slope is vegetated with grass and large trees and portions of the toe of the slope and the riverbank are lined with rip-rap boulders. Residential houses overlooking

the river are located at the top of the cliff along Hidden Valley Road, which generally follows the river alignment.

Geologically, the site area is located within the physiographic region known as the Waterloo Hills, which is characterized by sandy hills consisting of ridges of sandy till as well as kames and kame moraines, with outwash sands occupying the intervening hollows. The surficial soils of this region overly Silurian bedrock of the Guelph Formation. Locally, the site lies within the Grand River spillway system, which consists of alluvial terraces containing uniform sandy and gravelly materials, although the steep slope of the north bank of the river can be considered part of a kame moraine system composed mainly of till and sand and gravel deposits.

Photographs of the site are included in Appendix G. Both photographs are taken from the flood plain area on the south side of the Grand River. Photograph #1 is looking northward across the Grand River towards the area of the proposed North Abutment and Piers 1 and 2. Part of the existing Hwy 8 bridge can be seen on the right side of the photograph. Photograph #2 is taken from the area of Piers 3 and 4 and is looking southward across the floodplain towards the area of the proposed South Abutment. Part of the existing Hwy 8 bridge can be seen on the left side of the photograph.

3 SITE INVESTIGATION AND FIELD TESTING

The site investigation and field testing for this project were carried out between the period of July 27 to November 21, 2006. Twelve boreholes numbered 06-2 to 06-13 pertaining to the five-span structure were drilled to depths ranging from 6.3 m to 19.9 m. Boreholes 06-2 and 06-7 to 06-13 were drilled using truck and track-mounted CME 75 drill rigs in the vicinity of the proposed North and South Abutments and Piers 3 and 4. Boreholes 06-3 to 06-6 were drilled through the riverbed using a barge-mounted CME 75 drill rig in the vicinity of the proposed Piers 1 and 2. The boreholes were drilled as close as was accessible to the foundation elements. The approximate locations of the boreholes are shown on the attached Borehole Locations and Soil Strata Drawing in Appendix F.

Thurber located the borehole locations in the field with reference to the existing Grand River overpass structure. The borehole locations (with the exception of Boreholes 06-3 to 06-6, which were drilled in the Grand River) were subsequently surveyed by Callon Dietz Inc., who provided Thurber with the coordinates and geodetic elevations. Thurber obtained utility clearances prior to drilling.

Prior to drilling boreholes 06-3 to 06-6 in the Grand River, the Department of Fisheries and Oceans Canada determined that at the site of the new SBL crossing, the river contains a species of mussel (Wavy Rayed Lampmussel) that is protected by the Species At Risk Act. Therefore, prior to the commencement of the drilling activities in the river, a mussel relocation program was conducted in order to minimize the impact of the drilling activities on the mussel population at the site. Prior to future construction activities, it is possible that the site location may become repopulated with

mussels and therefore a new relocation program may need to be conducted, followed by a post-relocation monitoring program.

A combination of hollow-stem auger drilling techniques and casing and washboring methods were used to advance the boreholes. Samples were obtained at selected intervals using a split spoon sampler in conjunction with Standard Penetration Testing (SPT) in the overburden soils. One borehole at each foundation element was advanced from 2.9 m up to 6.0 m into bedrock by NQ size diamond coring techniques, with the exception of Borehole 06-2 at the north abutment, which was advanced greater than 3.0 m into refusal soil as defined by SPT 'N' values of greater than 100 blows per 0.3 m.

Groundwater conditions in the open boreholes were observed throughout the drilling operations. At each foundation element (with the exception of Piers 1 and 2, which are located within the river) a standpipe piezometer consisting of 19 mm PVC pipe with a slotted screen was installed and enclosed in filter sand to permit longer term groundwater level monitoring. 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 accordance with the requirements of MOE Reg. 903. 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
06-2 North Abutment	19.9 / 274.9	Piezometer with 1.5 m slotted screen installed with sand filter to 18.0 m, bentonite seal from 18.0 m to 17.4 m, grout from 17.4 m to 0.9 m and bentonite seal from 0.9 m to ground surface.
06-3 Pier #1	None Installed	Grouted with bentonite to riverbed surface.
06-4 Pier #1	None Installed	Grouted with bentonite to riverbed surface.
06-5 Pier #2	None Installed	Grouted with bentonite to riverbed surface.
06-6 Pier #2	None Installed	Grouted with bentonite to riverbed surface.
06-7 Pier #3	12.1 / 271.2	Piezometer with 1.5 m slotted screen installed with sand filter to 10.1 m, bentonite seal from 10.1 m to 9.7 m, grout from 9.7 m to 0.6 m and bentonite seal from 0.6 m to ground surface.
06-8 Pier #3	None Installed	Grouted with bentonite to ground surface.
06-9 Pier #4	None Installed	Grouted with bentonite to ground surface.
06-10 Pier #4	12.1 / 271.7	Piezometer with 1.5 m slotted screen installed with sand filter to 9.8 m, bentonite seal from 9.8 m to 9.1 m, grout from 9.1 m to 0.5 m and bentonite seal from 0.5 m to ground surface.
06-11 South Abutment	14.0 / 270.5	Piezometer with 1.5 m slotted screen installed with sand filter to 12.2 m, bentonite seal from 12.2 m to 11.6 m and grout from 11.6 m to ground surface.

06-12 South Abutment	None Installed	Grouted with bentonite to ground surface.
06-13 South Approach	None Installed	Grouted with bentonite to ground surface.

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. The results of point load tests on rock cores retrieved from the boreholes are shown in Table B1 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" and "Soil Strata" drawings in Appendix F. 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 factual data from the previous investigation is contained in Appendix C.

In general, the site is underlain by 10.5 m to greater than 19.9 m of overburden soils overlying Limestone bedrock. The overburden soils generally consist of topsoil, granular or clay fill, an upper sand and gravel deposit, sandy silt to silt and sand glacial till, and a lower sand and gravel deposit. Occasional zones of sand and silty clay glacial till were also encountered in the investigation.

5.1 Topsoil and Fill

Across the site 0.1 m to 0.2 m of topsoil was encountered that extends to elevations ranging from 294.7 m to 283.3 m. The topsoil thickness may vary between the borehole locations and at other areas of the site.

Borehole 06-2 was drilled in the ditch adjacent to the existing Highway 8 SBL. This borehole encountered a layer of silty clay fill with trace sand and gravel underlying the topsoil. The fill layer extends to a depth of 0.8 m or to an elevation of 294.1 m. The fill is considered to have a stiff consistency based on a Standard Penetration Test 'N' value of 8 blows per 0.3 m penetration. The moisture content of a sample of this material was 19%.

Boreholes 06-11 to 06-13 were drilled in the vicinity of the existing Highway 8 SBL embankment and the gravel trail near the existing south abutment. These boreholes encountered granular fill ranging from sand to sand to gravel underlying the topsoil. A thin layer (75 mm) of topsoil was also encountered beneath the granular fill in Boreholes 06-11 and 06-13. The granular fill and buried topsoil extends to a depth of 0.2 m to 0.7 m or to elevations ranging from 284.1 to 283.5 m. Standard penetration tests conducted in this layer gave 'N' values of 9 to 13 blows per 0.3 m penetration. Based on these results the fill is considered to have a loose to compact relative density. The moisture content of samples from this layer ranged from approximately 7% to 14%.

5.2 Sand

Underlying the topsoil, a layer of sand was encountered in the boreholes located in the floodplain on the south side of the river. The sand also contained some silt and trace gravel. The upper part of the sand was also mixed with topsoil. The sand deposit was approximately 1.4 m to 2.1 m thick and was encountered to depths of 1.5 m to 2.2 m or to elevations of 282.1 m to 281.1 m.

Standard penetration tests in this deposit gave 'N' values from 4 to 33 blows per 0.3 m penetration, indicating that the relative density of the material varies from loose to dense.

The moisture content of samples from this material ranged from approximately 13% to 57%, with the higher values being attributed to the presence of topsoil within the sand.

5.3 Upper Sand and Gravel

An upper deposit of sand and gravel ranging from sandy gravel to gravelly sand extends across most of the site except for at the location of the proposed North Abutment (Borehole 06-2). This deposit ranges in thickness from 0.2 m to 3.2 m and extends to depths of 2.3 m to 4.6 m or to elevations of 281.0 m to 279.1 m. The material contains trace silt and occasional to some cobbles and boulders. The presence of some rip-rap boulders was also observed on the riverbed at Boreholes 06-3 and 06-4 near the north shoreline.

Selected samples of this material were subjected to grain size distribution tests and the results are presented in Figures B4 and B5 in Appendix B.

Standard penetration tests in the upper sand and gravel deposit gave 'N' values from 11 to greater than 50 blows per 0.3 m penetration indicating that the relative density of the material varies from compact to very dense.

The moisture content of samples from this deposit ranged from approximately 4% to 21%.

5.4 Sandy Silt to Silt and Sand Till

Underlying the upper sand and gravel layer, a deposit of glacial till consisting of sandy silt ranging to silt and sand extends across the site. The till also contains trace to some clay, trace to some gravel and cobbles and boulders. The total thickness of the deposit ranges from 1.8 m to greater than 19.1 m, although layers of sand with trace to some silt and trace gravel as well as layers of silty clay till were encountered within this deposit. The deposit extends to depths ranging from 4.7 m to greater than 19.9 m or to elevations ranging from 277.8 m to 273.9 m. Glacial tills inherently contain cobbles and boulders.

Selected samples from this deposit were subjected to grain size distribution tests and the results are presented in Figures B2 and B3 in Appendix B.

SPT 'N' values ranged from 8 to greater than 50 blows per 0.3 m penetration, although were generally between 33 and greater than 50 blows per 0.3 m penetration, indicating that the material has a dense to very dense relative density. Some of the SPT 'N' values may represent tests conducted on cobbles and boulders.

The moisture content of samples from this deposit ranged from approximately 6% to 15%.

5.5 Silty Clay Till

Occasional zones of silty clay glacial till were encountered across the site. The glacial till contains varying amounts of sand, ranging from trace sand to sandy, as well as trace gravel. These zones range in thickness from 0.8 m to 7.6 m and were encountered extending to depths of 8.4 m to 15.2 m or to elevations of 279.6 m to 272.6 m.

Selected samples from this material were subjected to grain size distribution tests and the results are illustrated in Figure B1 in Appendix B. The results of Atterberg Limit tests conducted on selected samples from this material are shown in Figure B6 in Appendix B. All three samples tested plot as "CL".

SPT 'N' values in this material ranged from 24 to more than 50 blows for 0.3 m penetration, indicating a very stiff to hard relative density. Glacial tills inherently contain cobbles and boulders and some of the high SPT 'N' values may represent tests conducted on cobbles and boulders.

The moisture content of samples from this material ranged from approximately 7% to 18%.

5.6 Lower Sand and Gravel

A lower deposit of sand and gravel ranging to gravelly sand extends across the site and the layer overlies the bedrock. This deposit ranges in thickness from 2.0 m to 6.4 m and extends to depths of 10.5 m to 14.6 m or to elevations of 272.0 m to 269.6 m. The material also contains trace silt, occasional to some cobbles and distinct layers of boulders.

Selected samples from this material were subjected to grain size distribution testing and the results are shown in Figures B4 and B5 in Appendix B.

Standard Penetration tests in this deposit gave 'N' values that were more than 50 blows per 0.3 m penetration, indicating that the material has a very dense relative density. Some of the high SPT 'N' values may also represent tests conducted on cobbles and boulders.

The moisture content of samples from this deposit ranges from approximately 6% to 23%.

5.7 Bedrock

The overburden soils described above are underlain by limestone bedrock. Bedrock was proved by coring at the south abutment and at each of the four piers. Table 5.1 summarizes the bedrock depth and the elevations to the top of bedrock where rock was cored and where refusal was encountered on probable bedrock, but the rock was not cored.

The limestone bedrock is generally described as highly to moderately weathered, thinly bedded and grey in colour. Occasional pitted zones and occasional to frequent rubble zones indicate that the rock carries water bearing seams.

TABLE 5.1 – Depth to Bedrock at Foundation Elements

Location	BH Number	Depth to Bedrock (m)	Top of Bedrock Elevation (m)
Pier #1	06-3	10.5 / 9.0*	272.0
	06-4	11.7 / 9.7*	270.8
Pier #2	06-5	10.5 / 8.2*	272.0
	06-6	11.1 / 9.3*	271.4
Pier #3	06-7	12.0**	271.3**
	06-8	13.4	270.3
Pier #4	06-9	11.8	271.6
	06-10	12.2**	271.6**
South Abutment	06-11	14.0**	270.5**
	06-12	14.6	269.6

*Denotes depth to bedrock below river water level / below riverbed level.

**Denotes where refusal was encountered on probable bedrock.

Core recovery in the bedrock was between 55% and 100%. The RQD values generally ranged from 0% to 54% indicating very poor to poor rock quality.

The Fracture Index (FI) of the rock, expressed as fractures per 0.3 m of core, was generally high, ranging from 5 to greater than 10. The Fracture Indices greater than 10 indicate the presence of rubble zones within the rock mass. Some vertical joints were encountered in Borehole 06-6 and they were mostly tight with little to no sand infilling or secondary weathering material.

The estimated unconfined compressive strength of the rock cores tested generally ranges between 41 and 86 MPa indicating a medium strong to strong rock with occasional cores

exhibiting higher strength values of 105 to 155 MPa. These estimated rock strength values are based on point load tests that were conducted on rock cores recovered from the boreholes. Due to very poor rock quality in the cores, no point load tests were conducted on samples from Boreholes 06-3 and 06-4. A summary of the Point Load Test Results is presented in Table B1 in Appendix B.

5.8 Water Levels

A standpipe piezometer was installed in a selected borehole at each foundation element except for Piers 1 and 2, which are located in the river. Water levels were measured on separate visits made after the completion of drilling. The water level readings at the foundation elements are presented in Table 5.2.

Based on these observations, local groundwater levels exist at Elevations 283.0 m to 284.9 m. All groundwater observations at this site are short term and the levels are expected to fluctuate seasonally and after severe weather events.

Table 5.2: Water Level Measurements

Date	BH 06-2 N-Abutment	BH 06-7 Pier 3	BH 06-10 Pier 4	BH 06-11 S-Abutment
	Depth/ Elev. (m)	Depth/ Elev. (m)	Depth/ Elev. (m)	Depth/ Elev. (m)
August 1, 2006	-	1.5 / 281.9	-	-
August 9, 2006	-	0.3 / 283.1	0.8 / 283.0	-
August 10, 2006	-	0.4 / 283.0	0.8 / 283.0	1.3 / 283.2
August 11, 2006	-	0.4 / 283.0	0.8 / 283.0	1.2 / 283.3
August 14, 2006	-	0.4 / 283.0	0.9 / 282.9	1.2 / 283.3
August 15, 2006	-	0.4 / 283.0	0.9 / 282.9	1.2 / 283.3
August 16, 2006	-	0.4 / 283.0	0.9 / 282.9	1.2 / 283.3
September 29, 2006	-	0.4 / 283.0	0.7 / 283.1	1.5 / 283.0
January 4, 2007	9.89 / 284.9	-	-	-

6 MISCELLANEOUS

All-Terrain Drilling Limited of Waterloo, Ontario supplied track and truck mounted CME 75 drill rigs and conducted the drilling, sampling and in-situ testing operations for the boreholes drilled on land. Canadian Soil Drilling of Midhurst, Ontario supplied a barge mounted CME 75 drill rig and conducted the drilling, sampling and in-situ testing operations for the boreholes drilled in the Grand River. Water Systems Analysts of Guelph, Ontario conducted the mussel relocation program.

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

Mr. Alastair E. Gorman, P.Eng. and Mr. Mark E. Farrant, P.Eng. directed the field operations and prepared the report.

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

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Report Reviewed by:
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

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


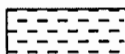



 Water Level
 Shear Strength Determination by Pocket Penetrometer

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

DISCONTINUITY SPACING		STRENGTH CLASSIFICATION			
Bedding	Bedding Plane Spacing	Rock Strength	Approximate Uniaxial Compressive Strength		Field Estimation of Hardness*
			(MPa)	(psi)	
Very thickly bedded	Greater than 2m	Extremely Strong	Greater than 250	Greater than 36,000	Specimen can only be chipped with a geological hammer
Thickly bedded	0.6 to 2m				
Medium bedded	0.2 to 0.6m	Very Strong	100-250	15,000 to 36,000	Requires many blows of geological hammer to break
Thinly bedded	60mm to 0.2m				
Very thinly bedded	20 to 60mm	Strong	50-100	7,500 to 15,000	Requires more than one blow of geological hammer to break
Laminated	6 to 20mm				
Thinly Laminated	Less than 6mm	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

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.

RECORD OF BOREHOLE No 06-2

1 OF 3

METRIC

G.W.P. 277-97-00 LOCATION Grand River Overpass SBL N 4 809 407.87 E 230 460.97 ORIGINATED BY GA
 HWY 8 BOREHOLE TYPE Hollow Stem Augers COMPILED BY WM
 DATUM Geodetic DATE 28.09.06 - 28.09.06 CHECKED BY MEF

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			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								WATER CONTENT (%)		
								20 40 60 80 100										
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE										
294.8																		
0.0	TOPSOIL (125 mm)																	
0.1	Silty CLAY, trace to some sand, trace gravel, occasional cobbles		1	SS	8													
294.1	Stiff Brown (FILL)																	
0.8	SILT and SAND, some clay, trace gravel		2	SS	8		294											
	Loose to Very Dense																	
	Brown Dry (TILL)		3	SS	50/ .100		293								5 38 41 16			
			4	SS	101/ .275		292											
			5	SS	105/ .225		291											
290.3																		
4.6	SAND, medium to coarse grained		6	SS	100		290											
	Very Dense Brown Moist																	
288.8							289											
6.0	Sandy SILT, trace gravel		7	SS	101/ .200		288											
	Very dense Brown Damp to dry (TILL)																	
287.2							287											
7.6	Silty CLAY, some sand to sandy, trace gravel		8	SS	104/ .050		286											
	Hard Grey (TILL)(CL)																	
			9	SS	113										0 20 40 40			
							285											

Continued Next Page

+³, ×³: Numbers refer to Sensitivity 20 15 10 5 0 (%) STRAIN AT FAILURE

METRIC

CHECKED BY MEF

Continued Next Page

(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 06-2

3 OF 3

METRIC

G.W.P. 277-97-00 LOCATION Grand River Overpass SBL N 4 809 407.87 E 230 460.97 ORIGINATED BY GA
 HWY 8 BOREHOLE TYPE Hollow Stem Augers COMPILED BY WM
 DATUM Geodetic DATE 28.09.06 - 28.09.06 CHECKED BY MEF

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		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			20	40					
19.9	END OF BOREHOLE AT 19.89 m Piezometer installation consists of 25mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH(m) ELEV.(m) 04.01.07 9.89 284.9				.075									GR SA SI CL

ONTMT4S 7938.GPJ 05/01/07

RECORD OF BOREHOLE No 06-3

2 OF 2

METRIC

G.W.P. 277-97-00 LOCATION Grand River Overpass SBL N 4 809 380.57 E 230 500.59 ORIGINATED BY MEF
HWY 8 BOREHOLE TYPE Hollow Stem Augers / NQ Tri-Cone / NQ Core Barrel COMPILED BY JHL
DATUM Geodetic DATE 2006-11-15 - 2006-11-16 CHECKED BY MEF

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
	Continued From Previous Page																
271.9																	
10.5	Highly weathered, thinly bedded, grey, LIMESTONE BEDROCK Rubble zone from 10.71 to 11.02 m		1	RUN												FI >10 >10	
271.2																	
11.3	END OF BOREHOLE AT 11.23 m. BOREHOLE GROUTED WITH BENTONITE TO RIVERBED SURFACE AT 1.47 m.																

ONTMT14S 7938.GPJ 6/18/07

RECORD OF BOREHOLE No 06-4

1 OF 2

METRIC

G.W.P. 277-97-00 LOCATION Grand River Overpass SBL N 4 809 369.73 E 230 496.77 ORIGINATED BY MEF
 HWY 8 BOREHOLE TYPE Hollow Stem Augers / NQ Tri-Cone / NQ Core Barrel COMPILED BY JHL
 DATUM Geodetic DATE 2006-11-20 - 2006-11-21 CHECKED BY MEF

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100		
282.5 0.0	WATER												
280.5 2.0	Gravelly SAND, some cobbles and rip-rap boulders, trace silt Brown Wet												
279.6 2.9	Sandy SILT, some gravel, trace clay Very Dense Grey Wet (TILL)		1	SS	50/ .100								
			2	SS	60/ .150								
			3	SS	50/ .050								
275.3 7.2	Gravelly SAND, trace silt Very Dense Grey Wet		4	SS	50/ .150								
			5	SS	50/ .050								

Continued Next Page

+³, ×³: Numbers refer to
Sensitivity

20
15
10
(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 06-4

2 OF 2

METRIC

G.W.P. 277-97-00 LOCATION Grand River Overpass SBL N 4 809 369.73 E 230 496.77 ORIGINATED BY MEF
 HWY 8 BOREHOLE TYPE Hollow Stem Augers / NQ Tri-Cone / NQ Core Barrel COMPILED BY JHL
 DATUM Geodetic DATE 2006-11-20 - 2006-11-21 CHECKED BY MEF

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL X LAB VANE									
Continued From Previous Page																	
272.0	Boulder at 10.52 to 10.97 m		6	SS	50/ .100		272										
271.5																	
270.8																	
11.7	Highly weathered, thinly bedded, grey, LIMESTONE BEDROCK , with frequent rubble zones, occasional pitted zones		1	RUN			271									FI >10 8 >10 >10 >10 >10 >10	
	END OF BOREHOLE AT 16.61 m. BOREHOLE GROUTED WITH BENTONITE TO RIVERBED SURFACE AT 2.00 m.		3	RUN			269									RUN 1# TCR=94%, SCR=87%, RQD=16%, UCS=MPa RUN 2# TCR=83%, SCR=62%, RQD=7%, UCS=MPa RUN 3# TCR=64%, SCR=60%, RQD=0%, UCS=MPa	
265.9							268										
16.6							267										
							266										

RECORD OF BOREHOLE No 06-5

1 OF 2

METRIC

G.W.P. 277-97-00 LOCATION Grand River Overpass SBL N 4 809 359.26 E 230 533.45 ORIGINATED BY MEF
 HWY 8 BOREHOLE TYPE Hollow Stem Augers / NQ Tri-Cone / NQ Core Barrel COMPILED BY JHL
 DATUM Geodetic DATE 2006-11-10 - 2006-11-10 CHECKED BY MEF

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60 80 100					
282.5 0.0	WATER													
280.2 2.3	Gravelly SAND, some cobbles, trace silt Dense Brown Wet		1	SS	32									57 35 8 (SI+CL)
279.2 3.2	Sandy SILT, some gravel, trace clay, occasional cobbles and boulders Very Dense Grey Wet (TILL)		2	SS	50/ .150									6 39 45 10
277.4 5.1	Gravelly SAND, trace silt, occasional cobbles Very Dense Grey Wet		3	SS	50/ .100									
			4	SS	50/ .150									
			5	SS	50/ .050									
			6	SS	60/ .150									

Continued Next Page

+³, X³: Numbers refer to Sensitivity 20 15 10 5 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 06-5

2 OF 2

METRIC

G.W.P.: 277-97-00 LOCATION Grand River Overpass SBL N 4 809 359.26 E 230 533.45 ORIGINATED BY MEF
HWY 8 BOREHOLE TYPE Hollow Stem Augers / NQ Tri-Cone / NQ Core Barrel COMPILED BY JHL
DATUM Geodetic DATE 2006-11-10 - 2006-11-10 CHECKED BY MEF

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100		
	Continued From Previous Page							SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE						
								WATER CONTENT (%) w _p — w — w _L						
								20	40	60	80	100		
271.9							272						FI	
10.5	Highly weathered, thinly bedded, grey, medium strong to strong, LIMESTONE BEDROCK, with frequent rubble zones, occasional pitted zones		1	RUN			271						>10	RUN 1# TCR=100%, SCR=78%, RQD=0%, UCS=70MPa
			2	RUN			270						>10	RUN 2# TCR=94%, SCR=63%, RQD=0%, UCS=86MPa
269.0													>10	
13.4	END OF BOREHOLE AT 13.41 m. BOREHOLE GROUTED WITH BENTONITE TO RIVERBED SURFACE AT 2.31 m.													

RECORD OF BOREHOLE No 06-6

1 OF 2

METRIC

G.W.P. 277-97-00 LOCATION Grand River Overpass SBL N 4 809 349.51 E 230 527.36 ORIGINATED BY MEF
HWY 8 BOREHOLE TYPE Hollow Stem Augers / NQ Tri-Cone / NQ Core Barrel COMPILED BY JHL
DATUM Geodetic DATE 2006-11-13 - 2006-11-14 CHECKED BY MEF

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	
282.5 0.0	WATER											
280.7 1.8	Gravelly SAND, some cobbles, trace silt Very Dense Brown Wet		1	SS	50/ .150							
279.8 2.7	Sandy SILT, some gravel, trace clay, occasional cobbles and boulders Very Dense Grey Wet (TILL)		2	SS	50/ .100							
277.8 4.7	Gravelly SAND, some cobbles, trace silt, occasional boulders Very Dense Grey Wet		3	SS	50/ .150							
			4	SS	50/ .125							
			5	SS	50/ .075							
			6	SS	50/ .100							

Continued Next Page

+³, X³: Numbers refer to
Sensitivity 20
15 10 5 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 06-6

2 OF 2

METRIC

G.W.P. 277-97-00 LOCATION Grand River Overpass SBL N 4 809 349.51 E 230 527.36 ORIGINATED BY MEF
 HWY 8 BOREHOLE TYPE Hollow Stem Augers / NQ Tri-Cone / NQ Core Barrel COMPILED BY JHL
 DATUM Geodetic DATE 2006-11-13 - 2006-11-14 CHECKED BY MEF

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100		
	Continued From Previous Page													
271.4														
11.1	Highly to moderately weathered, thinly bedded, grey, medium strong to strong, LIMESTONE BEDROCK, with frequent rubble zones, occasional pitted zones		1	RUN									FI	RUN 1# TCR=75%, SCR=69%, RQD=10%, UCS=47MPa
	Vertical joint from 12.55 to 12.65 m		2	RUN									>10	RUN 2# TCR=77%, SCR=64%, RQD=0%, UCS=41MPa
	Vertical joints from 13.31 to 13.41, and 13.72 to 13.87 m		3	RUN									>10	RUN 3# TCR=100%, SCR=76%, RQD=7%, UCS=78MPa
	Vertical joints from 15.09 to 15.21, and 15.55 to 15.60 m		4	RUN									>10	RUN 4# TCR=77%, SCR=71%, RQD=0%, UCS=MPa
	Vertical joint from 15.90 to 16.00 m		5	RUN									>10	RUN 5# TCR=82%, SCR=65%, RQD=25%, UCS=44MPa
266.1	Becoming moderately weathered												>10	
16.4													>10	
265.4													2	
17.1	END OF BOREHOLE AT 17.15 m. BOREHOLE GROUTED WITH BENTONITE TO RIVERBED SURFACE AT 1.85 m.													

ONTMT4S 7938.GPJ 6/18/07

RECORD OF BOREHOLE No 06-7

1 OF 2

METRIC

G.W.P. 277-97-00

LOCATION

Grand River Overpass SBL N 4 809 337.06 E 230 569.26

ORIGINATED BY SLL

HWY 8

BOREHOLE TYPE Hollow Stem Augers

COMPILED BY JHL

DATUM Geodetic

DATE

31.07.06 - 31.07.06

CHECKED BY MEF

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa				
283.4							20 40 60 80 100	PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L		
0.0	TOPSOIL: (125 mm)											
0.1	SAND, mixed with topsoil, some silt Loose to Compact Dark brown Moist		1	SS	4							
			2	SS	16							
281.9												
1.4	SAND, some silt, trace gravel, trace roots Loose Dark brown Moist to wet		3	SS	6							
281.1												
2.2	SAND and GRAVEL											
280.9	Brown Wet		4	SS	33							
2.4	SILT and SAND, some clay, trace gravel Dense to very dense Brown Moist (TILL)		5	SS	92							
	Occasional cobbles		6	SS	50/ .150							
	Occasional cobbles and boulders											
277.3												
6.1	SAND and GRAVEL, trace to some silt, occasional cobbles Very dense Grey Wet		7	SS	50/ .125							
			8	SS	50/ .125							
			9	SS	50/ .100							

Continued Next Page

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

RECORD OF BOREHOLE No 06-7

2 OF 2

METRIC

W.P. 277-97-00 LOCATION Grand River Overpass SBL N 4 809 337.06 E 230 569.26 ORIGINATED BY SLL
 HWY 8 BOREHOLE TYPE Hollow Stem Augers COMPILED BY JHL
 DATUM Geodetic DATE 31.07.06 - 31.07.06 CHECKED BY MEF

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
							20	40	60	80	100	W P	W	W L			
							○ UNCONFINED	+	FIELD VANE	● QUICK TRIAXIAL	×	LAB VANE					
							20	40	60	80	100	20	40	60			
271.3			10	SS	68/ .275												
271.9	Probable BEDROCK or BOULDERS		11	SS	50/ .050												
12.2	END OF BOREHOLE IN PROBABLE BEDROCK OR BOULDERS AT 12.24 m. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH(m) ELEV.(m) 01.08.06 1.50 281.90 09.08.06 0.31 283.09 10.08.06 0.36 283.04 11.08.06 0.36 283.04 14.08.06 0.41 282.99 15.08.06 0.41 282.99 16.08.06 0.43 282.97 29.09.06 0.35 283.05																

ONTMT4S 7938.GPJ 08/01/07

RECORD OF BOREHOLE No 06-8

1 OF 2

METRIC

G.W.P. 277-97-00

LOCATION Grand River Overpass SBL N 4 809 325.66 E 230 562.08

ORIGINATED BY MEF/SLI

HWY 8

BOREHOLE TYPE Hollow Stem Augers / NQ Core Barrel

COMPILED BY JHL

DATUM Geodetic

DATE 27.07.06 - 28.07.06

CHECKED BY MEF

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	
283.7												
0.0	TOPSOIL: (150 mm)											
0.2	SAND, mixed with topsoil, some silt Loose Brown Dry		1	SS	6		283					
282.7												
1.1	SAND, some silt, trace clay Loose to Compact Brown Moist		2	SS	4							
281.9												
1.8	Sandy GRAVEL, some cobbles, trace silt Dense to Very Dense Brown Wet		3	SS	11		282					
			4	SS	38		281					
			5	SS	74							
280.2												
3.5	Sandy SILT, some clay, trace gravel Very dense Grey Dry (TILL)						280					
			6	SS	108		279					
							278					
			7	SS	104/ .175		277					
							276					
275.6			8	SS	52							
8.1	SAND and GRAVEL, some cobbles, trace silt Very dense Brown Wet						275					
			9	SS	100/ .225							
							274					

Continued Next Page

+³, ×³: Numbers refer to
Sensitivity

20
15 5
10 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 06-9

1 OF 2

METRIC

G.W.P. 277-97-00 LOCATION Grand River Overpass SBL N 4 809 316.39 E 230 607.09 ORIGINATED BY SLL
 HWY 8 BOREHOLE TYPE Hollow Stem Augers / NQ Core Barrel COMPILED BY JHL
 DATUM Geodetic DATE 01.08.06 - 02.08.06 CHECKED BY MEF

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT Y kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60 80 100	20 40 60 80 100		
283.4												
0.0	TOPSOIL (125 mm)											
0.1	SAND, some silt, some topsoil, trace gravel Loose to Dense Dark brown Moist		1	SS	4		283					
			2	SS	33							
281.9							282					
1.5	Sandy GRAVEL, trace silt, occasional cobbles Very Dense to Compact Brown Wet		3	SS	53							
			4	SS	20		281					
			5	SS	58							
279.9							280					
3.6	Sandy SILT, trace gravel Very dense Brown Moist											
279.3	(TILL)											
4.2	SAND, some gravel, trace silt, occasional cobbles Very dense Brown Wet		6	SS	50/ .125		279					
277.7							278					
5.7	Sandy SILT, trace gravel, occasional cobbles Very dense Brown Moist (TILL)		7	SS	50/ .100							
							277					
276.1												
7.3	SAND and GRAVEL, trace silt Very dense Brown Moist		8	SS	76/ .225		276					
							275					
			9	SS	77/ .275		274					

Continued Next Page

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

RECORD OF BOREHOLE No 06-9

2 OF 2

METRIC

G.W.P. 277-97-00 LOCATION Grand River Overpass SBL N 4 809 316.39 E 230 607.09 ORIGINATED BY SLL
HWY 8 BOREHOLE TYPE Hollow Stem Augers / NQ Core Barrel COMPILED BY JHL
DATUM Geodetic DATE 01.08.06 - 02.08.06 CHECKED BY MEF

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT Y kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			20	40	60	80	100		
							SHEAR STRENGTH kPa						
							○ UNCONFINED + FIELD VANE						
							● QUICK TRIAXIAL × LAB VANE						
							20	40	60	80	100		
							WATER CONTENT (%)						
							20	40	60				
							PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT						
							W _P	W	W _L				
271.6			10	SS									
11.8	Highly to moderately weathered, thinly bedded, grey, medium strong to strong, LIMESTONE BEDROCK, with occasional rubble zones, occasional pitted zones		1	RUN									
			2	RUN									
			3	RUN									
			4	RUN									
266.9													
16.5	END OF BOREHOLE AT 16.48 m. BOREHOLE GROUTED WITH BENTONITE UPON COMPLETION.												

RECORD OF BOREHOLE No 06-10

1 OF 2

METRIC

G.W.P. 277-97-00

LOCATION Grand River Overpass SBL N 4 809 302.31 E 230 599.22

ORIGINATED BY SLL

HWY 8

BOREHOLE TYPE Hollow Stem Augers

COMPILED BY JHL

DATUM Geodetic

DATE 02.08.06 - 03.08.06

CHECKED BY MEF

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa				
								WATER CONTENT (%)				
283.8						20 40 60 80 100	PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT			
0.0	TOPSOIL: (150 mm)						W _P	W	W _L			
0.2	SAND, mixed with topsoil, some silt, trace roots Loose Dark brown Moist		1	SS	6		○ UNCONFINED	+ FIELD VANE				
			2	SS	5		● QUICK TRIAXIAL	× LAB VANE				
282.1			3	SS	50/ .050							
1.7	Sandy GRAVEL, trace silt, occasional cobbles Very dense Brown Wet Sand seam at 3.00 to 3.13 m Becoming grey		4	SS	74							
			5	SS	83							
279.1												
4.6	Sandy SILT, trace gravel Very dense Grey Moist (TILL)		6	SS	87/ .250							
			7	SS	50/ .125							
277.4												
6.4	Silty CLAY, trace sand Hard Grey (TILL)(CL)		8	SS	60							
275.4												
8.4	Sandy SILT, trace clay, trace gravel, occasional cobbles Very dense Grey Moist to wet: (TILL)		9	SS	50/ .125							
273.9												
9.9												

Continued Next Page

+³, ×³: Numbers refer to
Sensitivity

20
15 5
10 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 06-10

2 OF 2

METRIC

W.P. 277-97-00 LOCATION Grand River Overpass SBL N 4 809 302.31 E 230 599.22 ORIGINATED BY SLL
 HWY 8 BOREHOLE TYPE Hollow Stem Augers COMPILED BY JHL
 DATUM Geodetic DATE 08.02.06 - 08.03.06 CHECKED BY MEF

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT Y kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE								WATER CONTENT (%)
273.6	BOULDER: (300 mm)															
10.2	Gravelly SAND, trace silt Very dense Grey Wet		10	SS	50/ .075		273									
271.6			11	SS	88/ .175		272									27 69 4
274.8 12.2	Probable BEDROCK or BOULDERS END OF BOREHOLE IN PROBABLE BEDROCK OR BOULDERS AT 12.21 m. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH(m) ELEV.(m) 09.08.06 0.75 283.0 10.08.06 0.80 283.0 11.08.06 0.80 283.0 14.08.06 0.85 282.9 15.08.06 0.85 282.9 16.08.06 0.88 282.9 29.09.06 0.65 283.1														(SI+CL)	

RECORD OF BOREHOLE No 06-11

1 OF 2

METRIC

G.W.P. 277-97-00 LOCATION Grand River Overpass SBL N 4 809 300.78 E 230 631.30 ORIGINATED BY SLL
 HWY 8 BOREHOLE TYPE Hollow Stem Augers COMPILED BY JHL
 DATUM Geodetic DATE 08.08.06 - 09.08.06 CHECKED BY MEF

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100		
284.5														
0.0	TOPSOIL: (125 mm)													
0.1	SAND, some gravel, trace silt		1	SS	9									
284.0	Loose													
283.9	Dark brown													
0.6	Moist													
	(FILL)													
	TOPSOIL: (75 mm)													
	SAND and GRAVEL, trace silt,		2	SS	14									
	occasional cobbles													
	Compact to Dense													
	Brown													
	Moist													
			3	SS	30									
			4	SS	45									
			5	SS	39									
280.9														
3.6	SILT and SAND, some clay, trace													
	gravel													
	Very Dense													
	Brown													
	Moist													
	(TILL)													
			6	SS	71									
278.9														
5.6	SAND, trace to some silt, some													
	gravel													
	Very dense													
	Grey													
	Moist to wet													
			7	SS	90/ 275									
			8	SS	88/ 275									
275.9														
8.6	Silty CLAY, trace sand													
	Hard													
	Grey													
	(TILL)													
			9	SS	50/ .050									
275.1														
9.4	Gravelly SAND, trace silt													
	Very Dense													
	Grey													

Continued Next Page

+ 3, x 3: Numbers refer to
Sensitivity

20
15 5
10 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 06-11

2 OF 2

METRIC

W.P. 277-97-00 LOCATION Grand River Overpass SBL N 4 809 300.78 E 230 631.30 ORIGINATED BY SLL
 HWY 8 BOREHOLE TYPE Hollow Stem Augers COMPILED BY JHL
 DATUM Geodetic DATE 08.08.06 - 08.09.06 CHECKED BY MEF

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa	20 40 60 80 100	W _p W W _L	20 40 60			
	Wet		10	SS	50/	.075								
			11	SS	70/	275								
			12	SS	50/	.050								
270.5														0 93 2
14.0	END OF BOREHOLE AT 14.02 m. AUGER REFUSAL ON PROBABLE BEDROCK OR BOULDERS. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH(m) ELEV.(m) 10.08.06 1.27 283.2 11.08.06 1.21 283.3 14.08.06 1.23 283.3 15.08.06 1.20 283.3 16.08.06 1.24 283.3 29.09.06 1.50 283.0													(SI+CL)

ONTMT4S 7938.GPJ 08/01/07

METRIC

ORIGINATED BY SLL

COMPILED BY JHL

CHECKED BY MEF

+ 3, X 3: Numbers refer to Sensitivity

ONTMT4S 7938.GPJ 05/01/07

RECORD OF BOREHOLE No 06-13

1 OF 1

METRIC

G.W.P. 277-97-00

LOCATION Grand River Overpass SBL N 4 809 280.86 E 230 645.36

ORIGINATED BY SLL

HWY 8

BOREHOLE TYPE Hollow Stem Augers

COMPILED BY JHL

DATUM Geodetic

DATE 11.08.06 - 11.08.06

CHECKED BY MEF

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		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							WATER CONTENT (%)			
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE										
284.3							20	40	60	80	100							
0.0	TOPSOIL: (50 mm)																	
0.0	GRAVEL: (FILL)																	
0.1	TOPSOIL: (75 mm)																	
0.2	SAND and GRAVEL, trace silt Compact to Very Dense Brown Moist		1	SS	25													
			2	SS	34													
			3	SS	100/ .275													
			4	SS	61													
			5	SS	30													
281.0	SILT and SAND, some clay, trace gravel, occasional cobbles Dense to Very Dense Grey Moist (TILL)																	
3.4			6	SS	36													
			7	SS	50/ .075													
278.0	END OF BOREHOLE AT 6.33 m. BOREHOLE GROUTED WITH BENTONITE TO SURFACE.																	
6.3																		

ONTMT4S 7938.GPJ 05/01/07

+³, X³: Numbers refer to
Sensitivity

20
15 5
10 (%) STRAIN AT FAILURE

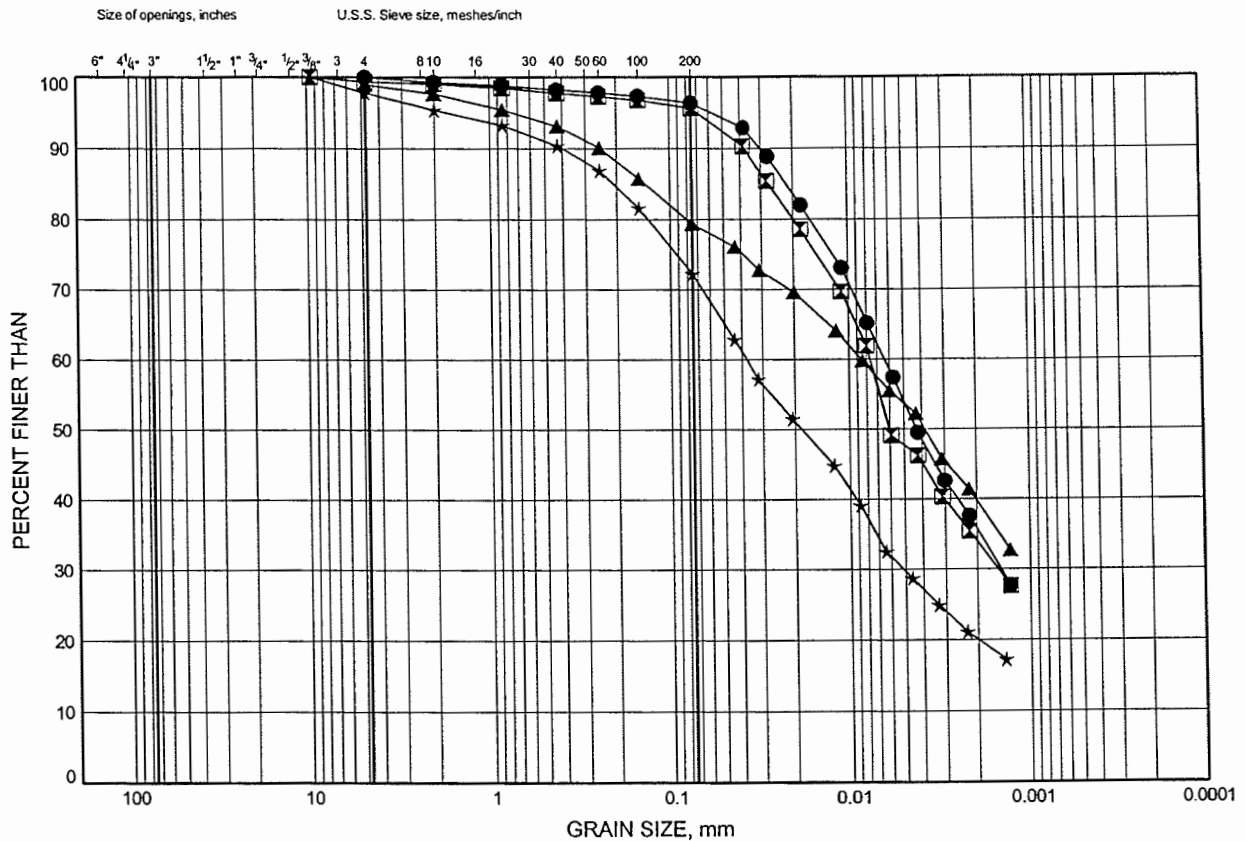
Appendix B

Laboratory Test Results

Highway 8 Widening Over Grand River GRAIN SIZE DISTRIBUTION

FIGURE B1

SILTY CLAY TO CLAYEY SILT TILL

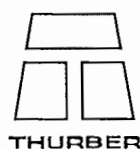


COBBLE SIZE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT and CLAY
	GRAVEL		SAND			FINE GRAINED

SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	06-10	7.92	275.86
⊠	06-12	10.97	273.22
▲	06-2	9.30	285.53
★	06-2	12.50	282.33

Date January 2007

Project 277-97-00



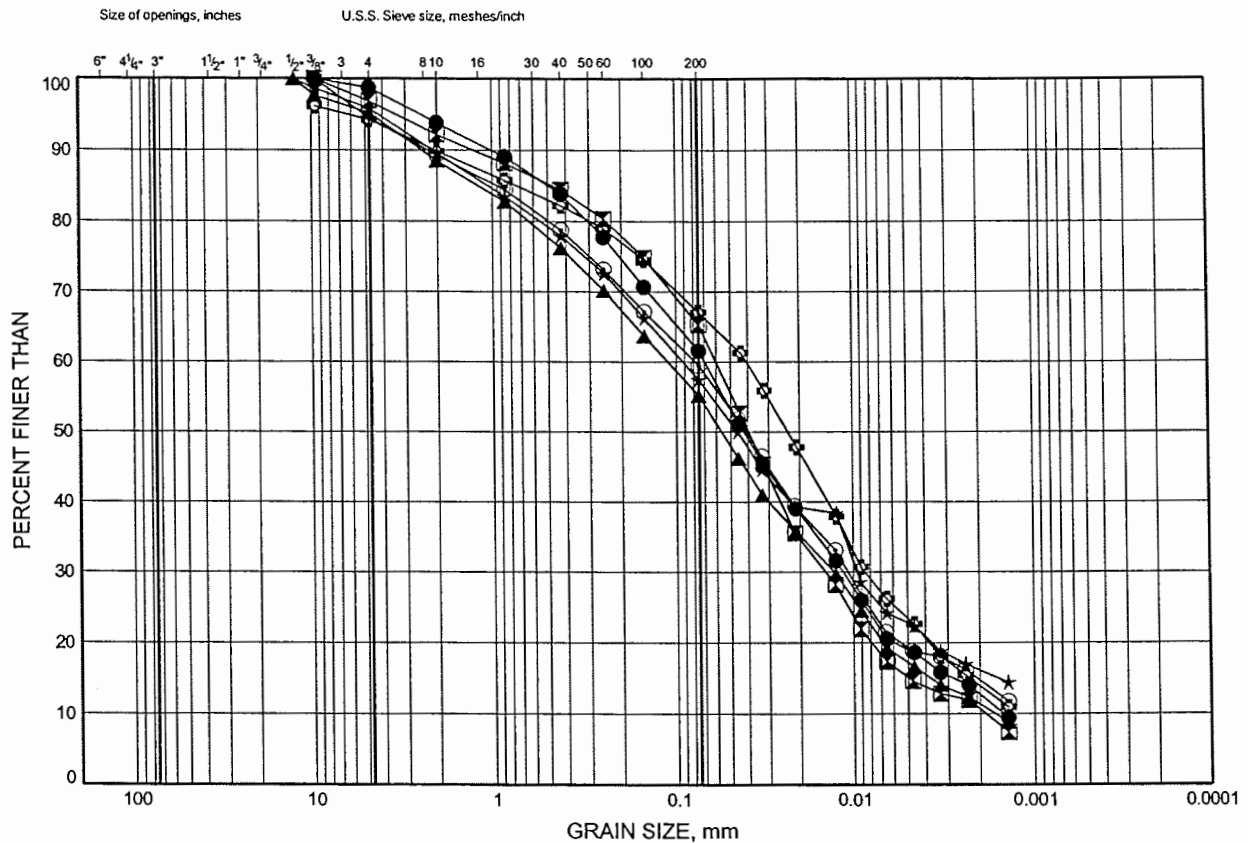
Prep'd JHL

Chkd. MEF

Highway 8 Widening Over Grand River GRAIN SIZE DISTRIBUTION

FIGURE B2

SANDY SILT TO SILT AND SAND TILL

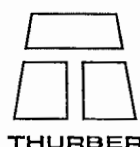


COBBLE SIZE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT and CLAY
	GRAVEL		SAND			FINE GRAINED

SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	06-11	4.88	279.63
⊠	06-12	6.22	277.97
▲	06-13	4.88	279.43
★	06-2	1.83	293.00
⊙	06-2	17.07	277.76
⊗	06-2	18.34	276.49

Date January 2007

Project 277-97-00



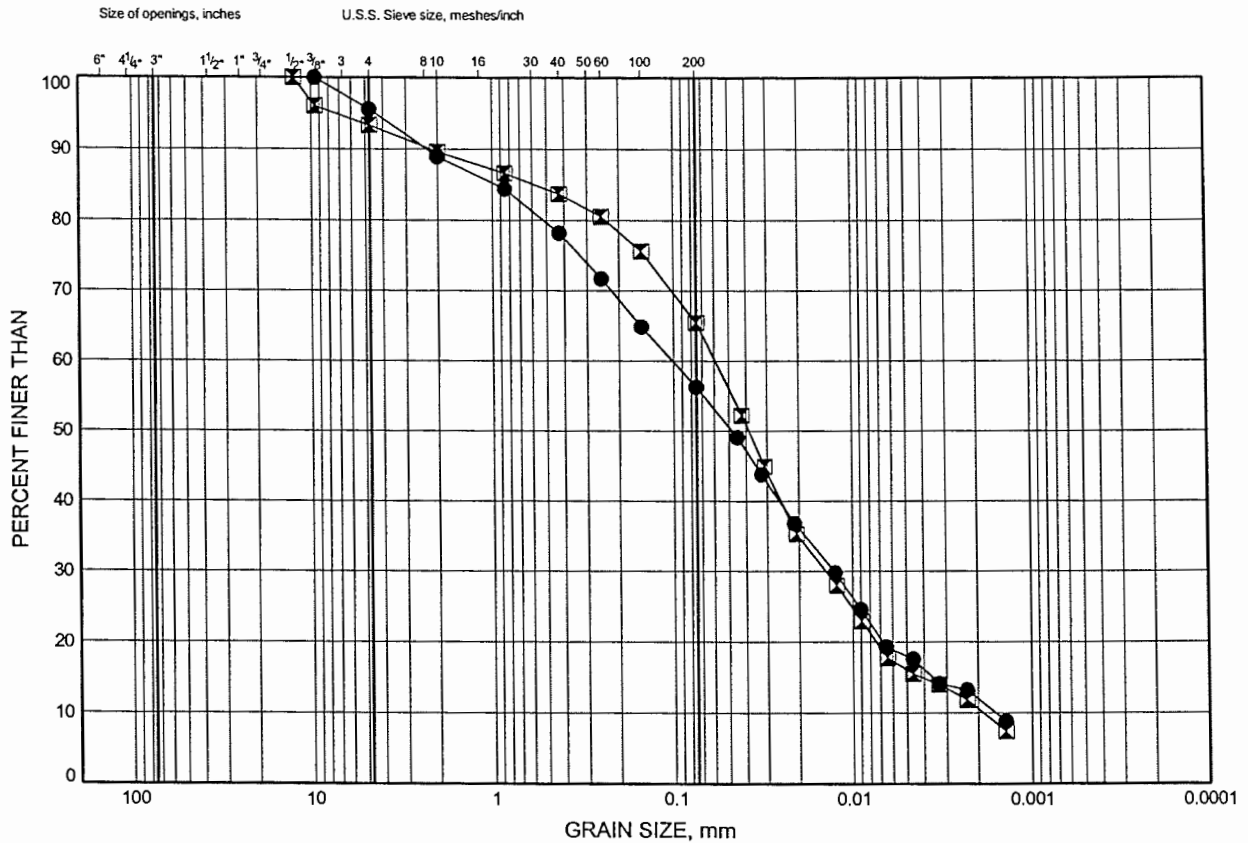
Prep'd JHL

Chkd. MEF

Highway 8 Widening Over Grand River GRAIN SIZE DISTRIBUTION

FIGURE B3

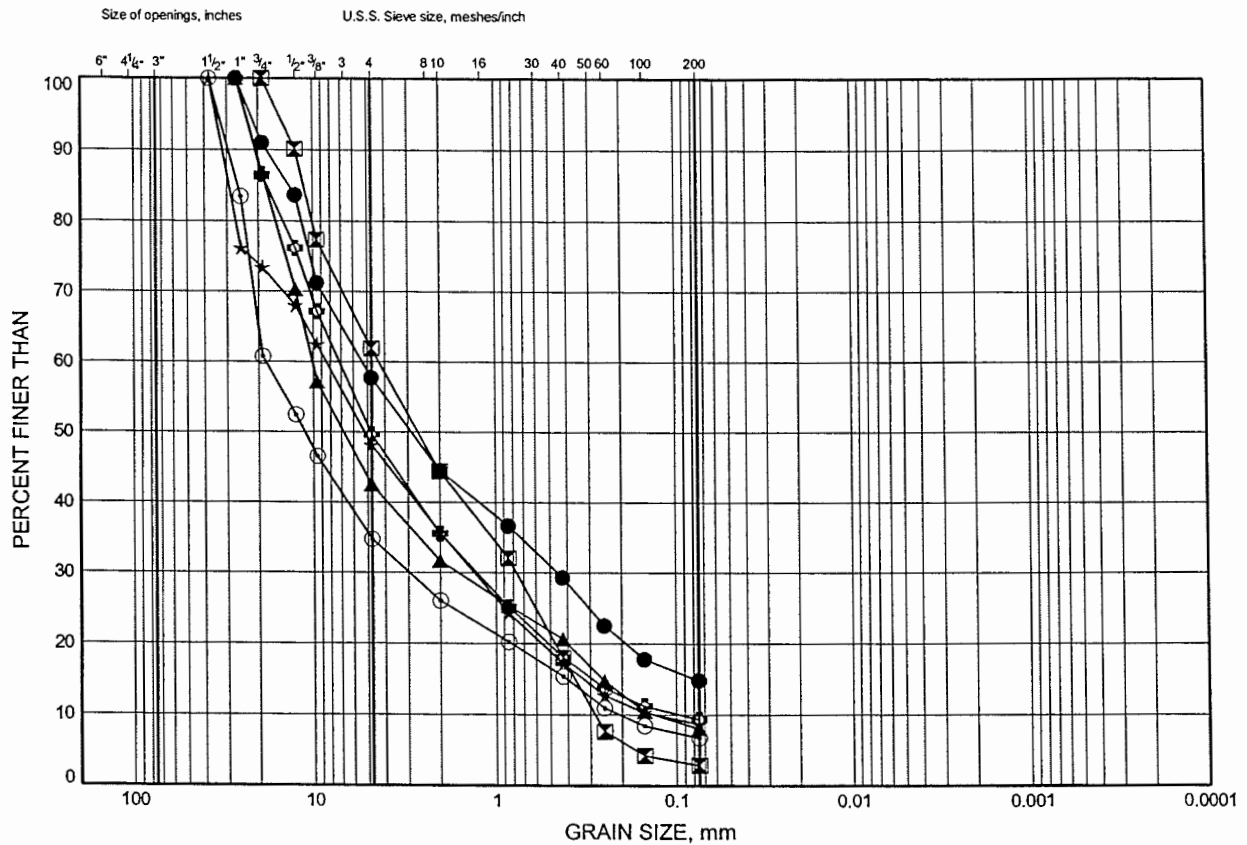
SANDY SILT TO SILT AND SAND TILL



Highway 8 Widening Over Grand River GRAIN SIZE DISTRIBUTION

FIGURE B4

SANDY GRAVEL TO GRAVELLY SAND

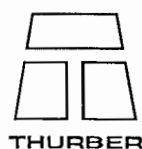


COBBLE SIZE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT and CLAY
	GRAVEL		SAND			FINE GRAINED

SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	06-7	6.22	277.13
⊠	06-7	9.19	274.16
▲	06-8	3.28	280.45
★	06-8	10.90	272.83
⊙	06-9	1.83	281.59
⊗	06-9	7.81	275.61

Date January 2007

Project 277-97-00



Prep'd JHL

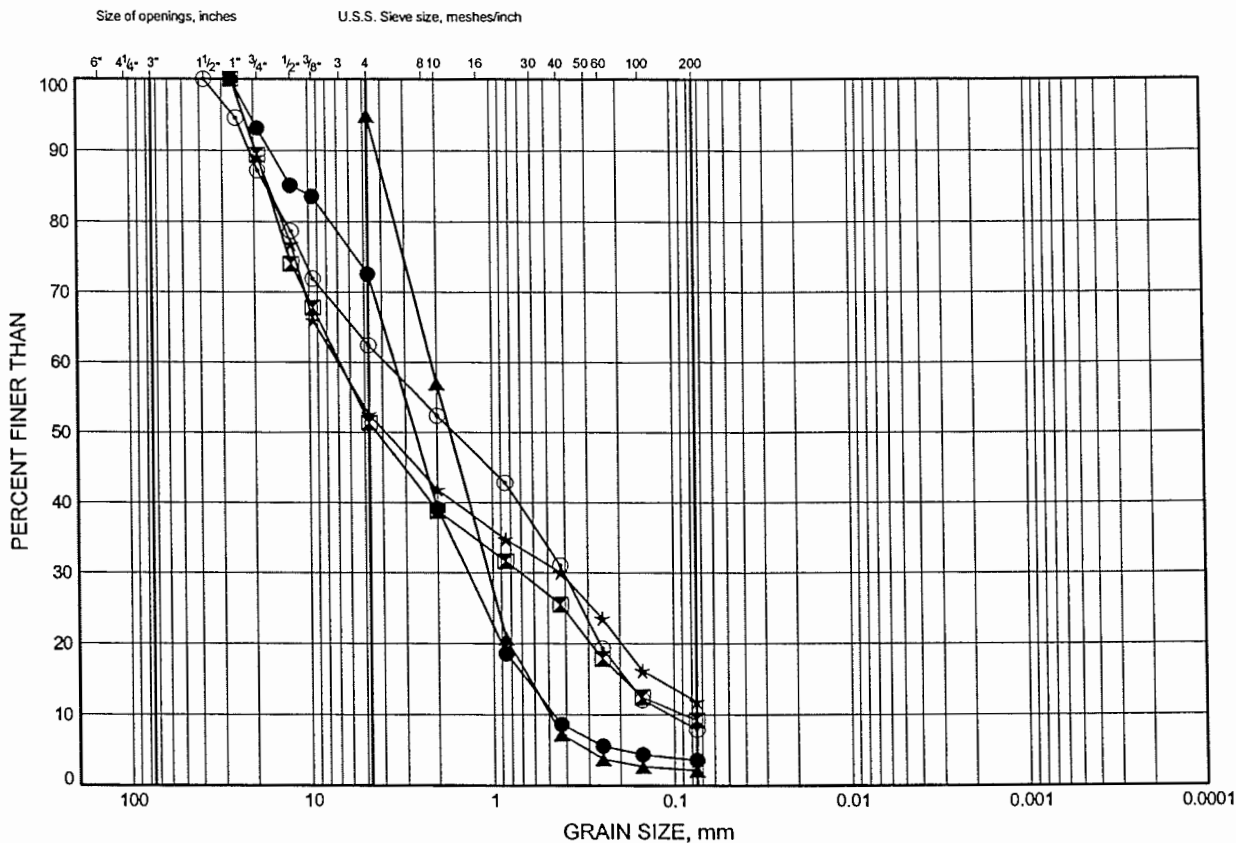
Chkd. MEF

Highway 8 Widening Over Grand River

GRAIN SIZE DISTRIBUTION

FIGURE B5

SANDY GRAVEL TO GRAVELLY SAND

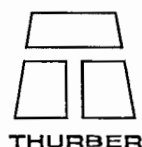


COBBLE SIZE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT and CLAY
	GRAVEL		SAND			FINE GRAINED

SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	06-10	12.04	271.75
◻	06-11	3.35	281.15
▲	06-11	13.82	270.69
★	06-12	3.18	281.02
⊙	06-13	2.51	281.80

Date January 2007

Project 277-97-00



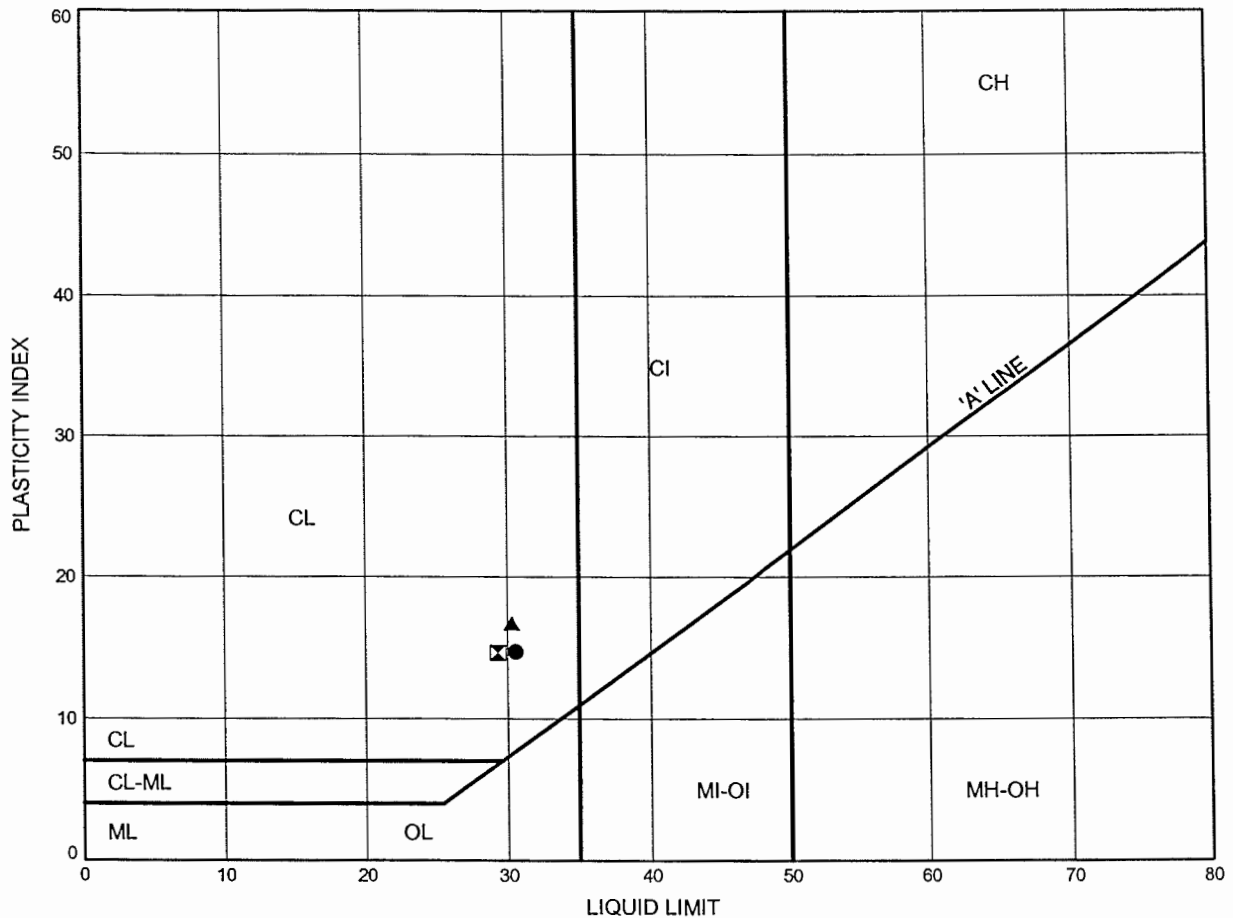
Prep'd JHL

Chkd. MEF

Highway 8 Widening Over Grand River
ATTERBERG LIMITS TEST RESULTS

FIGURE B6

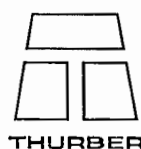
SILTY CLAY TILL



SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	06-10	7.92	275.86
⊠	06-12	10.97	273.22
▲	06-2	9.30	285.53

Date January 2007

Project 277-97-00



Prep'd JHL

Chkd. MEF

**TABLE B1 - Point Load Test Results
Highway 8 Widening over Grand River**

Depth			Is50	UCS (MPa)
feet	Inches	m		
06-5				
35	8	10.87	0.43	10.37
36	7	11.15	4.75	114.05
38	1	11.61	3.02	72.57
39	9	12.12	3.43	82.29
41	0	12.50	4.97	119.23
42	11	13.08	2.16	51.84

Total Rock Core			
Average	Minimum	Maximum	
75	10	119	MPa
Run #	Average		
1	69.82		
2	85.53		

Depth			Is50	UCS (MPa)
feet	Inches	m		
06-6				
36	11	11.25	0.97	23.33
38	6	11.73	2.92	69.98
41	7	12.67	1.73	41.47
43	3	13.18	3.24	77.76
53	4	16.26	1.68	40.43
54	4	16.56	1.94	46.66

Total Rock Core			
Average	Minimum	Maximum	
50	23	78	MPa
Run #	Average		
1	46.66		
2	41.47		
3	77.76		
5	43.54		

Depth			Is50	UCS (MPa)
feet	Inches	m		
06-8				
45	5	13.84	4.78	114.81
47	3	14.40	0.87	20.87
48	8	14.83	0.22	5.22
49	0.5	14.95	2.25	54.04
50	6	15.39	1.74	41.75
50	11	15.52	1.52	36.53
50	11	15.52	4.61	110.68
51	9	15.77	6.52	156.55
52	10	16.10	7.44	178.58

Total Rock Core			
Average	Minimum	Maximum	
80	5	179	MPa
Run #	Average		
1	48.73		
3	104.82		

Depth			Is50	UCS (MPa)
feet	Inches	m		
06-9				
39	7.5	12.08	6.09	146.12
41	6	12.65	2.61	62.62
42	11	13.08	2.61	62.62
42	11	13.08	1.99	47.74
43	1	13.13	1.33	31.92
45	1	13.74	2.72	65.23
46	9	14.25	1.09	26.09
50	7	15.42	1.52	36.53
52	2	15.90	2.39	57.40

Total Rock Core			
Average	Minimum	Maximum	
60	26	146	MPa
Run #	Average		
2	70.20		
3	45.66		
4	46.97		

Depth			Is50	UCS (MPa)
feet	Inches	m		
06-12				
48	10	14.88	3.03	72.80
50	9	15.47	1.300	31.20
52	9	16.08	5.136	123.26
53	9	16.38	4.334	104.01
55	2	16.81	6.661	159.86
56	3	17.15	5.634	135.21
56	3	17.15	7.029	168.70

Total Rock Core			
Average	Minimum	Maximum	
114	31	169	MPa
Run #	Average		
2	72.80		
3	86.16		
4	154.59		

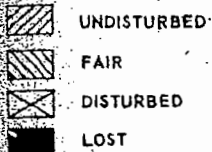
Appendix C

Factual Information from Previous Investigation for Existing Structure

e. m. peto associates, ltd.
SOIL ENGINEERING SERVICE - TORONTO, ONTARIO
BOREHOLE LOG

Job Name Proposed Hwy. #8 Crossing Job No. 58119 Borehole No. 2
Client Dept. of Highways of Ontario Casing BX Boring Date Oct. 14th - 16th, 1958
Datum D.H.O. Compiled By C.J.W. Checked By C.F.F.

SAMPLE CONDITION



SAMPLE TYPE

S.S. 2" STANDARD SPLIT TUBE SAMPLE
S.L. SPLIT BARREL WITH LINERS
S.T. THIN-WALLED SHELBY TUBE SAMPLE
W.S. WASH SAMPLE
R.C. ROCK CORE

ABBREVIATIONS

V.T. IN SITU VANE SHEAR TEST
Q/u UNCONFINED COMPRESSIVE STRENGTH
W.L. WATER LEVEL IN CASING
W.T. GROUND WATER TABLE IN SOIL

SOIL DESCRIPTION	COLOUR	Density or Consistency	Depth Elevation	Legend	Sample No. and Condition	Sample Type	No. of Blows per Ft	WATER LEVELS, SOIL MOISTURE & REMARKS
TOPSOIL 0'-0" TO 2'			0'-0" 925-19					
CRUSHED LIMESTONE AND GRAVEL, MATRIX OF SANDY TILL	GREY	VERY DENSE	2'-7" 922-6	1	SS	74		DUE TO STONE INTERFERENCE MOIST NAT. M.C. 9.3% W.L. AT 2'-7" ON 15 OCT. 58.
SANDY TILL WITH LIMESTONE FRAGMENTS	GREY	VERY DENSE	5'-0"	2	SS	145		MOIST NAT. M.C. 6.9%
SANDY TILL, GRITS AND PEBBLES	GREY			3	SS	68		MOIST NAT. M.C. 8.7%
AS ABOVE WITH GRAVEL	GREY	VERY DENSE	10'-0"	4	SS	48		MOIST NAT. M.C. 8.5% STIFFENS AT 12 FT
			14'-0" 911-19					DRILLED FROM 14'-0" TO 27'
MED COARSE SAND & GRAVEL IN MATRIX OF SANDY CLAY	OLIVE YELLOW	VERY DENSE	16'-8" 908-69	5	SS	135/10		HARD GOING FROM 14'-0" WET
			20'-0"					
LAYERLY SILT, GRITS, PEBBLES AND GRAVEL	BROWN	VERY DENSE		6	SS	123		WETTER THAN PLASTIC LIMIT
COARSE TO MED SAND WITH FINE GRAVEL	BROWN	VERY DENSE	25'-0"	7	WS	200/4 1/2		
			27'-0"					
AS ABOVE WITH BOULDERS								DIA DRILLED FROM 27' TO 37'
								FIRST RUN 27' TO 32' RECOVERED 10" THIS RUN CONSIDERED TO BE BOULDERS.
			32'-0" 893-19		BX CORE			SECOND RUN 32' TO 37' RECOVERED 77%
BANDED LIMESTONE	L. GREY	MED TO HRT HARDNESS APPROX. 4	37'-0" 888-19					
HOLE TERMINATED								WATER LEVEL DOWN AT 2" (WITH DEPTH OF HOLE 22'-3" BELOW
								THIS DEPTH WITH HOLE AT 37' ARTESIAN EFFECT NOTED AND WATER LEVEL ROSE TO ELEVATION 926-23

BOREHOLE LOG

Borehole No.3.....

Boring Date ..Oct., 18th-20th, 1958

Checked ByC.F.F.

ABBREVIATIONS

Y.T. IN SITU VANE SHEAR TEST

Q/u UNCONFINED COMPRESSIVE STRENGTH

W.L. WATER LEVEL IN CASING

W.T. GROUND WATER TABLE IN SOIL

R. C. ROCK CORE

FILE TERMINATED

BOREHOLE LOG

Checked By C. P. F.

W. T. GROUND WATER TABLE IN SOIL

SOIL DESCRIPTION	COLOR	Density or Consistency	Drpth Elevation	Legend	Sample No. and Condition	Sample Type	No. of Blows per Ft.	WATER LEVELS, SOIL MOISTURE & REMARKS
TOP SOIL			0-0					
SANDY LOAM WITH GRITS STONES AND ORGANIC MATTER,	DK BROWN	LOOSE	931-04		1 X	SS	6	SLIGHTLY MOIST UP TO 2" Φ
SILT, WITH DECOMPOSED SANDSTONE AND FRAGMENTS OF SCATTERED GRAVEL	YELLOWISH-BROWN	LOOSE			2 X	SS	6	SLIGHTY MOIST NAT M.C. 9.6%
SILT, SOME GRITS	YELLOWISH-BROWN	LOOSE			3 X	SS	5	MOIST. NAT M.C. 22.4% CHANGE OCCURS AT 7'-8"
SILT CHANGING TO MED. SAND AND GRITS	LT. YELLOWISH-BROWN TO V PALE BROWN	LOOSE	WL 8'-1" 922-96A		4 X	SS	3	WET. NAT. M.C. 22.4% STONE CONT. INCREASES AT 9'- STONE INTERFERENCE
SILTY COARSE SAND, GRITS & PEBBLES.		DENSE	12'-0"		5 X	SS	42	SATURATED M.C. 8.8% WATER IN CASING AT 12'-0"
SANDY TILL WITH GRITS AND PEBBLES	LT. YELLOWISH-BROWN	VERY DENSE	919-04		6 X	SS	109	MOIST. NAT M.C. 8.2%
SANDY TILL WITH GRITS AND PEBBLES	GREY	VERY DENSE	15'-0"		7 X	SS	113	MOIST NAT. M.C. 7.5% WASH WATER USED FROM 20'-0"
VERY SILTY COARSE SAND FINE GRAVEL GRITS AND PEBBLES	LT. YELLOWISH-BROWN		20'-0" 911-04		8 X	SS	200/4	SATURATED BOUNDERS FROM 20' TO 22'-0"
COARSE SAND, FINE GRAVEL GRITS & PEBBLES IN MATRIX OF SANDY TILL	YELLOWISH-BROWN	VERY DENSE	25'-0"		9 X	SS	75	SATURATED
MATRIX OF SANDY TILL WITH GRITS & PEBBLES	GREY MOTTLED BROWN	VER DENSE	30'-0"		10 X	SS	169	WET STONE IN SAMPLER TIP
MATRIX OF SANDY TILL WITH GRITS & PEBBLES	LT. YELLOWISH MOTTLED BROWN	VERY DENSE	35'-0"		11 X	SS	61	WET
AS ABOVE CHANGING TO FINE SANDY SILT	LT. YELLOWISH-BROWN	VERY DENSE	41'-0" 890-04		12 X	SS	89	WET HOLE TERMINATED

SOIL ENGINEERING SERVICE - TORONTO, ONTARIO





Job Name Proposed Hwy. #8 Crossing Job No. 58119
Grand River
 Client Dept. of Highways of Ontario Casing BX
 Datum D.H.O. Compiled By C.J.W.

SOIL DESCRIPTION	COLOUR	Density or Consistency	Depth Elevation	Legend	Sample No. and Condition	Sample Type	No. of Blows per Ft.	WATER LEVELS, SOIL MOISTURE & REMARKS
TOP SOIL 0'-0" TO 11"	BROWN		0-0 930-03		1 X SS			
GILTY MED-FINE SAND SOME ROOTS	STRONG BROWN	LOOSE			2 X SS		6	SLIGHTLY MOIST NAT. MC. 7.9%
S. / MED-FINE SAND, GRITS AND SCATTERED GRAVEL	PALE BROWN	LOOSE	5'-0" WL 6-11 928-16		3 X SS		9	MOIST NAT N = 11.6% GRAVEL CONT. INCREASED 6' - 2'
SILTY COARSE SAND MANY GRITS & PEBBLES	YELLOWISH BROWN	DENSE			4 X SS		34	WET NAT. MC. 8.9%
AS ABOVE CHANGING TO SILTY MED-FINE SAND, GRITS PEBBLES & OCC. GRAVEL.	DK YELLOWISH BROWN	VERY DENSE	10'-10" 919-19		5 X SS		103	VERYSOFT NAT M.C. 7.8% WASH WATER USED FROM 12'-0"
SANDY TILL	LT GREY	VERY DENSE			6 X SS		134	MOIST NAT M.C. 7.6%
AS ABOVE		VERY DENSE	15'-0" 917-03		7 X SS		101	MOIST VERY HARD AT 17'-0" BOULDERS AND GRAVEL
CLAYEY AND SILTY FINE TO MED. SAND GRITS & PEBBLES	GREY BROWN	VERY DENSE	20'-0"		8 X SS		78	QUITE MOIST
			25'-0"		9 X SS		54	QUITE MOIST
SILTY FINE TO COARSE SAND AND ANGULAR GRAVEL	PL. BROWN	VERY DENSE			10 X SS		90/40	26' TO 30' GRAVEL AND BOULDER VERY HARD GOING LOST WASH WATER AT 29'-0" QUITE MOIST WASH WATER RETURNED 31'-2" DRILLED FROM 31' TO 35' BOULDER IS AT 32' AND 33'-6"
AS ABOVE	PALE GREY BROWN	VERY DENSE	30'-0"		11 X SS		81	WET
COARSE WITH SOME MED SAND AND GRAVEL	PALE GREY BROWN	VERY DENSE	35'-0"		12 X SS		67	WET
SILTY COARSE TO FINE SAND AND GRAVEL	PALE GREY BROWN	VERY DENSE	38'-0" 892-03		13 X SS			HOLE TERMINATED WATER LEVEL 923-11

e. m. peto associates ltd.
SOIL ENGINEERING SERVICE - TORONTO, ONTARIO
BOREHOLE LOG

Job Name Proposed Hwy #8 Crossing Job No. 59119
Client Dept. of Highways of Ontario Grand River Casing BX
Datum D.H.O. Compiled By C.J.W.

Borehole No. 9
Boring Date Oct. 6th - 11th, 1958
Checked By C.F.F.

SAMPLE CONDITION
 UNDISTURBED
 FAIR
 DISTURBED
 LOST

SAMPLE TYPE
S.S. 2" STANDARD SPLIT TUBE SAMPLE
S.L. SPLIT BARREL WITH LINERS
S.T. THIN-WALLED SHELBY TUBE SAMPLE
W.S. WASH SAMPLE
R.C. ROCK CORE

ABBREVIATIONS
V.T. IN SITU VANE SHEAR TEST
Q/u UNCONFINED COMPRESSIVE STRENGTH
W.L. WATER LEVEL IN CASING
W.T. GROUND WATER TABLE IN SOIL

SOIL DESCRIPTION	COLOUR	Density or Consistency	Depth Elevation	Legend	Sample No. and Condition	Sample Type	No. of Blows per Ft	WATER LEVELS, SOIL MOISTURE & REMARKS
GRAVEL, PEBBLES, MUD, WATER			0-0' 922.20					RIVER LEVEL 922.45 ON 6 TH OCT 58 DEPTH OF WATER 3"
SILTY FINE & COARSE SAND AND GRAVEL	PALE GREY BROWN	COMPACT TO DENSE	5-0'		1	SS	28	WET NAT. MC. 15.6%
SILTY VERY FINE SAND GRITS AND PEBBLES	PL. BROWNISH GREY	VERY DENSE			2	SS	91	MOIST, NAT. MC. 8.0%
FINE TO MED. SAND GRITS AND PEBBLES	GREY	VERY DENSE			3	SS	93	MOIST NAT. MC. 7.7%
AS ABOVE	GREY	VERY DENSE			4	WS	160/4 1/2	10'-0" B. H. LOG 2 DRILLED 11'-2" TO 15'-3" DRILLED THROUGH BOULDERS & STONES
SAND & GRITS	GREY		15-0'					
SANDY TILL AND GRAVEL	YELLOWISH BROWN	VERY DENSE	16-9' 905.45		6	SS	150	17'-9" TO 22' DRILLED THROUGH WET. BOULDERS AND STONES
SILTY COARSE SAND WITH FINE TO ME GRAVEL	GREY	VERY DENSE	22-0' 900.20		7	SS	58	WET, 23'-0" TO 27' & 28' TO 33'-3" DRILLED THROUGH BOULDERS AND STONES LOST WASH WATER 24' TO 28'
AS ABOVE	GREY	VERY DENSE	25-0'		8	SS	112	WET
VERY FINE SANDY SILT	LIGHT YELLOWISH BROWN	VERY DENSE	30-11' 888.95		9	WS		VERY STIFF AT 29'-0" PROBABLY LAYER OF BOULDERS, TO 33'-3" 33'-5" TO 38'-3" DIA. DRILLING 48% RECOVERY
BANDED LIMESTONE	LT. GREY					BX CORE		SECTIONS OF BOTH C-REFS BARELY PITTED BY WATER ACTION
			43-3' 878.95					38'-4" TO 43'-3" 54% RECOVERY ARTESIAN EFFECT NOTED AS FOLLOWS FROM 22' WATER LEVEL ROSE IN CASING TO EL. 922.42 HOLE TERMINATED FROM 23' WATER LEVEL ROSE TO 923.20 WITH HOLE FROM 43'-3" WATER ROSE IN CASING FROM 927.26 TO 927.53

BOREHOLE LOG

Checked By C.F.F.

HOLE TERMINATED

e. m. peto associa... ltd.

SOIL ENGINEERING SERVICE .. TORONTO, ONTARIO

BOREHOLE LOG

Job Name Proposed Hwy. #8 Crossing Job No. 58119

Job Name: Grand River Job No. 20447

Client Dept. of Highways of Ontario Casing BX

Docum D.H.O. Compiled By C.J.W.

Borehole No. 12

Boring Date Oct. 14th - 20th, 1958

Checked By C.F.F.

SAMPLE CONDITION


SAMPLE TYPE

ABBREVIATIONS

 UNDISTURBED

S.S. 2" STANDARD SPLIT TUBE SAMPLE

V. T. IN SITU VANE SHEAR TEST

 FAIR

S.L. SPLIT BARREL WITH LINERS

Q/w UNCONFINED COMPRESSIVE STRENGTH

☒ DISTURBED

S. T. THIN-WALLED SHELBY TUBE SAMPLE

W.L. WATER LEVEL IN CASING

LOST

W.S. WASH SAMPLE

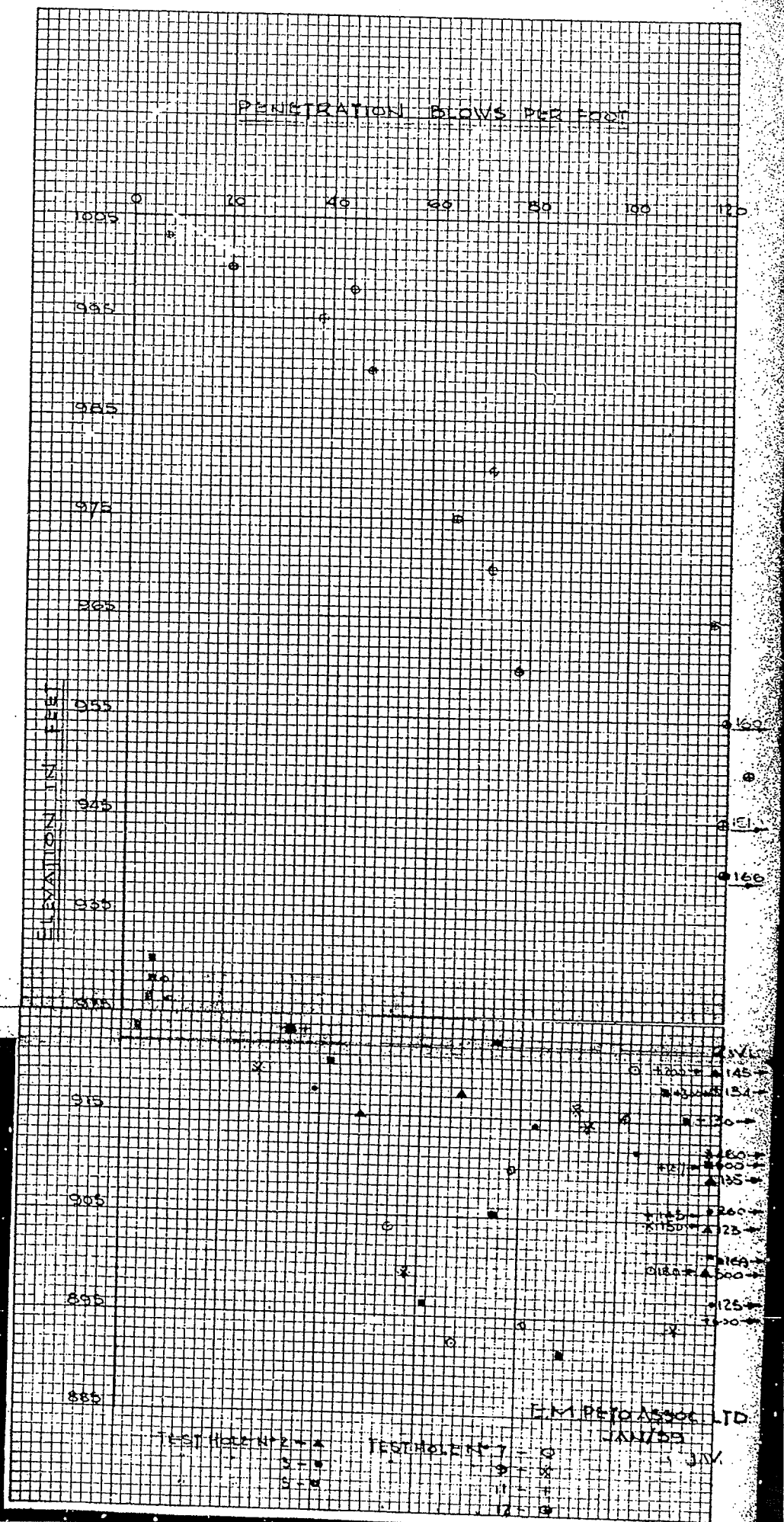
W. T. GROUND WATER TABLE IN SOIL

R. C. ROCK CORE

1. *Journal of the American Medical Association*, 1997; 277: 1001-1005.

SOIL DESCRIPTION	COLOR	Texture or Consistency	Depth Feet-Inch	Liquid Limit	Shrinkage and Consolidation	Sample Type	No. of Blows per Ft.	WATER LEVEL, SOIL MOISTURE & REMARKS
			0-0 100543					
SLIGHTLY SILTY MED.FINE SAND WITH BROKEN LIMESTONE FRAGMENTS	BROWN	LOOSE				1	S.S. 7	SLIGHTLY MOIST
AS ABOVE		COMPACT	5-0			2	S.S. 20	SLIGHTLY MOIST
SILTY MED-FINE SAND WITH A SEAM OF YELLOWISH-BROWN SANDY LOAM.	BROWN	DENSE				3	SS 44	SLIGHTLY MOIST. SOME ROOT IN SAMPLE
MED FINE SAND GRITS & PEBBLES PACKETS OF SILTY FINE SAND	PALE BROWN	DENSE	10-0 993-43			4	SS 38	MOIST NAT.M.C. 6.3%
			15-0					
SANDY CLAY WITH LIMESTONE FRAGMENTS GRITS & PEBBLES	BROWN	DENSE				5	S.S. 4A	FAIRLY MOIST.NAT.M.C. 8.8%
			19-0 986-45					
SANDY TILL GRITS AND PEBBLES	GREY	VERY DENSE				6	S.S. 136	FAIRLY MOIST
			24-0 981-43					
SILTY CLAY	DARK GREY-BROWN	VHARD				7	S.S. 72	SHEAR STRENGTH>2000 LBS./SQ FT. DRIER THAN PLASTIC LIMIT MOIST CONTENT 18.8%
			30-0					
AS ABOVE		V.HARD				8	SS 65	SHEAR STRENGTH>2000 LBS./SQ FT. DRIER THAN PLASTIC LIMIT MOIST. CONTENT 18.5%
			35-0					
AS ABOVE		V.HARD				9	SS 72	DRIER THAN PLASTIC LIMIT MOIST CONTENT 18.9%
			40-0 965-43					
AS ABOVE WITH GRITS AND PEBBLES		V.HARD				10	SS 117	DUE TO STONE INTERFERENCE MOISTURE AT PLASTIC LIMIT
			43-0 962-43					
			45-0					
SILTY FINE SAND WITH LIMESTONE & GRAVEL	GREY	VERY DENSE				11	SS 78	WET.
			50-0					
COARSE TO MED SAND AND FINE GRAVEL	BROWN	VERY DENSE				12	WASH SAMPLE 160	
			55-0					WITH 5' OF WATER AT 55 AND HOLE 55 DEEP LASTED WATER OVERNIGHT
SILTY FINE SAND WITH COARSE TO FINE GRAVEL UP TO 1 1/2"	GREY	VERY DENSE				13	SS 125	WET
			60-0 947-43					
			66-0					
SANDY TILL GRITS AND PEBBLES	GREY	VERY DENSE				14	SS 151	MOIST NAT M.C. 8.7%
			70-0 935-43					
AS ABOVE	GREY	VERY DENSE				15	SS 166	MOIST NAT M.C. 8.5%
			75-0 935-43					
			TO -0					FREE WATER LEVEL OBSERVED AT THIS LEVEL HOLE TERMINATED ON BOULDERS

K.M.
KCHLER & SERRI CO.
10 X 10.10 LINE INCH
330-20



e. m. peto associates ltd. SOIL TESTING LABORATORY

LIQUID LIMIT TEST

FLOW LINE CHARTS

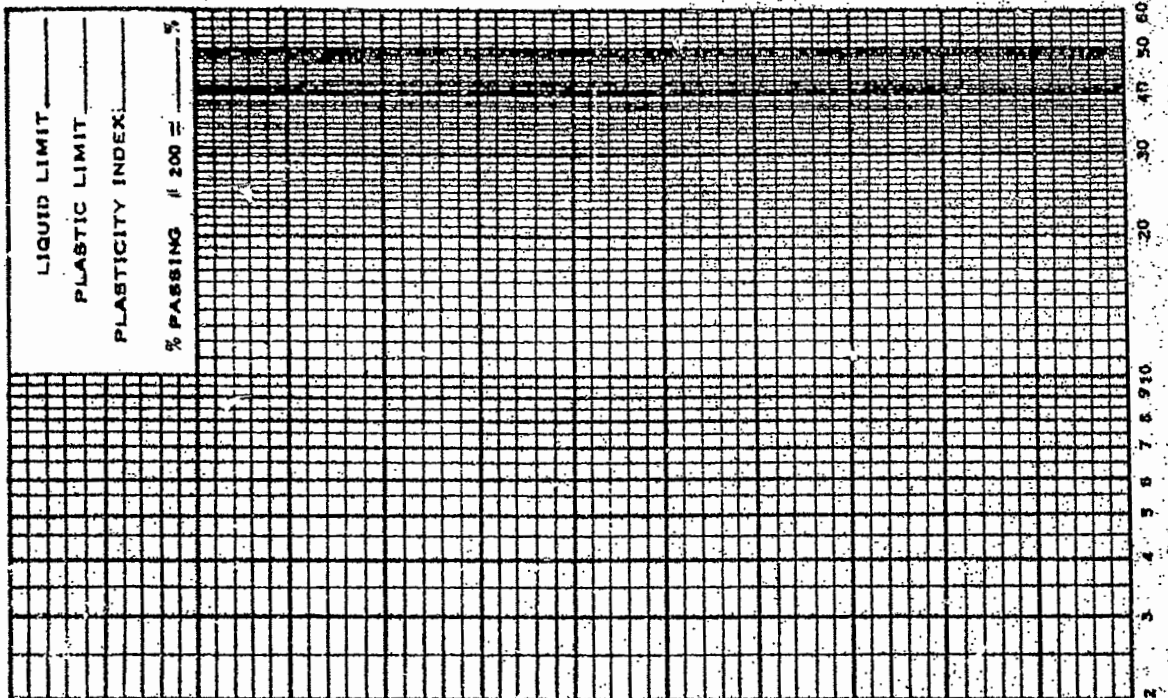
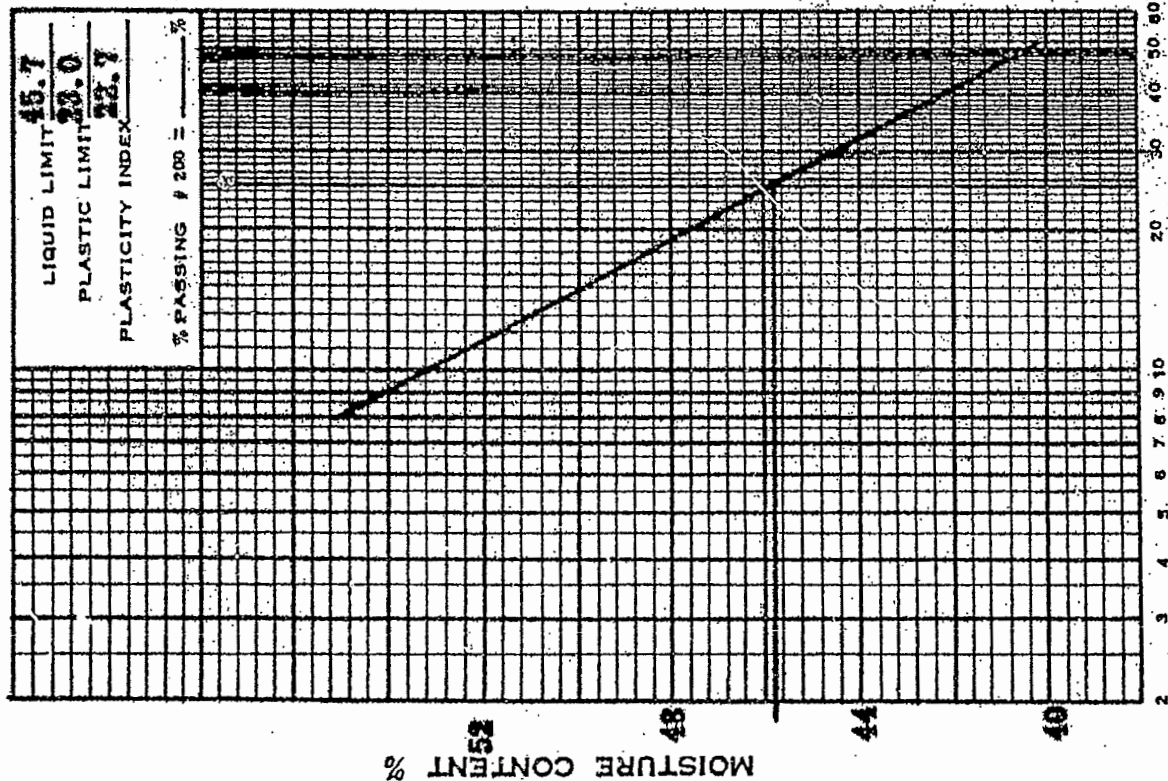
JOB No. **56119** PROJECT **Proposed Hw. & Grand River Crossing**
B.H. 12 Sample 8

SAMPLE FROM _____

SAMPLE FROM _____

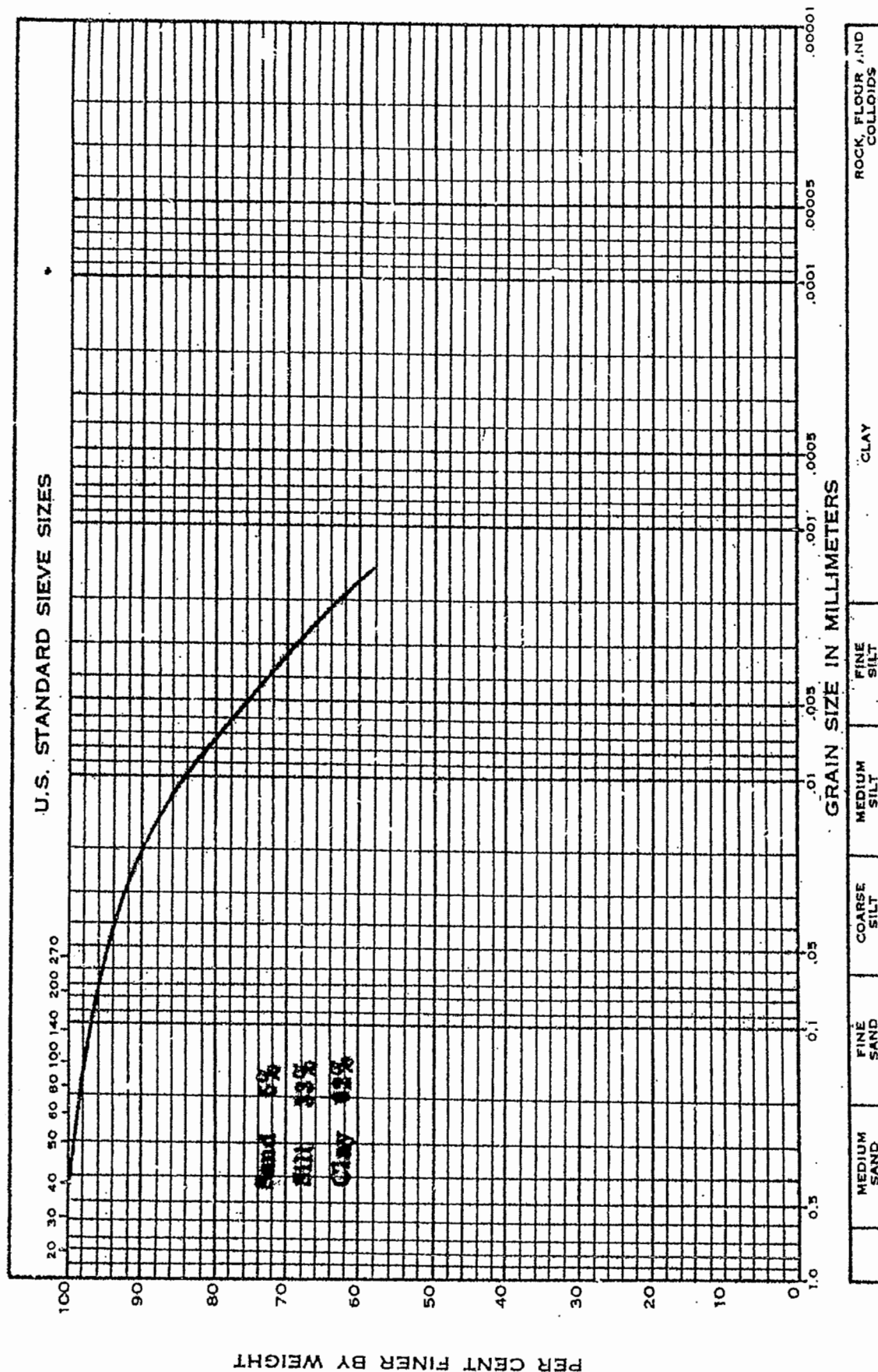
DEPTH **50'-31"**

DEPTH _____



NO. OF BLOWS (LOG SCALE)

E. M. PETO ASSOCIATES LTD.
HYDROMETER GRAIN SIZE DISTRIBUTION DIAGRAM

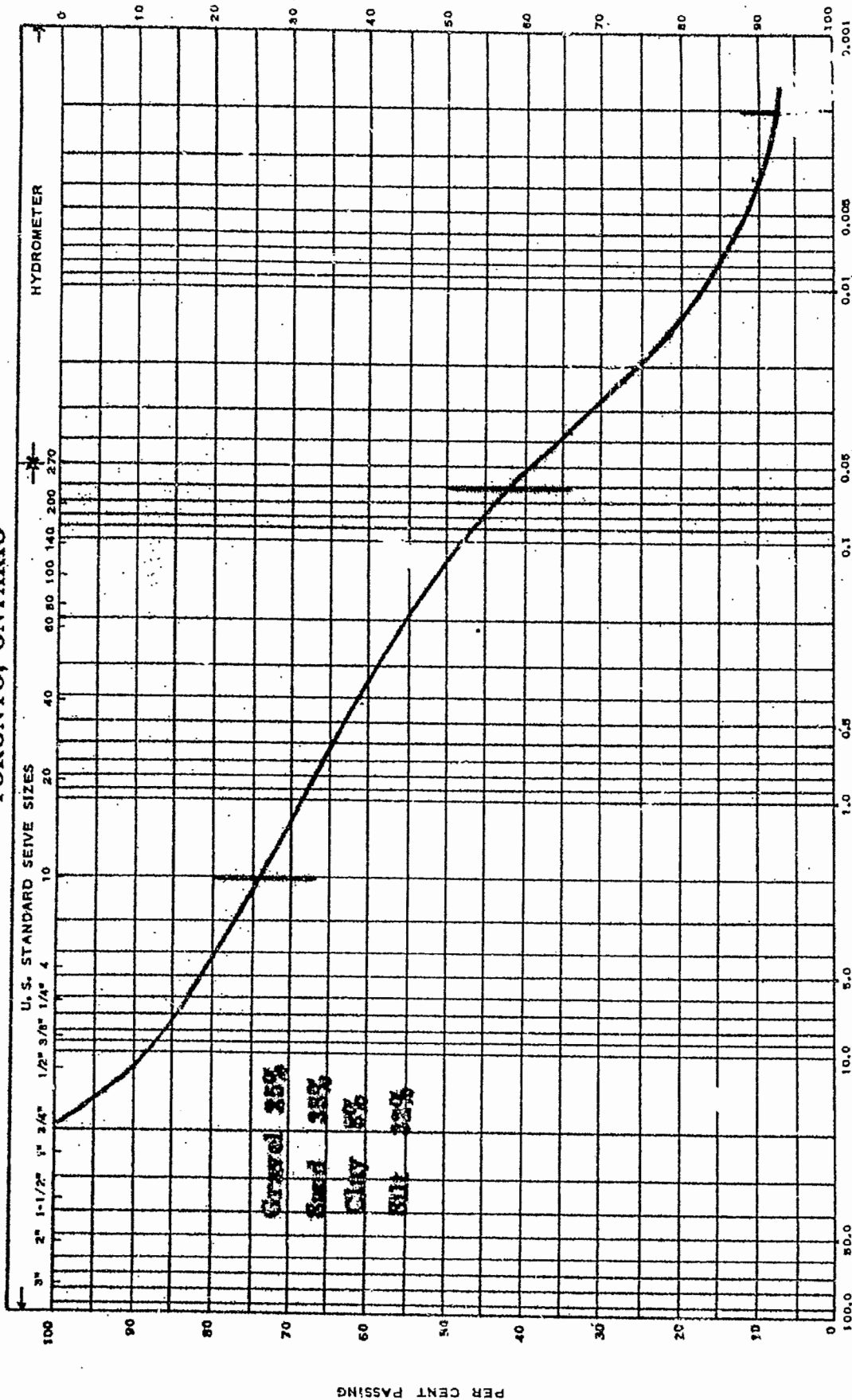


M.I.T. CLASSIFICATION

JOB NAME Proposed Hwy. 3 Grand River Crossing BOREHOLE No. 12 SAMPLE No. 8

DEPTH 30'-31' ELEVATION _____ REMARKS Dark gray brown silty clay

e. m. peto associates ltd.
TORONTO, ONTARIO



STONES	GRAVEL	COARSE SAND	MED. SAND	FINE SAND	COARSE SILT	MED. SILT	FINE SILT	CLAY

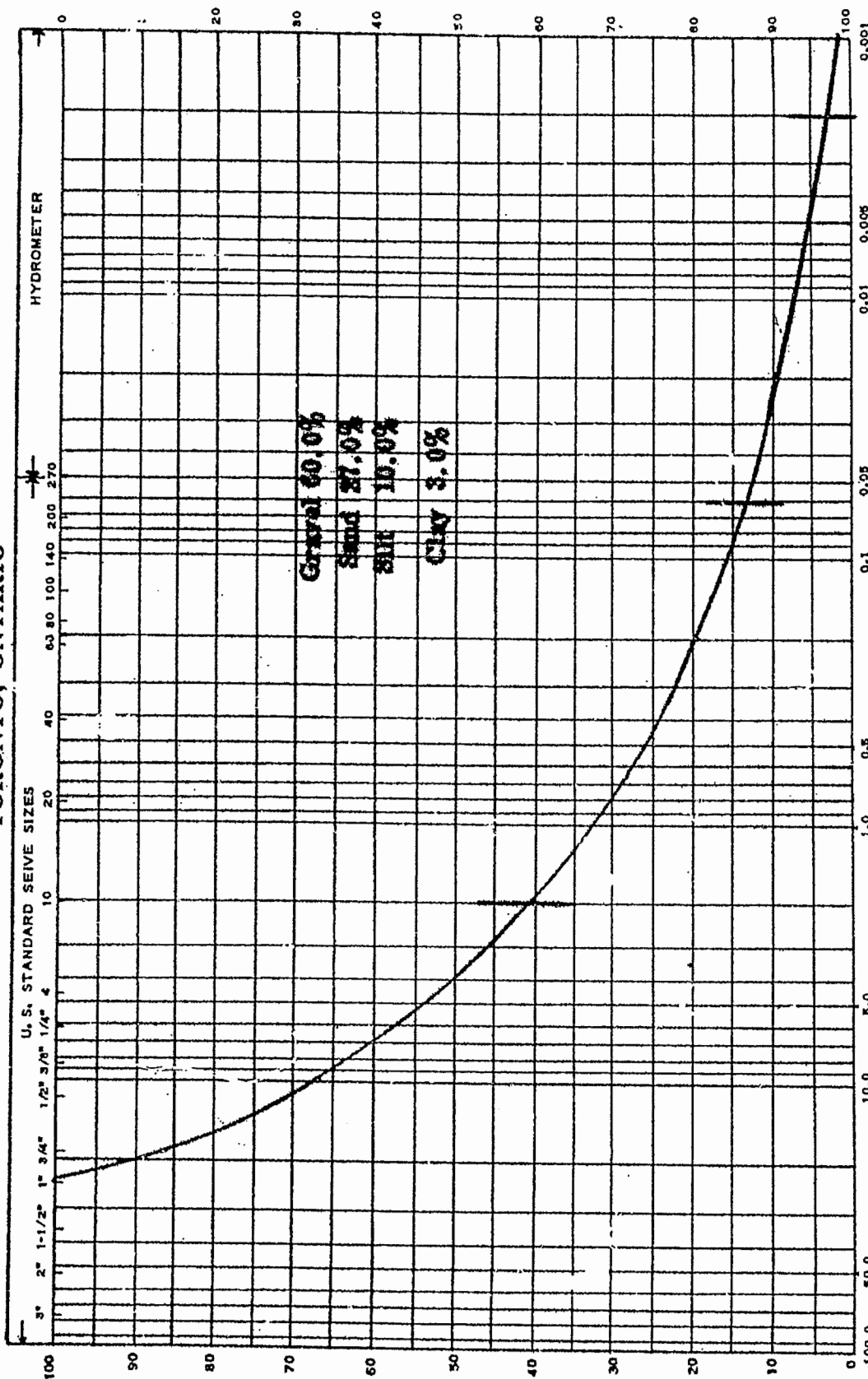
MASS. INST. OF TECH. CLASSIFICATION

JOB NAME Deepened Hwy. 8 Grand River Crossing - 58119 HOLE NO. 5 SAMPLE NO. 8

DEPTH 12'-13' ELEVATION _____ REMARKS Sandy fill

GRAIN SIZE DISTRIBUTION

e. m. peto associates ltd.
TORONTO, ONTARIO



STONES	GRAVEL	COARSE SAND	MED. SAND	FINE SAND	COARSE SILT	MED. SILT	FINE SILT	CLAY
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MASS. INST. OF TECH. CLASSIFICATION

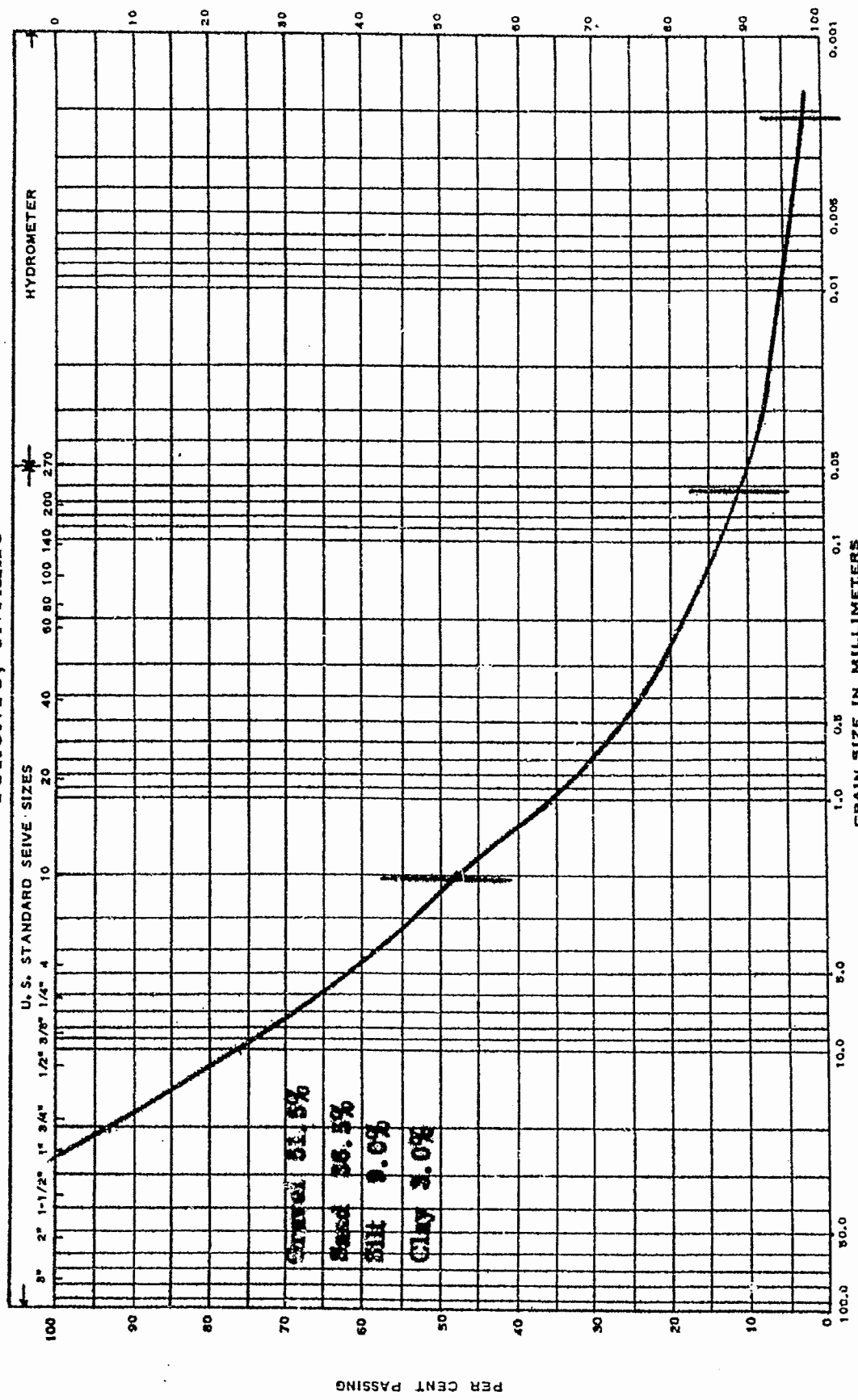
JOB NAME Proposed Hwy. 8 Grand River Crossing HOLE NO. 5 SAMPLE NO. 9

DEPTH 25'-26' ELEVATION

REMARKS

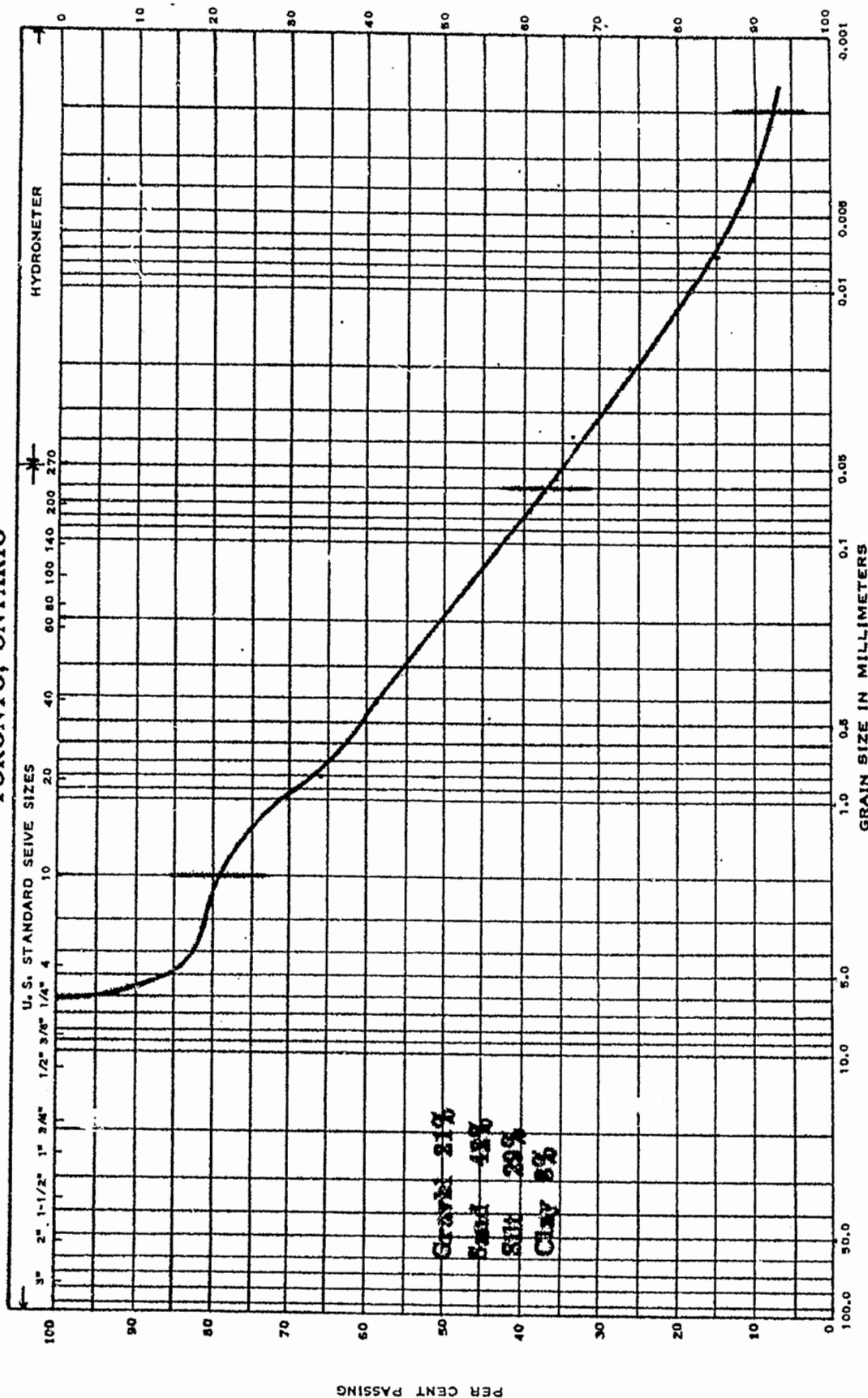
GRAIN SIZE DISTRIBUTION

e. m. peto associates ltd. TORONTO, ONTARIO

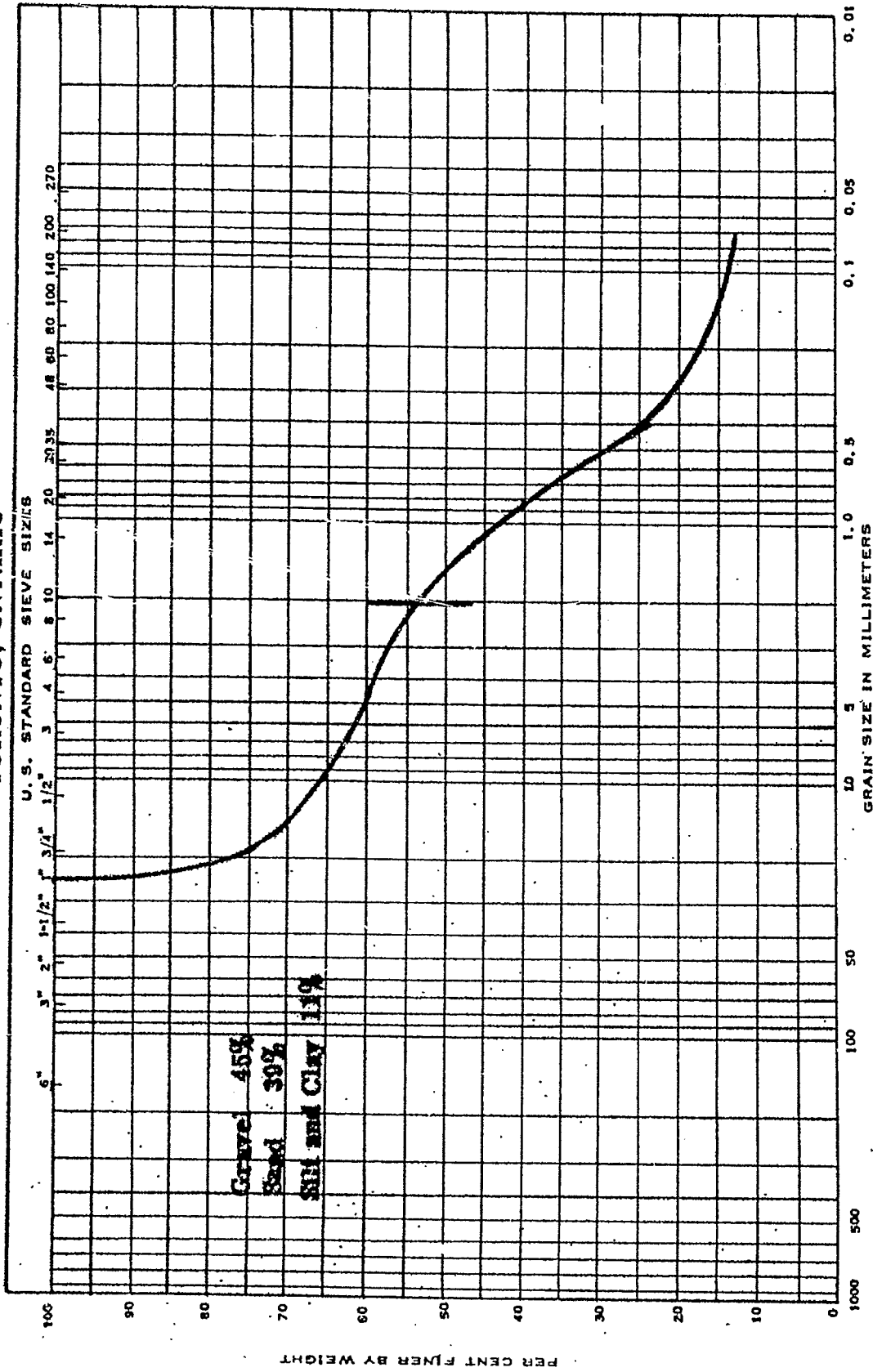


STONES	GRAVEL	COARSE SAND	MED. SAND	FINE SAND	COARSE SILT	MED. SILT	FINE SILT	CLAY
<p>Proposed Hwy. 8 Grand River Crossing 50119</p> <p>JOB NAME 35'-56' HOLE NO. 5 SAMPLE NO. 11</p> <p>REMARKS: slightly silty sandy gravel</p> <p>DEPTH _____ ELEVATION _____</p> <p>GRAIN SIZE DISTRIBUTION</p>								

e. m. peto associates ltd.
TORONTO, ONTARIO



e. m. peto associates ltd.
TORONTO, ONTARIO



BOULDERS	STONES	GRAVEL	COARSE SAND	MED. SAND	FINE SAND	COARSE SILT	MED. SILT

MASS. INST. OF TECH. CLASSIFICATION

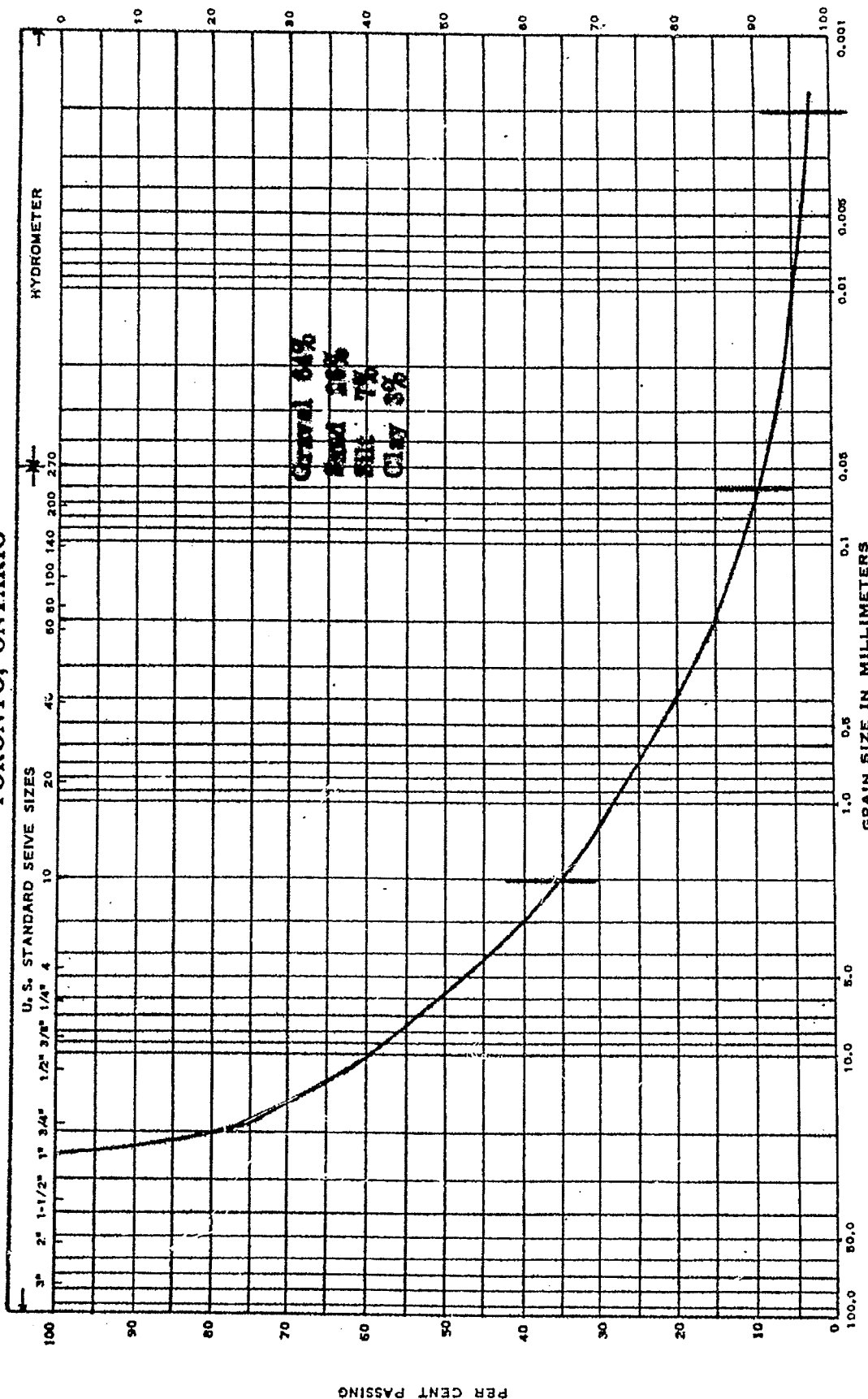
JOB NAME Proposed Hwy. 2 Grand River Crossing 58119

HOLE NO. 7 SAMPLE NO. 8

DEPTH	ELEVATION	REMARKS
20'-21'		Sandy gravel

GRAIN SIZE DISTRIBUTION DIAGRAM COARSE MATERIALS

e. m. peto associates ltd.
TORONTO, ONTARIO

[illegible]

JOB NAME Proposed Hwy. 8 Grand River Crossing 58119
HOLE NO. 7 SAMPLE NO. 9

DATE	DEPTH	ELEVATION	REMARKS
9-27-24	20		Slightly silty sandy gravel

GRAIN SIZE DISTRIBUTION

U. S. STANDARD SIEVE SIZES

GRAIN SIZE IN MILLIMETERS

PER CENT FINER BY WEIGHT

Coarse 72.0%
Sand 33.0%
Silt and Clay 5.0%

MASS. INST. OF TECH. CLASSIFICATION

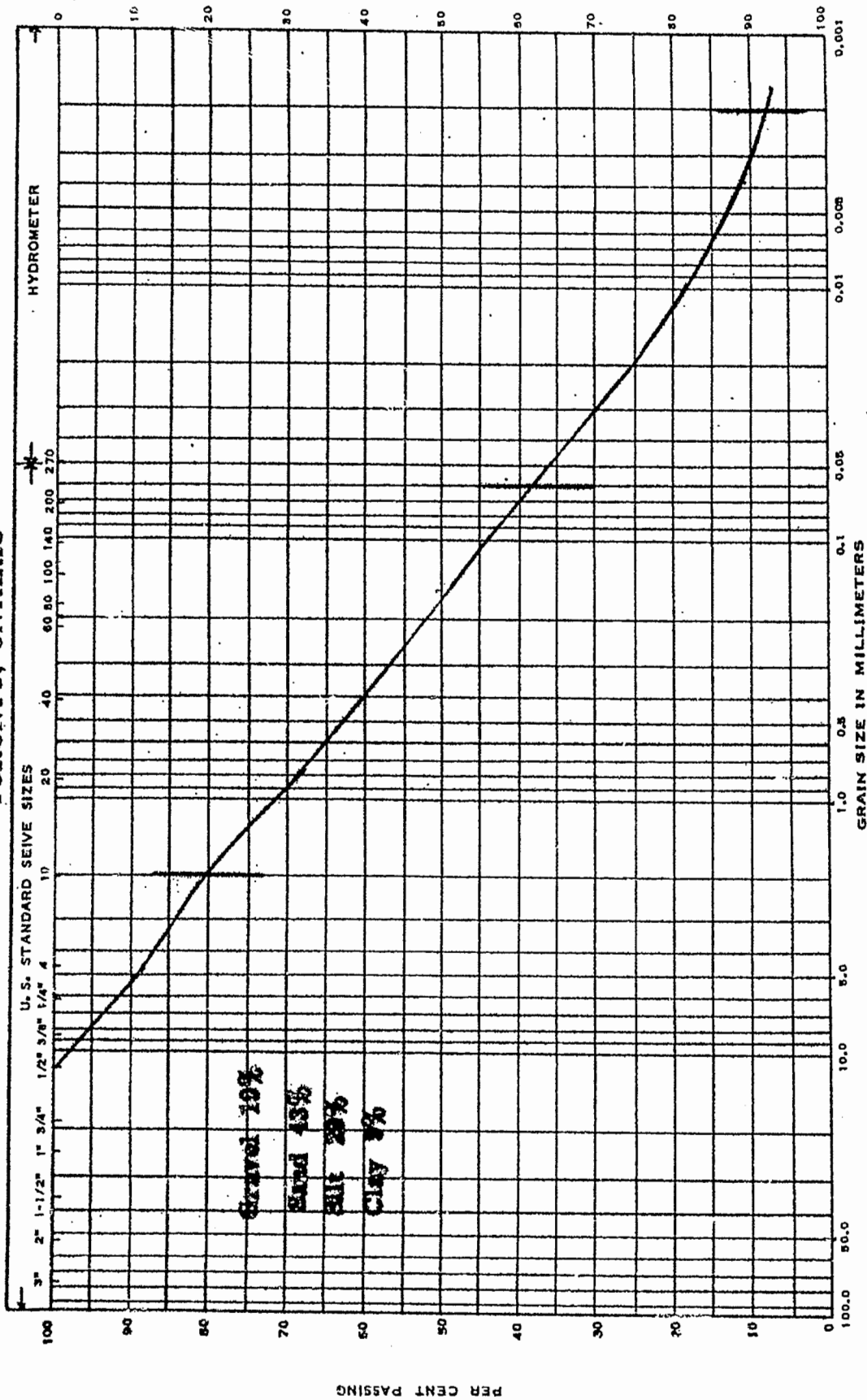
Proposed Hwy. 8 Grand River Crossing 13119

HOLE NO. 7 SAMPLE NO. 11

DEPTH	ELEVATION	REMARKS
15-50		Sandy gravel

GRAIN SIZE DISTRIBUTION DIAGRAM COARSE MATERIALS

e. m. peto associates ltd. TORONTO, ONTARIO



STONES	GRAVEL	COARSE SAND	MED. SAND	FINE SAND	COARSE SILT	MED. SILT	FINE SILT	CLAY
--------	--------	-------------	-----------	-----------	-------------	-----------	-----------	------

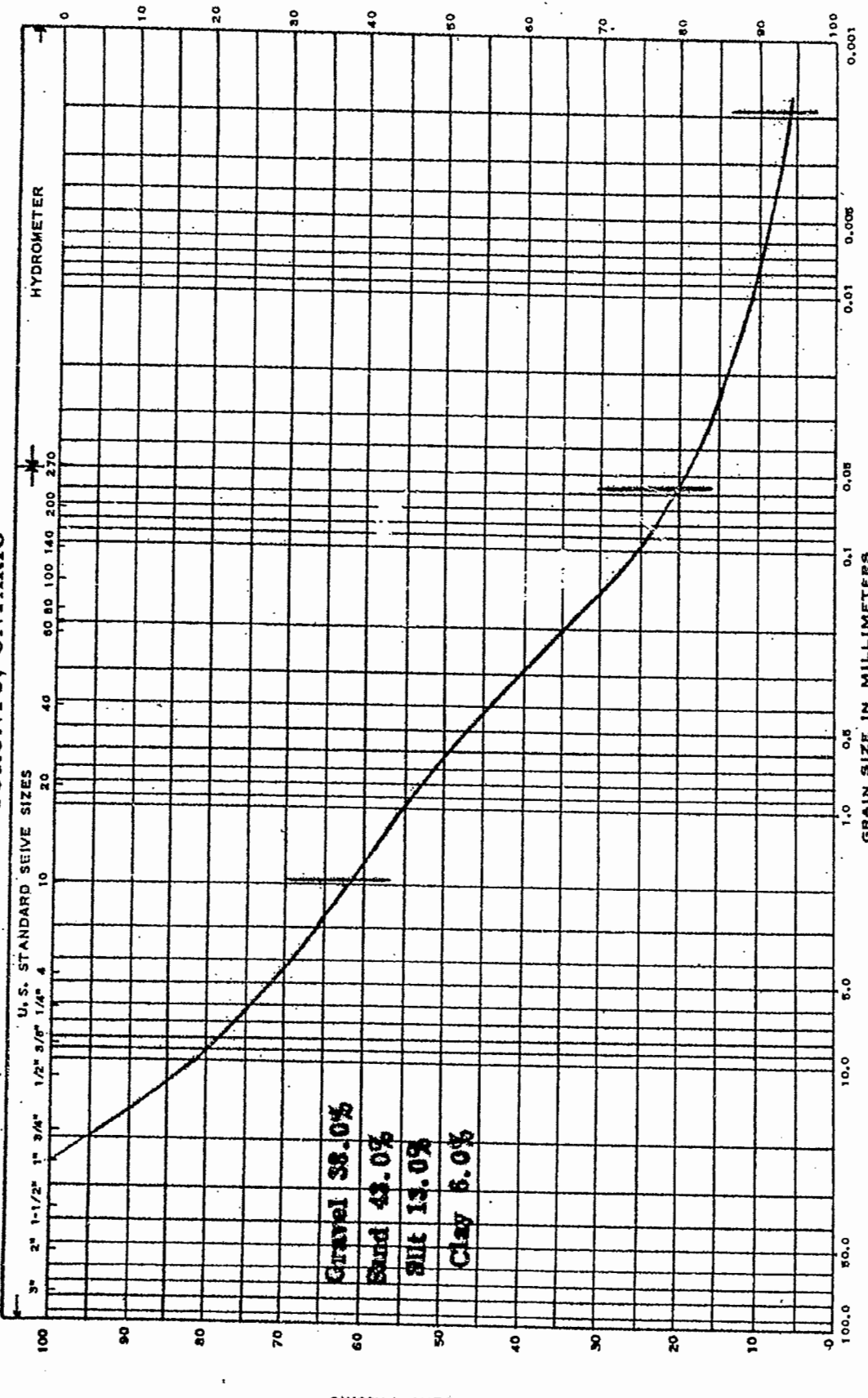
MASCH. INST. OF TECH. CLASSIFICATION

JOB NAME Proposed Hwy. 8 Grand River Crossing HOLE NO. 9 SAMPLE NO. 3

DEPTH 1'-8" ELEVATION _____ REMARKS Gray sandy fill

GRAIN SIZE DISTRIBUTION

e. n. peto associates ltd.



STONES	GRAVEL	COARSE SAND	MED. SAND	FINE SAND	COARSE SILT	MED. SILT	FINE SILT	CLAY
--------	--------	-------------	-----------	-----------	-------------	-----------	-----------	------

MASS. INST. OF TECH. CLASSIFICATION

Proposed Hwy. 2 Grand River Crossing 58110

HOLE NO. 9 SAMPLE NO. 8

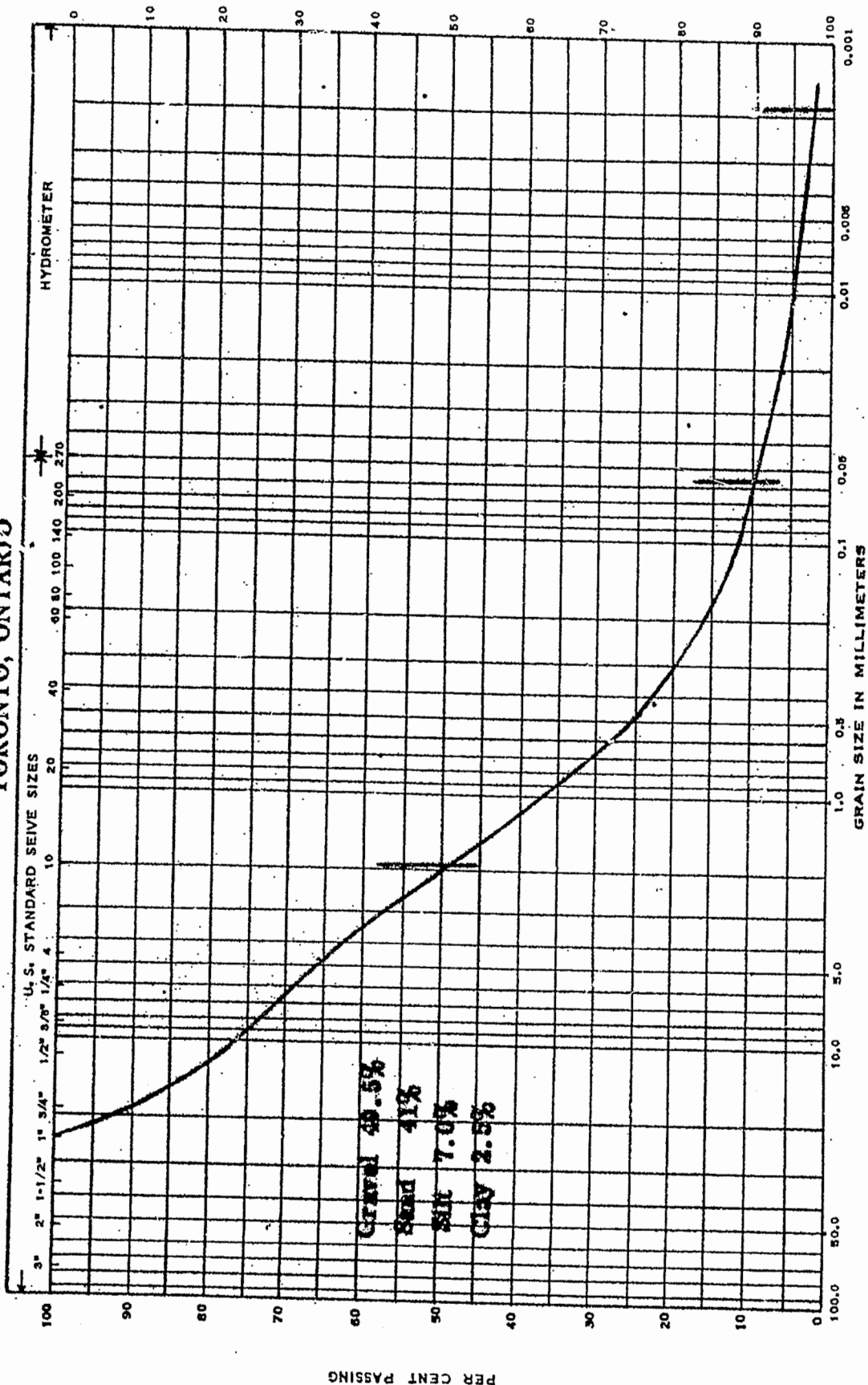
HOLE NO. 9 SAMPLE NO. 8

DEPTH 16'9" - 17'8" ELEVATION

Slightly silty sandy gravel

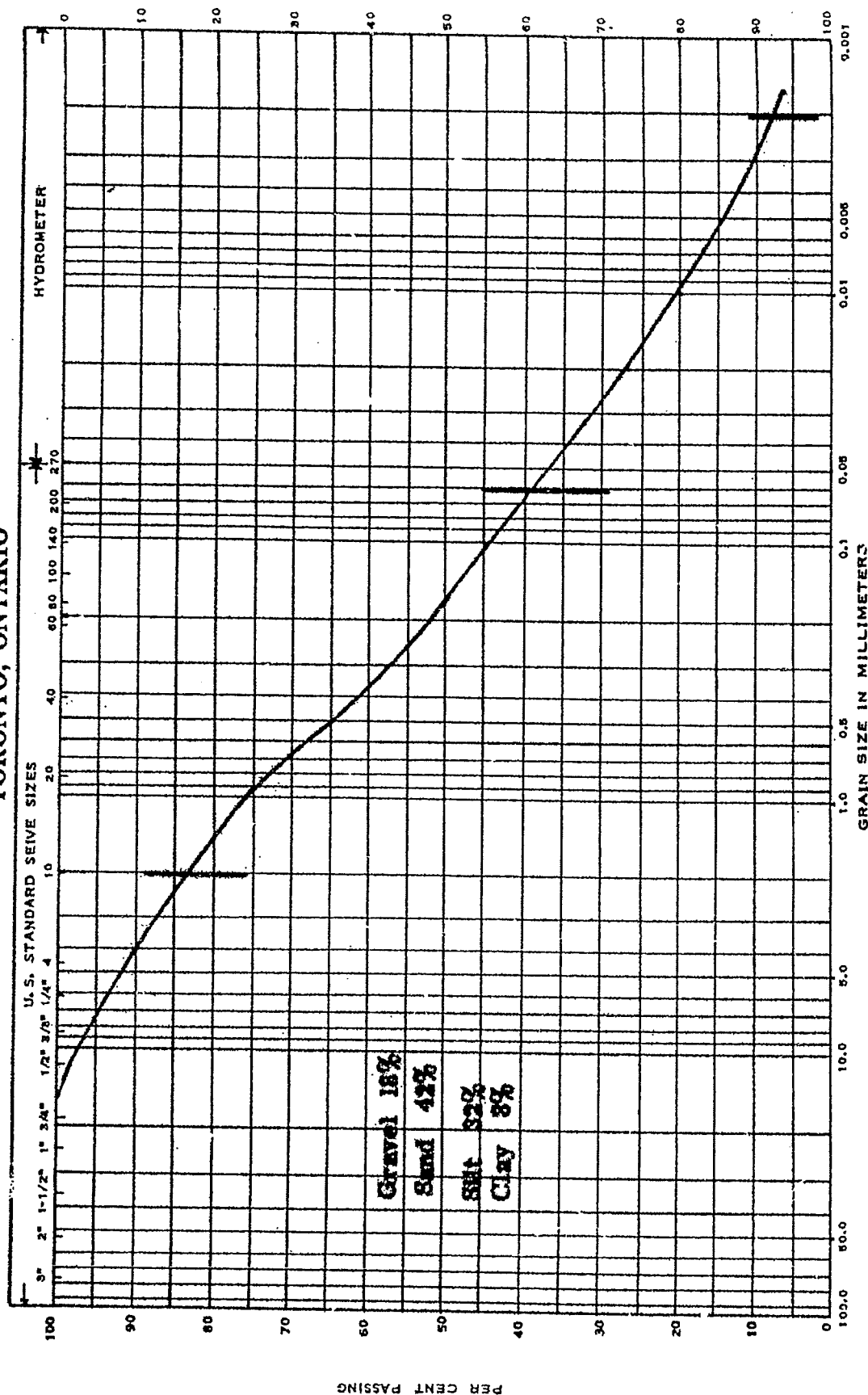
GRAIN SIZE DISTRIBUTION

C. M. Peto Associates Ltd.
TORONTO, ONTARIO



e. m. peto associates ltd.

TORONTO, ONTARIO



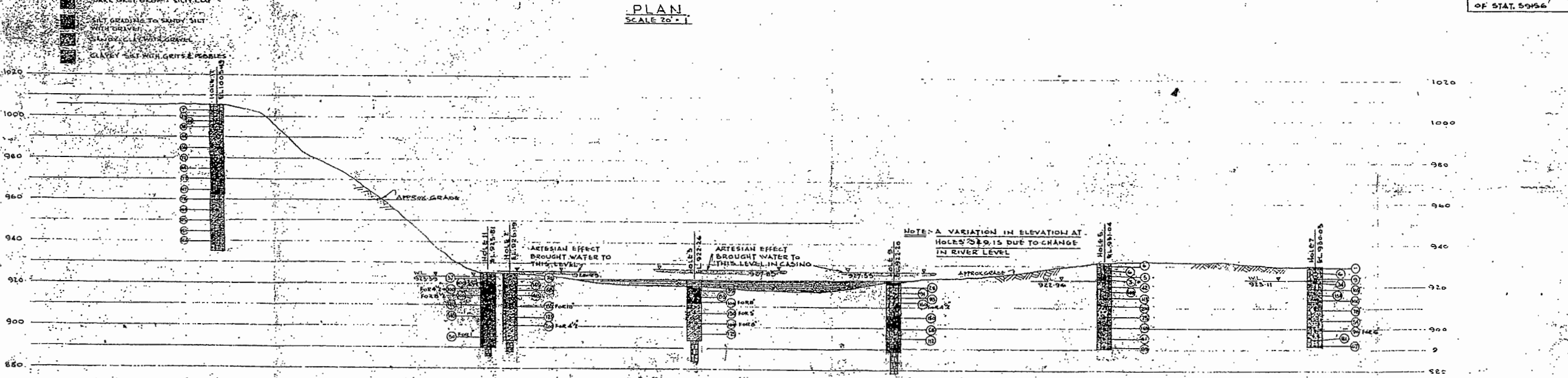
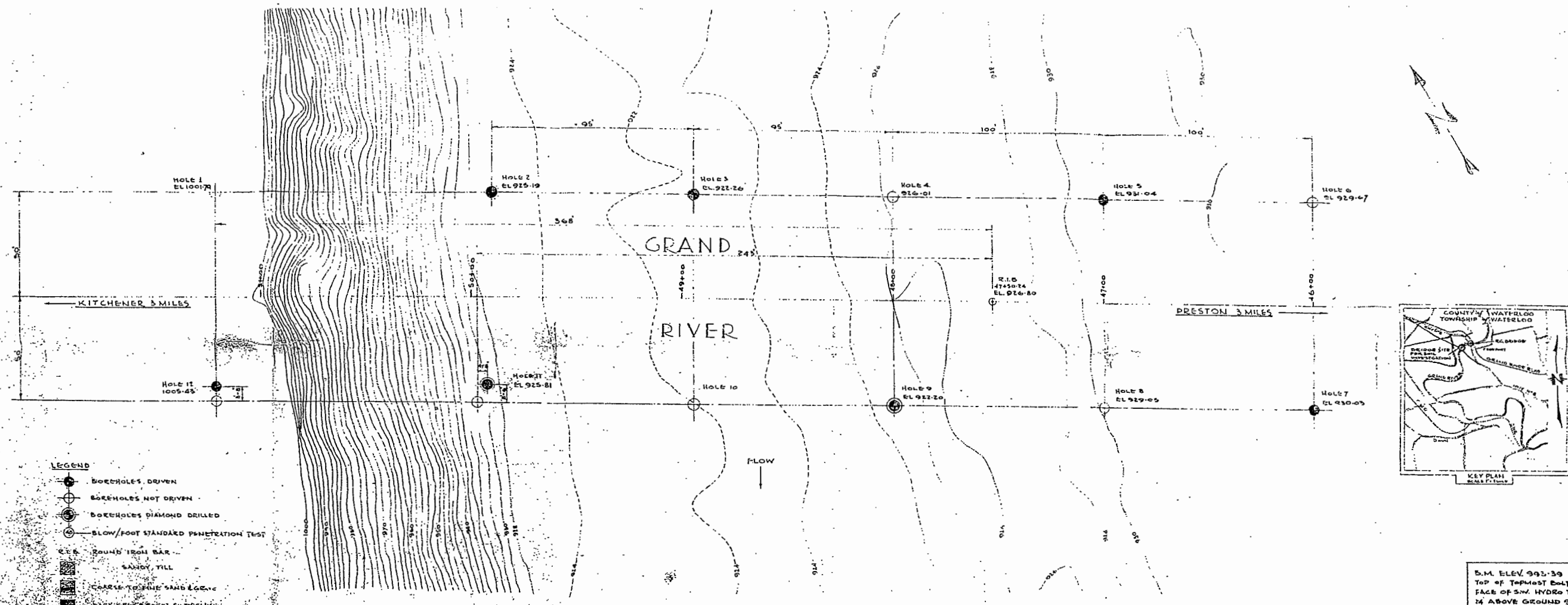
STONES	GRAVEL	COARSE SAND	MED. SAND	FINE SAND	COARSE SILT	MED. SILT	FINE SILT	CLAY
--------	--------	-------------	-----------	-----------	-------------	-----------	-----------	------

MASS. INST. OF TECH. CLASSIFICATION

JOB NAME Proposed Hwy. 8 Grand River Crossing 54119 HOLE NO. 11 SAMPLE NO. 3

DEPTH 7'-8" ELEVATION _____ REMARKS Gray sandy fill.

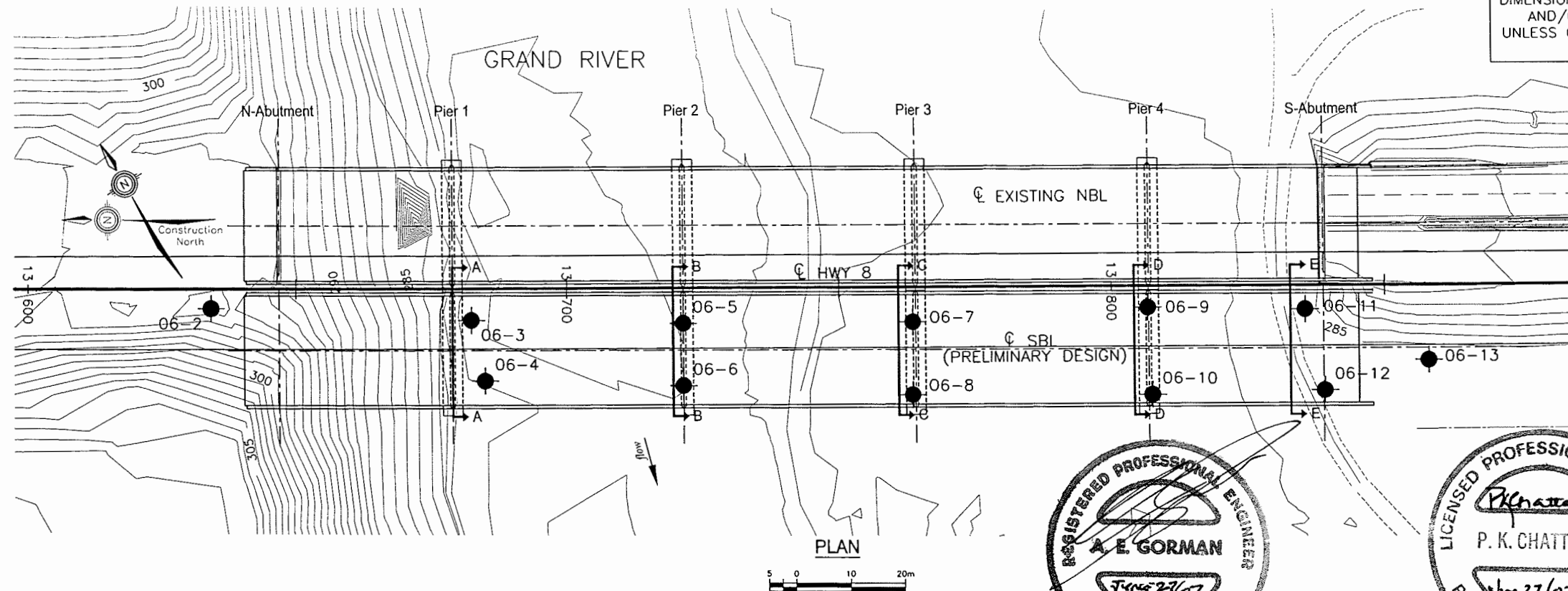
GRAIN SIZE DISTRIBUTION



13 JAN/59	ELEVATIONS CHANGED	CAN	CEP
DATE	REVISION	DIVISION	CRD
e.m. peto & associates ltd.			
SOIL SITE INVESTIGATION			
AT			
PROPOSED HWY 6 CROSSING			
OF GRAND RIVER NEAR FREEPORT			
FOR			
DEPARTMENT OF HIGHWAYS			
OUR JOB No. 58118	DATE 5 OCT 1958		
CLIENTS PLAN No. 62781-1	DATE 5 OCT 1958		

Appendix D

Drawings



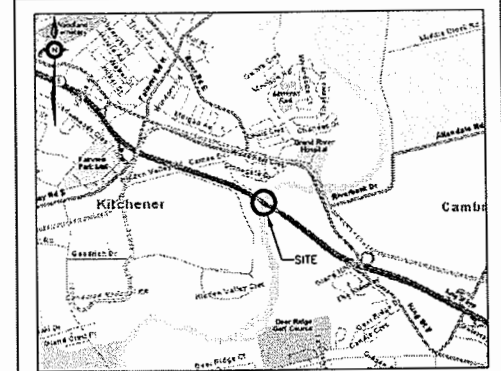
METRIC
 DIMENSIONS ARE IN METRES
 AND/OR MILLIMETRES
 UNLESS OTHERWISE SHOWN

CONT No
 GWP No.277-97-00
 GRAND RIVER CROSSING SBL
 HWY 8 WIDENING
 KITCHENER
 BOREHOLE LOCATIONS AND SOIL STRATA



**MORRISON
 HERSHFIELD**

THURBER ENGINEERING LTD.
 GEOTECHNICAL • ENVIRONMENTAL • MATERIALS



**KEYPLAN
 LEGEND**

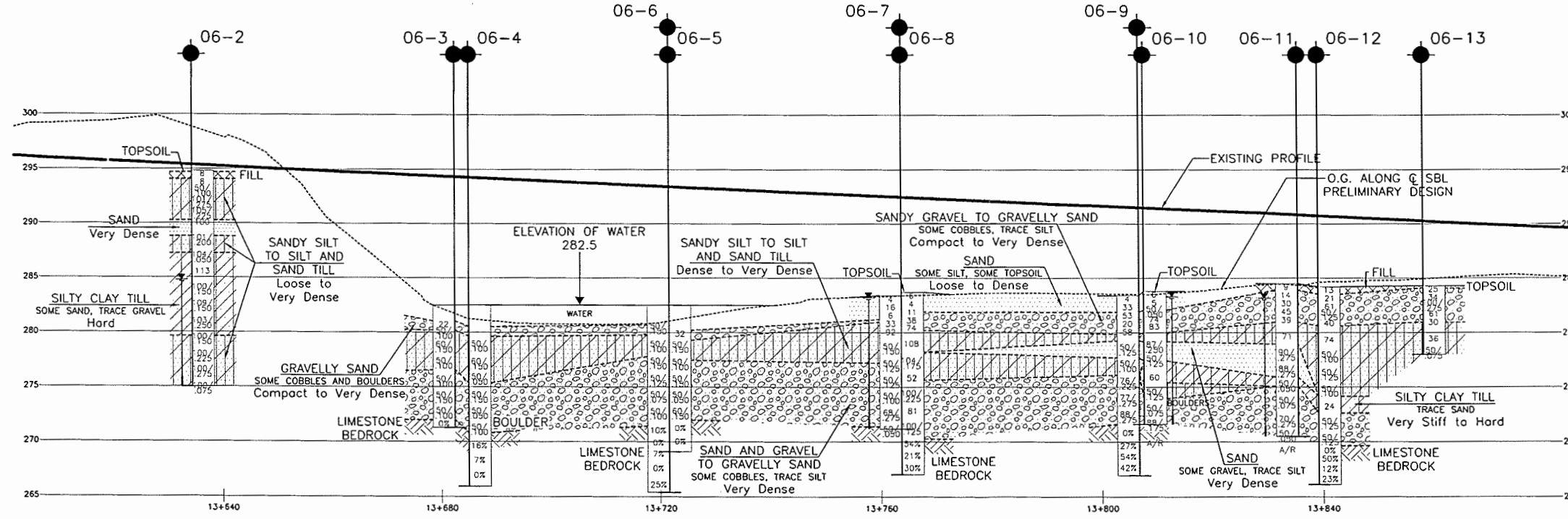
- ◆ BoreHole
- ◆ BoreHole and Cone
- N Blows /0.3m (Std Pen Test, 475J/blow)
- CONE Blows /0.3m (60° Cone, 475J/blow)
- PH Pressure, Hydraulic
- Water Level
- Head Artesian Water
- Piezometer
- 90% Rock Quality Designation (RQD)
- A/R Auger Refusal

NO	ELEVATION	NORTHING	EASTING
06-2	294.83	4 809 407.87	230 460.97
06-3	282.50	4 809 380.57	230 500.59
06-4	282.50	4 809 369.73	230 496.77
06-5	282.50	4 809 359.26	230 533.45
06-6	282.50	4 809 349.51	230 527.36
06-7	283.35	4 809 337.06	230 569.26
06-8	283.72	4 809 325.66	230 562.08
06-9	283.42	4 809 316.39	230 607.09
06-10	283.79	4 809 302.31	230 599.22
06-11	284.50	4 809 300.78	230 631.30
06-12	284.19	4 809 286.20	230 626.37
06-13	282.31	4 809 280.86	230 645.36

-NOTES-

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

GEOCREs No. 40P8-143



PROFILE ALONG PRELIMINARY SBL

Scale: 1:1000
 0 5 10 20m
 0 5 10m

DRAWING NOT TO BE SCALED
 100 mm ON ORIGINAL DRAWING

DATE	BY	DESCRIPTION
DESIGN	AEG	CHK PKC CODE
DRAWN	JHL	CHK PKC SITE
DATE	JAN 2007	DWG

METRIC
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN

CONT No
GWP No.277-97-00
GRAND RIVER CROSSING SBL
HWY 8 WIDENING
KITCHENER
SOIL STRATA

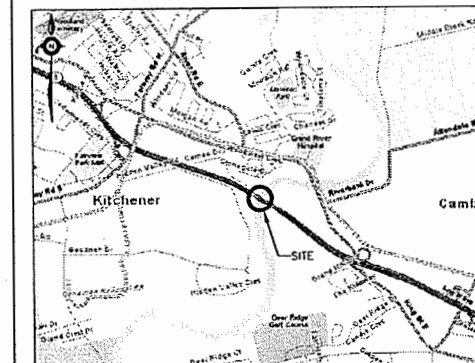


SHEET

MORRISON
HERSHFIELD



THURBER ENGINEERING LTD.
GEOTECHNICAL • ENVIRONMENTAL • MATERIALS



KEYPLAN

LEGEND

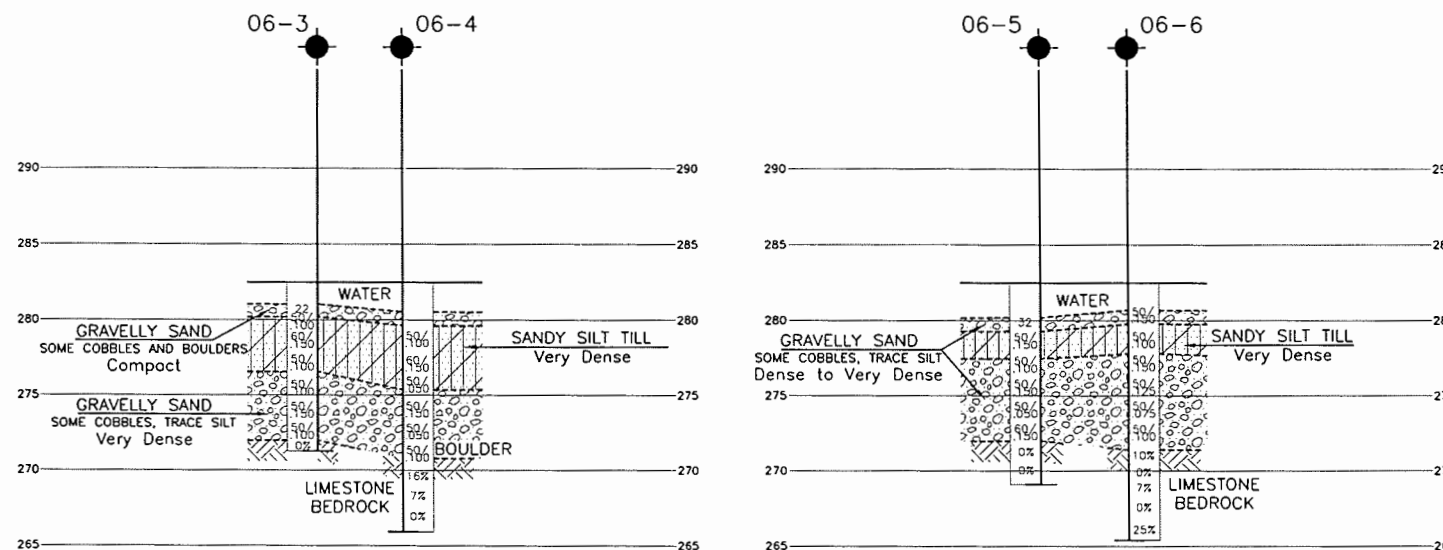
- BoreHole
- BoreHole and Cone
- N Blows /0.3m (Std Pen Test, 475J/blow)
- CONE Blows /0.3m (60° Cone, 475J/blow)
- PH Pressure, Hydraulic
- Water Level
- Head Artesian Water
- Piezometer
- 90% Rock Quality Designation (RQD)
- A/R Auger Refusal

NO	ELEVATION	NORTHING	EASTING
06-2	294.83	4 809 407.87	230 460.97
06-3	282.50	4 809 380.57	230 500.59
06-4	282.50	4 809 369.73	230 496.77
06-5	282.50	4 809 359.26	230 533.45
06-6	282.50	4 809 349.51	230 527.36
06-7	283.35	4 809 337.06	230 569.26
06-8	283.72	4 809 325.66	230 562.08
06-9	283.42	4 809 316.39	230 607.09
06-10	283.79	4 809 302.31	230 599.22
06-11	284.50	4 809 300.78	230 631.30
06-12	284.19	4 809 286.20	230 626.37
06-13	282.31	4 809 280.86	230 645.36

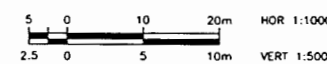
NOTES-

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

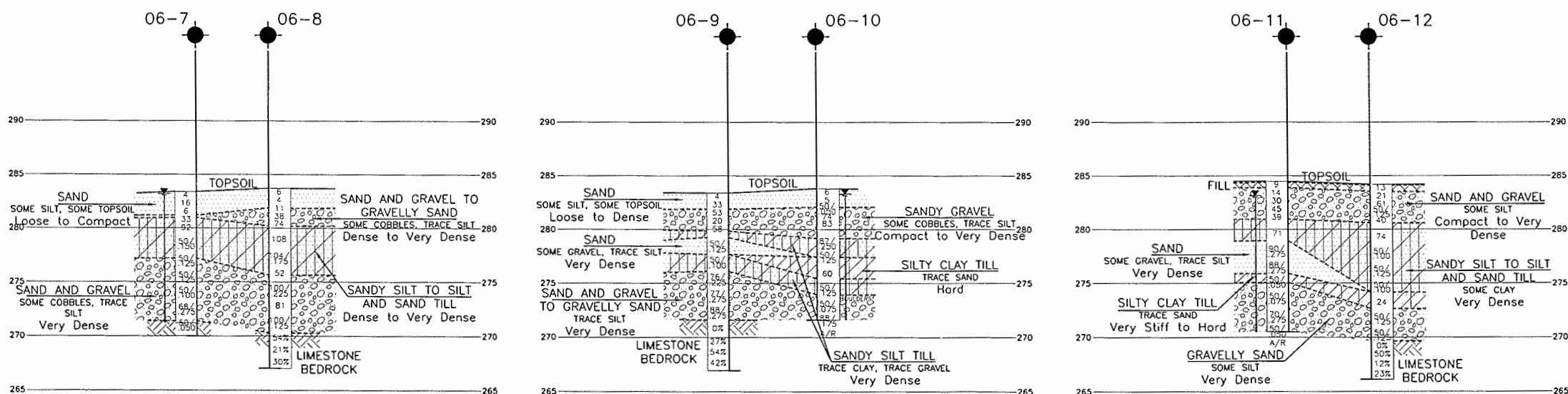
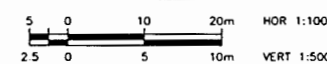
GEOCREs No. 40P8-143



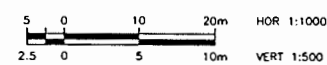
SECTION A-A



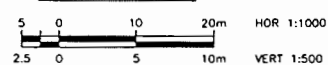
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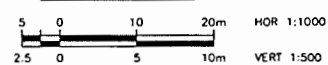
SECTION C-C



SECTION D-D



SECTION E-E



DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING

REVISIONS	DATE	BY	DESCRIPTION
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DRAWN	JHL	CHK	PKC
LOAD			
STRUCT			
DWG			

Appendix E

Site Photographs

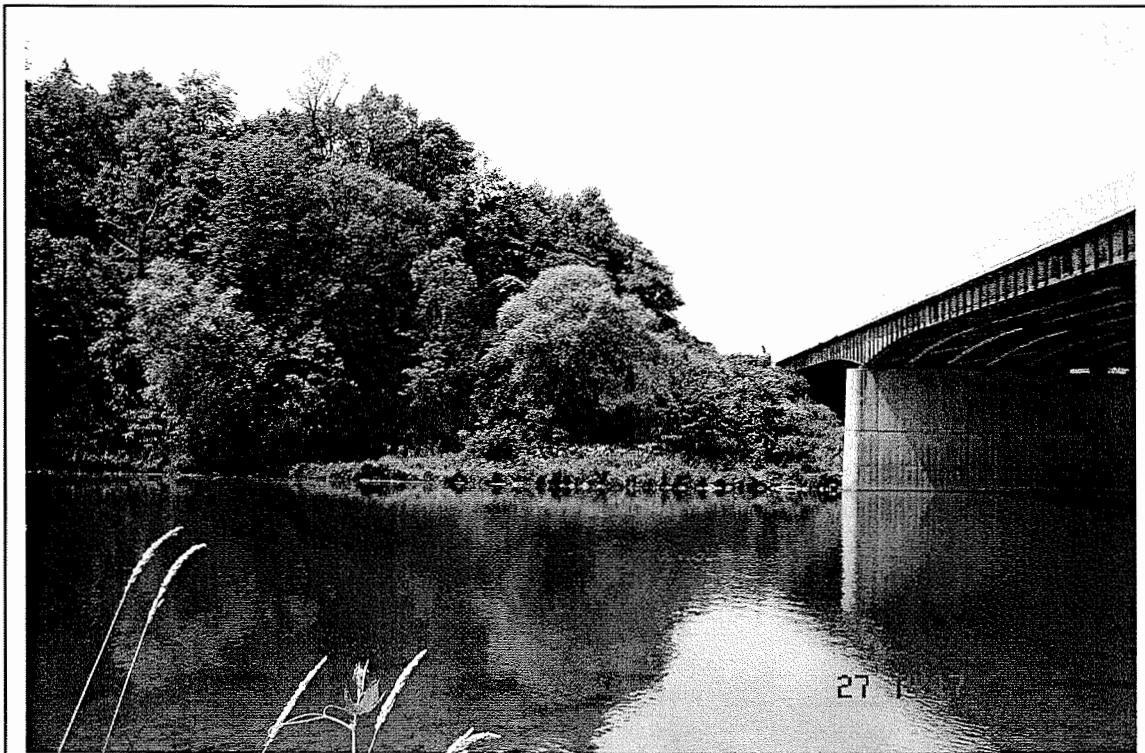


Photo 1, July 2006 – Looking from flood plain on south side of Grand River towards North Abutment and Piers 1 and 2. Existing bridge on right side of photo.

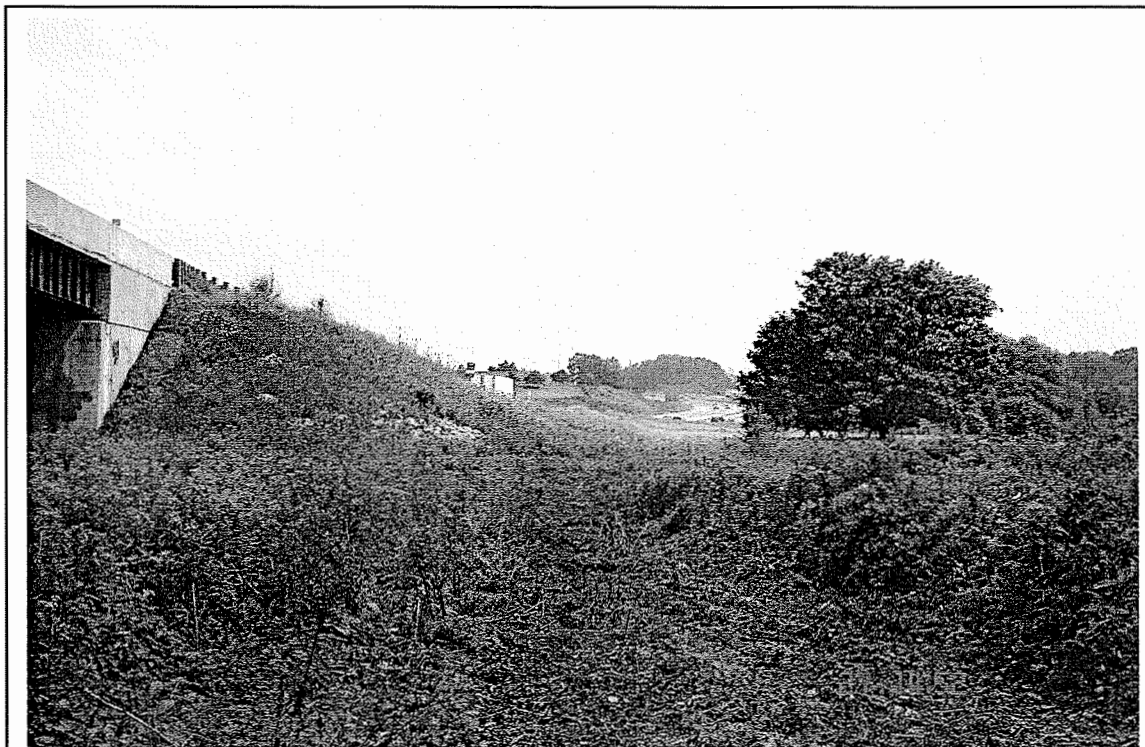


Photo 2, July 2006 – Looking from flood plain on south side of Grand River towards South Abutment. Existing bridge on left side of photo.