

REPORT

Foundation Investigation Report
Opasatika River Bridge
Replacement
Site No. 39W-062
Highway 11
District – New Liskeard

G.W.P. 319-85-00

LEA CONSULTING LTD.

PROJECT NO. 1015345
GEOCRES NO. 42G-28

PROJECT NO. 1015345

REPORT TO

**Lea Consulting Ltd.
625 Cochrane Drive
Suite 900
Markham, Ontario
L3R 9R9**

FOR

Foundation Investigation Report

ON

**Opasatika Bridge Replacement
Site 39W-062, Highway 11
District – New Liskeard, Ontario
G.W.P. 319-85-00
Geocres. No. 42G-28**

December 19, 2008

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FOUNDATION INVESTIGATION REPORT

Opasatika River Bridge Replacement Site No. 39W-062, Highway 11 Near Opasatika, Ontario G.W.P. 319-85-00 District – New Liskeard

1.0 INTRODUCTION

Jacques Whitford Limited (Jacques Whitford) was retained by Lea Consulting Ltd., to complete a Foundation Investigation Report for the replacement of the Opasatika River Bridge located on Highway 11 near Opasatika, approximately 34 km west of Kapuskasing, Ontario, (GWP No. 319-85-00).

The work was carried out under Agreement No. 5005-E-0025. Authorization to proceed with the investigation was provided by Mr. Peter Ojala, P.Eng., Vice President, Head of Bridges and Structures, of Lea Consulting Ltd, the prime consultant on this design assignment.

This foundation investigation report has been prepared specifically and solely for the project described herein. It contains the factual results of the foundation investigation and the laboratory testing.

2.0 SITE DESCRIPTION

The site is located on Highway 11 at the Opasatika River near Opasatika, Ontario, which is approximately 34 km west of Kapuskasing, Ontario.

Highway 11 is generally oriented in an east west direction with one east bound lane and one west bound lane. Highway 11 at the Opasatika River is built on embankments to a rural highway section with wide gravel shoulders and is generally 3 m higher than the surrounding lands. Drainage for Highway 11 is provided by ditches located along the sides of the highway, which are sloped to drain to the Opasatika River.

The existing bridge consists of a concrete deck, approximately 10 m wide, supported on four continuous cast concrete girders that are supported on three piers and two abutments. The distance between the abutments and the outer most piers is approximately 12 m to 13 m, while the distance between the piers is approximately 18 m to 19 m. The existing bridge was constructed in 1950 with no significant rehabilitation reported.

A construction drawing dated September 25, 1941, revised June 18, 1950, indicates that the existing bridge is supported on cruciform shaped caissons. The drawing indicates that the soil conditions at the site consist of “blue clay” overlying “hard pan”, which is underlain by “Gravel & Layers of Sand & Boulders”. However, the drawing does not indicate the bearing stratum of the caissons.

There is a parking and rest area located to the northwest of the bridge location. Overhead hydro and buried telephone cables are located along the north side of the highway right-of-way. There is an



Ontario Power Generation (OPG) water monitoring station near the northeast portion of the existing bridge. An Ontario Northland Railway (ONR) line is located approximately 40 m to the south of the centreline of the existing highway and generally runs parallel to the existing highway.

3.0 PHYSIOGRAPHY

Based on Map 2518, titled "Surficial Geology of Northern Ontario", dated 1987, by the Ministry of Northern Development and Mines, Highway 11 at the Opasatika River is situated on the boundary between deep water glaciolacustrine and glaciomarine deposits of clay-silt and a glacial till deposit generally comprised of unsorted boulders, gravel, sand, silt and clay sized particles.

Based on Map 2543, titled "Bedrock Geology of Ontario, East-Central Sheet", dated 1991, by the Ontario Ministry of Northern Development and Mines, the bedrock at the site is noted as Metasedimentary rock comprised of paragneisses and migmatites.

4.0 BACKGROUND

A preliminary investigation was carried out by Jacques Whitford Limited. The results of the preliminary investigation were provided in the following Preliminary Foundation Investigation and Design report:

- *Preliminary Foundation Investigation and Design Report*
Opasatika River Bridge Replacement
Site No. 39W-062
Highway 11
District – Cochrane
GWP 319-85-00
Geocres No. 42G-27
Jacques Whitford Project No. 1015345
Report Dated: June 5, 2008

The factual results from the preliminary investigation, including the Record of Borehole Sheets and Laboratory test data, have been incorporated into this report.

5.0 INVESTIGATION PROCEDURES

5.1 Field Program

The fieldwork for the preliminary investigation was carried out between July 18 and 21, 2007, and August 9 to 14, 2007. The field work for the detailed foundation investigation was carried out between August 13 and 15, 2008. A total of 9 boreholes were advanced for these investigations:

- 6 boreholes for the preliminary investigation, Boreholes OPA-07-1 to OPS-07-6; and
- 3 boreholes for the detailed investigation, Boreholes OPA-08-1 to OPA-08-3.



The investigation work was carried out using a combination of truck, track, barge and skid mounted drill rigs equipped with either 250 mm (outside diameter) continuous flight hollow-stem augers, 100 mm (outside diameter) continuous flight solid-stem augers or wash-boring equipment, supplied and operated by Walker Drilling Inc. and Abraflex Inc. The following table outlines the boreholes locations and numbering:

Side of River	Borehole Number	Element
East Side of River	OPA-08-3, OPA-07-6	East Abutment, and Approach fills
	OPA-08-2	East Pier
West Side of River	OPA-08-1	West Pier
	OPA-07-1, OPA-07-3	West Abutment and Approach fills

Boreholes OPA-07-2, OPA-07-4 and OPA-07-5 were advanced for the preliminary investigation to the south of the existing bridge. The results of these boreholes have been incorporated into this report.

Prior to commencing the field investigation, the borehole locations were cleared of underground utilities by the various utility companies. The borehole locations were established in the field by Jacques Whitford personnel.

Soil samples were recovered from the boreholes at regular intervals using a 50 mm Outside Diameter split-tube sampler by conducting Standard Penetration Tests (SPTs) in general accordance with the procedures outlined in ASTM specification D1586-99.

Where cohesive soils were encountered, in situ shear vane testing was carried out using a vane meeting the MTO N-Vane design requirements and following the procedures outlined in ASTM D2573-94.

Rock cores were obtained by coring the bedrock using standard NQ size diamond tipped coring equipment. The Total Core Recovery (TCR), Solid Core Recovery (SCR) and Rock Quality Designation (RQD) were recorded for the bedrock cores recovered from the boreholes.

Jacques Whitford field personnel recorded the conditions encountered in all boreholes at the time of the investigation. Soils were described in accordance with the MTO Soils Classification System for foundation reports.

The groundwater levels, where encountered and where practical, were measured in the boreholes during and on completion of drilling. All boreholes were backfilled in accordance with the Ontario Ministry of the Environment Regulation 903, using a cement/bentonite slurry.

All soil samples recovered from the boreholes were placed in moisture-proof bags and transported to our laboratory for detailed classification and testing as required. All rock cores were placed in rock core boxes and transported to our laboratory for detailed examination and selected laboratory testing.

5.2 Survey

The borehole locations were established by Jacques Whitford personnel and referenced to the stations on Highway 11, as noted on the Record of Borehole sheets. Offsets were referenced to the centre line of the proposed highway alignment looking up chainage. The borehole chainage and off-sets are provided on the Drawing Nos. 1 and 2 in **Appendix A** and on the Record of Borehole sheets in **Appendix B**.



The ground surface elevation at the borehole locations were inferred from a survey plan provided to Jacques Whitford by Lea Consulting Limited. It is understood that the survey plan was referenced to a Geodetic datum.

5.3 Laboratory Testing

All samples returned to the laboratory were subjected to detailed visual examination and classification. Approximately 25% of the soil samples were submitted for routine testing including moisture content determination, grain size distribution and Atterberg Limits testing. The laboratory results are provided on the Record of Borehole sheets in **Appendix B**. The results of the grain size analyses and Atterberg Limits tests are shown on Figure Nos. 1 through 8 in **Appendix C**. The following is a summary of the routine laboratory testing carried out:

Test Name	Number of Test
Grain Size Distribution with Hydrometer	14
Grain Size Distribution	4
Atterberg Limits	10
Moisture Content Testing	68

Unless requested in advance, all samples will be stored in our laboratory for a period of 12 months from the issue date of this report.

6.0 RESULTS OF THE INVESTIGATION

6.1 Subsurface Conditions

The subsurface conditions encountered in the boreholes are summarized on the Record of Borehole sheets provided in **Appendix B**. An explanation of the terms used on the Record of Borehole sheets is also provided in **Appendix B**.

A Borehole Location Plan and Soil Strata Plots of the soils encountered in the boreholes are provided on Drawing Nos. 1 and 2 in **Appendix A**.

A summary of the soil and groundwater conditions encountered in the boreholes is provided below.

6.2 Soil

6.2.1 Topsoil

Topsoil was encountered at the ground surface in Boreholes OPA-07-1, OPA-07-5 and OPA-08-3. The topsoil was approximately 125 mm thick in all boreholes.

6.2.2 Asphalt

Asphalt was encountered at the ground surface in Boreholes OPA-07-3 and OPA-07-6, and was approximately 175 mm and 65 mm thick, respectively.



6.2.3 Sand and Gravel Fill and Sand Fill

Sand and gravel fill and sand fill was encountered in Boreholes OPA-07-1, OPA-07-3, OPA-07-4, OPA-07-5 and OPA-07-6. The thickness of the sand and gravel fill and sand fill was approximately 0.4 m to 4.5 m and extended to depths of approximately 1.2 m to 4.6 m below existing grade, elevations of about 217.2 m to 219.6 m.

The sand contained trace to with silt, trace to some clay and trace gravel. Asphalt fragments were encountered in the sand fill sample obtained from Borehole OPA-07-4.

Laboratory testing performed on selected samples consisted of moisture content and grain size distribution tests. The test results are as follows:

- Moisture Content:
 - 7% to 34%
- Grain Size Distribution
 - 1% to 6% gravel;
 - 44% to 78% sand;
 - 20% to 51% fines (silt and clay)

The results of the moisture content tests and grain size distribution are provided on the Record of Borehole sheets in **Appendix B**. The results of the grain size distribution test are provided on Figure 1 in **Appendix C**.

6.2.4 Silty Clay to Clayey Silt Fill

Silty clay to clayey silt fill was encountered below the topsoil in Borehole OPA-08-3 and below the sand and gravel fill in Borehole OPA-07-5 at a depth of approximately 1.2 m below existing grade, an elevation of approximately 219.1 m. The thickness of silty clay fill was approximately 2.0 m and 0.5 m, and extended to depth of approximately 2.1 m and 1.7 m below existing grade, elevations of approximately 217.6 m and 218.6 m.

Based on visual examination the silty clay to clayey silt fill was found to be moist to wet.

Laboratory testing performed on selected samples consisted of two moisture content tests. The test results are as follows:

- Moisture Content:
 - 17% and 25%

The results of the moisture content tests are provided on the Record of Borehole sheets in **Appendix B**.

6.2.5 Peat (PT) and Organic Silt (OL)

A layer of non-fibrous peat and organic silt was encountered at the river bottom in Borehole OPA-08-2 and underlying the fill in Boreholes OPA-07-3, OPA-07-4 and OPA-08-3 at depths of approximately 0.0 m to 3.7 m below existing grade, elevations of about 219.6 m to 216.6 m. The peat and organic silt was approximately 2.4 m to 3.7 m thick and extended to depths of approximately 2.7 m to 6.1 m below existing grade, elevations of approximately 213.5 m and 217.2 m.

The non fibrous peat contained wood fragments, some silty clay, trace sand and was saturated.

The N-values obtained from the SPTs carried out in the non-fibrous peat and organic silt ranged from weight of hammer to 10.

Laboratory testing performed on selected peat samples consisted of moisture content and Atterberg Limits tests. The tests results are as follows:

- Moisture content:
 - 31% to 259%
- Atterberg Limits:
 - Liquid Limit: 59% and 92%
 - Plastic Limit: 41% and 64%
 - Plasticity Index: 18% and 28%

The results of the moisture content grain size distribution and Atterberg Limits Tests are provided on the Record of Borehole sheets in **Appendix B**. The results of the Atterberg Limits Tests are provided on Figure 2 in **Appendix C**.

Laboratory testing performed on selected samples of the organic silt consisted of moisture content , grain size distribution and Atterberg Limits tests. The tests results are as follows:

- Moisture content:
 - 29% to 37%
- Grain Size Distribution:
 - 2% gravel;
 - 27% sand;
 - 51% silt; and,
 - 20% clay.
- Atterberg Limits:
 - Liquid Limit: 34%
 - Plastic Limit: 24%
 - Plasticity Index: 10%

The results of the grain size distribution tests are provided on Figure No. 3 in **Appendix C**. The results of the Atterberg Limits Test are provided on Figure 4 in **Appendix C**.

6.2.6 Silty Clay (CL-ML to CI)

Silty clay was encountered in all boreholes except Borehole OPA-08-2. The silty clay was approximately 1.7 m to 6.1 m thick and extended to depths ranging from approximately 1.7 m to 11.8 m below existing grade, elevations in the range of 211.5 m to 214.6 m.

The silty clay contained varying amounts of sand (sandy to trace sand), trace to with organic matter, and was generally moist to wet. Strata of sand and silt were encountered within the silty clay layer. These are described separately below.

Based on the N-Values obtained from the SPT, the consistency of the silty clay ranged from soft to hard.

Laboratory testing performed on selected samples consisted of moisture content, grain size distribution and Atterberg Limits tests. The test results are as follows:

- Moisture Content:
 - 18% to 53%
- Grain Size Distribution:
 - 0% to 3% gravel;
 - 4% to 36% sand;
 - 34% to 65% silt; and,
 - 18% to 59% clay.
- Atterberg Limits:
 - Liquid Limit: 18% to 39%
 - Plastic Limit: 13% to 22%
 - Plasticity Index: 5% to 18%

The results of the moisture content, grain size distribution and Atterberg Limits tests, are provided on the Record of Borehole sheets in **Appendix B**.

The results of the grain size distribution tests are provided on Figure No. 5 in **Appendix C**. The results of the Atterberg Limits tests are provided on Figure No. 6 in **Appendix C**.

6.2.7 Silt (ML)

A layer of silt was encountered in Borehole OPA-07-2 within the silty clay at a depth of approximately 0.9 m below existing grade, an elevation of about 216.2 m. The silt was approximately 1.4 m thick and extended to a depth of approximately 2.3 m below existing grade, an elevation of about 214.9 m.

The silt contained some clay, trace sand and gravel and was generally saturated.

Based on the N-Values obtained from the SPTs, the silt was determined to be compact.

Laboratory testing performed on selected samples consisted of moisture content and grain size distribution tests. The test results are as follows:

- Moisture Content:
 - 19%
- Grain Size Distribution:
 - 2% gravel;
 - 1% sand;
 - 85% silt; and,
 - 12% clay.

The results of the moisture content and grain size distribution tests, are provided on the Record of Borehole sheets in **Appendix B**.

The results of the grain size distribution test is provided on Figure 7 in **Appendix C**.



One sample of the silt was submitted for Atterberg Limits testing. The test results indicated that the silt was non-plastic.

6.2.8 Sand (SP) and Silty Sand (SM)

A layer of sand and silty sand was encountered underlying the peat in Borehole OPA-08-2, and OPA 07-4, and within the silty clay in Boreholes OPA-07-2 and OPA-07-6. The sand was encountered at depths of approximately 2.3 m to 6.1 m below existing grade, elevations of about 213.5 m to 216.9 m. The thickness of the sand and silty sand ranged from approximately 0.9 m to 3.0 m and the unit extended to depths of approximately 3.8 m to 9.1 m, elevations of about 212.4 m to 213.9 m.

Based on the N-Values obtained from the SPTs, the silty sand was determined to be variable ranging from very loose to very dense. It is noted that an N-value of 100 for 127mm of penetration was recorded in the silty sand in Borehole OpA 07-2. This value may be reflective of the presence of cobbles or boulders.

Laboratory testing performed on selected samples consisted of moisture content testing. The test results are as follows:

- Moisture Content:
 - 22% to 33%

The results of the moisture content tests are provided on the Record of Borehole sheets in **Appendix B**.

6.2.9 Sandy Silt and Silty Sand Till (SM, SC-SM)

Sandy silt and silty sand till was encountered in all boreholes at depths of approximately 1.7 m to 11.8 m below existing grade, elevations of approximately 211.5 m to 214.6 m. The thickness of the sandy silt and silty sand till ranged from approximately 3.1m to 11.8 m and extended to the depths in the range of approximately 9.1 m to 19.8 m, elevations of approximately 202.4 m to 209.3 m.

The sandy silt and silty sand till strata contained trace to some gravel and clay, and was moist to wet. Rock fragments, cobbles and boulders were also encountered.

Based on N-values obtained from the SPTs, the compactness of the sandy silt and silty sand till was determined to be compact to very dense, but was generally dense.

Laboratory testing performed on selected samples consisted of moisture content and grain size. The test results are as follows:

- Moisture Content:
 - 6% to 19%
- Grain Size Distribution:
 - 2% to 16% gravel;
 - 28% to 77% sand;
 - 21% to 52% silt; and,
 - 3% to 20% clay.

The results of the moisture content and grain size distribution tests are provided on the Record of Borehole sheets in **Appendix B**.

The results of the grain size distribution test are provided on Figure 8 in **Appendix C**.

6.3 Bedrock

Bedrock was cored in all boreholes except Borehole OPA-07-3. The bedrock was encountered or inferred at depths of approximately 9.1 m to deeper than 19.8 m below existing grade, elevations of approximately 209.3 m to 202.4 m.

The bedrock generally consisted of metamorphic gneiss.

Core samples of the bedrock were obtained from all boreholes, except OPA-07-3. The observations of the rock cores are summarized as follows:

- Total Core Recovery (TCR): 62% to 100%, average of approximately 94%
- Solid Core Recover (SCR): 32% to 95%, average of approximately 70%
- Rock Quality Designation (RQD): 26% to 90%, average of approximately 65%

The results of the rock core analysis are provided on the Record of Borehole sheets in **Appendix B**.

6.4 Groundwater

It was not practical to measure the ground water on completion of drilling, given the methods employed to drill the boreholes. However, water was encountered on the sampling spoon during drilling at the depths and elevations noted in the following table:

Borehole Number	Groundwater First Encountered	
	Depth Below Existing Grade (m)	Elevation (m)
OPA-07-1	2.1	218.6
OPA-07-2	River Surface	218.5
OPA-07-3	4.8	218.5
OPA-07-4	River Surface	218.6
OPA-07-5	1.8	218.5
OPA-07-6	3.0	220.1
OPA-08-1	River Surface	218.3
OPA-08-2	River Surface	218.3
OPA-08-3	2.1	217.6

It should be noted that groundwater levels and the water level of the river are subject to seasonal fluctuations and responses to precipitation events.

7.0 CLOSURE

A soil investigation is a limited sampling of a site. The information is gathered at specific borehole locations and can only be extrapolated to an undefined limited area around the borehole locations. The extent of the limited area depends on the variability of the soil and ground water conditions as influenced by geological processes, as well as the history of the site reflecting natural conditions, construction activities and site use. Should any conditions at the site be encountered that differ from those at the borehole locations, we request that we be notified immediately in order to assess the additional information.

We trust the above information meets with your present requirements. Should you have any questions or require further information, please do not hesitate to contact us at your convenience.

Regards,

JACQUES WHITFORD LIMITED

Original signed by:

Geoffrey Creer, P. Eng.
Geotechnical Engineer

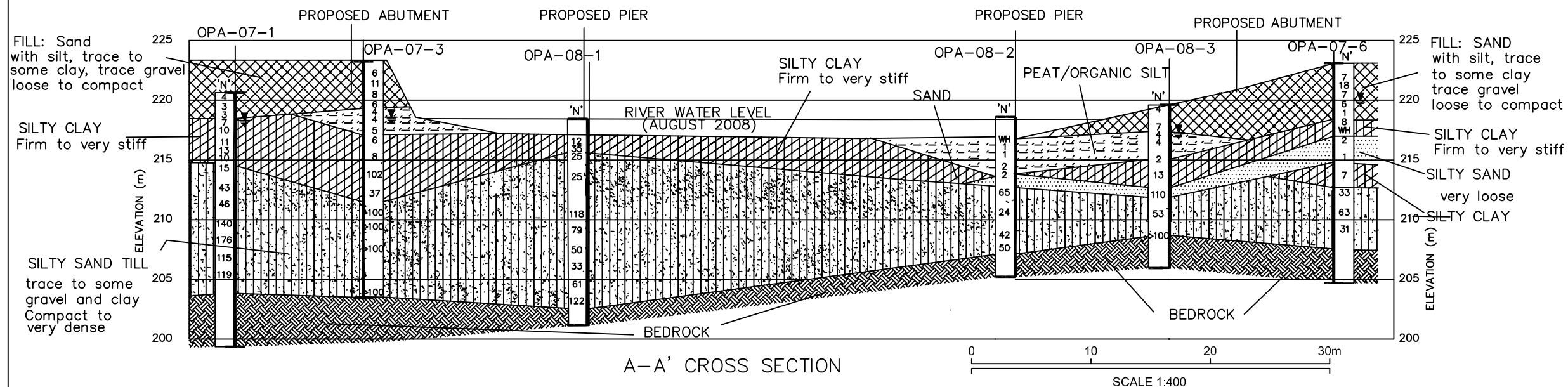
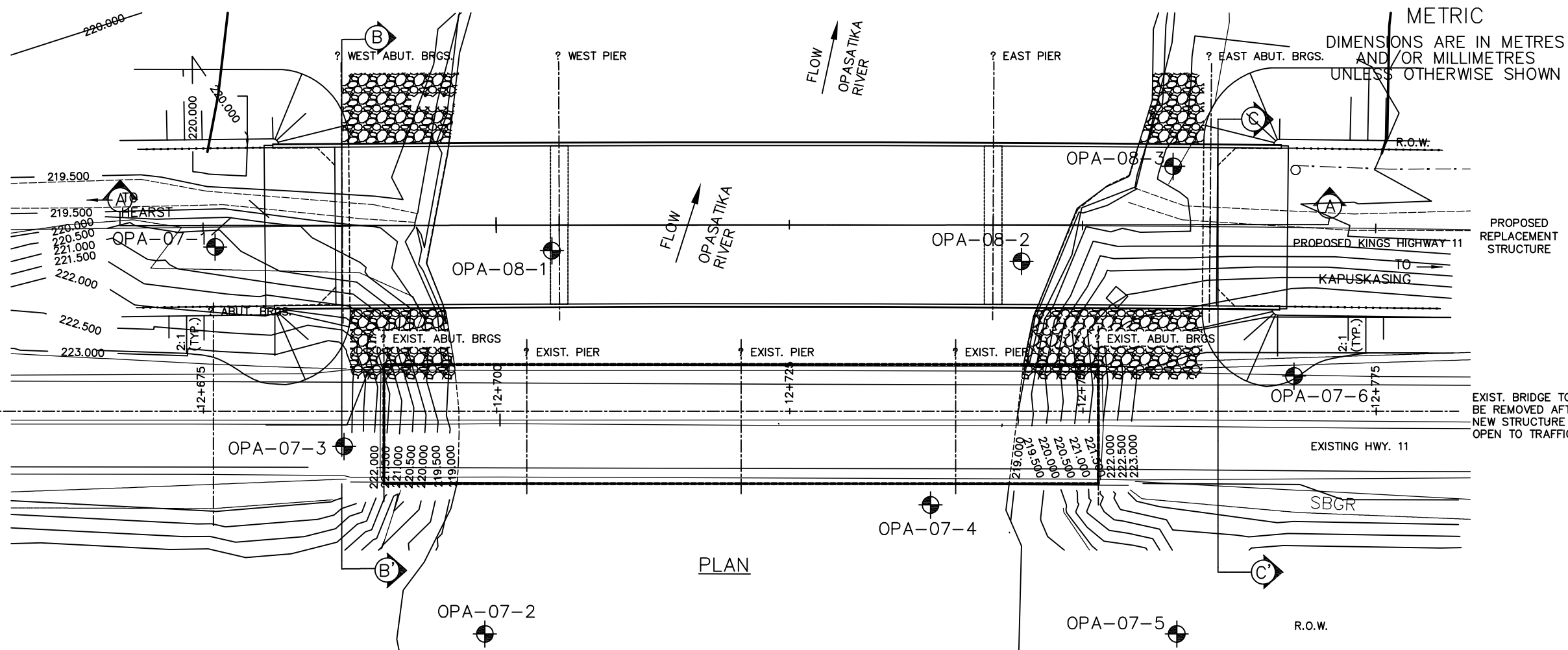
Original signed by:

Fred J. Griffiths, Ph. D., P. Eng.
Designated Principal
MTO Foundations Contact



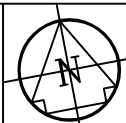
Appendix A

Drawings

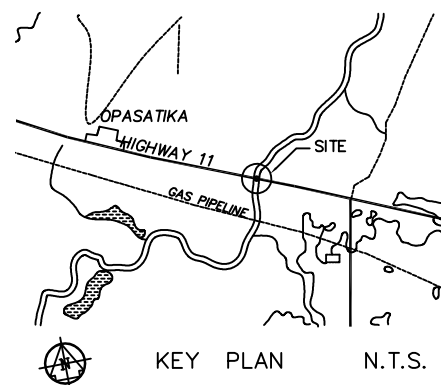


CONT No -
WP No 319-85-00

OPASATIKA RIVER BRIDGE
REPLACEMENT-BOREHOLE
LOCATIONS AND SOIL STRATA
(SECTION A-A')



SHEET
-



LEGEND

- BOREHOLE
- GROUNDWATER LEVEL

BOREHOLE NO.	STATION	OFFSET	ELEVATION
OPA-07-1	12+676	2m Rt.	220.7
OPA-07-2	12+695	35m Rt.	218.5
OPA-07-3	12+687	19m Rt.	223.3
OPA-07-4	12+737	24m Rt.	218.6
OPA-07-5	12+758	35m Rt.	220.3
OPA-07-6	12+768	13m Rt.	223.1
OPA-08-1	12+705	2m Rt.	218.3
OPA-08-2	12+745	3m Rt.	218.3
OPA-08-3	12+758	5m Lt.	219.7

NOTES:

- The boundaries between soil strata have been established only at borehole locations. Between boreholes the boundaries are assumed from geological evidence.
- 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.
- Base plan provided by LEA Consulting Ltd.
- This drawing is for subsurface information only. Surface details and features are for conceptual illustration only. The proposed structure location and features are shown for information purposes only.
- Offsets measured from proposed centreline.

GEOCRE NO. 42G-28
DISTRICT: 53

REVISIONS	DATE	BY	DESCRIPTION
DESIGN B.D.	CHK R.T.K.	CODE CHBDC_06	LOAD ONT CL-625 DATE DECEMBER_2008
DRAWN A.A.	CHK G.T.C.	SITE 39W-062	STRUCT - SCHEME - DWG 1

Appendix B

Terms and Symbols Used on the Record of Borehole Sheet
Record of Borehole Sheets

EXPLANATION OF TERMS USED IN REPORT

N VALUE: THE STANDARD PENETRATION TEST (SPT) N VALUE IS THE NUMBER OF BLOWS REQUIRED TO CAUSE A STANDARD 51mm O.D. SPLIT BARREL SAMPLER TO PENETRATE 0.3m INTO UNDISTURBED GROUND IN A BOREHOLE WHEN DRIVEN BY A HAMMER WITH A MASS OF 63.5kg, FALLING FREELY A DISTANCE OF 0.76m. FOR PENETRATIONS OF LESS THAN 0.3m N VALUES ARE INDICATED AS THE NUMBER OF BLOWS FOR THE PENETRATION ACHIEVED. AVERAGE N VALUE IS DENOTED THUS \bar{N} .

DYNAMIC CONE PENETRATION TEST: CONTINUOUS PENETRATION OF A CONICAL STEEL POINT (51mm O.D. 60° CONE ANGLE) DRIVEN BY 475 J IMPACT ENERGY ON 'A' SIZE DRILL RODS. THE RESISTANCE TO CONE PENETRATION IS MEASURED AS THE NUMBER OF BLOWS FOR EACH 0.3m ADVANCE OF THE CONICAL POINT INTO THE UNDISTURBED GROUND.

SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSENESS.

CONSISTENCY: COHESIVE SOILS ARE DESCRIBED ON THE BASIS OF THEIR UNDRAINED SHEAR STRENGTH (c_u) AS FOLLOWS:

c_u (kPa)	0 - 12	12 - 25	25 - 50	50 - 100	100 - 200	> 200
	VERY SOFT	SOFT	FIRM	STIFF	VERY STIFF	HARD

DENSENESS: COHESIONLESS SOILS ARE DESCRIBED ON THE BASIS OF DENSENESS AS INDICATED BY SPT N VALUES AS FOLLOWS:

N (BLOWS/0.3m)	0 - 5	5 - 10	10 - 30	30 - 50	> 50
	VERY LOOSE	LOOSE	COMPACT	DENSE	VERY DENSE

ROCKS ARE DESCRIBED BY THEIR COMPOSITION AND STRUCTURAL FEATURES AND / OR STRENGTH.

RECOVERY: SUM OF ALL RECOVERED ROCK CORE PIECES FROM A CORING RUN EXPRESSED AS A PERCENT OF THE TOTAL LENGTH OF THE CORING RUN.

MODIFIED RECOVERY: SUM OF THOSE INTACT CORE PIECES, 100mm+ IN LENGTH EXPRESSED AS A PERCENT OF THE LENGTH OF THE CORING RUN. THE ROCK QUALITY DESIGNATION (RQD), FOR MODIFIED RECOVERY, IS:

RQD (%)	0 - 25	25 - 50	50 - 75	75 - 90	90 - 100
	VERY POOR	POOR	FAIR	GOOD	EXCELLENT

JOINTING AND BEDDING:

SPACING	50mm	50 - 300mm	0.3m - 1m	1m - 3m	> 3m
JOINTING	VERY CLOSE	CLOSE	MOD. CLOSE	WIDE	VERY WIDE
BEDDING	VERY THIN	THIN	MEDIUM	THICK	VERY THICK

ABBREVIATIONS AND SYMBOLS

FIELD SAMPLING

S S	SPLIT SPOON	T P	THINWALL PISTON
W S	WASH SAMPLE	O S	OSTERBERG SAMPLE
S T	SLOTTED TUBE SAMPLE	R C	ROCK CORE
B S	BLOCK SAMPLE	P H	T W ADVANCED HYDRAULICALLY
C S	CHUNK SAMPLE	P M	T W ADVANCED MANUALLY
T W	THINWALL OPEN	F S	FOIL SAMPLE

STRESS AND STRAIN

u_w	kPa	PORE WATER PRESSURE
r_u	1	PORE PRESSURE RATIO
σ	kPa	TOTAL NORMAL STRESS
σ'	kPa	EFFECTIVE NORMAL STRESS
τ	kPa	SHEAR STRESS
$\sigma_1, \sigma_2, \sigma_3$	kPa	PRINCIPAL STRESSES
ϵ	%	LINEAR STRAIN
$\epsilon_1, \epsilon_2, \epsilon_3$	%	PRINCIPAL STRAINS
E	kPa	MODULUS OF LINEAR DEFORMATION
G	kPa	MODULUS OF SHEAR DEFORMATION
μ	1	COEFFICIENT OF FRICTION

MECHANICAL PROPERTIES OF SOIL

m_v	kPa ⁻¹	COEFFICIENT OF VOLUME CHANGE
C_c	1	COMPRESSION INDEX
C_s	1	SWELLING INDEX
C_α	1	RATE OF SECONDARY CONSOLIDATION
c_v	m ² /s	COEFFICIENT OF CONSOLIDATION
H	m	DRAINAGE PATH
T_v	1	TIME FACTOR
U	%	DEGREE OF CONSOLIDATION
σ'_{vo}	kPa	EFFECTIVE OVERBURDEN PRESSURE
σ'_p	kPa	PRECONSOLIDATION PRESSURE
τ_f	kPa	SHEAR STRENGTH
c'	kPa	EFFECTIVE COHESION INTERCEPT
ϕ'	-°	EFFECTIVE ANGLE OF INTERNAL FRICTION
c_u	kPa	APPARENT COHESION INTERCEPT
ϕ_u	-°	APPARENT ANGLE OF INTERNAL FRICTION
τ_R	kPa	RESIDUAL SHEAR STRENGTH
τ_r	kPa	REMOULDED SHEAR STRENGTH
S_t	1	SENSITIVITY = $\frac{c_u}{\tau_r}$

PHYSICAL PROPERTIES OF SOIL

ρ_s	kg/m ³	DENSITY OF SOLID PARTICLES	e	1, %	VOID RATIO	e_{min}	1, %	VOID RATIO IN DENSEST STATE
γ_s	kn/m ³	UNIT WEIGHT OF SOLID PARTICLES	n	1, %	POROSITY	I_D	1	DENSITY INDEX = $\frac{e_{max} - e}{e_{max} - e_{min}}$
ρ_w	kg/m ³	DENSITY OF WATER	w	1, %	WATER CONTENT	D	mm	GRAIN DIAMETER
γ_w	kn/m ³	UNIT WEIGHT OF WATER	S_r	%	DEGREE OF SATURATION	D_n	mm	n PERCENT - DIAMETER
P	kg/m ³	DENSITY OF SOIL	w_L	%	LIQUID LIMIT	C_u	1	UNIFORMITY COEFFICIENT
γ	kn/m ³	UNIT WEIGHT OF SOIL	w_p	%	PLASTIC LIMIT	h	m	HYDRAULIC HEAD OR POTENTIAL
ρ_d	kg/m ³	DENSITY OF DRY SOIL	w_s	%	SHRINKAGE LIMIT	q	m ³ /s	RATE OF DISCHARGE
γ_d	kn/m ³	UNIT WEIGHT OF DRY SOIL	I_p	%	PLASTICITY INDEX = $w_L - w_p$	v	m/s	DISCHARGE VELOCITY
ρ_{sat}	kg/m ³	DENSITY OF SATURATED SOIL	I_L	1	LIQUIDITY INDEX = $\frac{w - w_p}{I_p}$	i	1	HYDRAULIC GRADIENT
γ_{sat}	kn/m ³	UNIT WEIGHT OF SATURATED SOIL	I_C	1	CONSISTENCY INDEX = $\frac{w_L - w}{I_p}$	k	m/s	HYDRAULIC CONDUCTIVITY
ρ'	kg/m ³	DENSITY OF SUBMERGED SOIL	e_{max}	1, %	VOID RATIO IN LOOSEST STATE	j	kn/m ²	SEEPAGE FORCE
γ'	kn/m ³	UNIT WEIGHT OF SUBMERGED SOIL						

RECORD OF BOREHOLE No OPA-08-1

1 OF 2

METRIC

W.P. 319-85-00 LOCATION Highway 11, Opatatika River Sta. 12+705 o/s 2.0 m Rt ORIGINATED BY RP
 DIST 53 HWY 11 BOREHOLE TYPE Steel Casing, Split Spoon, Coring COMPILED BY RP
 DATUM Geodetic DATE 8.13.08 - 8.13.08 CHECKED BY GTC

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC NATURAL LIQUID LIMIT MOISTURE LIMIT CONTENT			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		W _p	W	W _L		
218.3 0.0	Water Surface Water													
216.0 2.3	Silty CLAY (CL), some sand, trace gravel, trace to some organics, wet Stiff to hard Grey		1	SS	12									
			2	SS	35									
214.3 4.0	Silty SAND (SM) TILL trace gravel, trace clay, moist to wet Dense to very dense Grey		3	SS	25									
			4	SS	25									
			5	SS	118									
			6	SS	79									
			7	SS	50									
			8	SS	33									
			9	SS	61									
203.5 14.8														

ONTARIO MOT 1015345 OPASATIKA AUG 2008.GPJ ONTARIO MOT.GDT 12/19/08

Continued Next Page

Numbers refer to Sensitivity \times^3, \times^3 \circ 3% STRAIN AT FAILURE

✕³, ×³: Numbers refer to Sensitivity ○^{3%} STRAIN AT FAILURE

RECORD OF BOREHOLE No OPA-08-2

1 OF 1

METRIC

W.P. 319-85-00 LOCATION Highway 11, Opatatika River Sta. 12+745 o/s 3.0 m Rt ORIGINATED BY RP
 DIST 53 HWY 11 BOREHOLE TYPE Steel Casing, Split Spoon, Coring COMPILED BY RP
 DATUM Geodetic DATE 8.14.08 - 8.14.08 CHECKED BY GTC

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 (%)					
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa		WATER CONTENT (%)				GR	SA	SI	CL		
218.3 0.0	Water Surface Water						218												
							217												
216.6 1.7	Non fibrous PEAT (PT), with silt and sand, wood debris, plant matter, saturated Very soft to soft Black		1	SS	WH		216												
			2	SS	1		215												
			3	SS	1		214												
			4	SS	2		213												
213.9 4.4	Sand (SP), trace silt, with organics, wet Very loose Dark Brown to Black		5	SS	2		212												
								211											
212.4 5.9	Sandy SILT and Silty SAND (SC-SM) TILL, trace gravel, trace clay, moist Dense to very dense Grey		6	SS	65		210												
								209											
							208												
							207												
							206												
207.5 10.8	Fair quality pinkish grey GNEISS - moderate joint spacing - fresh TCR = 90% SCR = 63% RQD = 55% TCR = 97% SCR = 85% RQD = 90%		1	NQ															
			2	NQ															
205.0 13.3	END OF BOREHOLE at approximately 13.3 m																		

ONTARIO MOT 1015345 OPASATIKA AUG 2008.GPJ ONTARIO MOT.GDT 12/19/08

RECORD OF BOREHOLE No OPA-08-3

1 OF 1

METRIC

W.P. 319-85-00 LOCATION Highway 11, Opasatika River Sta. 12+758 o/s 5.0 m Lt ORIGINATED BY RP
 DIST 53 HWY 11 BOREHOLE TYPE Steel Casing, Split Spoon, Coring COMPILED BY RP
 DATUM Geodetic DATE 8.15.08 - 8.15.08 CHECKED BY GTC

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	✕ LAB VANE	WATER CONTENT (%)					
219.7	Vegetated Ground Surface						20	40	60	80	100						
219.6 0.1	125 mm TOPSOIL: silty sand with gravel FILL: clayey silt, some gravel, with organics, wet Brown to grey		1	SS	4	▽											
			2	AS													
			3	SS	7												
217.6	Organic SILT (OL) some sand, trace gravel, trace clay, trace peat, moist to wet Loose Dark grey to black		4	SS	4												
			5	SS	4												
215.1	- wood fragments		6	SS	2												
4.6	Silty CLAY (CL), trace sand, trace gravel, wet Very soft to stiff Grey																
			7	SS	13												
212.4	SAND (SP) TILL, trace gravel, trace silt, wet Very Dense Grey		8	SS	110												
7.3 212.0																	
7.7	Silty SAND (SP) TILL, trace gravel, trace clay, moist Very Dense Grey		9	SS	53												
209.3	Fair quality pinkish grey GNEISS - moderate joint spacing - fresh TCR = 98% SCR = 84% RQD = 89% TCR = 90% SCR = 75% RQD = 85%		10	SS	100												
			1	NQ													
			2	NQ													
206.3 13.4	END OF BOREHOLE at approximately 13.4 m Groundwater first encountered at a depth of approximately 2.1 m (El. 217.6 m)																

ONTARIO MOT 1015345 OPASATIKA AUG 2008.GPJ ONTARIO MOT.GDT 12/19/08

RECORD OF BOREHOLE No OPA-07-1

1 OF 2

METRIC

W.P. 319-85-00 LOCATION Opasatika River Sta. 12+676 o/s 2 m Rt ORIGINATED BY NH
 DIST 53 HWY 11 BOREHOLE TYPE Hollow Stem Auger, Split Spoon COMPILED BY NH
 DATUM Geodetic DATE 7.21.07 - 7.21.07 CHECKED BY GTC

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						
220.7	Grass							20 40 60 80 100						
220.6	125 mm TOPSOIL: silty sand trace gravel with high organic content FILL: brown sand, some silt and clay, trace gravel, damp to moist		1	SS	4		220							1 78 (21)
220.0			2	SS	3									6 74 (20)
218.7			3	SS	3		219							
218.0	Silty CLAY (CL) trace to some sand, with organic matter, wet Firm to stiff Grey		4	SS	7		218							
214.6			5	SS	10		217							0 16 54 30
214.6			6	SS	11		216							
214.6			7	SS	13		215							
214.6			8	SS	10		214							
214.6	Silty SAND (SM) TILL, trace to some clay, trace gravel, occasional cobbles and boulders, wet Compact to very dense Grey		9	SS	15		213							
214.6			10	SS	43		212							
214.6			11	SS	46		211							5 39 46 10
214.6			12	SS	140		210							
214.6			13	SS	176		209							
214.6			14	SS	115		208							
214.6							207							
214.6							206							

Continued Next Page

×³, ×³: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

METRIC[illegible]

✖³, ×³: Numbers refer to Sensitivity ○^{3%} STRAIN AT FAILURE

RECORD OF BOREHOLE No OPA-07-2

1 OF 2

METRIC

W.P. 319-85-00 LOCATION Opasatika River Sta. 12+695 o/s 35 m Rt ORIGINATED BY NH
 DIST 53 HWY 11 BOREHOLE TYPE Steel Casing, Split Spoon COMPILED BY NH
 DATUM Geodetic DATE 8.9.07 - 8.10.07 CHECKED BY GTC

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 (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa		WATER CONTENT (%)			
218.5 0.0	WATER						20 40 60 80 100	20 40 60 80 100	10 20 30			GR SA SI CL	
217.1 1.4	Silty CLAY (CL-ML), wet Firm Grey		1	SS	7								
216.2 2.3	SILT (ML) some clay, trace sand and gravel, wet Compact Grey		2	SS	14								
			3	SS	12								2 1 85 12
214.9 3.7	Silty SAND (SM) with gravel Very dense Grey		4	SS	66								
			5	SS	100/ 127 mm								
213.3 5.2	CLAY (CI) with silt, trace gravel and sand, wet Stiff Grey		6	SS	14								3 4 34 59
212.4 6.1	Silty SAND (SM) TILL some clay, trace to some gravel, occasional cobbles and boulders, wet Compact to very dense Grey		7	SS	86								
			8	SS	50								
			9	SS	46								
			10	SS	26								
			11	SS	126								
204.6 13.9			12	SS	100/ 75 mm								

Continued Next Page

✕³, ✕³: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

ONTARIO MOT 1015345 OPASATIKA JULY 2007.GPJ ONTARIO MOT.GDT 12/19/08

✕³, ×³: Numbers refer to Sensitivity ○^{3%} STRAIN AT FAILURE

RECORD OF BOREHOLE No OPA-07-3

1 OF 2

METRIC

W.P. 319-85-00 LOCATION Opasatika River Sta. 12+687 o/s 19 m Rt ORIGINATED BY RG
 DIST 53 HWY 11 BOREHOLE TYPE Hollow Stem Auger, Split Spoon COMPILED BY OL
 DATUM Geodetic DATE 7.19.07 - 7.19.07 CHECKED BY GTC

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 (%)						
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa										WATER CONTENT (%)		
								○ UNCONFINED ✕ FIELD VANE ● QUICK TRIAXIAL ✕ LAB VANE										w _p w w _L		
223.3	Asphalt							20	40	60	80	100								
223.0	175 mm ASPHALT		1	AS	-		223													
0.2	FILL: brown sand, with silt, some clay, trace gravel		2	SS	6		222													
		3	SS	11																
		4	SS	8																
		5	SS	6																
		6	SS	6																
219.6	Non fibrous PEAT some silty clay, trace sand Loose Brown		6	SS	4		219													
7		SS	4																	
8		SS	5																	
9		SS	6																	
217.2	Silty CLAY (CL-ML) some sand, trace gravel Firm to Hard Brown to grey		9	SS	6		217													
10		SS	8																	
11		SS	102																	
12		SS	37																	
211.5	Silty SAND (SM) TILL some clay, trace gravel, with occasional to frequent cobbles and boulders Very dense Brown to grey		13	SS	110 / 250 mm		211													
210																				
209																				

Continued Next Page

Numbers refer to Sensitivity $\times 3, \times 3$ \circ 3% STRAIN AT FAILURE

METRIC

[illegible]






✖³, ✕³: Numbers refer to Sensitivity ○^{3%} STRAIN AT FAILURE

RECORD OF BOREHOLE No OPA-07-4

1 OF 2

METRIC

W.P. 319-85-00 LOCATION Opasatika River Sta. 12+737 o/s 24 m Rt ORIGINATED BY NH
 DIST 53 HWY 11 BOREHOLE TYPE Steel Casing, Split Spoon COMPILED BY NH
 DATUM Geodetic DATE 8.10.07 - 8.12.07 CHECKED BY GTC

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									WATER CONTENT (%)	
								○ UNCONFINED	✕ FIELD VANE	● QUICK TRIAXIAL	✕ LAB VANE							
218.6 0.0	WATER																	
217.6 1.0	FILL: black sand with asphalt		1	SS	5													
217.2 1.4	Non fibrous PEAT some silty clay, trace sand, with wood fragments Very loose to loose Grey		2	SS	10													
			3	SS	1													
			4	SS	7													
			5	SS	6													
213.5 5.1	SAND (SP) trace silt, wet Compact Grey		6	SS	23													
212.6 6.0	Silty CLAY (ML-CL), wet Hard Grey		7	SS	60													
211.6 7.0	Silty SAND (SM) TILL some gravel, trace clay, with rock fragments at 14.9 m to 15.9 m, occasional cobbles and boulders, wet Dense to very dense Grey		8	SS	82													
			9	SS	31													
			10	SS	56													
			11	SS	100/ 127 mm													
			12	SS	100/ 150 mm													

Continued Next Page

Numbers refer to Sensitivity O 3% STRAIN AT FAILURE

RECORD OF BOREHOLE No OPA-07-4

2 OF 2

METRIC

W.P. 319-85-00 LOCATION Opasatika River Sta. 12+737 o/s 24 m Rt ORIGINATED BY NH
 DIST 53 HWY 11 BOREHOLE TYPE Steel Casing, Split Spoon COMPILED BY NH
 DATUM Geodetic DATE 8.10.07 - 8.12.07 CHECKED BY GTC

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									
			13	SS	100/100 mm												
202.8			1	NQ			203										
15.8	Fair to poor quality pinkish GNEISS - very close to moderate joint spacing, dip 0 degrees to 80 degrees - slightly weathered to fresh - highly fractured at 16.9 m to 18.7 m TCR = 96% SCR = 66% RQD = 52% TCR = 100% SCR = 52% RQD = 26%		2	NQ			202										
			3	NQ			201										
199.9							200										
18.7	END OF BOREHOLE at approximately 18.7 m																

RECORD OF BOREHOLE No OPA-07-5

1 OF 2

METRIC

W.P. 319-85-00 LOCATION Opasatika River Sta. 12+758 o/s 35 m Rt ORIGINATED BY NH
 DIST 53 HWY 11 BOREHOLE TYPE Steel Casing, Split Spoon COMPILED BY NH
 DATUM Geodetic DATE 8.13.07 - 8.14.07 CHECKED BY GTC

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60 80 100	W _p W W _L	10 20 30	GR SA SI CL		
220.3	Grass													
220.0	125 mm TOPSOIL: silty sand with high organic content		1	SS	9		220							
219.1	FILL: brown sand and gravel, moist - moist to 1.2 m		2	SS	18		219							
218.6	FILL: silty clay, moist													
218.0	Silty CLAY (CL-ML) with sand, wet Firm to stiff Brown to grey		3	SS	9		218							
213.7	Sandy Silty CLAY (CL-ML) Firm to stiff Grey		4	SS	5		217							
			5	SS	4		216							
			6	SS	5		215							
			7	SS	7		214							
			8	SS	15		213							
			9	SS	16		212							
			10	SS	58		211							
			11	SS	102		210							
			12	SS	60		209							
			13	SS	43		208							
			14	SS	100/150 mm		207							
							206							

Continued Next Page

Numbers refer to Sensitivity \times^3, \times^3 \circ 3% STRAIN AT FAILURE

2 OF 2

METRIC

SOIL PROFILE						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	SAMPLES		SHEAR STRENGTH kPa			WATER CONTENT (%)					
			NUMBER	TYPE	"N" VALUES								
203.5	Silty SAND (SM) TILL trace gravel and clay, boulder at 13.1 m to 13.3 m, occasional cobbles and boulder, wet Dense to very dense Grey(<i>continued</i>)		15	SS	100/ 100 mm	205							
16.8			Fair quality grey GNEISS - close to moderate joint spacing, dip 0 degrees to 70 degrees - fresh - very hard at 18 m to 19.6 m TCR=100% SCR=80% RQD=73%	1	NQ		203						
200.7			2	NQ		202							
19.6			END OF BOREHOLE at approximately 19.6 m Groundwater first encountered at a depth of approximately 1.8 m (El. 218.5 m)				201						

✕³, ×³: Numbers refer to Sensitivity ○^{3%} STRAIN AT FAILURE

RECORD OF BOREHOLE No OPA-07-6

1 OF 2

METRIC

W.P. 319-85-00 LOCATION Opasatika River Sta. 12+768 o/s 13 m Rt ORIGINATED BY RG
 DIST 53 HWY 11 BOREHOLE TYPE Hollow Stem Auger, Split Spoon COMPILED BY OL
 DATUM Geodetic DATE 7.18.07 - 7.18.07 CHECKED BY GTC

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC NATURAL LIQUID LIMIT MOISTURE LIMIT CONTENT			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	W _p W W _L	10 20 30			
223.1	Asphalt													
223.0	63 mm ASPHALT FILL: brown sand, some silt and clay, trace gravel		1	AS	-									
			2	SS	7									5 71 (24)
			3	SS	18									
			4	SS	7									
			5	SS	6									
			6	SS	1									
218.5														
4.6	Silty CLAY (CL-ML) some sand, trace organic matter Firm Brown to grey		7	SS	8									
			8	SS	WH									
216.9														
6.1	Silty SAND (SM) with clay, wet Very loose Grey		9	SS	2									
			10	SS	1									
213.9														
9.1	Silty CLAY (CL-ML) some sand Firm Grey		11	SS	7									0 16 57 27
212.4														
10.7	Silty SAND (SM) TILL trace to some gravel, trace clay, with occasional cobbles and boulders, wet Dense to very dense Grey		12	SS	33									
			13	SS	63									
			14	SS	31									

Continued Next Page

Numbers refer to
Sensitivity

3% STRAIN AT FAILURE

METRIC

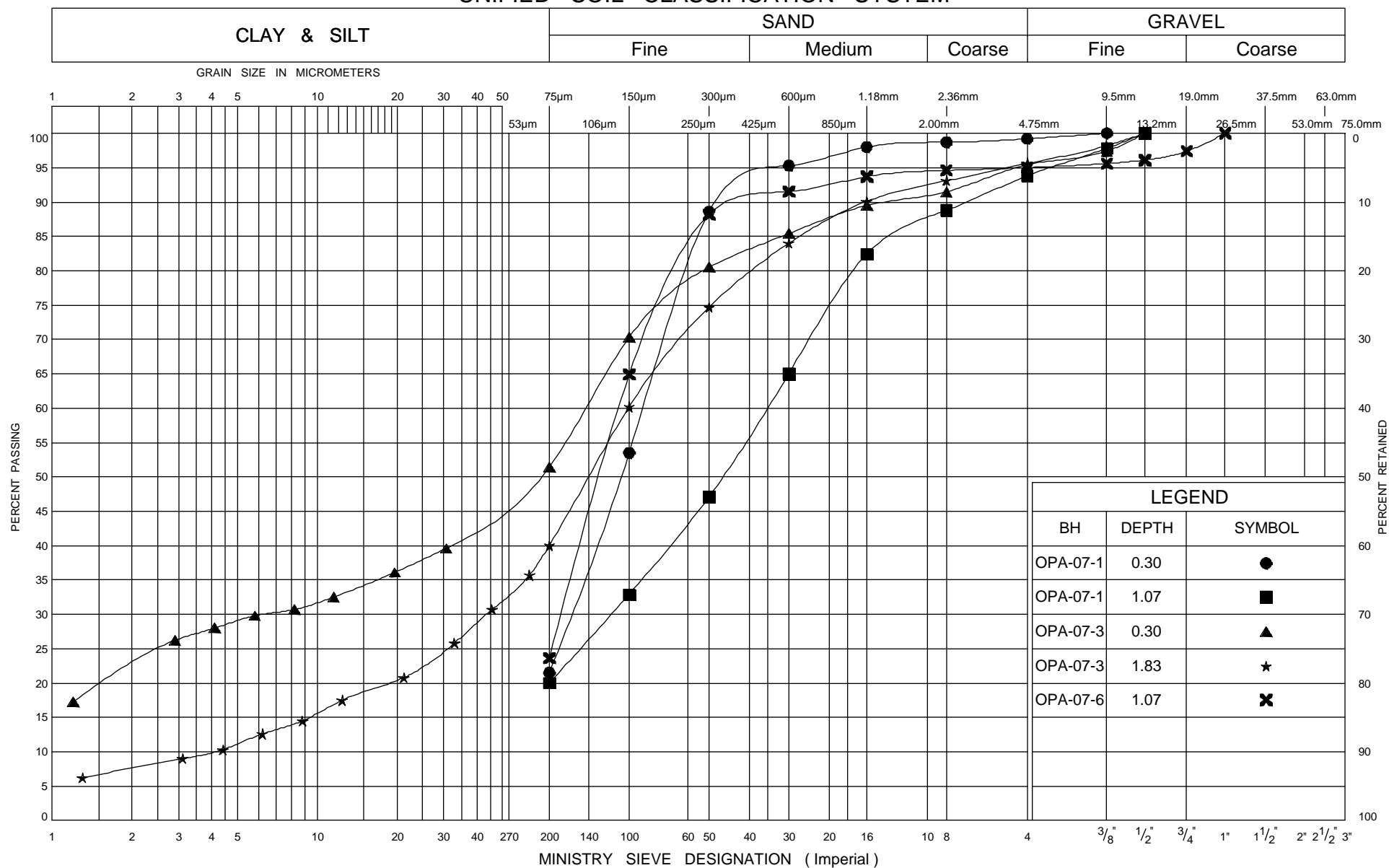
[illegible]

✕³, ×³: Numbers refer to Sensitivity ○^{3%} STRAIN AT FAILURE

Appendix C

Geotechnical Laboratory Test Results

UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of
Transportation

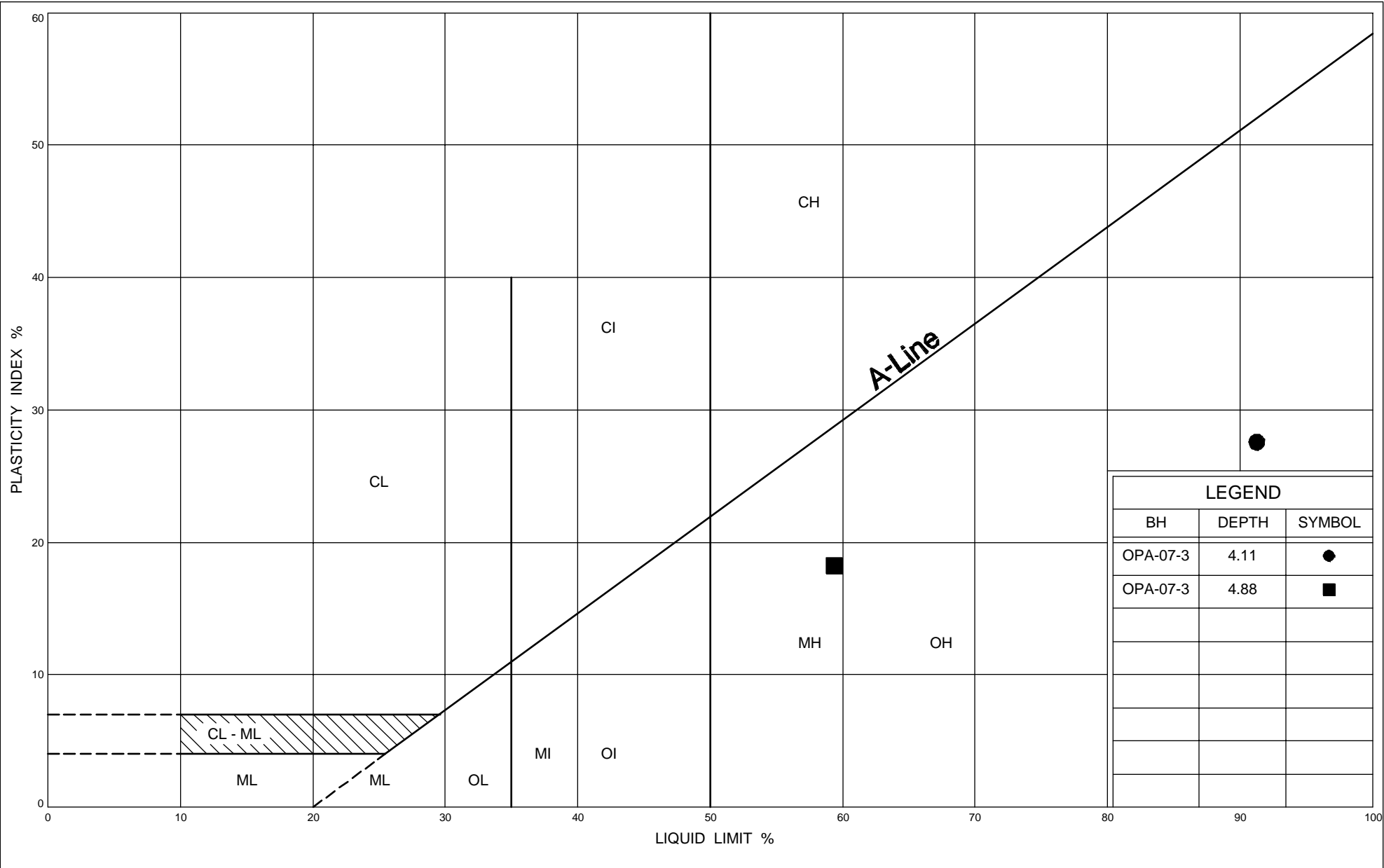
GRAIN SIZE DISTRIBUTION

Sand Fill

FIG No 1

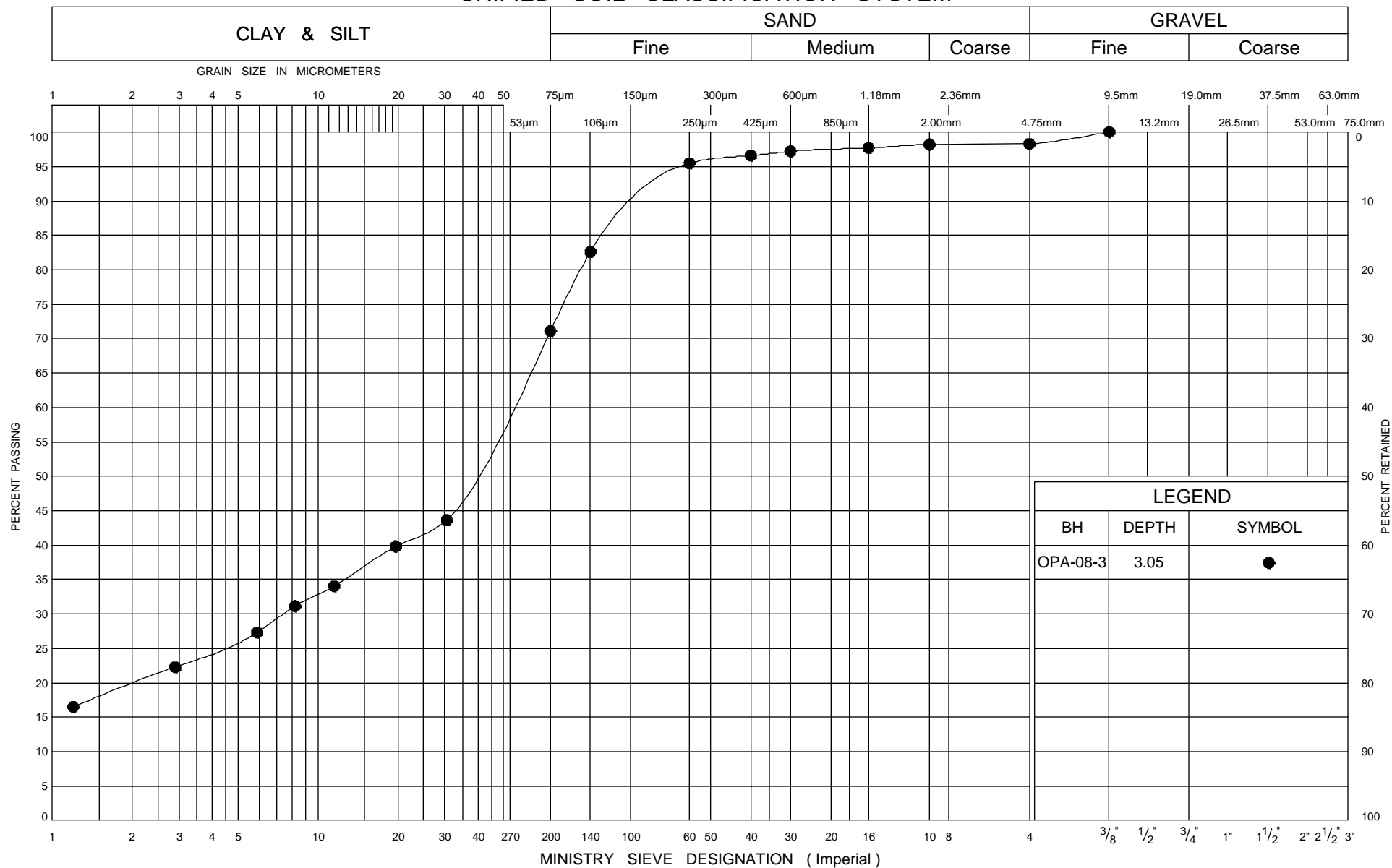
W P 319-85-00

Opasatika Bridge/Hwy 11, Hearst, Ont.



LEGEND		
BH	DEPTH	SYMBOL
OPA-07-3	4.11	●
OPA-07-3	4.88	■

UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of
Transportation

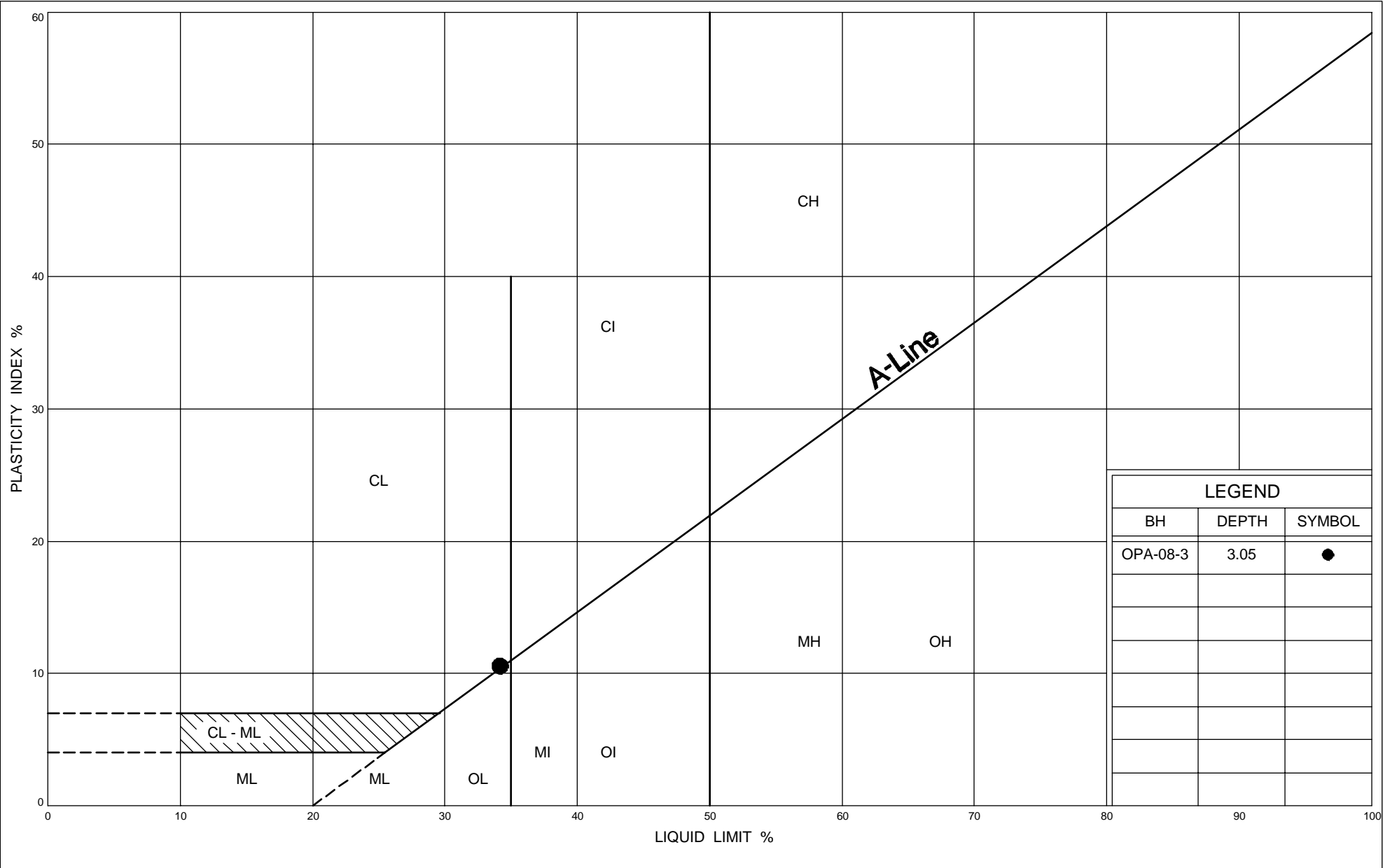
GRAIN SIZE DISTRIBUTION

Organic Sandy SILT with clay, trace gravel

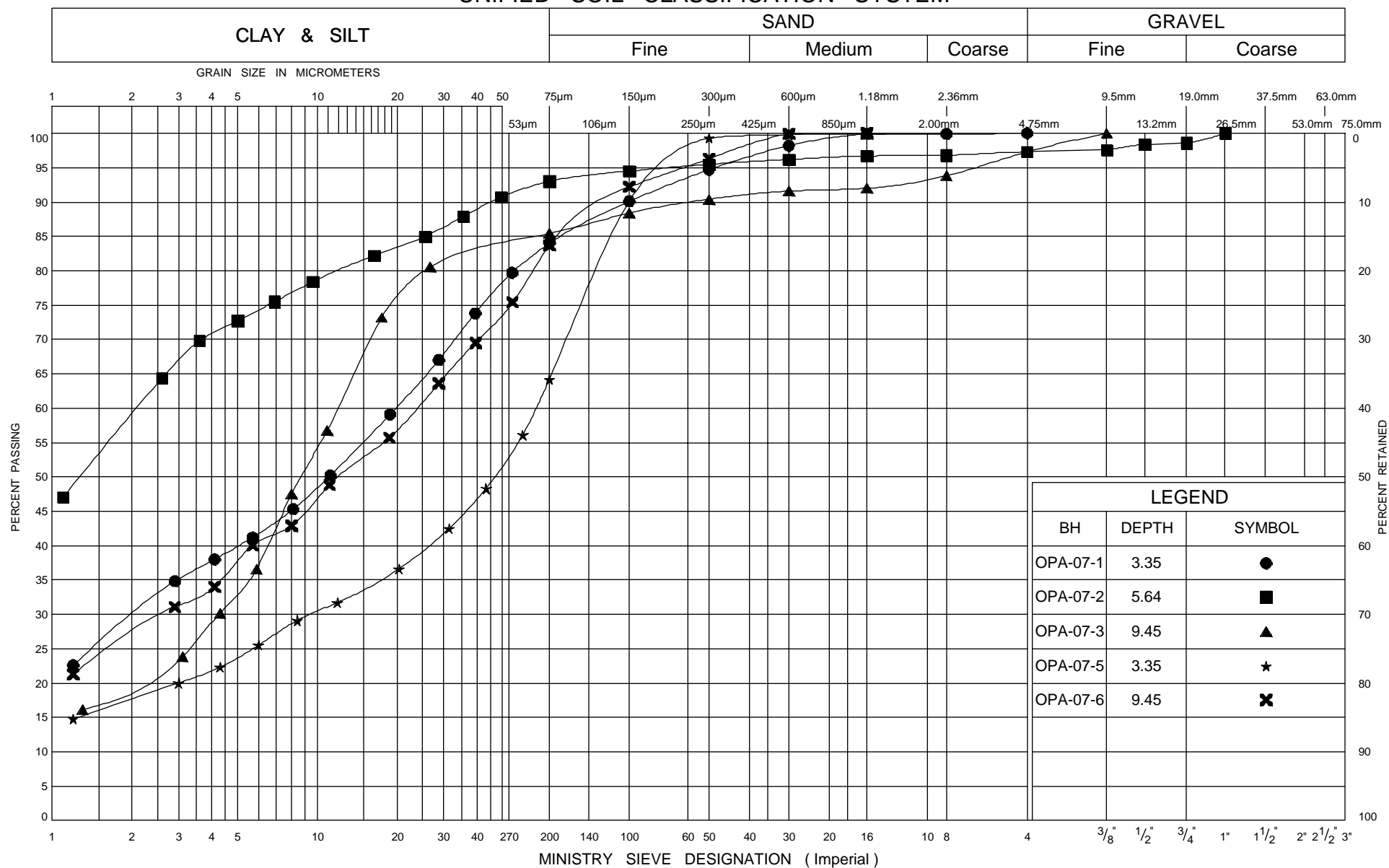
FIG No 3

W P 319-85-00

Opasatika Bridge/Hwy 11, Hearst, Ont.



UNIFIED SOIL CLASSIFICATION SYSTEM



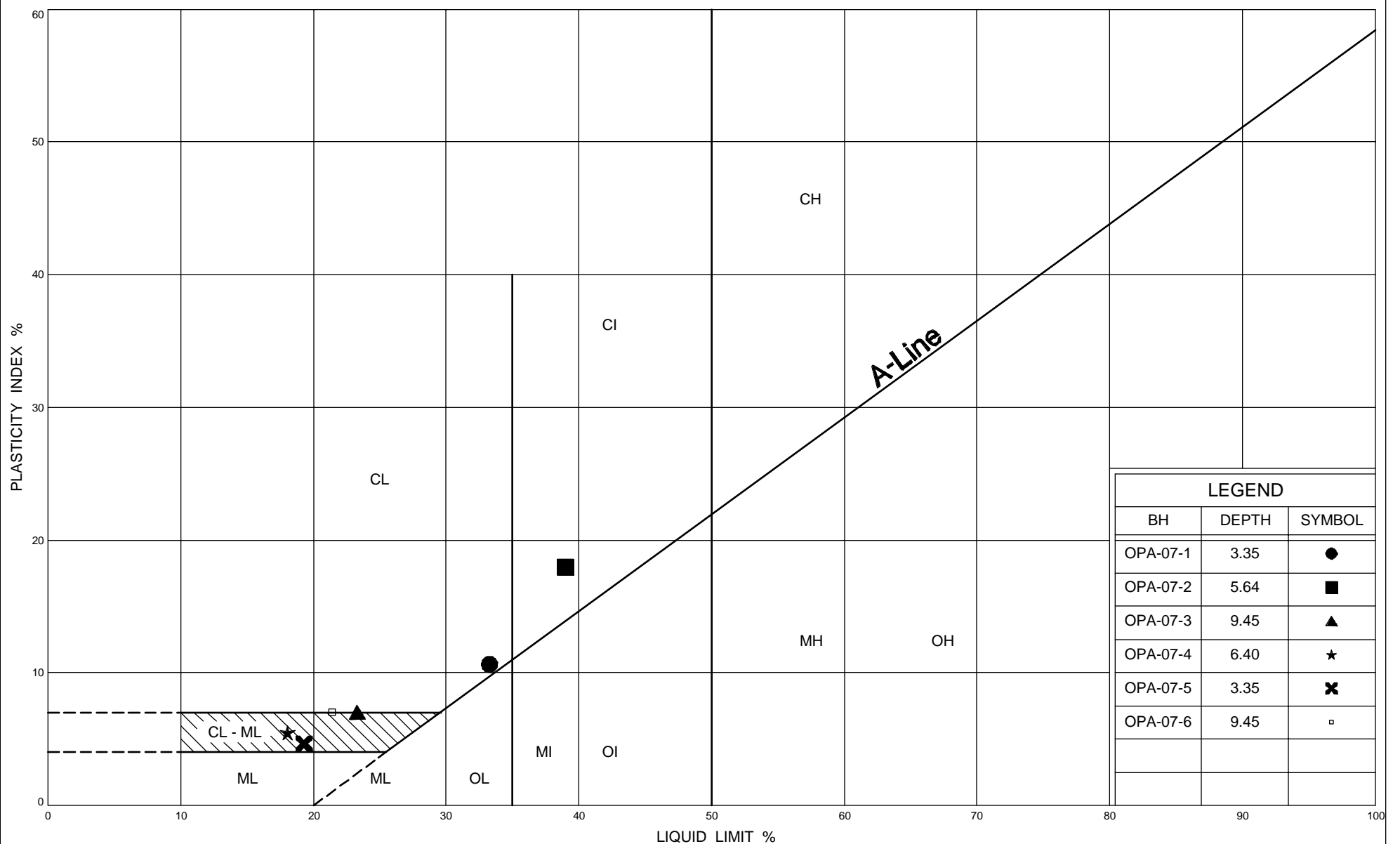
Ministry of
Transportation

GRAIN SIZE DISTRIBUTION
Clay (CI)
Silty Clay to Sandy Clayey Silt (CL-ML, CL)

FIG No 5

W P 319-85-00

Opasatika Bridge/Hwy 11, Hearst, Ont.



Coarse

LEGEND

BH	DEPTH	SYMBOL
OPA-07-2	3.20	●

BH	DEPTH	SYMBOL
OPA-07-2	3.20	●

OPA-07-2

3.20

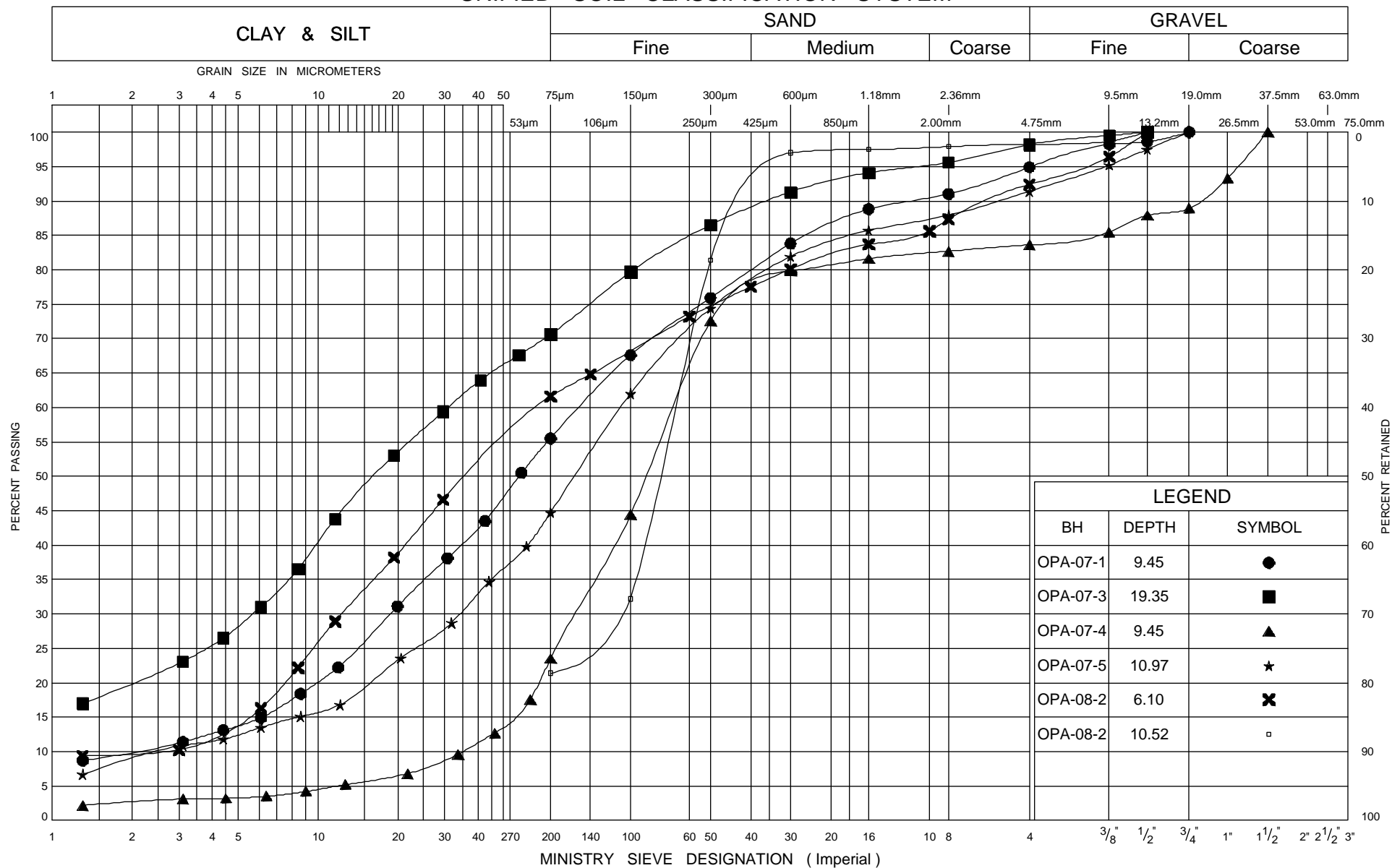


Silt (ML)

Opasatika Bridge/Hwy 11, Hearst, Ont.

Ministry of
Transportation

UNIFIED SOIL CLASSIFICATION SYSTEM



GRAIN SIZE DISTRIBUTION
Sand Silt and Silty Sand Till (SM, SC - SM)

FIG No 8

W P 319-85-00

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Ontario