

Report

Foundation Investigation
Report
Proposed Noise Barrier Wall
Sta . 13+900 to 14+375
Highway 402
City of Sarnia, Ontario
District - London
G.W.P. 3038-03-00

STANTEC CONSULTING LTD.

PROJECT NO. 1012607
GEOCRES NO. 40J16-81

REPORT NO. 1012607

REPORT TO **Stantec Consulting Limited**
 1400 Rymal Road
 Hamilton, Ontario

FOR **Foundation Investigation Report**

ON **Proposed Noise Barrier Wall**
 Sta. 13+900 to 14+375
 Highway 402
 City of Sarnia, Ontario
 G.W.P. 3038-03-00
 District – London
 GEOCRES NO. 40J16-81

November 7, 2008

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Record of Borehole Sheet
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FOUNDATION INVESTIGATION REPORT

**Proposed Noise Barrier Wall
Sta 13+900 to 14+375
Highway 402
City of Sarnia, Ontario
G.W.P. 3038-03-00
District – London**

1.0 INTRODUCTION

Jacques Whitford Limited (Jacques Whitford) was retained by Stantec Consulting Ltd. to complete a Foundation Investigation Report for a proposed noise barrier wall to be located on the north side of Highway 402 between Stations (Sta.) 13+900 and 14+375 in the City of Sarnia, Ontario (W.P. No. 3038-03-00).

The work was carried out under Agreement No. 3005-E-0029 and in general accordance with the Subconsultant Agreement dated May 24, 2006. Authorization to proceed with the investigation was provided by Mr. David Emery, P.Eng., of Stantec Consulting Ltd., the prime consultant on this detailed design assignment.

The scope of work for the foundation investigation is incorporated within Stantec's project, which forms part of the above noted subconsultant agreement.

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

2.0 SITE DESCRIPTION

The investigation is for a proposed noise barrier wall that will be located on the north side of Highway 402, east of Murphy Road, from approximately Sta. 13+900 to Sta. 14+375 in the City of Sarnia, Ontario.

Highway 402 is generally oriented in an east-west direction with two east bound and two west bound lanes. The highway is generally a semi-urban freeway with partially paved shoulders and a wide grass covered centre median. The highway is generally about 2 m to 3 m higher than the grade of the adjacent lands and 6 m to 9 m higher than the adjacent lands at overpasses.

Drainage is provided by ditches along the sides and in the central median of the highway. The ditches are sloped towards catch basins located along the existing highway. Regional drainage is towards the St. Clair River located approximately 4 km to the west of the noise barrier wall location.



3.0 PHYSIOGRAPHY

Based on the physiography of Southern Ontario by Chapman and Putnam (1984), this section of Highway 402 is situated in the physiographic region known as the Huron Fringe, a narrow geological strip between Lake Huron and the adjacent St. Clair Clay Plains. The Huron Fringe is composed mainly of surficial sands, silts and gravels, underlain by lacustrine clayey silt and silty clay.

The bedrock in the area consists of laminated, thinly bedded shale that is black to grey in colour and is of the Kettle Point Formation.

4.0 SCOPE OF WORK

The scope of work for the investigation was as follows:

- To investigate the soil and groundwater conditions along the length of the proposed noise barrier wall location by advancing a total of 7 boreholes (on the right shoulder) as outlined in the following table, and as shown on Drawings 1 and 2 in **Appendix A**.

Borehole Number	Borehole Location by Station	Borehole Offset from Centreline of Highway Median
08-2	14+370	19 m Lt
08-3	14+276	19 m Lt
08-4	14+206	20 m Lt
08-5	14+126	19 m Lt
08-6	14+098	25 m Lt
08-7	14+059	18 m Lt
08-8	13+978	21 m Lt
08-9	13+900	21 m Lt

- To conduct a laboratory testing program on selected samples of the soil obtained from the investigation; and,
- To prepare a Foundation Investigation and a Foundation Investigation and Design Report.

It is noted that Boreholes 08-1 and 08-6 were advanced to investigate the subsurface conditions for overhead sign support foundations. The factual results of Borehole 08-6 have been included in this report as they are within the study area. The factual results of Borehole 08-1 are provided under separate cover.

5.0 INVESTIGATION PROCEDURES

5.1 Field Program

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

Freeway traffic control during the drilling program was provided by On Track Safety Limited (OTS), using signs, traffic barrels and blocker vehicles, in accordance with the Ontario Traffic Manual (OTM) Book 7 Temporary Conditions.

The field investigation was carried out on August 7 and 8, 2008. The 8 boreholes (08-2 to 08-9) were advanced at the locations identified previously in this report and shown on the drawings provided in **Appendix A**.

The boreholes were advanced on the right shoulder of the highway to depths of approximately 6.6 m below existing grade using a truck mounted drill rig equipped with 150 mm diameter (outside diameter), solid-stem augers, supplied and operated by London Soils Inc. licensed under MOE Reg. 903 to install and decommission monitoring wells. Soil samples were recovered from the boreholes at regular intervals using a 50 mm Outside Diameter split-spoon sampler by conducting Standard Penetration Tests (SPTs) in general accordance with the procedures outlined in the ASTM specification D1586.

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

The groundwater levels, where encountered, were measured in the boreholes during and on completion of drilling. The boreholes were backfilled on completion of drilling in accordance with Ontario Ministry of the Environment Regulation 903.

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.

The subsurface conditions encountered in the boreholes are summarized on the Record of Borehole sheets in **Appendix B**. Additional comments are provided in the subsequent sections of this report.

5.2 Survey

The borehole locations were established in the field by Jacques Whitford personal by measuring from existing site features with a known station reference. Borehole locations and offsets are referenced to the stations established for the Highway 402 median centreline.

The ground surface elevations at the respective borehole locations were inferred from drawings provided by Stantec Consulting Limited. It is understood that the drawing elevations are referenced to a Geodetic datum.

5.3 Laboratory Testing

All samples transported to the laboratory were subjected to detailed visual examination and classification. Approximately 25% of the soil samples were submitted for routine testing including grain



size distribution, Atterberg Limits and moisture content determination 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 to 6 in **Appendix C**.

Unless requested in advance, all samples will be stored in our laboratory for a period of twelve 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 provided in **Appendix B**.

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

6.2 Soil

6.2.1 Asphalt

Asphalt was encountered at the ground surface in all boreholes and was approximately 150 mm thick.

6.2.2 Sand and Gravel Fill

Sand and gravel fill was encountered under the asphalt in all boreholes. The thickness of the sand and gravel ranged from approximately 0.6 m to 1.3 m.

The sand and gravel fill was generally moist and contained varying amounts of silt (trace to some).

Based on observations during drilling and the N-Values obtained from one Standard Penetration Test (SPT), the compactness of the sand and gravel fill was assessed to be compact.

Laboratory testing conducted on the one sample obtained consisted of moisture content testing. The test result was follows:

- Moisture Content:
 - 14%

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

6.2.3 Silty Clay Fill

Silty clay fill was encountered underlying the sand and gravel fill in Borehole 08-2 to 08-7 at depths of approximately 0.8 m (elevations of approximately 182.8 m to 188.2 m). The thickness of the silty clay fill ranged from approximately 0.7 m to 2.2 m.

The silty clay fill was generally moist and contained trace to some sand and trace gravel.



Based on the N-Value obtained from the SPT's, the consistency of the silty clay fill was assessed to be firm to hard.

Laboratory testing conducted on selected samples consisted of moisture content tests, two grain size distribution tests and a single Atterberg Limits test. The test results were as follows:

- Moisture Content:
 - 8% to 15%
- Grain Size Distribution:
 - 1% and 1% gravel;
 - 19% and 23% sand;
 - 43% and 37% silt; and,
 - 37% and 39% clay.
- Atterberg Limits:
 - Liquid Limit: 28%
 - Plastic Limit: 14%
 - Plasticity Index: 14%

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 1 in **Appendix C**. The results of the Atterberg Limits tests are provided on Figure 2 in **Appendix C**.

6.2.4 Silty Sand Fill

A layer of silty sand fill was encountered underlying the sand and gravel fill in Borehole 08-8 at a depth of approximately 0.8 m, (an elevation of approximately 182.2 m). The thickness of the silty sand fill was approximately 0.7 m.

The silty sand fill was generally moist and contained trace gravel and clay.

Based on the N-Value obtained from a single SPT, the compactness of the silty sand fill was assessed to be compact.

6.2.5 Native Sand (SM)

A deposit of native sand was encountered in underlying the fill in Borehole 08-7 at a depth of approximately 2.3 m (an elevation of approximately 181.3 m) below existing grade. The thickness of the sand stratum was approximately 3.8 m.

The sand was generally moist to wet and contained trace fines (silt and clay).

Based on the N-Values obtained from the SPTs, the compactness of the sand was assessed to be loose to compact.

Laboratory testing conducted on selected samples consisted of moisture content tests and a single grain size distribution test. The test results were as follows:

- Moisture Contents:



- 19% to 23%
- Grain Size Distribution:
 - 0% gravel;
 - 94% sand; and,
 - 6% fines (silt and clay).

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

The results of the grain size distribution tests are also provided on Figure 3 in **Appendix C**.

6.2.6 Silty Sand (SP-SM)

Silty sand was encountered underlying the fill in Boreholes 08-6, 08-8 and 08-9 and underlying the silty clay (described below) in Boreholes 08-5. The silty sand was encountered in these boreholes at depths of approximately 1.5 to 4.6 m below existing grade (elevations of approximately 180.2 m to 181.4 m). The thickness of the silty sand ranged from approximately 1.6 m to 3.1 m. Borehole 08-5 was terminated in the silty sand layer at a depth of approximately 6.6 m below existing grade (an elevation of approximately 178.2 m).

The silty sand was generally wet to saturated and contained trace to some clay and trace gravel.

Based on the N-Values obtained from the SPT's, the compactness of the silty sand was assessed to be very loose to compact.

Laboratory testing conducted on selected samples consisted of moisture content tests and a single grain size distribution test. The test results were as follows:

- Moisture Content:
 - 17% to 28%
- Grain Size Distribution:
 - 0% gravel;
 - 43% sand;
 - 47% silt; and,
 - 10% clay.

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

The results of the grain size distribution test are also provided on Figure 4 in **Appendix C**.

6.2.7 Silty Clay (CL)

Silty clay was encountered underlying the fill, sand, and silty sand in all boreholes. The silty clay was encountered at depths in the range of approximately 1.5 m to 6.1 m below existing grade (elevations of approximately 177.5 m to 186.4 m). Boreholes 08-2 to 08-4 and 08-6 to 08-9 were terminated in the silty clay at a depth of approximately 6.6 m below existing grade (elevations of approximately 176.2 m to 182.4 m).



The silty clay was generally moist to damp and generally contained some sand and trace gravel. The possible presence of cobbles and boulders was inferred in Borehole 08-2.

Based on the N-Values obtained from the SPTs, the consistency of the silty clay was assessed to be stiff to very hard, but was more typically stiff to very stiff.

Laboratory testing conducted on selected samples consisted of moisture content tests and two grain size distribution and Atterberg Limits tests. The test results were as follows:

- Moisture Content:
 - 11% to 18%
- Grain Size Distribution:
 - 1% gravel;
 - 23% and 24% sand;
 - 38% and 43% silt; and,
 - 33% and 36% clay
- Atterberg Limits:
 - Liquid Limit: 25% and 29%
 - Plastic Limit: 13% and 14%
 - Plasticity Index: 12% and 15%

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 5 in **Appendix C**. The results of the Atterberg Limits tests are provided on Figure 6.

6.3 Borehole Cave and Groundwater Conditions

The following table outlines the cave and groundwater conditions encountered during drilling:

Borehole	Cave on completion of drilling		Groundwater conditions on completion of drilling	
	Depth (m)	Elevation (m)	Depth (m)	Elevation (m)
08-2	Open	-	Dry	-
08-3	Open	-	Dry	-
08-4	Open	-	Dry	-
08-5	4.4	180.3	4.3	180.4
08-6	3.4	180.9	3.4	180.9
08-7	3.4	180.2	3.4	180.2
08-8	2.4	180.6	2.4	180.6
08-9	2.4	180.4	2.4	180.4

It is noted that the groundwater conditions reported were based on measurements obtained during and immediately after drilling and may therefore not be representative of the equilibrated groundwater level. In addition, the levels noted are subject to seasonal fluctuations and in response to weather events.

7.0 CLOSURE

A soil investigation is a limited sampling of a site. The information provided herein was obtained 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 groundwater 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 which 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

John J. Brisbois, M.Sc.Eng., P.Eng.
Principal

Original Signed by

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



Appendix A

Borehole Location Plans

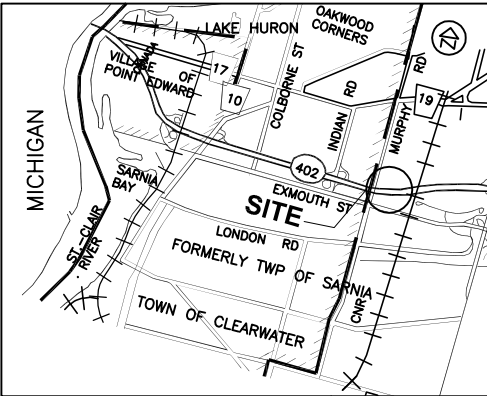
METRIC
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN

CONT. No.
WP No. 3038-03-00



BOREHOLE LOCATION PLAN
13+850 TO 14+400
PROPOSED NOISE BARRIER WALL
HIGHWAY 402,
SARNIA, ONTARIO

SHEET



LEGEND

BOREHOLE
(Jacques Whitford, 2008)

BH No.	ELEVATION (m)	STA.	OFF SET
08-2	188.9	14+370	19 m LT
08-3	187.7	14+276	19 m LT
08-4	186.4	14+206	20 m LT
08-5	184.7	14+126	19 m LT
08-6	184.3	14+098	25 m LT
08-7	183.6	14+059	18 m LT
08-8	182.9	13+978	21 m LT
08-9	182.8	13+900	21 m LT

0 m 100 m

Scale

NOTE:
* Base Plan provided by Stantec Consulting.
* Borehole locations and site features shown are approximate and may vary from that shown.

NOTE:1) The complete foundation investigation and design report for this project and other related documents may be examined at the Engineering Materials Office, Downsview. Information contained in this report and related documents is specifically excluded in accordance with the conditions of Section 102-2 of Form 100.
2) This drawing is for subsurface information only. Surface details and features are for conceptual illustration.

REVISIONS	DATE	BY	DESCRIPTION
1			

GEOGRES No 40 J16-81

HWY No 402	CHECKED	DATE 2008-10-29	DIST LONDON
SUBM'D GC	CHECKED	APPROVED	SITE -
DRAWN PC/HZ	CHECKED		DWG 1

Appendix B

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

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 08-2

1 OF 1

METRIC

W.P. 3038-03-00 LOCATION Highway 402, Stn.: 14+370 o/s: 19 m Lt, Twp of Sarnia ORIGINATED BY OL
 DIST London HWY 402 BOREHOLE TYPE Solid Stem Auger, Split Spoon COMPILED BY OL
 DATUM Geodetic DATE 8.7.08 - 8.7.08 CHECKED BY GC

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									
188.9	Hwy 402 W.B. Rt. Shoulder						20	40	60	80	100						
188.8	150 mm ASPHALT																
0.2	SAND and GRAVEL (FILL), damp Brown																
188.2																	
0.8	Silty CLAY (FILL), trace to some sand, trace gravel, moist, hard to very stiff, brown		1	SS	36												
			2	SS	28												
186.4			3	SS	30												
2.5	Silty CLAY, trace to some sand, trace gravel, moist, hard to very stiff, brown (CL)		4	SS	29												
	- Augers Grinding on possible cobble or boulder		5	SS	50 / 150 mm												
	- Augers Grinding on possible cobble or boulder																
	- hard		6	SS	36												
182.4																	
6.6	END OF BOREHOLE at approximately 6.6 m Borehole open and dry on completion of drilling																

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

RECORD OF BOREHOLE No 08-3

1 OF 1

METRIC

W.P. 3038-03-00 LOCATION Highway 402, Stn.: 14+276 o/s: 19 m Lt, Twp of Sarnia ORIGINATED BY OL
 DIST London HWY 402 BOREHOLE TYPE Solid Stem Auger, Split Spoon COMPILED BY OL
 DATUM Geodetic DATE 8.7.08 - 8.7.08 CHECKED BY GC

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					WATER CONTENT (%)				
							20	40	60	80	100	W _p	W	W _L			
187.7	Hwy 402 W.B. Rt. Shoulder																
187.6	150 mm ASPHALT		1	AS	--												
186.9	SAND and GRAVEL (FILL), damp Brown																
186.9			2	SS	23												
186.1	Silty CLAY (FILL), trace to some gravel and sand, moist, very stiff to hard, brown																
186.1			3	SS	24												
186.1			4	SS	33												
186.1			5	SS	20												
186.1			6	SS	24												
186.1			7	SS	28												
181.1	END OF BOREHOLE at approximately 6.6 m Borehole open and dry on completion of drilling																

RECORD OF BOREHOLE No 08-4

1 OF 1

METRIC

W.P. 3038-03-00 LOCATION Highway 402, Stn.: 14+206 o/s: 20 m Lt, Twp of Sarnia ORIGINATED BY OL
 DIST London HWY 402 BOREHOLE TYPE Solid Stem Auger, Split Spoon COMPILED BY OL
 DATUM Geodetic DATE 8.7.08 - 8.7.08 CHECKED BY GC

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa		WATER CONTENT (%)							
186.4	Hwy 402 W.B. Rt. Shoulder							20	40	60	80	100	w _p	w	w _L		
186.0	150 mm ASPHALT							20	40	60	80	100					
0.2	SAND and GRAVEL (FILL), damp Brown						186										
185.6																	
0.8	Silty CLAY (FILL), some sand, trace gravel, moist, firm, brown		1	SS	6		185							o			
184.8																	
1.5	Silty CLAY, some sand, trace gravel, moist to damp, very stiff to hard, brown (CL)		2	SS	25		184							o			
			3	SS	34		183							o			
			4	SS	21		182							o			
							181										
							180							o			
179.8			6	SS	19												
6.6	END OF BOREHOLE at approximately 6.6 m Borehole open and dry on completion of drilling																

RECORD OF BOREHOLE No 08-5

1 OF 1

METRIC

W.P. 3038-03-00 LOCATION Highway 402, Stn.: 14+126 o/s: 19 m Lt, Twp of Sarnia ORIGINATED BY OL
 DIST London HWY 402 BOREHOLE TYPE Solid Stem Auger, Split Spoon COMPILED BY OL
 DATUM Geodetic DATE 8.7.08 - 8.7.08 CHECKED BY GC

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																																												
184.7	Hwy 402 W.B. Rt. Shoulder					▽	184																																													
184.6	150 mm ASPHALT																																																			
0.2	SAND and GRAVEL (FILL), damp, brown		1	AS	-												183																																			
184.0																																																				
0.8	Silty CLAY (FILL), some sand, trace to some gravel, moist, very stiff, brown		2	SS	15																						182																									
			3	SS	15																															181																
182.6																																												180								
2.1	Silty CLAY, some sand, trace gravel, moist, very stiff, brown (CL)		4	SS	18	179																																														
	- stiff - moist to wet		5	SS	12																																															
180.2																																																				
4.6	Silty SAND, wet, compact, grey (SP-SM)		6	SS	12																																															
	- saturated		7	SS	17																																															
178.2																																																				
6.6	END OF BOREHOLE at approximately 6.6 m Borehole caved to a depth of approximately 4.4 m (Elev. 180.3 m) below existing grade on completion of drilling Groundwater measured in caved borehole at a depth of approximately 4.3 m (Elev. 180.4 m) below existing grade on completion of drilling																																																			

METRIC

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

RECORD OF BOREHOLE No 08-7

1 OF 1

METRIC

W.P. 3038-03-00 LOCATION Highway 402, Stn.: 14+059 o/s: 18 m Lt, Twp of Sarnia ORIGINATED BY OL
 DIST London HWY 402 BOREHOLE TYPE Solid Stem Auger, Split Spoon COMPILED BY OL
 DATUM Geodetic DATE 8.7.08 - 8.7.08 CHECKED BY GC

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			SHEAR STRENGTH kPa		WATER CONTENT (%)							
183.6	Hwy 402 W.B. Rt. Shoulder					▽							1	19	43	37	
183.0	150 mm ASPHALT																
0.2	SAND and GRAVEL (FILL), damp, brown																
182.8	Silty CLAY (FILL), some sand, trace gravel, very stiff, moist, grey		1	SS	16												
0.8			2	SS	24												
181.3	SAND, trace silt, compact to loose, moist, grey (SM) - trace topsoil in upper 200 mm		3	SS	18												
2.3			4	SS	16												
			5	SS	9												
177.5	Silty CLAY, some sand, trace gravel, very stiff, moist, grey (CL)		6	SS	16												
6.1	END OF BOREHOLE at approximately 6.6 m Borehole caved to a depth of approximately 3.4 m (Elev. 180.2 m) on completion of drilling Groundwater measured in caved borehole at a depth of approximately 3.4 m (Elev. 180.2 m) below existing grade on completion of drilling																
177.0																	
6.6																	

RECORD OF BOREHOLE No 08-8

1 OF 1

METRIC

W.P. 3038-03-00 LOCATION Highway 402, Stn.: 13+978 o/s: 21 m Lt, Twp of Sarnia ORIGINATED BY OL
 DIST London HWY 402 BOREHOLE TYPE Solid Stem Auger, Split Spoon COMPILED BY OL
 DATUM Geodetic DATE 8.7.08 - 8.7.08 CHECKED BY GC

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									
182.9	Hwy 402 W.B. Rt. Shoulder							20	40	60	80	100					
180.6	150 mm ASPHALT							20	40	60	80	100					
0.2	SAND and GRAVEL (FILL), damp, brown																
182.2																	
0.8	Silty SAND (FILL), trace to some gravel and clay, compact, moist, brown		1	SS	19		182										
181.4																	
1.5	Silty SAND, trace clay, compact to loose, moist, brown (SP-SM)		2	SS	17		181										
			3	SS	14		180										
			4	SS	7		179										
178.4																	
4.6	Silty CLAY, some sand, trace gravel, very stiff to stiff, moist to wet, grey (CL)		5	SS	25		178										
							177										
176.4			6	SS	12												
6.6	END OF BOREHOLE at approximately 6.6 m Borehole caved to a depth of approximately 2.4 m (Elev. 180.6 m) below existing grade on completion of drilling Groundwater measured in caved borehole at a depth of approximately 2.4 m (Elev. 180.6 m) below existing grade on completion of drilling																

RECORD OF BOREHOLE No 08-9

1 OF 1

METRIC

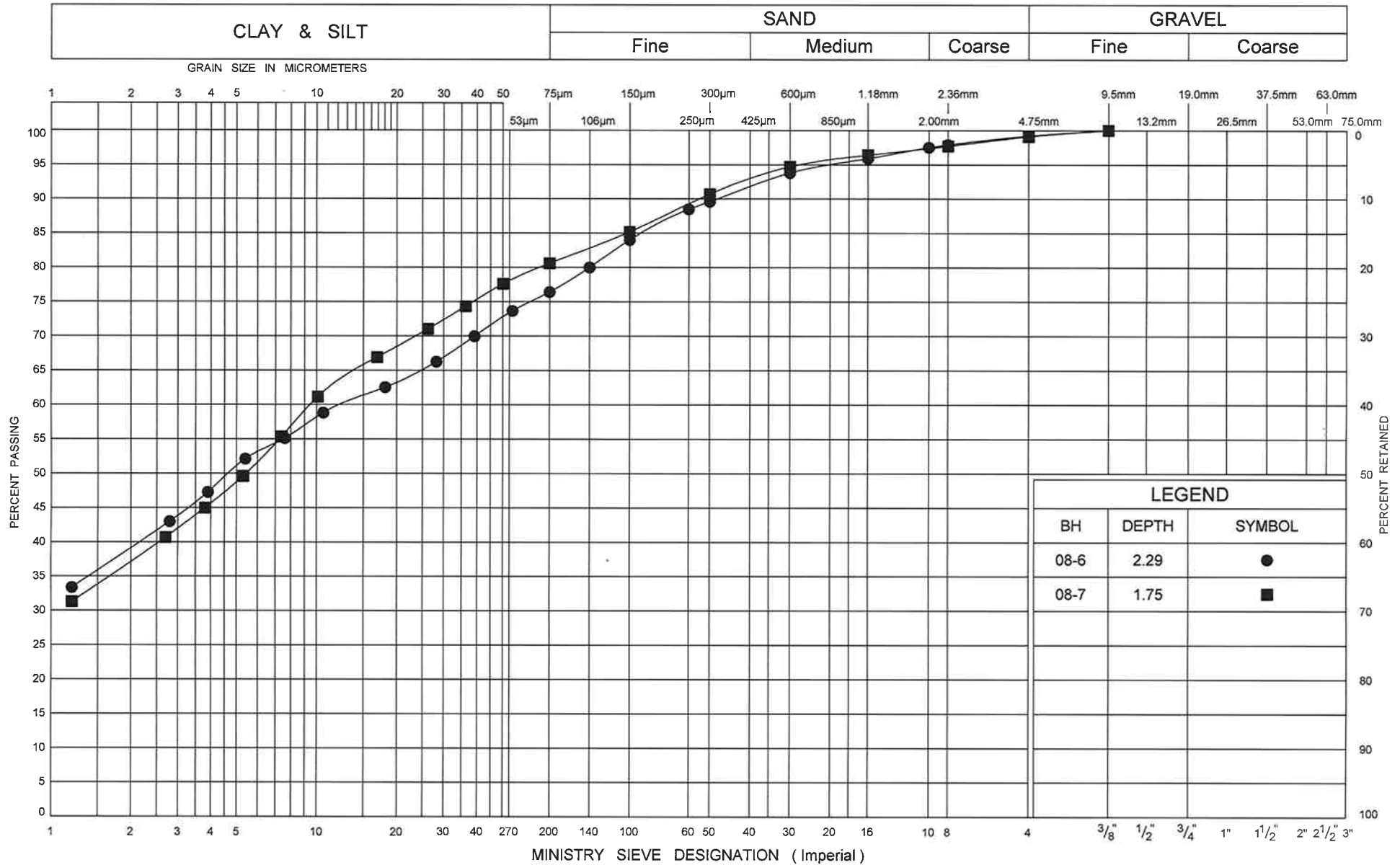
W.P. 3038-03-00 LOCATION Highway 402, Stn.: 13+900 o/s: 21 m Lt, Twp of Sarnia ORIGINATED BY OL
 DIST London HWY 402 BOREHOLE TYPE Solid Stem Auger, Split Spoon COMPILED BY OL
 DATUM Geodetic DATE 8.8.08 - 8.8.08 CHECKED BY GC

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 (%)
182.8	Hwy 402 W.B. Rt. Shoulder					▽												
180.6	150 mm ASPHALT																	
0.2	SAND and GRAVEL (FILL), damp, brown		1	SS	17													
181.2																		
1.5	Silty SAND, trace to some clay, compact to very loose, moist, brown (SP-SM)		2	SS	11													
			3	SS	8													
	- wet		4	SS	2													
178.2																		
4.6	Silty CLAY, some sand, trace gravel, hard to very stiff, moist, grey (CL)		5	SS	34													
176.2			6	SS	19													
6.6	END OF BOREHOLE at approximately 6.6 m Borehole caved to a depth of approximately 2.4 m (Elev. 180.4 m) below existing grade on completion of drilling Groundwater measured in caved borehole at a depth of approximately 2.4 m (Elev. 180.4 m) below existing grade on completion of drilling																	

Appendix C

Geotechnical Laboratory Test Results

UNIFIED SOIL CLASSIFICATION SYSTEM



GRAIN SIZE DISTRIBUTION

Silty Clay Fill

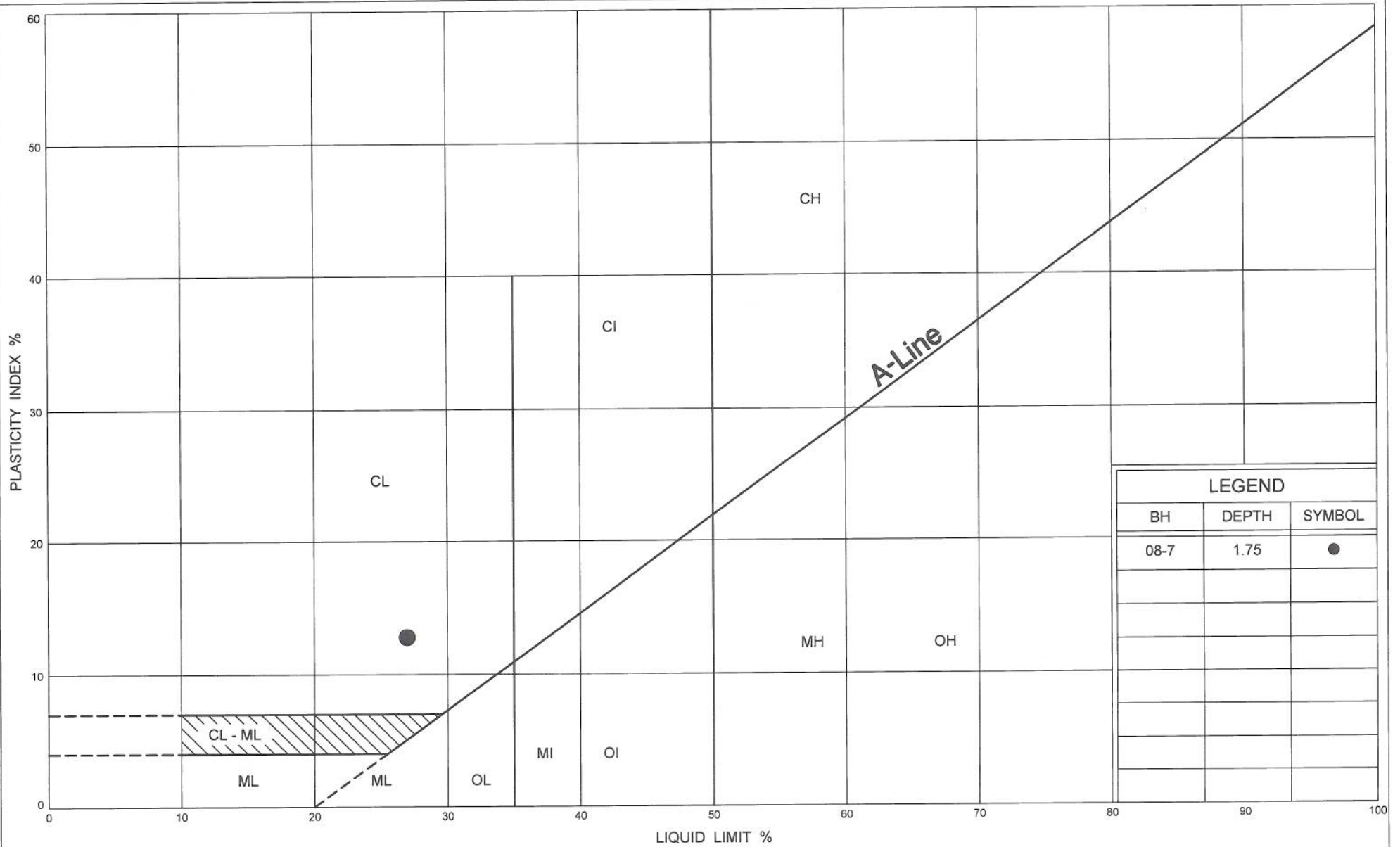
FIG No 1

W P 3038-03-00

Hwy 402, Township of Sarnia

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Transportation

Ontario



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Transportation

PLASTICITY CHART

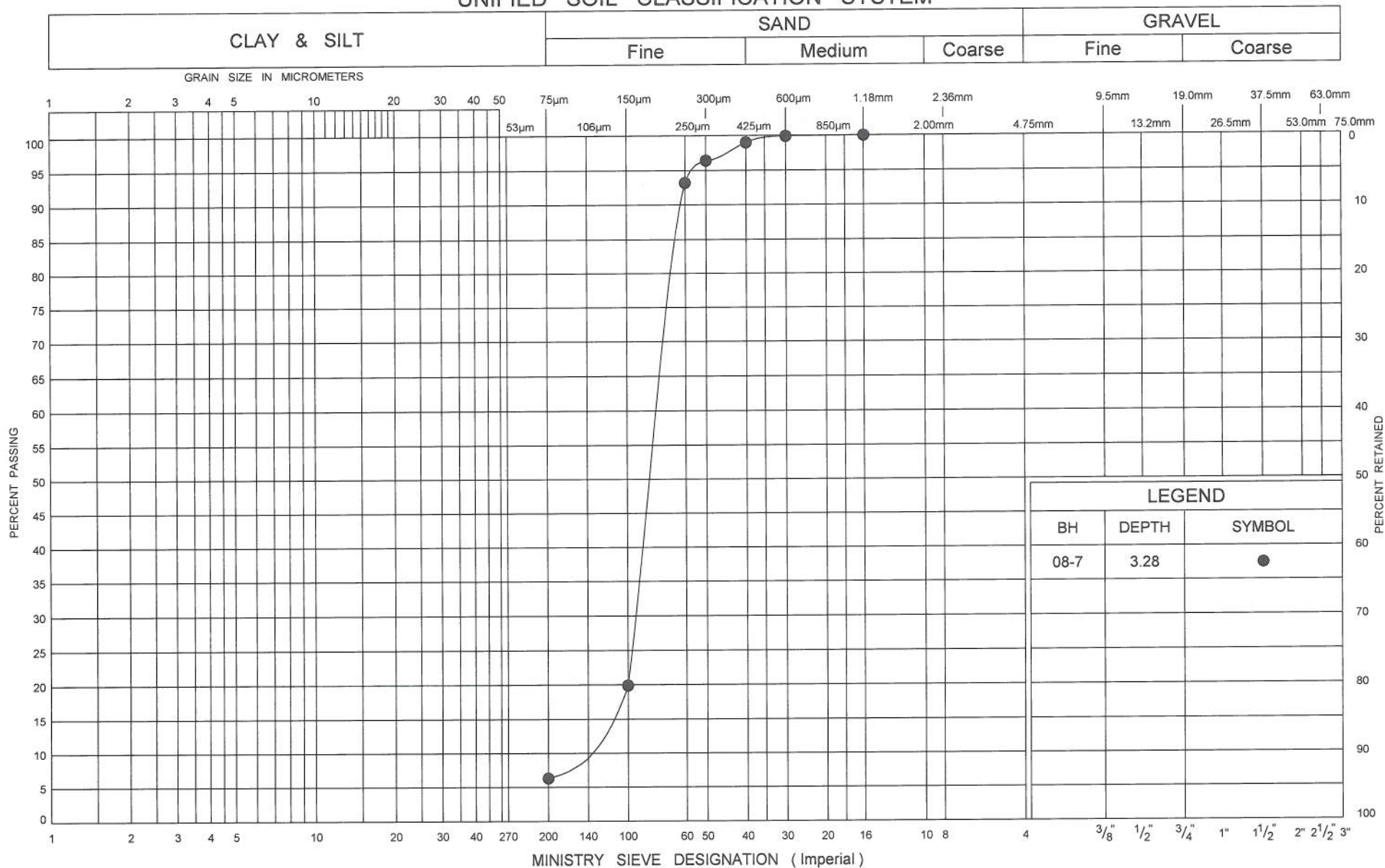
Silty Clay Fill

FIG No 2

W P 3038-03-00

Hwy 402, Township of Sarnia

UNIFIED SOIL CLASSIFICATION SYSTEM



GRAIN SIZE DISTRIBUTION

Sand, Trace Silt (SM)

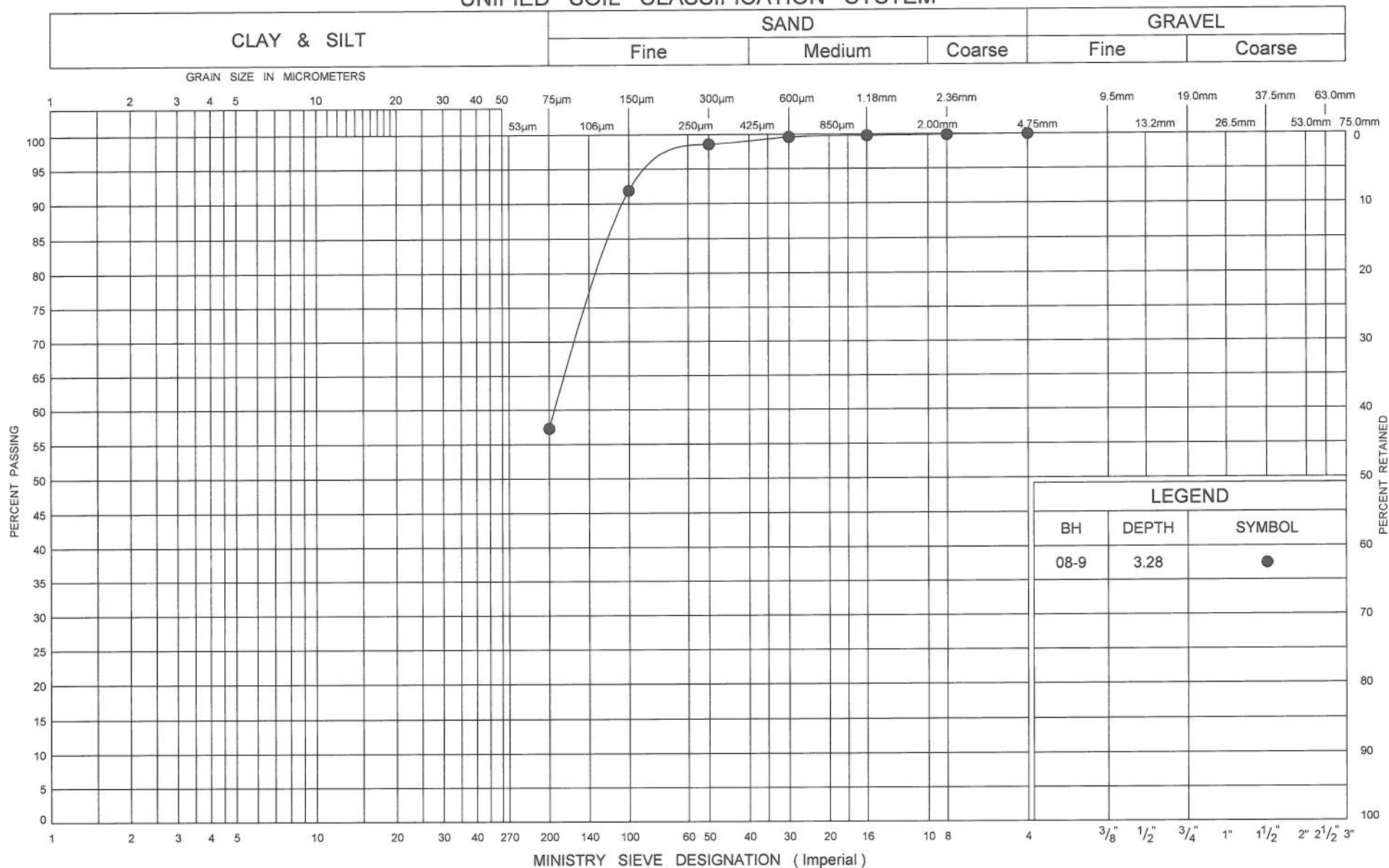
FIG No 3

W P 3038-03-00

Hwy 402, Township of Sarnia

Ministry of
Transportation

UNIFIED SOIL CLASSIFICATION SYSTEM



GRAIN SIZE DISTRIBUTION

Silty Sand (SP-SM)

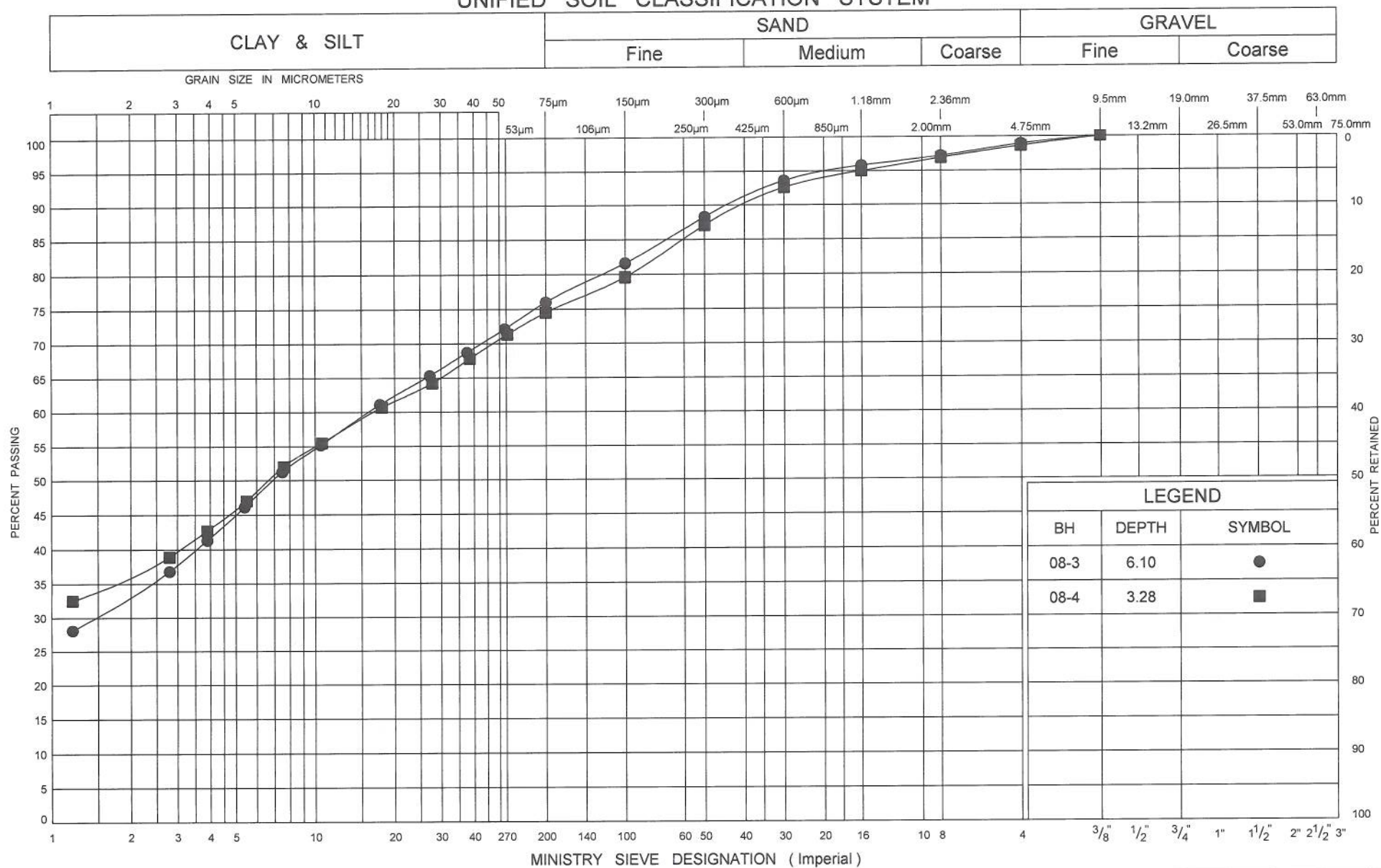
FIG No 4

W P 3038-03-00

Hwy 402, Township of Sarnia

Ministry of
Transportation

UNIFIED SOIL CLASSIFICATION SYSTEM



GRAIN SIZE DISTRIBUTION

Silty Clay (CL)

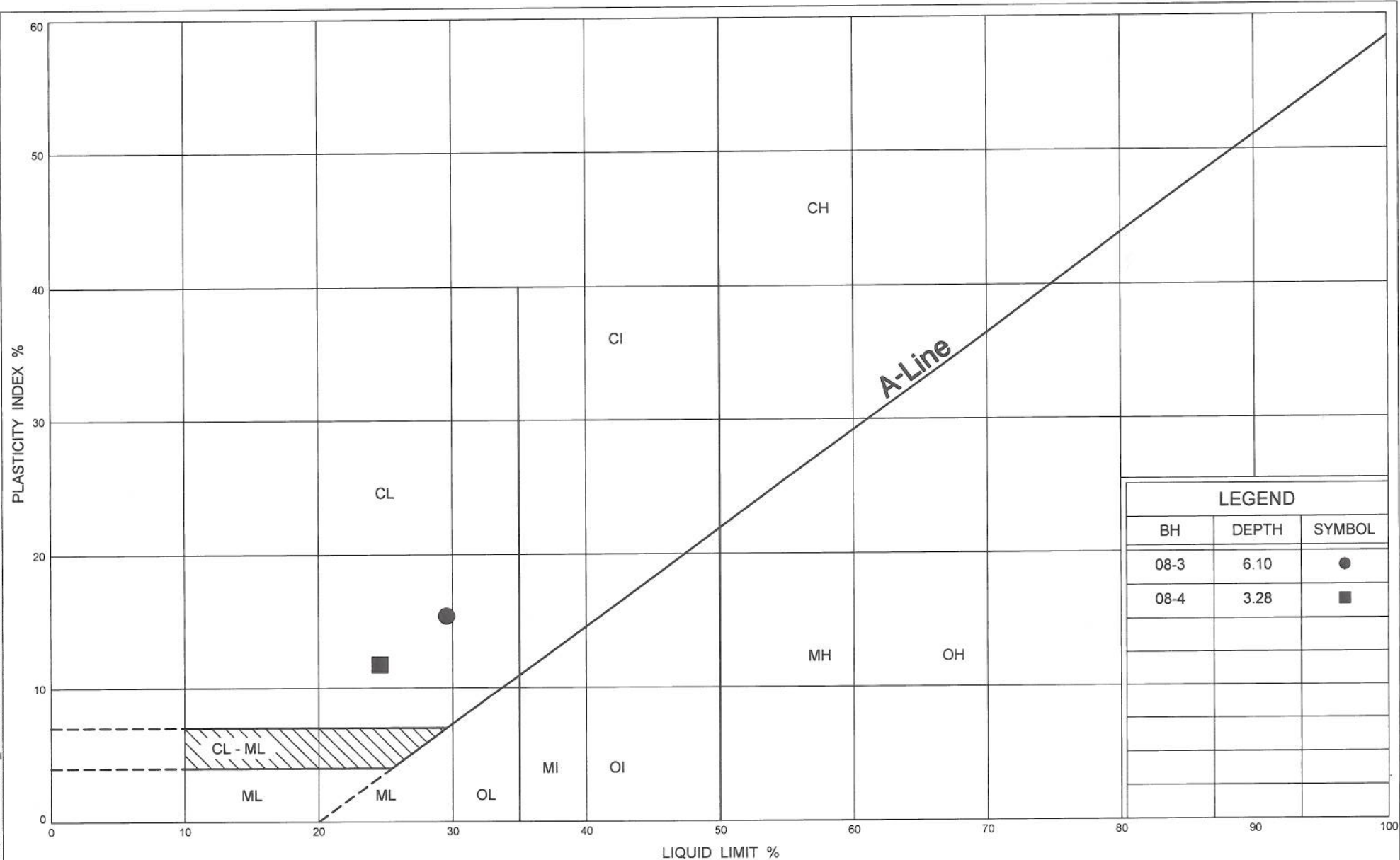
FIG No 5

W P 3038-03-00

Hwy 402, Township of Sarnia


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Ontario



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Transportation

PLASTICITY CHART Silty Clay (CL)

FIG No 6

W P 3038-03-00

Hwy 402, Township of Sarnia