Report

Foundation Investigation and Design Report
Proposed Overhead Sign Support Structures
Highway 402
City of Sarnia, Ontario
District - London
G.W.P. 3038-03-00

STANTEC CONSULTING LTD.

PROJECT NO. 1012607
GEOCRES NO. 40J16-82

REPORT NO. 1012607

REPORT TO	**Stantec Consulting Limited** **1400 Rymal Road** **Hamilton, Ontario**
FOR	**Foundation Investigation and Design Report**
ON	**Proposed Overhead Sign Support Structures** **Highway 402** **City of Sarnia, Ontario** **G.W.P. 3038-03-00** **District – London** **GEOCRES NO. 40J16-82**

November 7, 2008

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Jacques Whitford

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1.0 INTRODUCTION

Jacques Whitford Limited (Jacques Whitford) was retained by Stantec Consulting Ltd. to complete a Foundation Investigation and Design Report for 11 proposed overhead sign support structures located along Highway 402 between Station (Sta.) 10+989 and Sta. 15+300 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 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. (Stantec), the prime consultant on this 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 the foundation investigation and the results of the laboratory testing program.

2.0 SITE DESCRIPTION

The investigation is for 11 proposed overhead signs to be located on Highway 402 from Front Street to Modeland Road, Sta 10+900 to 15+300, 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 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, with 6 m to 9 m high embankments 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 1.4 km to the west of the highway.

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 at the proposed overhead sign locations by advancing a total of 11 boreholes, one at each sign location (on the right shoulder) as outlined in the following table:

Sign Location by Station	Borehole Number	Borehole Location by Station	Borehole Offset from Centreline of Highway Median
10+985	08-14	10+983	24 m Lt
11+600	08-13	11+600	25 m Lt
11+798	08-15	11+798	14 m Rt
12+200	08-12	12+200	25 m Lt
12+720	08-16	12+730	23 m Rt
13+125	08-11	13+125	16 m Lt
13+474	08-10	13+474	32 m Lt
14+100	08-06	14+098	25 m Lt
14+900	08-01	14+900	23 m Lt
15+090	08-17 A/B	15+090	23 m Rt
15+300	08-18	15+300	42 m Rt

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

It is noted that Boreholes 08-2 to 08-5 and 08-7 to 08-9 were advanced to investigate the subsurface conditions for a proposed noise barrier wall. The factual results of these boreholes 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, 8, 10 and 11, 2008. The 11 boreholes (08-1, 08-6 and 08-10 to 08-18) were advanced at the locations identified previously in this report and shown on the drawings provided in **Appendix A**.

The boreholes were advanced to depths consistent with the requirements outlined in the MTO Sign Support Manual, which specifies a depth of approximately 6.6 m below existing grade. The boreholes were advanced using a truck mounted drill rig equipped with 150 mm diameter (outside diameter), solid-stem augers, supplied and operated by London Soils Inc. 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 the existing features with a known station reference. The 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 4 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.

It is noted that environmental impacts, if any, will be discussed under separate cover.

6.2 Soil

6.2.1 Asphalt

Asphalt was encountered at the ground surface in Boreholes 08-6 and 08-10 to 08-16. The asphalt was approximately 100 mm to 150 mm thick.

6.2.2 Sand and Gravel Fill (SW) and Sand Fill

Sand and gravel fill and sand fill was encountered at the ground surface in Boreholes 08-1, 08-17 and 08-18, and underlying the asphalt in Boreholes 08-6 and 08-10 to 08-16. The sand and gravel fill ranged in thickness from approximately 0.5 m to 1.6 m.

Sand fill was encountered in Borehole 08-14, underlying fly and bottom ash (described below), at a depth of approximately 2.1 m below existing grade (elevation of approximately 181.8 m). The sand fill was approximately 1.8 m thick.

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

Based on the N-Values obtained from the Standard Penetration Tests (SPTs), the compactness of the sand and gravel fill and sand fill was assessed to be compact to very dense.

Laboratory testing conducted on selected samples consisted of moisture content tests. The test results were as follows:

- Moisture Content:
    - 2% to 7%

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

6.2.3 Fly and Bottom Ash Fill (SP-SM)

Fly and bottom ash fill was encountered in Borehole 08-14 at a depth of approximately 0.6 m below existing grade (an elevation of approximately 183.3 m). The thickness of the fly and bottom ash fill was approximately 1.5 m.

The fly and bottom ash was generally damp to wet. With respect to particle size, the fly and bottom ash fill could be characterised as a sand with some gravel and trace silt.

Based on the N-Values obtained from two SPTs, the compactness of the fly and bottom ash fill was assessed to be dense.

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

- Moisture Content:
    - 16% and 17%

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

6.2.4 Silty Sand Fill (SM)

A layer of silty sand fill was encountered underlying the sand and gravel fill in Borehole 08-11 at a depth of approximately 0.8 m (an elevation of approximately 182.7 m). The silty sand fill was approximately 0.8 m thick.

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

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

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

- Moisture Content:
    - 4%

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

6.2.5 Silty Clay Fill (CL-ML)

A layer of silty clay fill was encountered underlying the sand and gravel fill in Borehole 08-6 and 08-18 at a depth of approximately 0.8 m and 1.5 m (an elevation of approximately 183.5 m and 179.1 m). The silty clay fill was approximately 2.2 m and 0.7 m thick.

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

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

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

- Moisture Content:
    - 7% to 13%
- Grain Size Distribution:
    - 1% gravel;
    - 23% sand;
    - 37% silt; and,
    - 39% 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 tests are provided on Figure 1 in **Appendix C**.

6.2.6 Native Sand (SM) to Silty Sand (ML)

Native sand to silty sand was encountered in all boreholes, except Borehole 08-1, at depths of approximately 0.8 m to 4.0 m below existing grade (elevations of approximately 178.4 m to 183.1 m). The thickness of the sand ranged from approximately 1.6 m to 5.8 m. Boreholes 08-14, 08-15 and 08-18 were terminated in the sand stratum, at a depth of approximately 6.6 m (elevations of approximately 174.1 m to 177.4 m).

The sand was generally wet to saturated and contained trace gravel and trace to some fines (silt and clay).

A thin layer (0.4 m thick) of sandy silt was encountered over the native sand in Borehole BH08-12.

Based on the N-Values obtained from the SPTs, the compactness of the sand to silty sand was assessed to be loose to very dense, but was more typically compact.

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

- Moisture Contents:
    - 2% to 25%
- Grain Size Distribution:
    - 0% to 3% gravel;
    - 73% to 93% sand; and,
    - 6% to 27% 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 2 in **Appendix C.**

6.2.7 Silty Clay (CL)

Silty clay was encountered underlying the fill, sand and silty sand/sandy silt in Boreholes 08-1, 08-6, 08-10 to 08-13, 08-16 and 08-17. The silty clay was encountered at depths in the range of approximately 0.8 m to 6.2 m below existing grade (elevations of approximately 176.7 m to 183.5 m). Boreholes 08-1, 08-6, 08-10 to 08-13, 08-16 and 08-17 were terminated in the silty clay at a depth of approximately 6.6 m below existing grade (elevations of approximately 174.4 m to 178.4 m).

The silty clay was generally moist to damp and contained trace to some sand and trace gravel near the contact with the sand stratum described above, containing less sand with increasing depth.

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, grain size distribution and Atterberg Limits tests. The test results were as follows:

- Moisture Content:
  - 12% to 25%
- Grain Size Distribution:
  - 0 to 4% gravel;
  - 15% to 27% sand;
  - 36% to 46% silt; and,
  - 36% to 39% clay
- Atterberg Limits:
  - Liquid Limits: 25% to 32%
  - Plastic Limits: 13% to 22%
  - Plasticity Indices: 9% to 17%

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 3 in **Appendix C**. The results of the Atterberg Limits tests are provided on Figure 4 in **Appendix C**.

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)
08-1	Open	-	Dry	-
08-6	3.4 m	180.9	3.4	180.9
08-10	2.7	180.6	2.7	180.6
08-11	2.1	181.4	2.1	181.4
08-12	1.8	183.2	1.8	183.2
08-13	2.7	181.3	2.7	181.3
08-14	3.5	180.5	3.5	180.5
08-15	5.3	178.5	5.3	178.5
08-16	2.0	181.5	2.0	181.5
08-17 A/B	1.2	179.8	0.6	180.4
08-18	2.7	178.0	2.7	178.0

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 evenets.

7.0 CLOSURE

A soil investigation is a limited sampling of a site. The information herein is 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

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MTO Foundations Contact

FOUNDATION DESIGN REPORT

Proposed Overhead Sign Support Structures
Highway 402
City of Sarnia, Ontario
G.W.P. 3038-03-00
District – London

8.0 DISCUSSION

8.1 General

Highway 402 is generally oriented in an east-west direction with two east bound and two west bound lanes. The highway is 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, with 6 m to 9 m high embankments 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 1.4 km west of the highway.

8.2 Proposed Development

The Ministry of Transportation (MTO) is proposing to widen and upgrade the section of Highway 402, from the Blue Water International Bridge property east to Indian Road, a total distance of approximately 3.1 km (Sta. 10+500 to Sta. 13+600).

The widening work will include construction of two additional westbound lanes to the highway.

The planned development will include the construction of 11 overhead signs, 7 for the westbound lanes and 4 for the east bound lanes, at the locations outlined in the following table:

Borehole Location by Station	Comments
10+983	Westbound lanes approaching Front Street
11+600	Westbound lanes approaching Front Street
11+798	Eastbound lanes approaching Colborne Road
12+200	Westbound Lanes approaching Colborne Road
12+730	Eastbound lanes approaching Indian Road
13+125	Westbound lanes at Indian Road
13+474	Westbound lanes approaching Indian Road
14+098	Westbound lanes approaching Murphy Road
14+900	Westbound lanes approaching Murphy Road
15+090	Eastbound lanes approaching Modeland Road
15+300	Eastbound lanes approaching Modeland Road

It is understood that the signs will be a combination of tri-chord static signs and variable message signs. The footings for both sign types (one median mounted and one ground mounted for each structure) will be drilled, cast-in-place concrete caissons.

8.3 Subsurface Conditions

The soil conditions encountered in Borehole 08-1 advanced at Sta. 14+900, in the vicinity of Murphy Road, generally consisted of fill underlain by silty clay.

The soil conditions encountered in the remaining boreholes generally consisted of fill overlying sand, generally underlain by silty clay at depth.

Cave-in was measured in all boreholes, except Borehole 08-1, at depths in the range of approximately 1.2 m to 5.3 m (elevations of approximately 178.0 m to 183.2 m). Borehole 08-1 was open to the termination depth of 6.6 m (elevation of approximately 177.6 m) on completion of drilling.

Groundwater was measured in all boreholes, except Borehole 08-1, at depths of approximately 0.6 m to 5.3 m (elevations of approximately 178.0 m to 183.2 m). Borehole 08-1 was dry to the termination depth of 6.6 m (elevation of approximately 177.6 m) on completion of drilling.

9.0 RECOMMENDATIONS

9.1 Soil Parameters

The results of the field investigation and laboratory testing described herein have been used to estimate soil parameters for use in the design of the overhead sign support structure foundations.

Soils at the site have been grouped as cohesive or non-cohesive and have been assigned values of undrained shear strength (C_u) or angle of internal friction (Φ'), and bulk unit weight (γ). The Rankine passive earth pressure coefficients have been calculated based on the assigned angle of internal friction. The design parameters recommended for use on this project are shown in the table below. When using the table, the following should be considered:

- The soil parameters provided represent ultimate values and will need to be factored in accordance with the CHBDC.
- The unit weights provided are bulk unit weights. Below the groundwater table the submerged unit weights should be used, which can be obtained by subtracting 9.8 kN/m^3 from the bulk unit weights provided.
- The bulk unit weight for soils within the frost zone (1.2 m) may be assumed to be 20 kN/m^3. However, it is noted that the fly and bottom ash encountered at 10+983 has a bulk unit weight of approximately 14 kN/m^3.

Borehole Location by Station Borehole Number	Depth (m)	Soil Type	Group	Compactness or Consistency	Unit Weight (kN/m^3)	Effective Friction Angle (degrees)	Rankine Passive Earth Pressure Coefficient	Undrained Shear Strength (kPa)
10+983 08-14	1.2 – 2.1	Fly and Bottom Ash Fill*	Non-cohesive	Dense	14	30	3.00	-
	2.1 – 4.0	Sand fill	Non-cohesive	Dense to compact	18	30	3.00	-
	4.0 – 6.6	Sand	Non-cohesive	Dense to loose	18	30	3.00	-
11+600 08-13	1.2 – 1.5	Sand and gravel fill	Non-cohesive	Dense	21	31	3.12	-
	1.5 – 6.1	Sand	Non-cohesive	Dense to compact	18	30	3.00	-
	6.1 – 6.6	Silty clay	Cohesive	Very stiff	20	-	-	75
11+798 08-15	1.2 - 6.6	Sand	Non-cohesive	Very dense to compact	18	30	3.00	-
12+200 08-12	1.2 – 1.4	Sand and gravel fill	Non-cohesive	Compact	21	31	3.12	-
	1.4 – 1.8	Sandy silt	Non-cohesive	Compact	19	30	3.00	-
	1.8 – 6.2	Sand	Non-cohesive	Compact to dense	18	30	3.00	-
	6.2 – 6.6	Silty clay	Cohesive	Hard	20	-	-	100
12+730 08-16	1.2 – 1.5	Sand and gravel fill	Non-cohesive	Compact	21	31	3.12	-
	1.5 – 6.1	Silty sand	Non-cohesive	Compact	19	30	3.00	-
	6.1 – 6.6	Silty clay	Cohesive	Very stiff	20	-	-	75
13+125 08-11	1.2 – 1.5	Silty sand fill	Non-cohesive	Dense	19	30	3.00	-
	1.5 – 6.2	Sand	Non-cohesive	Compact to dense	18	30	3.00	-
	6.2 – 6.6	Silty clay	cohesive	Very stiff	20	-	-	75

Borehole Location by Station Borehole Number	Depth (m)	Soil Type	Group	Compactness or Consistency	Unit Weight (kN/m3)	Effective Friction Angle (degrees)	Rankine Passive Earth Pressure Coefficient	Undrained Shear Strength (kPa)
13+474 08-10	1.2 – 1.5	Sand and gravel fill	Non-cohesive	Compact to very dense	21	31	3.12	-
	1.5 – 5.6	Sand	Non-cohesive	Dense to compact	18	30	3.00	-
	5.6 – 6.6	Silty clay	Cohesive	Stiff	20	-	-	50
14+098 08-06	1.2 – 3.0	Silty clay	Cohesive	Very stiff	20	-	-	75
	3.0 – 4.6	Silty Sand	Non-cohesive	Dense	19	30	3.00	-
	4.6 – 6.6	Silty clay	cohesive	Stiff to hard	20	-	-	100
14+900 08-01	1.2 – 6.6	Silty clay	Cohesive	Hard to stiff	20	-	-	100
15+090 08-17 A/B	1.2 – 1.5	Sand and gravel fill	Non-cohesive	Loose to compact	21	31	3.12	-
	1.5 – 4.3	Silty sand	Non-cohesive	Compact	19	30	3.00	-
	4.3 – 6.6	Silty clay	Cohesive	Stiff	20	-	-	50
15+300 08-18	1.2 – 1.5	Sand and gravel fill	Non-cohesive	Compact	21	31	3.12	-
	1.5 – 2.3	Silty clay fill	Cohesive	Hard	19	-	-	100
	2.3 – 6.6	Sand	Non-cohesive	Loose to compact	18	30	3.00	-

***Fly ash and bottom ash properties were obtained from the following references:**

Toth, P.S. et al. (1988) "Coal ash as structural fill with special reference to Ontario Experience" Canadian Geotechnical Journal Vol. 25, pp. 694 – 704.

Kim, B. et. al. (2005) "Geotechnical Properties of Fly and Bottom Ash Mixtures for Use in Highway Embankments" Journal of Geotechnical and Environmental Engineering, ASCE Vol 131 No. 4 pp. 914 – 924.

Leonards and Baily (1982) "Pulverized Coal Ash as Structural Fill", Journal of Geotechnical and Environmental Engineering, ASCE, Vol 108, No. 4, pp. 517 - 531.

Note: The parameters provided herein are only applicable to the sampled and drilled depth of the boreholes.

9.2 MTO Standard Design

The MTO sign support manual stipulates that the caisson diameter for sign supports should be as follows:

Sign Type	Ground Mounted Footings	Median Mounted Footings
Tri-chord Static Sign Supports	1200 mm	1000 mm
Variable Message Sign Supports	920	920 mm

The manual indicates that each of the sign supports is to extend a minimum of 5 m below the frost penetration depth. MTO Standard Drawings SS118-3 to SS118-5 dated April 2007 and SS118-6 to SS118-8, dated November 2002, are based on the following assumed soil parameters below the frost layer:

Length of Caisson Below the Frost Penetration Depth	Case 1 (Sand)	Case 2 (Clay)
Upper 2/3	$\Phi' = 28^o$	C_u = 25 kPa
Lower 1/3	$\Phi' = 30^o$	C_u = 50 kPa

Where:
Φ' = the Angle of Internal friction
C_u = the Undrained Shear Strength

Given the soil conditions encountered, the foundation details provided by MTO Standard Drawings SS118-3 to SS118-5, dated April 2007 for tri-chord static signs supports, and SS118-6 to SS118-8 for variable message sign supports, may be used at this site.

Alternatively, or if other considerations preclude the use of the standard design, the footings may be redesigned using the suggested design methods and geotechnical design parameters provided in the following sections.

9.3 Cast-In-Place Concrete Caissons

9.3.1 Design Approach

The foundation must be designed to resist overturning moments caused by wind loads and should be designed in accordance with the CHBDC Section 6.13 and the method described by B. B. Broms in the following papers:

- Broms, B. B. 1964, “Lateral Resistance of Piles in Cohesive Soils.” J. of Soil Mech. And Found. Div., ASCE, vol. 90, SM2: 27-63.

- Broms, B. B. 1964, “Lateral Resistance of Piles in Cohesionless Soils.” J. of Soil Mech. And Found. Div., ASCE, vol. 90, SM3: 123-156.
- Broms, B. B. 1965, “Design of Laterally Loaded Piles.” J. of Soil Mech. And Found. Div., ASCE, vol. 91, SM3: 79-99.

For this site, the fill materials can be used in the calculations of lateral resistance, as the N-values indicate that these materials were likely placed with compaction.

9.3.2 Lateral Deflections

The horizontal subgrade reaction may be calculated based on the procedures outlined in the Canadian Foundation Engineering Manual.

The coefficient of horizontal subgrade reaction that is used for deflection calculations may be estimated for cohesive soils as follows:

$$k_s = 67\ C_u/d$$

Where k_s = the coefficient of horizontal subgrade reaction (pressure per length)
C_u = undrained shear strength of the soil = 50 kPa to 100 kPa for this application (see Table in Section 9.1)
d = caisson diameter

The coefficient of horizontal subgrade reaction that is used for deflection calculations for non-cohesive soils may be estimated as follows:

$$k_s = n_h(z/d)$$

Where k_s = the coefficient of horizontal subgrade reaction (pressure per length)
n_h = Coefficient related to soil density. This may be taken as 4,400 kN/m^3 for compact sandy soils (Table 20.3, p. 315, of the Canadian Foundation Engineering Manual, 3rd Edition, 1992)
z = depth below grade (m)
d = caisson diameter (m)

9.4 Frost Considerations

The site is located in an area with a mean freezing index of between 250 and 500 Degree days (^{o}Days), (Canadian Foundation Engineering Manual 2006). Based on Figure 3.4 of the MTO Pavement Design and Rehabilitation Manual, the frost penetration depth for this area is 1.2 m.

The material within the zone of frost penetration should not be included in the calculations of lateral resistance.

9.5 Soil Profile Type and Seismic Forces

The zonal acceleration ratio for the Sarnia area, as obtained from CHBDC (2006) Table A3.1.7., is 0.00.

It is recommended that Soil Profile IV as defined in CHBDC Section 4.4.6 be used in the seismic design of this site.

10.0 CONSTRUCTION RECOMMENDATIONS

10.1 Caisson Installation

Cave-in was measured in all boreholes, except Borehole 08-1, at depths in the range of approximately 1.2 m to 5.3 m (elevations of approximately 178.0 m to 183.2 m). Borehole 08-1 was open to the termination depth of 6.6 m below existing grade (an elevation of approximately 177.76 m) on completion of drilling.

Groundwater was measured in all boreholes, except Borehole 08-1, at depths of approximately 0.6 m to 5.3 m, elevations of approximately 178.0 m to 183.2 m. Borehole 08-1 was dry to the termination depth of 6.6 m below existing grade (an elevation of approximately 177.6 m) on completion of drilling.

Given that cave-in and groundwater were encountered in most of the boreholes, it is recommended that a temporary liner be used to keep the caisson holes open.

All loose material should be removed from the base of the caisson prior to placement of the reinforcing steel cage (as required) and concrete. Inspection and approval of the base of the caisson by the geotechnical consultant is recommended prior to installation of the reinforcing cage and placement of the concrete. Installation and inspection should be carried out in accordance with SP903S01.

10.2 Open Cut Excavations

Excavations and open trenches are not anticipated to be required for this application.

10.3 Staging

Through discussions with Stantec, it is understood that the construction of the overhead sign supports will be incorporated into the widening construction and rehabilitation of the highway. Issues due to staging are not anticipated.

10.4 Groundwater Control

Groundwater was encountered in the majority of the boreholes at depths of approximately 0.6 m to 5.3 m below existing grade (elevations of approximately 178.0 m to 183.2 m). Perched groundwater conditions may be encountered anywhere in the soil profiles, but most commonly in the fill.

Given the conditions encountered during the investigation, seepage should be expected. However, the seepage into caissons open for relatively short period of time is anticipated to be readily handled by conventional pumping techniques.

11.0 CLOSURE

Use of this report is subject to the Statement of General Conditions attached. It is the responsibility of Stantec Consulting Limited and the Ministry of Transportation Ontario, who are identified as "the Client" within the Statement of General Conditions, and its agents to review the conditions and to notify Jacques Whitford Limited should any these not be satisfied. The Statement of General Conditions addresses the following:

- Use of the report
- Basis of the report
- Standard of care
- Interpretation of site conditions
- Varying or unexpected site conditions
- Planning, design or construction

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
Designated Principal
MTO Foundations Contact

STATEMENT OF GENERAL CONDITIONS

USE OF THIS REPORT: This report has been prepared for the sole benefit of the Client or its agent and may not be used by any third party without the express written consent of Jacques Whitford Limited and the Client. Any use which a third party makes of this report is the responsibility of such third party.

BASIS OF THE REPORT: The information, opinions, and/or recommendations made in this report are in accordance with Jacques Whitford's present understanding of the site specific project as described by the Client. The applicability of these is restricted to the site conditions encountered at the time of the investigation or study. If the proposed site specific project differs or is modified from what is described in this report or if the site conditions are altered, this report is no longer valid unless Jacques Whitford is requested by the Client to review and revise the report to reflect the differing or modified project specifics and/or the altered site conditions.

STANDARD OF CARE: Preparation of this report, and all associated work, was carried out in accordance with the normally accepted standard of care in the state or province of execution for the specific professional service provided to the Client. No other warranty is made.

INTERPRETATION OF SITE CONDITIONS: Soil, rock, or other material descriptions, and statements regarding their condition, made in this report are based on site conditions encountered by Jacques Whitford at the time of the work and at the specific testing and/or sampling locations. Classifications and statements of condition have been made in accordance with normally accepted practices which are judgmental in nature; no specific description should be considered exact, but rather reflective of the anticipated material behavior. Extrapolation of in situ conditions can only be made to some limited extent beyond the sampling or test points. The extent depends on variability of the soil, rock and groundwater conditions as influenced by geological processes, construction activity, and site use.

VARYING OR UNEXPECTED CONDITIONS: Should any site or subsurface conditions be encountered that are different from those described in this report or encountered at the test locations, Jacques Whitford must be notified immediately to assess if the varying or unexpected conditions are substantial and if reassessments of the report conclusions or recommendations are required. Jacques Whitford will not be responsible to any party for damages incurred as a result of failing to notify Jacques Whitford that differing site or sub-surface conditions are present upon becoming aware of such conditions.

PLANNING, DESIGN, OR CONSTRUCTION: Development or design plans and specifications should be reviewed by Jacques Whitford, sufficiently ahead of initiating the next project stage (property acquisition, tender, construction, etc), to confirm that this report completely addresses the elaborated project specifics and that the contents of this report have been properly interpreted. Specialty quality assurance services (field observations and testing) during construction are a necessary part of the evaluation of sub-subsurface conditions and site preparation works. Site work relating to the recommendations included in this report should only be carried out in the presence of a qualified geotechnical engineer; Jacques Whitford cannot be responsible for site work carried out without being present.

Appendix A

Borehole Location Plans

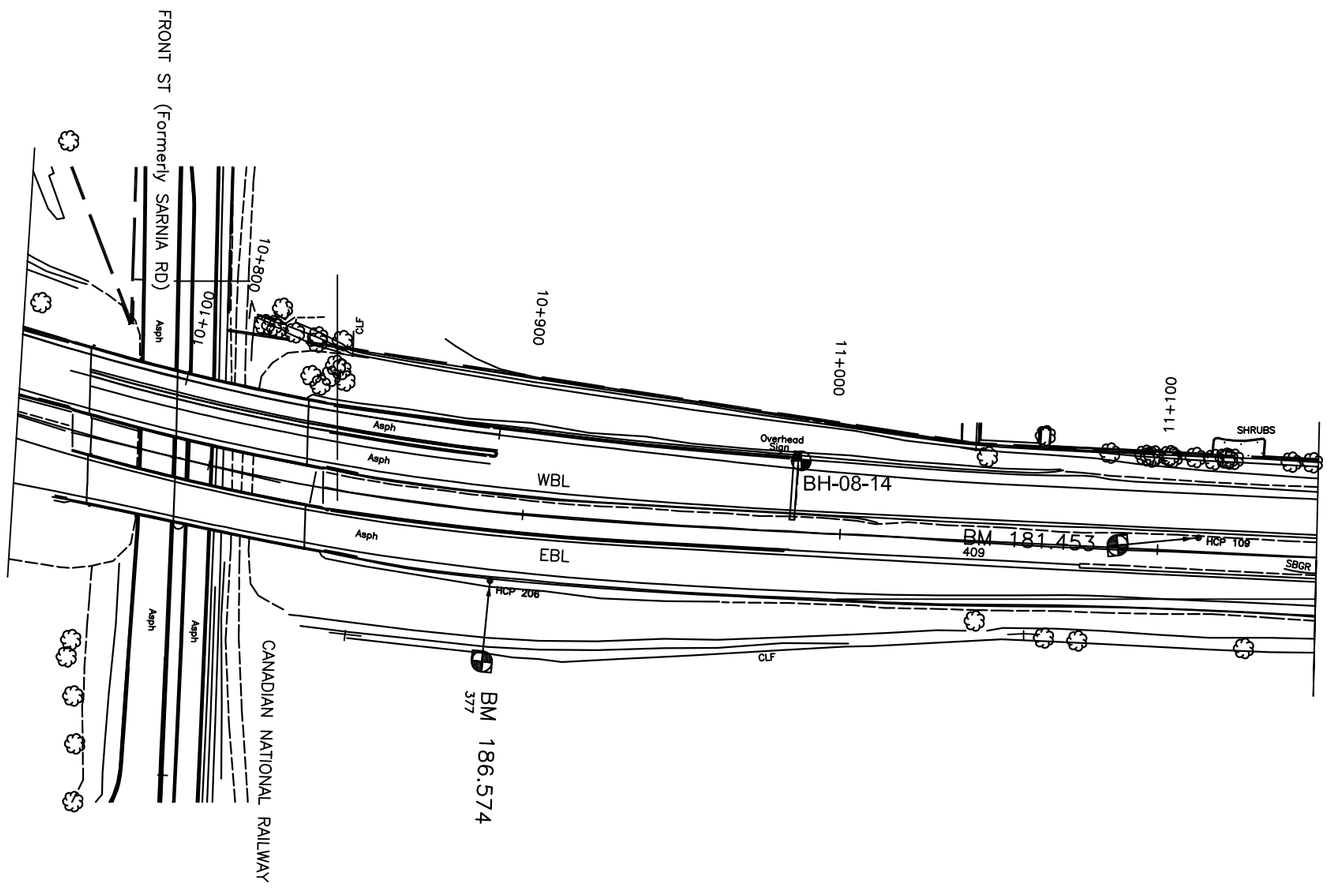
METRIC
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN

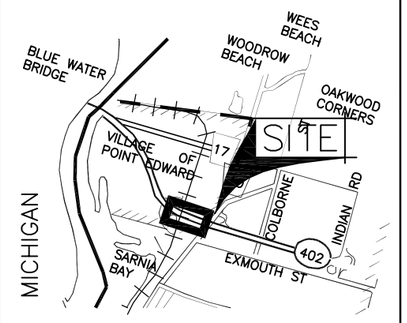
CONT. No.
WP No. 3038-03-00

NORTH

BOREHOLE LOCATION
10+750 TO 11+180
PROPOSED SIGN SUPPORT
STRUCTURE,
HIGHWAY 402,
SARNIA, ONTARIO

SHEET





LEGEND

- Borehole (Jacques Whitford, 2008)

BH No.	ELEVATION (m)	STA.	OFFSET
08-14	183.9	10+983	24m 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 illistration.

REVISIONS			
	--	-	
	DATE	BY	DESCRIPTION

GEOCRES No 40 J16-82

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

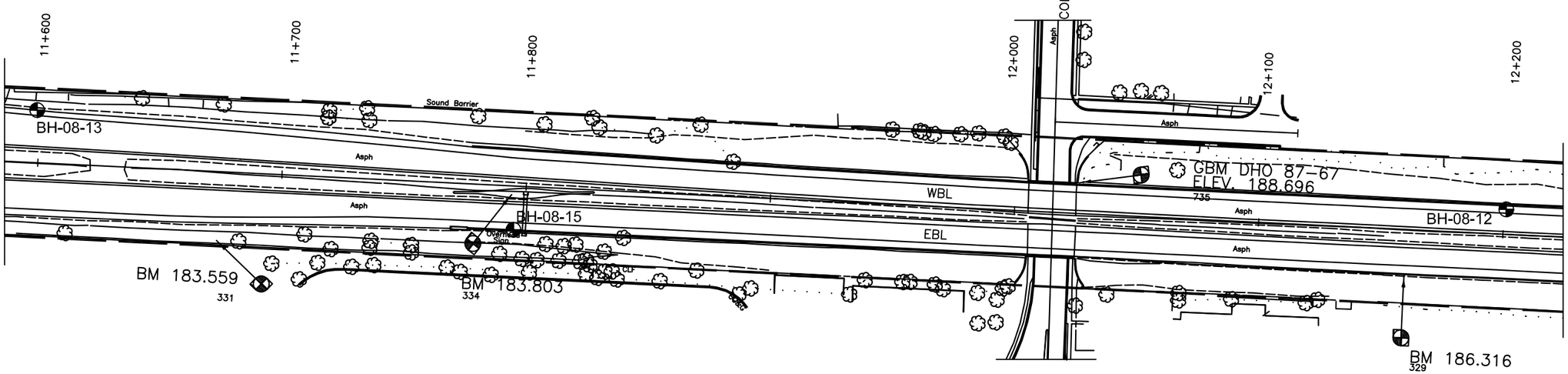
METRIC
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN

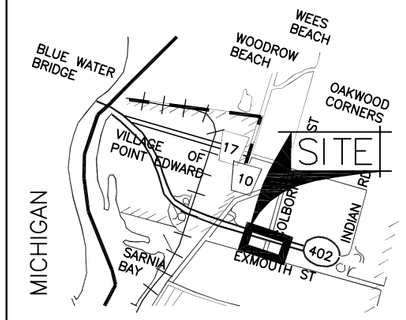
CONT. No.
WP No. 3038–03–00

NORTH

BOREHOLE LOCATION
11+600 TO 12+200
PROPOSED SIGN SUPPORT
STRUCTURE,
HIGHWAY 402,
SARNIA, ONTARIO

SHEET





LEGEND

- Borehole with (Jacques Whitford, 2008)

BH No.	ELEVATION (m)	STA.	OFFSET
08–12	185.0	12+200	25 m LT
08–13	183.9	11+600	25 m LT
08–15	183.8	11+798	14 m RT

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.

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2) This drawing is for subsurface information only. Surface details and features are for conceptual illistration.

REVISIONS			
	––	–	
	DATE	BY	DESCRIPTION

GEOCRES No 40 J16–82

HWY No 402			DIST LONDON
SUBM'D GC	CHECKED	DATE 2008–10–29	SITE –
DRAWN PC/HZ	CHECKED	APPROVED	DWG 2

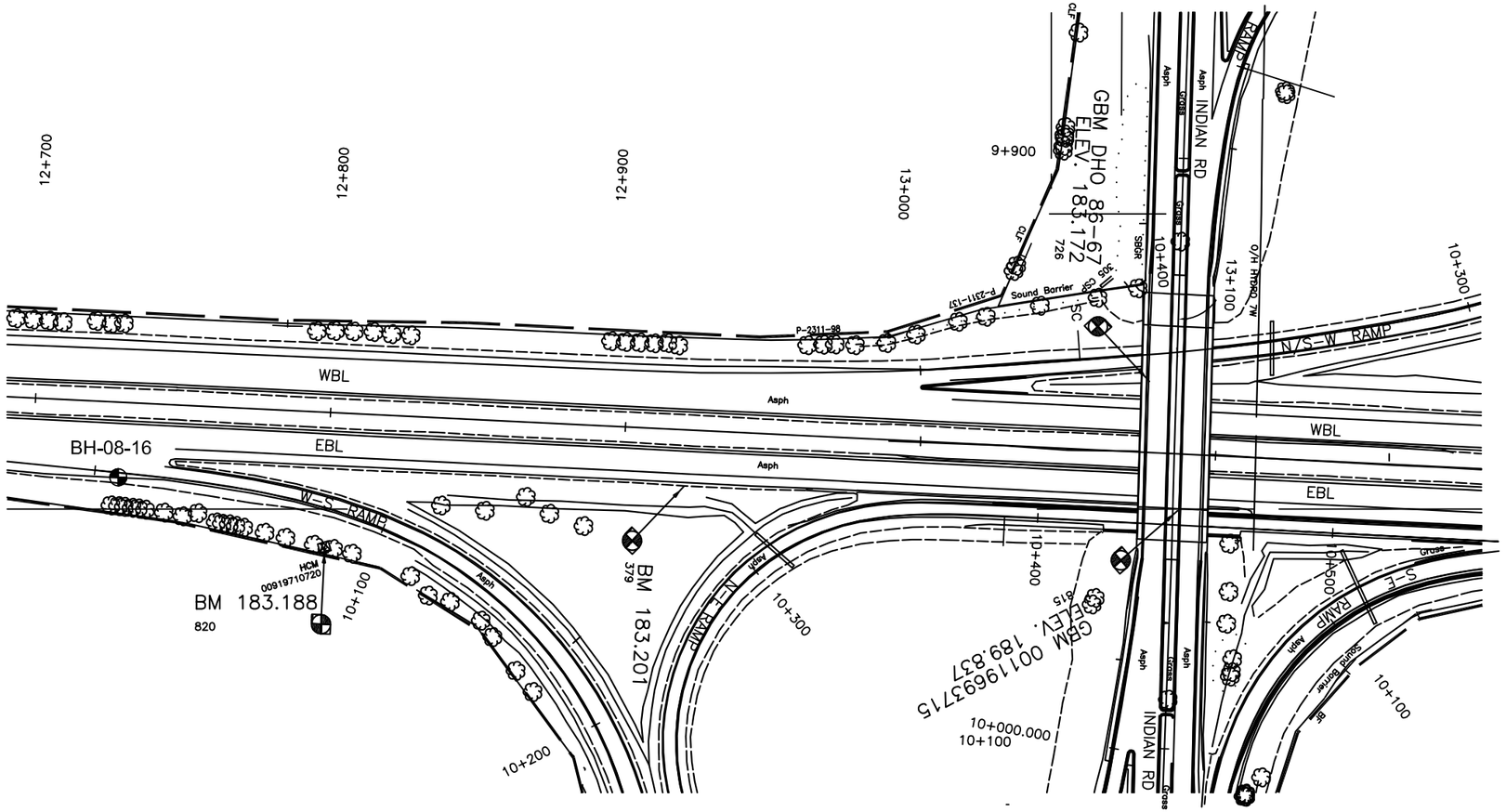
METRIC
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN

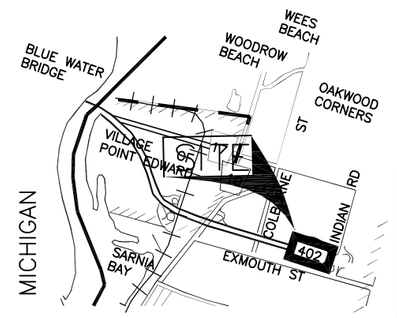
CONT. No.
WP No. 3038-03-00

NORTH

BOREHOLE LOCATION
12+700 TO 12+980
PROPOSED SIGN SUPPORT
STRUCTURE,
HIGHWAY 402, SARNIA, ONTARIO

SHEET





LEGEND

- BOREHOLE (Jacques Whitford, 2008)
- △ Benchmark

BH No.	ELEVATION (m)	STATION	OFF SET
08-16	183.5	12+730	23 m RT

0 m — 100 m
Scale

NOTE
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2) This drawing is for subsurface information only. Surface details and features are for conceptual illistration.

REVISIONS			
	--	-	
	DATE	BY	DESCRIPTION

GEOCRES No 40 J16-82

HWY No 402			DIST LONDON
SUBM'D GC	CHECKED	DATE 2008-10-29	SITE -
DRAWN PC/HZ	CHECKED	APPROVED	DWG 3

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

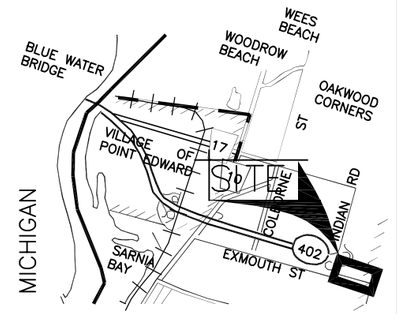
CONT. No.
WP No. 3038-03-00

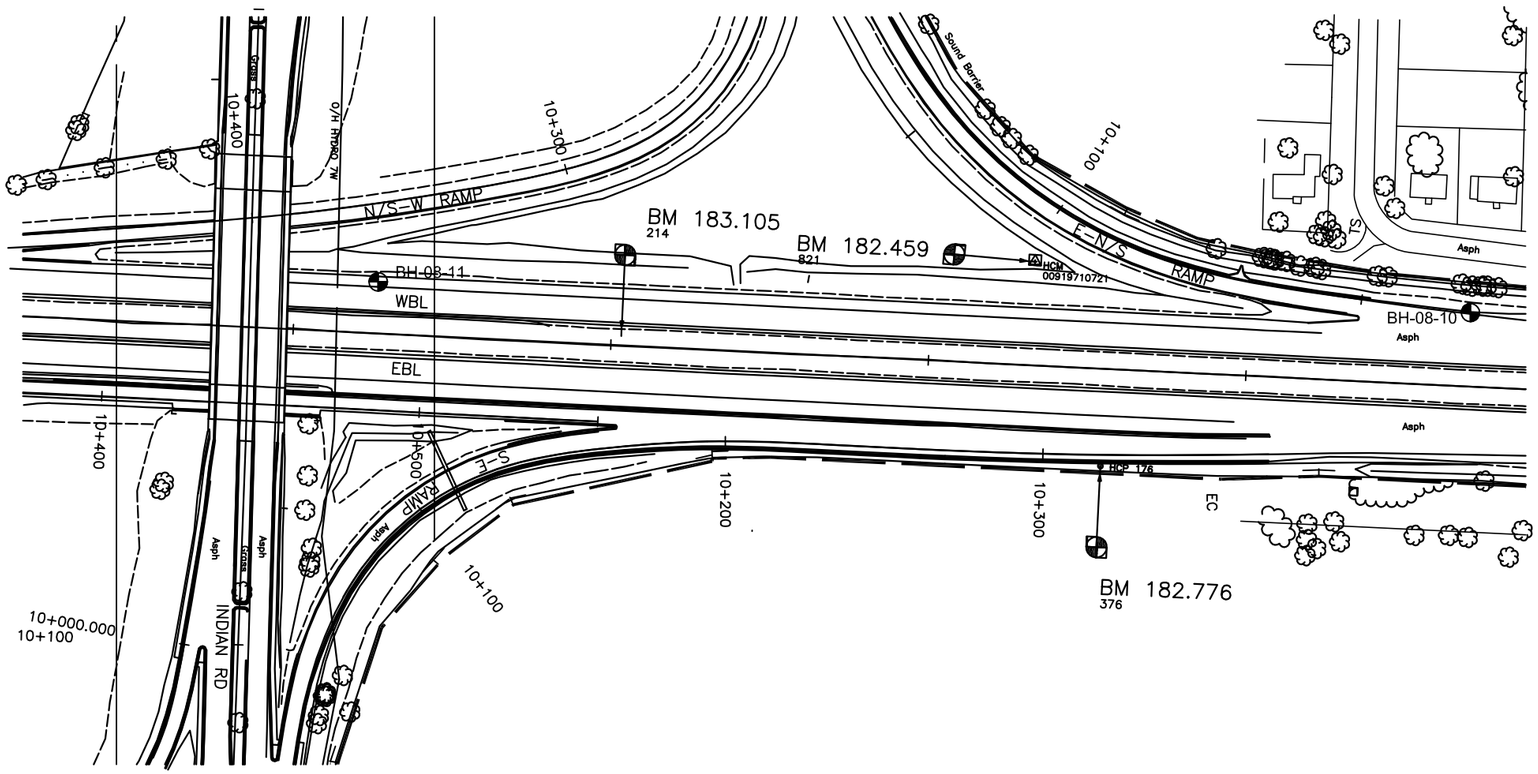
NORTH

SHEET

BOREHOLE LOCATION
13+025+13+480
PROPOSED SIGN SUPPORT
STRUCTURE,
HIGHWAY 402, SARNIA, ONTARIO

Jacques Whitford





LEGEND

● BOREHOLE
(Jacques Whitford, 2008)

BH No.	ELEVATION (m)	STA.	OFF SET
08-10	183.2	13+474	32 m LT
08-11	183.5	13+125	16 m LT

0 m — 100 m
Scale

NOTE
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* Borehole locations and site features shown are approximate and may vary from that shown.

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2) This drawing is for subsurface information only. Surface details and features are for conceptual illistration.

REVISIONS			
	--	-	
	DATE	BY	DESCRIPTION

GEOCRES No 40 J16-82

HWY No 402			DIST LONDON
SUBM'D GC	CHECKED	DATE 2008-10-29	SITE -
DRAWN PC/HZ	CHECKED	APPROVED	DWG 4

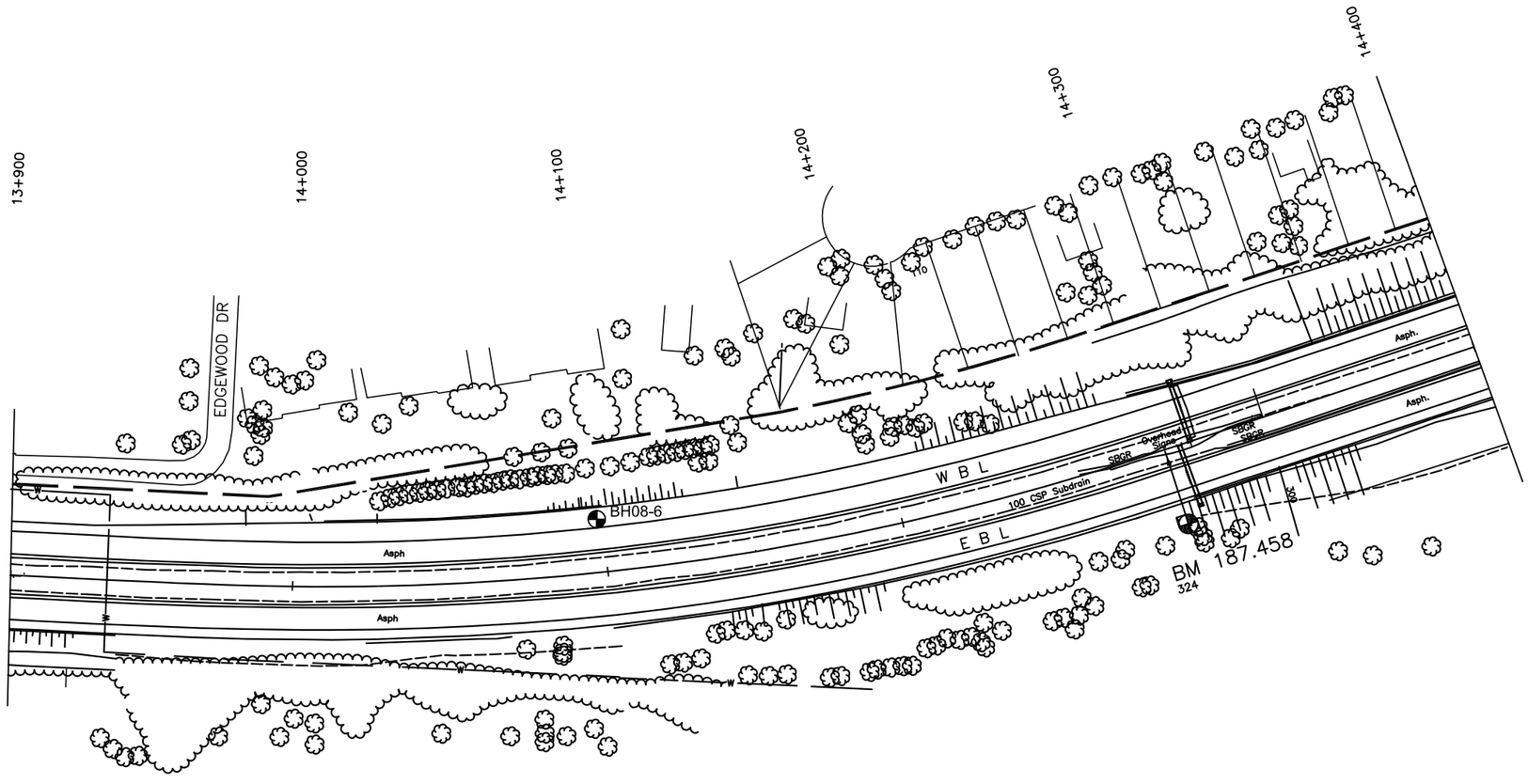
METRIC
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN

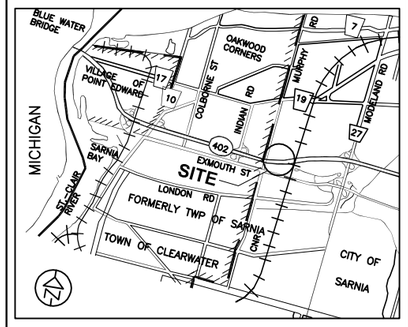
CONT. No.
WP No. 3038-03-00

NORTH

BOREHOLE LOCATION
13+900 TO 14+400
PROPOSED SIGN SUPPORT
STRUCTURE,
HIGHWAY 402,
SARNIA, ONTARIO

SHEET





LEGEND

● BOREHOLE
(Jacques Whitford, 2008)

BH No.	ELEVATION (m)	STATION	OFFSET
08-6	184.3	14+098	25 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.

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2) This drawing is for subsurface information only. Surface details and features are for conceptual illistration.

REVISIONS			
	--	-	
	DATE	BY	DESCRIPTION

GEOCRES No 40 J16-82

HWY No 402			DIST LONDON
SUBM'D GC	CHECKED	DATE 2008-10-29	SITE —
DRAWN PC/HZ	CHECKED	APPROVED	DWG 5

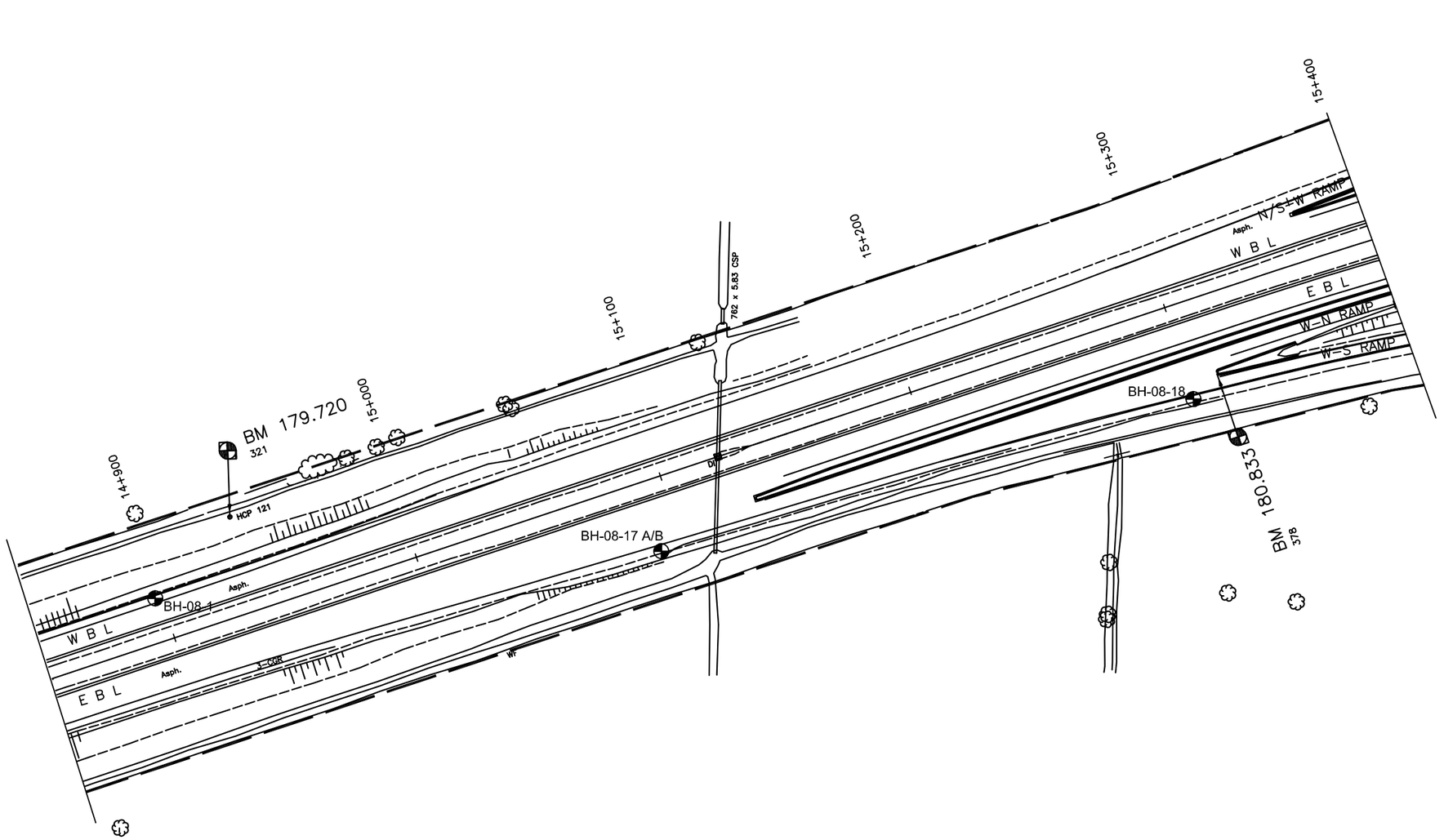
METRIC
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN

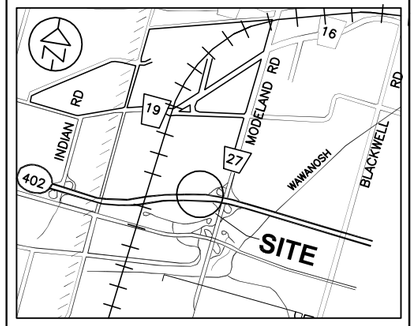
CONT. No.
WP No. 3038-03-00

NORTH

BOREHOLE LOCATION
14+850 to 15+400
PROPOSED SIGN SUPPORT
STRUCTURE,
HIGHWAY 402,
SARNIA, ONTARIO

SHEET





LEGEND

● BOREHOLE
(Jacques Whitford, 2008)

BH No.	ELEVATION (m)	NORTHING	EASTING
08-1	184.2	14+900	23 m LT
08-17 A/B	181.0	15+090	23 m RT
08-18	180.7	15+300	42 m RT

0 m — 100 m
Scale

NOTE
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* Borehole locations and site features shown are approximate and may vary from that shown.

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

GEOCRES No 40J16-82

HWY No 402			DIST LONDON
SUBM'D GC	CHECKED	DATE 2008-10-29	SITE -
DRAWN PC/HZ	CHECKED	APPROVED	DWG 6

Appendix B

Terms and Symbols Used on the Record of Borehole Sheet

Record of Borehole Sheet

Jacques Whitford

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 (R Q D), 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
γ_s	kN/m^3	UNIT WEIGHT OF SOLID PARTICLES
ρ_w	kg/m^3	DENSITY OF WATER
γ_w	kN/m^3	UNIT WEIGHT OF WATER
ρ	kg/m^3	DENSITY OF SOIL
γ	kN/m^3	UNIT WEIGHT OF SOIL
ρ_d	kg/m^3	DENSITY OF DRY SOIL
γ_d	kN/m^3	UNIT WEIGHT OF DRY SOIL
ρ_{sat}	kg/m^3	DENSITY OF SATURATED SOIL
γ_{sat}	kN/m^3	UNIT WEIGHT OF SATURATED SOIL
ρ'	kg/m^3	DENSITY OF SUBMERGED SOIL
γ'	kN/m^3	UNIT WEIGHT OF SUBMERGED SOIL

e	1,%	VOID RATIO
n	1,%	POROSITY
w	1,%	WATER CONTENT
S_r	%	DEGREE OF SATURATION
w_L	%	LIQUID LIMIT
w_P	%	PLASTIC LIMIT
w_S	%	SHRINKAGE LIMIT
I_P	%	PLASTICITY INDEX = $w_L - w_P$
I_L	1	LIQUIDITY INDEX = $\frac{w - w_P}{I_P}$
I_C	1	CONSISTENCY INDEX = $\frac{w_L - w}{I_P}$
e_{max}	1,%	VOID RATIO IN LOOSEST STATE
e_{min}	1,%	VOID RATIO IN DENSEST STATE
I_D	1	DENSITY INDEX = $\frac{e_{max} - e}{e_{max} - e_{min}}$
D	mm	GRAIN DIAMETER
D_n	mm	n PERCENT - DIAMETER
C_U	1	UNIFORMITY COEFFICIENT
h	m	HYDRAULIC HEAD OR POTENTIAL
q	m^3/s	RATE OF DISCHARGE
v	m/s	DISCHARGE VELOCITY
i	1	HYDRAULIC GRADIENT
k	m/s	HYDRAULIC CONDUCTIVITY
j	kN/m^3	SEEPAGE FORCE

RECORD OF BOREHOLE No 08-14

1 OF 1

METRIC

W.P. 3038-03-00 LOCATION Highway 402, Stn.: 10+983 o/s: 24 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 8.11.08 - 8.11.08 CHECKED BY GC

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (20 40 60 80 100): ○ UNCONFINED ● QUICK TRIAXIAL × FIELD VANE × LAB VANE	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
183.9	Hwy 402 W.B. Rt. Shoulder										
183.8	150 mm ASPHALT										
0.2 / 183.3	SAND and GRAVEL (FILL), damp, dark brown										
0.6	SAND, some gravel, trace silt, moist, dense, black (Fly and bottom Ash)		1	SS	37		183		○		
			2	SS	49				○		
181.8							182				
2.1	Sand, some gravel, trace silt (FILL), moist, compact		3	SS	42				○		
	- compact		4	SS	19	▽	181		○		
180.0											
4.0	SAND, some silt, trace gravel, dense to loose, moist to wet, grey		5	SS	32		180		○		1 83 (15)
							179				
			6	SS	9		178		○		
177.4											
6.6	END OF BOREHOLE at approximately 6.6 m Borehole caved to a depth of approximately 3.5 m (Elev. 180.5 m) below existing grade on completion of drilling Groundwater measured in caved borehole at a depth of approximately 3.5 m (Elev. 180.5 m) below existing grade on completion of drilling										

$\times^3$, $\times^3$: Numbers refer to Sensitivity $\circ^{3\%}$ STRAIN AT FAILURE

RECORD OF BOREHOLE No 08-13

1 OF 1

METRIC

W.P. 3038-03-00 LOCATION Highway 402, Stn.: 11+600 o/s: 25 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 8.10.08 - 8.11.08 CHECKED BY GC

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (20 40 60 80 100): ○ UNCONFINED ● QUICK TRIAXIAL × FIELD VANE × LAB VANE	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
183.9	Hwy 402 W.B. Rt. Shoulder										
183.8	150 mm ASPHALT										
0.2	SAND and GRAVEL (FILL), damp, brown		1	SS	46		183		○		
182.4											
1.5	SAND, some silt and clay, dense to compact, moist, brown (SM)		2	SS	36		182		○		
			3	SS	24	▽	181		○		
			4	SS	18				○		
	- dense		5	SS	37		179		○		0 73 (27)
177.9							178				
6.1	Silty CLAY, very stiff, moist to wet, grey (CL)		6	SS	24				○		
177.4											
6.6	END OF BOREHOLE at approximately 6.6 m Borehole caved to a depth of approximately 2.7 m (Elev. 181.3 m) below existing grade on completion of drilling Groundwater measured in caved borehole at a depth of approximately 2.7 m (Elev. 181.3 m) below existing grade on completion of drilling.										

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

RECORD OF BOREHOLE No 08-15

1 OF 1

METRIC

W.P. 3038-03-00 LOCATION Highway 402, Stn.: 11+798 o/s: 14 m Rt, Twp of Sarnia; ORIGINATED BY OL

DIST London HWY 402 BOREHOLE TYPE Solid Stem Auger, Split Spoon COMPILED BY OL

DATUM Geodetic DATE 8.11.08 - 8.11.08 CHECKED BY GC

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (20 40 60 80 100): ○ UNCONFINED, ● QUICK TRIAXIAL, × FIELD VANE, ⨯ LAB VANE	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
183.8	Hwy 402 E.B. Rt. Shoulder										
183.7	100 mm ASPHALT										
0.1	SAND and GRAVEL (FILL), damp, brown										
183.0											
0.8	SAND, some to trace gravel, some silt, very dense to dense, moist, brown (SM)		1	SS	55		183		○		
			2	SS	35		182		○		
			3	SS	41				○		0 92 (8)
			4	SS	50		181		○		
			5	SS	37	▽	180		○		
							179		○		
177.7							178				
6.1	Medium SAND, some to trace gravel, compact, saturated, grey		6	SS	19				○		1 89 (11)
177.2											
6.6	END OF BOREHOLE at approximately 6.6 m Borehole caved to a depth of approximately 5.3 m (Elev. 178.5 m) below existing grade on completion of drilling Groundwater measured in caved borehole at a depth of approximately 5.3 m (Elev. 178.5 m) below existing grade on completion of drilling										

$\times^3$, $\times^3$: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

RECORD OF BOREHOLE No 08-12

1 OF 1

METRIC

W.P. 3038-03-00 LOCATION Highway 402, Stn.: 12+200 o/s: 25 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 8.10.08 - 8.10.08 CHECKED BY GC

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (20 40 60 80 100): ○ UNCONFINED ● QUICK TRIAXIAL × FIELD VANE × LAB VANE	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
185.0	Hwy 402 W.B. Rt. Shoulder										
184.9	140 mm ASPHALT										
184.9 / 0.1	SAND and GRAVEL (FILL), damp, brown		1	SS	23		184		○		
183.6 / 1.4	Sandy SILT, with organics, trace clay, compact, moist, brown (SM)		2	SS	29	▽	183		○		
183.1 / 1.8	SAND, some silt, trace gravel, compact, moist, brown (SM)		3	SS	24				○		
			4	SS	18		182		○		
	- dense - wet		5	SS	46		181		○		
178.7 / 6.2	Silty CLAY, trace sand, hard, moist, grey (CL)		6	SS	50		180		○		
178.4 / 6.6	END OF BOREHOLE at approximately 6.6 m Borehole caved to a depth of approximately 1.8 m (Elev. 183.2 m) below existing grade on completion of drilling Groundwater measured in caved borehole at a depth of approximately 1.8 m (Elev. 183.2 m) below existing grade on completion of drilling						179				

$\times^3$, $\times^3$: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

RECORD OF BOREHOLE No 08-16

1 OF 1

METRIC

W.P. 3038-03-00 LOCATION Highway 402, Stn.: 12+730 o/s: 23 m Rt, Twp of Sarnia ORIGINATED BY OL

DIST London HWY 402 BOREHOLE TYPE Solid Stem Auger, Split Spoon COMPILED BY OL

DATUM Geodetic DATE 8.11.08 - 8.11.08 CHECKED BY GC

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: ○ UNCONFINED ● QUICK TRIAXIAL × FIELD VANE × LAB VANE (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
183.5	Hwy 402 E.B. Rt. Ramp Shoulder										
183.4 / 0.1	100 mm ASPHALT SAND and GRAVEL (FILL), damp, brown		1	SS	22		183		○		
181.9											
1.5	Silty SAND, trace gravel, compact, moist, brown (SM)		2	SS	21	▽	182		○		
	- wet		3	SS	23		181		○		
180.1			4	SS	25				○		
3.4	- grey						180				
	- silty, wet		5	SS	28		179		○		
177.4							178				
6.1 / 176.9	Silty CLAY, very stiff, saturated, grey (CL)		6	SS	27		177		○		
6.6	END OF BOREHOLE at approximately 6.6 m Borehole caved to a depth of approximately 2.0 m (181.5 m) below existing grade on completion of drilling Groundwater measured in caved borehole at a depth of approximately 2.0 m (181.5 m) below existing grade on completion of drilling										

$\times^3$, $\times^3$: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

RECORD OF BOREHOLE No 08-11

1 OF 1

METRIC

W.P. 3038-03-00 LOCATION Highway 402, Stn.: 13+125 o/s: 16 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

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa: ○ UNCONFINED ● QUICK TRIAXIAL × FIELD VANE × LAB VANE (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
183.5	Hwy 402 W.B. Rt. Shoulder										
183.4	100 mm ASPAHLT										
0.1	SAND and GRAVEL (FILL), damp, brown						183				
182.7											
0.8	Silty SAND (FILL), trace gravel, damp to moist, brown		1	SS	37				○		
181.9							182				
1.5	SAND, trace gravel, silt and clay, compact, moist, brown (SM)		2	SS	20	▽			○		
			3	SS	18		181		○		3 88 (9)
180.4											
3.0	- grey - wet		4	SS	24		180		○		
	- dense		5	SS	30		179		○		
							178				
177.2									●—○—●		0 27 37 36
6.2	Silty CLAY, very stiff, moist to wet, grey (CL)		6	SS	25		177				
176.9											
6.6	END OF BOREHOLE at approximately 6.6 m										

Borehole caved to a depth of approximately 2.1 m (Elev. 181.4 m) below existing grade on completion of drilling

Groundwater measured in caved borehole at a depth of approximately 2.1 m (Elev. 181.4 m) below existing grade on completion of drilling

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

$\circ^{3\%}$ STRAIN AT FAILURE

RECORD OF BOREHOLE No 08-10

1 OF 1

METRIC

W.P. 3038-03-00 LOCATION Highway 402, Stn.: 13+474 o/s: 32 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

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL × FIELD VANE ⨯ LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
183.2	Hwy 402 W.B. Rt. Shoulder										
183.0 / 0.1	100 mm ASPAHLT SAND and GRAVEL (FILL), damp, brown		1	AS	--		183		○		
			2	SS	50 / 75 mm				○		
181.7							182				
1.5	SAND, trace gravel, trace silt and clay, dense to compact, moist, brown (SM)		3	SS	30				○		
			4	SS	20	▽	181		○		1 93 (6)
			5	SS	14		180		○		
178.7											
4.6	- grey - wet		6	SS	17		179		○		
177.6							178				
5.6	Silty CLAY, with sand, stiff, wet, grey (CL)		7	SS	12		177		○		
176.7											
6.6	END OF BOREHOLE at approximately 6.6 m Borehole caved to a depth of approximately 2.7 m (Elev. 180.6 m) below existing grade on completion of drilling Groundwater measured in caved borehole at a depth of approximately 2.7 m (Elev. 180.6 m) below existing grade on completion of drilling										

$\times^3$, $\times^3$: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

RECORD OF BOREHOLE No 08-6

1 OF 1

METRIC

W.P. 3038-03-00 LOCATION Highway 402, Stn.: 14+098 o/s: 25 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

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (20 40 60 80 100): ○ UNCONFINED ● QUICK TRIAXIAL × FIELD VANE ⨯ LAB VANE	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
184.3	Hwy 402 W.B. Rt. Shoulder						184				
184.0	150 mm ASPHALT										
0.2	SAND and GRAVEL (FILL), damp, brown										
183.5											
0.8	Silty CLAY (FILL), trace to some gravel, very stiff, damp, brown (CL)		1	SS	17		183		○		
			2	SS	26				○		
			3	SS	16		182		○		1 23 37 39
181.2											
3.0	Silty SAND, trace gravel, dense, wet, grey (SM)		4	SS	35	▽	181		○		
179.7							180				
4.6	Silty CLAY, moist to wet, stiff to hard, grey (CL)		5	SS	9				○		
			6	SS	35		179		○		
177.7							178				
6.6	END OF BOREHOLE at approximately 6.6 m Borehole caved to a depth of approximately 3.4 m (Elev. 180.9 m) below existing grade on completion of drilling Groundwater measured in caved borehole at a depth of approximately 3.4 m (Elev. 180.9 m) below existing grade on completion of drilling										

$\times^3$, $\times^3$: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

RECORD OF BOREHOLE No 08-1

1 OF 1

METRIC

W.P. 3038-03-00 LOCATION Highway 402, Stn.: 14+900 o/s: 23 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 8.6.08 - 8.6.08 CHECKED BY GC

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: ○ UNCONFINED ● QUICK TRIAXIAL × FIELD VANE × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
184.2	Hwy 402 W.B. Rt. Shoulder										
0.0	SAND and GRAVEL (FILL), damp Brown		1	SS	58		184		○		
183.4											
0.8	Silty CLAY, moist, hard, brown (CL)		2	SS	40		183		○		
182.6											
1.5	- grey - very stiff to hard		3	SS	24				○		
	- trace to some gravel		4	SS	32		182		○		
			5	SS	32		181		○—●		4 15 46 36
	- very moist - stiff to very stiff		6	SS	12		180		○		
							179				
177.6			7	SS	19		178		○		
6.6	END OF BOREHOLE at approximately 6.6 m Borehole open and dry on completion of drilling										

$\times^3$, $\times^3$: Numbers refer to Sensitivity ○$^{3\%}$ STRAIN AT FAILURE

RECORD OF BOREHOLE No 08-17A

1 OF 1

METRIC

W.P. 3038-03-00 LOCATION Highway 402, Stn: 15+090 o/s: 23 m Rt, Twp of Sarnia ORIGINATED BY OL

DIST London HWY 402 BOREHOLE TYPE Solid Stem Auger, Split Spoon COMPILED BY OL

DATUM Geodetic DATE 8.11.08 - 8.11.08 CHECKED BY GC

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (20 40 60 80 100): ○ UNCONFINED ● QUICK TRIAXIAL × FIELD VANE × LAB VANE	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
181.0	Hwy 402 E.B. Rt. Shoulder										
0.0	SAND and GRAVEL (FILL), trace silt, wet, brown										
			1	SS	12		180				
179.4											
1.6	END OF BOREHOLE at approximately 1.6 m Borehole encountered obstruction at a depth of approximately 1.6 m. Borehole relocated to approximately 1.5 m east (BH 08-17B).										

×³, ×³: Numbers refer to Sensitivity

○³% STRAIN AT FAILURE

RECORD OF BOREHOLE No 08-17B

1 OF 1

METRIC

W.P. 3038-03-00 LOCATION Highway 402, Stn: 15+090 o/s: 23 m Rt, Twp of Sarnia ORIGINATED BY OL

DIST London HWY 402 BOREHOLE TYPE Solid Stem Auger, Split Spoon COMPILED BY OL

DATUM Geodetic DATE 8.11.08 - 8.11.08 CHECKED BY GC

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: ○ UNCONFINED ● QUICK TRIAXIAL × LAB VANE ✖ FIELD VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
181.0	Hwy 402 E.B. Rt. Shoulder										
0.0	Borehole augered to 1.5 m.					▽	180				
179.4											
1.5	Silty SAND, compact, moist, brown (SM)		1	SS	24		179				
			2	SS	25		178				
176.7							177				
4.3	Silty CLAY, stiff, wet, grey (CL)		3	SS	9		176		○ ●		0 26 36 36
			4	SS	10		175				
174.4											
6.6	END OF BOREHOLE at approximately 6.6 m Borehole caved to a depth of approximately 1.2 m below existing grade (Elev. 179.8 m) on completion of drilling Groundwater measured in caved borehole at a depth of approximately 0.6 m below existing grade (Elev. 180.4 m) on completion of drilling										

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

RECORD OF BOREHOLE No 08-18

1 OF 1

METRIC

W.P. 3038-03-00 LOCATION Highway 402, Stn: 15+300 o/s: 42 m Rt, Twp of Sarnia; ORIGINATED BY OL

DIST London HWY 402 BOREHOLE TYPE Solid Stem Auger, Hollow Stem Auger, Split Spoon COMPILED BY OL

DATUM Geodetic DATE 8.11.08 - 8.11.08 CHECKED BY GC

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (20 40 60 80 100): ○ UNCONFINED ● QUICK TRIAXIAL × FIELD VANE ⨯ LAB VANE	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
180.7	Hwy 402 E.B. Rt. Shoulder										
0.0	SAND and GRAVEL (FILL), damp, brown						180				
179.1											
1.5	Silty clay, some gravel, trace to some sand, moist, hard, brown (FILL)		1	SS	50 / 150 mm		179		○		
178.4											
2.3	SAND, some silt, trace to some gravel, loose to compact, wet to saturated, grey (SM)					▽	178		○		
			2	SS	8				○		
							177				
			3	SS	6		176		○		
							175				
174.1			47	SS	12						
6.6	END OF BOREHOLE at approximately 6.6 m Borehole caved to a depth of approximately 2.7 m (Elev. 178.0 m) below existing grade on completion of drilling Groundwater measured in caved borehole at a depth of approximately 2.7 m (Elev. 178.0 m) below existing grade on completion of drilling										

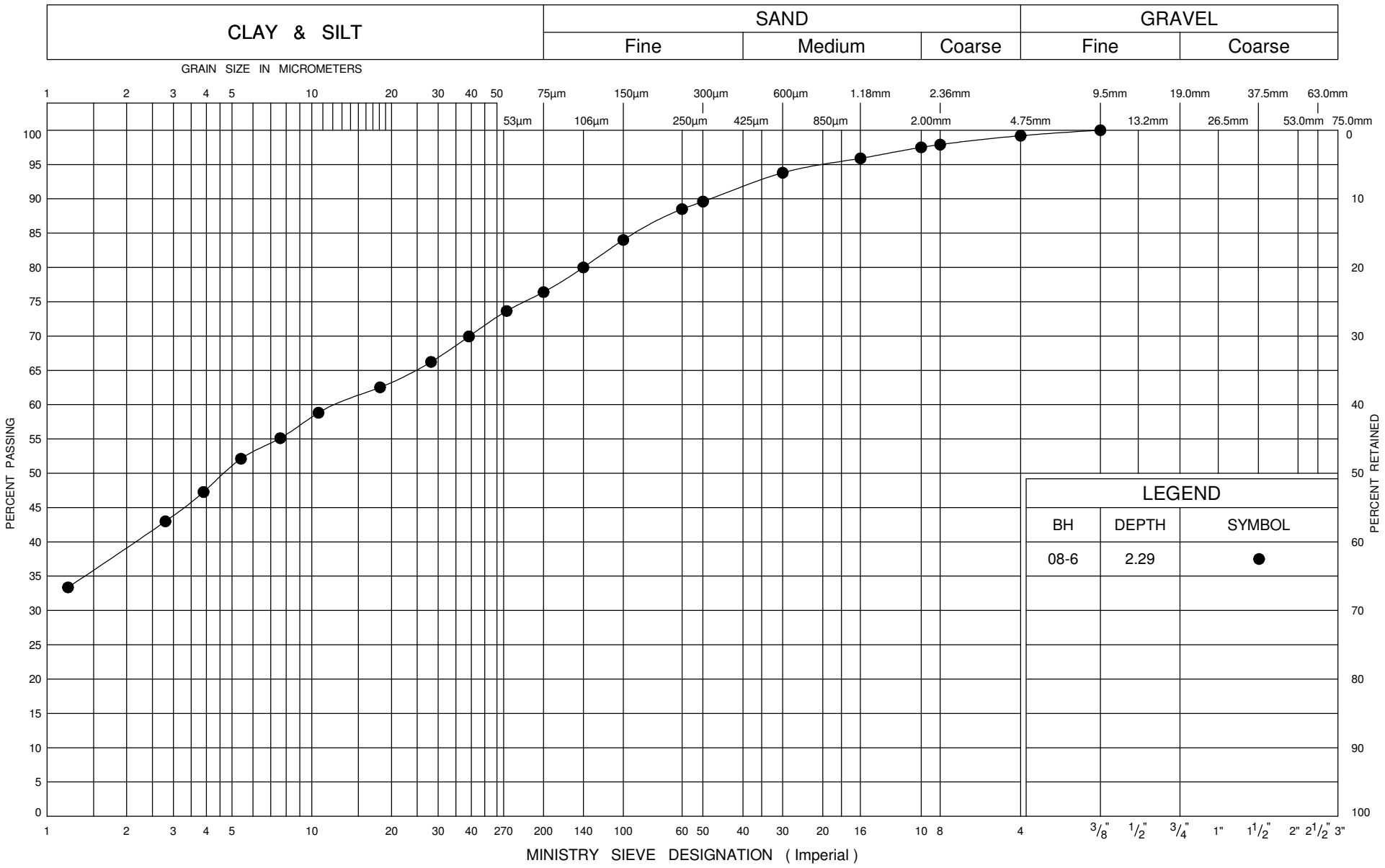
$\times^3$, $\times^3$: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

Appendix C

Geotechnical Laboratory Test Results

Jacques Whitford

UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of Transportation
Ontario

GRAIN SIZE DISTRIBUTION

Silty CLAY (FILL)

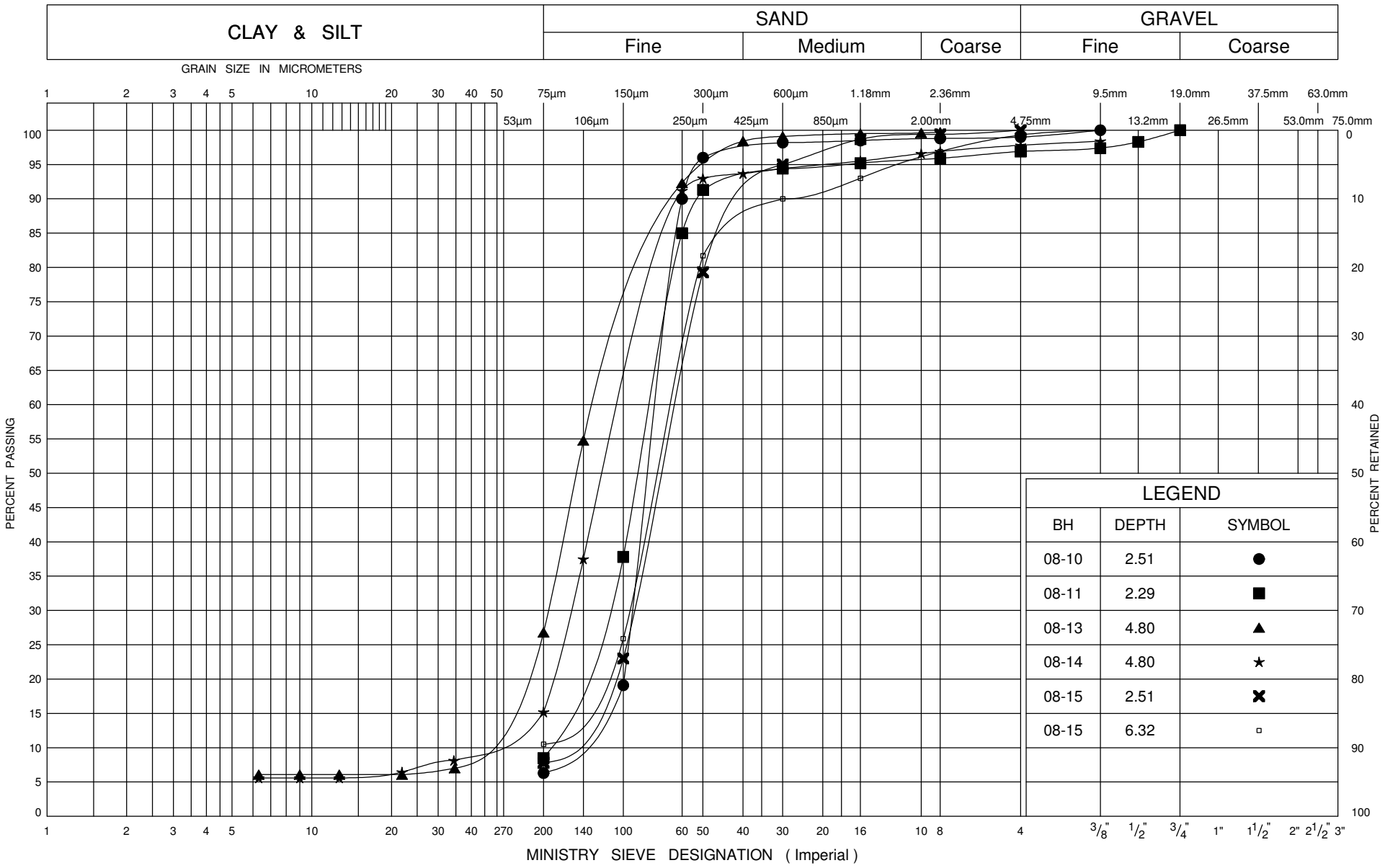
FIG No 1

W P 3038-03-00

Hwy 402, Township of Sarnia

ONTARIO MOT GRAIN SIZE 1012607_AUG 2008.GPJ ONTARIO MOT.GDT 11/19/08

UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of Transportation
Ontario

GRAIN SIZE DISTRIBUTION

Native SAND

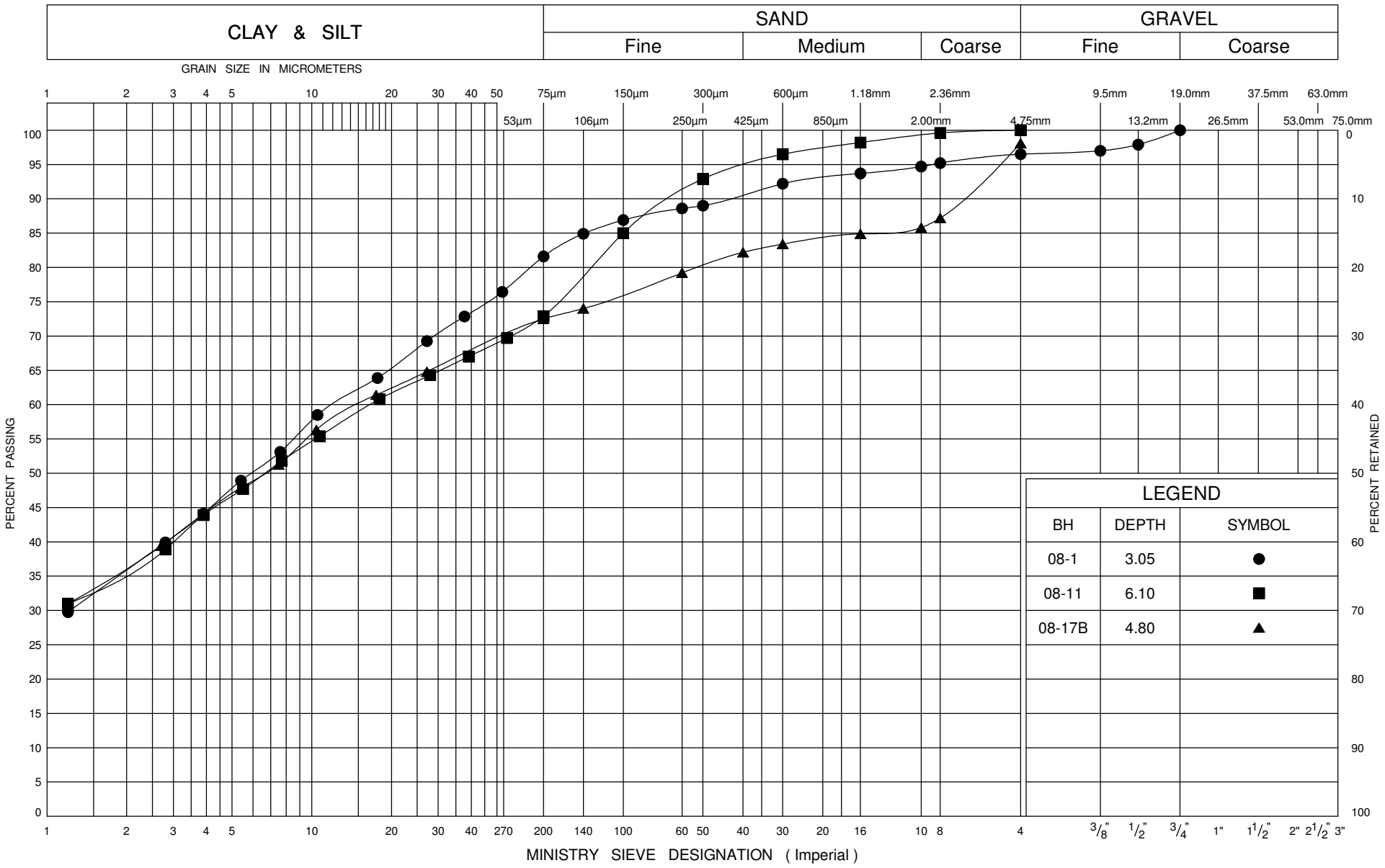
FIG No 2

W P 3038-03-00

Hwy 402, Township of Sarnia

ONTARIO MOT GRAIN SIZE 1012607_AUG 2008.GPJ ONTARIO MOT.GDT 11/19/08

UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of Transportation
Ontario

GRAIN SIZE DISTRIBUTION

Silty CLAY (CL)

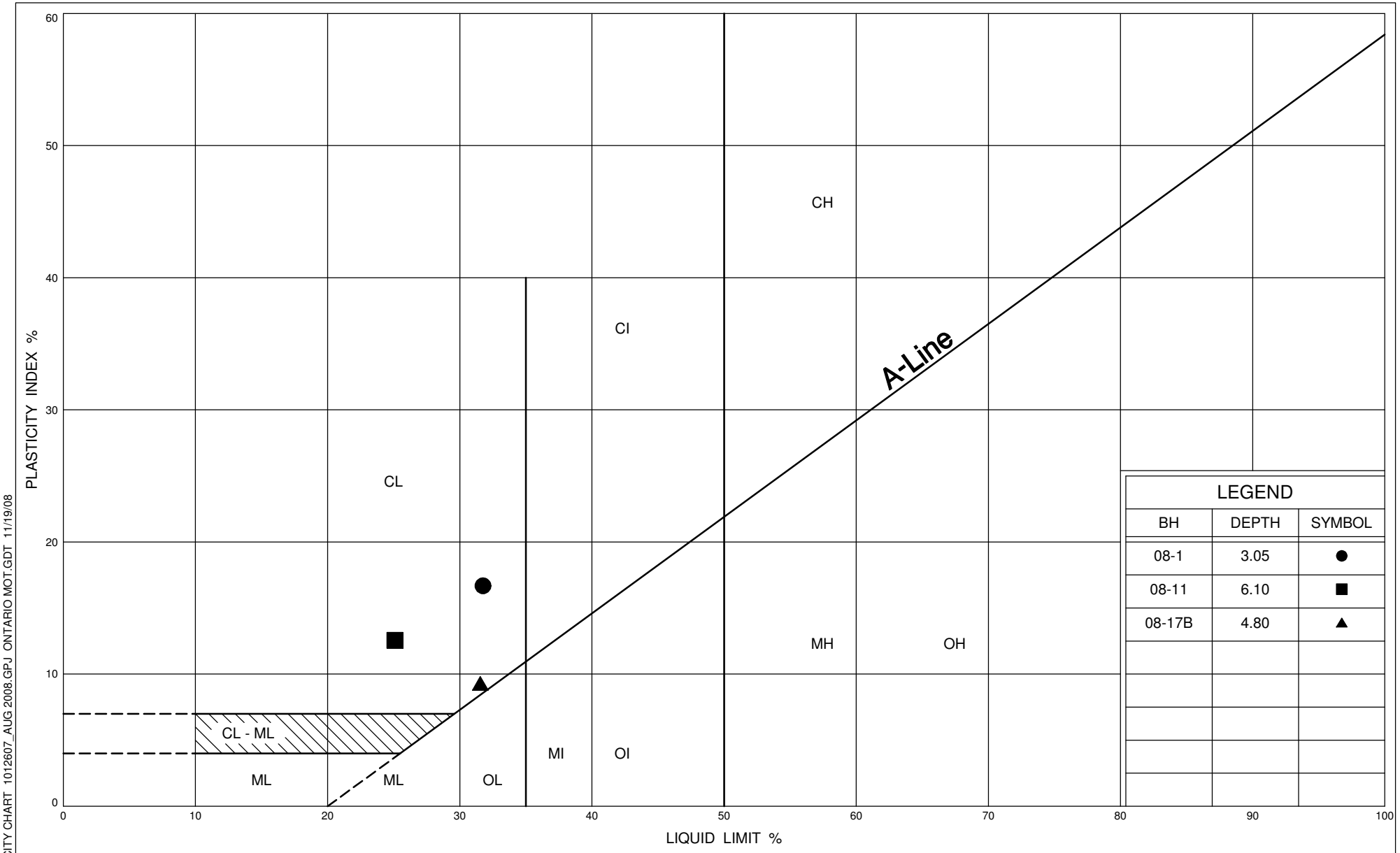
FIG No 3

W P 3038-03-00

Hwy 402, Township of Sarnia

ONTARIO MOT GRAIN SIZE 1012607_AUG 2008.GPJ ONTARIO MOT.GDT 11/19/08

Oct 75, FF - S - 21



LEGEND		
BH	DEPTH	SYMBOL
08-1	3.05	●
08-11	6.10	■
08-17B	4.80	▲

ONTARIO MOT PLASTICITY CHART 1012607_AUG 2008.GPJ ONTARIO MOT.GDT 11/19/08

Ministry of Transportation
Ontario

PLASTICITY CHART

Silty CLAY (CL)

FIG No 4

W P 3038-03-00

Hwy 402, Township of Sarnia