

FINAL REPORT

Foundation Investigation Report
Christina Street Underpass,
Site 14-37 Highway 402
City of Sarnia, Ontario
District - London
G.W.P. 3038-03-00

STANTEC CONSULTING LTD.

PROJECT NO. 1012607
GEOCRES NO. 40J16-78

PROJECT NO. 1012607

REPORT TO **Stantec Consulting Inc.**
 1400 Rymal Road East
 Hamilton, ON
 L8W 3N9

FOR **Final**
 Foundation Investigation Report

ON **Christina Street Underpass,**
 Site 14-37 Highway 402
 City of Sarnia, Ontario
 G.W.P. 3038-03-00
 District – London
 GEOCRES NO. 40J16-78

September 26, 2008

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Record of Borehole Sheets
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FOUNDATION INVESTIGATION REPORT

**Christina Street Underpass,
Site 14-37 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 and Design Report for the proposed Highway 402 Underpass at Christina Street, in the City of Sarnia, Ontario, (GWP 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 site location is on Highway 402 at the Christina Street Interchange (IC-2) in the City of Sarnia, Ontario.

Highway 402 at Christina Street is a semi-urban freeway with wide gravel shoulders and a wide grass covered centre median. The highway is slightly lower than the grade of the surrounding lands. Highway 402 is generally oriented in an east-west direction with two east bound and two west bound lanes passing below Christina Street.

Drainage is provided by ditches located 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 project site.

The existing Christina Street underpass is a rigid frame structure, consisting of 2 - 15 m spans (approximate) with a wide central pier. The bridge is constructed of reinforced concrete. Based on the as-built drawings dated August 1950, revised October 1950, it is understood that the existing bridge structure is supported on shallow footings placed on the native sand at an elevation of approximately 179.8 m. The existing bridge deck is at an elevation of approximately 188.9 m and the profile of Highway 402 is at an elevation of approximately 181.7 m.



Christina Street is 4 lanes wide, locally widened in areas to accommodate left and right turning lanes. At the bridge approaches, the street is constructed on embankments that are approximately 6 m high at the abutment locations. Drainage is provided by concrete gutters and a series of catch basins.

A representative site photograph of the underpass structure is provided in **Appendix E**.

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

4.0 BACKGROUND

Previous Investigations

A previous assessment of the site was carried out by Golder Associates Ltd. The results of the assessment were provided in a written report titled:

Preliminary Foundation Investigation and Design Report, Proposed Christina Street Underpass Replacement, Highway 402, GWP 3038-03-00, Agreement Number 3005-A-000394, Dated October 14, 2005.

The reported subsurface conditions included the following strata types:

| Strata | Layer Thickness (m) | Depth to underside of Strata (m) |
|-----------------|---------------------|------------------------------------|
| Fill | 0.8 to 1.0 | 0.8 to 1.0 |
| Sand | 3.7 to 4.6 | 4.9 to 5.9 |
| Peat | 0.15 (G-BH1 Only) | 6.3 |
| Clayey silt | 11.2 to 17.7 | 17.4 to 22.6 |
| Silty clay | 26.2 to 31.9 | 48.8 to 49.4 |
| Silt | 0.9 (G-BH1 Only) | 50.4 |
| Sand and Gravel | 0.9 (G-BH2 Only) | 50.3 |
| Till | 3.2 and 4.8 | Termination depth of the boreholes |

The sand layer was generally reported to be compact with exception of the lower portion at one of the boreholes, which was very loose.

The clayey silt layer was stated to be firm to very stiff, with actual reported measurements indicating stiff to very stiff conditions. Laboratory tests were reported as follows:

- Moisture contents ranging from 12% to 26%, average of about 19%;
- Average plastic limit of approximately 15; and,
- Average liquid limit of approximately 31.
- Pre-consolidation pressure of 150 kPa from the consolidation test on a sample from Elevation 169.5 m. This indicates that the sample was slightly overconsolidated by 10 kPa.

The silty clay layers were stated to be firm to very stiff based on the SPT N-values. Laboratory tests were reported as follows:

- Moisture contents ranging from 27% to 33%, average of about 30%;
- Average plastic limit of approximately 21; and,
- Average liquid limit of approximately 43.

The till was very dense with SPT N-values exceeding 100. Laboratory tests were reported as follows:

- Moisture contents ranging from 7% to 26%, average of about 12%; and,
- Shale fragments were also reported in the till.

These boreholes have been referenced in this report as Boreholes G-BH1 and G-BH2.

5.0 INVESTIGATION PROCEDURES

5.1 Field Program

The fieldwork for the present investigation was carried out between October 31, 2006, and November 10, 2006, and December 6 to 12, 2006. A total of 13 boreholes were advanced to depths ranging from approximately 6.7 m to 57 m using a track and truck mounted drill rigs equipped with 250 mm (outside diameter), hollow-stem augers and mud-rotary drilling, supplied and operated by Aardvark Drilling Inc.

The following outlines the general purpose of the boreholes:

| Location | Boreholes |
|-----------------------------------|-----------------------------------|
| South Abutment and approach fills | CS-1 and G-BH2 |
| Central pier | CS-2 |
| North Abutment and Approach fills | CS-3, CS-4 and G-BH1 |
| Retaining Walls | R-1 to R-5 |
| Embankment and approach fills | CS-1, CS-3, CS-4 and CS-6 to CS-8 |

Borehole CS-5 was advanced at the site for a proposed storm water management pond. The results of the storm water management pond foundation investigation and geotechnical recommendations for design are provided under separate cover.

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

Soil samples were recovered from the boreholes at regular intervals using a 50 mm Outside Diameter split-tube sampler by conducting Standard Penetration Tests (SPTs) in general accordance with the procedures outlined in the ASTM specification D1586-99. Relatively undisturbed samples were obtained by pushing thin walled sample tubes in general accordance with ASTM D1587.

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

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

The groundwater levels, where encountered, were measured in the boreholes at the completion of drilling. All boreholes were backfilled in accordance with Ontario Regulation 903, using cement/bentonite slurry.

All soil samples recovered from the boreholes were placed in moisture-proof bags and returned to our laboratory for detailed classification and testing as required.

5.2 Survey

The borehole locations were established by Jacques Whitford personnel and referenced to the stations on Christina Street, the respective ramps, or Highway 402. Offsets were referenced looking up chainage. The borehole locations are also referenced to Northing and Easting co-ordinates, which are provided on the Record of Borehole sheets and on Drawing Nos. 1 to 4.

The ground surface elevation at the borehole locations were surveyed by Jacques Whitford personnel. The boreholes were surveyed to one of the following benchmarks, as identified on a Survey Drawing by J. D. Barnes, titled "Pre-Engineering Sta. 11+000 to Sta. 11+700", with a survey date of August, 2004.

- BM 812, a bronze plate set in the concrete sidewalk on the west side of Christina Street, south of the existing south bridge abutment, with a reported Geodetic elevation of 186.87 m.
- BM 332, a monument set at Sta. 11+430, off-set 20 m left, with a reported Geodetic elevation of 183.55 m.

The benchmark locations are shown on Drawing No. 1 in **Appendix A**.

5.3 Laboratory Testing

All samples returned to the laboratory were subjected to detailed visual examination and classification. Representative samples of the native soils were tested for grain size, Atterberg Limits and unit weight testing. In addition, a series of samples were submitted for moisture content determination. Consolidation testing of one soil sample obtained by Jacques Whitford was carried out by Golder Associates on our behalf. The results of the grain size analyses, Atterberg Limits, consolidation and unit weight tests are shown on Figure Nos. 1 through 7 in **Appendix C**. The laboratory testing carried



out by Golder Associates for the preliminary foundation investigation has been incorporated into this report and is included in **Appendix D**.

Unless requested in advance, all samples will be stored in our laboratory for a period of 12 months after issuance of this report.

6.0 RESULTS OF THE INVESTIGATION

6.1 Subsurface Conditions

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

The boreholes from the preliminary geotechnical investigation, completed by Golder Associates, have been incorporated herein, and are also provided in **Appendix B**. In addition, the laboratory test data from the preliminary report have been incorporated into this report and are provided in **Appendix D**.

Borehole Location plans and strata plots of the soils encountered in the boreholes are provided on Drawing Nos. 1 to 4 in **Appendix A**.

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 several boreholes. The following table outlines the borehole location, borehole number and asphalt thickness measured at each borehole, where encountered:

| Location | Borehole Number | Asphalt Thickness (mm) |
|------------------|-----------------|------------------------|
| Christina Street | CS-1 | 150 |
| Christina Street | CS-3 | 200 |
| Christina Street | R-1 | 150 |
| Christina Street | R-2 | 150 |
| S-E Ramp | R-4 | 180 |
| S-E Ramp | R-5 | 200 |

6.2.2 Topsoil

Topsoil was encountered at the ground surface in Boreholes G-BH1 and G-BH2.

6.2.3 Sand Fill

Sand fill was encountered at the ground surface in Boreholes CS-2, CS-6 to CS-8 and R-1, and below the asphalt or topsoil in all other boreholes. The granular material ranged in thickness from approximately 0.7 m to 5.1 m. Thicker sand fill, in the range of approximately 4.6 m to 5.3 m, was encountered in Boreholes CS-1 and CS-3, which were drilled through the approach embankments for the existing bridge structure.

The sand fill generally consisted of sand and gravel directly below the asphalt, grading to sand, trace gravel with increasing depth. The sand fill contained trace silt and was generally moist to damp.

Based on the N-Values obtained from the Standard Penetration Tests (SPTs), the compactness of the sand fill was variable ranging from very dense to very loose, but was typically compact.

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

- Moisture Content:
 - 5% to 8%
- Gradation:
 - 9% to 37% gravel;
 - 51% to 86% sand; and,
 - 4% to 12% 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 provided on Figure 1 in **Appendix C**.

6.2.4 Native Sand

Native sand was encountered below the fill in all boreholes. The sand was encountered at depths ranging from approximately 0.9 m to 5.3 m below existing grade, or at elevations of approximately 183.1 to 176.7 m. The thickness of the sand ranged from approximately 2.8 m to 7.6 m.

The sand was generally moist to wet. Based on the N-Values obtained from the SPTs, the compactness of the sand ranged from very dense to compact.

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

- Moisture Content:
 - 10% to 30%
- Gradation:
 - 0% to 10% gravel;
 - 83% to 96% sand; and,
 - 2% to 17% 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 provided on Figures 2 and 3 in **Appendix C** and on Figure A-1 in **Appendix D**.

A second layer of sand was encountered below the silty clay in Borehole G-BH2, at a depth of approximately 49.7 m or elevation of about 131.9 m. This layer of sand was approximately 0.6 m thick and contained gravel and trace silt.

6.2.5 Peat

A peat seam was encountered in Borehole G-BH1 below a thin seam of clay silt (noted below) at a depth of approximately 6.1 m below grade, or elevation 175.9 m. The peat was described by Golder as follows:

- 150 mm thick;
- Moisture content: 110%;
- Saturated;
- Fibrous; and,
- SPT N-value of 4.

6.2.6 Clayey Silt / Silty Clay

Clayey silt / silty clay was encountered below the sand in all boreholes. The clayey silt / silty clay was encountered at depths in the range of approximately 4.7 m to 12.2 m below existing grade, or elevations of approximately 174.7 m to 177.6 m. All boreholes, with the exception of Boreholes CS-2, G-BH1 and G BH2, were terminated in the clayey silt / silty clay at depths in the range of approximately 6.7 m to 15.8 m or elevations of approximately 170.5 m to 177.9 m. The clayey silt / silty clay was approximately 43 m, 44 m and 45 m thick in Boreholes CS-2, G-BH1, and G-BH2, respectively.

The clayey silt / silty clay was generally moist to damp.

The upper 2 m of the silty clay generally could be classified as very stiff to hard, indicating this layer is likely a desiccated layer. Below this depth, the consistency of the clayey silt / silty clay is generally stiff.

In situ shear vane testing was carried out in the clayey silt / silty clay. The results of the testing indicated that the shear strength of the clayey silt / silty clay was variable ranging from approximately 55 kPa to >140kPa, but was more typically in the range of approximately 70 kPa to 85 kPa.

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

- Moisture Content:
 - 13% to 34%.
- Gradation:
 - 0% to 7% gravel;
 - 5% to 32% sand;
 - 40% to 75% silt; and,
 - 17% to 42% clay.

- Atterberg Limits:
 - Liquid Limits: 24 to 47; and,
 - Plastic Limits: 10 to 24.
- Unit Weight: 20.9 to 21.5 kN/m³.

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

The results of the grain size distribution tests are provided on Figure 4 in **Appendix C** and Figure A-2 and A-5 in **Appendix D**. The results of the Atterberg Limits tests are provided on Figure 5 in **Appendix C**, and Figure A-3 and A-6 in **Appendix D**.

The results of the consolidation tests carried out by Golder on behalf of Jacques Whitford in January 2007 for the present investigation are provided on Figure 6 in **Appendix C**.

The results of the consolidation tests carried out by Golder as part of the October 2005 Preliminary Foundation Investigation are provided on Figure A-4 in **Appendix D**.

The results of the unit weight tests are provided on Figure 7 in **Appendix C**.

6.2.7 Silt

Silt was encountered below the clayey silt /silty clay in Borehole G-BH1 at a depth of approximately 49.4 m or an elevation of about 131.9 m. The silt was described by Golder as follows:

- Approximately 1 m thick;
- Contained trace clay and layers of silty clay;
- Generally wet;
- Compact; and,
- Moisture content of 26%.

6.2.8 Sandy Silt Till

Sandy silt till was encountered below the silt, sand or clayey silt / silty clay in Boreholes CS-2, G-BH1 and G-BH2 at depths in the range of approximately 47.2 m to 50.4 m below existing grade or elevations of approximately 130.9 to 133.8 m. Boreholes CS-2, G-BH1 and G-BH2 were terminated in the sandy silt till stratum at depths of approximately 53.5 to 57.0 m below existing grade, elevations of approximately 124.4 m to 128.1 m.

The sandy silt till was generally moist. Based on the N-Values obtained from the SPTs, the compactness of the sandy silt till was very dense.

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

- Moisture Content:
 - 8% to 11%.
- Gradation:



- 11% gravel;
- 43% sand;
- 33% silt; and,
- 13% 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 provided on Figure A-7 in **Appendix D**.

6.3 Groundwater

Ground water was encountered in the boreholes during drilling. It was not practical to measure the ground water on completion of drilling in all of the boreholes, given the use of drillers mud during drilling. The following table provides a summary of the groundwater conditions encountered:

| Borehole | Drill Date | Ground Water First Encountered | | Ground Water measured on Completion of Drilling | | Depth to Cave of Borehole (m) | |
|----------|------------|--------------------------------|---------------|---|---------------|-------------------------------|---------------|
| | | Depth (m) | Elevation (m) | Depth (m) | Elevation (m) | Depth (m) | Elevation (m) |
| CS-1 | 06-11-08 | - | - | 7.6 | 179.3 | 6.5 | 180.4 |
| CS-2 | 06-12-06 | - | - | - | - | - | - |
| CS-3 | 06-11-08 | - | - | 7.6 | 179.2 | 6.7 | 180.1 |
| CS-6 | 06-11-10 | 3.0 | 180.1 | * | * | 2.9 | 180.2 |
| CS-7 | 06-11-10 | 3.0 | 180.1 | * | * | 2.6 | 180.6 |
| CS-8 | 06-11-10 | 4.0 | 179.5 | * | * | 2.9 | 180.6 |
| R-1 | 06-11-09 | 4 | 179.4 | * | * | 3.3 | 180.1 |
| R-2 | 06-11-09 | 6.1 | 178.7 | * | * | 4.4 | 180.4 |
| R-3 | 06-11-10 | 4.6 | 179.1 | * | * | 3.5 | 180.2 |
| R-4 | 06-11-10 | 4 | 180.0 | * | * | 3.7 | 180.3 |
| R-5 | 06-11-10 | - | - | * | * | 3 | 180.0 |
| G-BH1 | 04-07-12 | 1.8 | 179.5 | * | * | - | - |
| G-BH2 | 04-07-19 | 1.7 | 179.9 | * | * | - | - |

* - Could not be measured due to the drilling techniques used.

Fluctuation in the groundwater level due to seasonal variations or in response to a particular precipitation event should be anticipated.

7.0 CLOSURE

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

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

Yours very truly,

JACQUES WHITFORD LIMITED

Original Signed By:

Geoffrey Creer, P.Eng.
Geotechnical Engineer

Original Signed By:

Raymond Haché, P.Eng.
Principal, Geotechnical Service Director, and
Designated Principal
MTO Foundations Contact

GC/RH/dd

Enclosures

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APPENDIX A

Drawings

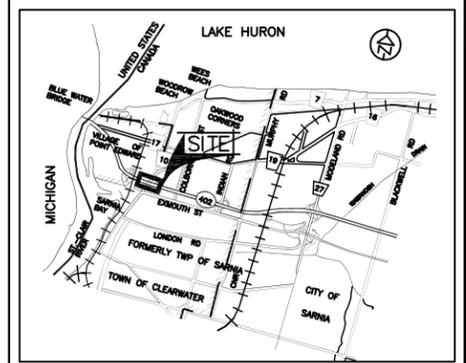
METRIC
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AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN

HWY 402
STATION -
11+200 TO 11+600

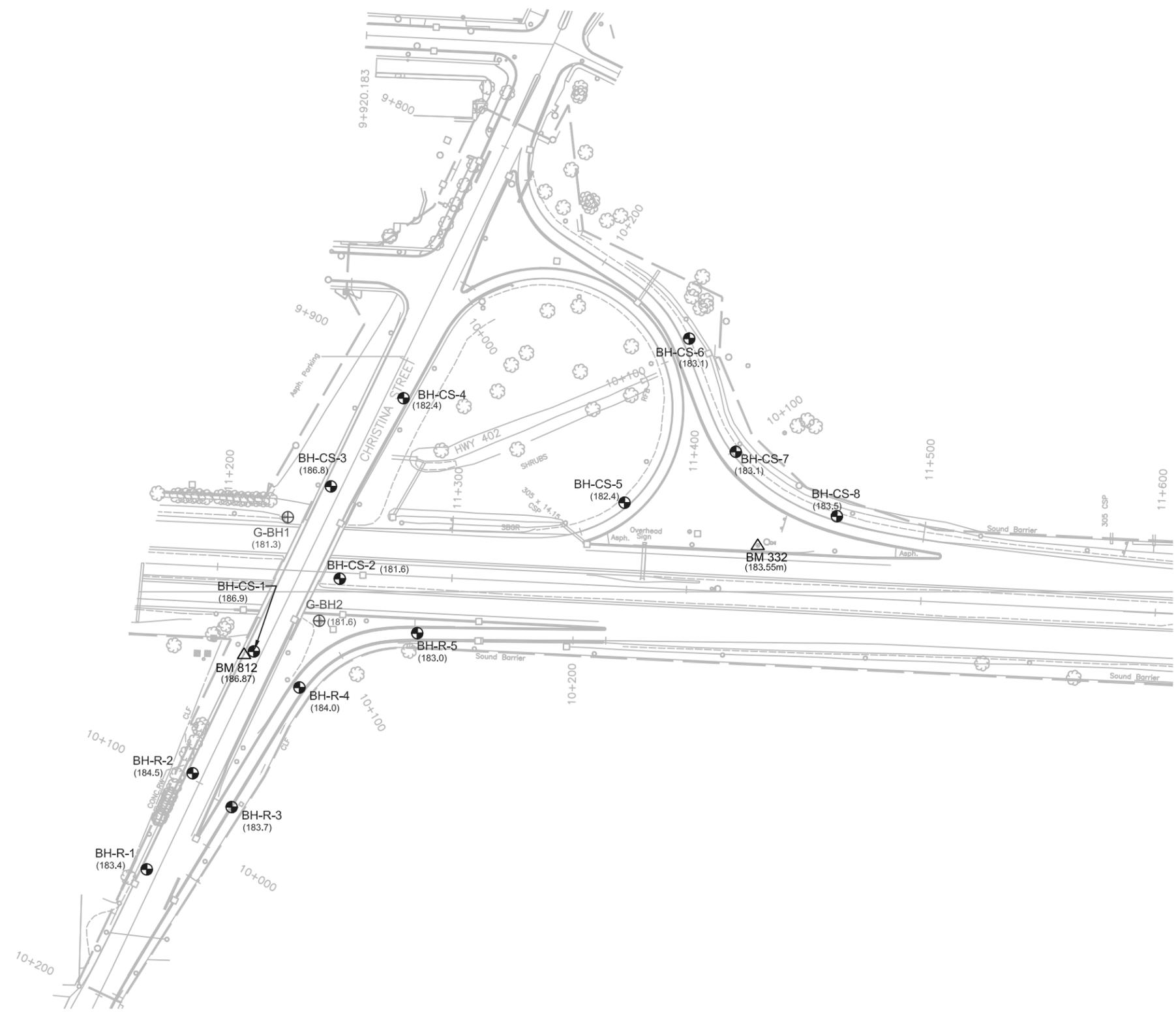


HIGHWAY 402
CHRISTINA STREET
UNDERPASS
BOREHOLE LOCATION PLAN

SHEET



N.T.S



LEGEND

- Borehole (Jacques Whitford, 2006)
- ⊕ Borehole (By Golder, 2004)
- △ Benchmark

| BH No. | ELEVATION (m) | NORTHING | EASTING |
|--------|---------------|------------|-----------|
| CS-1 | 186.9 | 476 0877.2 | 313 072.4 |
| CS-2 | 181.6 | 476 0908.3 | 313 107.7 |
| CS-3 | 186.8 | 476 0940.7 | 313 102.6 |
| CS-4 | 182.4 | 476 0974.3 | 313 133.6 |
| CS-5 | 182.4 | 476 0953.8 | 313 243.0 |
| CS-6 | 183.1 | 476 1014.9 | 313 255.9 |
| CS-7 | 183.1 | 476 0961.6 | 313 279.1 |
| CS-8 | 183.4 | 476 0931.3 | 313 327.9 |
| R-1 | 183.4 | 476 0780.2 | 313 025.7 |
| R-2 | 184.8 | 476 0821.0 | 313 045.6 |
| R-3 | 183.7 | 476 0777.0 | 313 043.1 |
| R-4 | 184.0 | 476 0858.0 | 313 093.2 |
| R-5 | 183.0 | 476 0880.2 | 313 140.8 |
| G-BH1 | 181.3 | 476 0934.8 | 313 086.3 |
| G-BH2 | 181.6 | 476 0884.5 | 313 100.0 |

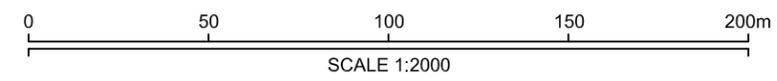
NOTE

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

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

| REVISIONS | DATE | BY | DESCRIPTION |
|-----------|------|----|-------------|
| | | | |

| | | | |
|---------------------|---------|-----------------|-----------------------|
| GEOGRES No 40J16-78 | | | |
| HWY No 402 | CHECKED | DATE 2008-09-24 | DIST LONDON |
| SUBM'D GC | CHECKED | APPROVED | SITE 14-37 |
| DRAWN PC/HZ | CHECKED | APPROVED | DWG 1012807-GEO-CS-01 |



P:\1000xx\CHRIS\TINA_S\1012807\GEO-CS-01_borehole locations 20080924.dwg (Model)

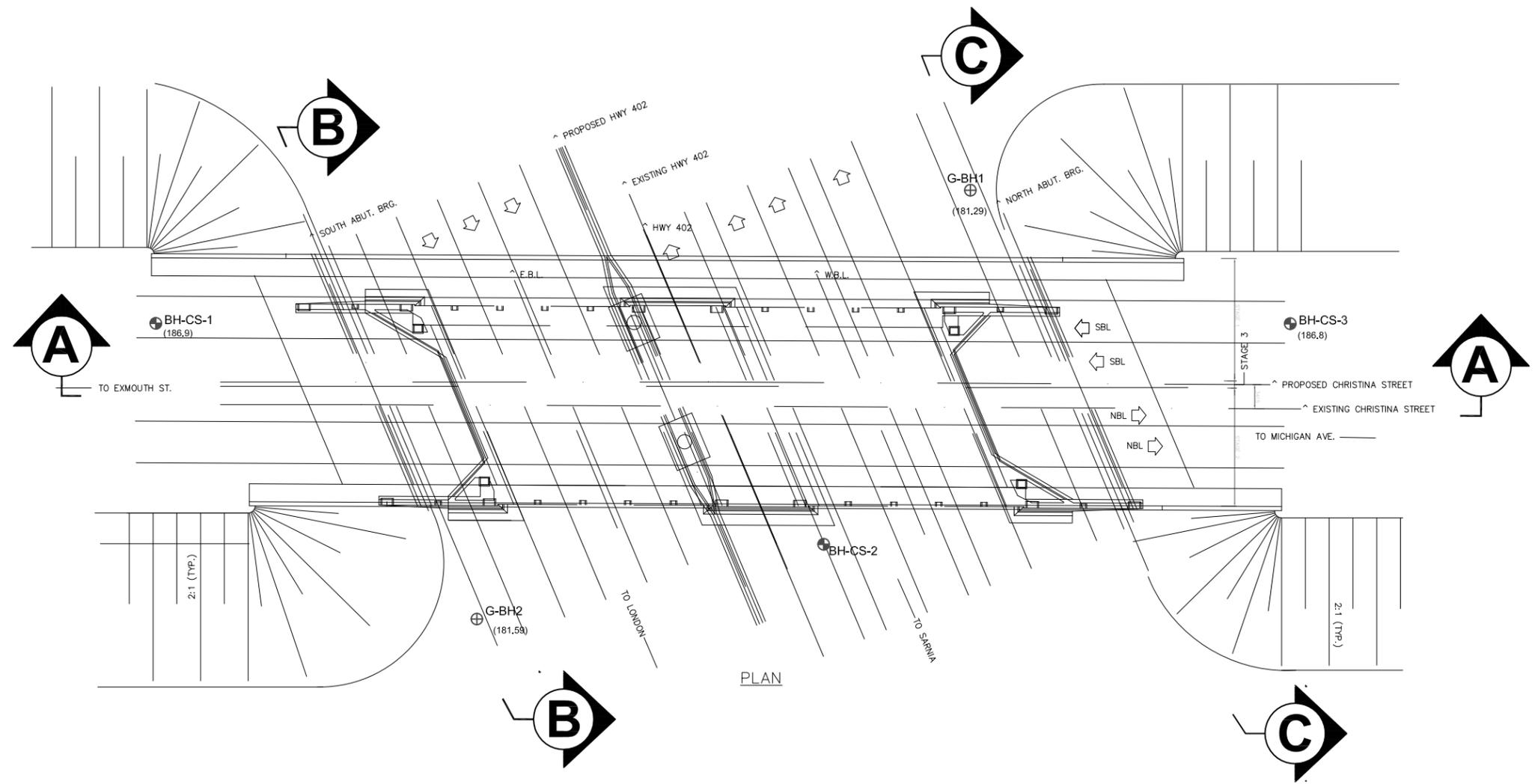
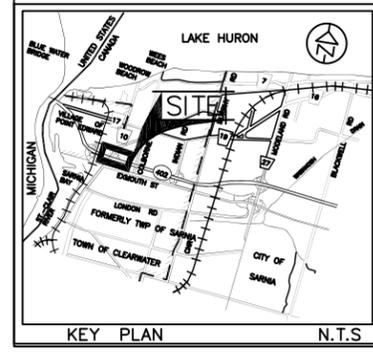
METRIC
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN

HWY 402
CONT No -
WP No 3038-03-00



CHRISTINA STREET
UNDERPASS
BOREHOLE LOCATION PLAN

SHEET



LEGEND

- ⊕ Borehole (Jacques Whitford, 2006)
- ⊕ Borehole (By Golder, 2004)

| BH No. | ELEVATION (m) | NORTHING | EASTING |
|--------|---------------|-------------|-----------|
| CS-1 | 186.9 | 4 760 877.2 | 313 072.4 |
| CS-2 | 181.6 | 4 760 908.3 | 313 107.7 |
| CS-3 | 186.8 | 4 760 940.7 | 313 102.6 |
| G-BH1 | 181.3 | 4 760 934.8 | 313 086.3 |
| G-BH2 | 181.6 | 4 760 884.5 | 313 100.0 |



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

- NOTES: 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.
2) Base plan provided by Stantec Consulting Ltd.
3) This drawing is for subsurface information only. Surface details and features are for conceptual illustration.

| REV | DATE | BY | DESCRIPTION |
|-----|------|----|-------------|
| | | | |

GEOCRE No 40J16-78

| | | | |
|-------------|---------|-----------------|-------------|
| HWY No 402 | CHECKED | DATE 2008-09-24 | DIST LONDON |
| SUBM'D GC | CHECKED | SITE 14-37 | |
| DRAWN PC/HZ | CHECKED | APPROVED | DWG 2 |

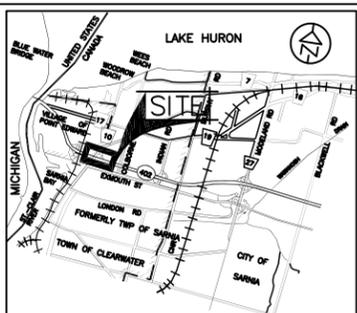
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DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN

HWY 402
CONT No -
WP No 3038-03-00



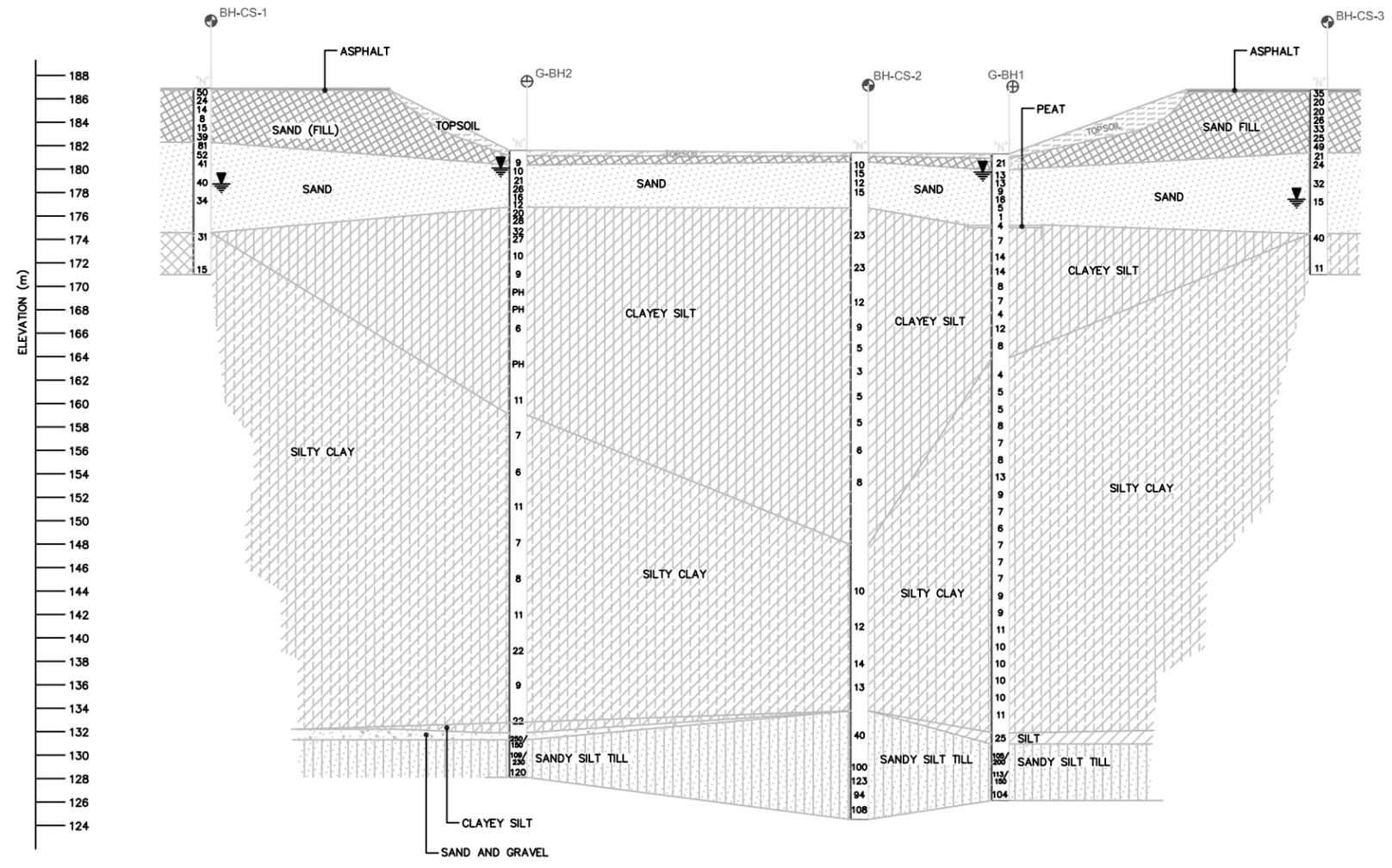
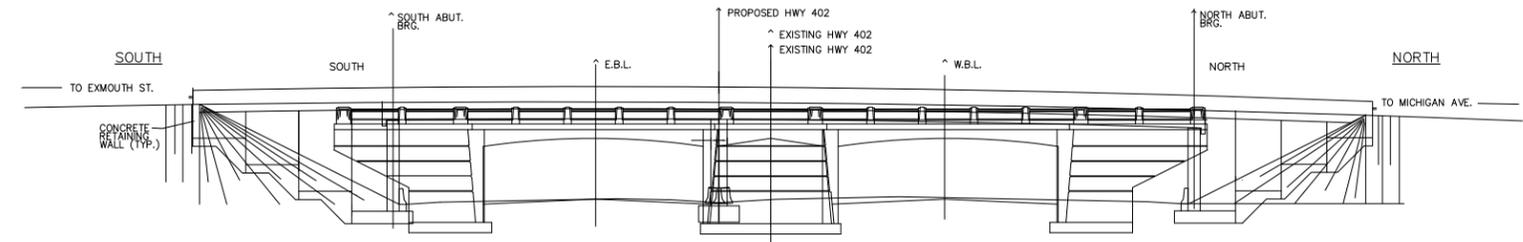
CHRISTINA STREET
UNDERPASS
SOIL STRATA SECTION A

SHEET



KEY PLAN

N.T.S.



A-A SOIL PROFILE

LEGEND

- ⊕ Borehole (Jacques Whitford, 2006)
- ⊕ Borehole (By Golder, 2004)
- ▽ WL at time of investigation 04 03

| BH No. | ELEVATION (m) | NORTHING | EASTING |
|--------|---------------|-------------|-----------|
| CS-1 | 186.9 | 4 760 877.2 | 313 072.4 |
| CS-2 | 181.6 | 4 760 908.3 | 313 107.7 |
| CS-3 | 186.8 | 4 760 940.7 | 313 102.6 |
| G-BH1 | 181.3 | 4 760 934.8 | 313 086.3 |
| G-BH2 | 181.6 | 4 760 884.5 | 313 100.0 |



NOTES

- The boundaries between soil strata have been established only at Bore Hole locations. Between Bore holes the boundaries are assumed from geological evidence.
- NOTES: 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.
2) Base plan provided by Stantec Consulting Ltd.
3) This drawing is for subsurface information only. Surface details and features are for conceptual illustration.

| REVISION | DATE | BY | DESCRIPTION |
|----------|------|----|-------------|
| | | | |
| | | | |

GEOCRE No 40J16-78

| | | | |
|-------------|---------|-----------------|-------------|
| HWY No 402 | CHECKED | DATE 2008-09-24 | DIST LONDON |
| SUBM'D GC | CHECKED | DATE 2008-09-24 | SITE 14-37 |
| DRAWN PC/HZ | CHECKED | APPROVED | DWG 3 |

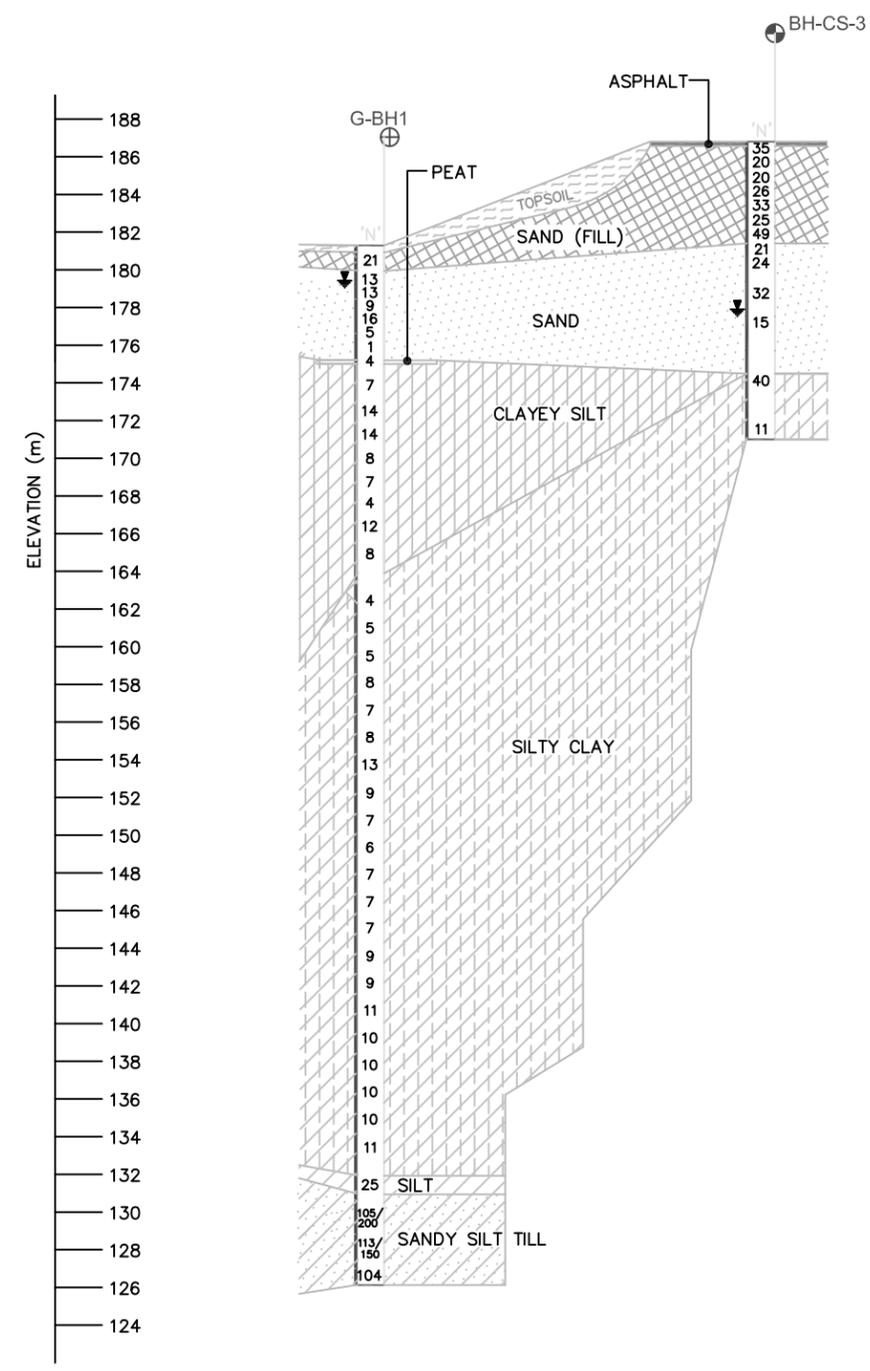
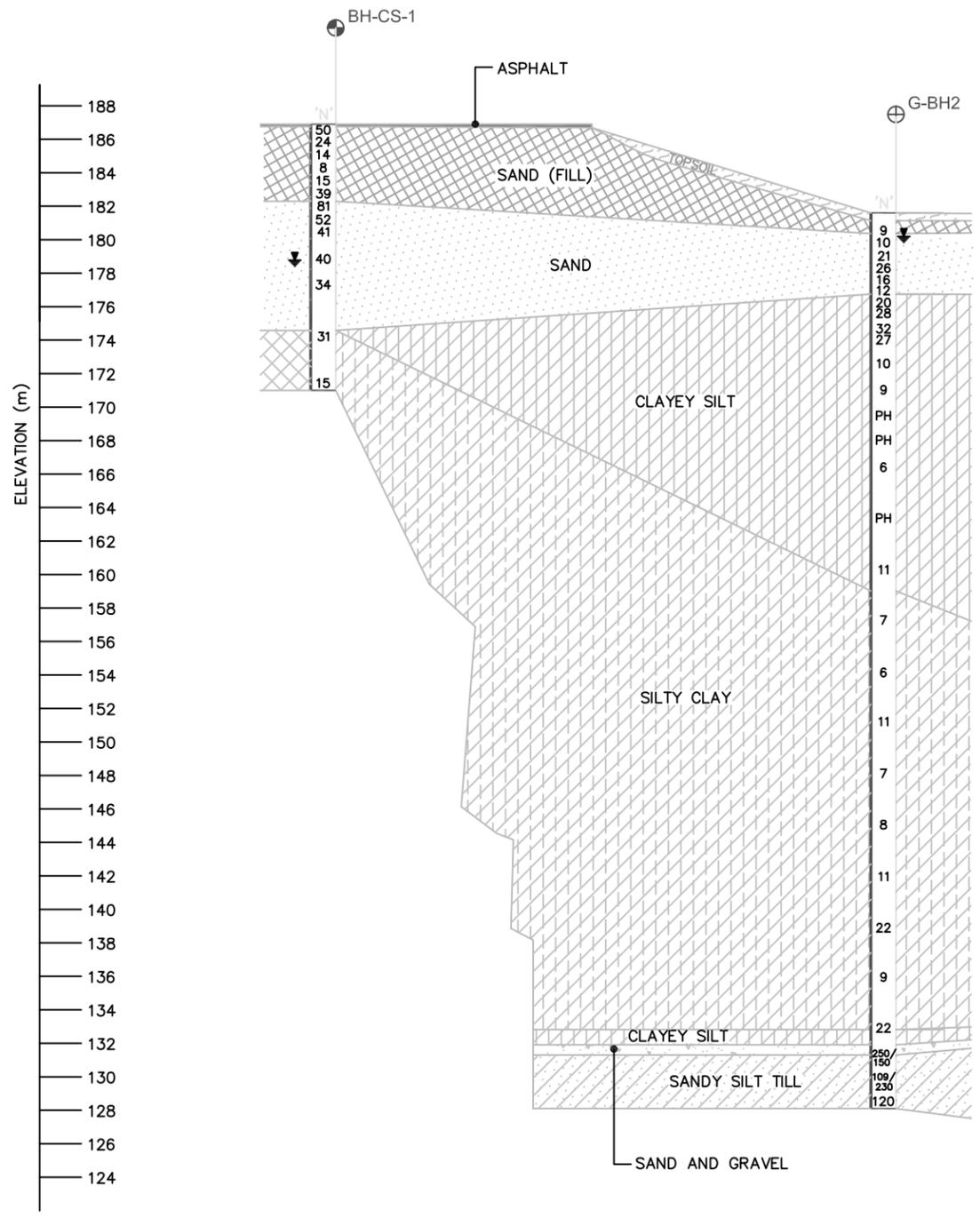
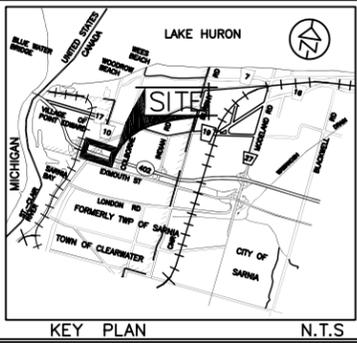
METRIC
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN

HWY 402
CONT No -
WP No 3038-03-00



CHRISTINA STREET
UNDERPASS
SOIL STRATA SECTION B AND C

SHEET



LEGEND

- ⊕ Borehole (Jacques Whitford, 2006)
- ⊕ Borehole (By Golder, 2004)
- ↓ W.L. at time of investigation 04 03

| BH No. | ELEVATION (m) | NORTHING | EASTING |
|--------|---------------|-------------|-----------|
| CS-1 | 186.9 | 4 760 877.2 | 313 072.4 |
| CS-3 | 186.8 | 4 760 940.7 | 313 102.6 |
| G-BH1 | 181.3 | 4 760 934.8 | 313 086.3 |
| G-BH2 | 181.6 | 4 760 884.5 | 313 100.0 |



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

NOTES: 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.
2) Base plan provided by Stantec Consulting Ltd.
3) This drawing is for subsurface information only. Surface details and features are for conceptual illustration.

| REV | DATE | BY | DESCRIPTION |
|-----|------|----|-------------|
| | | | |

GEOCREs No 40J16-78

| | | | |
|-------------|---------|-----------------|------------|
| HWY No 402 | CHECKED | DATE 2008-09-24 | SITE 14-37 |
| SUBM'D GC | CHECKED | DATE 2008-09-24 | SITE 14-37 |
| DRAWN PC/HZ | CHECKED | DATE 2008-09-24 | SITE 14-37 |

APPENDIX B

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



EXPLANATION OF TERMS USED IN REPORT

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

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

SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSENESS.

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

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

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

| N (BLOWS/0.3 m) | 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:

| R Q D (%) | 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 CS-1

2 OF 2

METRIC

W.P. 3038-03-00 LOCATION Christina St. Str.: 10+035 o/s: 5.5 m Rt; N4760877.2, E313072.4 ORIGINATED BY KH
 DIST London HWY 402 BOREHOLE TYPE Hollow Stem Auger, Split Spoon COMPILED BY MW
 DATUM Geodetic DATE 11.8.06 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 | 20 | 40 | 60 | 80 | | | | | |
| 171.0 | - grey, trace sand, wet (continued) | | 13 | SS | 15 | | | | | | | | | | | |
| 15.8 | END OF BOREHOLE at approximately 15.8 m Groundwater measured at a depth of approximately 7.6 m (Elev. 179.3 m) on completion of drilling Borehole caved to a depth of approximately 6.5 m (Elev. 180.4 m) on completion of drilling | | | | | | | | | | | | | | | |

ONTARIO MOT - 1012607.GPJ ONTARIO MOT.GDT 11/19/08

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

RECORD OF BOREHOLE No CS-2

1 OF 4

METRIC

W.P. 3038-03-00 LOCATION Highway 402, Stn.: 11+250 o/s: C.L.; N4760908.3, E313107.7 ORIGINATED BY KH
 DIST London HWY 402 BOREHOLE TYPE Hollow Stem Auger, Tricone, Split Spoon COMPILED BY MW
 DATUM Geodetic DATE 12.6.06 - 12.12.06 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 | | | | | | | | |
| | | | | | | 20 40 60 80 100 | | | | | | | | | | |
| 181.6 | Hwy 402 Median Ditch | | | | | | | | | | | | | | | |
| 0.0 | SAND (FILL), trace silt, trace gravel, trace organic matter, moist, brown (SW) | | | | | | | | | | | | | | | |
| 180.8 | | | | | | 181 | | | | | | | | | | |
| 0.8 | SAND, some silt, trace gravel, wet, compact, brown (SP) | | 1 | SS | 10 | | | | | | | | | | | |
| | | | 2 | SS | 15 | 180 | | | | | | | | | | |
| 179.3 | | | | | | | | | | | | | | | | |
| 2.3 | Silty SAND, trace organic matter, wet, compact, grey (SM) | | 3 | SS | 12 | 179 | | | | | | | | | | |
| | | | 4 | SS | 15 | 178 | | | | | | | | | | |
| 176.9 | | | | | | | | | | | | | | | | |
| 4.7 | Clayey SILT, trace gravel, trace sand, wet, very stiff, grey (CL) | | 5a | | | 177 | | | | | | | | | | |
| | | | 5b | SS | 23 | | | | | | | | | | | |
| | | | | | | 176 | | | | | | | | | | |
| | | | 6 | SS | 23 | 175 | | | | | | | | | | |
| | | | | | | | | | | | | | | | | |
| | - stiff | | 7 | SS | 12 | 174 | | | | | | | | | | |
| | | | | | | | | | | | | | | | | |
| | | | 8 | SS | 9 | 172 | | | | | | | | | | |
| | | | | | | | | | | | | | | | | |
| | - firm | | 9 | SS | 5 | 171 | | | | | | | | | | |
| | | | | | | | | | | | | | | | | |
| | | | 10 | TW | | 170 | | | | | | | | | | |
| | | | | | | | | | | | | | | | | |
| | - soft | | 11 | SS | 3 | 169 | | | | | | | | | | |
| | | | | | | | | | | | | | | | | |
| | | | | | | 168 | | | | | | | | | | |
| | | | | | | | | | | | | | | | | |
| | | | | | | 167 | | | | | | | | | | |

Continued Next Page

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

ONTARIO MOT - 1012607.GPJ ONTARIO MOT.GDT - 11/19/08

RECORD OF BOREHOLE No CS-2

2 OF 4

METRIC

W.P. 3038-03-00 LOCATION Highway 402, Stn.: 11+250 o/s: C.L.; N4760908.3, E313107.7 ORIGINATED BY KH
 DIST London HWY 402 BOREHOLE TYPE Hollow Stem Auger, Tricone, Split Spoon COMPILED BY MW
 DATUM Geodetic DATE 12.6.06 - 12.12.06 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 | | | | | |
| | Clayey SILT, trace gravel, trace sand, wet, very stiff, grey (CL) (continued) - firm | | 12 | SS | 5 | | | | | | | | |
| | | | | | | 166 | | | | | | | |
| | | | | | | 165 | | | | | | | |
| | | | | | | 164 | | | | | | | |
| | - stiff | | 13 | VT | | 163 | 2.33 | | | | | | |
| | | | | | | 162 | | | | | | | |
| | | | | | | 161 | | | | | | | |
| | - hard | | 14 | VT | | 160 | | 150 kPa | | | | | |
| | | | | | | 159 | | | | | | | |
| | | | | | | 158 | | | | | | | |
| | | | | | | 157 | | | | | | | |
| | - firm | | 15 | SS | 5 | 156 | | | | | | 20.9 | |
| | | | 16 | TW | | 155 | | | | | | | |
| | | | | | | 154 | | | | | | | |
| | | | 17 | SS | 6 | 153 | | | | | | | |
| | | | | | | 152 | | | | | | | |

ONTARIO.MOT_1012607.GPJ ONTARIO.MOT.GDT_11/19/08

Continued Next Page

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

RECORD OF BOREHOLE No CS-2

4 OF 4

METRIC

W.P. 3038-03-00 LOCATION Highway 402, Stn.: 11+250 o/s: C.L.; N4760908.3, E313107.7 ORIGINATED BY KH
 DIST London HWY 402 BOREHOLE TYPE Hollow Stem Auger, Tricone, Split Spoon COMPILED BY MW
 DATUM Geodetic DATE 12.6.06 - 12.12.06 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 | | | | | | | | |
| | | | | | | 20 | 40 | 60 | 80 | 100 | | | | | | |
| | | | | | | ○ UNCONFINED × FIELD VANE ● QUICK TRIAXIAL × LAB VANE | | | | | WATER CONTENT (%) | | | | | |
| | | | | | | 20 | 40 | 60 | 80 | 100 | 10 | 20 | 30 | | | |
| 134.3 | Silty CLAY, trace gravel, trace sand, wet, hard, grey (CL) <i>(continued)</i> | | 24 | SS | 13 | | | | | | | | | | | |
| 47.2 | Sandy SILT (TILL), some gravel, trace clay, wet, dense to very dense, grey (SM) | | | | | | | | | | | | | | | |
| | - some gravel | | 25 | SS | 40 | | | | | | | | | | | |
| | | | 26 | SS | 100 | | | | | | | | | | | |
| | | | 27 | SS | 123 | | | | | | | | | | | |
| | | | 28 | SS | 94 | | | | | | | | | | | |
| | | | 29 | SS | 108 | | | | | | | | | | | |
| 124.6 | END OF BOREHOLE at approximately 57.0 m | | | | | | | | | | | | | | | |

ONTARIO MOT - 1012607.GPJ ONTARIO MOT.GDT 11/19/08

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

RECORD OF BOREHOLE No CS-3

2 OF 2

METRIC

W.P. 3038-03-00 LOCATION Christina St. Stn.: 9+965 o/s: 5.5 m Rt; N4760940.7, E313102.6 ORIGINATED BY KH
 DIST London HWY 402 BOREHOLE TYPE Hollow Stem Auger, Split Spoon COMPILED BY MW
 DATUM Geodetic DATE 11.8.06 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 | 20 | 40 | 60 | 80 | | | | | |
| | | | | | | | | | | | | | | | | |
| 171.0 | - grey, wet Stiff (continued) | | 13 | SS | 11 | | | | | | | | | | | 3 21 44 32 |
| 15.8 | END OF BOREHOLE at approximately 15.8 m Groundwater measured at a depth of approximately 7.6 m (Elev. 179.2 m) on completion of drilling Borehole caved to a depth of approximately 6.7 m (Elev. 180.1 m) on completion of drilling | | | | | | | | | | | | | | | |

ONTARIO MOT 1012607.GPJ ONTARIO MOT.GDT 11/19/08

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

RECORD OF BOREHOLE No CS-6

1 OF 1

METRIC

W.P. 3038-03-00 LOCATION Christina St. E-N Ramp Str.: 10+160 o/s: 4.0 m Rt; N4761014.9, E313255.9 ORIGINATED BY KH
 DIST London HWY 402 BOREHOLE TYPE Hollow Stem Auger, Split Spoon COMPILED BY MW
 DATUM Geodetic DATE 11.10.06 CHECKED BY GC

| SOIL PROFILE | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT | | | | | PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT | | | UNIT WEIGHT γ kN/m ³ | REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL |
|---------------|--|----------------------------|--------|------|----------------------------|--------------------------------|---|--------------------|----|-----|-------------------|--|----------------|---|---|--|
| ELEV DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | | | "N" VALUES | SHEAR STRENGTH kPa | | | | | W _p | W | | |
| | | | | | | 20 | 40 | 60 | 80 | 100 | WATER CONTENT (%) | | | | | |
| | | | | | | ○ UNCONFINED × FIELD VANE | | | | | | | | | | |
| | | | | | | ● QUICK TRIAXIAL × LAB VANE | | | | | | | | | | |
| 183.1 0.0 | Christina St E-N Ramp, Rt. Shoulder SAND (FILL), some gravel, trace silt and clay, damp, compact, brown (SW) | [Cross-hatched pattern] | 1 | SS | 20 | | | | | | | | | | | |
| | - trace gravel, trace organic matter, moist | | 2 | SS | 11 | | | | | | | | | | | |
| 181.4 1.7 | SAND, trace gravel, trace silt and clay, moist, loose to dense, brown (SP) | [Dotted pattern] | 3 | SS | 7 | | | | | | | | | | | |
| | | | 4 | SS | 25 | | | | | | | | | | | |
| | | | 5 | SS | 18 | | | | | | | | | | | |
| 179.3 3.8 | - grey, some silt and clay, no gravel dense | [Dotted pattern] | 6 | SS | 31 | | | | | | | | | | | |
| | | | 7 | SS | 31 | | | | | | | | | | | |
| 177.4 5.6 | Silty CLAY, some sand, trace gravel, moist, very stiff, grey (Cl) | [Diagonal hatched pattern] | 8 | SS | 18 | | | | | | | | | | | |
| | - with sand | | 9 | SS | 23 | | | | | | | | | | | |
| 174.8 8.2 | END OF BOREHOLE at approximately 8.2 m Water first encountered on spoon at a depth of approximately 3.0 m (180.1 m) below grade Borehole caved to a depth of approximately 2.9 m (Elev. 180.2 m) on completion of drilling | | | | | | | | | | | | | | | |

ONTARIO.MOT_1012607.GPJ ONTARIO.MOT.GDT_11/19/08

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

RECORD OF BOREHOLE No CS-7

1 OF 1

METRIC

W.P. 3038-03-00 LOCATION Christina St. E-N Ramp Str.: 10+100 o/s: 4.0 m Rt; N4760961.6, E313279.1 ORIGINATED BY KH
 DIST London HWY 402 BOREHOLE TYPE Hollow Stem Auger, Split Spoon COMPILED BY MW
 DATUM Geodetic DATE 11.10.06 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 | | | | | | | | |
| | | | | | | 20 | 40 | 60 | 80 | 100 | | | | | | |
| 183.1 0.0 | Christina St E-N Ramp, Rt. Shoulder SAND (FILL), with gravel, trace silt and clay, trace asphalt fragment, moist, compact, brown (SW) | | 1 | SS | 24 | | | | | | | | | | 28 67 (5) | |
| | | | 2 | SS | 12 | | | | | | | | | | | |
| 181.5 1.5 | SAND, trace gravel, trace silt and clay, moist, compact to dense, brown (SP) | | 3 | SS | 11 | | | | | | | | | | | |
| | | | 4 | SS | 30 | | | | | | | | | | | |
| | - no gravel, wet | | 5 | SS | 32 | | | | | | | | | 0 90 (10) | | |
| | | | 6 | SS | 36 | | | | | | | | | | | |
| 178.5 4.6 | - grey | | 7 | SS | 34 | | | | | | | | | | | |
| 177.4 5.6 | Silty CLAY, some sand, trace gravel, moist, hard, grey (CL) | | 8 | SS | 36 | | | | | | | | | 3 19 51 27 | | |
| | - trace gravel and sand | | 9 | SS | 42 | | | | | | | | | | | |
| 174.8 8.2 | END OF BOREHOLE at approximately 8.2 m Water first encountered on spoon at a depth of approximately 3.0 m (180.1 m) below grade Borehole caved to a depth of approximately 2.6 m (Elev. 180.5 m) on completion of drilling | | | | | | | | | | | | | | | |

ONTARIO.MOT_1012607.GPJ ONTARIO.MOT.GDT_11/19/08

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

RECORD OF BOREHOLE No CS-8

1 OF 1

METRIC

W.P. 3038-03-00 LOCATION Christina St. E-N Ramp Str.: 10+040 o/s: 3.5 m Rt; N4760931.3, E313327.9 ORIGINATED BY KH
 DIST London HWY 402 BOREHOLE TYPE Hollow Stem Auger, Split Spoon COMPILED BY MW
 DATUM Geodetic DATE 11.10.06 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 | | | | | W _p | W | | | W _L |
| | | | | | | 20 | 40 | 60 | 80 | 100 | | | | | | | |
| 183.5 0.0 | Christina St E-N Ramp, Rt. Shoulder SAND (FILL), with gravel, trace silt, damp, compact to dense, brown (SW) | | 1 | SS | 23 | | | | | | | | | | | | |
| | - trace silt | | 2 | SS | 38 | | | | | | | | | | | | |
| 181.9 1.5 | SAND, trace gravel, trace silt and clay, moist, compact to dense, brown (SP) | | 3 | SS | 16 | | | | | | | | | | | | |
| | - wet | | 4 | SS | 26 | | | | | | | | | | | | |
| | | | 5 | SS | 26 | | | | | | | | | | | | |
| | | | 6 | SS | 36 | | | | | | | | | | | | |
| 178.9 4.6 | - grey, some silt and clay, no gravel | | 7 | SS | 33 | | | | | | | | | | | | |
| 177.8 5.6 | Silty CLAY, some sand, trace gravel, wet, very stiff, grey (CL) | | 8 | SS | 24 | | | | | | | | | | | | |
| 175.2 8.2 | - trace sand | | 9 | SS | 29 | | | | | | | | | | | | |
| | END OF BOREHOLE at approximately 8.2 m Water first encountered on spoon at a depth of approximately 4.0 m (179.5 m) below grade Borehole caved to a depth of approximately 2.9 m (Elev. 180.6 m) on completion of drilling | | | | | | | | | | | | | | | | |

ONTARIO MOT - 1012607.GPJ ONTARIO MOT.GDT - 11/19/08

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

RECORD OF BOREHOLE No R-1

1 OF 1

METRIC

W.P. 3038-03-00 LOCATION Christina St. Str.: 10+145 o/s: 5.5 m Rt; N4760780.2, E313025.7 ORIGINATED BY KH
 DIST London HWY 402 BOREHOLE TYPE Hollow Stem Auger, Split Spoon COMPILED BY MW
 DATUM Geodetic DATE 11.9.06 - 11.9.06 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 | | | | | | | | |
| | | | | | | 20 | 40 | 60 | 80 | 100 | | | | | | |
| 183.4 | Christina St S.B. D.L. | | | | | | | | | | | | | | | |
| 180.0 | 150 mm ASPHALT | | | | | | | | | | | | | | | |
| 0.2 | SAND (FILL), some gravel, trace silt, trace organic matter, damp, very dense to compact, brown (SW) | | 1 | SS | 88 | | | | | | | | | | | |
| | - augers grinding on possible cobble or boulder | | 2 | SS | 19 | | | | | | | | | | | |
| | | | 3A | SS | | | | | | | | | | | | |
| | - trace gravel | | 3B | SS | 10 | | | | | | | | | | | |
| 181.1 | | | | | | | | | | | | | | | | |
| 2.3 | SAND, trace gravel, trace silt and clay, moist, dense, brown (SP) | | 4 | SS | 31 | | | | | | | | | | | 4 89 (7) |
| | - saturated | | 5 | SS | 37 | | | | | | | | | | | |
| | | | 6 | SS | 34 | | | | | | | | | | | |
| | | | 7 | SS | 33 | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | |
| 177.8 | | | | | | | | | | | | | | | | |
| 5.6 | - grey | | 8 | SS | 39 | | | | | | | | | | | 0 92 (8) |
| | | | | | | | | | | | | | | | | |
| 175.8 | | | | | | | | | | | | | | | | |
| 7.6 | Clayey SILT, some sand, wet, very soft to firm, grey (CL) | | 9 | SS | 2 | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | |
| | - trace sand | | 10 | SS | 5 | | | | | | | | | | | 0 8 75 17 |
| 173.7 | | | | | | | | | | | | | | | | |
| 9.8 | END OF BOREHOLE at approximately 9.8 m | | | | | | | | | | | | | | | |
| | Water first encountered on spoon at a depth of approximately 4.0 m (179.4 m) below grade | | | | | | | | | | | | | | | |
| | Borehole caved to a depth of approximately 3.3 m (Elev. 180.1 m) on completion of drilling | | | | | | | | | | | | | | | |

ONTARIO MOT - 1012607.GPJ ONTARIO MOT.GDT - 11/19/08

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

RECORD OF BOREHOLE No R-2

1 OF 2

METRIC

W.P. 3038-03-00 LOCATION Christina St. Str.: 10+100 o/s: 5.5 m Rt; N4760821.0, E313045.6 ORIGINATED BY KH
 DIST London HWY 402 BOREHOLE TYPE Hollow Stem Auger, Split Spoon COMPILED BY MW
 DATUM Geodetic DATE 11.9.06 - 11.9.06 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 | | | | | W _p | W | | |
| | | | | | | 20 40 60 80 100 | ○ UNCONFINED | ✕ FIELD VANE | | | | | | | | |
| | | | | | | 20 40 60 80 100 | ● QUICK TRIAXIAL | ✕ LAB VANE | | | | | | | | |
| | | | | | | | WATER CONTENT (%) | | | | | | | | | |
| 184.8 | Christina St S.B. D.L. | | | | | | | | | | | | | | | |
| 184.6 | 150 mm ASPHALT | | | | | | | | | | | | | | | |
| 0.2 | SAND (FILL), some gravel, trace silt and clay, moist, dense, brown (SW) | | 1 | SS | 44 | | | | | | | | | | | |
| 184.0 | | | 2A | SS | | 184 | | | | | | | | | | |
| 183.8 | 150 mm Silty CLAY (FILL), some sand, trace gravel, damp, grey (CL) | | 2B | SS | 29 | | | | | | | | | | | |
| 0.9 | SAND (FILL), trace gravel, trace silt and clay, moist, compact, brown (SW) | | 3A | SS | | | | | | | | | | | | |
| 183.3 | | | 3B | SS | 17 | 183 | | | | | | | | | | |
| 183.2 | 100 mm Silty CLAY (FILL), some sand, trace gravel, damp, grey (CL) | | 4A | SS | | | | | | | | | | | | |
| 1.6 | SAND (FILL), trace gravel, trace silt and clay, moist, compact, brown (SW) | | 4B | SS | 52 | 182 | | | | | | | | | | |
| 182.5 | | | 5 | SS | 25 | | | | | | | | | | | |
| 2.3 | SAND, some gravel, trace silt and clay, moist, dense to compact, brown (SP) | | 6 | SS | 26 | 181 | | | | | | | | | | |
| | | | 7 | SS | 30 | 180 | | | | | | | | | | |
| | | | 8 | SS | 31 | 179 | | | | | | | | | | |
| 179.2 | - grey | | 9 | SS | 12 | 178 | | | | | | | | | | |
| 5.6 | | | 10A | SS | | 177 | | | | | | | | | | |
| | | | 10B | SS | 40 | 176 | | | | | | | | | | |
| 175.6 | Silty CLAY, trace gravel, trace sand, damp, hard to very stiff, grey (CL) | | 11 | SS | 17 | 175 | | | | | | | | | | |
| 9.2 | | | | | | 174 | | | | | | | | | | |
| | | | | | | 173 | | | | | | | | | | |
| | | | | | | 172 | | | | | | | | | | |
| | | | | | | 171 | | | | | | | | | | |
| | | | | | | 170 | | | | | | | | | | |
| | - some sand, wet Stiff | | | | | | | | | | | | | | | |

ONTARIO MOT - 1012607.GPJ ONTARIO MOT.GDT - 11/19/08

Continued Next Page

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

RECORD OF BOREHOLE No R-2

2 OF 2

METRIC

W.P. 3038-03-00 LOCATION Christina St. Str.: 10+100 o/s: 5.5 m Rt; N4760821.0, E313045.6 ORIGINATED BY KH
 DIST London HWY 402 BOREHOLE TYPE Hollow Stem Auger, Split Spoon COMPILED BY MW
 DATUM Geodetic DATE 11.9.06 - 11.9.06 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 | 20 | 40 | 60 | 80 | | | | | |
| 168.9 | Silty CLAY, trace gravel, trace sand, damp, hard to very stiff, grey (CL) <i>(continued)</i> |  | 12 | SS | 8 | | | | | | | | | | | 2 16 45 38 |
| 15.8 | END OF BOREHOLE at approximately 15.8 m Water first encountered on spoon at a depth of approximately 6.1 m (178.7 m) below grade Borehole caved to a depth of approximately 4.4 m (Elev. 180.4 m) on completion of drilling | | | | | | | | | | | | | | | |

ONTARIO.MOT_1012607.GPJ ONTARIO.MOT.GDT_11/19/08

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

RECORD OF BOREHOLE No R-3

1 OF 1

METRIC

W.P. 3038-03-00 LOCATION Christina St. S-E Ramp Stn.: 9+985 o/s: 3.0 m Rt; N4760777.0, E313043.1 ORIGINATED BY KH
 DIST London HWY 402 BOREHOLE TYPE Hollow Stem Auger, Split Spoon COMPILED BY MW
 DATUM Geodetic DATE 11.10.06 - 11.10.06 CHECKED BY GC

| SOIL PROFILE | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT | | | | | PLASTIC NATURAL LIQUID LIMIT MOISTURE LIMIT CONTENT | | | UNIT WEIGHT γ kN/m ³ | REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL |
|---------------|---|------------|--------|------|----------------------------|-----------------|---|--------------------|-----------------|-----------------|----------|---|----------------|---|---|--|
| ELEV DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | | | "N" VALUES | SHEAR STRENGTH kPa | | | | | W _p | W | | |
| | | | | | | 20 40 60 80 100 | 20 40 60 80 100 | 20 40 60 80 100 | 20 40 60 80 100 | 20 40 60 80 100 | 10 20 30 | | | | | |
| 183.7 0.0 | Christina St S-E Ramp, Rt. Shoulder SAND (FILL), with gravel, some silt, some organic matter, moist, compact, brown (SW) | | 1 | SS | 17 | | | | | | | | | | | |
| | | | 2 | SS | 15 | | | | | | | | | | | |
| 182.0 1.7 | SAND, trace gravel, trace silt and clay, moist, compact, brown (SP) | | 3 | SS | 14 | | | | | | | | | | | 3 95 (2) |
| | | | 4 | SS | 24 | | | | | | | | | | | |
| | | | 5 | SS | 24 | | | | | | | | | | | |
| 179.6 4.1 | - grey, wet | | | | | | | | | | | | | | | |
| | | | 6 | SS | 21 | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | |
| | | | 7 | SS | 14 | | | | | | | | | | | 1 88 (11) |
| | | | | | | | | | | | | | | | | |
| 175.8 7.9 | Silty CLAY, trace gravel, trace sand, moist, hard, grey (CL) | | | | | | | | | | | | | | | |
| | | | 8 | SS | 39 | | | | | | | | | | | |
| 173.9 9.8 | END OF BOREHOLE at approximately 9.8 m Water first encountered on spoon at a depth of approximately 4.6 m (179.1 m) below grade Borehole caved to a depth of approximately 3.5 m (Elev. 180.2 m) on completion of drilling | | | | | | | | | | | | | | | |

ONTARIO MOT - 1012607.GPJ ONTARIO MOT.GDT - 11/19/08

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

RECORD OF BOREHOLE No R-4

1 OF 1

METRIC

W.P. 3038-03-00 LOCATION Christina St. S-E Ramp Stn.: 10+077 o/s: 2.0 m Rt; N4760858.0, E313093.2 ORIGINATED BY KH
 DIST London HWY 402 BOREHOLE TYPE Hollow Stem Auger, Split Spoon COMPILED BY MW
 DATUM Geodetic DATE 11.10.06 - 11.10.06 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 | 20 | 40 | 60 | 80 | | | | | | 100 | SHEAR STRENGTH kPa | | | | | | | |
| | | | | | | | | | | | ○ UNCONFINED | × FIELD VANE | WATER CONTENT (%) | | | | | | | | | | | | |
| | | | | | | | | | | | ● QUICK TRIAXIAL | × LAB VANE | 20 | 40 | 60 | 80 | 100 | 10 | 20 | 30 | | GR | SA | SI | CL |
| 184.0 | Christina St S-E Ramp, D.L. | | | | | | | | | | | | | | | | | | | | | | | | |
| 180.0 | 180 mm ASPHALT | | | | | | | | | | | | | | | | | | | | | | | | |
| 0.2 | SAND (FILL), some silt, some organic matter, trace gravel, trace clay, moist, compact, brown (SW) | | 1 | SS | 30 | | | | | | | | | | | | | | | | | | | | |
| 183.1 | SAND, trace gravel, trace silt and clay, moist, compact to dense, brown (SP) | | 2 | SS | 23 | | | | | | | | | | | | | | | | | | | | |
| 0.9 | | | 3 | SS | 37 | | | | | | | | | | | | | | | | | | | | |
| | | | 4 | SS | 14 | | | | | | | | | | | | | | | | | | | | |
| | | | 5 | SS | 23 | | | | | | | | | | | | | | | | | | | | |
| 179.9 | - grey | | | | | | | | | | | | | | | | | | | | | | | | |
| 4.1 | - wet | | 6 | SS | 33 | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | | |
| | - some silt | | 7 | SS | 27 | | | | | | | | | | | | | | | | | | | | |
| 176.1 | Silty CLAY, trace gravel, trace sand, moist, hard, grey (CL) | | | | | | | | | | | | | | | | | | | | | | | | |
| 7.9 | | | 8 | SS | 43 | | | | | | | | | | | | | | | | | | | | |
| 174.2 | END OF BOREHOLE at approximately 9.8 m Water first encountered on spoon at a depth of approximately 4.0 m (180.0 m) below grade Borehole caved to a depth of approximately 3.7 m (Elev. 180.3 m) on completion of drilling | | | | | | | | | | | | | | | | | | | | | | | | |
| 9.8 | | | | | | | | | | | | | | | | | | | | | | | | | |

ONTARIO MOT - 1012607.GPJ ONTARIO MOT.GDT - 11/19/08

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

RECORD OF BOREHOLE No BH1

2 OF 4

METRIC

PROJECT 041-130099-2 LOCATION N 4760934.8 : E 313088.3 ORIGINATED BY MA
 G.W.P. 3038-03-00 DIST 1 HWY 402 BOREHOLE TYPE POWER AUGER/HOLLOW STEM & MUD ROTARY COMPILED BY BG
 DATUM GEODETIC DATE July 12, 2004 - July 15, 2004 CHECKED BY RJB

| SOIL PROFILE | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT | | | | | PLASTIC LIMIT w _p | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w _L | UNIT WEIGHT γ | REMARKS & GRAIN SIZE DISTRIBUTION (%) | | | | | | | | | |
|--------------|---|------------|---|-----------|-------------------------|-----------------|--|----|----|----|----|---------------------------------|-------------------------------|--------------------------------|------------------|---------------------------------------|-----|----|----|----|----|-----|----|----|----|
| ELEV DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | | | "N" VALUES | 20 | 40 | 60 | 80 | | | | | | 100 | 20 | 40 | 60 | 80 | 100 | 10 | 20 | 30 |
| 163.92 | CLAYEY SILT, trace to some sand, trace to some gravel Firm to very stiff Grey | [Hatched] | 15 | SS | 12 | | | | | | | | | | | | | | | | | | | | |
| 17.37 | | | SILTY CLAY, trace sand, trace gravel, Firm to stiff, Grey | [Hatched] | 16 | SS | 8 | | | | | | | | | | | | | | | | | | |
| | 17 | SS | | | 4 | | | | | | | | | | | | | | | | | | | | |
| | 18 | SS | | | 5 | | | | | | | | | | | | | | | | | | | | |
| | 19 | SS | | | 5 | | | | | | | | | | | | | | | | | | | | |
| | 20 | SS | | | 8 | | | | | | | | | | | | | | | | | | | | |
| | 21 | SS | | | 7 | | | | | | | | | | | | | | | | | | | | |
| | 22 | SS | | | 8 | | | | | | | | | | | | | | | | | | | | |
| | 23 | SS | | | 13 | | | | | | | | | | | | | | | | | | | | |
| | 24 | SS | | | 9 | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | | |

ON MTO 041-130099-2.GPJ ON MOT.GDT 10/12/05

Continued Next Page

+3, x3: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

RECORD OF BOREHOLE No BH1 3 OF 4 METRIC

PROJECT 041-130099-2 LOCATION N 4760934.8; E 313086.3 ORIGINATED BY MA
 G.W.P. 3038-03-00 DIST 1 HWY 402 BOREHOLE TYPE POWER AUGER/HOLLOW STEM & MUD ROTARY COMPILED BY BG
 DATUM GEODETIC DATE July 12, 2004 - July 15, 2004 CHECKED BY [Signature]

| SOIL PROFILE | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT | | | | | PLASTIC LIMIT w _p | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w _L | UNIT WEIGHT γ | REMARKS & GRAIN SIZE DISTRIBUTION (%) | | | | | | | | | |
|-----------------|---|----------------------|---|----------------------|-------------------------|-----------------|--|--------------------|----|-----|----|---------------------------------|-------------------------------|--------------------------------|------------------|---------------------------------------|-------------------|----|----|----|----|----|--|--|---------|
| ELEV DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | | | "N" VALUES | SHEAR STRENGTH kPa | | | | | | | | | WATER CONTENT (%) | | | | | | | | |
| | | | | | | 20 | 40 | 60 | 80 | 100 | 20 | 40 | 60 | 80 | 100 | 10 | 20 | 30 | GR | SA | SI | CL | | | |
| | SILTY CLAY, trace sand, trace gravel, Firm to stiff, Grey | [Hatched Strat Plot] | 25 | SS | 7 | | | | | | | | | | | | | | | | | | | | |
| | | | 26 | SS | 8 | | | | | | | | | | | | | | | | | | | | 5 53 42 |
| | | | 27 | SS | 7 | | | | | | | | | | | | | | | | | | | | |
| | | | 28 | SS | 7 | | | | | | | | | | | | | | | | | | | | |
| | | | 29 | SS | 7 | | | | | | | | | | | | | | | | | | | | |
| | | | 30 | SS | 9 | | | | | | | | | | | | | | | | | | | | |
| | | | 31 | SS | 9 | | | | | | | | | | | | | | | | | | | | |
| | | | 32 | SS | 11 | | | | | | | | | | | | | | | | | | | | |
| | | | 33 | SS | 10 | | | | | | | | | | | | | | | | | | | | |
| 138.01 43.26 | | | SILTY CLAY, trace sand, Firm to stiff, Grey | [Hatched Strat Plot] | 34 | SS | 10 | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | | |

ON_MTO 041-130099-2.GPJ ON_MOT.GDT 10/12/05

Continued Next Page

+³, x³: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

PROJECT 041-130099-2

RECORD OF BOREHOLE No BH2

2 OF 4

METRIC

G.W.P. 3038-03-00

LOCATION N 4761884.5 :E 313100.0

ORIGINATED BY MA

DIST 1 HWY 402

BOREHOLE TYPE POWER AUGER/HOLLOW STEM & MUD ROTARY/TRI-CONE

COMPILED BY BG

DATUM GEODETIC

DATE July 19, 2004 - July 20, 2004

CHECKED BY [Signature]

| SOIL PROFILE | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT | | | | PLASTIC LIMIT | NATURAL MOISTURE CONTENT | LIQUID LIMIT | UNIT WEIGHT γ kN/m ³ | REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL | |
|--------------|--|------------|--------|------|-------------------------|--|--|--------------------|----|-------------|---------------|--------------------------|--------------|--|--|-------------------|
| ELEV DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | | | "N" VALUES | SHEAR STRENGTH kPa | | | | | | | | WATER CONTENT (%) |
| | | | | | | 20 | 40 | 60 | 80 | 100 | w_p | w | w_L | | | |
| | | | | | | ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE | | | | ○ ○ ○ | | | | | | |
| | CLAYEY SILT, trace to some sand, trace gravel, Firm to very stiff, Brown becoming grey at about elev. 173.4m | | 15 | SS | 8 | | | | | | | | | | | |
| | | | 166 | | | | | | | | | | | | | |
| | | | 165 | | | | | | | | | | | | | |
| | | | 164 | | | | | | | | | | | | | |
| | | | 163 | | | | | | | | | | | | | |
| | | | 16 | TO | PH | | | | | | | | | | | |
| | | | 17 | SS | 11 | | | | | | | | | | | |
| | | | 160 | | | | | | | | | | | | | |
| | | | 159.03 | | | | | | | | | | | | | |
| | SILTY CLAY, trace sand, trace gravel, Firm to very stiff, Grey | | 18 | SS | 7 | | | | | | | | | | | |
| | | | 159 | | | | | | | | | | | | | |
| | | | 158 | | | | | | | | | | | | | |
| | | | 157 | | | | | | | | | | | | | |
| | | | 156 | | | | | | | | | | | | | |
| | | | 19 | SS | 6 | | | | | | | | | | | |
| | | | 154 | | | | | | | | | | | | | |
| | | | 153 | | | | | | | | | | | | | |
| | | | 152 | | | | | | | | | | | | | |

ON_MTD 041-130099-2.GPJ ON_MOT.GDT 10/12/05

Continued Next Page

+³, x³: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

RECORD OF BOREHOLE No BH2

3 OF 4

METRIC

PROJECT 041-130099-2 LOCATION N 4761884.5 : E 313100.0 ORIGINATED BY MA
 G.W.P. 3038-03-00 BOREHOLE TYPE POWER AUGER/HOLLOW STEM & MUD ROTARY/TRI-CONE COMPILED BY BG
 DIST 1 HWY 402 DATE July 19, 2004 - July 20, 2004 CHECKED BY [Signature]
 DATUM GEODETIC

| SOIL PROFILE | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT | | | PLASTIC LIMIT w _p | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w _L | UNIT WEIGHT γ kN/m ³ | REMARKS & GRAIN SIZE DISTRIBUTION (%) | |
|--------------|--|------------|--------|------|-------------------------|------------------|--|--------------------|----|---------------------------------|-------------------------------|--------------------------------|---------------------------------------|---------------------------------------|-------------------|
| ELEV DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | | | "N" VALUES | SHEAR STRENGTH kPa | | | | | | | WATER CONTENT (%) |
| | | | | | | ○ UNCONFINED | + | FIELD VANE | | | | | | GR SA SI CL | |
| | | | | | | ● QUICK TRIAXIAL | x | LAB VANE | | | | | | | |
| | | | | | | 20 | 40 | 60 | 80 | 100 | 10 | 20 | 30 | | |
| | SILTY CLAY, trace sand, trace gravel, Firm to very stiff, Grey | | 20 | SS | 11 | | | | | | | | | 1 19 56 24 | |
| 151 | | | | | | | | | | | | | | | |
| 150 | | | | | | | | | | | | | | | |
| 149 | | | | | | | | | | | | | | | |
| 148 | | | | | 21 | SS | 7 | | | | | | | | |
| 147 | | | | | | | | | | | | | | | |
| 146 | | | | | | | | | | | | | | | |
| 145 | | | | | 22 | SS | 8 | | | | | | | 46 | |
| 144 | | | | | | | | | | | | | | | |
| 143 | | | | | | | | | | | | | | | |
| 142 | | | 23 | SS | 11 | | | | | | | | | | |
| 141 | | | | | | | | | | | | | | | |
| 140 | | | | | | | | | | | | | | | |
| 139 | | | 24 | SS | 22 | | | | | | | | | | |
| 138 | | | | | | | | | | | | | | | |
| 137 | | | | | | | | | | | | | | | |

ON: MTC 041-130099-2.GPJ ON: MCT.GDT 10/2/05

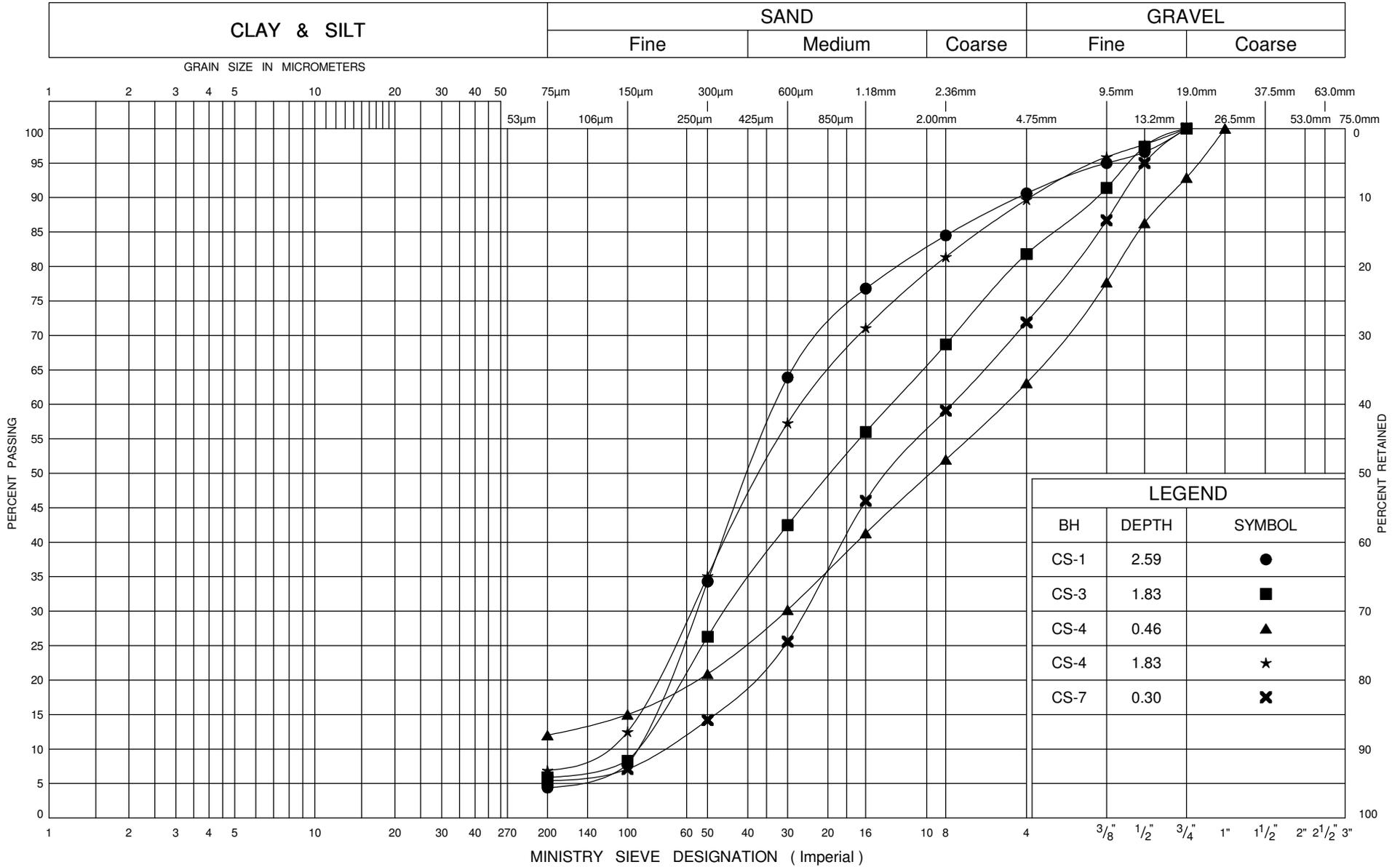
Continued Next Page

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

APPENDIX C

Geotechnical Laboratory Test Results

UNIFIED SOIL CLASSIFICATION SYSTEM



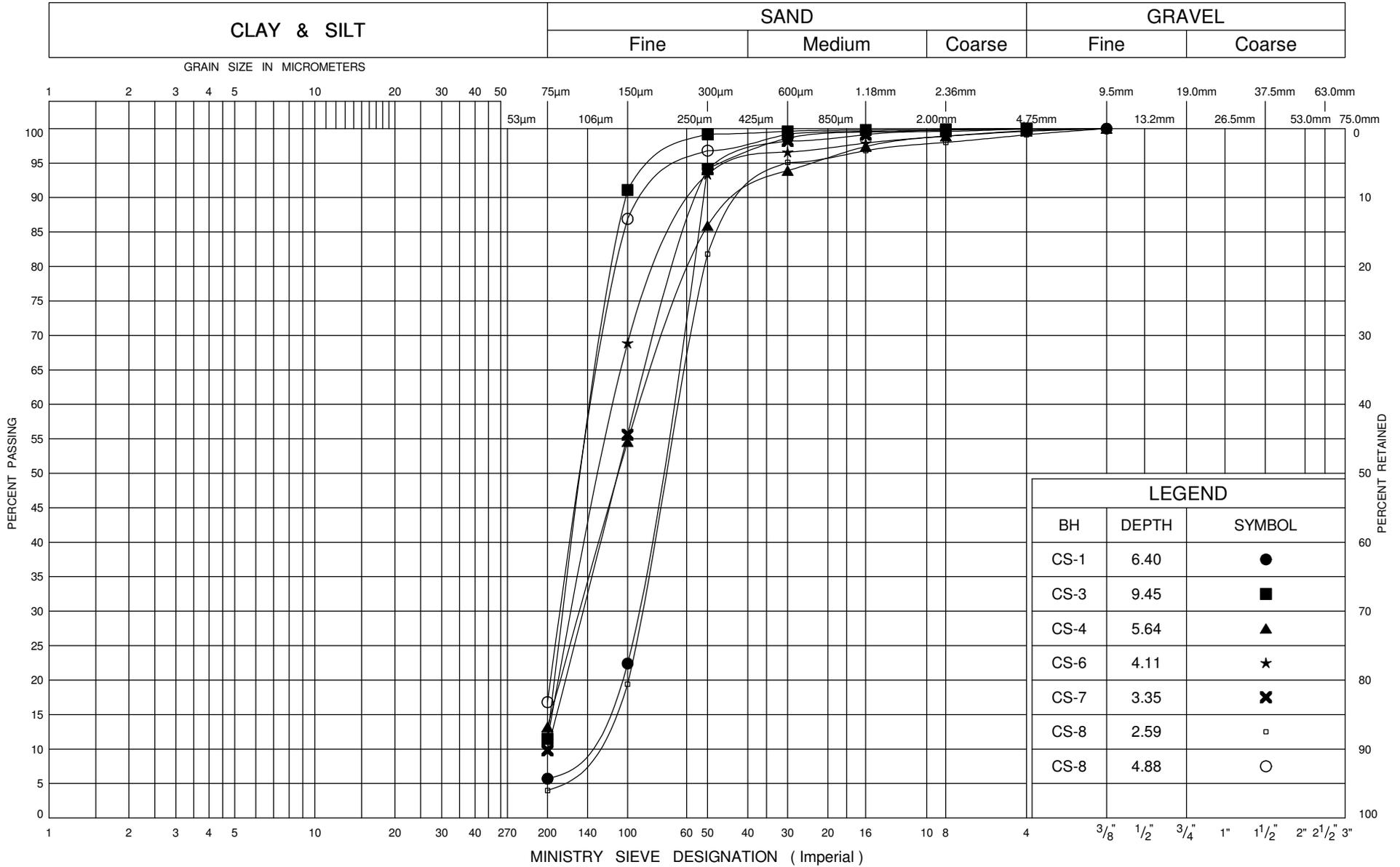
ONTARIO MOT GRAIN SIZE 1012607.GPJ ONTARIO MOT.GDT 11/19/08



GRAIN SIZE DISTRIBUTION SAND (FILL)

FIG No 1
W P 3038-03-00
Hwy 402, Township of Sarnia

UNIFIED SOIL CLASSIFICATION SYSTEM

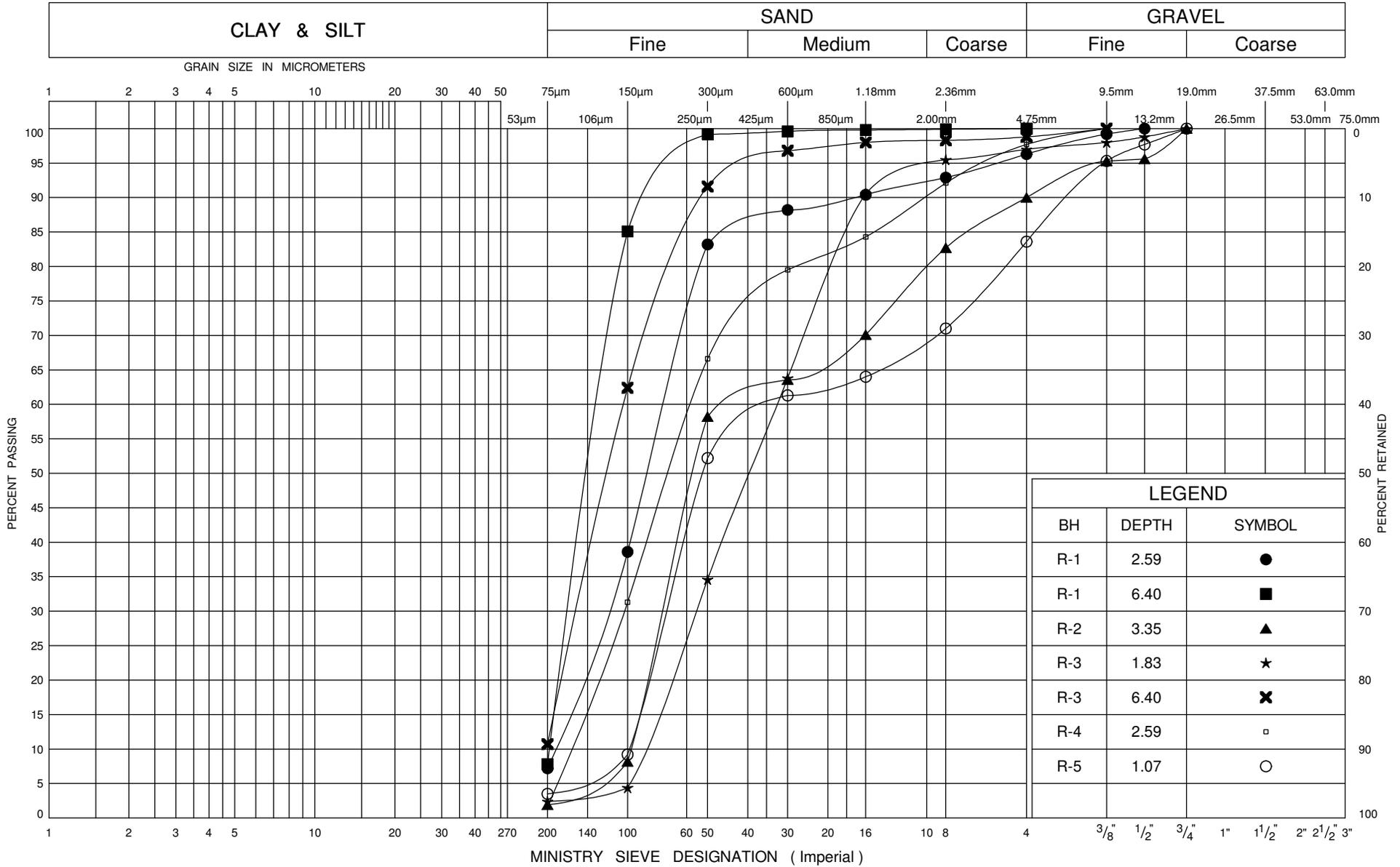


GRAIN SIZE DISTRIBUTION SAND

FIG No 2
W P 3038-03-00
Hwy 402, Township of Sarnia



UNIFIED SOIL CLASSIFICATION SYSTEM



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



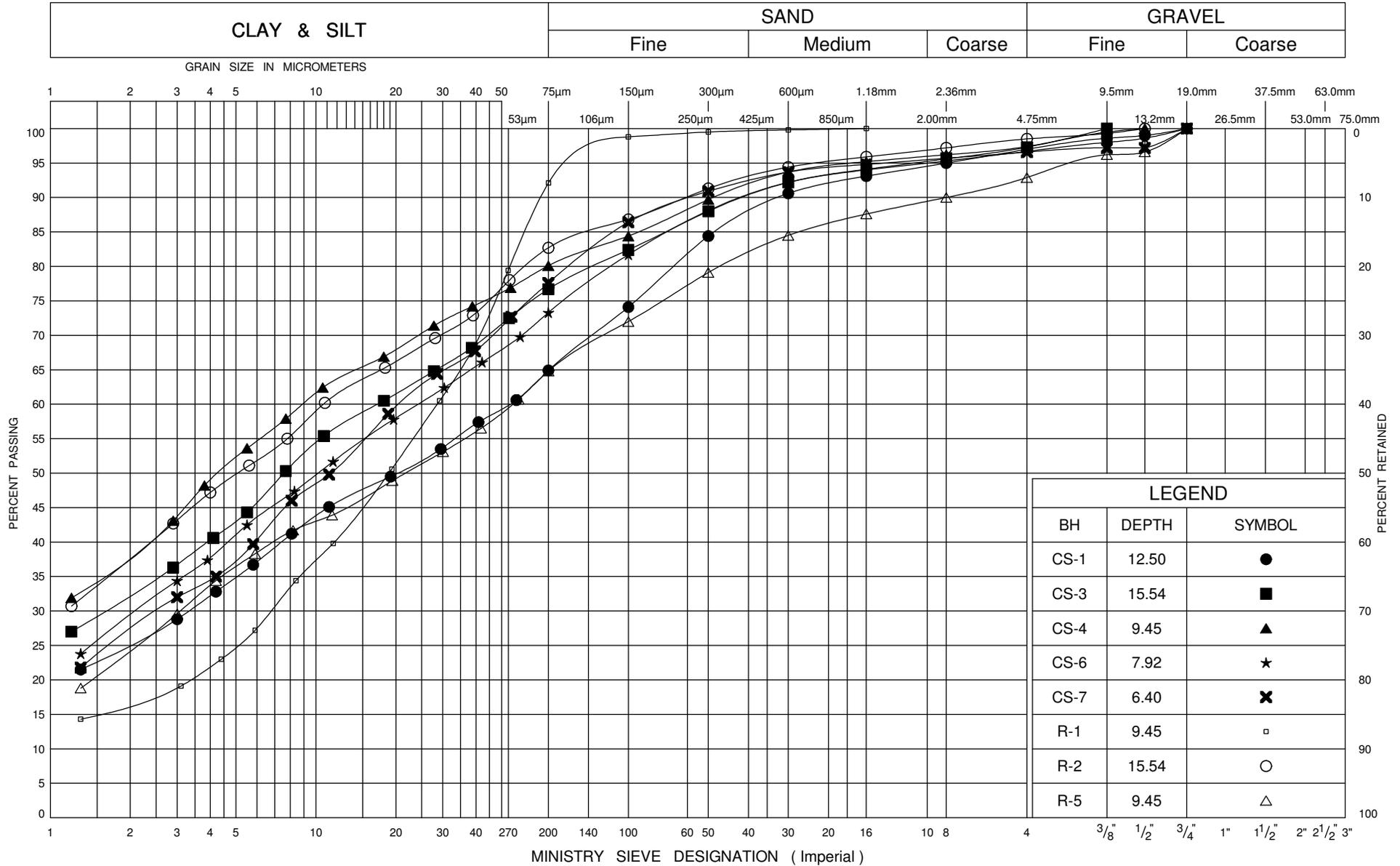
GRAIN SIZE DISTRIBUTION SAND

FIG No 3

W P 3038-03-00

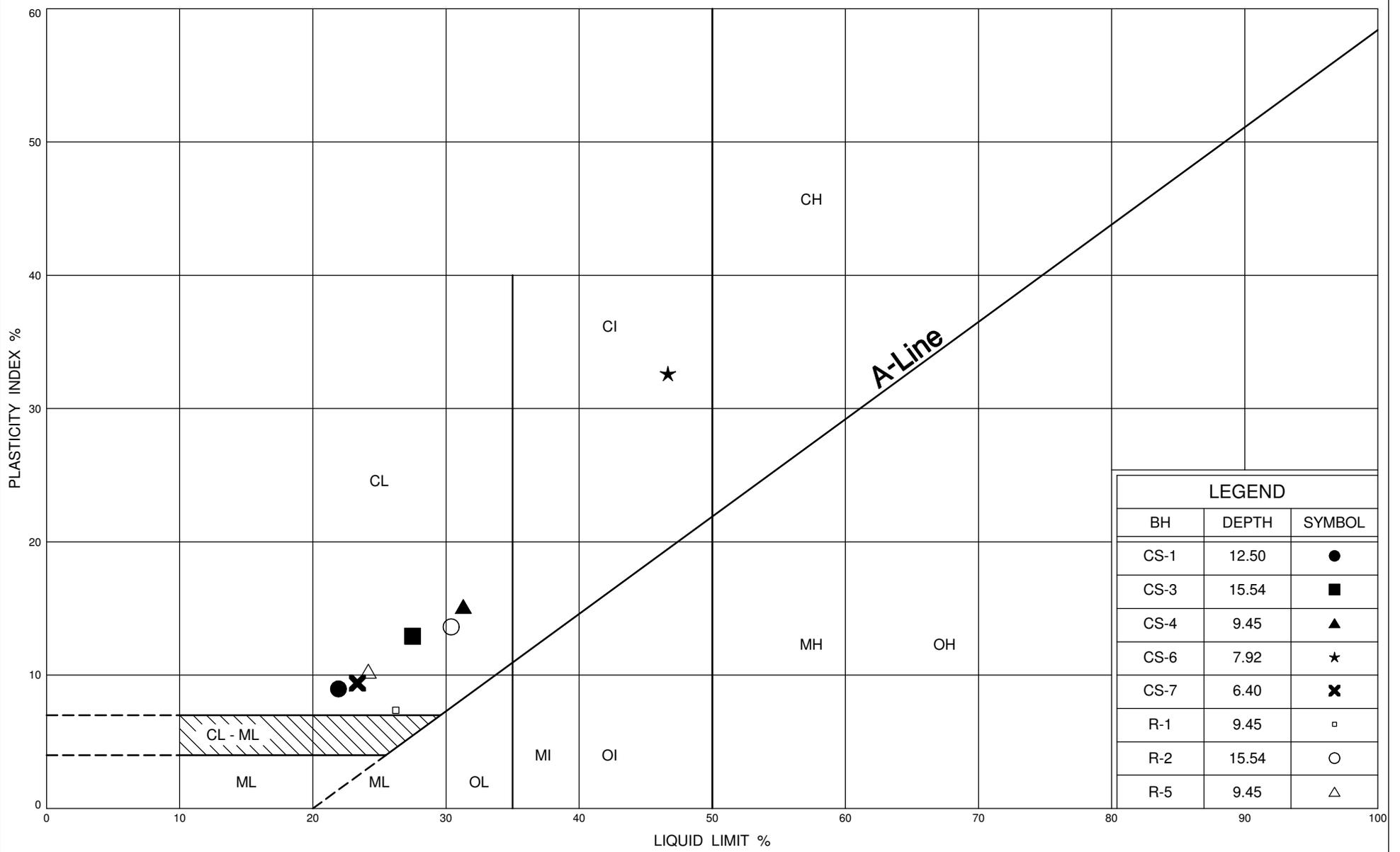
Hwy 402, Township of Sarnia

UNIFIED SOIL CLASSIFICATION SYSTEM



GRAIN SIZE DISTRIBUTION
Clayey SILT/ Silty CLAY

FIG No 4
W P 3038-03-00
Hwy 402, Township of Sarnia



| LEGEND | | |
|--------|-------|--------|
| BH | DEPTH | SYMBOL |
| CS-1 | 12.50 | ● |
| CS-3 | 15.54 | ■ |
| CS-4 | 9.45 | ▲ |
| CS-6 | 7.92 | ★ |
| CS-7 | 6.40 | ✕ |
| R-1 | 9.45 | □ |
| R-2 | 15.54 | ○ |
| R-5 | 9.45 | △ |

ONTARIO MOT PLASTICITY CHART 1012607.GPJ_ONTARIO MOT.GDT 11/19/08



PLASTICITY CHART
Clayey SILT/ Silty CLAY

FIG No 5
W P 3038-03-00
Hwy 402, Township of Sarnia

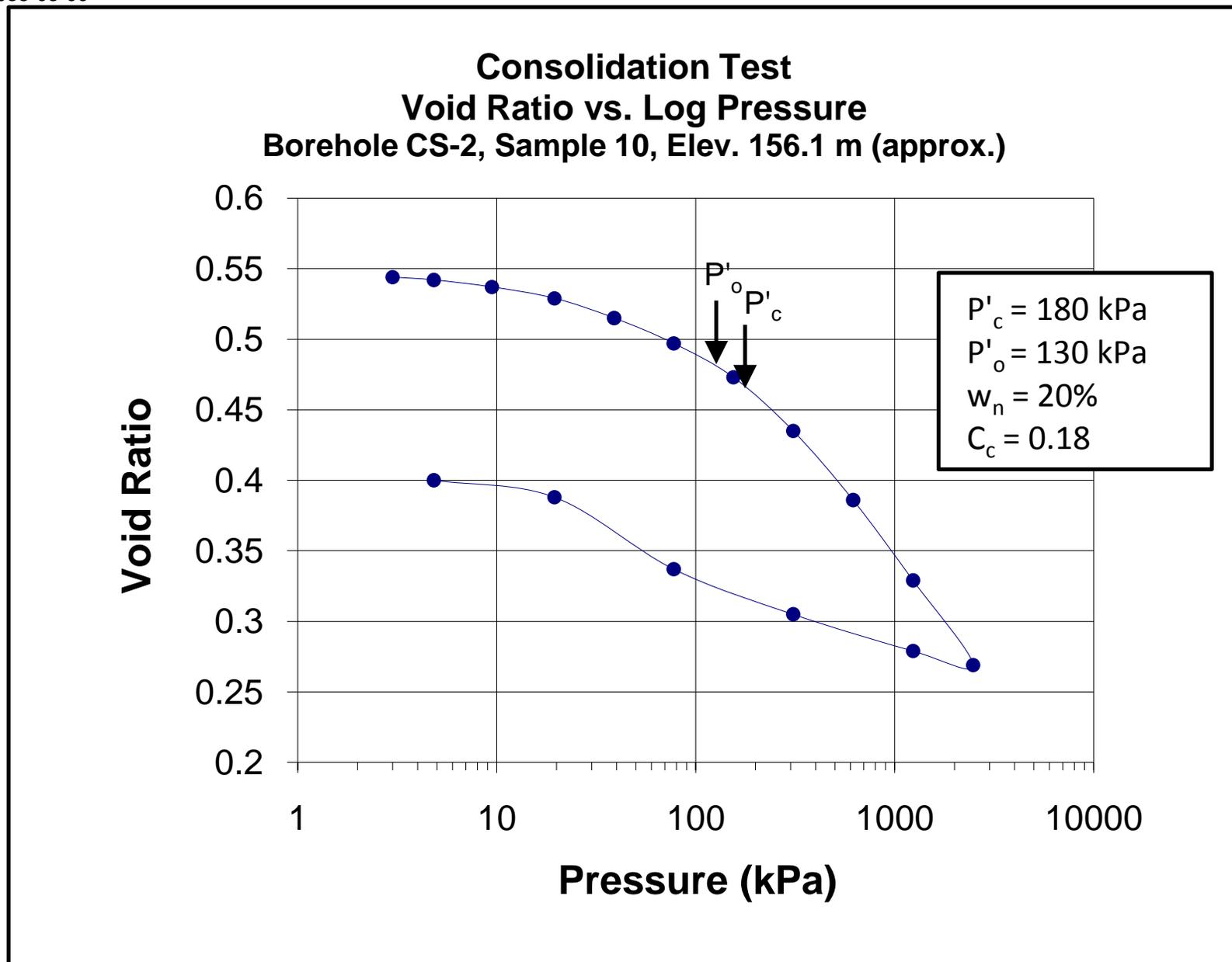


Figure 6



**Jacques Whitford
Limited**

7271 Warden Ave,
Markham, Ontario
L3R 5X5
Tel: (905) 474 -7700
Fax: (905) 479-9326

**Density/Bulk Unit Weight
Of Soil Specimen**

Figure 7

Client: Stantec/MTO

Project No.: 1012607

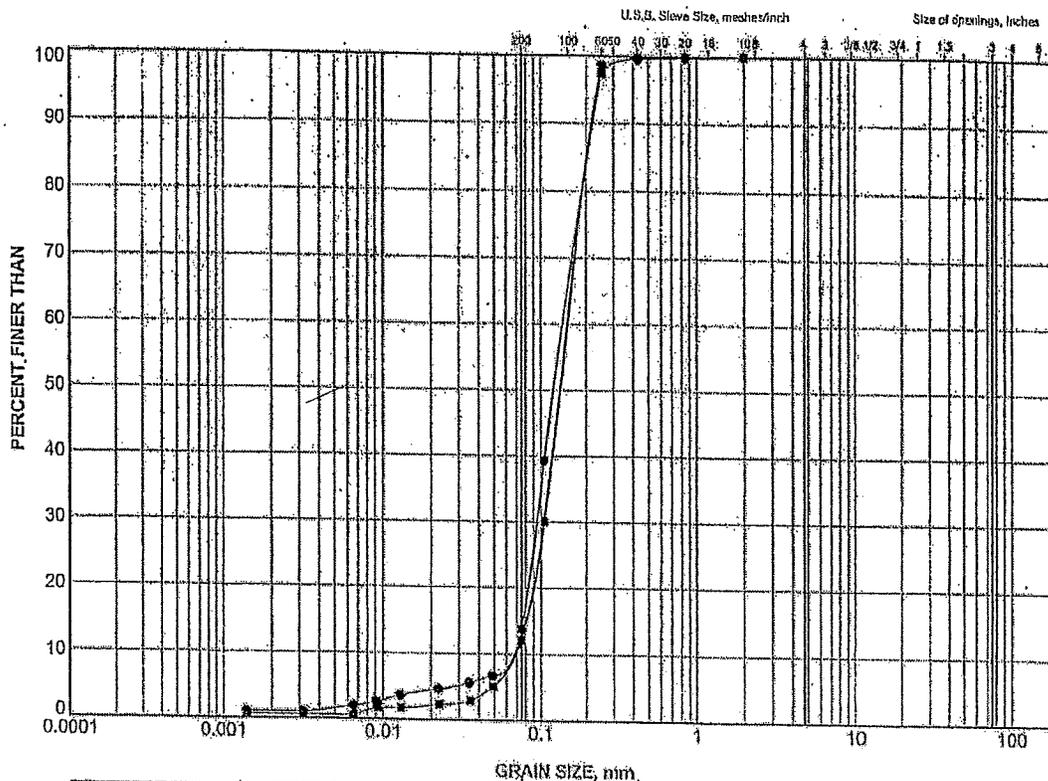
Location: Highway 402 Underpass at Christina Street
Sarnia, Ontario

| | <i>Unit</i> | | 1 | 2 | 3 |
|--|-------------------------|------------------------------------|--------------------|----------------------|----------------------|
| Borehole No. | | | BH R4-8 | BH CS4-13 | BH R2-10B |
| Mass of soil specimen in air | <i>gms</i> | A | 138.6 | 96.3 | 97.1 |
| Mass of soil specimen in liquid (oil) | <i>gms</i> | B | 83.3 | 58.4 | 58.1 |
| Mass of Liquid displaced | <i>cc</i> | C=(A-B) | 55.3 | 37.9 | 39.0 |
| Specific Gravity of Liquid (oil) | | γ_L | 0.8714 | 0.8714 | 0.8714 |
| Density of soil sample | <i>Kg/m³</i> | $D = \frac{1000A*\gamma_L}{(A-B)}$ | 2184 | 2214 | 2170 |
| Unit Weight of soil sample | <i>KN/m³</i> | $U = \frac{U}{D*0.009807}$ | 21.4 | 21.7 | 21.28 |

APPENDIX D

Laboratory Test Results - Preliminary Foundation Investigation Report





| | | | | | | | |
|---------------|----------------|--------|-----------|------|-------------|--|----------------|
| CLAY AND SILT | GRAIN SIZE, mm | | SAND SIZE | | GRAVEL SIZE | | Cobble Silt |
| | fine | medium | coarse | fine | coarse | | |

LEGEND

| SYMBOL | BOREHOLE | SAMPLE | ELEV (m) |
|--------|----------|--------|----------|
| ● | BH1 | 4 | 178.0 |
| ■ | BH2 | 2 | 179.8 |

PROJECT: CHRISTINA STREET UNDERPASS REPLACEMENT
 GWP 3038-03-00
 HWY 402

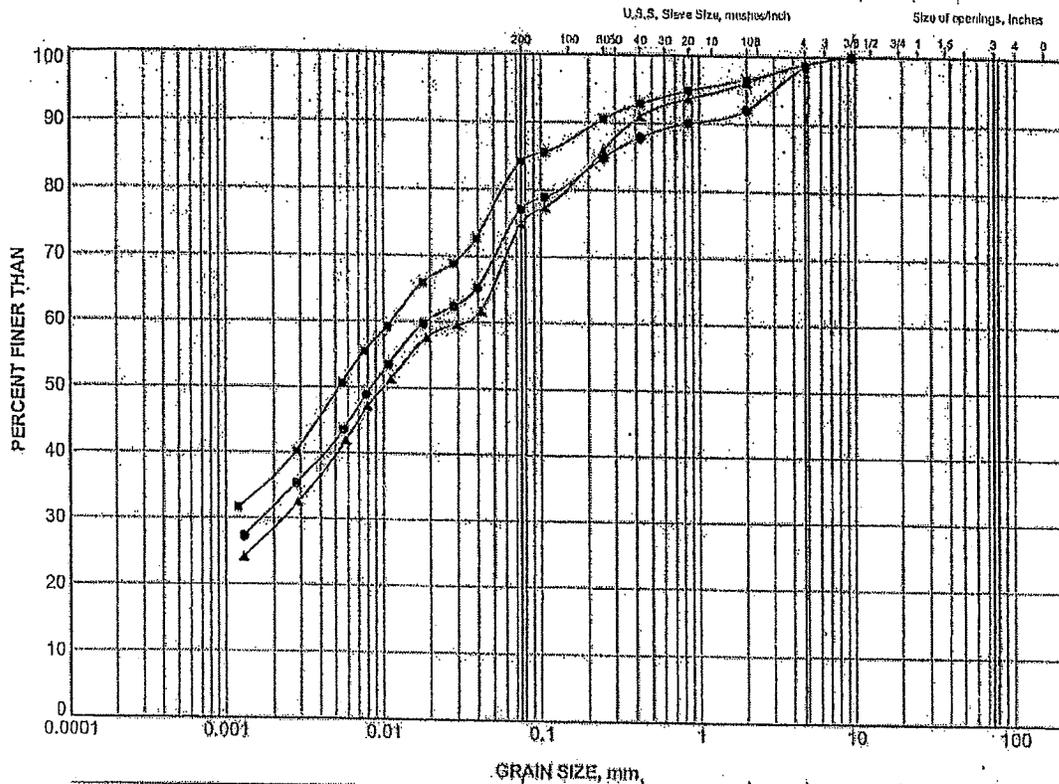
TITLE: GRAIN SIZE DISTRIBUTION
 FINE SAND

| | | | |
|-------------|------------|----------|-----------------|
| PROJECT No. | 011-120027 | FILE No. | GRA-13038-2-GP1 |
| DRAWN | WDF | SCALE | N/A |
| CHECK | WDF | DATE | NOV |

FIGURE A-1

Golder Associates
LONDON, ONTARIO

LBN: JFC, NEW GSDR, LBN: GDF



| CLAY AND SILT | GRAIN SIZE, mm | | | | | Cobble Size |
|---------------|----------------|--------|--------|-------------|--------|-------------|
| | fine | medium | coarse | fine | coarse | |
| | SAND SIZE | | | GRAVEL SIZE | | |

| LEGEND | | | |
|--------|----------|--------|----------|
| SYMBOL | BOREHOLE | SAMPLE | ELEV (m) |
| ● | BH1 | 11 | 172.0 |
| ■ | BH1 | 14 | 167.6 |
| ▲ | BH2 | 9 | 174.6 |

PROJECT
CHRISTINA STREET UNDERPASS REPLACEMENT
 GWP 3038-03-00
 HWY 402

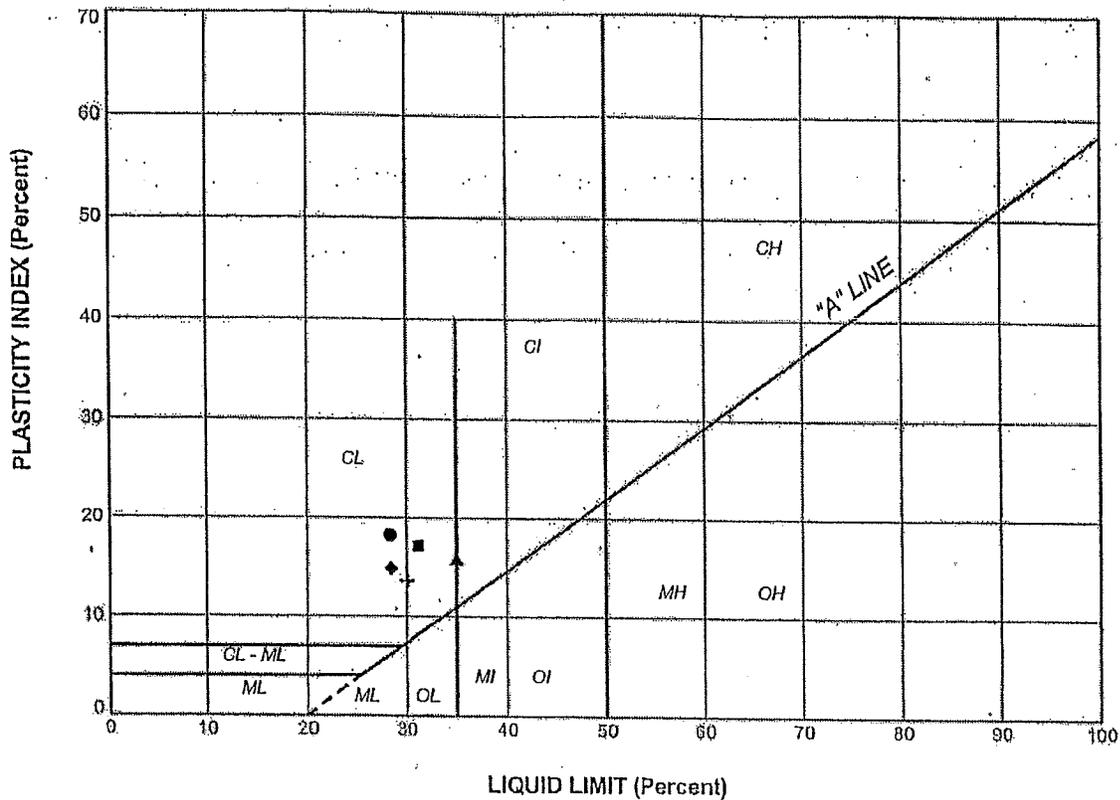
TITLE
GRAIN SIZE DISTRIBUTION
 CLAYEY SILT

| | | | |
|-------------|------------|----------|------------------|
| PROJECT No. | D11-100289 | FILE No. | D11-100289-2.GPJ |
| DESIGNED BY | WGF | DATE | SEP 14/04 |
| CHECKED BY | AP | DATE | 012-0105 |

FIGURE A-2

Golder Associates
 LONDON, ONTARIO

EDMONTON, NEW GLDR LEVAGSDT



SOIL TYPE PLASTICITY
 C = Clay L = Low
 M = Silt I = Intermediate
 O = Organic H = High

LEGEND

| SYMBOL | BOREHOLE | SAMPLE | ELEV (m) | LL(%) | PL(%) | PI |
|--------|----------|--------|----------|-------|-------|------|
| ● | BH1 | 10 | 173.8 | 28.4 | 10.2 | 18.2 |
| ■ | BH1 | 15 | 166.4 | 31.2 | 14.1 | 17.1 |
| ▲ | BH2 | 8 | 175.8 | 35.0 | 19.2 | 15.8 |
| + | BH2 | 12 | 171.2 | 30.1 | 16.5 | 13.6 |
| + | BH2 | 13 | 169.7 | 28.5 | 13.7 | 14.8 |

PROJECT: CHRISTINA STREET UNDERPASS REPLACEMENT
 GWP 3038-03-00
 HWY 402

DATE:

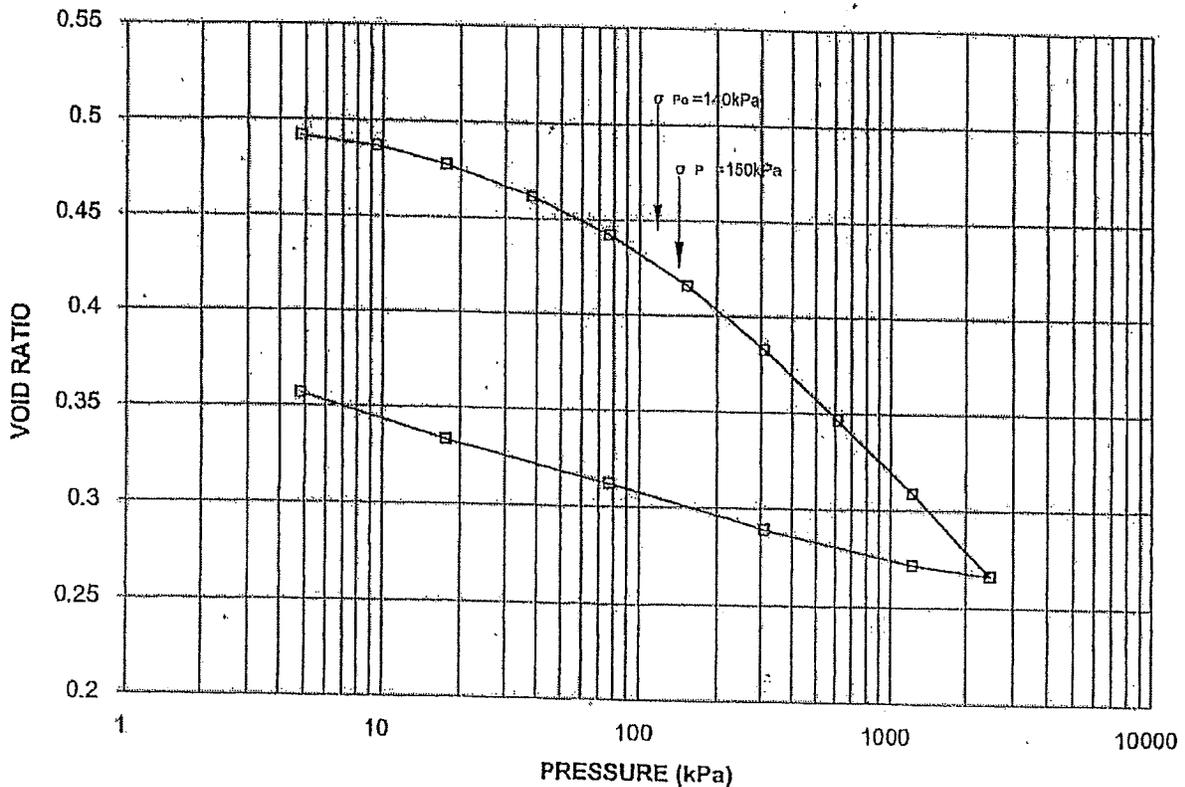
**PLASTICITY CHART
 (Clayey Silt)**

| | | | |
|-------------|--------------|----------|-------------------|
| PROJECT No: | D11-100000-2 | FILE No: | D11-100000-2 (3P) |
| SCALE: | N/A | REV: | |
| DRAWN BY: | OG | DATE: | 07/10/04 |
| CHECK: | [Signature] | | |

FIGURE A-3

Golder Associates
 LONDON, ONTARIO

PLOT BY: ENCLER CONSULT



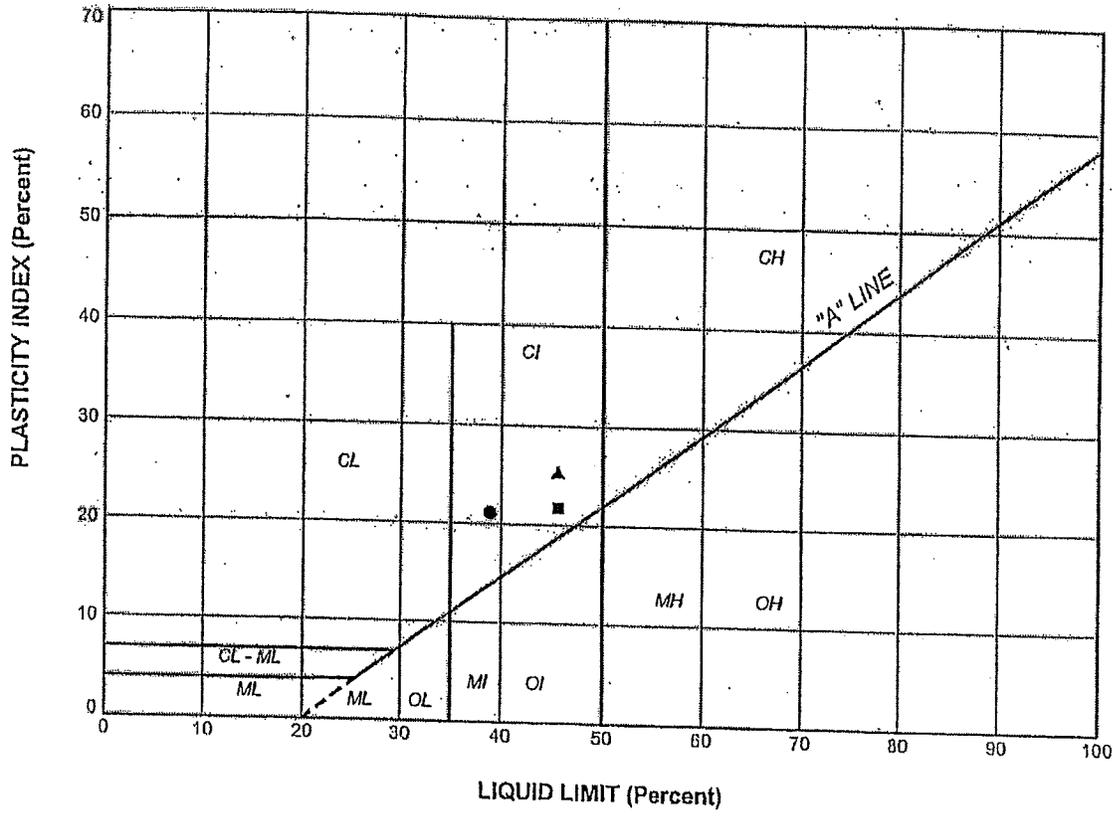
BOREHOLE 2, SAMPLE 13, ELEV. 169.5m

NOTE
 1) THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ACCOMPANYING TEXT.

| | | | |
|---|-------|-------------------------|--------|
| PROJECT | | | |
| CHRISTINA STREET UNDERPASS REPLACEMENT GWP 3038-03-00 HWY 402 | | | |
| TITLE | | | |
| CONSOLIDATION TEST VOID RATIO VS. LOG PRESSURE | | | |
| PROJECT No. 041-130000-2 | | FILE No. 041130000-2004 | |
| DATE | SCALE | AS SHOWN | REV. 0 |
| ADD. CHECK | DATE | FIGURE A-4 | |



Drawing file: 041130000-2004.dwg Oct 13, 2005 - 9:08am



SOIL TYPE
 C = Clay
 M = Silt
 O = Organic

PLASTICITY
 L = Low
 I = Intermediate
 H = High

LEGEND

| SYMBOL | BOREHOLE | SAMPLE | ELEV (m) | LL(%) | PL(%) | PI |
|--------|----------|--------|----------|-------|-------|------|
| ● | BH1 | 18 | 161.8 | 38.9 | 17.8 | 21.1 |
| ■ | BH1 | 28 | 146.5 | 45.8 | 23.9 | 21.7 |
| ▲ | BH2 | 22 | 145.3 | 45.6 | 20.3 | 25.3 |

PROJECT: CHRISTINA STREET UNDERPASS REPLACEMENT
 GWP 3038-03-00
 HWY 402

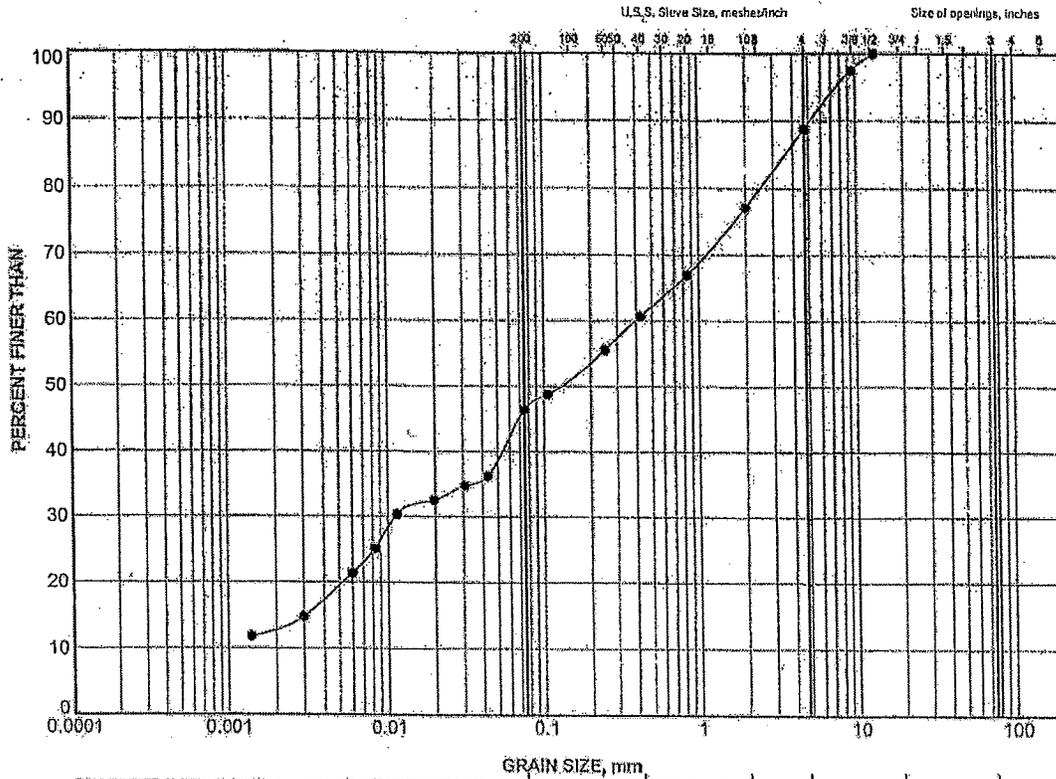
PLASTICITY CHART
 (Silty Clay)

| | | | |
|-------------|--------------|----------|-----------------|
| PROJECT No. | 041-130009-2 | FILE No. | 011-150099a.GPJ |
| DRAWN | BO. | DATE | SEP. 1994 |
| CHECK | JW | DATE | OCT. 12/95 |

Golder Associates
 LONDON, ONTARIO

FIGURE A-6

AUTO PL. SLEP. LONGST



| | | | | | | |
|---------------|-----------|--------|--------|-------------|--------|-------------|
| CLAY AND SILT | fine | medium | coarse | fine | coarse | Cobble Size |
| | SAND SIZE | | | GRAVEL SIZE | | |

| LEGEND | | | |
|--------|----------|--------|----------|
| SYMBOL | BOREHOLE | SAMPLE | ELEV (m) |
| ● | BH1 | 39 | 129.0 |

| | | | | | |
|---|-------------|------------|-----------|---------------|------------|
| PROJECT: CHRISTINA STREET UNDERPASS REPLACEMENT GWP 3038-03-00 HWY 402 | | | | | |
| TITLE: GRAIN SIZE DISTRIBUTION SANDY SILT TILL | | | | | |
|  Golder Associates LONDON, ONTARIO | PROJECT NO. | 041-130029 | FILE NO. | 041-130029.03 | |
| | DRAWN | WDB | SEP 14/04 | SCALE | N/A |
| | CHECK | AW | 07/10/05 | REV | |
| | | | | | FIGURE A-7 |

LON-MET-NEW GLDR-CON-001

Appendix E

Representative Site Photographs



Photo 1: Christina Street Underpass looking west from Highway 402.



Photo 2: Christina Street Underpass looking south along Christina to Highway 402.