

Golder Associates Ltd.

309 Exeter Road, Unit #1
London, Ontario, Canada N6L 1C1
Telephone: (519) 652-0099
Fax: (519) 652-6299



**FOUNDATION INVESTIGATION AND DESIGN REPORT
BREAKAWAY AND OVERHEAD SIGNS
HIGHWAY 401 RECONSTRUCTION
GWP 64-00-00, AGREEMENT NUMBER 3004-E-0034
MINISTRY OF TRANSPORTATION - SOUTHWESTERN REGION**

Submitted to:

Dillon Consulting Limited
P.O. Box 426, Terminal B
495 Richmond Street
London, Ontario
N6A 4W7

DISTRIBUTION:

8 Copies - Dillon Consulting Limited
2 Copies - Golder Associates Ltd.

December 14, 2006

05-1130-209-1-5
Geocres No. 40J2-84



TABLE OF CONTENTS

<u>SECTION</u>	<u>PAGE</u>
----------------	-------------

PART A – FOUNDATION INVESTIGATION REPORT

1.0	INTRODUCTION.....	1
2.0	SITE DESCRIPTION.....	2
2.1	General	2
2.2	Site Geology	2
3.0	INVESTIGATION PROCEDURES.....	4
4.0	SUBSURFACE CONDITIONS.....	6
4.1	Site Stratigraphy.....	6
4.2	Breakaway Signs (Boreholes 501 to 509 and 511 to 513)	6
4.2.1	Topsoil and Fill	6
4.2.2	Sand and Silt	7
4.2.3	Clayey Silt Till	7
4.3	Overhead Signs (Boreholes 510, 514 to 517, 205 and 704)	7
4.3.1	Topsoil and Fill	7
4.3.2	Sand.....	8
4.3.3	Clayey Silt Till	8
4.4	Groundwater Conditions.....	9
5.0	MISCELLANEOUS.....	11

PART B - FOUNDATION DESIGN REPORT

6.0	ENGINEERING RECOMMENDATIONS	12
6.1	General	12
6.2	Caisson Foundations for Overhead Signs	12
6.2.1	Vertical Loads.....	13
6.2.2	Lateral Loads.....	14
6.3	Construction Considerations	15
7.0	MISCELLANEOUS.....	16

In Order
Following
Page 16

LIST OF ABBREVIATIONS

LIST OF SYMBOLS

RECORDS OF BOREHOLES

FIGURE 1 – Key Plan

DRAWING 1 –Borehole Locations

APPENDIX A – Laboratory Test Data (Figures A-1 to A-5)

PART A

FOUNDATION INVESTIGATION REPORT

BREAKAWAY AND OVERHEAD SIGNS

HIGHWAY 401 RECONSTRUCTION
GWP 64-00-00, AGREEMENT NUMBER 3004-E-0034
MINISTRY OF TRANSPORTATION – SOUTHWESTERN REGION

1.0 INTRODUCTION

Golder Associates Ltd. (Golder) has been retained by Dillon Consulting Limited (Dillon) on behalf of the Ministry of Transportation, Ontario (MTO) to provide foundations engineering services as part of the detail design work for the section of Highway 401 described by GWP 64-00-00. This section of Highway 401 is some 8.4 kilometres in length and extends from 0.4 kilometres east of Highway 3 easterly to 1.5 kilometres west of Manning Road in the County of Essex, Ontario.

GWP 64-00-00 includes:

- Replacement of the pavement structure;
- Construction of a median barrier and closed drainage system;
- Replacement of the Walker Road and Conrail overpasses and associated roadworks;
- Construction of an underpass and new ramps at Dougall Parkway;
- Reconstruction of Provincial Roads truck and interchange;
- Rehabilitation of four Highway 401 underpass structures;
- Extension, rehabilitation or replacements of concrete culverts; and
- Upgrading of permanent highway signing and lighting.

The purpose of this foundations investigation was to determine the subsurface conditions at the proposed overhead and breakaway sign locations by drilling boreholes, carrying out in-situ tests and laboratory tests on selected samples. The terms of reference for the scope of work are outlined in the MTO's request for proposal and in Golder proposal P51-3094, dated October 14, 2005. The work was carried out in accordance with our Quality Control Plan for Foundation Engineering Detail Design Services dated December 8, 2005 and our letter dated July 6, 2006.

The centreline and stations of the alignment were surveyed by others prior to commencing the foundation investigation program. Dillon provided Golder with preliminary drawings for this project in digital format.

2.0 SITE DESCRIPTION

2.1 General

GWP 64-00-00 comprises the reconstruction and widening of some 8.4 kilometres of Highway 401 extending from 0.4 kilometres east of Highway 3 easterly to 1.5 kilometres west of Manning Road in the County of Essex, Ontario. The location of the project is shown on the Key Plan, Figure 1. The Highway 401 project chainage extends from Station 10+330 to Station 18+700 in the Township of Sandwich South. GWP 64-00-00 includes the rehabilitation of four structures, the reconstruction of four structures including one with new approach embankments, one structural culvert replacement, the extension and rehabilitation of several concrete culverts, high mast lighting, new overhead and breakaway signs, and reconstruction and widening or rehabilitation of the pavements within the project limits.

This report addresses the subsurface conditions at the locations of the proposed overhead and breakaway signs. The general location of the site is shown on the Key Plan, Figure 1.

Highway 401 is one of the most important transportation facilities in Ontario and connects major urban centres in southern Ontario with Quebec and the United States of America. The subject section of Highway 401 is a Class I, controlled access, divided rural freeway. West of Essex County Road 42 (formerly Highway 2), the existing cross-section consists of 9.1 metre wide median flanked by two 3.5 metre wide lanes in each direction. Apart from the interchange and truck inspection station areas which are wider, the right-of-way is generally 91 metres wide. East of Essex County Road 42, there are two 3.65 metres wide lanes in each direction separated by a 15.0 metre wide median.

The topography in the project area is flat to gently rolling with original ground surface elevations varying from 186 to 192 metres. There are several residential subdivisions west of Provincial Road (Essex County Road 46) on the north side of Highway 401. The land use on the south side of Highway 401, between the western project limit and 8th Concession Road is predominantly commercial and industrial with pockets of new development. East of Provincial Road, the land use is generally agricultural.

2.2 Site Geology

The project lies within the Essex Clay Plain, a subregion of the physiographic region of southern Ontario known as the St. Clair Clay Plains, identified in "The Physiography of Southern Ontario" by Chapman and Putnam (1984). The clay plain is described as a till plain that has been smoothed by shallow deposits of lacustrine clay which settled in the depressions of the till. The prevailing soil type is reportedly the Brookston clay. In addition, the physiographic mapping indicates an area of sandy soils near the western end of the project.

Based on the Ontario Department of Mines and Northern Affairs Preliminary Map P.749 entitled “Quaternary Geology of the Windsor-Essex Area, Western Part”, and Map P.750 entitled “Quaternary Geology of the Windsor-Essex Area, Eastern Part”, the project area is reportedly located in predominantly clayey silt till. Some areas of glaciofluvial sand and gravel as well as areas with a thin, discontinuous veneer of glaciolacustrine sand are indicated on the mapping.

Based on the available bedrock geology mapping, the subcropping bedrock consists of limestone of the Dundee formation of Middle Devonian age.

3.0 INVESTIGATION PROCEDURES

The field work for this investigation was carried out between July 6 and 27, 2006 at which time nineteen boreholes were drilled at the locations indicated on Drawing 1.

The as-drilled borehole locations, ground surface elevations and borehole depths are as follows:

<u>BOREHOLE</u>	<u>LOCATION (m)</u>			<u>GROUND SURFACE ELEVATION</u>	<u>BOREHOLE DEPTH</u>
	<u>Northing</u>	<u>Easting</u>	<u>Chainage</u>	(m)	(m)

BREAKAWAY SIGNS

501	4,678,378	268,323	14+500 Rt	187.91	3.66
502	4,678,225	268,696	14+900 Rt	187.32	3.66
503	4,678,127	269,694	15+900 Rt	186.20	3.66
504	4,678,110	270,094	16+300 Rt	186.83	3.66
505	4,678,025	272,217	18+425 Rt	185.26	3.66
506	4,678,155	270,146	16+350 Lt	186.00	3.66
507	4,678,169	269,846	16+050 Lt	186.21	3.66
508	4,678,215	268,950	15+150 Lt	186.90	3.66
509	4,678,286	268,663	14+850 Lt	187.17	3.66
511	4,677,764	265,211	11+000 Lt	189.61	5.03
512	4,677,701	265,200	10+950 Rt	189.85	4.27
513	4,678,198	265,762	11+700 Rt	191.78	3.66

OVERHEAD SIGNS

510	4,678,734	266,949	13+025 Rt	195.46	4.27
514	4,678,406	268,369	14+530 Lt	188.18	7.32
515	4,678,804	267,447	13+530 Lt	191.18	8.08
516	4,678,593	266,364	12+425 Lt	190.67	8.08
517	4,678,380	265,995	12+000 Rt	189.82	8.08
205	4,678,757	266,975	13+025 Rt	199.90	11.89
704	4,678,758	266,953	13+025 Rt	200.30	11.13

The soil stratigraphy encountered in the boreholes is shown on the attached Record of Borehole sheets.

It should be noted that boreholes were not drilled for the proposed overhead sign at Station 12+900 Lt since the locations of both footings are in an area where some 10 metres of fill is to be placed. Similarly, the outside footing for the proposed overhead sign at Station 13+025 Rt is in an area where some 10 metres of fill is to be placed for widening to the right. The inside footing will be in the existing fill and the outside footing in a combination of new fill and existing fill. It

is not considered reasonable to drill boreholes for the locations where the extensive new fills are to be placed; however, the existing fill at the outside footing location was investigated.

All of the boreholes, except borehole 510, were advanced using an all terrain vehicle mounted power auger supplied and operated by a specialist drilling contractor. Samples of the overburden were obtained at suitable intervals of depth using 50 millimetre outside diameter split spoon sampling equipment in accordance with the standard penetration test (SPT) procedures.

Borehole 510 was not accessible to the heavy drilling equipment and was advanced to the depth feasible by Golder staff using manual drilling techniques. Samples of the overburden were obtained at suitable intervals of depth using 50 millimetre outside diameter split spoon sampling equipment and a 31.8 kilogram sampling hammer. The driving resistances obtained were adjusted to reflect approximate standard penetration test N values.

Groundwater conditions were observed in the boreholes throughout the drilling operations. All of the boreholes were backfilled in accordance with current regulations and MTO recommended procedures.

The field work was supervised on a full-time basis by experienced members of our engineering staff who arranged for underground utility locates, directed the drilling, sampling and in situ testing operations, logged the boreholes and cared for the samples obtained. The soil samples were identified in the field, placed in labeled containers and transported to Golder's London laboratory for further examination and routine testing. Index and classification tests consisting of water content determinations, grain size distribution analyses and Atterberg limits determinations were carried out on selected samples. The results of the field and laboratory testing are given on the Record of Borehole sheets and in Appendix A.

Temporary traffic control was carried out in accordance with the Ontario Traffic Manual, Book 7, dated March 2001.

4.0 SUBSURFACE CONDITIONS

4.1 Site Stratigraphy

The detailed subsurface soil and groundwater conditions encountered in the boreholes and the results of the in situ and laboratory testing are provided on the attached Record of Borehole sheets following the text of this report and in Appendix A. The stratigraphic boundaries shown on the Record of Borehole sheets are inferred from non-continuous sampling and observations of drilling resistance and may represent transitions between soil types rather than exact planes of geological change. Further, the subsurface conditions may vary significantly between and beyond the borehole locations.

In summary, the boreholes drilled for the proposed breakaway and overhead signs encountered surficial topsoil and fill overlying firm to hard clayey silt till. In addition, thin layers of sand and silt were encountered in some of the boreholes.

A detailed description of the subsurface conditions encountered in the boreholes is provided on the Record of Borehole sheets and is summarized in the following sections.

4.2 Breakaway Signs (Boreholes 501 to 509 and 511 to 513)

4.2.1 Topsoil and Fill

Topsoil layers 0.2 to 1.0 metres thick were encountered at ground surface in boreholes 501, 503 to 509 and 513. These layers had an average thickness of about 0.3 metres.

Granular base materials about 0.2 metres thick were encountered at the shoulder surface in borehole 511.

Stiff to very stiff clayey fill materials were encountered at ground surface in borehole 512, beneath the granular base in borehole 511 and beneath the surficial topsoil in boreholes 501, 504, 505, 506 and 508. The fill was encountered between elevation 185.1 and 189.9 metres. The fill materials were 0.2 to 1.8 metres thick at the borehole locations with an average thickness of about 0.7 metres. The fill had N values, as determined in the standard penetration testing, of 10 to 18 blows per 0.3 metres with water contents of 17 to 20 per cent.

Layers of buried topsoil were encountered beneath the fill in boreholes 508 and 512 at elevation 186.6 and 188.7 metres, respectively. The buried topsoil layers were 0.1 to 0.3 metres thick at the borehole locations.

4.2.2 Sand and Silt

Beneath the topsoil in borehole 507, thin, surficial layers of compact sand and silt were encountered at elevation 185.3 metres. These layers were about 0.4 metres thick at the borehole location. The sand and silt had an N value of 10 blows per 0.3 metres and natural water contents of 15 and 21 per cent, respectively.

4.2.3 Clayey Silt Till

Firm to hard, but generally stiff to hard, clayey silt till was encountered beneath the surficial topsoil in boreholes 503, 508, 509, 512 and 513, beneath the fill in boreholes 501, 504, 505, 506 and 511, beneath the sand and silt in borehole 507 and at ground surface in borehole 502. The surface of the till was encountered between elevations 184.8 and 191.6 metres. All of these boreholes were terminated in the clayey silt till after exploring it for 2.3 to 3.7 metres. The clayey silt till had N values of 7 to 47 blows per 0.3 metres with natural water contents of 11 to 19 per cent and an average water content of about 14 per cent. The clayey silt till had corresponding average plastic and liquid limits of 14 and 29 per cent, respectively, based on seven Atterberg limits determinations indicating a clay of low plasticity. The Atterberg limits data are provided on the Plasticity Chart, Figures A-4 and A-5.

Grain size distribution curves for samples of the clayey silt till recovered from the standard penetration testing are provided on Figures A-1 and A-2.

Although not specifically encountered in the boreholes, the presence of cobbles and boulders should be expected in the clayey silt till.

4.3 Overhead Signs (Boreholes 510, 514 to 517, 205 and 704)

4.3.1 Topsoil and Fill

Topsoil layers 0.1 to 0.2 metres thick were encountered at ground surface in boreholes 510, 514 and 516.

Asphalt was encountered at the roadway surface in boreholes 205 and 704. The asphalt was 0.2 to 0.3 metres thick at the borehole locations. Beneath the asphalt in borehole 704, some 0.2 metres of concrete was encountered.

Granular fill materials were encountered at ground surface in borehole 515 and beneath the concrete in borehole 704. The granular fill materials were 0.6 to 0.8 metres thick at the borehole locations. Standard penetration testing in the granular fill in borehole 704 indicated an N value of 21 blows per 0.3 metres.

Firm to hard clayey silt fill materials were encountered beneath the topsoil in borehole 510, beneath the asphalt in borehole 205 and beneath the granular fill in boreholes 515 and 704. The fill materials were encountered between elevation 190.4 and 199.7 metres. Borehole 510 was terminated in the fill after exploring it for 4.1 metres. Where fully penetrated in the other boreholes, the clayey silt fill materials were 0.8 to 7.4 metres thick. The clayey silt fill materials had N values of 5 to 32 blows per 0.3 metres with water contents of 11 to 18 per cent, with an average water content of about 14 per cent. The clayey silt fill had corresponding average plastic and liquid limits of 14 and 29 per cent, respectively, based on four Atterberg limits determinations indicating a clay of low plasticity. The Atterberg limits data are provided on the Plasticity Chart, Figures A-4 and A-5.

Grain size distribution curves for samples of the clayey silt fill recovered from the standard penetration testing are provided on Figure A-3.

Buried topsoil was encountered beneath the fill in borehole 515 at elevation 189.7 metres. The buried topsoil was 0.2 metres thick and had an N value of 17 blows per 0.3 metres with a water content of about 12 per cent.

4.3.2 Sand

A surficial layer of sand 0.2 metres thick was encountered beneath the topsoil in borehole 514 at elevation 188.1 metres.

4.3.3 Clayey Silt Till

Stiff to hard clayey silt till was encountered beneath the topsoil in boreholes 515 and 516, beneath the fill in boreholes 205 and 704, beneath the sand in borehole 514 and at ground surface in borehole 517. The surface of the till was encountered between elevations 187.9 and 192.3 metres. All of these boreholes were terminated in the clayey silt till after exploring it for 2.9 to 8.1 metres. The clayey silt till had N values of 8 to 52 blows per 0.3 metres with natural water contents of 6 to 22 per cent and an average water content of about 14 per cent. In situ vane testing carried out in the clayey silt till in borehole 517 indicated undrained shear strengths of 93 to greater than 140 kilopascals with a sensitivity of 1.2. The clayey silt till had corresponding average plastic and liquid limits of 14 and 27 per cent, respectively, based on eight Atterberg limits determinations indicating a clay of low plasticity. The Atterberg limits data are provided on the Plasticity Charts, Figures A-4 and A-5.

Grain size distribution curves for samples of the clayey silt till recovered from the standard penetration testing are provided on Figures A-1 and A-2.

The presence of cobbles and boulders should be expected in the clayey silt till.

4.4 Groundwater Conditions

Groundwater conditions were observed in the boreholes during drilling. Groundwater was encountered at elevation 183.3 metres in borehole 507 and at elevation 187.5 metres in borehole 511. These water levels are not considered to represent long-term, stabilized groundwater levels. The other boreholes remained dry during drilling. This information is summarized below:

<u>BOREHOLE</u>	<u>GROUND SURFACE ELEVATION</u> (m)	<u>ENCOUNTERED GROUNDWATER ELEVATION</u> (m)
BREAKAWAY SIGNS		
501	187.91	Dry
502	187.32	Dry
503	186.20	Dry
504	186.83	Dry
505	185.26	Dry
506	186.00	Dry
507	186.21	183.3
508	186.90	Dry
509	187.17	Dry
511	189.61	187.5
512	189.85	Dry
513	191.78	Dry
OVERHEAD SIGNS		
510	195.46	Dry
514	188.18	Dry
515	191.18	Dry
516	190.67	Dry
517	189.82	Dry
205	199.90	Dry
704	200.30	Dry

The above-noted water levels are not considered to represent long-term, stabilized groundwater levels. Based on the conditions encountered in these boreholes such as the colour change from brown to grey, and the borehole drilled for the other foundation engineering components of the project, the long-term groundwater level is estimated to be about 2 metres below the original ground surface or from approximately elevation 183 metres in the eastern portion of the site to

elevation 189 metres in the western portion of the site. Seasonal variations in the groundwater levels should be expected.

5.0 MISCELLANEOUS

This investigation was carried out using equipment supplied and operated by Lantech Drilling Services Inc., an Ontario Ministry of Environment licensed well contractor. The field operations were supervised by Mr. Michael Arthur and Mr. Chris Collins under the direction of Mr. David J. Mitchell. The laboratory testing was carried out at Golder's London laboratory under the direction of Mr. Chris M. Sewell. The laboratory is an accredited participant in the MTO Soil and Aggregate Proficiency Program and is certified by the Canadian Council of Independent Laboratories and MTO. This report was prepared by Mr. Michael E. Beadle, P. Eng. under the direction of the Project Manager, Mr. Philip R. Bedell, P. Eng. This report was reviewed by Mr. Fintan J. Heffernan, P. Eng., the Designated MTO Contact and Quality Control Auditor for this assignment.

GOLDER ASSOCIATES LTD.

Michael E. Beadle, P. Eng.
Senior Geotechnical Engineer

Philip R. Bedell, P. Eng.
Principal

Fintan J. Heffernan, P. Eng.
MTO Designated Contact

MEB/PRB/FJH/cr
n:\active\2005\1130 - geotechnical\1130-200\05-1130-209-1 dillon - gwp 64-00-00 fdns - hwy 401\reports\(-5) signs\dec 15 06 (final) - parts a&b - overhead & breakaway signs.doc

PART B

FOUNDATION DESIGN REPORT

OVERHEAD SIGNS

HIGHWAY 401 RECONSTRUCTION
GWP 64-00-00, AGREEMENT NUMBER 3004-E-0034
MINISTRY OF TRANSPORTATION – SOUTHWESTERN REGION

6.0 ENGINEERING RECOMMENDATIONS

6.1 General

This section of the report provides our recommendations on the foundation aspects of the design of the proposed overhead signs to be constructed as part of GWP 64-00-00. The recommendations are based on our interpretation of the factual information obtained during the investigation and on the available background information collected by others. It should be noted that the interpretation and recommendations are intended for use only by the design engineer. Where comments are made on construction they are provided only in order to highlight those aspects which could affect the design of the project. Those requiring information on aspects of construction should make their own interpretation of the factual information provided as it may affect equipment selection, proposed construction methods and scheduling.

Based on the information provided, the overhead signs are to located approximately as follows and the relevant boreholes are:

<u>LOCATION</u>	<u>DIRECTION</u>	<u>BOREHOLE</u>
12+000	Eastbound	517
12+425	Westbound	516
12+900	Westbound	(New Fill)
13+025	Eastbound	205, 510, 704
13+530	Westbound	515
14+530	Westbound	514

6.2 Caisson Foundations for Overhead Signs

Caisson foundations for overhead sign supports should be designed in accordance with the requirements in MTO's *Sign Support Manual*. The *Sign Support Manual* includes a standard caisson foundation design (Section 4 and Standard Drawings SS118-3, SS118-4 and SS118-5), in which the caissons are extended 5 metres below the design frost depth (i.e. a total length of 6.2 metres below grade for this project), except where bedrock is encountered within this depth. The standard design is based on the following minimum soil conditions:

- **Case 1 (Cohesionless Soils):** Sand with a friction angle of 28 degrees surrounding the upper two-thirds of the portion of the caisson foundation below the frost depth, and sand with a friction angle of 30 degrees surrounding the lower third of the portion of the caisson below the design frost depth.

- **Case 2 (Cohesive Soils):** Soft clay with an undrained shear strength of 25 kilopascals (kPa) surrounding the upper two-thirds of portion of caisson foundation below the frost depth, and “soft” clay with an undrained shear strength of 50 kPa surrounding the lower third of the portion of the caisson below the design frost depth.

The standard foundation design provided in MTO’s *Sign Support Manual* does not apply to sites where extensive poor fill materials or materials softer than those of Case 2 are present. For such subsurface conditions, a site-specific design is required.

Based on the review of the subsurface information and the placement of properly compacted approved earth fill for the new and widened embankments, the subsurface soils at all of the proposed sites have undrained shear strengths that exceed the input parameters used in the modeling of the standard caisson foundations, and therefore the standard caisson foundation design is suitable for these sites.

However, should detailed analysis of the caisson foundation be required, the following parameters may be used:

<u>SOIL TYPE</u>	<u>ANGLE OF FRICTION, ϕ</u> (°)	<u>COHESION, c_u</u> (kPa)	<u>COEFFICIENT OF PASSIVE EARTH PRESSURE, K_p</u>	<u>TOTAL UNIT WEIGHT, γ</u> (Mg/m ³)	<u>SHAFT RESISTANCE FACTOR, (α)</u>
Fill	25	75	2.5	1.9	0.4
Clayey Silt Till					
- above elevation 185 metres	28	200	2.8	1.9	0.3
- below elevation 185 metres	28	100	2.8	1.9	0.4

6.2.1 Vertical Loads

Based on the subsurface conditions encountered in the boreholes, the unit shaft resistance that may be used in the assessment of the vertical load carrying capacity of the caissons may be calculated using the following equation:

$$F_s = \alpha c_u d C$$

where α is a shaft resistance factor and d is the depth along the caisson, C is the circumference of the caisson, and c_u is the average undrained shear strength of each layer.

The upper 1.2 metres below the ground surface should be neglected to account for frost action. While any portion of the caisson within fill materials would normally be neglected. The overhead sign foundations at Stations 13+025 will be founded entirely in existing firm to very stiff clayey silt fill materials and at Station 12+900 in new fill, therefore, at these two locations, it will be necessary to utilize the fill to resist the applied loadings with the parameters for the fill given in the table in Section 6.2 above.

The component of vertical load carrying capacity that may be derived from end bearing in the cohesive soils may be calculated using the following equation:

$$Q_b = 6c_u A_b$$

where c_u is the undrained shear strength of the cohesive founding layer and A_b is the cross-sectional area of the caisson.

A resistance factor of 0.4 should be applied to obtain the factored axial resistance at ultimate limit states (ULS). The axial resistance at serviceability limit states (SLS) is greater than at ULS and ULS values will govern design.

6.2.2 Lateral Loads

The unfactored passive lateral earth pressure distributed along the caisson may be calculated using the following equations:

$$P_p = K_p \gamma d + 2 c_u \sqrt{K_p} \quad \text{above the groundwater table, and}$$

$$P_p = K_p \gamma d_w + K_p \gamma' (d - d_w) + 2 c_u \sqrt{K_p} \quad \text{below the groundwater table,}$$

where

- K_p is the passive earth pressure coefficient;
- γ is the bulk unit weight (kN/m^3);
- γ' is the effective unit weight below the groundwater level (kN/m^3);
- d is the depth below the ground surface (m);
- d_w is the depth to the groundwater level (m); and
- c_u is the undrained shear strength (kPa).

In the design of the foundations, the passive resistance within the upper 1.2 metres below ground surface should be neglected to account for frost action. The unfactored lateral resistance should be calculated assuming an equivalent pile width equal to three times the caisson diameter. A resistance factor of 0.5 should be applied to this calculated lateral resistance in order to obtain the factored lateral geotechnical resistance.

Where an undrained shear strength, c_u , is provided, the undrained capacity of the caisson should be checked to determine whether the drained or undrained case will govern. In this case, the lateral resistance for the length of the caisson within cohesive soil should be calculated assuming an unfactored passive lateral pressure distribution varying linearly from $2 c_u$ at the surface to $9 c_u$ at a depth of three pile diameters and beyond acting over the actual width of the caisson. A resistance factor of 0.5 should be applied to this calculated lateral resistance in order to obtain the factored lateral geotechnical resistance.

In general, any portion of the caisson within fill and/or organic materials should be neglected; however, as indicated above, the overhead signs at Station 12+900 and 13+025 will be founded in fill, therefore, at these two locations it will be necessary to utilize the fill to resist the applied loadings with the parameters for the fill given in the table in Section 6.2, above.

6.3 Construction Considerations

A temporary liner will be required to support the sides of the excavation and permit cleaning and inspection of the base. Careful cleaning of the base of the caisson should be carried out prior to placement of concrete to remove all loosened or disturbed materials. Surface water run off should be directed away from the excavation.

In addition, the overhead signs at Station 12+900 and 13+025 will be founded either partially or completely within new embankment fill materials. Further, the new embankment locations should be preloaded to allow some of the settlements to occur prior to roadway and sign construction. It is recommended that the overhead sign foundations be installed following the preload period to minimize, to the extent possible, the magnitude of the post construction caisson foundation settlements. However, it should be noted that ongoing consolidation settlements of the embankment and caissons will occur subsequent to construction. Therefore, the anchor bolts in the caisson foundation should be longer than typical to allow further vertical adjustment of the sign(s), as required. Settlement monitoring of the caisson foundations in all areas of new embankment or embankment widening is recommended to document the actual post construction deformation(s) and to determine when base plate adjustments are required. The details of the overall monitoring program are being provided for the contract package under a separate cover.

It should also be noted that, should lightweight fill be utilized to construct the proposed embankments and widenings, considerable difficulty should be anticipated during installation of the overhead sign foundations due to the nature of these fill materials. In addition, it is expected that the characteristics of the lightweight fill would be such that the standard caisson design would not apply. Should lightweight fill be used, the foundation recommendations for caissons founded in the fill should be revisited.

7.0 MISCELLANEOUS

This report was prepared by Mr. Michael E. Beadle, P. Eng. under the direction of the Project Manager, Mr. Philip R. Bedell, P. Eng. This report was reviewed by Mr. Fintan J. Heffernan, P. Eng., the Designated MTO Contact and Quality Control Auditor for this assignment.

GOLDER ASSOCIATES LTD.

Michael E. Beadle, P. Eng.
Senior Geotechnical Engineer

Philip R. Bedell, P. Eng.
Principal

Fintan J. Heffernan, P. Eng.
MTO Designated Contact

MEB/PRB/FJH/cr
n:\active\2005\1130 - geotechnical\1130-200\05-1130-209-1 dillon - gwp 64-00-00 fdns - hwy 401\reports\(-5) signs\dec 15 06 (final) - parts a&b - overhead & breakaway signs.doc

LIST OF ABBREVIATIONS

The abbreviations commonly employed on Records of Boreholes, on figures and in the text of the report are as follows:

I. SAMPLE TYPE

AS	Auger sample
BS	Block sample
CS	Chunk sample
SS	Split-spoon
DS	Denison type sample
FS	Foil sample
RC	Rock core
SC	Soil core
ST	Slotted tube
TO	Thin-walled, open
TP	Thin-walled, piston
WS	Wash sample

III. SOIL DESCRIPTION

(a) Cohesionless Soils

Density Index (Relative Density)	N Blows/300 mm or Blows/ft.
Very loose	0 to 4
Loose	4 to 10
Compact	10 to 30
Dense	30 to 50
Very dense	over 50

II. PENETRATION RESISTANCE

Standard Penetration Resistance (SPT), N:

The number of blows by a 63.5 kg. (140 lb.) hammer dropped 760 mm (30 in.) required to drive a 50 mm (2 in.) split spoon sampler for a distance of 300 mm (12 in.)

Consistency

	<u>kPa</u>	<u>psf</u>
Very soft	0 to 12	0 to 250
Soft	12 to 25	250 to 500
Firm	25 to 50	500 to 1,000
Stiff	50 to 100	1,000 to 2,000
Very stiff	100 to 200	2,000 to 4,000
Hard	over 200	over 4,000

(b) Cohesive Soils

Dynamic Cone Penetration Resistance; N_d :

The number of blows by a 63.5 kg. (140 lb.) hammer dropped 760 mm (30 in.) to drive uncased a 50 mm (2 in.) diameter, 60° cone attached to "A" size drill rods for a distance of 300 mm (12 in.).

PH: Sampler advanced by hydraulic pressure

PM: Sampler advanced by manual pressure

WH: Sampler advanced by static weight of hammer

WR: Sampler advanced by weight of sampler and rod

Piezo-Cone Penetration Test (CPT)

A electronic cone penetrometer with a 60° conical tip and a project end area of 10 cm² pushed through ground at a penetration rate of 2 cm/s. Measurements of tip resistance (Q_t), porewater pressure (PWP) and friction along a sleeve are recorded electronically at 25 mm penetration intervals.

IV. SOIL TESTS

w	water content
w_p	plastic limit
w_l	liquid limit
C	consolidation (oedometer) test
CHEM	chemical analysis (refer to text)
CID	consolidated isotropically drained triaxial test ¹
CIU	consolidated isotropically undrained triaxial test with porewater pressure measurement ¹
D_R	relative density (specific gravity, G_s)
DS	direct shear test
M	sieve analysis for particle size
MH	combined sieve and hydrometer (H) analysis
MPC	Modified Proctor compaction test
SPC	Standard Proctor compaction test
OC	organic content test
SO_4	concentration of water-soluble sulphates
UC	unconfined compression test
UU	unconsolidated undrained triaxial test
V	field vane (LV-laboratory vane test)
γ	unit weight

Note: 1 Tests which are anisotropically consolidated prior to shear are shown as CAD, CAU.

LIST OF SYMBOLS

Unless otherwise stated, the symbols employed in the report are as follows:

I. General

π	3.1416
$\ln x$,	natural logarithm of x
\log_{10}	x or log x, logarithm of x to base 10
g	acceleration due to gravity
t	time
F	factor of safety
V	volume
W	weight

II. STRESS AND STRAIN

γ	shear strain
Δ	change in, e.g. in stress: $\Delta \sigma$
ϵ	linear strain
ϵ_v	volumetric strain
η	coefficient of viscosity
ν	poisson's ratio
σ	total stress
σ'	effective stress ($\sigma' = \sigma - u$)
σ'_{vo}	initial effective overburden stress
$\sigma_1, \sigma_2, \sigma_3$	principal stress (major, intermediate, minor)
σ_{oct}	mean stress or octahedral stress $= (\sigma_1 + \sigma_2 + \sigma_3)/3$
τ	shear stress
u	porewater pressure
E	modulus of deformation
G	shear modulus of deformation
K	bulk modulus of compressibility

III. SOIL PROPERTIES

(a) Index Properties

$\rho(\gamma)$	bulk density (bulk unit weight*)
$\rho_d(\gamma_d)$	dry density (dry unit weight)
$\rho_w(\gamma_w)$	density (unit weight) of water
$\rho_s(\gamma_s)$	density (unit weight) of solid particles
γ'	unit weight of submerged soil ($\gamma' = \gamma - \gamma_w$)
D_R	relative density (specific gravity) of solid particles ($D_R = \rho_s / \rho_w$) (formerly G_s)
e	void ratio
n	porosity
S	degree of saturation

(a) Index Properties (continued)

w	water content
w_l	liquid limit
w_p	plastic limit
I_p	plasticity index $= (w_l - w_p)$
w_s	shrinkage limit
I_L	liquidity index $= (w - w_p) / I_p$
I_C	consistency index $= (w_l - w) / I_p$
e_{max}	void ratio in loosest state
e_{min}	void ratio in densest state
I_D	density index $= (e_{max} - e) / (e_{max} - e_{min})$ (formerly relative density)

(b) Hydraulic Properties

h	hydraulic head or potential
q	rate of flow
v	velocity of flow
i	hydraulic gradient
k	hydraulic conductivity (coefficient of permeability)
j	seepage force per unit volume

(c) Consolidation (one-dimensional)

C_c	compression index (normally consolidated range)
C_r	recompression index (over-consolidated range)
C_s	swelling index
C_a	coefficient of secondary consolidation
m_v	coefficient of volume change
c_v	coefficient of consolidation
T_v	time factor (vertical direction)
U	degree of consolidation
σ'_p	pre-consolidation pressure
OCR	over-consolidation ratio $= \sigma'_p / \sigma'_{vo}$

(d) Shear Strength

τ_p, τ_r	peak and residual shear strength
ϕ'	effective angle of internal friction
δ	angle of interface friction
μ	coefficient of friction $= \tan \delta$
c'	effective cohesion
c_u, s_u	undrained shear strength ($\phi = 0$ analysis)
p	mean total stress $(\sigma_1 + \sigma_3)/2$
p'	mean effective stress $(\sigma'_1 + \sigma'_3)/2$
q	$(\sigma_1 + \sigma_3)/2$ or $(\sigma'_1 + \sigma'_3)/2$
q_u	compressive strength $(\sigma_1 + \sigma_3)$
S_t	sensitivity

- Notes:**
- 1 $\tau = c' + \sigma' \tan \phi'$
 - 2 shear strength $= (\text{compressive strength})/2$
 - * density symbol is ρ . Unit weight symbol is γ where $\gamma = \rho g$ (i.e. mass density x acceleration due to gravity)

RECORD OF BOREHOLE No 205

1 OF 1

METRIC

PROJECT 05-1130-209-1
G.W.P. 64-00-00 LOCATION N 4678756.9 ; E 266974.8 ORIGINATED BY M.A.
DIST HWY 401 BOREHOLE TYPE HOLLOW STEM AUGER COMPILED BY L.M.K.
DATUM GEODETIC DATE July 25, 2006 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL LIQUID LIMIT MOISTURE CONTENT			UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					WATER CONTENT (%)				GR	SA	SI	CL
								○ UNCONFINED	+ FIELD VANE	● QUICK TRIAXIAL	× LAB VANE	W _P	W	W _L						
199.90	ROAD SURFACE																			
0.00	ASPHALT																			
0.21	FILL, clayey silt, some sand, trace gravel																			
0.46	Brown																			
0.64	FILL, sand and gravel, some silt		1	SS	12															
	Brown																			
	FILL, clayey silt, trace to some sand, trace gravel, trace topsoil		2	SS	8															
	Firm to Very Stiff																			
	Brown and Grey																			
			3	SS	6															
			4	SS	14															
			5	SS	11															
			6	SS	11															
			7	SS	22															
			8	SS	18															
			9	SS	13															
192.28																				
7.62	CLAYEY SILT, trace to some sand, trace gravel (TILL)		10	SS	23															
	Very Stiff to Hard																			
	Brown																			
			11	SS	25															
			12	SS	17															
			13	SS	33															
			14	SS	43															
188.01																				
11.89	END OF BOREHOLE																			
	Borehole Dry During Drilling																			
	July 25, 2006																			

ONL_MTO 051130209-1.GPJ LDN_MTO.GDT 12/18/06

PROJECT <u>05-1130-209-1</u>		RECORD OF BOREHOLE No 501		1 OF 1	METRIC
G.W.P. <u>64-00-00</u>		LOCATION <u>N 4678378.3 ; E 268323.2</u>		ORIGINATED BY <u>C.C.</u>	
DIST <u> </u> HWY <u>401</u>		BOREHOLE TYPE <u>SOLID STEM AUGER</u>		COMPILED BY <u>T.M.</u>	
DATUM <u>GEODETIC</u>		DATE <u>July 6, 2006</u>		CHECKED BY <u> </u>	

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE LIQUID LIMIT LIMIT CONTENT LIMIT			UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							WATER CONTENT (%)			
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE							w _p w w _L			
187.91	GROUND SURFACE							20	40	60	80	100						
0.00	TOPSOIL, clayey Brown																	
0.15	FILL, clayey silt, some sand, trace gravel, topsoil partings and pockets Stiff Brown and Grey		1	SS	11		187								○			
186.69																		
1.22	CLAYEY SILT, some sand, trace gravel (TILL) Very Stiff to Hard Brown and Grey		2	SS	29		186											
			3	SS	28		185								○	┌───┐		4 28 36 32
			4	SS	34													
184.25	END OF BOREHOLE																	
3.66	Borehole Dry During Drilling July 6, 2006.																	

ONL_MTO_051130209-1.GPJ LDN_MTO.GDT 12/18/06

PROJECT <u>05-1130-209-1</u>		RECORD OF BOREHOLE No 502		1 OF 1		METRIC	
G.W.P. <u>64-00-00</u>		LOCATION <u>N 4678225.2 ; E 268695.8</u>		ORIGINATED BY <u>C.C.</u>			
DIST <u> </u> HWY <u>401</u>		BOREHOLE TYPE <u>SOLID STEM AUGER</u>		COMPILED BY <u>T.M.</u>			
DATUM <u>GEODETIC</u>		DATE <u>July 6, 2006</u>		CHECKED BY <u> </u>			

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL LIMIT MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					WATER CONTENT (%)				GR	SA	SI	CL	
								20	40	60	80	100	W _p	W	W _L						
187.32	GROUND SURFACE																				
0.00	CLAYEY SILT, some sand, trace gravel, silt pockets (TILL) Very Stiff to Stiff Brown becoming grey at about elev. 184.4m																				
			1	SS	20																
			2	SS	25																
			3	SS	26																
			4	SS	15																
183.66	END OF BOREHOLE																				
3.66	Borehole Dry During Drilling July 6, 2006.																				

ONL_MTO_051130209-1.GPJ LDN_MTO.GDT 12/18/06

PROJECT <u>05-1130-209-1</u>		RECORD OF BOREHOLE No 503		1 OF 1		METRIC	
G.W.P. <u>64-00-00</u>		LOCATION <u>N 4678126.5 ;E 269694.0</u>		ORIGINATED BY <u>C.C.</u>			
DIST <u> </u> HWY <u>401</u>		BOREHOLE TYPE <u>SOLID STEM AUGER</u>		COMPILED BY <u>T.M.</u>			
DATUM <u>GEODETIC</u>		DATE <u>July 6, 2006</u>		CHECKED BY <u> </u>			

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)					
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					w _p w w _L				GR SA SI CL					
												20 40 60 80 100										
186.20	GROUND SURFACE																					
0.00	TOPSOIL, clayey Black						186															
185.89	CLAYEY SILT, trace to some sand, trace gravel (TILL) Very Stiff to Hard Brown becoming grey at about elev. 183.9m						185															
0.31							184															
		1	SS	20																		
		2	SS	40																		
		3	SS	23																		

ONL_MTO_051130209-1.GPJ LDN_MTO.GDT 12/18/06

PROJECT <u>05-1130-209-1</u>		RECORD OF BOREHOLE No 504		1 OF 1		METRIC	
G.W.P. <u>64-00-00</u>		LOCATION <u>N 4678110.3 :E 270093.7</u>		ORIGINATED BY <u>C.C.</u>			
DIST <u> </u> HWY <u>401</u>		BOREHOLE TYPE <u>SOLID STEM AUGER</u>		COMPILED BY <u>T.M.</u>			
DATUM <u>GEODETIC</u>		DATE <u>July 6, 2006</u>		CHECKED BY <u> </u>			

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL LIQUID MOISTURE LIMIT CONTENT LIMIT			UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					WATER CONTENT (%)				GR	SA	SI	CL
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE	20	40	60	80	100	w _p	w		w _L			
186.83	GROUND SURFACE																			
0.00	TOPSOIL, sandy																			
0.15	Brown																			
0.31	FILL, clayey topsoil mixed silty clay																			
	Brown																			
	CLAYEY SILT, trace to some sand, trace gravel (TILL) Stiff to Hard Brown becoming grey at about elev. 184.5m		1	SS	10															
			2	SS	23									○						
			3	SS	35															
			4	SS	22									○						
183.17	END OF BOREHOLE																			
3.66	Borehole Dry During Drilling July 6, 2006.																			

PROJECT <u>05-1130-209-1</u>		RECORD OF BOREHOLE No 505		1 OF 1	METRIC
G.W.P. <u>64-00-00</u>		LOCATION <u>N 4678025.4 ; E 272216.9</u>		ORIGINATED BY <u>C.C.</u>	
DIST <u> </u> HWY <u>401</u>		BOREHOLE TYPE <u>SOLID STEM AUGER</u>		COMPILED BY <u>T.M.</u>	
DATUM <u>GEODETIC</u>		DATE <u>July 6, 2006</u>		CHECKED BY <u> </u>	

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL LIMIT MOISTURE LIQUID CONTENT LIMIT			UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																													
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					W _p W W _L				WATER CONTENT (%)																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																													
													20	40	60		80	100																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																												

ONL_MTO_051130209-1.GPJ LDN_MTO.GDT 12/18/06

PROJECT <u>05-1130-209-1</u>		RECORD OF BOREHOLE No 506		1 OF 1 METRIC	
G.W.P. <u>64-00-00</u>		LOCATION <u>N 4678155.2 ; E 270145.5</u>		ORIGINATED BY <u>C.C.</u>	
DIST <u> </u> HWY <u>401</u>		BOREHOLE TYPE <u>SOLID STEM AUGER</u>		COMPILED BY <u>T.M.</u>	
DATUM <u>GEODETIC</u>		DATE <u>July 6, 2006</u>		CHECKED BY <u> </u>	

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL LIMIT MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					WATER CONTENT (%)				GR	SA	SI	CL
								20	40	60	80	100	w _p	w	w _L					
186.00	GROUND SURFACE																			
0.00	TOPSOIL, sandy Black																			
0.15	FILL, clayey topsoil, pockets and layers of clayey silt Black																			
185.29																				
0.71	CLAYEY SILT, trace to some sand, trace gravel (TILL) Stiff to Hard Brown becoming grey at about elev. 183.9m		1	SS	15															
			2	SS	32															
			3	SS	36															
			4	SS	25															
182.34																				
3.66	END OF BOREHOLE																			
	Borehole Dry During Drilling July 6, 2006.																			

ONL_MTO_051130209-1.GPJ LDN_MTO.GDT 12/18/06

PROJECT <u>05-1130-209-1</u>		RECORD OF BOREHOLE No 507		1 OF 1		METRIC	
G.W.P. <u>64-00-00</u>		LOCATION <u>N 4678169.4 ; E 269845.9</u>		ORIGINATED BY <u>C.C.</u>			
DIST <u> </u> HWY <u>401</u>		BOREHOLE TYPE <u>SOLID STEM AUGER</u>		COMPILED BY <u>T.M.</u>			
DATUM <u>GEODETIC</u>		DATE <u>July 6, 2006</u>		CHECKED BY <u> </u>			

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							WATER CONTENT (%)			
								○ UNCONFINED + FIELD VANE	● QUICK TRIAXIAL × LAB VANE									
186.21	GROUND SURFACE							20	40	60	80	100	10	20	30			
0.00	TOPSOIL, clayey Stiff Black					▽												
185.25																		
0.96	SAND, fine, trace silt, trace gravel Compact Brown		1	SS	10													
1.08																		
1.37	SILT, trace sand, some clay Compact Grey		2	SS	29													
	CLAYEY SILT, trace to some sand, trace gravel (TILL) Very Stiff Grey																	
			3	SS	26													
			4	SS	17													
182.55	END OF BOREHOLE																	
3.66	Water level encountered in Borehole at about elev. 183.3m During Drilling July 6, 2006.																	

PROJECT <u>05-1130-209-1</u>		RECORD OF BOREHOLE No 508		1 OF 1		METRIC	
G.W.P. <u>64-00-00</u>		LOCATION <u>N 4678215.4 ; E 268950.1</u>		ORIGINATED BY <u>C.C.</u>			
DIST <u> </u> HWY <u>401</u>		BOREHOLE TYPE <u>SOLID STEM AUGER</u>		COMPILED BY <u>T.M.</u>			
DATUM <u>GEODETIC</u>		DATE <u>July 7, 2006</u>		CHECKED BY <u> </u>			

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 (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					W _p	W	W _L		GR	SA	SI	CL
								20	40	60	80	100								
186.90	GROUND SURFACE																			
0.00	TOPSOIL, sandy Brown																			
0.15																				
0.31	FILL, silty clay, some sand, trace gravel, topsoil pockets Brown and Grey																			
0.61	TOPSOIL, clayey Brown		1	SS	32															
	CLAYEY SILT, trace to some sand, trace gravel (TILL) Stiff to Hard Brown becoming grey at about elev. 184.8m		2	SS	40															
			3	SS	22															
			4	SS	15															
183.24	END OF BOREHOLE																			
3.66	Borehole Dry During Drilling July 7, 2006.																			

ONL_MTO_051130209-1.GPJ LDN_MTO.GDT 12/18/06

PROJECT <u>05-1130-209-1</u>		RECORD OF BOREHOLE No 509		1 OF 1		METRIC	
G.W.P. <u>64-00-00</u>		LOCATION <u>N 4678286.3 ; E 268663.0</u>		ORIGINATED BY <u>C.C.</u>			
DIST <u> </u> HWY <u>401</u>		BOREHOLE TYPE <u>SOLID STEM AUGER</u>		COMPILED BY <u>T.M.</u>			
DATUM <u>GEODETIC</u>		DATE <u>July 7, 2006</u>		CHECKED BY <u> </u>			

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 (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					WATER CONTENT (%)				GR	SA	SI	CL
								20	40	60	80	100	W _p	W	W _L					
187.17	GROUND SURFACE																			
0.00	TOPSOIL, clayey Black																			
0.18	CLAYEY SILT, trace to some sand, trace gravel (TILL) Stiff to Hard Grey		1	SS	26									○						
			2	SS	35									○						
			3	SS	17									○						
			4	SS	15									○						
183.51	END OF BOREHOLE																			
3.66	Borehole Dry During Drilling July 7, 2006.																			

PROJECT <u>05-1130-209-1</u>		RECORD OF BOREHOLE No 510		1 OF 1		METRIC	
G.W.P. <u>64-00-00</u>		LOCATION <u>N 4678733.6 ; E 266949.3</u>		ORIGINATED BY <u>M.A.</u>			
DIST <u> </u> HWY <u>401</u>		BOREHOLE TYPE <u>HAND AUGER</u>		COMPILED BY <u>L.M.K.</u>			
DATUM <u>GEODETIC</u>		DATE <u>July 27, 2006</u>		CHECKED BY <u> </u>			

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL LIMIT MOISTURE LIQUID CONTENT LIMIT			UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					WATER CONTENT (%)				GR	SA	SI	CL
													20	40	60					
195.46	GROUND SURFACE																			
0.00	TOPSOIL, silty Brown																			
0.15	FILL, clayey silt, trace to some sand, trace gravel Firm to Hard Brown and Grey																			
			1	SS	5								○							
			2	SS	5								○							
			3	SS	9								○							
			4	SS	32								○							
			5	SS	14								○							
191.19	END OF BOREHOLE																			
4.27	Borehole Dry During Drilling July 27, 2006																			

RECORD OF BOREHOLE No 511

1 OF 1

METRIC

PROJECT 05-1130-209-1
G.W.P. 64-00-00 LOCATION N 4677763.6 ; E 265211.3 ORIGINATED BY D.J.M.
DIST HWY 401 BOREHOLE TYPE HOLLOW STEM AUGER COMPILED BY T.M.
DATUM GEODETIC DATE July 12, 2006 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
								○ UNCONFINED	+	FIELD VANE	● QUICK TRIAXIAL	×					
189.61	GROUND SURFACE						20	40	60	80	100						
0.00	FILL, crushed granular																
0.15	FILL, clayey silt, trace topsoil, trace sand, trace gravel Stiff Brown and black																
			1	SS	14												
			2	SS	10												
187.63	CLAYEY SILT, trace to some sand, trace gravel (TILL) Stiff to Hard Brown becoming grey at about elev. 186.0m																
1.98			3	SS	15												
			4	SS	47												
184.58	END OF BOREHOLE		5	SS	24												
5.03	Borehole Dry During Drilling June 12, 2006.																

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

RECORD OF BOREHOLE No 512

1 OF 1

METRIC

PROJECT 05-1130-209-1
G.W.P. 64-00-00 LOCATION N 4677701.1 ; E 265200.0 ORIGINATED BY D.J.M.
DIST HWY 401 BOREHOLE TYPE HOLLOW STEM AUGER COMPILED BY T.M.
DATUM GEODETIC DATE July 12, 2006 CHECKED BY

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									
189.85	GROUND SURFACE							20	40	60	80	100					
0.00	FILL, clayey silt, trace sand, topsoil and gravel Very Stiff Brown																
188.69			1	SS	18		189										
1.22	TOPSOIL, clayey Black CLAYEY SILT, trace to some sand, trace gravel (TILL) Stiff to Hard Brown becoming grey at about elev. 186.3m		2	SS	10		188										
			3	SS	14		187										
			4	SS	36		186										
			5	SS	34												
185.58	END OF BOREHOLE																
4.27	Borehole Dry During Drilling July 12, 2006.																

PROJECT <u>05-1130-209-1</u>		RECORD OF BOREHOLE No 513		1 OF 1		METRIC	
G.W.P. <u>64-00-00</u>		LOCATION <u>N 4678197.8 ; E 265762.0</u>		ORIGINATED BY <u>C.C.</u>			
DIST <u> </u> HWY <u>401</u>		BOREHOLE TYPE <u>HOLLOW STEM AUGER</u>		COMPILED BY <u>T.M.</u>			
DATUM <u>GEODETIC</u>		DATE <u>July 13, 2006</u>		CHECKED BY <u> </u>			

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT						PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						W _p W W _L				GR SA SI CL																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																				
													20	40	60	80		100																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																				
191.78	GROUND SURFACE																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																					

ONL_MTO_051130209-1.GPJ LDN_MTO.GDT 12/18/06

RECORD OF BOREHOLE No 514

1 OF 1

METRIC

PROJECT 05-1130-209-1

G.W.P. 64-00-00

LOCATION N 4678406.4 ; E 268368.9

ORIGINATED BY C.C.

DIST HWY 401

BOREHOLE TYPE HOLLOW STEM AUGER

COMPILED BY T.M.

DATUM GEODETIC

DATE July 7, 2006

CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa		W _P W W _L					WATER CONTENT (%)
188.18	GROUND SURFACE							20	40	60	80	100			
0.00	TOPSOIL, sandy Brown						188								
0.12															
0.27	SAND, silty fine Brown														
	CLAYEY SILT, trace to some sand, trace gravel (TILL) Stiff to Hard Brown becoming grey at about elev. 184.6m		1	SS	21		187								
			2	SS	33										
			3	SS	32		186								
			4	SS	28		185								
			5	SS	17		184								
			6	SS	12		183								
			7	SS	14		182								
			8	SS	11										
			9	SS	13		181								
180.86	END OF BOREHOLE														
7.32	Borehole Dry During Drilling July 7, 2006.														

RECORD OF BOREHOLE No 515

1 OF 1

METRIC

PROJECT 05-1130-209-1
G.W.P. 64-00-00 LOCATION N 4678804.1 ; E 267447.0 ORIGINATED BY C.C.
DIST HWY 401 BOREHOLE TYPE HOLLOW STEM AUGER COMPILED BY T.M.
DATUM GEODETIC DATE July 10, 2006 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
								○ UNCONFINED	+ FIELD VANE	● QUICK TRIAXIAL	× LAB VANE	WATER CONTENT (%)					
191.18	GROUND SURFACE						20	40	60	80	100						
0.00	FILL, silty sand and gravel, clayey layers Brown																
190.42																	
0.76	FILL, clayey silt, some sand, trace gravel, gravel partings Very Stiff Brown and grey		1	SS	16												
189.65																	
1.53	TOPSOIL, clayey Black		2	SS	17								○				
1.68	CLAYEY SILT, trace to some sand, trace gravel (TILL) Very Stiff to Hard Brown becoming grey at about elev. 186.0m													○			
			3	SS	25												
			4	SS	44									○			
			5	SS	52								○	┌───┐			
			6	SS	52									○			
			7	SS	22												
			8	SS	19									○			
			9	SS	21												
			10	SS	19									○			
183.10	END OF BOREHOLE																
8.08	Borehole Dry During Drilling July 10, 2006.																

RECORD OF BOREHOLE No 516

1 OF 1

METRIC

PROJECT 05-1130-209-1
G.W.P. 64-00-00 LOCATION N 4678593.3 ; E 266364.3 ORIGINATED BY C.C.
DIST HWY 401 BOREHOLE TYPE HOLLOW STEM AUGER COMPILED BY T.M.
DATUM GEODETIC DATE July 11, 2006 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE									
190.67	GROUND SURFACE						20	40	60	80	100						
0.00	TOPSOIL, clayey Brown																
0.15	CLAYEY SILT (TILL), some sand, trace gravel, silt pockets and silty sand partings																
189.76	Very Stiff Brown and Grey		1	SS	15									○			
0.91	CLAYEY SILT, trace to some sand, trace gravel (TILL), with cobbles Stiff to Hard Brown becoming grey at about elev. 187.1m		2	SS	28									○			
			3	SS	50									○	—	0 28 38 34	
			4	SS	38									○			
			5	SS	26									○			
			6	SS	18									○			
			7	SS	16									○	—	3 29 39 29	
			8	SS	15									○			

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

RECORD OF BOREHOLE No 517

1 OF 1

METRIC

PROJECT 05-1130-209-1 LOCATION N 4678379.5 ; E 265995.4 ORIGINATED BY C.C.
G.W.P. 64-00-00 DIST HWY 401 BOREHOLE TYPE HOLLOW STEM AUGER COMPILED BY T.M.
DATUM GEODETIC DATE July 13, 2006 CHECKED BY _____

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									WATER CONTENT (%)	
								○ UNCONFINED	+ FIELD VANE	● QUICK TRIAXIAL	× LAB VANE							
189.82	GROUND SURFACE																	
0.00	CLAYEY SILT, trace to some sand, trace gravel (TILL) Stiff to Hard Brown becoming grey at about elev. 186.9m																	
			1	SS	28													
			2	SS	30													
			3	SS	43													
			4	SS	24													
			5	SS	14													
			6	SS	8													
			7	SS	9													

RECORD OF BOREHOLE No 704

1 OF 1

METRIC

PROJECT 05-1130-209-1

G.W.P. 64-00-00

LOCATION N 4678758.2 ; E 266952.8

ORIGINATED BY D.J.M. / N.R.

DIST HWY 401

BOREHOLE TYPE POWER AUGER

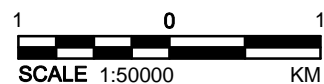
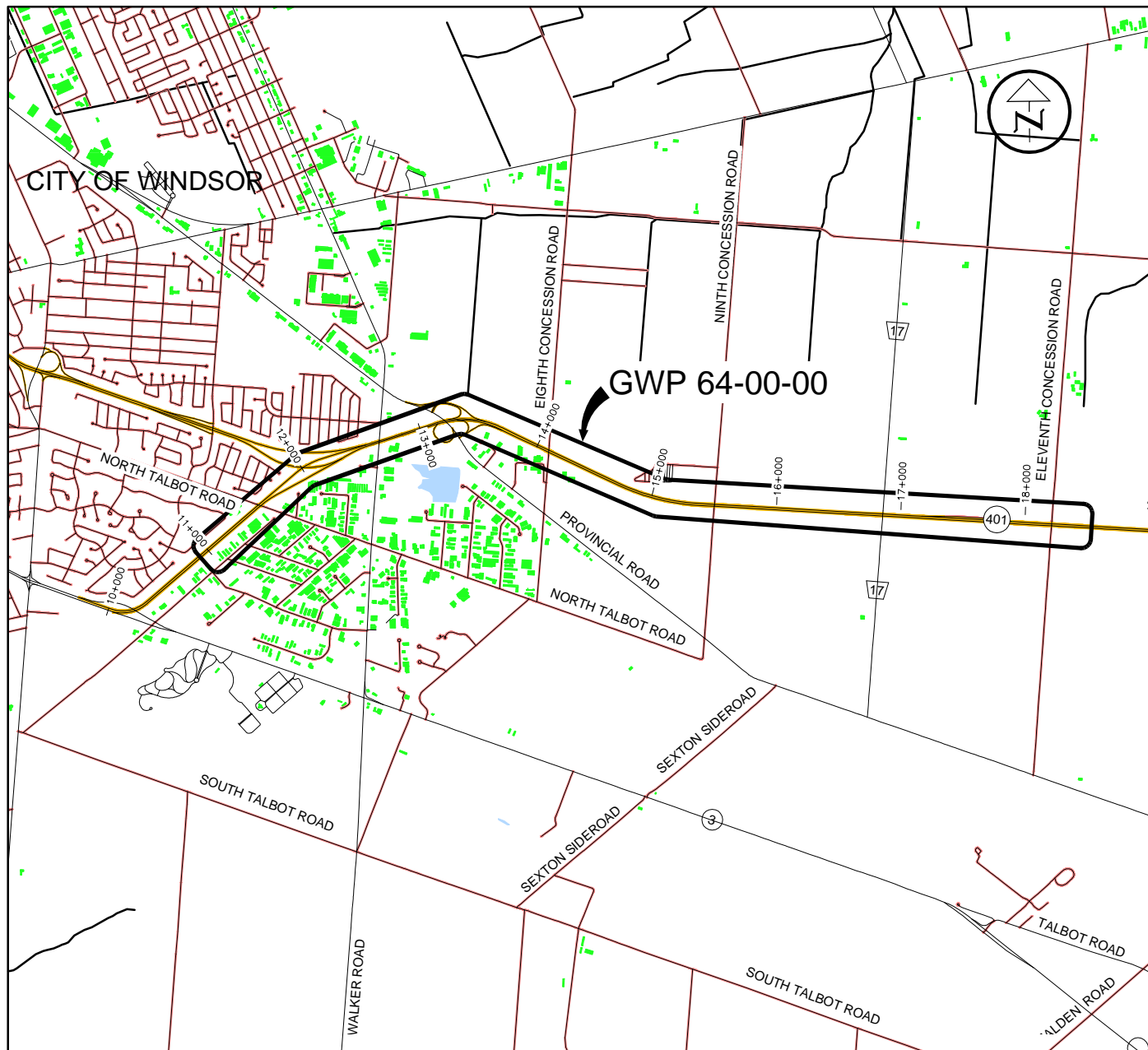
COMPILED BY L.M.K.

DATUM GEODETIC

DATE July 20, 2006


CHECKED BY

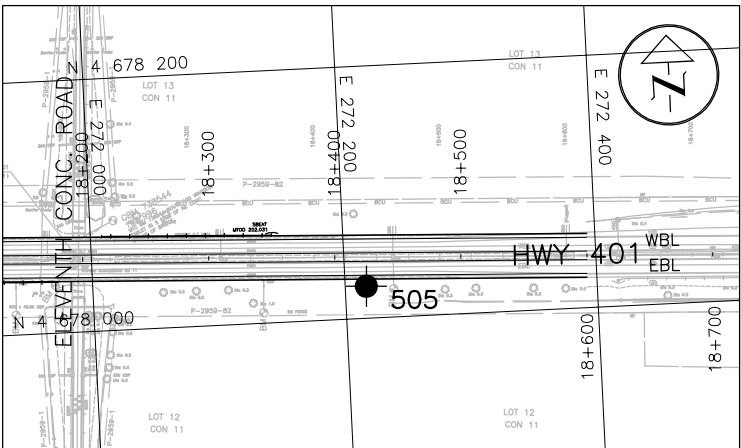
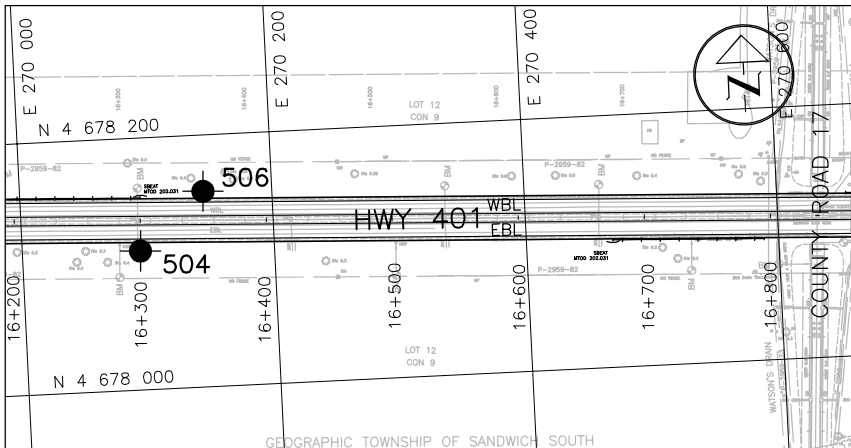
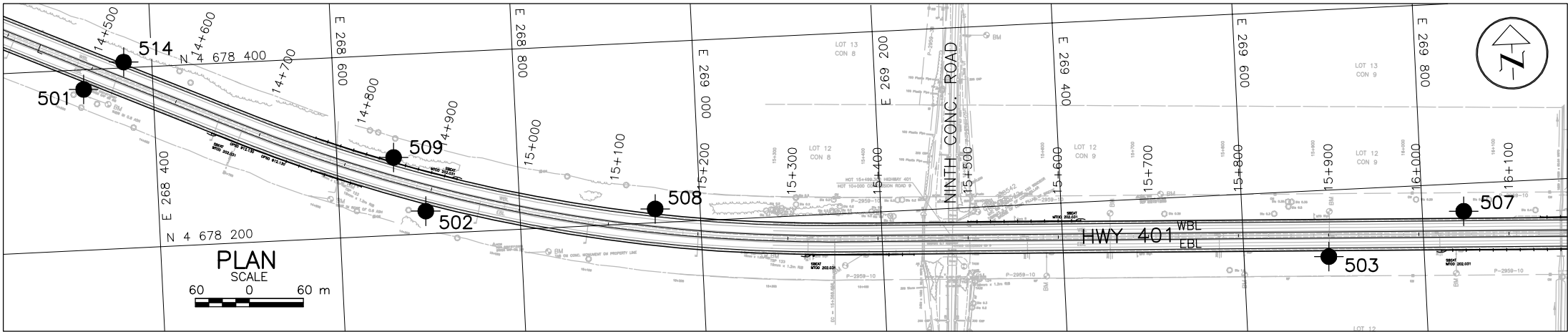
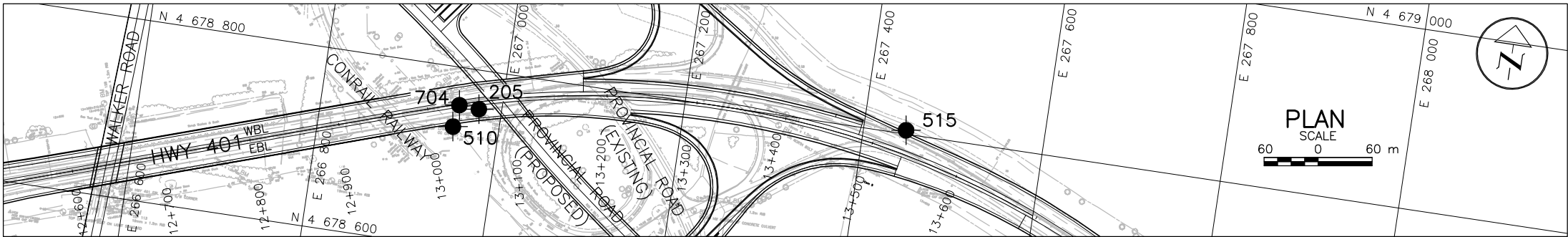
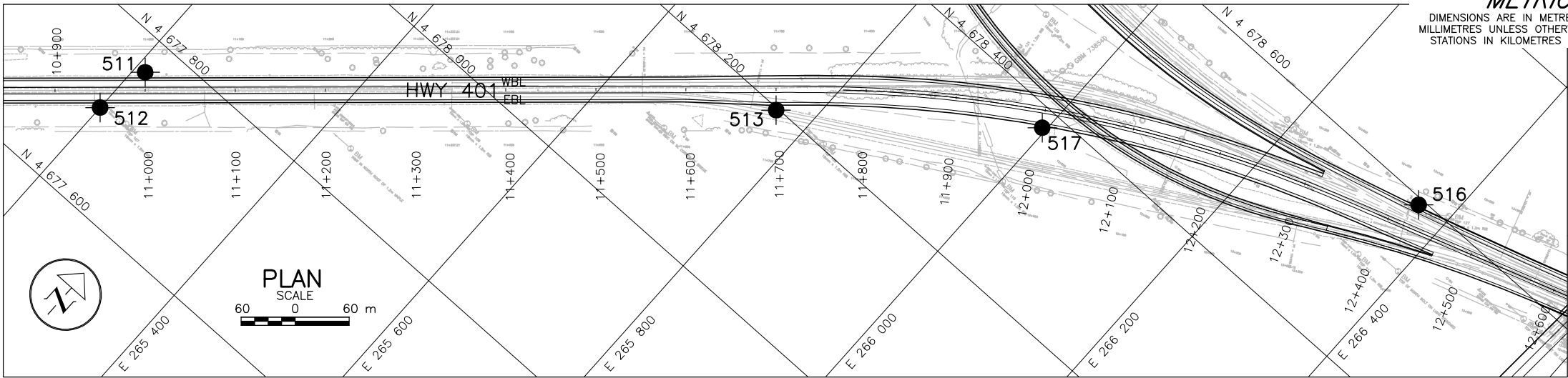
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa										WATER CONTENT (%)
								20 40 60 80 100										
200.30	PAVEMENT SURFACE																	
0.00	ASPHALT																	
0.25	CONCRETE						200											
0.48	FILL, sand and gravel Compact Brown		1	SS	21									○				
199.23	FILL, clayey silt, trace to some sand, trace gravel, trace topsoil Firm to Very Stiff Brown and Grey		2	SS	7		199							○	10	20	30	2 35 34 29
1.07			3	SS	9		198							○				
			4	SS	19		197							○				
			5	SS	12		196							○				
			6	SS	16		195							○	10	20	30	14 29 32 25
			7	SS	15		194							○				
			8	SS	27		193							○				
			9	SS	19		192							○				
192.07	CLAYEY SILT, some sand, trace gravel (TILL) Very Stiff Brown		10	SS	16		191							○				
8.23			11	SS	17		190							○				
			12	SS	19									○				
			13	SS	27									○				
189.17	END OF BOREHOLE																	
11.13	Borehole Dry During Drilling July 20, 2006																	



NOTE

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

PROJECT		BREAKAWAY AND OVERHEAD SIGNS HWY 401 RECONSTRUCTION GWP 64-00-00			
TITLE		KEY PLAN			
 Golder Associates LONDON, ONTARIO		PROJECT No. 05-1130-209-1-5		FILE No. 051130209-1EE001	
		CADD	WDF/DCH	Oct. 19/06	SCALE AS SHOWN
		CHECK			REV. 0
					FIGURE 1



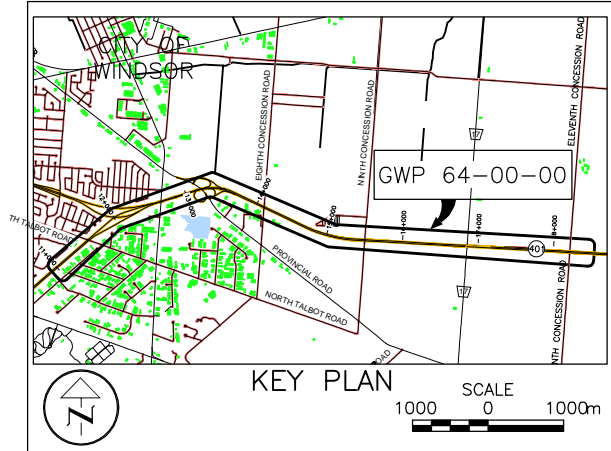
CONT No.
WP No. 64-00-00

BREAKAWAY AND OVERHEAD SIGNS
HIGHWAY 401 RECONSTRUCTION

BOREHOLE LOCATIONS



Golder Associates Ltd.
LONDON, ONTARIO, CANADA



LEGEND

● Borehole – Current Investigation

No.	ELEVATION	CO-ORDINATES (MTM Zone 11)	
		NORTHING	EASTING
205	199.90	4 678 756.9	266 974.8
501	187.91	4 678 378.3	268 323.2
502	187.32	4 678 225.2	268 695.8
503	186.20	4 678 126.5	269 694.0
504	186.83	4 678 110.3	270 093.7
505	185.26	4 678 025.4	272 216.9
506	186.00	4 678 155.2	270 145.5
507	186.21	4 678 169.4	269 845.9
508	186.90	4 678 215.4	268 950.1
509	187.17	4 678 286.3	268 663.0
510	195.46	4 678 733.6	266 949.3
511	189.61	4 677 763.6	265 211.3
512	189.85	4 677 701.1	265 200.0
513	191.78	4 678 197.8	265 762.0
514	188.18	4 678 406.4	268 368.9
515	191.18	4 678 804.1	267 447.0
516	190.67	4 678 593.3	266 364.3
517	189.82	4 678 379.5	265 995.4
704	200.30	4 678 758.2	266 952.8

NOTES

This drawing is for subsurface information only. Surface details and features are for conceptual illustration.

The boundaries between soil strata have been established only at borehole locations. Between boreholes the boundaries are assumed from geological evidence.

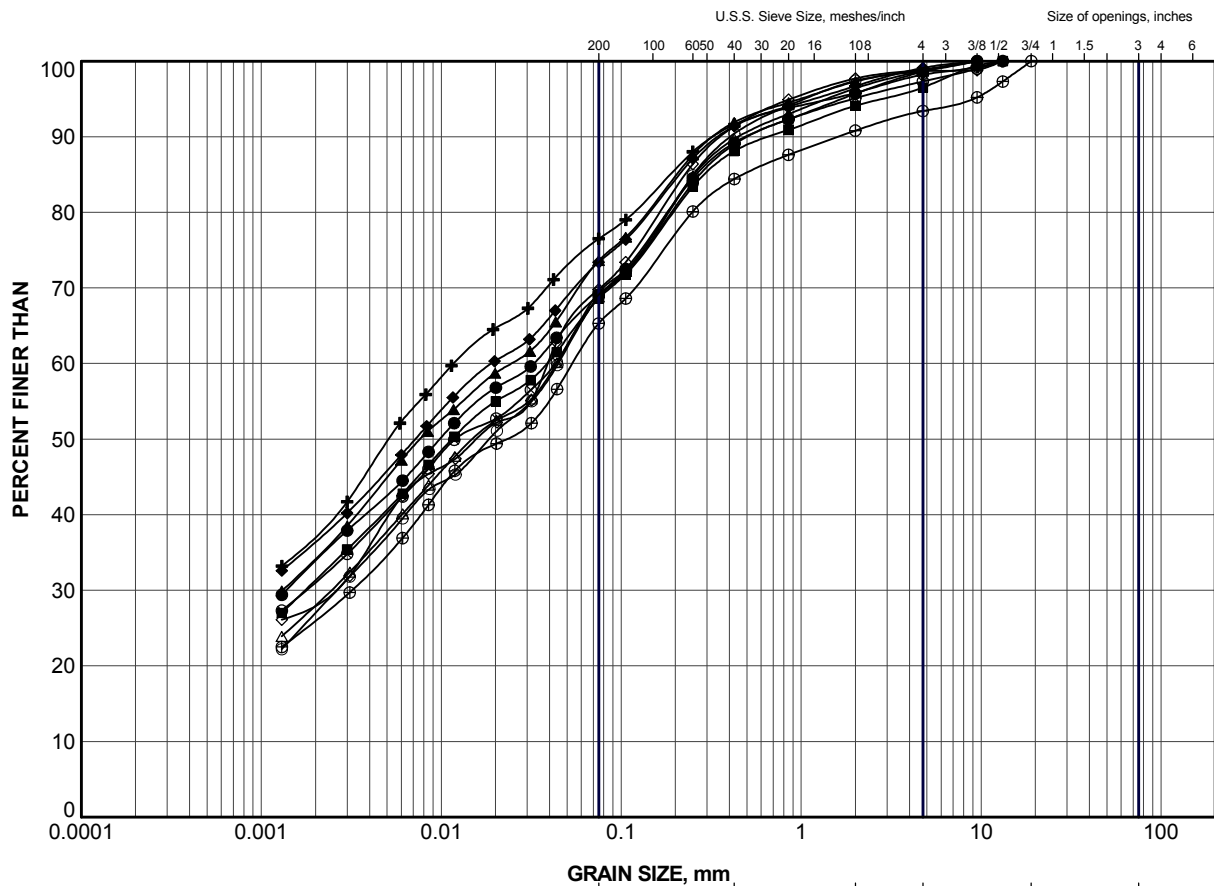
REFERENCE

Base plans provided in digital format by DILLON CONSULTING LIMITED.

NO.	DATE	BY	REVISION
Geocres No.	40J2-84		
HWY.	401	PROJECT NO.	05-1130-209-1-5
SUBM'D.	DUP	CHKD.	DUP
DRAWN:	DCH	CHKD.	MEB
DATE:	Oct. 18/06	APPD.	
SITE:		DWG.	1

APPENDIX A

LABORATORY TEST DATA (FIGURES A-1 to A-5)



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

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	205	11	191.3
■	501	3	185.4
▲	503	3	183.7
+	505	3	182.7
◆	507	3	183.7
◇	511	4	186.3
○	512	4	186.6
△	513	3	189.3
⊗	514	3	185.7
⊕	514	7	182.6

PROJECT

BREAKAWAY AND OVERHEAD SIGNS
HWY 401 RECONSTRUCTION
GWP 64-00-00

TITLE

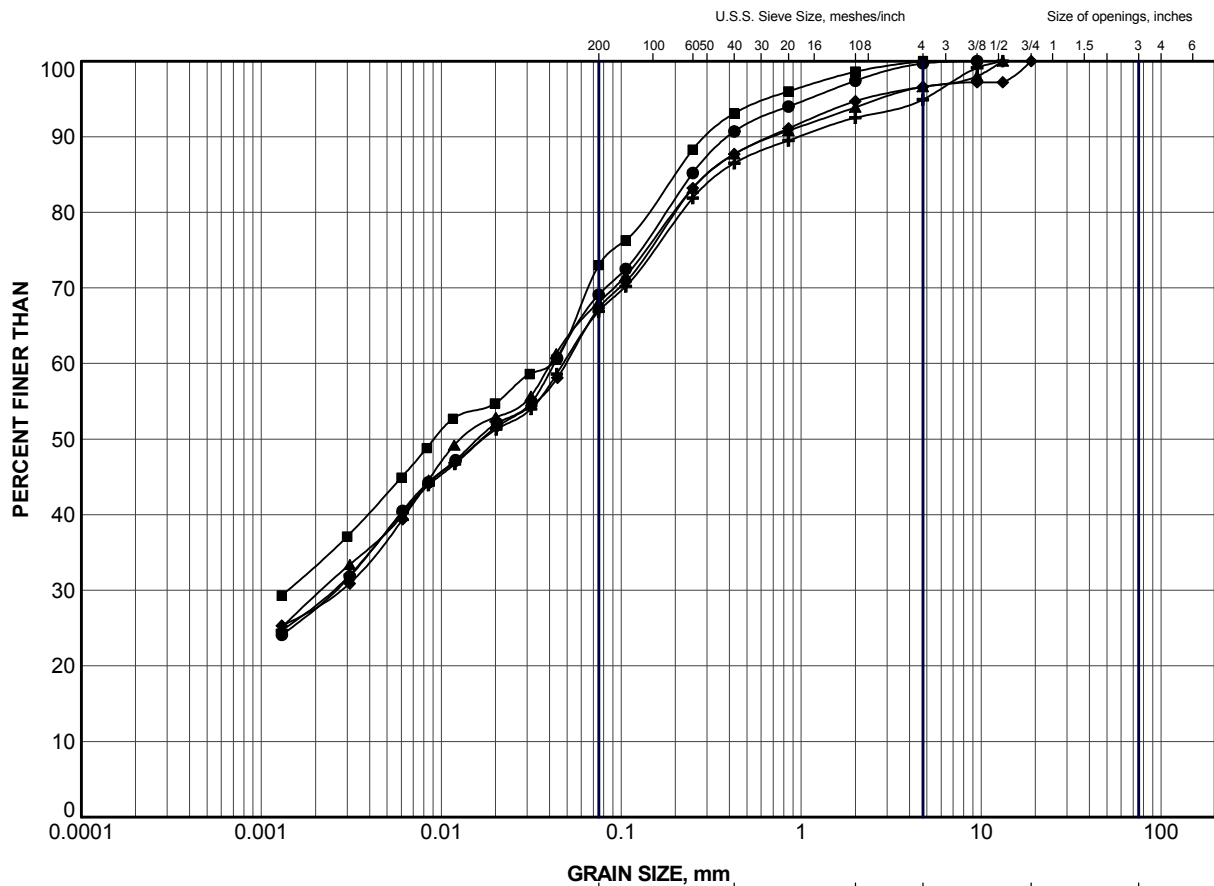
GRAIN SIZE DISTRIBUTION
CLAYEY SILT (TILL)



Golder Associates
LONDON, ONTARIO

PROJECT No.	05-1130-209-1-5	FILE No.	051130209-1.GPJ
DRAWN	DCH	Oct 19/06	SCALE N/A REV.
CHECK			


FIGURE A-1

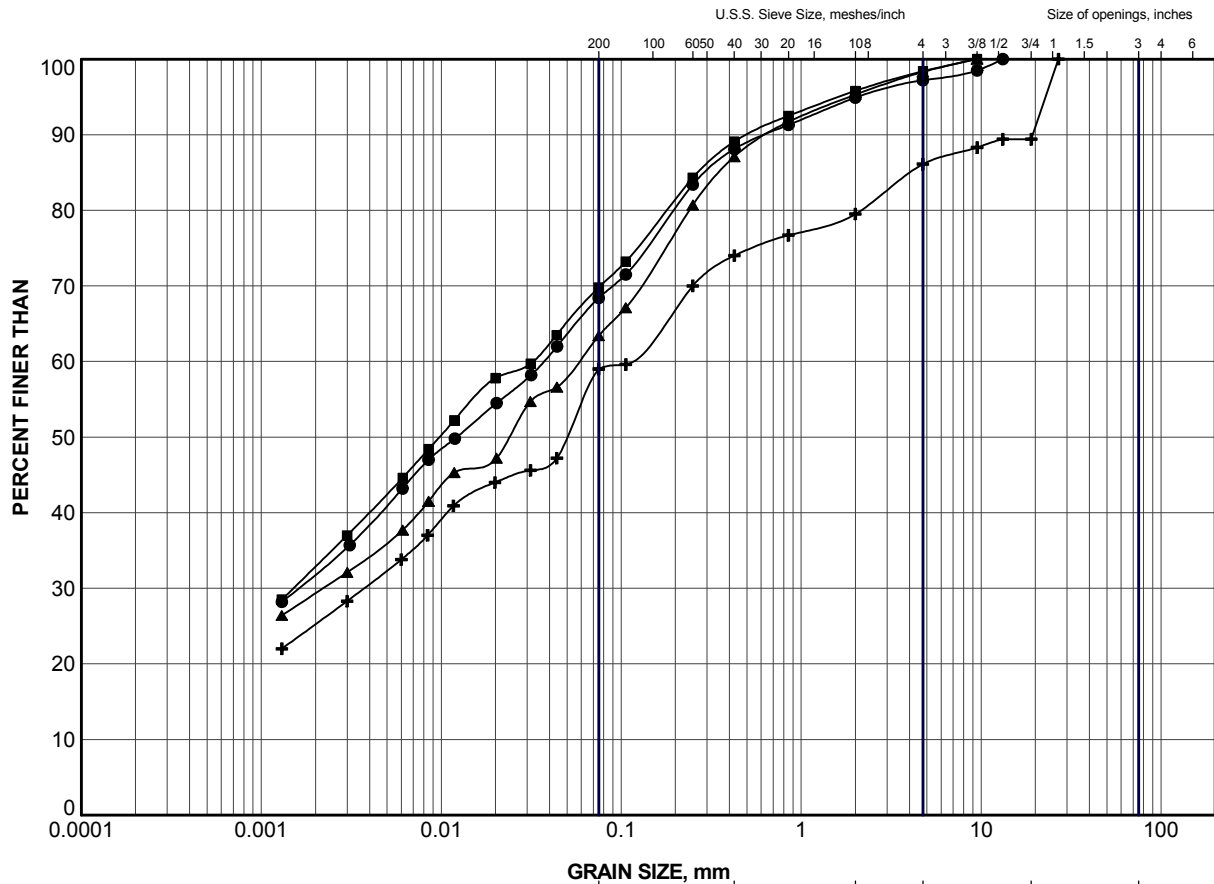


GRAVEL SIZE, mm						
CLAY AND SILT	fine	medium	coarse	fine	coarse	Cobble Size
	SAND SIZE			GRAVEL SIZE		

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	515	5	187.1
■	516	3A	188.2
▲	516	7	185.1
⊕	517	5	185.8
◆	517	7	183.5


PROJECT		BREAKAWAY AND OVERHEAD SIGNS HWY 401 RECONSTRUCTION GWP 64-00-00			
TITLE		GRAIN SIZE DISTRIBUTION CLAYEY SILT (TILL)			
PROJECT No.		05-1130-209-1-5		FILE No. 051130209-1.GPJ	
DRAWN		DCH		Oct 19/06	
CHECK					
 Golder Associates LONDON, ONTARIO		FIGURE A-2			

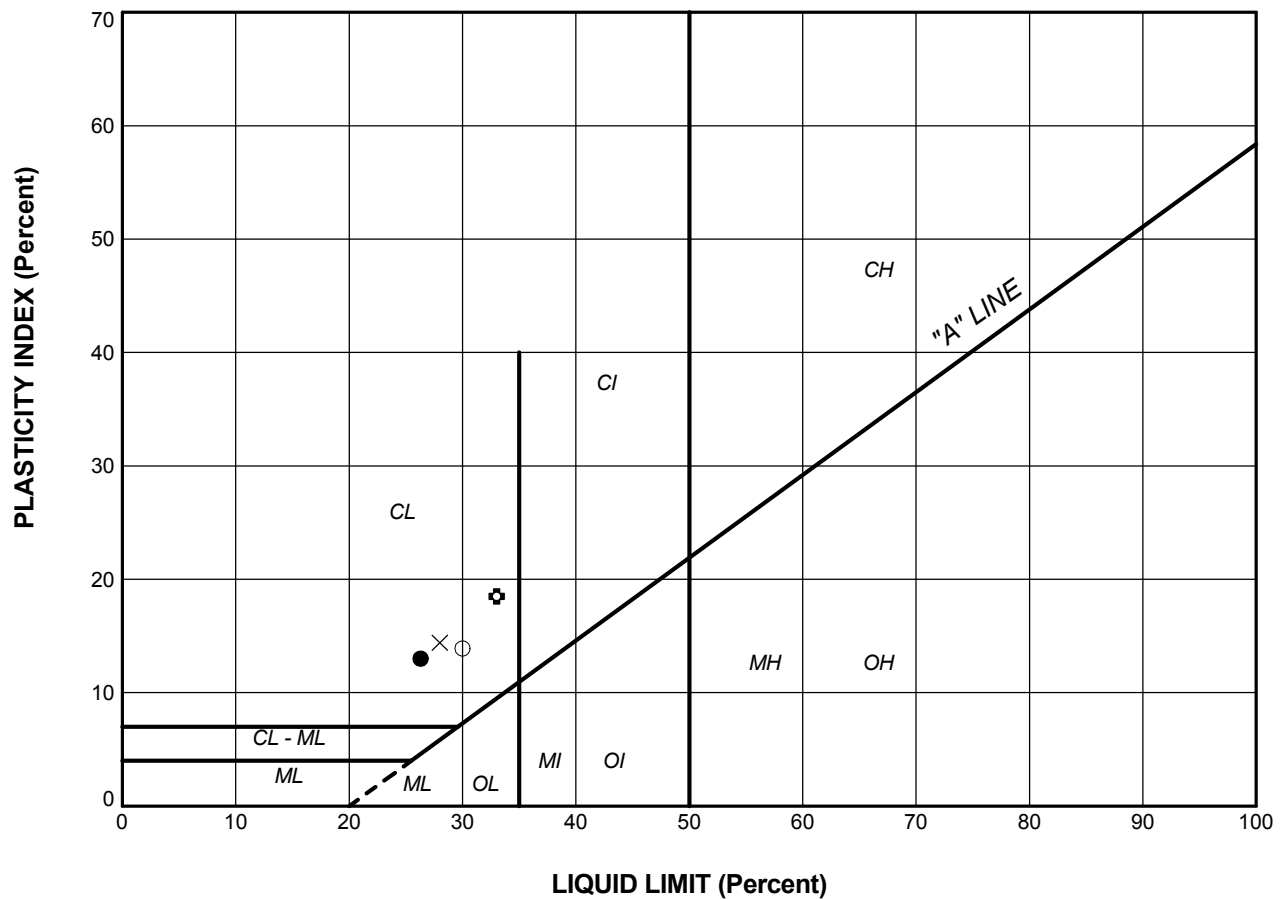


GRAVEL SIZE, mm						
CLAY AND SILT	fine	medium	coarse	fine	coarse	Cobble Size
	SAND SIZE			GRAVEL SIZE		

LEGEND


SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	205	6	195.1
■	510	3	192.9
▲	704	2	198.6
+	704	6	195.5

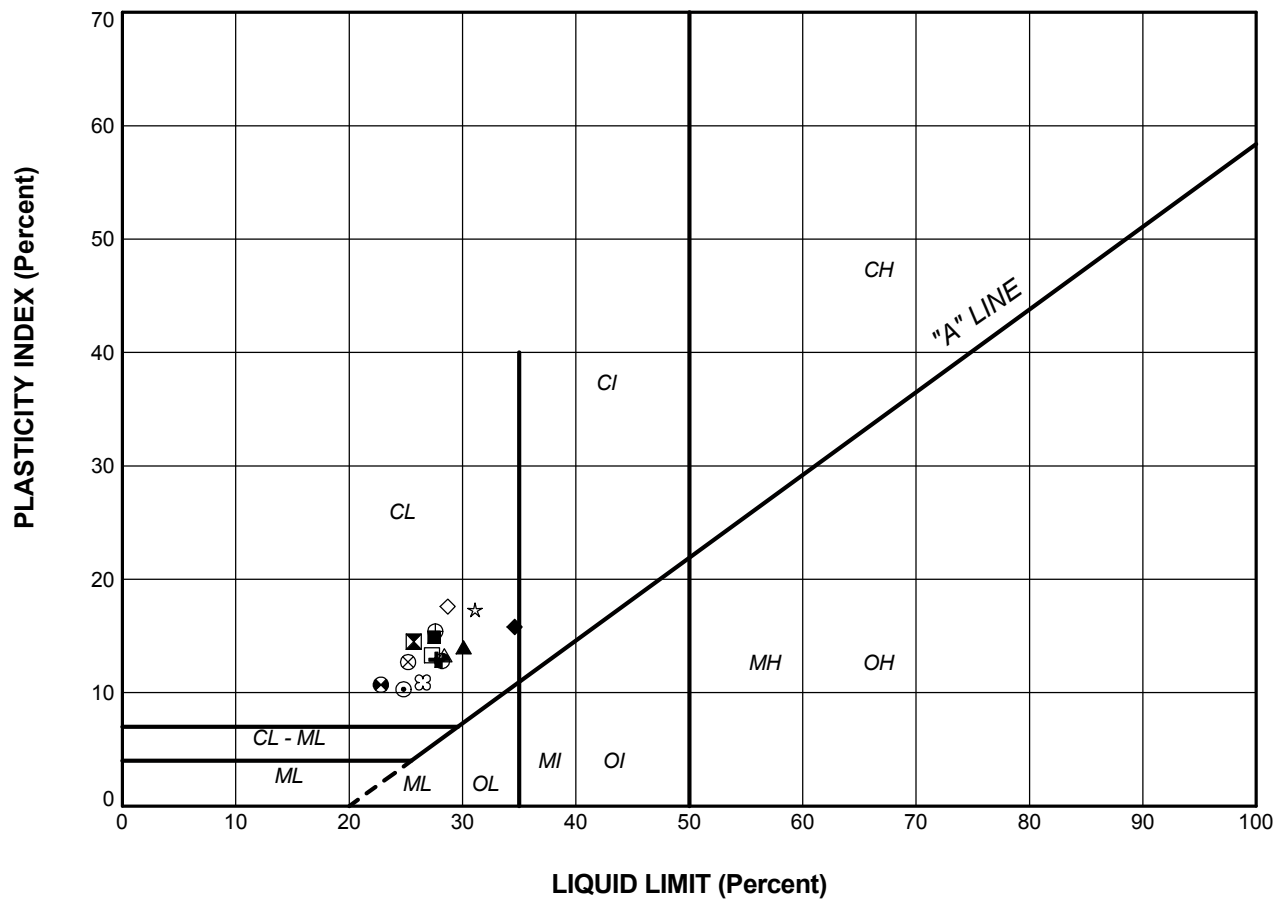
PROJECT		BREAKAWAY AND OVERHEAD SIGNS HWY 401 RECONSTRUCTION GWP 64-00-00			
TITLE		GRAIN SIZE DISTRIBUTION FILL, clayey silt			
 Golder Associates LONDON, ONTARIO		PROJECT No. 05-1130-209-1-5		FILE No. 051130209-1.GPJ	
		DRAWN DCH Oct 19/06		SCALE N/A REV.	
		CHECK			
		FIGURE A-3			



LEGEND


SYMBOL	BOREHOLE	SAMPLE	LL(%)	PL(%)	PI
FILL, clayey silt					
●	205	6	26.3	13.3	13.0
○	510	3	30.0	16.1	13.9
⊕	704	2	33.0	14.5	18.5
×	704	6	28.0	13.6	14.4

PROJECT				BREAKAWAY AND OVERHEAD SIGNS HWY 401 RECONSTRUCTION GWP 64-00-00			
TITLE							
PLASTICITY CHART							
PROJECT No. 05-1130-209-1-5				FILE No. 051130209-1.GPJ			
DRAWN		DCH		Oct 19/06		SCALE N/A REV.	
CHECK						FIGURE A-4	
 Golder Associates LONDON, ONTARIO							



LEGEND

SYMBOL	BOREHOLE	SAMPLE	LL(%)	PL(%)	PI
CLAYEY SILT (TILL)					
■	205	11	27.5	12.6	14.9
▲	501	3	30.1	16.1	14.0
+	503	3	27.7	14.8	12.9
◆	505	3	34.6	18.8	15.8
◇	507	3	28.7	11.1	17.6
△	511	4	28.4	15.1	13.3
⊗	512	4	25.2	12.5	12.7
⊕	513	3	27.6	12.2	15.4
□	514	3	27.3	14.0	13.3
⊙	514	7	22.8	12.1	10.7
⊗	515	5	28.2	15.4	12.8
☆	516	3A	31.1	13.8	17.3
⊗	516	7	26.5	15.6	10.9
⊕	517	5	25.7	11.2	14.5
⊙	517	7	24.8	14.5	10.3

PROJECT				BREAKAWAY AND OVERHEAD SIGNS HWY 401 RECONSTRUCTION GWP 64-00-00			
TITLE				PLASTICITY CHART			
PROJECT No.		05-1130-209-1-5		FILE No.		051130209-1.GPJ	
DRAWN	DCH	Oct 19/06		SCALE	N/A	REV.	
CHECK				FIGURE A-5			
 Golder Associates LONDON, ONTARIO							