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**PRELIMINARY FOUNDATION
INVESTIGATION AND DESIGN REPORT
MT. ALBERT ROAD OVERPASSES
HIGHWAY 404 EXTENSION
FROM GREEN LANE TO HIGHWAY 12/48
AGREEMENT NO. 2005-A-000585**

Submitted to:

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TABLE OF CONTENTS

<u>SECTION</u>	<u>PAGE</u>
PART A - PRELIMINARY FOUNDATION INVESTIGATION REPORT	
1.0 INTRODUCTION	1
2.0 SITE DESCRIPTION	2
3.0 INVESTIGATION PROCEDURES	3
4.0 SITE GEOLOGY AND STRATIGRAPHY	4
4.1 Regional Geological Conditions	4
4.2 Site Stratigraphy	5
4.2.1 Fill	6
4.2.2 Upper Silt	6
4.2.3 Upper Clayey Silt Till / Sandy Silt Till	6
4.2.4 Lower Silt	7
4.2.5 Lower Clayey Silt Till / Sandy Silt Till	7
4.3 Groundwater Conditions	7
5.0 CLOSURE	9
PART B - PRELIMINARY FOUNDATION DESIGN REPORT	
6.0 PRELIMINARY ENGINEERING RECOMMENDATIONS	10
6.1 General	10
6.2 Bridge and Retaining Wall Foundation Options	10
6.3 Spread Footings	11
6.3.1 Geotechnical Resistance	12
6.3.2 Resistance to Lateral Loads	13
6.3.3 Frost Protection	13
6.4 Steel H-Pile Foundations	13
6.4.1 Axial Geotechnical Resistance	14
6.4.2 Frost Protection	14
6.5 Retained Soil System (RSS) Walls	14
6.6 Permanent Cut Slope Design and Construction	16
6.7 Groundwater Control During Construction	16
7.0 CLOSURE	17

In Order
Following
Page 17

Table 1
Lists of Abbreviations and Symbols
Records of Boreholes 101 to 104
Drawings 1 and 2
Figures 1 to 6

LIST OF TABLES

Table 1	Comparison of Feasible Foundation Alternatives, Mt. Albert Road Overpass Structures
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LIST OF DRAWINGS

Drawing 1	Mt. Albert Road Overpasses, Borehole Locations
Drawing 2	Mt. Albert Road Overpasses, Soil Strata

LIST OF FIGURES

Figure 1	Grain Size Distribution Test Results – Upper Silt
Figure 2	Grain Size Distribution Test Result – Upper Clayey Silt Till / Sandy Silt Till
Figure 3	Plasticity Chart – Upper Clayey Silt Till / Sandy Silt Till
Figure 4	Grain Size Distribution Test Results – Lower Silt
Figure 5	Grain Size Distribution Test Result – Lower Clayey Silt Till / Sandy Silt Till
Figure 6	Plasticity Chart – Lower Clayey Silt Till / Sandy Silt Till

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PART A

**PRELIMINARY
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1.0 INTRODUCTION

Golder Associates Ltd. (Golder) has been retained by URS Canada Inc. (URS) on behalf of the Ministry of Transportation, Ontario (MTO) to carry out preliminary foundation investigations associated with the extension of Highway 404 from Herald Road (Green Lane) to Highway 12/48 in the Town of East Gwillimbury, in the Regional Municipality of York.

Foundation investigation services are required for the following planning and preliminary design components of the Highway 404 extension study:

- **Planning Component:** As part of the environmental assessment study, foundation investigation is required at three environmentally significant water crossings along the extension, namely Maskinonge River, Black River, and Pepperlaw Brook.
- **Preliminary Design Component:** Preliminary foundation investigations are required for six proposed road crossings along the Highway 404 extension; from south to north, these are Mt. Albert Road, Doane Road, Queensville Sideroad, Bradford Bypass, Boag Sideroad, and Woodbine Avenue.

This report addresses the preliminary foundation investigation carried out for the Mt. Albert Road overpass structures.

The terms of reference for the foundation investigation are outlined in MTO's Request for Proposal for Agreement No. 2005-A-000585, issued in September 2003, in Clarifications 1 through 9 issued by MTO throughout the proposal preparation period, and in Golder's Proposal No. P31-1427, submitted in November 2003.

2.0 SITE DESCRIPTION

The proposed Mt. Albert Road (York Regional Road 13) overpass structures are located about 350 m west of the existing Mt. Albert Road – Woodbine Avenue intersection in the Town of East Gwillimbury, in the Regional Municipality of York.

The surface topography in the Town of East Gwillimbury is generally flat-lying to gently sloping. The existing ground surface in the immediate vicinity of the proposed Mt. Albert Road structure site is at about Elevation 270 m to 271 m; the ground surface slopes downward towards the south and east.

3.0 INVESTIGATION PROCEDURES

A subsurface investigation was carried out for the proposed Mt. Albert Road overpass structures in May 2004, at which time four boreholes (Boreholes 101 to 104) were advanced at the site using a track-mounted drill rig, supplied and operated by Walker Drilling Ltd. of Utopia, Ontario. The boreholes were advanced on the north and south shoulders of the existing Mt. Albert Road, in alignment with the proposed north- and southbound lanes of Highway 404.

The boreholes were advanced using solid stem augers to depths ranging from 9.2 m to 12.3 m below the existing ground surface. Samples of the overburden were obtained at 0.75 m to 1.5 m intervals of depth, using 50 mm outside diameter split-spoon samplers driven by an automatic hammer in accordance with the Standard Penetration Test (SPT) procedure. The water level in the open boreholes was observed throughout the drilling operations, and a piezometer was installed in Borehole 104 to monitor the groundwater level at the site. Boreholes 101, 102 and 103 were backfilled to ground surface using bentonite pellets upon completion. In Borehole 104, the piezometer tip and sand filter pack were backfilled to ground surface using bentonite pellets; this installation will be abandoned in accordance with Regulation 903 requirements once additional groundwater level readings are obtained.

The field work was supervised on a full-time basis by members of Golder's staff who located the boreholes in the field, directed the drilling, sampling, and in situ testing operations, and logged the boreholes. The soil samples were identified in the field, placed in labelled containers and transported to Golder's laboratory in Mississauga for further examination and testing. Index and classification tests consisting of water content determinations, Atterberg limits testing and grain size distribution analyses were carried out on selected soil samples.

The borehole locations were measured by Golder Associates relative to site features, and the ground surface elevations at the borehole locations were determined from the DTM for this project. The borehole locations (including MTM NAD83 northing and easting coordinates) and ground surface elevations (referenced to geodetic datum) are summarized in the following table and are shown on Drawing 1.

<i>Borehole Number</i>	<i>MTM NAD83 Northing (m)</i>	<i>MTM NAD83 Easting (m)</i>	<i>Ground Surface Elevation (m)</i>
101	4,885,216	311,133	271.1
102	4,885,206	311,101	271.1
103	4,885,188	311,104	270.9
104	4,885,199	311,139	270.4

4.0 SITE GEOLOGY AND STRATIGRAPHY

4.1 Regional Geological Conditions

The study area for this assignment lies within three physiographic regions, as delineated in *The Physiography of Southern Ontario*¹:

- The Schomberg Clay Plain, which is present from the existing northern terminus of Highway 404 at Herald Road (Green Lane) to south of Mt. Albert Road.
- The Peterborough Drumlin Field, which is present at two locations along the proposed alignment: from south of Mt. Albert Road to approximately Ravenshoe Road (just north of the proposed Woodbine Avenue structure); and again from about Pepperlaw Road (near the boundary of York and Durham Regions) to beyond the eastern limit of the proposed extension at Highway 12/48.
- The Simcoe Lowlands, which are present along the proposed alignment from approximately Ravenshoe Road to Pepperlaw Road.

The Mt. Albert Road site is located within the Peterborough Drumlin Field, near the border of the Schomberg Clay Plain physiographic region.

The surficial soils in the Schomberg Clay Plain consist of stratified deposits of clay and silt, with an average thickness of about 4 m to 5 m, that overlie a drumlinized till plain (which is contiguous with the Peterborough Drumlin Field). The rolling relief of the underlying till plain has not been entirely eliminated, and so this region is not as flat as typical lake plains. Most of the smaller drumlins have been completely covered by silts and clays; however, some of the larger drumlins in this region are not completely buried.

The surficial soils in the Peterborough Drumlin Field consist of drumlinized till. Toward the western portion of this physiographic region, where the Highway 404 extension will be constructed, the till is typically sandy. Some of the drumlins in this area have shallow coverings of silt and fine sand, between about 0.5 m and 2.5 m in thickness. "Wave-washed" drumlins, with exposed bouldery surfaces, are also present near the Simcoe Lowlands immediately south and east of Lake Simcoe. Localized deposits of silt, clay and peat are found in the low-lying areas between drumlins.

The surficial soils in the Simcoe Lowlands, to the south and southeast of Lake Simcoe, consist of sands, silts and clays that were deposited within a former glacial lake. Throughout Georgina Township, where much of the Highway 404 extension will be constructed, the plain is generally

¹ Chapman, L.J. and D.F. Putnam. *The Physiography of Southern Ontario*, Ontario Geological Survey Special Volume 2, Third Edition, 1984. Accompanied by Map P.2715, Scale 1:600,000.

low and swampy; Black River and Pefferlaw Brook, the most important streams in this area, have failed to provide good drainage, and occupy long swampy valleys. It is noted that several areas of drumlinized till break the continuity of the Simcoe Lowlands plain. Such areas, which formed islands in the former glacial lake, occur along the proposed highway extension near Keswick and Belhaven, and again in the vicinity of Virginia.

4.2 Site Stratigraphy

As part of the subsurface investigation at this site, four boreholes were advanced within the limits of the proposed overpass structures. The borehole locations and ground surface elevations are shown on Drawing 1.

The detailed subsurface soil and groundwater conditions encountered in the boreholes and the results of in situ and laboratory testing are given on the Record of Borehole sheets and Figures 1 to 6. The stratigraphic boundaries shown on the borehole records are inferred from non-continuous sampling and, therefore, represent transitions between soil types rather than exact planes of geological change. Subsoil conditions will vary between and beyond the borehole locations.

In summary, the native subsoil conditions at the site consist of the following:

- An upper silt deposit, the base of which was encountered in the boreholes between 1.5 m and 3.1 m depth, that has a compact relative density based on measured Standard Penetration Test (SPT) "N" values of 12 to 29 blows per 0.3 m of penetration.
- An upper clayey silt till / sandy silt till deposit, approximately 0.8 m to 3 m thick, that has a stiff to hard consistency / compact to very dense relative density, based on measured SPT "N" values of 12 to 62 blows (but more typically 21 to 32 blows) per 0.3 m of penetration.
- A lower silt deposit, between 1.5 m and 3.8 m thick, that is dense to very dense based on measured SPT "N" values ranging from 32 to 109 blows per 0.3 m of penetration.
- A lower clayey silt till / sandy silt till deposit, the surface of which was encountered at about 6.1 m to 7.6 m depth (between about Elevations 263.3 m and 264.3 m); this deposit is typically hard / very dense, with measured SPT "N" values generally greater than 100 blows per 0.3 m of penetration.

A more detailed description of the subsurface conditions encountered in the boreholes is provided in the following sections, and stratigraphic sections at the site are provided on Drawing 2.

4.2.1 Fill

About 0.8 m of sand and gravel fill was encountered in Boreholes 101 and 102, which were drilled on the existing north shoulder of Mt. Albert Road. The measured SPT "N" values of 12 and 15 blows per 0.3 m of penetration indicate that this existing fill has a compact relative density.

4.2.2 Upper Silt

An upper silt deposit, between 0.8 m and 3.1 m thick, is present below the existing fill in Boreholes 101 and 102, and extends from ground surface in Boreholes 103 and 104. The silt contains trace sand and gravel, and trace to some clay. The result of one Atterberg limits test indicated the sample tested to be non-plastic. The results from two grain size distribution tests are shown on Figure 1.

The measured SPT "N" values within the upper silt deposit range from 12 to 29 blows, but are typically between 20 and 23 blows per 0.3 m of penetration, indicating that this soil has a compact density.

4.2.3 Upper Clayey Silt Till / Sandy Silt Till

The upper silt stratum is underlain by an upper till deposit that is about 0.8 m to 3 m thick, with its surface encountered in the boreholes between about Elevations 267.9 m and 268.8 m, and its base encountered between about Elevations 266.5 m and 268.1 m.

The upper till ranges in composition from clayey silt with sand and trace gravel, to sandy silt containing trace clay and trace gravel; a grain size distribution test result for one sample of the upper till deposit is presented on Figure 2. Atterberg limits tests were carried out on two samples of the upper till, and the results are plotted on Figure 3. The measured plastic limits were 10 and 12 per cent, the measured liquid limits were 15 and 20 per cent, and the plasticity indices were 3 and 10 per cent. These test results confirm that the samples of the upper till vary in composition from sandy silt to low-plasticity clayey silt.

The measured SPT "N" values within this deposit range from 12 to 62 blows, but are more typically in the range of 21 to 32 blows per 0.3 m of penetration, indicating that the deposit is generally very stiff to hard / compact to dense.

4.2.4 Lower Silt

The upper till deposit is underlain by a 1.5 m to 3.8 m thick lower silt stratum that was encountered below about Elevation 266.5 m to 268.1 m in the boreholes (about 2.3 m to 6.1 m below ground surface). The lower silt deposit contains some clay, and trace sand; the results of two grain size distribution tests are shown on Figure 4. An Atterberg limits test was carried out on a representative sample of the lower silt; the results indicated the sample to be non-plastic.

The measured SPT "N" values range from 32 to 109 blows, with an average of about 65 blows per 0.3 m of penetration; the deposit has a dense to very dense relative density, but is typically very dense.

4.2.5 Lower Clayey Silt Till / Sandy Silt Till

The lower silt deposit is underlain by a lower till, the surface of which was encountered below about Elevation 263.3 m to 264.3 m (about 6.1 m to 7.6 m below the existing ground surface at the site). All four boreholes were terminated within this lower till deposit.

The lower till deposit ranges in composition from clayey silt with sand to some sand, containing trace gravel, to sandy silt containing trace to some clay and trace gravel. The result from one grain size distribution test is shown on Figure 5. Atterberg limits testing was carried out on two samples of the lower till, and the results are plotted on Figure 6. The measured plastic limits were 11 and 14 per cent, the measured liquid limits were 15 and 20 per cent, and the plasticity indices were 4 and 7 per cent. These test results confirm that the samples of the lower till vary in composition from sandy silt to low-plasticity clayey silt.

The measured SPT "N" values are generally greater than 100 blows per 0.3 m of penetration, indicating that the lower till is typically hard / very dense. However, SPT "N" values of 22 and 28 blows per 0.3 m of penetration were measured in the upper sample of this till deposit in Boreholes 102 and 103; this portion of the till is very stiff / compact.

4.3 Groundwater Conditions

Both the upper and lower silt deposits at this site are water-bearing. The upper silt deposit is saturated below about 0.5 m to 1.5 m depth, based on the moisture conditions of the recovered soil samples; the groundwater level within the upper silt is probably "perched" by the underlying upper till stratum. The lower silt deposit is saturated; all soil samples recovered from the lower silt as part of this borehole investigation were wet.

The water level in the open boreholes ranged from about 3.1 m to 5.2 m below the existing ground surface upon completion of drilling, varying between approximately Elevation 266 m and

268 m. A piezometer was installed within the lower till deposit in Borehole 104 to monitor the groundwater level. The following table summarizes the water level readings obtained in the open boreholes immediately following completion of drilling operations, and in the piezometer approximately two weeks following completion of the borehole:


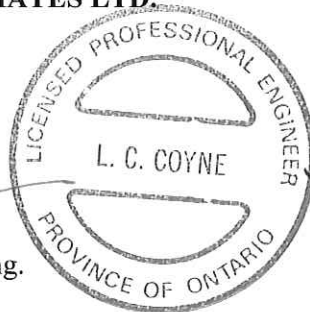


<i>Borehole No.</i>	<i>Water Level in Open Borehole (May 25, 2004)</i>		<i>Water Level in Piezometer (June 9, 2004)</i>	
	<i>Depth</i>	<i>Elevation</i>	<i>Depth</i>	<i>Elevation</i>
101	3.1 m	268.0 m	—	—
102	5.2 m	265.9 m	—	—
103	4.6 m	266.3 m	—	—
104	3.1 m	267.3 m	1.2 m	269.2 m

It should be noted that groundwater levels are expected to fluctuate seasonally and are expected to rise during wet periods of the year.

5.0 CLOSURE

This Preliminary Foundation Investigation Report was prepared by Ms. Lisa Coyne, P.Eng., an Associate and geotechnical engineer with Golder, with technical input from Ms. Anne Poschmann, P.Eng., a Principal with Golder. Mr. Fintan Heffernan, Golder's Designated MTO Contact for this project, conducted an independent quality review of the report.

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PART B

**PRELIMINARY
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6.0 PRELIMINARY ENGINEERING RECOMMENDATIONS

6.1 General

This section of the report provides foundation design recommendations for the preliminary design of the proposed Mt. Albert Road overpass structures. The recommendations are based on interpretation of the factual data obtained from the boreholes advanced during the subsurface investigation at this site. The interpretation and recommendations provided are intended to provide the designers with sufficient information to assess the feasible foundation alternatives and to carry out preliminary design of the proposed structure foundations. Where comments are made on construction they are provided in order to highlight those aspects which could affect the preliminary design of the project.

Further borehole drilling will be required during the detail design phase of the project, when the ultimate configuration of the proposed bridges is known. Additional boreholes will be required within the foundation footprints to confirm founding elevations if shallow foundations are adopted, and deeper boreholes will be required as part of the detail design phase of investigation at this site, in order to confirm the continuity of the hard/very dense lower till deposit with depth, if deep foundations are adopted.

6.2 Bridge and Retaining Wall Foundation Options

The proposed Mt. Albert Road overpass structures will each be single-span and will accommodate a minimum two-lane cross-section on Mt. Albert Road, although greater span lengths are also being evaluated in order to accommodate the potential future widening of Mt. Albert Road from two to four lanes. It is understood that Mt. Albert Road is to be constructed in a cut that is between 5 m and 6 m deep, such that the finished grade of the local road is at about Elevation 265 m. The finished grade of Highway 404 is proposed to be at about Elevation 271.8 m within the limits of the proposed overpass structures and their immediate approach embankments. The natural ground surface at the site varies from about Elevation 270 m to 271 m.

The subsurface conditions at the site consist of upper and lower silt deposits, interlayered with an upper and a lower till deposit. Both the upper and lower silt deposits are water-bearing, and the groundwater level at the site is relatively high, between about 1 m and 1.5 m below the existing ground surface. The surface of the lower till deposit was encountered in the boreholes between Elevations 263.3 m and 264.3 m, approximately 0.7 m to 1.7 m below the proposed finished grade of Mt. Albert Road. Standard Penetration Test (SPT) "N" values of greater than 100 blows per 0.3 m of penetration were measured in the lower till at and below these elevations in Boreholes 101 and 104 at the NBL bridge. In Boreholes 102 and 103 at the SBL bridge, SPT "N"

values greater than 100 blows per 0.3 m of penetration were measured within the lower till below about Elevation 262 m.

Based on the proposed road grades and the subsurface conditions at the site, the following foundation options are considered suitable for the proposed Mt. Albert Road overpass structures:

- **Spread footings founded on the lower till deposit:** This option could be adopted to support a closed, rigid frame structure that accommodates either two or four lanes of traffic on Mt. Albert Road. Excavations for this option would extend through both the upper and lower silt deposits, and would be more than 6 m below the groundwater table at the site. Precautions to maintain an undisturbed foundation subgrade would be required.
- **Spread footings "perched" on a granular pad within the native soils above the Mt. Albert Road cut grade:** This option could be adopted to support an open structure, with 2 horizontal to 1 vertical (2H:1V) foreslopes in front of the abutment footings if the native soils comprising the foreslopes are excavated and replaced with compacted granular fill. Footing excavations for this option would still extend below the groundwater table at this site, although such excavations would not be required to extend through the full thickness of the lower silt stratum as for the above option.
- **Steel H-piles driven to found within the lower till deposit:** This option could be adopted to support either a conventional or an integral abutment-type structure. Given that the site soils will not present long-term settlement issues, the site is considered suitable for the use of integral abutments in conjunction with a retained soil system (RSS) wall. Alternatively, an open bridge configuration could be adopted, in conjunction with 2H:1V foreslopes in front of the abutment pile caps if the native soils comprising the foreslopes are excavated and replaced with compacted granular fill. It is noted that the lower till deposit, into which the piles would be driven, is hard/very dense and it is therefore expected that heavy driving conditions will be encountered during pile installation. It is also noted that construction difficulties will exist for both RSS walls and abutment foreslopes, owing to the presence of the water-bearing silt deposits at the site; further discussion on these two aspects is provided in Sections 6.5 and 6.7 of this report.

Recommendations for preliminary design of spread footings and steel H-pile foundations are presented in the following sections. A summary comparison of the advantages, disadvantages and approximate costs associated with each of the feasible foundation options is presented in Table 1 following the text of this report.

6.3 Spread Footings

The bridge abutments and any associated concrete cantilever wing walls / retaining walls may be supported on spread footings placed on the properly prepared lower clayey silt till / sandy silt till soils at or below Elevation 263.3 m for the NBL bridge, depending on the final site grades and minimum frost protection requirements, and below Elevation 262 m for the SBL bridge. It is

noted that these founding levels are up to about 6 m to 7 m below the groundwater level at the site. Appropriate procedures will have to be adopted during excavation, subgrade preparation, and footing construction to ensure that the founding soils are not softened or disturbed prior to concrete placement.

Alternatively, spread footings for the abutments or for concrete cantilever wing walls / retaining walls may be “perched” above the Mt. Albert Road cut grade. The thickness and consistency of the upper till deposit is variable and it may not be possible to achieve consistent founding conditions (the subgrade would vary from the upper till to the lower silt deposit), and it may be difficult to maintain undisturbed founding strata. In addition, there may be insufficient capacity available from spread footings placed on the upper till to support the proposed overpass structures. In this regard, it is recommended that “perched” spread footings be placed on a compacted granular pad within the Highway 404 approaches. As above, appropriate procedures will have to be adopted during excavation, subgrade preparation, placement and compaction of the granular pad, and footing construction, to ensure that the founding soils are not disturbed prior to concrete placement. It is expected that a mud coat would be needed in this regard.

6.3.1 Geotechnical Resistance

Spread footings placed on the surface of the properly prepared lower till deposit, at or below Elevation 263.3 m for the NBL structure, and Elevation 262 m for the SBL structure, may be designed based on the following factored geotechnical resistance at Ultimate Limit States (ULS) and geotechnical resistance at Serviceability Limit States (SLS) for 25 mm of settlement.

<i>Footing Width</i>	<i>Factored Resistance at ULS</i>	<i>Geotechnical Resistance at SLS</i>
3 m	800 kPa	750 kPa
4 m	950 kPa	750 kPa

For spread footings placed within the Highway 404 approaches on a compacted Granular “A” pad, a factored geotechnical resistance at ULS of 900 kPa may be assumed for preliminary design. The required thickness of the Granular “A” pad will depend on the underlying native soils. For preliminary design, it could be assumed that subexcavation would be required to Elevation 267 m for the NBL structure, and to Elevation 265 m for the SBL structure. For the SBL structure, a minimum thickness of 3 m of compacted Granular “A” should be provided under the footing. A geotechnical resistance at SLS of 350 kPa may be assumed for preliminary design purposes.

The geotechnical resistances provided above will have to be reviewed during detail design based on the final geometry of the foundations, approach embankments and permanent cut slopes. In addition, further borehole drilling should be carried out to obtain additional data within the footing footprint in order to confirm the founding elevations.

The geotechnical resistances provided above are given under the assumption that the loads will be applied perpendicular to the surface of the footings. Where the load is not applied perpendicular to the surface of the footing, inclination of the load should be taken into account in accordance with Sections 6.7.2 and 6.7.4 of the *Canadian Highway Bridge Design Code (CHBDC)* and its *Commentary*.

6.3.2 Resistance to Lateral Loads

Resistance to lateral forces / sliding resistance between the concrete footings and the subgrade should be calculated in accordance with Section 6.7.5 of the *CHBDC*. The coefficient of friction, $\tan \delta'$, between cast-in-place concrete footings and the undisturbed, properly prepared subgrade may be taken as given in the following table. These represent unfactored values; in accordance with the *CHBDC*, a factor of 0.8 is to be applied in calculating the horizontal resistance.

<i>Subgrade</i>	<i>Coefficient of Friction ($\tan \delta'$)</i>
Hard / very dense lower till	0.55
Compacted Granular "A" pad	0.5

6.3.3 Frost Protection

A minimum of 1.5 m of soil cover, or equivalent, is required above the spread footings for frost protection purposes.

6.4 Steel H-Pile Foundations

Steel H-piles driven to found within the lower till deposit may be used for support of the abutments. The surface of this deposit was encountered between Elevations 263.3 m and 264.3 m in the boreholes. It is understood that, if a false abutment configuration is adopted for the structure, the corrugated steel pipe (CSP) liners for the integral abutment piles would extend below the Mt. Albert Road cut grade, to about Elevation 264 m. If an open bridge configuration is adopted, it is understood that the CSP liners (if required) would be maintained higher.

Based on the design pile tip elevation given in Section 6.4.1, it will be necessary to penetrate up to about 6 m into the lower till deposit in order to achieve the necessary axial resistances for the piles. If a false abutment configuration is adopted for the structure, the base of the CSP will extend to approximately the surface of the 100-blow lower till deposit and pre-augering will be required at least for a nominal distance to start the piles. Stiffening of the pile toe and top will be required for protection during driving, as difficult driving conditions are anticipated based on the hard/very dense nature of the lower till and the expected presence of cobbles and boulders within this deposit. It is noted that heavy driving was encountered for the 7 m to 12 m driven pile

lengths within the same hard/very dense till deposit at the Green Lane/Herald Road – Highway 404 structure site (approximately 2.5 km south of the Mt. Albert Road site).

It is also noted that the upper and lower silt deposits at the site are water-bearing and, as such, will flow into the auger hole if left unsupported during hole formation and installation of CSP liners, if required at the site. The use of a temporary liner or casing will be required in order to carry out such installations with minimal loss of ground.

6.4.1 Axial Geotechnical Resistance

It is understood that, based on the preliminary structural design completed to date, a factored axial resistance at ULS of at least 1,050 kN per pile is required. In order to achieve a factored axial resistance at ULS of 1,100 kN, steel HP 310 x 110 piles would have to be driven to Elevation 258 m. This would result in piles of approximately 9.5 m in length, assuming that the underside of the pile cap is at approximately Elevation 267.5 m.

The settlement of the individual piles and the pile group at the ULS resistnace is anticipated to be less than 25 mm. Therefore, the geotechnical resistance at SLS for 25 mm of settlement may also be taken as 1,100 kN.

It is noted that deeper boreholes will be required as part of the detailed design phase of investigation at this site, in order to confirm the continuity of the hard/very dense lower till deposit with depth as required for the preliminary pile design recommendations provided above. The preliminary recommendations given above will have to be evaluated further during the detailed design stage, once the structure and cut configurations are established.

6.4.2 Frost Protection

The pile caps should be provided with a minimum of 1.5 m of soil cover for frost protection.

6.5 Retained Soil System (RSS) Walls

A mechanically-reinforced soil retaining wall system (retained soil system, or RSS wall) consists of granular fill, placed and compacted in layers, and reinforced with metal or fabric strips or grids. A facing material, typically pre-cast concrete panels mechanically fastened to the reinforcing strips or grids, is used to form the face of the reinforced soil structure and to prevent the loss of fill material. This facing material is often supported on a narrow strip footing.

RSS walls could be adopted at this site in conjunction with integral abutments, although it is noted that a geotextile or appropriately-graded filter material (for example, concrete sand) will be required between the native soils and the granular soil used for the RSS wall, in order to prevent loss of fine soil particles into the voids within the granular fill.

Depending upon where the walls are used, RSS walls at this site would be about 4 m to 6 m high. The RSS walls could be founded on the soils as present at the Mt. Albert Road cut grade. Since the founding soils at this level will consist of the lower silt deposit, below the groundwater level, appropriate procedures (such as mud coat placement) will have to be adopted during excavation and subgrade preparation to ensure that the founding soils are not disturbed prior to placement and compaction of the granular fill for the RSS wall. Alternatively, the RSS walls could be founded on a compacted Granular "A" pad placed on the lower till deposit; in this case, subexcavation as deep as Elevation 263.3 m will be required. Assuming that the RSS wall acts as a unit and utilizes the full width of the reinforced soil mass, which is taken as two-thirds of the height of the wall, the following factored geotechnical resistances at ULS may be used for design of RSS walls.

<i>Wall Height</i>	<i>Assumed Footing Width</i>	<i>Factored Geotechnical Resistance at ULS</i>	
		<i>At Proposed Cut Grade</i>	<i>On Granular "A" Pad</i>
4 m	2.7 m	175 kPa	275 kPa
6 m	4 m	250 kPa	400 kPa

The settlement of the founding soils as a result of these magnitudes of loading is expected to be less than 25 mm; therefore the ULS conditions will govern for design of RSS walls at this site.

Appropriate subgrade protection measures will also be needed for the strip footing that supports the RSS facing panels, particularly where the lower silt forms the founding stratum. If the silt deposit is loosened or disturbed by construction procedures, ponded water or seepage, then the strip footings would have to be supported on a compacted Granular "A" pad, following subexcavation of the lower silt soils down to the surface of the lower till deposit.

The resistance to lateral forces / sliding resistance between the compacted granular fill (assumed to be Granular "A") and the subgrade soils should be calculated in accordance with Section 6.7.5 of the *CHBDC*. The coefficient of friction, $\tan \delta$, between the compacted Granular "A" and the properly prepared subgrade may be taken as given in the following table. These represent unfactored values; in accordance with the *CHBDC*, a factor of 0.8 is to be applied in calculating the horizontal resistance.

<i>Subgrade</i>	<i>Coefficient of Friction ($\tan \delta'$)</i>
Very dense lower silt	0.4
Hard / very dense lower till	0.55

The internal stability of the mechanically-reinforced soil walls should be checked by the RSS supplier / designer. The factor of safety related to global stability under static loading for properly designed and constructed RSS walls at this site is greater than 1.3.

6.6 Permanent Cut Slope Design and Construction

Mt. Albert Road is to be constructed in a cut that is up to about 6 m deep at the location of the proposed overpass structures. The permanent cut slopes will extend through the upper silt and upper till deposits, and will terminate in the lower silt deposit at the structure sites. Ditches adjacent to the permanent cut slopes may extend into the lower till deposit. It is noted that both the upper silt and lower silt deposits are water-bearing, and the Mt. Albert Road cut will extend up to about 5 m below the current groundwater level at the structure sites.

Limit equilibrium slope stability analyses have been carried out as part of the preliminary design works to determine what cut slope configuration is necessary to achieve a minimum factor of safety of 1.3 against global instability. The results of the static analysis indicate that the permanent cut slopes should be formed with a maximum gradient of 2.5 horizontal to 1 vertical (2.5H:1V). Even with this inclination, drainage will be critical in order to maintain the integrity of the slopes. It will be necessary to install a granular drainage blanket and french drains on the cut slope faces, connected to the road drainage works.

In order to shorten the structure length for an "open" configuration overpass, consideration could be given to excavating the native soils comprising the abutment foreslopes, and replacing these with compacted granular fill; abutment foreslopes comprised of compacted Granular "A" could be constructed with a maximum gradient of 2H:1V as opposed to 2.5H:1V.

It is noted that further investigation will be required as part of detailed design to confirm these preliminary cut slope recommendations for the area east and west of the proposed overpass structures.


6.7 Groundwater Control During Construction


It is noted that the upper and lower silt deposits are too fine-grained for the use of conventional or vacuum well points. In order to control the groundwater during construction works, it is recommended that the general excavation for the Mt. Albert Road cut be begun on the low side, to the east, and that a drainage outlet be established to effect some drainage of the upper and lower silt deposits as the excavation proceeds.

7.0 CLOSURE

This Preliminary Foundation Design Report was prepared by Ms. Lisa Coyne, P.Eng., an Associate and geotechnical engineer with Golder, with technical input from Ms. Anne Poschmann, P.Eng., a Principal with Golder. Mr. Fintan Heffernan, Golder's Designated MTO Contact for this project, conducted an independent quality review of the report.

GOLDER ASSOCIATES LTD.


Lisa C. Coyne, P.Eng.
Associate




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



LCC/ASP/FJH/lcc

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TABLE 1
COMPARISON OF FEASIBLE FOUNDATION ALTERNATIVES
MT. ALBERT ROAD OVERPASS STRUCTURES

<i>Foundation Option</i>	<i>Feasibility</i>	<i>Advantages</i>	<i>Disadvantages</i>	<i>Approximate Costs (See Note)</i>
Spread footings on lower till deposit	<ul style="list-style-type: none"> Feasible for support of abutments and retaining walls 	<ul style="list-style-type: none"> Minimal excavation beyond that required to form Mt. Albert Road cut slopes 	<ul style="list-style-type: none"> Excavations will extend through water-bearing upper and lower silt deposits; groundwater control in silt deposits will be difficult 	<ul style="list-style-type: none"> Approximately \$270,000 for footings only, assuming 4 m wide footings
Spread footings "perched" above Mt. Albert Road cut grade on compacted granular fill (open bridge configuration)	<ul style="list-style-type: none"> Feasible for support of abutments and retaining walls 	<ul style="list-style-type: none"> Shorter abutment wall than for footings supported on lower till deposit 	<ul style="list-style-type: none"> Excavations would still extend through water-bearing upper silt and terminate within lower silt; groundwater control in silt deposits will be difficult Longest structure span would be required to accommodate a four-lane configuration 	<ul style="list-style-type: none"> Approximately \$270,000, assuming 4 m wide footings, excluding cost of compacted granular pad Note that structure cost will be higher due to longer bridge spans to accommodate abutment foreslopes
Steel H-pile foundations driven to found within lower clayey silt till (either open or false abutment configuration)	<ul style="list-style-type: none"> Feasible for support of abutments and retaining walls 	<ul style="list-style-type: none"> Allows for use of integral abutments Could obtain shorter span length if native soils comprising abutment foreslopes are removed and replaced with compacted granular fill (i.e. 2H:1V for granular fill foreslopes, versus 2.5H:1V for native foreslopes) 	<ul style="list-style-type: none"> Heavy pile driving expected within lower till due to its hard/very dense nature Significant excavation required if abutment foreslopes are to be removed and replaced with compacted granular fill; geotextile and/or filter layer will be required between native soils and new granular foreslopes If false abutment configuration adopted, significant excavation required for construction of RSS walls, extending through water-bearing upper and lower silt deposits; groundwater control in silt deposits will be difficult. In addition, geotextile and/or filter layer would be required behind and below RSS wall to mitigate loss of fine silt particles. 	<ul style="list-style-type: none"> Approximately \$300,000 for piles and pile caps, assuming single row of piles at each foundation element (i.e. structure) This does not include cost for RSS wall construction and materials (if false abutment configuration adopted), and does not reflect cost of potentially longer structure span length if open configuration adopted

NOTE: The approximate costs provided in the table above are rough estimates and are intended for comparison purposes only. The costs assume two overpass structures, with each foundation element approximately 17 m in length to allow for three lanes plus shoulders on each of the Highway 404 NBL and SBL structures.

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.) drive open sampler for a distance of 300 mm (12 in.)

(b) Cohesive Soils

Consistency	c_u, s_u kPa	psf
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

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 test¹
CIU consolidated isotropically undrained triaxial test with porewater pressure measurement¹
 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.

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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
*	Density symbol is ρ . Unit weight symbol is γ where $\gamma = \rho g$ (i.e. mass density \times acceleration due to gravity)

(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 $= (\text{Compressive strength})/2$

PROJECT 04-1111-016		RECORD OF BOREHOLE No 101		1 OF 1	METRIC
W.P. _____		LOCATION N 4885216.0; E 3111133.0		ORIGINATED BY PKS	
DIST Central HWY 404		BOREHOLE TYPE 108 mm Diameter Solid Stem Augers		COMPILED BY NK	
DATUM Geodetic		DATE May 25, 2004		CHECKED BY LCC	

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 (%)		
271.1	GROUND SURFACE						20	40	60	80	100									
0.0	Sand and gravel (FILL) Compact Brown Moist		1	SS	15															
270.3																				
0.8	Silt, trace sand and gravel, trace to some clay Compact Brown Moist to wet		2	SS	22															
			3	SS	13															
268.8																				
2.3	Clayey Silt with sand, trace gravel (TILL) Stiff to hard Brown Moist to wet		4	SS	12															
			5	SS	32															
266.5																				
4.6	Silt, some clay, trace sand Very dense Grey Wet		6	SS	92															
			7	SS	72															
263.5																				
7.6	Clayey Silt with sand, trace gravel to Sandy Silt, trace to some clay, trace gravel (TILL) Hard/Very dense Grey Moist to wet		8	SS	100/15															
			9	SS	100/18															
260.3																				
10.8	End of Borehole Note: Water level in open borehole at 3.1m depth (Elev. 268.0m) on completion of drilling		10	SS	100/10															

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PROJECT <u>04-1111-016</u>		RECORD OF BOREHOLE No 102		1 OF 1	METRIC
W.P. _____		LOCATION <u>N 4885206.0 ; E 311101.0</u>		ORIGINATED BY <u>PKS</u>	
DIST <u>Central</u> HWY <u>404</u>		BOREHOLE TYPE <u>108 mm Diameter Solid Stem Augers</u>		COMPILED BY <u>NK</u>	
DATUM <u>Geodetic</u>		DATE <u>May 25, 2004</u>		CHECKED BY <u>LCC</u>	

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	× REMOULDED						
271.1	GROUND SURFACE														
0.0	Sand and gravel (FILL) Compact Brown Moist		1	SS	12										
270.3															
0.8	Silt, trace sand and gravel, trace to some clay Compact Brown Moist to wet		2	SS	28										
			3	SS	26										
			4	SS	29										
268.1															
3.1	Clayey Silt with sand to Sandy Silt, trace clay, trace gravel (TILL) Very stiff to hard/Compact to very dense Grey Wet		5	SS	29										
			6	SS	62										
265.0															
6.1	Silt, some clay, trace sand Dense Grey Wet		7	SS	42										
263.5															
7.6	Clayey Silt with sand, trace gravel to Sandy Silt, trace to some clay, trace gravel (TILL) Very stiff to hard/Compact to very dense Grey Wet		8	SS	28										
			9	SS	115										
			10	SS	100/25										
258.8															
12.3	End of Borehole		11	SS	100/10										
	Note: Water level in open borehole at 5.2m depth (Elev. 265.9m) on completion of drilling														

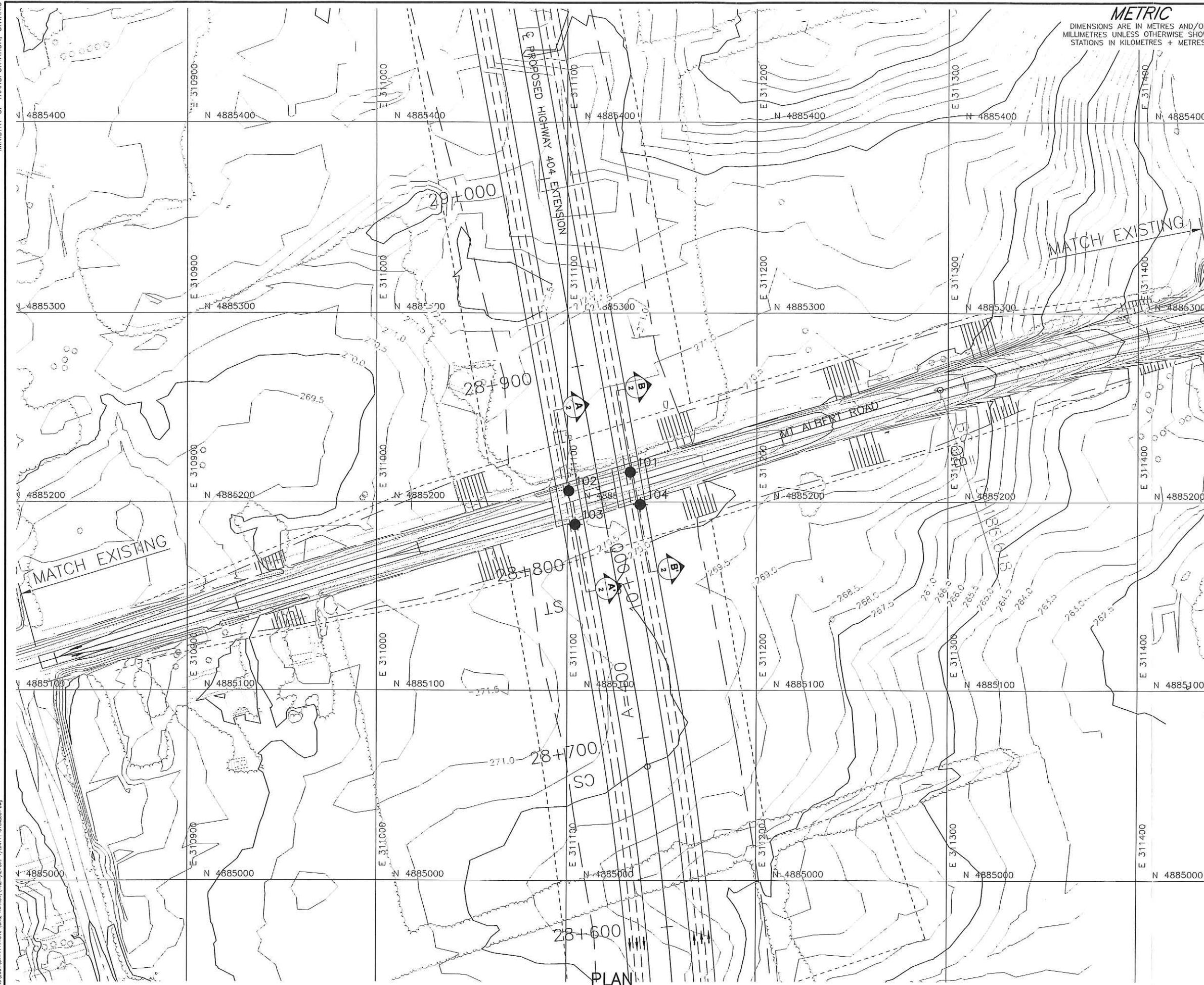
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PROJECT		LOCATION		RECORD OF BOREHOLE No 103		1 OF 1		METRIC								
W.P. _____		N 4885188.0 ; E 311104.0		ORIGINATED BY		PKS										
DIST Central HWY 404		BOREHOLE TYPE 108 mm Diameter Solid Stem Augers		COMPILED BY		NK										
DATUM Geodetic		DATE May 25, 2004		CHECKED BY		LCC										
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 (%)
270.9	GROUND SURFACE							20	40	60	80	100				
0.0	Silt, trace sand and gravel, trace to some clay Loose to compact Brown, becoming grey at 2.7 m depth Wet		1	SS	6											
			2	SS	12											
			3	SS	20											
			4	SS	21											
267.9																
3.1	Clayey Silt with sand, trace gravel (TILL) Very stiff Grey Wet		5	SS	21											
266.3																
4.6	Silt, some clay, trace sand Dense to very dense Grey Wet		6	SS	68											
			7	SS	32											
263.3																
7.6	Clayey Silt with sand, trace gravel to Sandy Silt, trace to some clay, trace gravel (TILL) Very stiff to hard/Compact to very dense Grey Wet		8	SS	22											
			9	SS	100/18											
			10	SS	100/18											
258.6																
12.3	End of Borehole		11	SS	100/13											
	Note: Water level in open borehole at 4.6m depth (Elev. 266.3m) on completion of drilling															

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MISS MTO 041111016AAGRD.GPJ ON MOT.GDT 3/8/04

+³, X³: Numbers refer to Sensitivity O^{3%} STRAIN AT FAILURE

**METRIC**
 DIMENSIONS ARE IN METRES AND/OR
 MILLIMETRES UNLESS OTHERWISE SHOWN.
 STATIONS IN KILOMETRES + METRES.

 CONT No.
 WP No.

 HIGHWAY 404 EXTENSION
 MT ALBERT ROAD OVERPASS
 BOREHOLE LOCATIONS


SHEET


Golder Associates Ltd.
 MISSISSAUGA, ONTARIO, CANADA

 KEY PLAN
 SCALE
 1.5 0 1.5 km
LEGEND

Borehole - Current Investigation

No.	ELEVATION	CO-ORDINATES	
		NORTHING	EASTING
101	271.1	4885215.9	311133.2
102	271.1	4885205.9	311100.7
103	270.9	4885188.1	311104.0
104	270.4	4885198.7	311138.5

REFERENCE

Base plans provided in digital format by URS Canada Inc. on June 6, 2004, drawing files 404-base-north.dwg and 404-base-south.dwg. On February 3, 2006, drawings x-align-south.dwg and x-design.dwg

NO.	DATE	BY	REVISION
Geocres No.		PROJECT NO. 04-1111-016	
HWY. 404		DIST.	
SUBM'D. PKS	CHKD. LCC	DATE: MAR 2006	SITE:
DRAWN: JDR/MSM	CHKD. LCC	APPD. LCC	DWG. 1

METRIC
DIMENSIONS ARE IN METRES AND/OR
MILLIMETRES UNLESS OTHERWISE SHOWN.
STATIONS IN KILOMETRES + METRES.

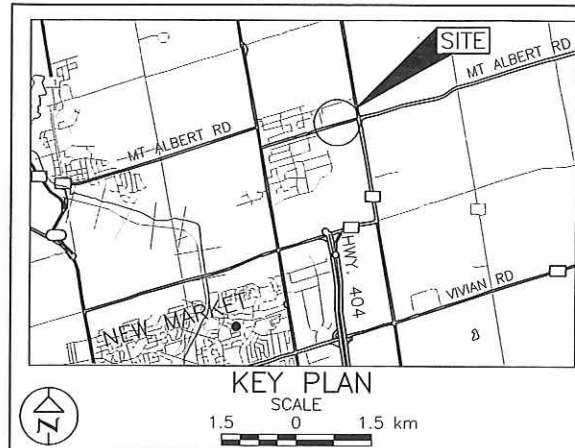
CONT No.
WP No.

HIGHWAY 404 EXTENSION
MT ALBERT ROAD OVERPASS
SOIL STRATA

SHEET



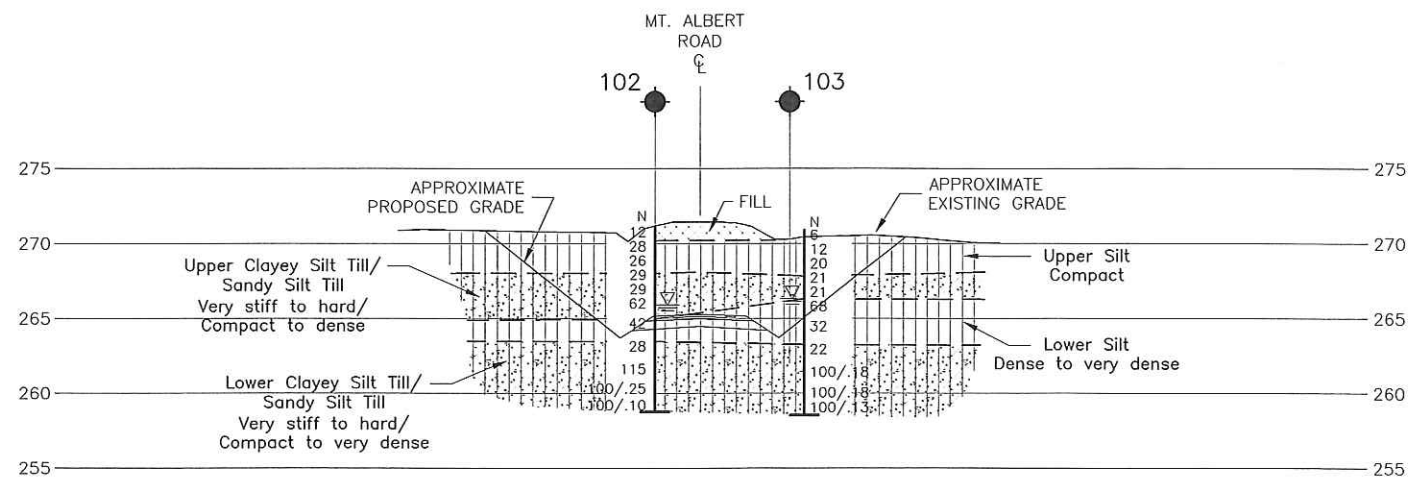
Golder Associates Ltd.
MISSISSAUGA, ONTARIO, CANADA



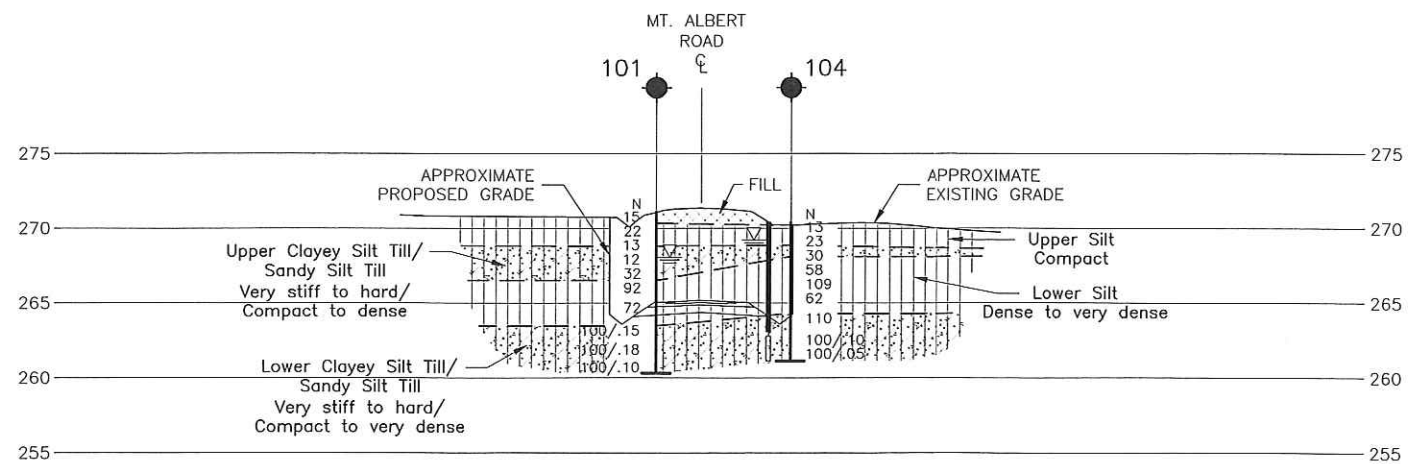
LEGEND

● Borehole - Current Investigation

No.	ELEVATION	CO-ORDINATES	
		NORTHING	EASTING
101	271.1	4885215.9	311133.2
102	271.1	4885205.9	311100.7
103	270.9	4885188.1	311104.0
104	270.4	4885198.7	311138.5



A-A'
1
PROFILE ALONG HIGHWAY 404 SBL



B-B'
1
PROFILE ALONG HIGHWAY 404 NBL

SCALE
20 0 20 40 m

NOTES

This drawing is for subsurface information only. The proposed structure details/works are shown for illustration purposes only and may not be consistent with the final design configuration as shown elsewhere in the Contracts Documents.

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

The complete foundation investigation and design report for this project and other related documents may be examined at the Materials Engineering and Research Office, Downsview. Information contained in this report and related documents is specifically excluded in accordance with Section GC 2.01 of OPS General Conditions.

REFERENCE

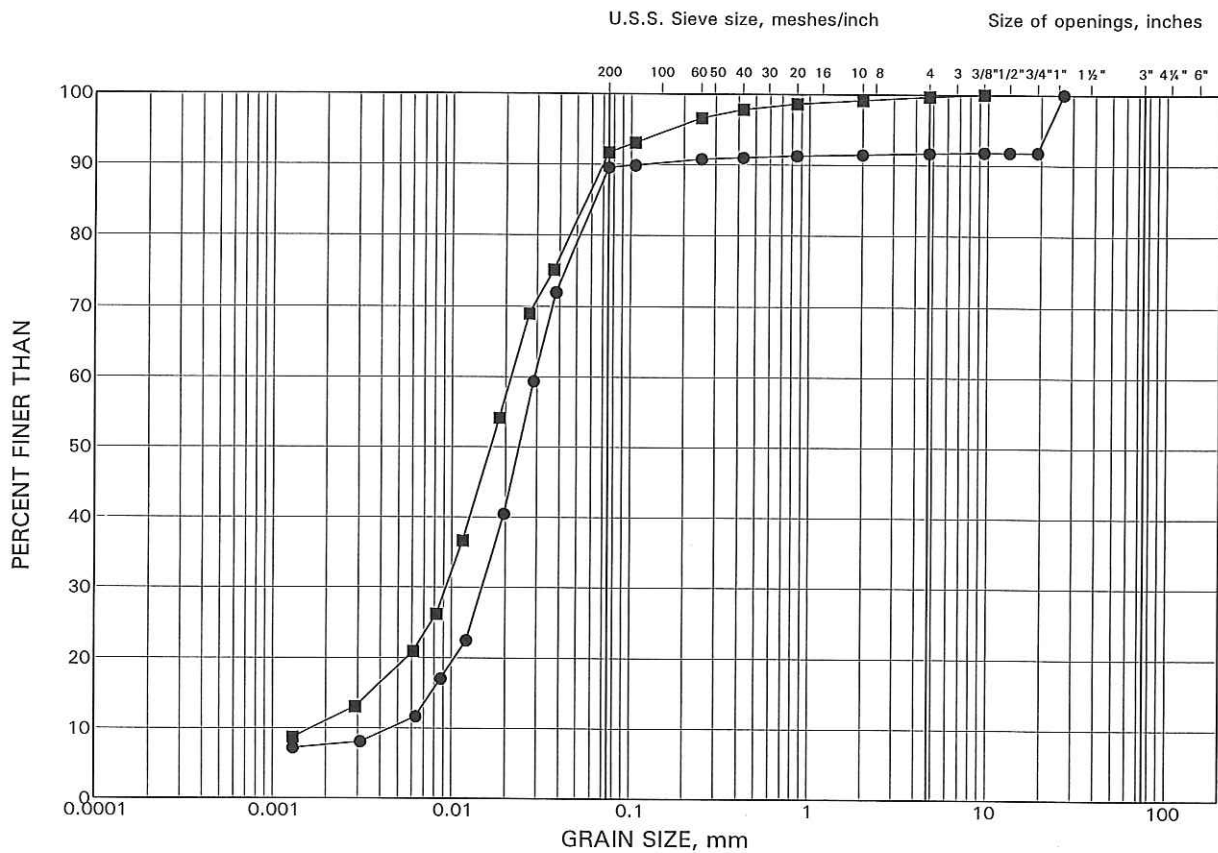
Base plans provided in digital format by URS Canada Inc. on June 6, 2004, drawing files 404-base-north.dwg and 404-base-south.dwg.
On February 3, 2006, drawings x-align-south.dwg and x-design.dwg

NO.	DATE	BY	REVISION
Geocres No.			
HWY. 404		PROJECT NO. 04-1111-016	
SUBM'D. PKS	CHKD. LCC	DATE: MAR 2006	SITE:
DRAWN: MSM	CHKD. LCC	APPD. LCC	DWG. 2

GRAIN SIZE DISTRIBUTION TEST RESULTS

Upper Silt

FIGURE 1



SILT AND CLAY SIZES		FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE
FINE GRAINED		SAND SIZE			GRAVEL SIZE		SIZE

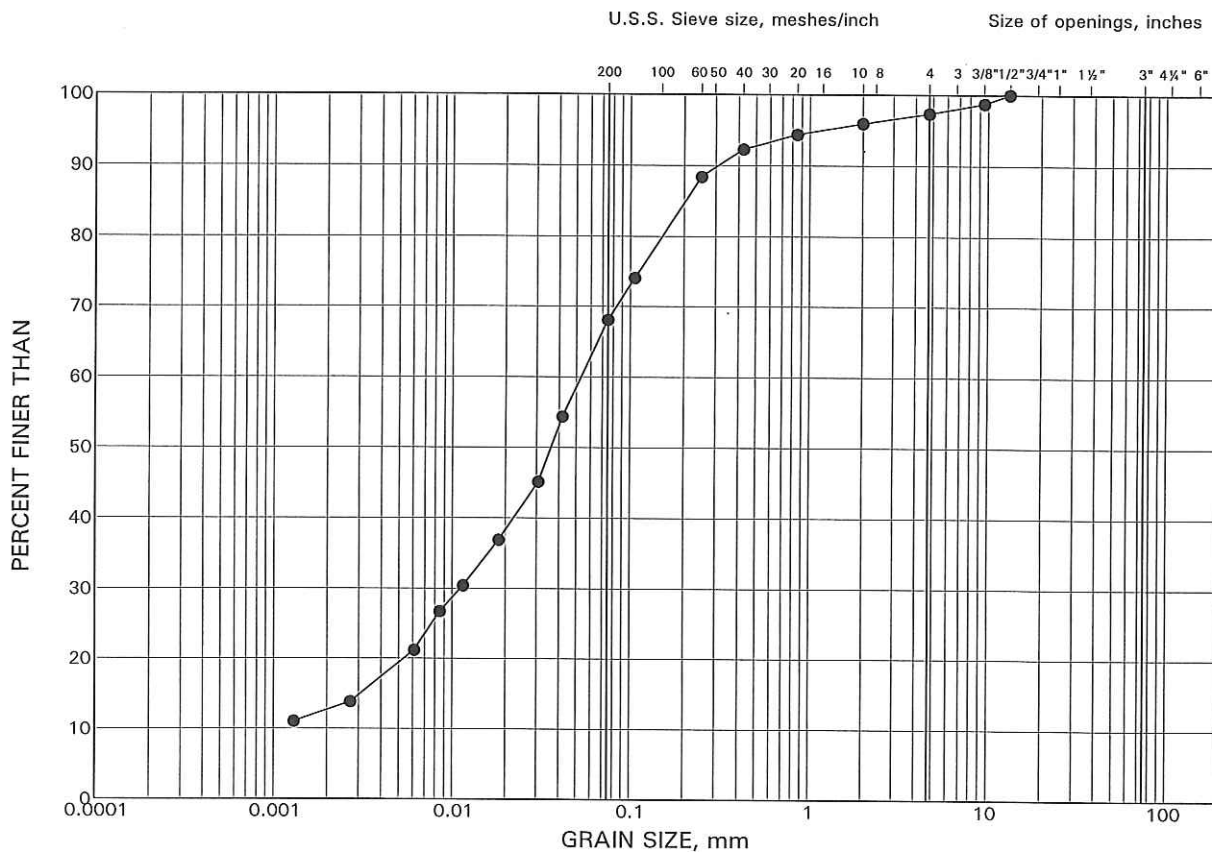
LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION (m)
●	101	3	269.4
■	102	4	268.6

GRAIN SIZE DISTRIBUTION TEST RESULT

Upper Clayey Silt Till

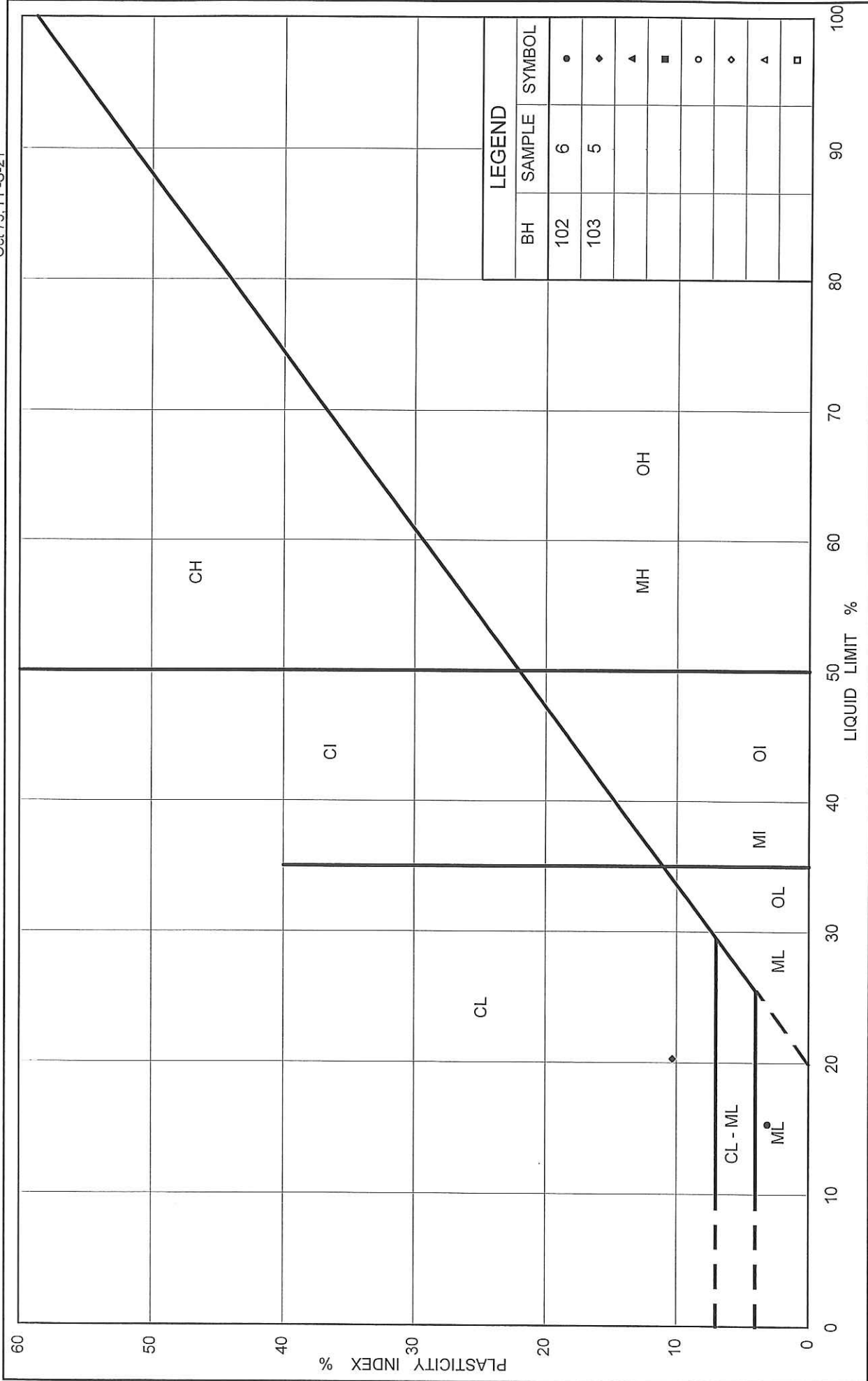
FIGURE 2



SILT AND CLAY SIZES		FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE
FINE GRAINED		SAND SIZE			GRAVEL SIZE		SIZE

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION (m)
•	103	5	267.7



PLASTICITY CHART Upper Clayey Silt Till / Sandy Silt Till

Ministry of Transportation



Ontario

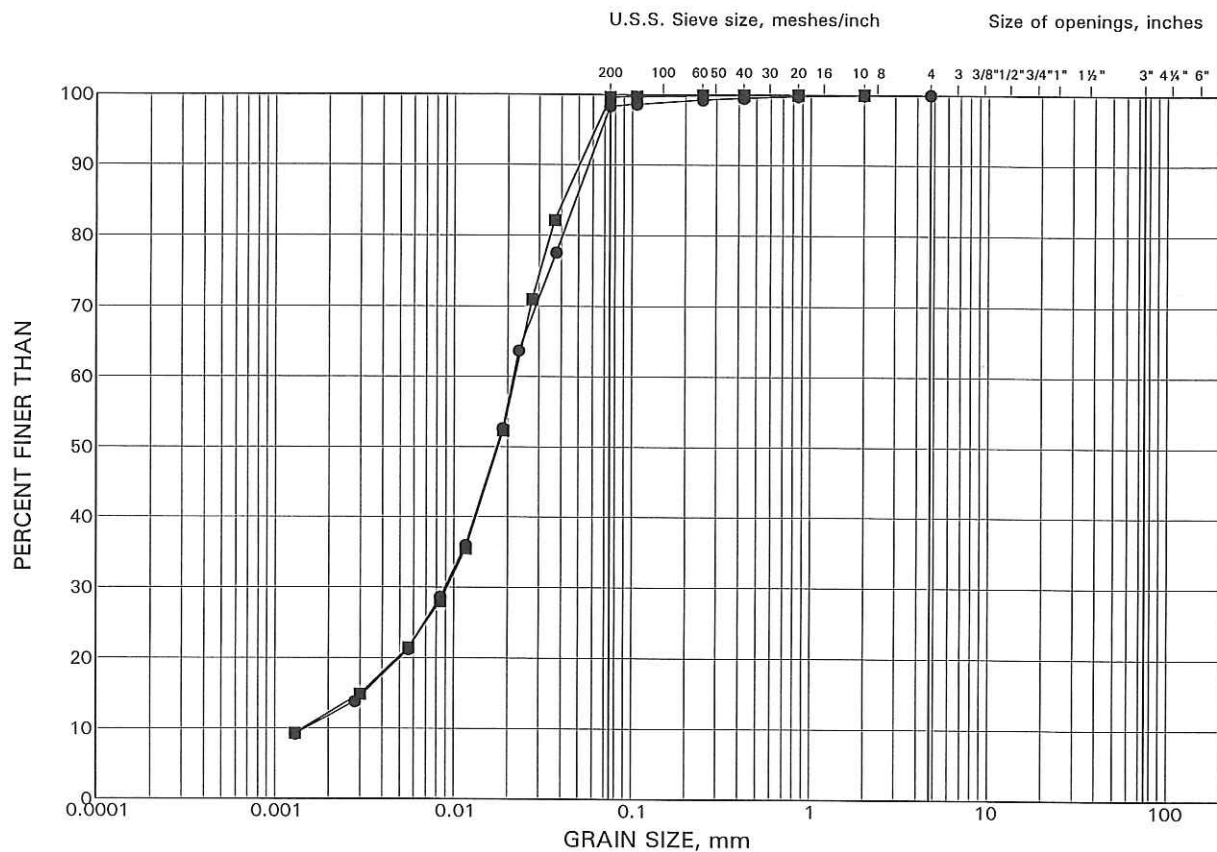
FIG No. 3

Project No. 04-1111-016

GRAIN SIZE DISTRIBUTION TEST RESULTS

Lower Silt

FIGURE 4



SILT AND CLAY SIZES	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE
FINE GRAINED	SAND SIZE			GRAVEL SIZE		SIZE

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION (m)
●	101	7	264.8
■	104	6	265.6

FIGURE 5

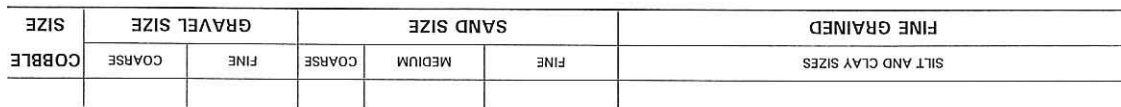


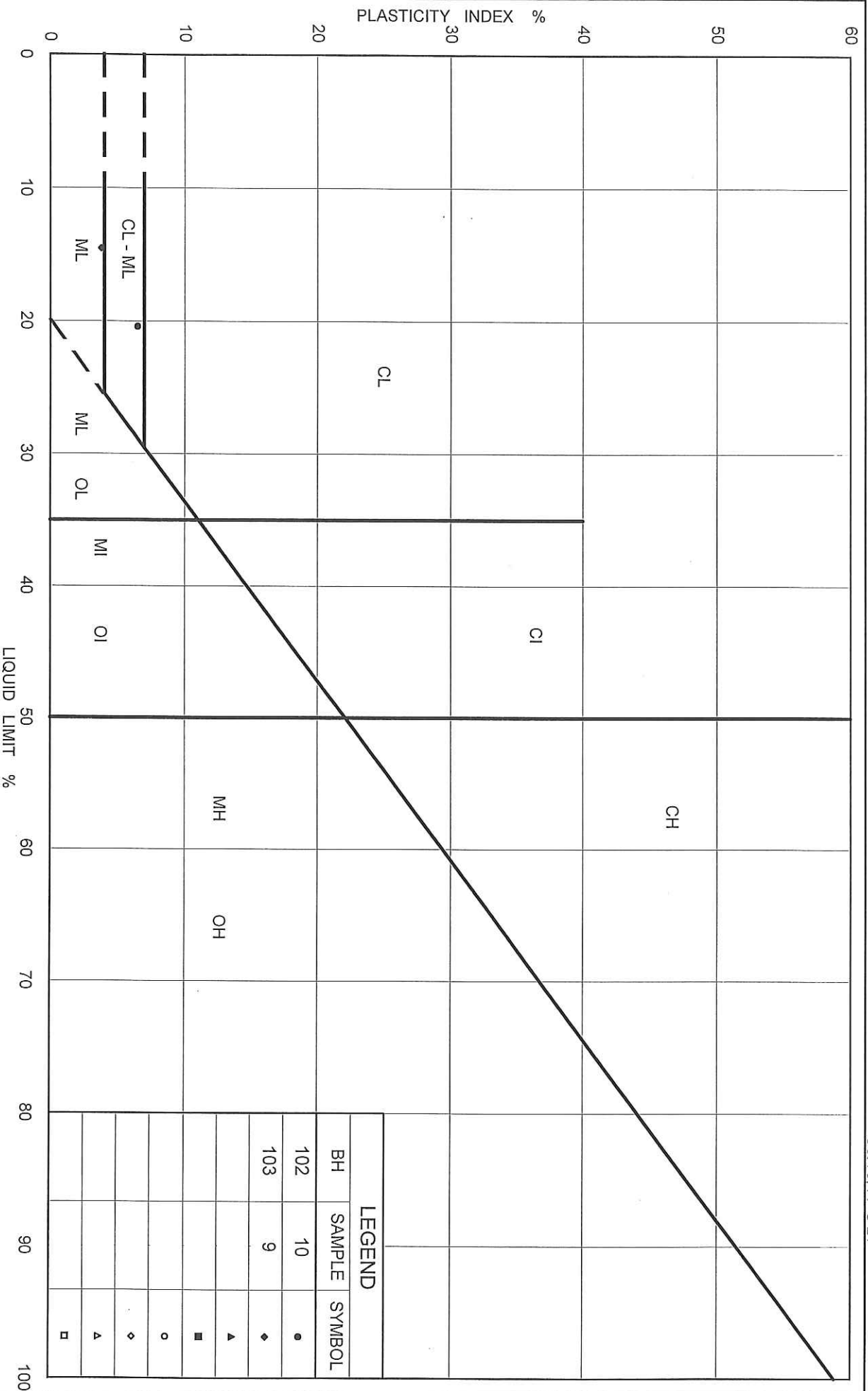
FIGURE 5

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION (m)
●	104	7	264.1

FINE GRAINED		SAND SIZE			GRAVEL SIZE		SIZE
SILT AND CLAY SIZES		FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE

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FIG No. 6

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