February, 2014

FOUNDATION INVESTIGATION AND DESIGN REPORT

High Fills and Deep Cuts
Highway 401/Holt Road Interchange
Site 21-159
Clarington, Ontario
G.W.P. 2101-08-00

Submitted to:
URS Canada Inc.
4th Floor
30 Leek Crescent
Richmond Hill, Ontario
L4B 4N4

GEOCRES No.: 30M15-158
Report Number: 09-1111-0019

Distribution:

5 Copies - MTO - Central Region

1 Copy - MTO - Foundations Section

2 Copies - URS Canada Inc.

2 Copies - Golder Associates Ltd.

REPORT

Golder Associates

Table of Contents

PART A

FOUNDATION INVESTIGATION REPORT
HIGH FILLS AND DEEP CUTS
HIGHWAY 401/HOLT ROAD INTERCHANGE – SITE 21-159
CLARINGTON, ONTARIO
G.W.P. 2101-08-00

February, 2014
Report No. 09-1111-0019

Golder Associates

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 provide foundation engineering services for the Highway 401/Holt Road Interchange reconfiguration in the Town of Clarington, Regional Municipality of Durham, Ontario.

This report addresses the results of the subsurface investigation carried out for the high fills and deep cuts required for the construction of new interchange ramps and realigned Holt Road and South Service Road.

The Terms of Reference and scope of work for the foundation engineering services are outlined in MTO's Request for Proposal (RFP) for Assignment No. 2008-E-0059 dated March 2009 and associated clarifications, and in Section 6.8 of the *Technical Proposal* for this assignment. Golder's Scope of Work for this assignment was developed based on the proposed ramp and service road profiles provided by URS at the preliminary design stage of this assignment and is summarised in Golder's Scope Change Letters dated January 24, August 7, and August 23, 2013.

2.0 SITE DESCRIPTION

The existing Highway 401/Holt Road Underpass Interchange is located near the entrance to the Darlington Nuclear Power Plant, approximately 10 km east of Oshawa, Ontario.

Based on the drawings of the proposed new Highway 401/Holt Road Interchange provided by URS (Drawing No. 2013-10-24-Hwy401-HoltRd_profile and 2013-10-24-Hwy401-HoltRd_plan), the existing Holt Road will be realigned and a new bridge structure will be constructed about 30 m to the east of the existing bridge with associated interchange ramps, as shown on Drawing 1. Further, it is understood that the South Service Road will be realigned to the south as part of the interchange reconfiguration, to accommodate the future Highway 407 East Durham Link that connects to Highway 401 immediately to the west of the site.

In general, the terrain in the area of the proposed new interchange is relatively flat to gently rolling, with the natural ground surface within the limits of the project ranging between about Elevation 111 m and 116 m, with the exception of the existing soil disposal mound on OPG property between Park Road and Solina Road which is up to about Elevation 132 m, and an existing fill mound east of Park Road on the south side of the existing South Service Road which is up to about Elevation 131 m.

The Highway 401 grade in the vicinity of the existing and the new Holt Road Interchange is at about Elevation 112 m. The existing Holt Road Underpass approach embankments have been constructed of earth fill, up to about 6.5 m high, with the Holt Road surface at about Elevation 118.5 m. The existing approach embankment side slopes are inclined at approximately 2 horizontal to 1 vertical (2H:1V). The current interchange configuration permits access only to Holt Road from the eastbound Highway 401 and to Highway 401 westbound from Holt Road.

The high fill and deep cut areas are located along the proposed interchange ramps and along the proposed realigned Holt Road and South Service Road. The approximate locations, extent and depths/height of these high fill and deep cut sections are summarized below and shown on Drawing 1.

High Fill/ Deep Cut Area	Approximate Location	Horizontal Distance (m)	Average Fill/Cut Depth (m)
1 - High Fill	Holt Road STA 10+050 to 10+170	120	4.5 to 9
2 - High Fill	E-N/S Ramp –STA 9+850 to 9+970	120	2 to 4.5
3 - High Fill	E-N/S Ramp –STA 10+200 to 10+500	300	3 to 4.5
4 - High Fill	N/S-E Ramp –STA 9+610 to 9+740	130	4.5 to 6.8
5 - High Fill	N/S-W Ramp –STA 9+670 to 9+740	70	3 to 4
6 - High Fill	W-N/S Ramp –STA 11+550 to 11+580	30	4.5 to 5.5
7 - Deep Cut	South Service Road STA 13+160 to 13+265	105	6 to 9
8 - Deep Cut	South Service Road (Soil Disposal Mound) STA 11+850 to 12+500	650	12 to 17

The ramp and service road alignments and profiles have been revised since the preliminary design stage and some areas are no longer considered to be “high fills” based on MTO Foundations criteria, however the results of the subsurface investigation in these areas are also included in this report.

3.0 INVESTIGATION PROCEDURES

3.1 Previous Investigations

During a previous investigation carried out by Ecoplans Ltd. (Ecoplans) in 2010, a total of 15 boreholes and/or monitoring wells were advanced/installed in the vicinity of the proposed South Service Road deep cut Area 8. The subsurface information obtained during the current borehole investigation presented in Appendices A to H as noted in Section 3.2 has been supplemented with the borehole and monitoring well records from the previous investigation which are included in Appendix J.

3.2 Current Investigation

The field work for this investigation was carried out by Golder during the period between May 27 and August 22, 2013, and consisted of drilling and sampling forty one (41) boreholes (Boreholes 13-1 to 13-21, 13-23 to 13-41 and 13-50) to depths ranging from 4.6 m to 18.7 m below existing ground surface. The approximate borehole locations are summarized below and shown on Drawings A1 to H1, in Appendices A to H respectively. The results of chemical analyses on composite soil samples are presented in Appendix I.

The boreholes were drilled by conventional track and truck mounted drill rigs supplied and operated by KC Drilling Ltd. of Innisfil, Ontario and Strong Soil Search Inc. of Claremont, Ontario. The boreholes were advanced through the overburden using 108 mm, 120 mm and 150 mm solid stem augers. In general, samples of the overburden soils were obtained at intervals of depth ranging from 0.75 m to 1.5 m using a 50 mm outer diameter (O.D.) split-spoon sampler operated by automatic hammers on the drill rigs, performed in accordance with Standard Penetration Testing (SPT) procedures, as specified in ASTM Method D1586.

The groundwater conditions were observed in the open boreholes during and immediately following the drilling operations and are described on the Record of Borehole sheets in the corresponding appendices. It should be

noted that groundwater elevations as encountered in the boreholes may not be representative of static groundwater levels since the groundwater levels in the boreholes may not have stabilized on completion of drilling. Furthermore, groundwater elevations will vary depending on seasonal fluctuations in precipitation and on local soil permeability. All boreholes were abandoned by backfilling to the surface with bentonite upon completion in accordance with Ontario Regulation 903 (as amended).

The soil cuttings from the borehole drilled on OPG property were collected and contained in steel drums which were temporarily stored on-site while analytical testing was completed to categorize the soil for disposal. Following the receipt of the analytical results (included in Appendix I) the soil drums were removed from site by Detox Environmental Services Inc.

The boreholes were advanced to depths up to 18.7 m below existing ground surface, generally penetrating below ground surface to a depth equivalent to the proposed height of the embankment fill or to fifty percent of the depth of a cut below the base of the proposed cut and a minimum of 3 m into competent material.

The proposed centreline of each roadway and ramp alignment was staked at 50 m intervals in the field by URS prior to drilling. The as-drilled borehole locations, in stations and offsets, were measured in reference to the centreline alignment and were subsequently converted into MTM NAD 83 coordinates using the base drawing provided by URS in AutoCAD format. Borehole elevations were surveyed by a member of our technical staff in reference to the surveyed ground surface elevations at the centreline median. For locations where the centreline elevations were not surveyed in close proximity to the as-drilled boreholes, ground surface elevations at the centreline were obtained from the contour plan provided by URS (ACAD-X-base.dwg, received January 2009) and confirmed for elevations relative to the boreholes surveyed to the staked locations. The borehole locations shown on Drawings A1 to H1 are positioned relative to MTM NAD 83 northing and easting coordinates and the ground surface elevations are referenced to Geodetic datum.

Summary of Borehole Locations and Elevations

High Fill/Deep Cut Area Number and Location	Borehole Number	MTM NAD83 Northing (m)	MTM NAD83 Easting (m)	Ground Surface Elevation (m)	Borehole Depth (m)	Reference
High Fill Area 1 - Holt Road STA 10+050 to 10+170	BH 13-1	4860691.2	367324.1	111.0	9.2	Appendix A
	BH 13-2	4860647.0	367303.2	116.3	7.7	
	BH 13-3	4860654.6	367347.6	110.9	7.7	
	BH 13-4	4860579.7	367324.9	113.5	4.7	
	BH 13-15	4860637.2	367352.9	111.1	7.7	
	BH 13-23	4860626.5	367292.1	113.2	6.2	
	BH 13-50	4860895.0	367316.0	111.0	9.2	
High Fill Area 2 - E-N/S Ramp – STA 9+850 to 9+970	BH 13-12	4860902.8	367970.2	95.1	6.2	Appendix B
	BH 13-13	4860887.0	367915.3	98.0	6.3	
	BH 13-14	4860876.8	367861.3	98.5	6.3	
High Fill Area 3 - E-N/S Ramp – STA 10+200 to 10+500	BH 13-5	4860837.2	367583.1	102.7	4.7	Appendix C
	BH 13-6	4860859.5	367541.4	102.9	6.2	
	BH 13-7	4860886.7	367489.8	104.0	7.8	

High Fill/Deep Cut Area Number and Location	Borehole Number	MTM NAD83 Northing (m)	MTM NAD83 Easting (m)	Ground Surface Elevation (m)	Borehole Depth (m)	Reference
	BH 13-8	4860903.2	367447.8	105.6	7.8	
	BH 13-9	4860920.2	367399.7	107.2	4.6	
	BH 13-10	4860950.2	367357.9	108.4	6.2	
	BH 13-11	4860938.7	367308.4	109.7	4.7	
High Fill Area 4 - N/S-E Ramp – STA 9+610 to 9+740	BH 13-15	4860637.2	367352.9	111.1	7.7	Appendix D
	BH 13-16	4860658.9	367387.0	110.1	7.7	
	BH 13-17	4860692.5	367411.1	110.0	6.2	
	BH 13-18	4860727.4	367436.9	108.7	4.6	
High Fill Area 5 - N/S-W Ramp – STA 9+670 to 9+740	BH 13-19	4860918.3	367294.0	110.0	4.6	Appendix E
	BH 13-20	4860925.5	367329.7	109.1	6.2	
	BH 13-21	4860898.2	367353.9	108.7	4.7	
High Fill Area 6 - W-N/S Ramp – STA 11+550 to 11+580	BH 13-2	4860647.0	367303.2	116.3	7.7	Appendix F
	BH 13-23	4860626.5	367292.1	113.2	6.2	
Deep Cut Area 7 - South Service Road STA 13+160 to 13+265	BH 13-39	4860503.8	367085.2	131.0	7.9	Appendix G
	BH 13-40	4860481.2	367127.2	131.0	12.3	
	BH 13-41	4860463.4	367175.4	126.4	8.0	
Deep Cut Area 8 - South Service Road (Soil disposal mound) STA 11+850 to 12+500	BH 13-24	4860345.0	365782.0	112.5	9.4	Appendix H
	BH 13-25	4860299.2	365845.5	123.2	18.7	
	BH 13-26	4860322.0	365891.5	123.5	17.1	
	BH 13-27	4860307.0	365920.0	126.6	17.2	
	BH 13-28	4860335.0	365939.0	123.8	17.1	
	BH 13-29	4860399.0	365975.0	113.1	7.6	
	BH 13-30	4860327.0	366044.0	129.4	17.2	
	BH 13-31	4860387.0	366081.0	118.9	9.6	
	BH 13-32	4860336.0	366145.0	130.5	9.2	
	BH 13-33	4860348.0	366194.0	129.4	17.1	
	BH 13-34	4860350.0	366245.0	131.8	17.1	
	BH 13-35	4860464.0	366268.0	117.9	6.4	
	BH 13-36	4860427.0	366329.0	120.9	6.6	
	BH 13-37	4860429.0	366380.0	119.0	5.8	
	BH 13-38	4860467.0	366422.0	119.8	5.5	

Prepared by: MWK, Checked by KJB

The field work was observed by members of our engineering and technical staff who located the boreholes, arranged for the clearance of underground services, observed the drilling, sampling and in situ testing operations, logged the boreholes, and examined and cared for the soil samples. The samples were identified in the field, placed in appropriate containers, labelled and transported to our Mississauga geotechnical laboratory

where the samples underwent further detailed visual examination and laboratory testing. All of the laboratory tests were carried out to MTO and/or ASTM Standards, as appropriate. Classification testing (water content, Atterberg limits and grain size distribution) was carried out on selected samples. The results of the laboratory classification testing are included in the associated appendices and are summarized on the Record of Borehole sheets.

4.0 SITE GEOLOGY AND SUBSURFACE CONDITIONS

4.1 Regional Geology

This section of Highway 401 is located within the Iroquois Plain physiographic region, as delineated in *The Physiography of Southern Ontario* (Chapman and Putnam, 1984)[1] and *Urban Geology of Canadian Cities* (Karrow and White, 1998)[2]. The Iroquois Plain, extending around the western shores of Lake Ontario, is comprised of the flat to undulating lakebed and beaches of the former glacial Lake Iroquois, which occupied this area during the last glacial recession.

The surficial soils in this area of the Iroquois Plain are typically comprised of glaciolacustrine clays, silts and sands to gravelly sands, which are underlain by an extensive till deposit that is mapped in this area as the Bowmanville Till. Within the area approximately bounded by Holt Road and Morgan's Road, the surficial glaciolacustrine deposits are absent or of limited thickness and the Bowmanville Till unit is frequently present immediately below the ground surface. Between these limits, an extensive surficial deposit of clayey silt to silty clay is present over the Bowmanville Till (Karrow and White, 1998). More recent alluvial deposits of gravel, sand, silt and/or clay are present in the valleys associated with Bowmanville Creek, Soper Creek, Wilmot Creek and Graham Creek.

The overburden soils are underlain by limestone bedrock of the Lindsay Formation, Simcoe Group (Geological Survey of Canada, 1991).[3]

4.2 Subsurface Conditions

Reference is made to Appendices A to H which include the Borehole Location and Soil Strata Drawings, the Record of Boreholes and the laboratory test results for High Fill/Deep Cut Areas 1 to 8, respectively. An overall description of the stratigraphy at each site is given in the following sections. However, the factual data presented in the Record of Borehole Sheets governs any interpretation of the site conditions.

The stratigraphic boundaries shown on the Record of Boreholes and on the interpreted stratigraphic sections (Drawings A1, B1, C1, D1, E1, F1, G1, H1 and H2) are inferred from non-continuous sampling and therefore represent transitions between soil types rather than exact planes of geological change. The subsoil conditions will vary between and beyond the borehole locations.

4.3 High Fill Area 1 – Holt Road STA 10+050 to STA 10+170

The plan and profile along the centreline of the new Holt Road alignment showing the borehole locations and interpreted stratigraphy between about STA 10+050 and STA 10+170 are shown on Drawing A1 in Appendix A.

[1] Chapman, L.J., and Putnam, D.F., 1984. *The Physiography of Southern Ontario*, 3rd Edition. Ontario Geological Survey, Special Volume 2. Ontario Ministry of Natural Resources.

[2] Karrow, P. F., and White, O. L., 1998. *Urban Geology of Canadian Cities.* Geological Association of Canada Special Paper No. 42. St. John's, Nfld.

[3] Ontario Geological Society, 1991. *Geology of Ontario*. Special Volume 4, Part 1. Eds. P.C. Thurston, H.R. Williams, R.H. Sutcliffe and G.M. Stott. Ministry of Northern Development and Mines, Ontario.

The proposed roadway embankment will be up to about 9 m high relative to existing grade. A total of seven (7) boreholes (Boreholes 13-1 to 13-4, 13-15, 13-23 and 13-50) were completed to investigate the subsurface conditions within this High Fill Area. The topography of this section of proposed roadway is generally flat and low-lying, encompassing a wet grassy area.

In general, the subsurface soils along the new Holt Road alignment in this area consist of a surficial layer of topsoil, in places underlain by clayey silt fill, underlain by a till deposit comprised of clayey silt with sand. At Borehole 13-2, which was drilled through the existing Holt Road embankment, encountered asphalt at ground surface underlain by cohesive and non-cohesive fill which was underlain by the till deposit.

4.3.1 Asphalt

An approximately 150 mm thick layer of asphalt was encountered at ground surface in Borehole 13-2 which was drilled through the existing Holt Road embankment.

4.3.2 Topsoil

A 0.3 m to 0.5 m thick surficial layer of topsoil was encountered at the ground surface in Boreholes 13-1, 13-3, 13-4, 13-15, 13-23 and 13-50.

4.3.3 Sand Fill

A fill deposit consisting of brown sand, some gravel, trace silt was encountered below the asphalt in Borehole 13-2. The surface of this deposit was encountered at a depth of about 0.2 m below ground surface (Elevation 116.1 m) and its thickness is about 0.6 m.

The natural water content measured on one sample of this deposit is about 3 per cent.

4.3.4 Clayey Silt Fill

A fill deposit consisting of brown sandy clayey silt, to clayey silt, trace to some sand, trace to some gravel, containing trace organics was encountered below the granular fill in Borehole 13-2, and beneath the topsoil in Boreholes 13-1, 13-3, 13-15 and 13-50. The surface of this deposit was encountered at depths between about 0.3 m and 0.8 m below ground surface (Elevation 110.6 m to 115.5 m) and its thickness ranges from about 0.4 m to 4.8 m.

Standard Penetration Test SPT ‘N’-values recorded within the cohesive fill range between 16 blows and 106 blows per 0.3 m of penetration suggesting that the clayey silt fill has a very stiff to hard consistency.

The natural water content measured on samples of this fill deposit range from about 13 per cent to 22 per cent.

Grain size distribution test results of three samples from this deposit are shown on Figure A1 in Appendix A.

Atterberg limits tests were carried out on two specimens of the clayey silt fill deposit and measured liquid limits of 20 per cent and 27 per cent, plastic limits of 13 per cent and 14 per cent and plasticity indices of 7 per cent and 14 per cent. The results of the Atterberg limits tests are shown on the plasticity chart on Figure A2 in Appendix A and indicate that the material is a clayey silt of low plasticity.

4.3.5 Clayey Silt Till

A till deposit consisting of brown to grey clayey silt with sand, trace to some gravel, was encountered below the topsoil or fill deposits (where present) in all of the boreholes advanced within this high fill section. The clayey silt

till deposit contains cobbles and boulders at various depths as inferred from grinding of the augers during drilling operations. The surface of this deposit was encountered between about 0.4 m and 5.6 m below ground surface (Elevation 109.7 m to 113.1 m) and it was not fully penetrated in any of the boreholes to depths of up to 9.2 m below ground surface (Elevation 101.8 m).

SPT 'N'-values recorded within this till deposit range between 21 blows per 0.3 m of penetration and 100 blows per 0.03 m of penetration, but are generally greater than 100 blows per 0.3 m of penetration, suggesting that the clayey silt till has a very stiff to hard, but generally hard consistency.

The natural water content measured on samples of this till deposit ranges from about 5 per cent to 14 per cent.

Grain size distribution test results of fourteen samples from this deposit are shown on Figure A3 in Appendix A.

Atterberg limits tests were carried out on six specimens of the clayey silt till deposit and measured liquid limits ranging from 13 per cent to 28 per cent, plastic limits ranging from 10 per cent to 14 per cent, and plasticity indices ranging from 2 per cent to 14 per cent. The results of the Atterberg limits tests are shown on the plasticity chart on Figure A4 in Appendix A and indicate that the material is a clayey silt of low plasticity with zones that may be classified as silt of slight plasticity.

4.3.6 Groundwater Conditions

In general, the samples taken in the boreholes were moist. Water levels observed in the boreholes during or upon completion of drilling range from about Elevation 105.5 m to Elevation 112.6 m, measured at depths between about 0.9 m to 7.3 m below ground surface.

It should be noted that the water levels measured during or on completion of the drilling operations have not stabilized and do not accurately reflect the groundwater table elevation at this site. Further, the water level at the site is expected to fluctuate seasonally in response to changes in precipitation and snow melt, and is expected to be higher during the spring season and periods of precipitation.

4.4 High Fill Area 2 – E-N/S Ramp – STA 9+850 to STA 9+970

The plan and profile along the centreline of the new E-N/S Ramp alignment showing the borehole locations and interpreted stratigraphy between about STA 9+850 and STA 9+970 are shown on Drawing B1 in Appendix B. The proposed ramp embankment will be up to about 4.5 m high relative to existing grade. A total of three (3) boreholes (Boreholes 13-12 to 13-14) were completed to investigate the subsurface conditions within this potential high fill area. The topography of this section of proposed ramp is flat and low-lying, encompassing a farm field and wooded area.

In general, the subsurface soils along the new E-N/S ramp alignment in this area consist of a surficial layer of topsoil underlain by deposits of cohesive and non-cohesive fill which are in turn underlain by a sand and silt till deposit.

4.4.1 Topsoil

A 0.4 m thick surficial layer of topsoil was encountered at the ground surface in all of the boreholes advanced within this high fill embankment section.

SPT 'N'-values measured within the topsoil deposit range between 13 blows and 16 blows per 0.3 m of penetration, suggesting a firm to stiff consistency.

4.4.2 Sandy Silt Fill

A fill deposit consisting of brown sandy silt, some gravel, trace clay trace organics was encountered below the topsoil in Borehole 13-13. The top of this deposit was encountered at about Elevation 97.6 m and its thickness is about 0.3 m.

4.4.3 Clayey Silt Fill

A fill deposit consisting of brown clayey silt with sand to some sand, trace gravel trace organics, was encountered below the granular fill in Borehole 13-13, and below the topsoil in Boreholes 13-12 and 13-14. The top of this deposit varies between about Elevation 98.1 m and 94.7 m and its thickness ranges from about 0.6 m to 1.0 m.

SPT 'N'-values recorded within the cohesive fill are 13 blows and 19 blows per 0.3 m of penetration suggesting that the clayey silt fill has a stiff to very stiff consistency.

The natural water content measured on two samples of this fill deposit is about 14 per cent and 18 per cent.

Grain size distribution test results of two samples of this deposit are shown on Figure B1 in Appendix B.

Atterberg limits tests were carried out on two specimens of the cohesive fill deposit and measured liquid limits of about 24 per cent and 29 per cent, plastic limits of about 15 per cent and plasticity indices of about 10 per cent and 14 per cent. The results of the Atterberg limits tests are shown on the plasticity chart on Figure B2 in Appendix B and indicate that the material is classified clayey silt of low plasticity.

4.4.4 Silt and Sand Till

A till deposit consisting of silt and sand, trace to some gravel, trace to some clay, was encountered below the cohesive fill deposit in all of the boreholes advanced within this high fill section. The presence of cobbles and boulders within the fill deposit is inferred from grinding of the augers as the boreholes were advanced. The top of this deposit varies between about Elevation 97.5 m and 93.7 m and it was not fully penetrated in any of the boreholes to depths of up to 6.3 m below ground surface (Elevation 88.9 m).

SPT 'N'-values recorded within this till deposit range between 53 blows per 0.3 m of penetration and 63 blows per 0.05 m of penetration, but are generally greater than 100 blows per 0.3 m of penetration indicating that the silt and sand till has a very dense relative density.

The natural water content measured on samples of this till deposit ranges from about 5 per cent to 8 per cent.

Grain size distribution test results of six samples from this deposit are shown on Figure B3 in Appendix B.

Atterberg limits tests were carried out on three specimens of the sand and silt till deposit and measured liquid limits ranging from about 12 per cent to 13 per cent, plastic limits of about 10 per cent, and plasticity indices ranging from about 2 per cent to 4 per cent. The results of the Atterberg limits tests are shown on the plasticity chart on Figure B4 in Appendix B and indicate that the fines material is a silt of slight plasticity.

4.4.5 Groundwater Conditions

In general, the samples taken in the boreholes were moist. Water levels observed in the boreholes during or upon completion of drilling range from about Elevation 94.6 m to 92.1 m, measured at depths between about 3.0 m to 5.9 m below ground surface.

It should be noted that the water levels measured during or on completion of the drilling operations have not stabilized and do not accurately reflect the groundwater table elevation at this site. Further, the water level at the site is expected to fluctuate seasonally in response to changes in precipitation and snow melt, and is expected to be higher during the spring season and periods of precipitation.

4.5 High Fill Area 3 –E-N/S Ramp – STA 10+200 to STA 10+500

The plan and profile along the centreline of the new Highway 401/Holt Road E-N/S Ramp alignment showing the borehole locations and interpreted stratigraphy between about STA 10+200 and STA 10+500 are shown on Drawing C1 in Appendix C. The proposed ramp embankment will be up to about 4.5 m high relative to existing grade. A total of seven (7) boreholes (Boreholes 13-5 to 13-11) were completed to investigate the subsurface conditions within this high fill area. The topography of this section of proposed roadway is generally flat and low-lying, encompassing a farm field.

In general, the subsurface soils along the new E-N/S ramp alignment in this area consist of a surficial layer of topsoil underlain by a deposit of clayey silt to silty sand which is underlain by till deposits consisting of silt and sand and clayey silt with sand.

4.5.1 Topsoil

A 0.2 m to 0.7 m thick deposit of topsoil was encountered at the ground surface in all of the boreholes advanced within this high fill area.

SPT ‘N’-values measured within the topsoil deposit range between 2 blows and 23 blows per 0.3 m of penetration suggesting a soft to very stiff consistency.

4.5.2 Clayey Silt Fill

A fill deposit consisting of brown clayey silt with sand, some gravel containing rootlets and trace organics, was encountered below the topsoil in Borehole 13-5, located adjacent to the existing Highway 401 Westbound lanes embankment. The surface of this deposit was encountered at about 0.4 m below ground surface (Elevation 102.4 m) and its thickness is about 0.8 m.

One SPT ‘N’-value recorded within this cohesive fill deposit is 32 blows per 0.3 m of penetration suggesting a hard consistency.

The natural water content measured on one sample of this fill deposit is about 17 per cent.

The result of a grain size distribution test of one sample from this deposit is shown on Figure C1 in Appendix C.

An Atterberg limits test was carried out on one specimen of the clayey silt fill deposit and measured a liquid limit of 22 per cent, a plastic limit of 12 per cent, and a plasticity index of 10 per cent. The result of the Atterberg limits test is shown on the plasticity chart on Figure C2 in Appendix C and indicates that the material is a clayey silt of low plasticity.

4.5.3 Clayey Silt

A cohesive soil deposit consisting of brown clayey silt, some sand, trace to some gravel, trace organics (i.e. rootlets), was encountered below the topsoil in Boreholes 13-6 to 13-8. The presence of cobbles and boulders within this deposit is inferred from grinding of augers as the boreholes were advanced. The surface of this

deposit was encountered between about 0.5 m and 0.7 m below ground surface (Elevation 105.1 m to 102.2 m) and its thickness ranges from about 0.6 m to 0.9 m.

SPT 'N'-values recorded within this deposit range between 8 blows and 24 blows per 0.3 m of penetration suggesting that the clayey silt deposit has a stiff to very stiff consistency.

The natural water content measured on samples of this deposit ranges from about 24 per cent to 27 per cent.

The grain size distribution test results of three samples from this deposit are shown on Figure C3 in Appendix C.

Atterberg limits tests were carried out on three specimens of the clayey silt deposit and measured liquid limits ranging from about 30 per cent to 32 per cent, plastic limits ranging from about 12 per cent to 14 per cent, and the plasticity indices ranging from about 17 per cent to 18 per cent. The results of the Atterberg limits tests are shown on the plasticity chart on Figure C4 in Appendix C and indicate that the material is a clayey silt of low plasticity.

4.5.4 Silty Sand, Silt and Sand to Sand and Gravel

A granular deposit consisting of silt and sand to sand and gravel, trace to some clay, was encountered below the clayey silt deposit in Borehole 13-7 and a silty sand deposit was encountered below the topsoil in Borehole 13-10. The presence of cobbles and boulders within this deposit is inferred from grinding of augers as the boreholes were advanced. The surface of these granular deposits was encountered at depths of about 0.2 m and 1.1 m below ground surface (Elevation 108.3 m and 102.9 m, respectively) and the thickness of the deposits is about 0.5 m and 3.2 m in Boreholes 13-10 and 13-7, respectively.

SPT 'N'-values recorded within these granular deposits range between 31 blows per 0.3 m of penetration and 100 blows or greater per 0.03 m of penetration in the silt and sand to sand and gravel deposit and 31 blows per 0.3 m of penetration in the silty sand deposit, indicating a dense to very dense relative density.

The natural water content measured on samples of the silty sand to sand and gravel deposit range from about 1 per cent to 7 per cent.

The grain size distribution test result of one sample of the silt and sand deposit from Borehole 13-7 is shown on Figure C5 in Appendix C.

4.5.5 Silt and Sand to Sand Till

A till deposit consisting of silt and sand to sand, trace to some gravel, trace to some clay, containing cobbles and boulders, was encountered below the cohesive fill deposit in Borehole 13-5, below the clayey silt deposit in Boreholes 13-6 and 13-8 and below the silty sand deposit in Borehole 13-10. The presence of cobbles and boulders within this deposit is inferred from grinding of augers as the boreholes were advanced. The surface of this deposit was encountered between about 0.7 m and 1.4 m below ground surface (Elevations 107.7 m to 101.5 m) and its thickness was between 3.0 m and 4.8 m in Boreholes 13-10 and 13-8, respectively, where it was fully penetrated, and is 3.5 m and 4.8 m thick in Boreholes 13-5 and 13-6 where it was not fully penetrated.

SPT 'N'-values recorded within this till deposit range between 57 blows per 0.3 m of penetration and 100 blows per 0.08 m of penetration, but are generally greater than 100 blows per 0.3 m of penetration, indicating that the silt and sand to sand till deposit has a very dense relative density.

The natural water content measured on samples of this till deposit range from about 4 per cent to 14 per cent.

Grain size distribution test results of five samples from this deposit are shown on Figure C6 in Appendix C.

Atterberg limits tests were carried out on three specimens of the silt and sand till deposit and measured liquid limits ranging from about 12 per cent to 14 per cent, plastic limits ranging from about 10 per cent to 11 per cent, and plasticity indices ranging from about 2 per cent to 3 per cent. The results of the Atterberg limits tests are shown on the plasticity chart on Figure C7 in Appendix C and indicate that the fines portion of this deposit consist of a silt of slight plasticity.

4.5.6 Clayey Silt Till

A till deposit consisting of brown to grey clayey silt with sand to trace sand, trace to some gravel, was encountered below the sand and gravel in Borehole 13-7, below the topsoil in Boreholes 13-9 and 13-11 and below the silt and sand to sand till in Boreholes 13-8 and 13-10. The presence of cobbles and boulders within this deposit is inferred from grinding of augers as the boreholes were advanced. The surface of this deposit was encountered between about 0.4 m and 6.2 m below ground surface (Elevation 109.3 m to 99.4 m) and the deposit is between 1.6 m and 4.3 m thick but was not fully penetrated in any of the boreholes to depths of up to 7.8 m below ground surface (Elevation 96.2 m).

SPT 'N'-values recorded within this till deposit range between 96 blows per 0.3 m of penetration and 100 blows per 0.05 m of penetration, indicating that the clayey silt till has a hard consistency.

The natural water content measured on samples of this till deposit range from about 4 per cent to 18 per cent.

The grain size distribution test results of six samples from this deposit are shown on Figure C8 in Appendix C.

Atterberg limits tests were carried out on seven specimens of the clayey silt till deposit and measured liquid limits ranging from about 13 per cent to 34 per cent, plastic limits ranging from about 9 per cent to 14 per cent and plasticity indices ranging from about 4 per cent to 20 per cent. The results of the Atterberg limits tests are shown on the plasticity chart on Figure C9 in Appendix C and indicate that the material is classified as clayey silt of low plasticity.

4.5.7 Groundwater Conditions

In general, the samples taken in the boreholes were moist. Water levels observed in the boreholes during or upon completion of drilling range from about Elevation 104.7 m to 99.0 m, measured at depths between about 0.9 m and 3.7 m below ground surface. Boreholes 13-9 and 13-11 were dry upon completion of drilling.

It should be noted that the water levels measured during or on completion of drilling operations have not stabilized and do not accurately reflect the groundwater table elevation at this site. Further, the water level at the site is expected to fluctuate seasonally in response to changes in precipitation and snow melt, and is expected to be higher during the spring season and periods of precipitation.

4.6 High Fill Area 4 –N/S-E Ramp - STA 9+610 to STA 9+740

The plan and profile along the centreline of the new Highway 401/Holt Road N/S-E Ramp alignment showing the borehole locations and interpreted stratigraphy between about STA 9+610 and STA 9+740 are shown on Drawing D1 in Appendix D. The proposed ramp embankment will be up to about 7 m high relative to existing grade. A total of four (4) boreholes (Boreholes 13-15 to 13-18) were completed to investigate the subsurface

conditions within this high fill area. The topography of this section of proposed ramp is generally flat and low-lying, encompassing a wet grassy area and the existing South Service Road alignment.

In general, the subsurface soils along the new N/S-E Ramp alignment in this area consist of a layer of topsoil underlain by deposits of sandy silt to sand and gravel fill and/or clayey silt fill, which are underlain by a clayey silt with sand till deposit or a silt and sand till deposit.

4.6.1 Topsoil

A 0.2 m to 0.4 m thick layer of topsoil was encountered at the ground surface in all of the boreholes advanced within this high fill area.

4.6.2 Sandy Silt to Sand and Gravel Fill

A granular fill deposit consisting of sandy silt, trace gravel to sand and gravel, trace to some silt, trace clay, trace organics, was encountered below the topsoil in Boreholes 13-18 and 13-17. The surface of this granular deposit was encountered at depths of 0.2 m and 0.3 m below ground surface (Elevation 109.8 m and 108.4 m) and its thickness is 1.9 m and 0.5 m in Boreholes 13-17 and 13-18, respectively.

SPT 'N'-values recorded within this granular fill deposit range between 16 blows and 58 blows per 0.3 m of penetration, indicating a compact to very dense relative density.

The natural water content measured on one sample of the sand and gravel portion of the fill deposit is 8 per cent.

4.6.3 Clayey Silt Fill

A fill deposit consisting of brown clayey silt, some sand to sandy, trace to some gravel, was encountered below the granular fill in Borehole 13-17, and below the topsoil in Boreholes 13-15 and 13-16. The surface of this deposit was encountered between about 0.4 m and 2.1 m below ground surface (Elevation 110.7 m to 107.9 m) and its thickness ranges from about 0.4 m to 1.0 m.

SPT 'N'-values recorded within this cohesive fill range between 13 blows and 28 blows per 0.3 m of penetration suggesting that the fill deposit has a stiff to hard consistency.

The natural water content measured on samples of this fill deposit range from about 14 per cent to 18 per cent.

The grain size distribution test results of three samples from this deposit are shown on Figure D1 in Appendix D.

Atterberg limits tests were carried out on three specimens of the clayey silt fill deposit and measured liquid limits ranging from about 22 per cent to 27 per cent, plastic limits ranging from about 10 per cent to 13 per cent, and plasticity indices ranging from about 9 per cent to 17 per cent. The results of the Atterberg limits tests are shown on the plasticity chart on Figure D2 in Appendix D and indicate that the material is a clayey silt of low plasticity.

4.6.4 Sand and Gravel

A deposit of sand and gravel some silt, trace clay, containing cobbles and boulders, was encountered below the fill deposits in Borehole 13-17. The presence of cobbles and boulders within this deposit is inferred from grinding of augers as the boreholes were advanced. The surface of this deposit was encountered at a depth of about 2.9 m below ground surface (Elevation 107.1 m) and its thickness is about 2.5 m.

SPT 'N'-values recorded within this granular deposit are 100 blows per 0.13 m of penetration and 100 blows per 0.05 m of penetration, indicating a very dense relative density.

The natural water content measured on a sample of this sand and gravel deposit is about 3 per cent.

4.6.5 Silt and Sand Till

A till deposit consisting of brown to grey silt and sand, trace to some clay, trace to some gravel, was encountered below the fill deposit in Borehole 13-18. The presence of cobbles and boulders within this deposit is inferred from grinding of augers as the boreholes were advanced. The surface of this deposit was encountered at about 0.8 m below ground surface (Elevation 107.9 m) and it was not fully penetrated up to a depth of 4.6 m below ground surface (Elevation 104.1 m).

SPT 'N'-values recorded within this till deposit range between 32 blows per 0.3 m of penetration and 100 blows or greater per 0.05 m of penetration indicating a dense to very dense relative density.

The natural water content measured on samples of this till deposit range from about 5 per cent to 9 per cent.

Grain size distribution test results of two samples of the silt and sand till deposit are shown on Figure D3 in Appendix D.

Atterberg limits tests were carried out on two specimens of the silt and sand till deposit and measured liquid limits of 13 per cent and 15 per cent, plastic limits of 10 per cent, and plasticity indices of 3 per cent and 5 per cent. The results of the Atterberg limits tests are shown on the plasticity chart on Figure D4 in Appendix D and indicate that the material is a slightly plastic silt.

4.6.6 Clayey Silt Till

A till deposit consisting of brown to grey clayey silt with sand, trace to some gravel, was encountered below the topsoil, sand and gravel, or fill deposits (where present) in Boreholes 13-15 to 13-17. The surface of this deposit was encountered between about 0.8 m and 5.4 m below ground surface (Elevation 109.7 m to 104.6 m) and it was not fully penetrated in any of the boreholes to depths of up to 7.7 m below ground surface (Elevation 102.4 m).

SPT 'N'-values recorded within this till deposit range between 54 blows per 0.3 m of penetration and 100 blows or greater per 0.1 m of penetration, suggesting a hard consistency.

The natural water content measured on samples of this till deposit range from about 5 per cent to 9 per cent.

Grain size distribution test results of seven samples of the clayey silt till deposit are shown on Figure D5 in Appendix D.

Atterberg limits tests were carried out on three specimens of the clayey silt till deposit and measured liquid limits ranging from about 14 per cent to 16 per cent, plastic limits of about 10 per cent, and plasticity indices ranging from 4 per cent to 6 per cent. The results of the Atterberg limits tests are shown on the plasticity chart on Figure D6 in Appendix D and indicate that the material is a clayey silt of low plasticity.

4.6.7 Groundwater Conditions

In general, the samples taken in the boreholes were moist to wet. Water levels observed in the boreholes during or upon completion of drilling range from about Elevation 108.2 m to 105.8 m, measured at depths between about 1.8 m and 4.3 m below ground surface. Borehole 13-18 was dry upon completion of drilling.

It should be noted that the water levels measured during or on completion of the drilling operations have not stabilized and do not accurately reflect the groundwater table elevation at this site. Further, the water level at the site is expected to fluctuate seasonally in response to changes in precipitation and snow melt, and is expected to be higher during the spring season and periods of precipitation.

4.7 High Fill Area 5 – N/S-W Ramp - STA 9+670 to STA 9+740

The plan and profiles along the centreline of the new Highway 401/Holt Road N/S-W Ramp alignment showing the borehole locations and interpreted stratigraphy between about STA 9+670 and STA 9+740 are shown on Drawing E1 in Appendix E. The proposed ramp embankment will be up to about 4 m high relative to existing grade. A total of three (3) boreholes (Boreholes 13-19 to 13-21) were completed to investigate the subsurface conditions within this high fill area. The topography of this section of proposed ramp is generally flat and low-lying, encompassing a farm field.

In general, the subsurface soils along the new N/S-W Ramp alignment in this area consist of a layer of topsoil underlain by a deposit of silty sand which is underlain by a silt and sand till deposit.

4.7.1 Topsoil

A 0.2 m to 0.3 m thick surficial layer of topsoil was encountered at the ground surface in all of the boreholes advanced within this high fill area.

4.7.2 Silty Sand

A granular deposit consisting of silty sand trace gravel, trace clay, trace organics (rootlets), was encountered below the topsoil in Boreholes 13-19 and 13-20. The surface of this deposit was encountered at depths of 0.3 m and 0.2 m below ground surface (Elevation 109.7 m and 108.9 m) and the deposit is 1.2 m and 0.5 m thick in Boreholes 13-19 and 13-20, respectively.

SPT ‘N’-values recorded within this granular deposit range between 16 blows and 73 blows per 0.3 m of penetration, indicating that the silty sand deposit has a compact to very dense relative density.

The natural water content measured on one sample of this silty sand deposit is about 11 per cent.

4.7.3 Silt and Sand Till

A till deposit consisting of sand and silt, trace to some gravel, trace to some clay, was encountered below the silty sand deposit in Boreholes 13-19 and 13-20 and below the topsoil in Borehole 13-21. The presence of cobbles and boulders within this deposit is inferred from grinding of augers as the boreholes were advanced. The surface of this deposit was encountered between about 0.2 m and 1.5 m below ground surface (between Elevations 108.5 m and 108.4 m) and the deposit is between 3.1 m and 5.5 m thick but was not fully penetrated in any of the boreholes advanced within this high fill area.

SPT 'N'-values recorded within this till deposit range between 27 blows per 0.3 m of penetration and 50 blows per 0.05 m of penetration, but are generally greater than 100 blows per 0.3 m of penetration indicating that the sand and silt till deposit has a compact to very dense, but generally very dense, relative density.

The natural water content measured on samples of this till deposit range from about 4 per cent to 9 per cent.

The grain size distribution test results of six samples from this deposit are shown on Figure E1 in Appendix E.

Atterberg limits tests were carried out on two specimens of the sand and silt till deposit. One test indicated that the material is non-plastic and one test measured a liquid limit of 14 per cent, a plastic limit of 10 per cent, and a corresponding plasticity index of 4 per cent. The results of the Atterberg limits tests are shown on the plasticity chart on Figure E2 and on the Record of Borehole sheets in Appendix E and indicate that the fines material of the deposit consists of non-plastic silt to silt of slight plasticity.

4.7.4 Groundwater Conditions

In general, the samples taken in the boreholes were moist. The open boreholes were all noted to be dry upon completion of drilling to depths of up to 6.2 m (Elevation 102.9 m).

It should be noted that the water levels measured during or on completion of the drilling operations have not stabilized and do not accurately reflect the groundwater table elevation at this site. Further, the water level at the site is expected to fluctuate seasonally in response to changes in precipitation and snow melt, and is expected to be higher during the spring season and periods of precipitation.

4.8 High Fill Area 6 – W- N/S Ramp STA 11+550 to STA 11+580

The plan and profile along the centreline of the new Highway 401/Holt Road W-N/S Ramp alignment showing the borehole locations and interpreted stratigraphy between about STA 11+550 and STA 11+580 are shown on Drawing F1 in Appendix F. The proposed ramp embankment will be up to about 5.5 m high relative to existing grade. A total of two (2) boreholes (Boreholes 13-23 and 13-2) were completed to investigate the subsurface conditions within this high fill area. The topography of this section of proposed roadway is generally flat and low-lying, encompassing a wet grassy field with areas of shallow standing water near the existing Holt Road drainage ditches.

In general, the subsurface soils along the new ramp alignment in this area consist of asphalt at ground surface underlain by cohesive and non-cohesive fill which is underlain by a clayey silt till deposit at the borehole drilled through the existing Holt Road embankment and a layer of topsoil underlain by a deposit of clayey silt till at the toe of the embankment..

4.8.1 Asphalt

An approximately 150 mm thick layer of asphalt was encountered at ground surface in Borehole 13-2.

4.8.2 Sand Fill

A fill deposit consisting of brown sand, some gravel, trace silt was encountered below the asphalt in Borehole 13-2. The surface of this deposit was encountered at a depth of about 0.2 m below ground surface (Elevation 116.1 m) and its thickness is about 0.6 m.

The natural water content measured on one sample of this fill deposit is about 3 per cent.

4.8.3 Clayey Silt Fill

A fill deposit consisting of brown to grey clayey silt, some sand to sandy, trace to some gravel trace organics (rootlets), was encountered below the granular fill in Borehole 13-2. The surface of this deposit was encountered at a depth of about 0.8 m below ground surface (Elevation 115.5 m) and its thickness is about 4.8 m.

SPT 'N'-values recorded within the cohesive fill deposit range between 23 blows and 106 blows per 0.3 m of penetration suggesting that the clayey silt fill deposit has a very stiff to hard consistency.

The natural water content measured on two samples of this fill deposit are 13 per cent and 15 per cent.

The grain size distribution test results of two samples from this fill deposit are shown on Figure F1 in Appendix F.

An Atterberg limits test carried out on one specimen of the clayey silt fill deposit measured a liquid limit of about 20 per cent, a plastic limit of about 13 per cent, and a plasticity index of about 7 per cent. The result of the Atterberg limits test is shown on the plasticity chart on Figure F2 in Appendix F and indicates that the material is a clayey silt of low plasticity.

4.8.4 Topsoil

A 0.5 m thick surficial layer of topsoil was encountered at the ground surface in Borehole 13-23.

4.8.5 Clayey Silt Till

A till deposit consisting of brown to grey clayey silt with sand, trace to some gravel, was encountered below the topsoil or fill deposits (where present) in both of the boreholes advanced within this high fill section. The presence of cobbles and boulders within this deposit is inferred from grinding of augers as the boreholes were advanced. The surface of this deposit was encountered at depths of about 0.5 m and 5.6 m below ground surface (Elevation 112.7 m and 110.7 m) and the thickness of the deposit is 5.7 m and 1.1 m in Boreholes 13-23 and 13-2, respectively, but the deposit was not fully penetrated in either borehole.

SPT 'N'-values recorded within this till deposit range between 36 blows per 0.3 m of penetration and 100 blows per 0.03 m of penetration, but are generally greater than 100 blows per 0.3 m of penetration, suggesting that the clayey silt till deposit has hard a consistency.

The natural water content measured on samples of this till deposit ranges from about 5 per cent to 9 per cent.

The grain size distribution test results of three samples from this deposit are shown on Figure F3 in Appendix F.

Atterberg limits tests were carried out on two specimens of the clayey silt till deposit and measured liquid limits of about 14 per cent and 15 per cent, plastic limits of about 10 per cent, and plasticity indices of about 4 per cent and 5 per cent. The results of the Atterberg limits tests are shown on the plasticity chart on Figure F4 in Appendix F and indicate that the material is a clayey silt of low plasticity.

4.8.6 Groundwater Conditions

In general, the samples taken in the boreholes were moist to wet. The water levels observed in Boreholes 13-23 and 13-2 during or upon completion of drilling were at about Elevation 108.6 m, measured at depths of about 4.9 m and 7.3 m below ground surface in the respective boreholes.

It should be noted that the water levels measured during or on completion of the drilling operations have not stabilized and do not accurately reflect the groundwater table elevation at this site. Further, the water level at the site is expected to fluctuate seasonally in response to changes in precipitation and snow melt, and is expected to be higher during the spring season and periods of precipitation.

4.9 Deep Cut Area 7 – South Service Road STA 13+160 to STA 13+265

The plan and profile along the centreline of the new South Service Road alignment extending to the west of the new Holt Road alignment showing the borehole locations and interpreted stratigraphy between about STA 13+160 and STA 13+265 are shown on Drawing G1 in Appendix G. A cut up to about 9 m deep will be required to achieve the proposed roadway profile within this area. A total of three (3) boreholes (Boreholes 13-39 to 13-41) were completed to investigate the subsurface conditions within this cut area. The topography of this section of proposed roadway is relatively elevated compared to the adjacent land east and west of the proposed cut area. As described in Part C of the as built report for the Darlington Nuclear Power Plant (Ontario Hydro, 1981) this deep cut extends through a soil mound described to have been constructed primarily of “topsoil” stripped from other areas of the OPG site as part of the construction of the switch yard and tower pads in 1978 and 1979. No details are given in the report on the construction (i.e. method of placement, compaction, etc.) or soil classification of the “topsoil” mound.

In general, the subsurface soils along the new South Service Road alignment in the proposed cut area consist of a layer of topsoil underlain by a deposit of clayey silt fill, trace organics, which is underlain by a sand and silt to sandy silt till deposit.

4.9.1 Topsoil

A 0.4 m to 0.5 m thick surficial layer of topsoil was encountered at the ground surface in the three boreholes advanced within this deep cut area.

SPT ‘N’-values measured within the topsoil layer range from 8 blows to 13 blows per 0.3 m of penetration, suggesting a stiff consistency.

The natural water content measured on two samples of the topsoil layer are about 20 per cent and 22 per cent.

4.9.2 Clayey Silt Fill

A fill deposit consisting of clayey silt with sand, trace gravel, trace organics was encountered below the topsoil in all of the boreholes advanced within this cut area. The surface of this fill deposit was encountered at depths between about 0.4 m and 0.5 m below ground surface (between Elevations 130.5 m to 126.0 m) and the thickness of the deposit ranges from about 2.3 m to 3.9 m.

SPT ‘N’-values measured within this fill deposit range between 7 blows and 32 blows per 0.3 m of penetration, suggesting that the clayey silt fill deposit has a firm to hard consistency.

The natural water content measured on samples of the clayey silt fill deposit ranges from 18 per cent to 27 per cent with the higher moisture content indicative of observed higher organic content.

The grain size distribution test results of four samples from this deposit are shown on Figure G1 in Appendix G.

An Atterberg limits test was carried out on one specimen of the clayey silt fill deposit and measured a liquid limit of about 29 per cent, a plastic limit of about 17 per cent, and a plasticity index of about 12 per cent. The result of

the Atterberg limits test are shown on the plasticity chart on Figure G2 in Appendix G and indicate that the material is classified as a clayey silt of low plasticity.

4.9.3 Silt to Silt and Sand Till

A till deposit consisting of silt to sandy silt to silt and sand, trace to some gravel, trace to some clay, was encountered below the fill deposit in the three boreholes advanced within this cut area. The presence of cobbles and boulders within this deposit is inferred from grinding of augers as the boreholes were advanced. The surface of the till deposit was encountered at depths between about 2.7 m and 4.4 m below ground surface (between Elevations 123.7 m and 126.6 m) and the thickness of the deposit is between 3.5 m and 7.9 m but the deposit was not fully penetrated in any of the boreholes.

SPT 'N'-values measured within this till deposit range between 45 blows per 0.3 m of penetration and 100 blows per 0.13 m of penetration, but are generally greater than 100 blows per 0.3 m of penetration, indicating that the silt to silt and sand till deposit has a dense to very dense, but generally very dense, relative density.

The natural water content measured on samples of this till deposit range from about 6 per cent to 15 per cent.

The grain size distribution test results of five samples from this deposit are shown on Figure G3 in Appendix G.

Atterberg limits tests were carried out on four specimens of the silt to silt and sand till deposit. One test indicates that the fines portion of the sample is non-plastic. Three tests measured liquid limits ranging from about 13 per cent to 19 per cent, plastic limits ranging from about 10 per cent to 15 per cent and plasticity indices ranging from about 1 per cent to 4 per cent. The results of the Atterberg limits tests are shown on the plasticity chart on Figure G4 in Appendix G and indicate that the fines portion of the till samples consists of silt of slight plasticity.

4.9.4 Groundwater Conditions

In general, the samples taken in the boreholes were moist. Water levels observed in the boreholes during or upon completion of drilling range from about Elevation 125.5 m to 120.3 m, measured at a depth ranging from about 5.5 m to 7.7 m below ground surface.

It should be noted that the water levels measured during or on completion of the drilling operations have not stabilized and do not accurately reflect the groundwater table elevation at this site. Further, the water level at the site is expected to fluctuate seasonally in response to changes in precipitation and snow melt, and is expected to be higher during the spring season and periods of precipitation.

4.10 Deep Cut Area 8 – South Service Road (Soil Disposal Mound), STA 11+850 to STA12+500

The plan and profile along the proposed cut side slope of the new South Service Road alignment showing the borehole locations and interpreted stratigraphy between about STA 11+850 and STA 12+500 are shown on Drawing H1, and various cross-sections through the cut area are shown on Drawing H2, in Appendix H. A cut of up to about 17 m deep will be required to achieve the proposed roadway profile within this area which is located within the soil disposal mound on OPG property. A total of fifteen (15) boreholes (Boreholes 13-24 to 13-38) were completed to investigate the subsurface conditions within this cut area.

With reference to the draft proposed South Service Road West (Solina Road to Park Road) realignment plan and typical cross sections provided by URS (Drawings 1 to 3, dated September 2013), the ground surface at the

crest of the existing OPG soil disposal mound parallel to the proposed cut ranges from about Elevation 125 m to Elevation 130 m with slope heights ranging from about 12 m to 17 m high relative to the ground surface along the existing South Service Road. The existing north facing slope of the soil disposal mound is inclined at 4 Horizontal to 1 Vertical (4H:1V) with 2 m wide benches located about every 5 metres vertical height.

As described in the as-built report for the Darlington Nuclear Power Plant (Ontario Hydro, 1981), the existing soil disposal mound consists of soil excavated for construction of the Darlington Nuclear Power facility. The as-built report indicates that the soil mound was constructed as a means of disposing of deleterious material or overburden not suited or required for construction or backfilling of structures. The proposed cut area for the South Service Road alignment is located along the northern portion of the soil disposal mound (i.e. north of the interface, as shown on Figure 1 of the as-built report) where interglacial soils (i.e. fine sand and silt) were deposited. The soil mound in this area was constructed by end dumping the interglacial soils and allowing the piles to air dry for 3 to 4 days, then levelling the piles into approximately 1 m thick lifts. During winter conditions the soil piles did not drain effectively due to freezing, and as a result the contractor was allowed to end-dump soil in approximately 3 m thick lifts. The as-built report indicates that compaction of the soil that was spread in 1 m thick lifts achieved approximately 88 per cent of the Standard Proctor Maximum Dry Density. The as-built report indicates that, during construction, water was observed to be continually flowing from the pile at the base of the north face and that boils at the top of the pile were occurring during soil placement. In order to control erosion caused by water seepage, shot-rock was placed at specified locations on the face of the soil disposal mound.

The ground cover on the existing soil disposal mound slope consists of grasses and small shrubs, with sparse small trees as observed during site visits in 2012 and during the recent borehole drilling in 2013. Areas of dense tree cover are present at the toe and base of the north facing slope and along the existing Waterfront Trail, parallel to and south of the existing South Service Road.

In general, the subsurface soils along the new South Service Road alignment in this area consist of a surficial fill deposit consisting of silt and sand to clayey silt with sand, containing interlayers/pockets of sand and silty clay throughout. The fill is generally underlain by a till deposit comprised of hard clayey silt with sand.

4.10.1 Topsoil

A 0.7 m and 0.5 m thick layer of dark brown topsoil was encountered at the ground surface in Boreholes 13-37 and 13-38, respectively.

The SPT ‘N’-values measured within the topsoil layer are 34 blows and 9 blows per 0.3 m penetration, suggesting a stiff to hard consistency.

The natural water content measured on two samples of the topsoil layer are about 4 per cent and 11 per cent.

4.10.2 Fill (Soil Disposal Mound)

A deposit of fill was encountered from ground surface in Boreholes 13-24 to 13-36 and below the topsoil in Boreholes 13-37 and 13-38. The fill deposit is comprised of an heterogeneous mixture, pockets and layers of both cohesive and non-cohesive soils. The cohesive fill generally consists of clayey silt with sand and pockets of silty clay, and the non-cohesive fill generally consists of sandy silt to sand and silt to silty sand, trace to some gravel. In Borehole 13-29, a 0.8 m thick surficial layer of cobbles and boulders (rockfill) was encountered at the ground surface. Trace organics, were frequently encountered in the upper 1 m to 1.5 m depth of the fill and increased organic content (i.e. wood fragments) was encountered in Borehole 13-35. The overall thickness of

the fill deposit ranges from 1.4 m to greater than 17.2 m at the borehole locations, although several of the boreholes did not fully penetrate the fill mound.

The fill mound can be roughly described as consisting of an upper deposit of sandy silt to silt and sand to sand, underlain by an intermediate layer of clayey silt with sand and a lower layer of sandy silt, in places underlain by a lower layer of clayey silt to silty clay, as shown in the profile and cross-sections on Drawings H1 and H2 in Appendix H.

SPT 'N'-values recorded within the portions of the mound comprised of non-cohesive fill range between 7 blows per 0.3 m of penetration and 50 blows per 0.08 m of penetration, indicating that the non-cohesive fill deposits have a loose to very dense relative density, but typically a dense to very dense relative density. SPT 'N'-values recorded within the portion of the mound comprised of cohesive fill range between 6 blows per 0.3 m of penetration and 50 blows per 0.05 m of penetration, suggesting that the cohesive fill has firm to hard, but typically a hard consistency.

The natural water content measured on samples of the fill deposits range from about 4 per cent to 16 per cent for the non-cohesive fill and from about 8 per cent to 20 per cent for the cohesive fill. Moisture contents of 23 per cent and 50 per cent were measured on a pocket of silty clay and organics in Borehole 13-29 and 13-35 respectively.

The grain size distribution test results of sixteen samples from the non-cohesive portions of the fill deposit are shown on Figure H1 in Appendix H.

Two Atterberg Limits tests on samples of the sandy silt fill indicate a non-plastic condition on one sample and measured a liquid limit of about 15 per cent, a plastic limit of about 12 per cent and a plasticity index of about 3 per cent as presented on Figure H2 in Appendix H.

The grain size distribution test results of sixteen samples from the cohesive portions of the fill deposit are shown on Figure H3 in Appendix H.

Atterberg limits tests were carried out on eleven specimens of the cohesive fill deposit and measured liquid limits ranging from about 16 per cent to 38 per cent, plastic limits ranging from 9 per cent to 16 per cent and plasticity indices ranging from 2 per cent to 23 per cent. The results of the Atterberg limits tests on samples of the cohesive fill are shown on the plasticity chart on Figure H4 in Appendix H and indicate that the cohesive fill soils typically consist of clayey silt of low plasticity with two test results indicating silty clay (pockets) in Borehole 13-25 and 13-29 of intermediate plasticity.

A portion of the soil samples not tested for soil classification were combined and mixed thoroughly to create a bulk/composite sample of the overall fill deposit for Standard Proctor maximum dry density testing. The moisture content of the composite sample was about 11 per cent and the results of the Standard Proctor maximum dry density test indicate that the maximum dry density of the composite sample is 1,989 kg/m^3 at an optimum moisture content of about 10 per cent. The results of the Standard Proctor maximum dry density test are shown on Figure H5 in Appendix H.

4.10.3 Clayey Silt Till

A till deposit consisting of brown to grey clayey silt with sand, trace to some gravel to gravelly, was encountered below the fill deposit in all of the boreholes that penetrated the soil disposal mound within this cut section

(Boreholes 13-24 to 13-29, 13-31, 13-35 and 13-38). The presence of cobbles and boulders within this deposit is inferred from grinding of augers as the boreholes were advanced. The surface of the till deposit was encountered between about 1.4 m and 14.6 m below ground surface (Elevation 109.4 m to 117.1 m) and the thickness of the deposit ranges from 1.1 m to 8 m but the deposit was not fully penetrated in any of the boreholes to depths of up to 18.7 m below ground surface (Elevation 101.7 m).

SPT 'N'-values recorded within the clayey silt till deposit range between 30 blows per 0.3 m of penetration and 50 blows per 0.05 m of penetration, but are generally greater than 100 blows per 0.3 m of penetration, suggesting that the clayey silt till has hard consistency.

The natural water content measured on samples of the till deposit range from about 6 per cent to 18 per cent.

Grain size distribution test results of eight samples from the clayey silt till deposit are shown on Figure H6 in Appendix H.

Atterberg limits tests were carried out on three specimens of the clayey silt till deposit and measured liquid limits ranging from about 16 per cent to 17 per cent, plastic limits range from about 10 per cent to 12 per cent and plasticity indices ranging from about 5 per cent to 6 per cent. The results of the Atterberg limits tests are shown on the plasticity chart on Figure H7 in Appendix H and indicate that the material is classified as clayey silt of low plasticity.

4.10.4 Groundwater Conditions

The groundwater level within Deep Cut Area 8 ranges from about Elevation 121 m at the east limit of the soil disposal mound to about Elevation 117 m at the west limit of the soil disposal mound based on the recorded water level measurements in the monitoring wells by Ecoplans in January 2010 as presented below, and based on water levels recorded in the open boreholes during Golder's 2013 geotechnical investigation (as noted on the Record of Borehole sheets in Appendix H). The groundwater level near the toe of the north facing slope of the disposal mound (i.e. adjacent to the existing South Service Road) ranges from about Elevation 118 m at the east limit to about Elevation 112 m at the west limit of the mound based on the recorded water level measurements in January 2010 taken by Ecoplans. The water levels measured in the monitoring wells by Ecoplans suggest that groundwater has "perched" or stabilized within the soil disposal mound up to about 5 m higher than the groundwater level measured in the surrounding grade.

Monitoring Well ID*	Measurements by Ecoplans (January 2010)	Measurements by Golder (July 2013)
MW1S	115.3	116.5
MW1D	116.7	115.0
MW2S	118.7	118.6
MW2D	118.8	118.8
MW3S	120.5	120.3
MW3D	120.5	120.3
MW4	118.5	118.3
MW5	114.3	114.2
MW6	112.1	112.8

*Water level readings in monitoring wells installed by Ecoplans (2010)

It should be noted that the water levels measured during or on completion of the drilling operations (i.e. the water levels shown on the Record of Boreholes in Appendix H) have not stabilized and do not accurately reflect the groundwater table elevation at this site. Further, the water level at the site is expected to fluctuate seasonally in response to changes in precipitation and snow melt, and is expected to be higher during the spring season and periods of precipitation.

4.11 Analytical Testing

Soil cuttings from the boreholes drilled on OPG property (i.e. Deep Cut Areas 7 and 8) were contained in steel drums which were temporarily stored on-site while analytical testing was completed to categorize the soil for disposal purposes.

Three composite soil samples collected from the drums containing the soil cuttings were tested for the suite of metals noted in Schedule 4 of MOE's Registration Guidance Manual for Generators of Liquid Industrial and Hazardous Waste (MOE, June 2011) using the Toxicity Characteristic Leaching Procedure (TCLP) Regulation 558. The samples were submitted to AGAT Laboratories in Mississauga, Ontario for TCLP analyses of metals.

Based on the results of the chemical analyses (as shown in Appendix I), the samples tested meet the current MOE Schedule 4 standards for the metals selected for testing, and the soil samples are be classified as non-toxic based on the TCLP quality criteria.

Following the receipt of the analytical results which are included in Appendix I the soil drums were removed from OPG property by Detox Environmental Services Inc. for disposal,

5.0 CLOSURE

This report was prepared by Mr. Matthew Kelly, P.Eng., a Geotechnical Engineer with Golder and reviewed by Mr. Kevin Bentley, P.Eng. Mr. Jorge M.A. Costa, P.Eng., Golder's MTO's Designated Contact for this project conducted an independent quality control review of this report.

GOLDER ASSOCIATES LTD

LICENSED PROFESSIONAL ENGINEER
M. W. KELLY
100125796
Feb 14, 2014
PROVINCE OF ONTARIO

Matthew Kelly, P.Eng.,
Geotechnical Engineer

Kevin Bentley, P.Eng.,
Geotechnical Engineer, Associate

LICENSED PROFESSIONAL ENGINEER
J. M. A. COSTA
Feb 14/2014
PROVINCE OF ONTARIO

Jorge, M. A. Costa, P.Eng.,
Designated MTO Foundations Contact, Principal
MWK/KJB/JMAC/jl

n:\active\2009\1111\09-1111-0019 urs - hwy 401 holt rd - clarington\reporting\detail design\deep cuts and high fills\final\09-1111-0019 draft 14jan holt road_cuts and fills kjb version .docx

PART B

FOUNDATION INVESTIGATION REPORT
HIGH FILLS AND DEEP CUTS
HIGHWAY 401/HOLT ROAD INTERCHANGE – SITE 21-159
CLARINGTON, ONTARIO
G.W.P. 2101-08-00

February, 2014
Report No. 09-1111-0019

Golder Associates

6.0 DISCUSSION AND ENGINEERING RECOMMENDATIONS

This section of the report provides an interpretation of the geotechnical data obtained during the investigation and recommendations on the foundation aspects of design of the proposed works. The recommendations provided are intended for the guidance of the design engineer. Where comments are made on construction, they are provided to highlight aspects of construction that could affect the design of the project. Those requiring information on aspects of construction must make their own interpretation of the subsurface information provided as it affects their proposed construction methods, costs, equipment selection, scheduling and the like.

6.1 General

Golder Associates Ltd. (Golder) was retained by URS Canada Inc. (URS) on behalf of Ministry of Transportation, Ontario (MTO) to provide recommendations on foundation aspects for the design and construction of six high fill embankments (designated High Fill Areas 1 to 6) and two deep cut excavations (designated Deep Cut Areas 7 and 8) as part of the Highway 401/Holt Road Interchange reconfiguration in the Town of Clarington, Regional Municipality of Durham, Ontario. The scope of work includes stability and settlement analyses, recommendations for stable embankment and cut slope geometry, selection of embankment fill materials, and implementation of ground improvement techniques that may be required as a means to mitigate settlements and to improve stability (if necessary). The work also includes addressing any specialized construction concerns and potential geotechnical challenges associated with embankment and cut slope construction.

6.2 High Fill Embankments

Based on the plan and profile drawing of the new ramps and service roads provided to us by URS (File No. 2013-10-24-Hwy401-HoltRd_profile and 2013-10-24-Hwy401-HoltRd_plan), it is our understanding that the interchange reconfiguration will require high fill embankments up to about 9 m high. Based on discussions with URS, the existing Holt Road is to remain operational to live traffic during construction of the adjacent high fill embankments and traffic staging has been considered in the analyses and the recommendations provided herein.

Sections 6.2.2 and 6.2.3 of this report summarize the methods used for the analysis of stability and settlement for critical sections of embankment construction for the new interchange ramps and associated service roads. The results of the analyses and recommendations on mitigating stability and time-dependent settlements, if required, in high fill areas are presented for each individual High Fill Area in Section 6.2.4.

6.2.1 Embankment Fill Types and Benching Requirements

Different embankment fill alternatives (i.e. rock fill, granular fill or suitable earth fill) provide relative advantages and disadvantages in terms of availability, weight (i.e. driving force and applied load to founding subsoils), construction cost and time, ease of construction and post-construction performance. Earth fill is preferred for use in embankment construction at the site as suitable material is readily available from on-site deep cut excavation areas. Additional earth fill if required or can be imported from off-site provided it meets the criteria for earth fill as per OPSS 212 (Borrow). The costs associated with importing rock fill are considered to outweigh the benefits at this site.

The stability and settlement analyses discussed in Section 6.2.4 have been carried out on the basis that the ramp embankments will be constructed of suitable earth fill.

Earth Fill

The main advantage of using suitable earth fill is the ease of construction and negligible post-construction settlement within the embankment fill itself if predominantly non-cohesive soils are used. Post-construction settlements should be expected if cohesive soils are used. For this project, suitable earth fill from the Deep Cut Areas 7 and 8 can be considered for re-use as embankment fill within a core zone of the embankments below the depth of frost penetration, as described below.

Based on the results of the subsurface investigation carried out in Deep Cut Areas 7 and 8 which extended along the proposed South Service Road to the west of Holt Road, the subsoils potentially available for use as embankment fill consist predominantly of; sand and silt till from deep cut area 7; and sand and silt to sandy silt and clayey silt fill within the existing soil disposal mound (i.e. existing fill soils) from Deep Cut Area 8. The fill comprised of clayey silt with sand trace organics encountered in Deep Cut Area 7 is not considered suitable for re-use as embankment fill considering that the moisture content of the fill is too high (i.e. greater than 20 per cent) to allow for proper compaction of the materials, and considering that this soil mound was a designated topsoil disposal area in the past and contains varying amounts organics.

For comparison purposes and to further assess the suitability of the existing fill materials for re-use (on or off site) in roadway embankment construction, the grain size envelope for the silt and sand till deposit encountered in Area 7 and the silt and sand to sandy silt and clayey silt fill soils in Area 8 are plotted against the grain size envelope for OPSS Prov.1010 (Select Subgrade Material (SSM)) on Figures G5 and H8, respectively. Given that the grain size distribution of the majority of the soil samples from Deep Cut Areas 7 and 8 do not meet the OPSS SSM specification, these soils are considered not suitable for re-use as select subgrade material for embankment construction. It is noted that pockets/interlayers of silty clay were encountered within the existing fill soils in Area 8 and may need to be segregated or thoroughly mixed with granular soils prior to re-use in embankment construction to avoid creating localized zones of different fill characteristics/behavior that could result in differential settlement.

Comparing the ranges of moisture content of the till and fill soils, the results of the Atterberg Limits tests of the till (Figures G4 and H7 from Deep Cut Areas 7 and 8) and of the fill (Figures H2 and H4 from Deep Cut Area 8), and the results of the standard proctor maximum dry density test of the combined soil disposal mound fill (Figure H5) to the criteria in OPSS 212 (Borrow), both the till from Deep Cut Area 7 and the soil disposal mound fill from Deep Cut Area 8 are considered suitable for utilization as earth borrow. However, both the till and fill soils from these deep cut areas are considered to be moderately to highly frost susceptible (MTO, 2012), (Townsend and Csathy, 1963) and will be potentially difficult to compact, especially for soils obtained below the groundwater level within the soil disposal mound. If these soils are proposed to be used as engineered fill, the location of use should be restricted to non-settlement sensitive areas and below the depth of frost penetration depth. Depending on the percentage of fines (silt/clay and sand) content, difficulties should be expected if placing and compacting such soils in wet or inclement weather conditions.

The potentially suitable soils described above were encountered in the boreholes at moisture contents ranging from about 6 per cent to 12 per cent for the silt and sand till deposits in Area 7 and from about 9 per cent to 15 per cent for the fill comprised of sand and silt/sandy silt/clayey silt with sand in Area 8.

The suitability of the till and fill soils from Deep Cut Areas 7 and 8 for use as embankment fill (i.e. earth borrow) should be further assessed on bulk samples from test pit excavation, specifically for compliance with OPSS 212 (Borrow).

For earth (granular) fill embankments with side slopes at 2H:1V, a 2 m wide berm should be incorporated into the side slope profile for uninterrupted slopes greater than 8 m high.

We cannot comment of the suitability of the soils from an environmental perspective.

6.2.2 Stability

The following sections outline the methodology used to evaluate embankment stability at the embankments in High Fill Areas 1 to 6. In addition, the parameters used in the analyses for each of the critical section(s) are presented together with the results of the analyses in Section 6.2.4.

6.2.2.1 Methodology

Stability analyses were performed for the critical sections of the proposed fill embankments corresponding to the greatest new embankment height and/or the maximum thickness of soft/loose, compressible soils. The stability of the critical sections of the proposed new embankment section(s) was analyzed using limit equilibrium methods.

All limit equilibrium slope stability analyses were performed using the commercially available program Slide (Version 6.0), produced by Rocscience Inc., employing the Morgenstern-Price method of analysis. For all analyses, the factor of safety of numerous potential failure surfaces was computed in order to establish the minimum factor of safety. The factor of safety is defined as the ratio of the forces tending to resist failure to the driving forces tending to cause failure. A target minimum Factor of Safety of 1.3 is normally adopted for the design of embankment slopes under static conditions. This factor of safety is considered adequate for the embankments at these sites considering the design requirements and the field data available and is based on deep-seated, global failure surfaces that would affect the operation of the roadway. The stability analyses were performed to check that the target minimum factor of safety was achieved for the various embankment heights and geometries.

The stability analyses assume that any surficial or near surface organics or existing fill deposits will be removed prior to construction of the new embankments and that suitable earth fill will be used for replacement of sub-excavated material (as discussed in Section 6.2.1). The piezometric conditions required in the analyses were based on the groundwater levels observed during the recent drilling investigation.

6.2.2.2 Parameter Selection

The simplified stratigraphy together with the associated strength and unit weight employed for the different native soil types for the critical sections in each high fill area are summarized in Section 6.4. The earth fill modeled in the analyses is assumed to have a unit weight of 20 kN/m^3 and an effective friction angle of 32^o and the embankments constructed with 2H:1V side slopes.

The subsoils encountered in the various areas are generally composed of a thin layer of topsoil and organic material underlain by sand and silt or clayey silt till deposits. For granular soils, effective stress parameters were employed in the analyses assuming drained conditions. The effective stress parameters (effective friction angle and effective cohesion) for the granular soils were estimated from empirical correlations using the results of

in-situ Standard Penetration Tests (SPT), in conjunction with engineering judgement based on experience in similar soil conditions.

For cohesive deposits, both effective stress and total stress (assuming undrained conditions) parameters were employed in the analyses to determine the critical case. The total stress parameters (i.e. average mobilized undrained shear strength – s_u) for the cohesive soils were estimated from correlations with the SPT results and laboratory (natural water content) test data.

When developing the area-specific correlations of engineering parameters based on laboratory or field test data, the results from all high fill areas were combined to provide a larger set of parameters to evaluate. It was considered that all the high fill areas exhibited sufficiently similar soil mineralogy and geology that correlations based on all of the data would be justified. Having developed the area-specific correlations, the test results for each individual high fill area were examined and the design parameters developed accordingly.

According to Table C4.2 of the *Commentary* to the *CHBDC*, this site is located in Seismic Zone 1, and the site-specific zonal acceleration ratio (A) for the Oshawa/Clarington area is 0.05. The site-specific peak ground acceleration (PGA) is 0.08g based on the NRC website; therefore, the more conservative *NRC* value has been used in the assessment presented below. The Site Coefficient (S) may be taken as 1.0, consistent with Soil Profile Type I in accordance with Section 4.4.6 and Table 4.4 of *CHBDC* (2006). Based on the subsurface conditions at the site, an amplification of the ground motion is not recommended for design, resulting in a ground surface acceleration of approximately 0.08g.

6.2.3 Settlement

The following sections outline the methods used to conduct the settlement analyses at the various high fill areas. In addition, the parameters used in the analyses for each of the critical section(s) are presented along with the results of the analyses in Section 6.2.4.

6.2.3.1 Methodology

To estimate the magnitude of the expected settlements, analyses were carried out on the critical sections of the proposed embankments using the commercially available program Settle^{3D} (Version 2.0) produced by Rocscience Inc. and/or hand/spreadsheet calculations. Critical sections generally correspond to the greatest new embankment height.

The sources of settlement were considered to include:

- immediate settlement of the native granular soils and very stiff to hard/dense to very dense till deposits; and
- self-weight compression of the embankment fill materials (short-term).

The height of the embankments vary along the proposed alignments within each high fill area and as such the settlements along the length of a given alignment will similarly vary. Given that the analyses were carried out in the critical sections of each high fill area, the settlements estimated will generally represent the maximum value along a given alignment.

The settlement analysis assumes any existing fills, topsoil, and native soils containing organics are completely stripped and the new embankment fill is placed and compacted on a competent, relatively undisturbed native soil

subgrade and that suitable earth fill will be used for replacement of any sub-excavated material. Details on the thickness of organic or existing fill deposits at each high fill area are presented in Sections 4.3 to 4.8. The piezometric conditions required in the analyses was based on the groundwater levels noted during the subsurface investigation.

6.2.3.2 Parameter Selection

The simplified stratigraphy, together with the associated deformation parameters employed for the different native soil types for the critical sections in each high fill area, are given in the following sections.

The immediate compression of suitable earth fill soils and very stiff to hard/dense to very dense till deposits was modeled by estimating an elastic modulus of deformation based on the SPT 'N'-values and using correlations proposed by Bowles (1984) and Kulhawy and Mayne (1990). These estimated values were compared with the typical range of expected values for similar soil types, as outlined in CHBDC (2006) and adjusted, if necessary.

6.2.3.3 Settlement of Embankment Fill

The estimates of settlements given below do not include compression of the embankment fill itself, which would occur during and after the construction of the embankment depending on the type of materials used. The magnitude of fill compression may range from 0.5 to 1 per cent of the height of the embankment, assuming approximately 98 per cent compaction of the embankment fill is achieved, relative to the material's standard Proctor maximum dry density. In the case where granular fill is used for embankment construction, settlement of the fill itself is expected to occur essentially during embankment construction, whereas non-granular earth fill materials are expected to exhibit some additional settlement over time.

6.2.4 Results of Analysis

The results of the stability and settlement analyses for each high fill area are provided in the following sections. In addition, the options and recommendations for achieving the target factor of safety for the required embankment geometry and for minimizing post-construction settlements are also discussed (as required).

6.2.4.1 High Fill Area 1 – Holt Road STA 10+050 to STA 10+170

The area extending from about STA 10+060 to STA 10+170 along the proposed new Holt Road alignment requires embankments up to about 9 m high to achieve the proposed vertical roadway profile. The natural topography of this section of proposed roadway is flat and low-lying, encompassing a wet grassy area.

In general, the subsurface soils along the new Holt Road alignment in this area consist of asphalt at ground surface underlain by cohesive and non-cohesive fill at the existing Holt Road, or a layer of topsoil underlain by clayey silt fill at the toe of the existing roadway embankments, all underlain by a deposit of silty sand to sandy silt till.

Details of the subsurface conditions for this high fill area are presented in Section 4.3 and shown on Drawing A1 in Appendix A.

In keeping with Section 6.2.1 on embankment fill types, the new embankment was analyzed assuming a suitable earth fill composition and 2H:1V side slopes. The stability and settlement analyses assume that the organic soils and existing fill soils encountered at/below ground surface that do not form part of the existing Holt Road embankment have been removed prior to construction of the new high fill embankment. Where the new embankment meets the existing Holt Road embankment, any loose/soft or organic material should be stripped

from the existing embankment side slopes and the new fill should be 'keyed into' the existing very stiff to hard fill as discussed in Section 6.4.3. The simplified stratigraphy and the associated unit weight, strength and deformation employed for the different soil types encountered in this area are summarized below.

Soil Conditions	Bulk Unit Weight (kN/m^3)	Elastic Modulus (MPa)	Effective Friction Angle (°)	Undrained Shear Strength (kPa)
New embankment fill (Earth fill)	20	Not applicable	32	--
Existing very stiff to hard clayey silt fill	19	Not applicable	28	100
Very stiff to hard clayey silt with sand till	20	75	35	150

The piezometric condition used in the analyses assumes the water table at about 1 m below ground surface, based on the highest groundwater levels noted during drilling.

6.2.4.1.1 Stability

Based on the results of the subsurface investigation and review of the profile drawing, the critical section (i.e. greatest embankment height and/or maximum thickness of soft, compressible foundation soils) for this high fill section is located at about STA 10+060. The stability analysis performed on the critical section(s) indicates that after the completion of construction, the embankment will have a Factor of Safety (FoS) of 1.3 or greater for deep-seated, global failure surfaces that would impact the operation of the roadway as shown on Figure A5 in Appendix A.

Pseudo-static seismic slope stability analyses for a 2H:1V slope indicate that the embankment will have a Factor of Safety equal to or greater than 1.1 against deep-seated slope instability, using a peak ground acceleration of 0.08g, as shown on Figure A6 in Appendix A.

The results of the pseudo-static seismic stability analysis does indicate that some shallow sloughing could occur on the embankment slopes during seismic events. This sloughing would not, however, impair the use of the highway, and would mainly be a maintenance issue. The potential for sloughing due to seismic events would be reduced by providing well-vegetated side slopes, as recommended in Section 6.3.2.

6.2.4.1.2 Settlement

To estimate the magnitude of the anticipated settlements due to new construction, an analysis was carried out on the critical section(s) representative of the subsurface conditions within the high fill section at about STA 10+060, using the elastic deformation moduli as given above.

Based on this assessment, the settlement of the foundation soils under the new up to 8.7 m high embankment is estimated to be less than 25 mm. This settlement is expected to occur relatively quickly during and immediately following construction of the embankment based on the nature of the existing fill and native subgrade soils at the site.

6.2.4.2 High Fill Area 2 – E-N/S Ramp – STA 9+850 to STA 9+970

The area extending from about STA 9+850 to STA 9+970 along the proposed Highway 401/Holt Road E-N/S Ramp alignment requires a new embankment up to about 4.5 m high to achieve the proposed vertical ramp profile. The natural topography of this section of proposed interchange ramp is flat and low-lying, encompassing a farm field and wooded area.

In general, the subsurface soils along the new E-N/S Ramp alignment in this area consist of a layer of topsoil underlain by deposits of cohesive and non-cohesive fill which are in turn underlain by a sand and silt till deposit.

Details of the subsurface conditions for this high fill area are presented in Section 4.4 and shown on Drawing B1 in Appendix B.

In keeping with Section 6.2.1 on embankment fill types, the new embankment was analyzed assuming a suitable earth fill composition and 2H:1V side slopes. The stability and settlement analyses assume that the organic soils and existing fill soils encountered at/below ground surface within the footprint of the proposed embankment have been removed prior to construction of the new high fill embankment. Where the new embankment transitions into the existing Highway 401 embankment, any loose/soft or organic material should be stripped from the existing embankment side slopes and the new fill should be 'keyed into' the existing very stiff to hard fill as discussed in Section 6.4.3. The simplified stratigraphy and the associated unit weight, strength and deformation employed for the different soil types encountered in this area are summarized below.

Soil Conditions	Bulk Unit Weight (kN/m^3)	Elastic Modulus (MPa)	Effective Friction Angle (°)	Undrained Shear Strength (kPa)
New embankment fill (Earth fill)	20	Not applicable	32	--
Existing fill (removed)	20	Not applicable	28	50
Very dense sand and silt till	20	100	35	--

The piezometric condition used in the analyses assumes the water table at about 3 m below ground surface, based on the highest groundwater levels noted during drilling.

6.2.4.2.1 Stability

Based on the results of the subsurface investigation and review of the profile drawing, the critical section (i.e. greatest embankment height and/or maximum thickness of soft, compressible foundation soils) for this high fill section is located at about STA 9+970. The stability analysis performed on the critical section(s) indicates that after the completion of construction, the embankment will have a Factor of Safety (FoS) greater than 1.3 for deep-seated, global failure surfaces that would impact the operation of the roadway, as shown on Figure B5 in Appendix B.

Pseudo-static seismic slope stability analyses for a 2H:1V slope indicate that the embankment will have a Factor of Safety equal to or greater than 1.2 against deep-seated slope instability, using a peak ground acceleration of 0.08g, as shown on Figure B6 in Appendix B.

The results of the pseudo-static seismic stability analyses do indicate that some shallow sloughing could occur on the embankment slopes during seismic events. This sloughing would not, however, impair the use of the highway, and would mainly be a maintenance issue. The potential for sloughing due to seismic events would be reduced by providing well-vegetated side slopes, as recommended in Section 6.3.2.

6.2.4.2.2 Settlement

To estimate the magnitude of the anticipated settlements due to new construction, an analysis was carried out on the critical section(s) representative of the subsurface conditions within the high fill area at about STA 9+970, using the elastic deformation moduli as given above.

Based on this assessment, the settlement of the foundation soils under the new up to 4.5 m high embankment is estimated to be less than 25 mm. This settlement is expected to occur relatively quickly during and immediately following construction of the embankment based on removal of the the existing fill and nature of the subgrade soils at the site.

6.2.4.3 High Fill Area 3 – E-N/S Ramp – STA 10+200 to STA 10+500

The area extending from about STA 10+200 to STA 10+500 along the proposed Highway 401/Holt Road E-N/S Ramp alignment requires a new embankment up to about 4.5 m high to achieve the proposed vertical ramp profile. The natural topography of this section of proposed interchange ramp is flat and low-lying, encompassing a farm field.

In general, the subsurface soils along the new E-N/S Ramp alignment in this area consist of a layer of topsoil underlain by a deposit of clayey silt or sand and gravel which is underlain by sand and silt and clayey silt till deposits.

Details of the subsurface conditions for this high fill area are presented in Section 4.5 and shown on Drawing C1 in Appendix C.

In keeping with Section 6.2.1 on embankment fill types, the new embankment was analyzed assuming a suitable earth fill composition and 2H:1V side slopes. The stability and settlement analyses assume that the organic soils and existing fill soils encountered at/below ground surface have been removed prior to construction of the new high fill embankment. The simplified stratigraphy and the associated unit weight, strength and deformation employed for the different soil types encountered in this area are summarized below.

Soil Conditions	Bulk Unit Weight (kN/m^3)	Elastic Modulus (MPa)	Effective Friction Angle (°)	Undrained Shear Strength (kPa)
New embankment fill (Earth fill)	20	Not applicable	32	--
Stiff to very stiff clayey silt	20	25	30	50
Very dense sand and silt to hard clayey silt till	20	100	35	200

The piezometric condition used in the analyses assumes the water table at about 1 m below ground surface, based on the highest groundwater levels noted during drilling.

6.2.4.3.1 Stability

Based on the results of the subsurface investigation and review of the profile drawing, the critical section (i.e. greatest embankment height and/or maximum thickness of soft, compressible foundation soils) for this high fill area is located between about STA 10+300 and 10+450. The stability analysis performed on the critical section(s) indicates that after the completion of construction, the embankment will have a Factor of Safety (FoS) equal to or greater than 1.3 for deep-seated, global failure surfaces that would impact the operation of the roadway, as shown on Figure C10 in Appendix C.

Pseudo-static seismic slope stability analyses for a 2H:1V slope indicate that the embankment will have a Factor of Safety equal to or greater than 1.1 against deep-seated slope instability, using a peak ground acceleration of 0.08g, as shown on Figure C11 in Appendix C.

The results of the pseudo-static seismic stability analyses do indicate that some shallow sloughing could occur on the embankment slopes during seismic events. This sloughing would not, however, impair the use of the highway, and would mainly be a maintenance issue. The potential for sloughing due to seismic events would be reduced by providing well-vegetated side slopes, as recommended in Section 6.3.2.

6.2.4.3.2 Settlement

To estimate the magnitude of the anticipated settlements due to new construction, an analysis was carried out on the critical section(s) representative of the subsurface conditions within the high fill area between about STA 10+300 and STA 10+450, using the elastic deformation moduli given above.

Based on this assessment, the settlement of the foundation soils under the new up to 4.5 m high embankment is estimated to be less than 25 mm. This settlement is expected to occur relatively quickly during and immediately following construction of the embankment based on removal of the existing fill and the nature of the subgrade soils at the site.

6.2.4.4 High Fill Area 4 – N/S-E Ramp – STA 9+610 to STA 9+740

The area extending from about STA 9+610 to STA 9+740 along the proposed Highway 401/Holt Road N/S-E Ramp alignment requires a new embankment up to about 6.8 m high to achieve the proposed vertical ramp profile. The natural topography of this section of proposed interchange ramp is flat and low-lying, encompassing a wet grassy area and the existing South Service Road.

In general, the subsurface soils along the new N/S-E Ramp alignment in this area consist of a layer of topsoil underlain by a deposit of clayey silt fill which is underlain by a clayey silt with sand till deposit, and encountered both granular and cohesive fill deposits underlain by a sand and gravel deposit which is underlain by the till deposit at the existing South Service Road embankment.

Details of the subsurface conditions for this high fill area are presented in Section 4.6 and shown on Drawing D1 in Appendix D.

In keeping with Section 6.2.1 on embankment fill types, the new embankment was analyzed assuming a suitable earth fill composition and 2H:1V side slopes. The stability and settlement analyses assume that the organic soils and existing fill soils encountered at/below ground surface have been removed prior to construction of the new high fill embankment. The simplified stratigraphy and the associated unit weight, strength and deformation employed for the different soil types encountered in this area are summarized below.

Soil Conditions	Bulk Unit Weight (kN/m^3)	Elastic Modulus (MPa)	Effective Friction Angle (°)	Undrained Shear Strength (kPa)
New embankment fill (Earth fill)	20	Not applicable	32	--
Very stiff clayey silt fill	19	20	30	50
Hard clayey silt till	20	100	35	200

The piezometric condition used in the analyses assumes the water table at about 1.8 m below ground surface, based on the highest groundwater levels noted during drilling.

6.2.4.4.1 Stability

Based on the results of the subsurface investigation and review of the profile drawing, the critical section (i.e. greatest embankment height and/or maximum thickness of soft, compressible foundation soils) for this high fill area is located at about STA 9+610. The stability analysis performed on the critical section(s) indicates that after the completion of construction, the embankment will have a Factor of Safety (FoS) greater than 1.3 for deep-seated, global failure surfaces that would impact the operation of the roadway as shown on Figure D7 in Appendix D.

Pseudo-static seismic slope stability analyses for a 2H:1V slope indicate that the embankment will have a Factor of Safety equal to or greater than 1.1 against deep-seated slope instability, using a peak ground acceleration of 0.08g, as shown on Figure D8 in Appendix D.

The results of the pseudo-static seismic stability analyses do indicate that some shallow sloughing could occur on the embankment slopes during seismic events. This sloughing would not, however, impair the use of the highway, and would mainly be a maintenance issue. The potential for sloughing due to seismic events would be reduced by providing well-vegetated side slopes, as recommended in Section 6.3.2.

6.2.4.4.2 Settlement

To estimate the magnitude of the anticipated settlements due to new construction, an analysis was carried out on the critical section(s) representative of the subsurface conditions within the high fill area at about STA 9+610, using the elastic deformation moduli as given above.

Based on this assessment, the settlement of the foundation soils under the new up to 6.8 m high embankment is estimated to be less than 25 mm. This settlement is expected to occur relatively quickly during and immediately following construction of the embankments based on the nature of the fill and subgrade soils at the site.

6.2.4.5 High Fill Area 5 – N/S-W Ramp – STA 9+670 to STA 9+740

The area extending from about STA 9+670 to STA 9+740 along the proposed Highway 401/Holt Road N/S-W Ramp alignment requires a new embankment up to about 4 m high to achieve the proposed vertical ramp profile. The natural topography of this section of proposed highway is flat and low-lying, encompassing a farm field.

In general, the subsurface soils along the new N/S-W ramp alignment in this area consist of a layer of topsoil underlain by a deposit of silty sand which is underlain by a sand and silt till deposit.

Details of the subsurface conditions for this high fill area are presented in Section 4.7 and shown on Drawing E1 in Appendix E.

In keeping with Section 6.2.1 on embankment fill types, the new embankment was analyzed assuming a suitable earth fill composition and 2H:1V side slopes. The stability and settlement analyses assume that the organic soils and existing fill soils encountered at/below ground surface have been removed prior to construction of the new embankment. The simplified stratigraphy and the associated unit weight, strength and deformation employed for the different soil types encountered in this area are summarized below.

Soil Conditions	Bulk Unit Weight (kN/m^3)	Elastic Modulus (MPa)	Effective Friction Angle (°)	Undrained Shear Strength (kPa)
New embankment fill (Earth fill)	20	Not applicable	32	--
Compact to very dense silty sand	19	35 MPa	32	--
Dense to very dense sand and silt till	20	100 MPa	35	--

The piezometric condition used in the analyses assumes the water table at about 6 m below ground surface, based on the highest groundwater levels noted during drilling.

6.2.4.5.1 Stability

Based on the results of the subsurface investigation and review of the profile drawing, the critical section (i.e. greatest embankment height and/or maximum thickness of soft, compressible foundation soils) for this high fill area is located between about STA 9+670 and 9+700. The stability analysis performed on the critical section(s) indicates that after the completion of construction, the embankment will have a Factor of Safety (FoS) greater than 1.3 for deep-seated, global failure surfaces that would impact the operation of the roadway as shown on Figure E3 in Appendix E.

Pseudo-static seismic slope stability analyses for a 2H:1V slope indicate that the embankment will have a Factor of Safety equal to or greater than 1.1 against deep-seated slope instability, using a peak ground acceleration of 0.08g, as shown on Figure E4 in Appendix E.

The results of the pseudo-static seismic stability analyses do indicate that some shallow sloughing could occur on the embankment slopes during seismic events. This sloughing would not, however, impair the use of the highway, and would mainly be a maintenance issue. The potential for sloughing due to seismic events would be reduced by providing well-vegetated side slopes, as recommended in Section 6.3.2.

6.2.4.5.2 Settlement

To estimate the magnitude of the anticipated settlements due to new construction, an analysis was carried out on the critical section(s) representative of the subsurface conditions within the high fill area between about STA 9+670 and 9+700, using the elastic deformation moduli as given above.

Based on this assessment, the settlement of the foundation soils under the new up to 4 m high embankment is estimated to be less than 25 mm. This settlement is expected to occur relatively quickly during and immediately following construction of the embankments based on the nature of the subgrade soils at the site.

6.2.4.6 High Fill Area 6 – W-N/S Ramp – STA 10+550 to STA 10+580

The area extending from about STA 10+550 to STA 10+580 along the proposed Highway 401/Holt Road W-N/S Ramp alignment requires a new embankment up to about 5.5 m high, and potentially up to 7 m high where new fill is required over the existing roadway fill, to achieve the proposed vertical ramp profile. The natural topography of this section of proposed interchange ramp is flat and low-lying, encompassing a grassy area with light tree cover.

In general, the subsurface soils along the new ramp alignment in this area consist of a layer of topsoil underlain by a deposit of clayey silt till, and asphalt at ground surface underlain by cohesive and non-cohesive fill which is underlain by the till deposit under the existing Holt Road embankment.

Details of the subsurface conditions for this high fill area are presented in Section 4.8 and shown on Drawing F1 in Appendix F.

In keeping with Section 6.2.1 on embankment fill types, the new embankment was analyzed assuming a suitable earth fill composition and 2H:1V side slopes. The stability and settlement analyses assume that the organic soils and existing fill soils encountered at/below ground surface that do not form part of the existing Holt Road embankment have been removed prior to construction of the new high fill embankment. Where the new embankment meets the existing Holt Road embankment, any loose/soft or organic material should be stripped from the existing embankment side slopes and the new fill should be 'keyed into' the existing very stiff to hard fill as discussed in Section 6.4.3. The simplified stratigraphy and the associated unit weight, strength and deformation employed for the different soil types encountered in this area are summarized below.

Soil Conditions	Bulk Unit Weight (kN/m^3)	Elastic Modulus (MPa)	Effective Friction Angle (°)	Undrained Shear Strength (kPa)
New embankment fill (Earth fill)	20	Not applicable	32	--
Hard clayey silt till	20	100 MPa	35	200

The piezometric condition used in the analyses assumes the water table at about 4.9 m below ground surface, based on the highest groundwater levels noted during drilling.

6.2.4.6.1 Stability

Based on the results of the subsurface investigation and review of the profile drawing, the critical section (i.e. greatest embankment height and/or maximum thickness of soft, compressible foundation soils) for this high fill area is located at about STA 10+550, and potentially may be up to 7 m high to the north of about STA 10+580 in the roundabout roadway. The stability analysis performed on the critical section at STA 10+550 indicates that after the completion of construction (including removal and replacement of any topsoil or existing unsuitable fill), the embankment will have a Factor of Safety (FoS) greater than 1.3 for deep-seated, global failure surfaces that would impact the operation of the roadway as shown on Figure F5 in Appendix F. A check on the stability of a 7 m high embankment constructed of new fill over existing roadway fill confirms that the Factor of Safety will also be greater than 1.3.

Pseudo-static seismic slope stability analyses for a 2H:1V slope indicate that the embankment will have a Factor of Safety equal to or greater than 1.1 against deep-seated slope instability, using a peak ground acceleration of 0.08g, as shown on Figure F6 in Appendix F.

The results of the pseudo-static seismic stability analyses do indicate that some shallow sloughing could occur on the embankment slopes during seismic events. This sloughing would not, however, impair the use of the highway, and would mainly be a maintenance issue. The potential for sloughing due to seismic events would be reduced by providing well-vegetated side slopes, as recommended in Section 6.3.2.

6.2.4.6.2 Settlement

To estimate the magnitude of the anticipated settlements due to new construction, analysis was carried out on the critical section(s) representative of the subsurface conditions within the high fill area at about STA 10+550 for the 5.5 m high embankment using the elastic deformation moduli as given above.

Based on this assessment, the settlement of the foundation soils under the new up to 5.5 m high embankments is estimated to be less than 25 mm. This settlement is expected to occur relatively quickly during and immediately following construction of the embankments based on the nature of the subgrade soils at the site. Although the 7 m high section of the embankment in the roundabout roadway includes a new 2 m thick zone of fill over the existing embankment, the settlement of the overall embankment is estimated to be less than 25 mm.

6.3 Deep Cut Sections

Based on the vertical profiles and cross sections for the proposed interchange ramp and service road configurations, earth cuts are required at two sites within the project limits along the proposed South Service Road alignment as summarised below.

Site Number and Location	Extent	Horizontal Distance (m)	Approximate Depth of Cut (m)	Comments
Area 7 – South Service Road	Sta. 13+160 to 13+265	105	6 to 9	Cut to be made through existing fill mound; cut is 4.5 m to 7.5 m deep along centre line of roadway
Area 8 – South Service Road	Sta. 11+850 to 12+500	650	12 to 17	Toe of new slope will be located up to about 14 m to the south of the existing toe of the Soil Disposal Mound

6.3.1 Global Stability

The following sections outline the methodology used to evaluate embankment (I.e. cut slope) stability at the Deep Cut Areas 7 and 8. In addition, the parameters used in the analyses for each of the critical section(s) and the results of the analysis are also presented.

In accordance with MTO's standard practice, a minimum 2 m wide mid-height bench should be provided where cut slopes inclined at 2H:1V or steeper are greater than 6 m high (such as in Area 8), such that the uninterrupted

slope height does not exceed 6 m, in order to control surficial erosion and improve stability. If the slope angle is shallower than 2H:1V consideration can be given to increasing the vertical height between benches.

6.3.1.1 Methodology

Global stability analyses have been carried out for the critical sections using limit equilibrium methods. Critical sections correspond to the greatest cut height and/or the maximum thickness of weak/soft soils. Similar to the slope stability analysis for the High Fill Areas 1 to 6, all limit equilibrium slope stability analyses were performed using the commercially available program Slide (Version 6.0), produced by Rocscience Inc., to establish that the minimum target factor of safety of 1.3 is obtained. This minimum factor of safety is considered appropriate for the cut slope on this project, considering the design and performance requirements and the available field and laboratory testing data. Under earthquake conditions a factor of safety of 1.0 is considered appropriate for global stability.

The piezometric conditions required in the analyses were based on the groundwater levels observed during the subsurface investigation.

6.3.1.2 Parameter Selection

The simplified stratigraphy together with the associated strength and unit weight employed for the different native soil types for the critical sections in each deep cut area are summarized in Section 6.3.1.3 for each deep cut area.

The subsoils encountered in the various areas are composed of cohesive and granular fill soils underlain by sand and silt to clayey silt till. For granular soils, effective stress parameters (assuming drained conditions) for the granular soils were estimated from empirical correlations using the results of in situ Standard Penetration Tests (SPT), in conjunction with engineering judgement based on experience in similar soil conditions.

For cohesive deposits, both effective stress and total stress (assuming undrained conditions) parameters were employed in the analyses to determine the critical case. The total stress parameters (i.e. average mobilized undrained shear strength – s_u) for the cohesive soils were estimated from correlations with the SPT results and laboratory (natural water content) test data.

As per the assessment for the High Fill Areas, this site is located in Seismic Zone 1, and the site-specific peak ground acceleration (PGA) is 0.08g based on the NRC website. The Site Coefficient (S) may be taken as 1.0, consistent with Soil Profile Type I in accordance with Section 4.4.6 and Table 4.4 of *CHBDC* (2006) and the ground surface acceleration is approximately 0.08g.

6.3.1.3 Results of Analysis

6.3.1.3.1 *Deep Cut Area* 7 – South Service Road - STA 13+160 to STA 13+265

The area extending from about STA 13+160 to STA 13+265 along the proposed new South Service Road alignment requires a cut up to about 9 m deep through an existing fill mound to achieve the proposed vertical roadway profile. The natural topography of this section of proposed roadway is flat and low-lying, encompassing a grassy area with some tree cover.

In general, the subsurface soils along the new South Service Road alignment in this area consist of a layer of topsoil underlain by a deposit of fill comprised of clayey silt with sand which is underlain by a silt to silt and sand till deposit.

Details of the subsurface conditions for this deep cut area are presented in Section 4.9 and shown on Drawing G1 in Appendix G.

The simplified stratigraphy and the associated unit weight and strength parameters employed for the different soil types encountered in this area are summarized below.

Soil Conditions	Bulk Unit Weight (kN/m^3)	Effective Friction Angle (°)	Undrained Shear Strength (kPa)
Firm to hard clayey silt fill	19	30	25
Dense to very dense sand and silt to sandy silt till	20	35	--

The piezometric condition used in the analyses was the water table at about 6 m below ground surface, which is the highest groundwater level noted during drilling.

Based on the results of the subsurface investigation and review of the profile drawing, the critical section (i.e. greatest cut slope height and/or maximum thickness of loose/soft foundation soils) for this cut section is located at about STA 13+235. The stability analysis performed on the critical section(s) indicates that after the completion of excavation the cut slope inclined at 2H:1V, will have a Factor of Safety (FoS) equal to or greater than 1.3 for deep-seated, global failure surfaces that would impact the operation of the roadway, as shown on Figure G6 in Appendix G.

Pseudo-static seismic slope stability analyses for a 2H:1V cut slope configuration indicate that the cut slopes will have a Factor of Safety equal to or greater than 1.1 against deep-seated slope instability, using a peak ground acceleration of 0.08g, as shown on Figure G7 in Appendix G.

The results of the pseudo-static seismic stability analyses indicate that some shallow sloughing could occur on the cut slopes during seismic events. This sloughing would not, however, impair the use of the highway, and would mainly be a maintenance issue. The potential for sloughing due to seismic events would be reduced by providing well-vegetated side slopes, as recommended in Section 6.3.2.

6.3.1.3.2 *Deep Cut Area* 8 – South Service Road - STA 11+850 to STA 12+500

The area extending from about STA 11+850 to STA 12+500 along the proposed new South Service Road alignment requires a cut up to about 17 m deep through the existing OPG soil disposal mound to achieve the proposed vertical roadway profile. The existing north face of the soil disposal mound is inclined at 4 Horizontal to 1 Vertical (4H:1V) with 2 m wide benches located about every 5 metres vertical height.

Based on the plan and section drawings provided by URS, the proposed new South Service Road and Waterfront Trail will be relocated about 50 m to 100 m to the south of the existing road, requiring a cut into the existing soil disposal mound. The preferred design is to cut into the soil disposal mound slopes as steep as technically feasible from the existing slope angle of 4H:1V in order to reduce the volume of soil to be excavated and to limit the construction footprint on OPG property.

In general, the subsurface soils along the new South Service Road alignment in this area consist of a layer of topsoil underlain by a fill deposit consisting of somewhat interlayered zones of silt to sandy silt, clayey silt with

sand to silt and sand to sand and silty clay in places. The fill is generally underlain by a deposit of hard clayey silt with sand till.

The simplified stratigraphy and the associated unit weight and strength employed for the different soil types encountered in this area are summarized below.

Soil Conditions	Bulk Unit Weight (kN/m^3)	Effective Friction Angle (°)	Undrained Shear Strength (kPa)
Existing fill (overall soil disposal mound)	21	29	75
Hard clayey silt with sand till	20	35	200

The groundwater level within Deep Cut Area 8 ranges from about Elevation 121 m at the east limit to about Elevation 117 m at the west limit of the soil disposal mound based on the recorded water level measurements in the monitoring wells by Ecoplans in January 2010 and by Golder in July 2013 and based on water levels recorded in the open boreholes during Golder's 2013 geotechnical investigation. The groundwater level near the toe of the disposal mound (i.e. adjacent to the existing South Service Road) ranges from about Elevation 118 m at the east limit to about Elevation 112 m at the west limit of the mound based on the recorded water level measurements by Ecoplans in January 2010 and by Golder in July 2013. The water levels measured in the monitoring wells by Ecoplans suggest that groundwater has "perched" or stabilized within the soil disposal mound up to about 5 m higher than the groundwater level measured in the surrounding grade.

The configuration of the realigned South Service Road and inclination of the cut slope used in the models are based on the typical design sections provided by URS showing the maximum slope height. A 2 m wide mid-height bench was also incorporated into the slope for the stability analysis model as adopted by MTO for cuts greater than 6 m deep. The piezometric conditions used in the analyses are based on the highest groundwater level recorded during current drilling operations and/or the highest groundwater level recorded from the nearest monitoring well by Ecoplans, which was measured to be at about Elevation 119 m near the critical section chosen for the model (i.e. Section C-C' on Drawing H2).

The stability analysis performed on the critical section(s) indicate that to achieve a Factor of Safety (FoS) equal to or greater than 1.3 for deep-seated, global failure surfaces that would impact the operation of the roadway the cut slope should be inclined at 3H:1V or flatter, and should incorporate a 2 m wide bench near the mid-level of the cut. The results of the static global stability analysis are shown on Figure H9 in Appendix H.

Pseudo-static seismic slope stability analyses for the 3H:1V cut slope configuration incorporating a 2 m wide bench, indicate that the cut slope will have a Factor of Safety equal to or greater than 1.0 against deep-seated slope instability, using a peak ground acceleration of 0.08g, as shown on Figure H10 in Appendix H. The results of the pseudo-static seismic stability analyses do indicate that some shallow sloughing could occur on the cut slopes during seismic events. This sloughing would not, however, impair the use of the highway, and would mainly be a maintenance issue. The potential for sloughing due to seismic events would be reduced by providing well-vegetated side slopes, as recommended in Section 6.3.2.

6.3.2 Surficial Stability & Erosion Protection

Surface water should be directed away from the permanent excavation / deep cut areas at all times. The drainage facilities at the crest of the new cut and along any mid-height benches should be designed such that surface water is directed into the existing overall drainage system and reduces infiltration. As a result, additional benches or benches located at certain specific elevations may be required in order to tie-in to the existing drainage system. It is recommended that the new benches be designed with a slight back-slope, (i.e. 1 per cent) to contain and channel surface water flow and reduce the potential for surface water from progressing down the slope face and to direct surface water into the existing or new stormwater management system for the site.

To reduce erosion on the permanent cut slopes due to surface water flow, it is recommended that topsoil and seeding be placed as soon as possible in accordance with OPSS 804 (Seed and Cover) or consistent with OPG standards/methods that have proven effective. The As-Built report for the soil disposal mound (Ontario Hydro, 1981) includes a description of a seeding program which tested various seeding methods and mixtures on the mound and the effectiveness of each. Excavation of the deep cuts should be completed sufficiently early in the year to allow for protective growth on the cut slopes to occur. If protection is not in place before winter, remedial works on the side slopes in the Spring may be required prior to topsoil placement and seeding as a result of erosional damage. The surrounding ditches may also require remediation due to the inflow and accumulation of eroded fill materials during and shortly after construction, and during regular maintenance activities. A typical cross-section showing the overall slope geometry and typical cross-sections of the recommended drainage features are shown on Figure H11 in Appendix H.

Given that the stabilized groundwater level within the soil disposal mound is reportedly up to about 5 m above the surrounding groundwater level, which is anticipated to be at or near the proposed intercepter ditch level (at the base of the cut), groundwater seepage, to the surface of the cut slope during and after construction is anticipated. As a result of the existing high groundwater level relative to the proposed base of the cut, it is recommended that either a dewatering program be implemented (as discussed in Section 6.4.2) or the proposed intercept ditch profile, or a pilot trench, be excavated as soon as possible in the construction operations and finger ditches /sub-drains be installed (as required) progressively as the subgrade is lowered and in advance of the final side-slopes being excavated to the design grade, to allow the groundwater to drain progressively thereby reducing the risk of surficial instability along the side-slopes and disturbance/softening of the existing fill soils. Seeding/re-vegetation of the cut slope below the water table should not be carried out until the slope has had sufficient time to drain and groundwater is not actively seeping out of the face of the cut slope (estimated to be approximately in 2 to 4 weeks).

Provided that the cut is allowed sufficient time to drain, a permanent side-slope no steeper than 3H:1V and incorporation of a 2 m wide mid-slope bench is considered adequate for the period of excavation operations , but a contingency / allowance for temporary slope protection using gravel sheeting (minimum 0.5 m thick and as per OPSS 511) should be included in the Contract. Gravel sheeting, or ‘shot-rock’, was previously used by OPG during the construction of the soil disposal mound (as described in Section 4.10 and encountered in Borehole 13-29) and proved to be successful in protecting the face of the slope from erosion due to water seepage. The gravel sheeting would likely be required only in localized areas and could be removed prior to re-vegetating the slope after the slope has had sufficient time to drain.

If sufficient time is not available in the construction schedule to allow for gravity drainage or the slope face cannot be adequately protected from erosion, a dewatering program as discussed in Section 6.4.2 should be implemented.

6.4 Design and Construction Considerations

6.4.1 Excavation

For temporary excavations, the existing fills and the native firm to stiff or loose to compact soils are considered to be Type 3 soils and the remaining native soils such as the till deposits that may be excavated at this site are considered to be Type 2 soil according to the *Occupational Health and Safety Act and Regulation for Construction Projects* (OHSA) Ontario Regulation 213, Construction Projects (as amended). As such, temporary excavations in Type 2 soils should be carried out with walls sloped to within 1.2 m of the bottom with a slope having a minimum gradient of 1H:1V provided water is allowed sufficient time to drain. Similarly, Type 3 soils should have a minimum 1H:1V gradient to the base of the excavation. If dewatering is not implemented or if sufficient time is not allowed for the soils to drain during excavation operations, temporary side-slopes should be no steeper than 2.5H:1V.

All excavations must be carried out in accordance with the latest edition of the Ontario Health and Safety Act (OHSA) O. Reg 213/91 (Construction Projects).

6.4.2 Control of Groundwater

Details of the groundwater levels encountered at each site during the field investigation are summarized in Sections 4.3 to 4.10. Excavation below the groundwater level is only anticipated to be required for the deep cut within the existing OPG soil disposal mound (Area 8). All other excavations are anticipated to extend to an elevation higher than the groundwater table. Perched water may be present within the surficial soil and fill deposits above the very dense/hard till deposits. However it is expected that such seepage volumes will be minor and could be controlled by pumping from properly filtered sumps within the excavations. It is anticipated that a Permit to Take Water (PTTW) will not be required for control of the groundwater seepage at these locations.

If sufficient time is not available in the construction schedule to allow for gravity drainage of the groundwater within the soil disposal mound (Area 8) to the interceptor ditches via finger trenches/sub drains (as discussed in Section 6.3.2), a dewatering program should be implemented prior to the start of excavation operations below the water table. The goal of the dewatering system should be to lower the groundwater level and maintain it below the proposed excavation grade for the South Service Road and the associated ditches. This could be accomplished by pumping from either drilled well points or from properly filtered sumps excavated in a line along the slope face immediately upslope of the location where the proposed excavation grade meets the elevation of the existing water table (i.e. about 117 m to 121 m). It is estimated that wells/sumps spaced at approximately every 3 m along the slope parallel to South Service Road and a pumping duration of approximately 2 weeks will be required to adequately lower the groundwater table.

The groundwater level in Area 8 will stabilize over time, is anticipated to be lowered by up to 5 m near the toe of the excavated side-slope and gradually rise within the soil mound to meet the existing groundwater level within the undisturbed portion of the mound. Given the generally dense to very dense relatively density/firm to hard consistency of the existing fill and considering there is a net unloading within the deep cut section, settlement

due to lowering of the groundwater level is not anticipated to be a concern. Settlements of the ground surface near the crest of the excavated side slope are expected to be less than 25 mm.

A NSSP for dewatering during deep cut excavations is included in Appendix K.

6.4.3 Subgrade Preparation and Embankment Construction

Prior to placing any embankment fill, all topsoil, organic matter and existing loose/soft fill materials should be stripped from the footprint of the embankment areas and the exposed subgrade soils should be proof-rolled prior to fill placement, in accordance with SP 206S03 (Earth Excavation and Grading). Considering that the majority of the existing fills contain organics as encountered in several boreholes advanced at the site, it is recommended that all existing fills be removed from within the new embankment footprint where fill heights are in excess of 4.5 m. If existing fills are to remain below the new embankments where fills are less than 4.5 m, with the exception of the very stiff to hard embankment fills that support the existing Holt Road at High Fill Areas 1 and 6 and Hwy 401 at the east end of High Fill Area 2, there should be a transition zone to avoid abrupt differential settlements that could be propagated to the road surface. The transition zone should extend from the point where the embankment is 4.5 m high back along the alignment at a 3H:1V slope where the thickness of the new fill is less than 4.5 m high and the existing fill is to be left in place.

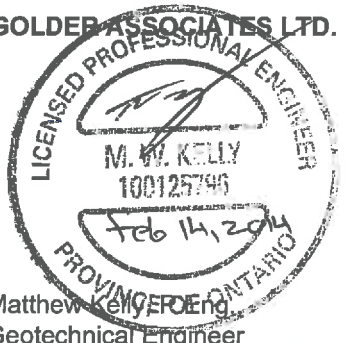
Any new embankment fill should be placed and compacted in accordance with SP 206S03 (Earth Excavation and Grading), and OPSS 501/SP105S21 (Compaction), with inspection and field density testing by qualified personnel during placement operations to confirm that appropriate materials are used and that adequate levels of compaction are achieved. Where new embankments or widened embankments meet existing embankment fill (i.e. at High Fill Areas 1, 2, and 6), benching of the existing embankment side slopes should be carried out to "key in" the new fill materials for the widening, in accordance with OPSD 208.010 *(Benching of Earth Slopes).*

The use of suitable granular fill for construction of roadway embankments is recommended rather than the use of cohesive fill, since the majority of settlement of granular fills would occur during construction whereas some settlement of cohesive fills, if used, would occur post-construction.

7.0 CLOSURE

This report was prepared by Mr. Matthew Kelly, P.Eng., a Geotechnical Engineer with Golder and reviewed by Mr. Kevin Bentley, P.Eng. Mr. Jorge M.A. Costa, P.Eng., Golder's MTO's Designated Contact for this project conducted an independent quality control review of this report.

GOLDER ASSOCIATES LTD.



Matthew Kelly, P.Eng.
Geotechnical Engineer

Kevin Bentley, P.Eng.,
Geotechnical Engineer, Associate

Jorge, M. A. Costa, P.Eng.
Designated MTO Foundations Contact, Principal
MWK/KJB/JMAC/jl

n:\active\2009\1111\09-1111-0019 urs - hwy 401 holt rd - clarington\reporting\detail design\deep cuts and high fills\final\09-1111-0019 draft 14jan holt road_cuts and fills kjb version .docx

REFERENCES

Bowles, J. E., 1984. *Physical and Geotechnical Properties of Soils*, Second Edition. McGraw Hill Book Company, New York.

Canadian Standards Association (CSA), 2006. *Canadian Highway Bridge Design Code* and *Commentary on CAN/CSA S6 06*. CSA Special Publication, S6.1 06.

Chapman, L. J., and Putnam, D.F., 1984. *The Physiography of Southern Ontario*, 3rd Edition. Ontario Geological Survey, Special Volume 2. Ontario Ministry of Natural Resources.

Ecoplans. *Phase II Environmental Site Assessment, OPG Darlington Soil Mound, Darlington Nuclear Site, Town of Clarington, Ontario.* July, 2010

Karrow, P. F., and White, O. L., 1998. *Urban Geology of Canadian Cities.* Geological Association of Canada Special Paper No. 42. St. John's, Nfld.

Kulhawy, F.H. and Mayne, P.W., 1990. Manual on Estimating Soil Properties for Foundation Design. EL 6800, Research Project 1493 6. Prepared for Electric Power Research Institute, Palo Alto, California.

Ministry of Transportation, Ontario, 2012. Pavement Design and Rehabilitation Manual, Second Edition, Section 3.2.5.

Ontario Geological Society, 1991. *Geology of Ontario*. Special Volume 4, Part 1. Eds. P.C. Thurston, H. R. Williams, R. H. Sutcliffe and G. M. Stott. Ministry of Northern Development and Mines, Ontario.

Ontario Hydro, *Darlington G.S. 'A' as Built Report For: Disposal Mound, Earth Embankment, Switchyard and Tower Pads, Principal Soil Excavation Areas. Report No. 81212.* May 29, 1981

Townsend, D.L., and Csathy, T.I., 1963. Compilation of Frost Suceptibility Criteria up to 1961. Ontario Joint Highway Research Program, Department of Civil Engineering, Queen's University, Kingston, Ontario.

Ontario Provincial Standard Specifications (OPSS)

OPSS 212	Construction Specification for Borrow
OPSS 501/SP105S21	Construction Specification For Compacting
OPSS 511	Construction Specification For Rip-Rap, Rock Protection, And Granular Sheeting
OPSS 804	Construction Specification for Seed and Cover

Ontario Provincial Standard Drawings

OPSD 202.010	Slope Flattening, Using Surplus Excavated Material on Earth or Rock Embankment
OPSD 208.010	Benching of Earth Slopes

Ministry of Transportation Ontario Special Provisions

SP 110S13	Material Specification for Aggregates – Base, Subbase, Select Subgrade, and Backfill

Ontario Water Resources Act

Ontario Regulation 372/97	Amendment to Ontario Regulation 903
Ontario Regulation 903/90	Wells

ASTM International

ASTM D1586 Standard Test Method for Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils

Commercial Software

GeoStudio (Version 7.13) by Geo-Slope International Ltd.
Settle 3D (Version 2.003) by Rocscience Inc.

MINISTRY OF TRANSPORTATION, ONTARIO

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

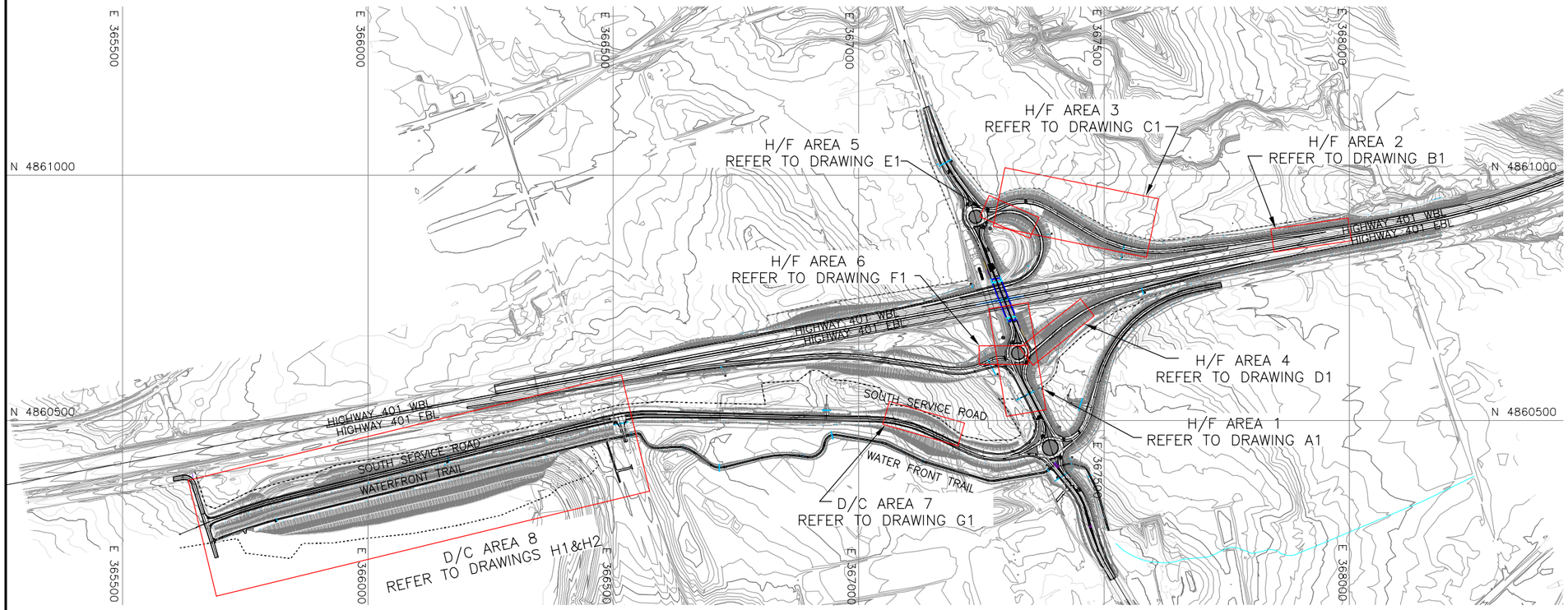
CONT No.
GWP No.2101-08-00

HIGHWAY 401/HOLT ROAD
INTERCHANGE RECONFIGURATION

INDEX PLAN

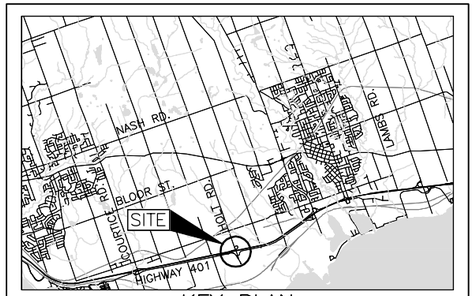
SHEET

Golder Associates Ltd.
MISSISSAUGA, ONTARIO, CANADA



PLAN

SCALE
100 0 100 200 m



KEY PLAN
SCALE
2 0 2 4 km

LEGEND

- H/F High Fill Area
- D/C Deep Cut Area

NOTES

This drawing is for general 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 complete Foundation Investigation 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 plan provided in digital format by URS, drawing file no. 2013-10-24-Hwy401-HoltRd_plan.dwg, received October 23, 2013

NO.	DATE	BY	REVISION

Geocres No. 30M15-158

HWY. 401		PROJECT NO. 09-1111-0019	DIST.
SUBM'D.	CHKD. MWK	DATE: Oct. 2013	SITE: 21-159
DRAWN: JFC	CHKD. KJD	APPD. JMAC	DWG. 1

PLOT DATE: January 21, 2014
FILENAME: T:\Projects\2009\09-1111-0019 (URS_Clarington)\-DA- Holt Road_South Service Road_Ramps\Vol1\1100\19DA001.dwg

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
FoS	factor of safety

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
υ	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 multiplied by acceleration due to gravity)

(a) Index Properties (continued)

w	water content
w_l or LL	liquid limit
w_p or PL	plastic limit
I_p or PI	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_α	secondary compression index
m_v	coefficient of volume change
c_v	coefficient of consolidation (vertical direction)
c_h	coefficient of consolidation (horizontal direction)
T_v	time factor (vertical direction)
U	degree of consolidation
σ'_p	pre-consolidation stress
OCR	over-consolidation ratio = σ'_p / σ'_{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 = (compressive strength)/2

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

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.)

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, 60º 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 cm^2 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.

III. SOIL DESCRIPTION

(a) Non-Cohesive (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

(b) Cohesive Soils

Consistency

	c_u, s_u kPa	c_u, s_u 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

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.

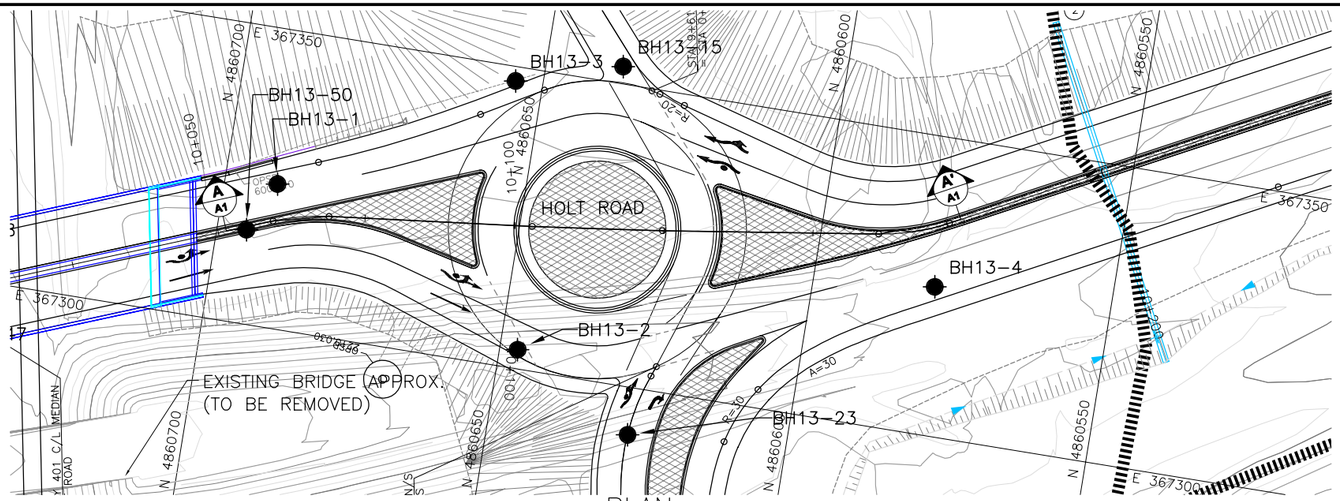
V. MINOR SOIL CONSTITUENTS

Per cent by Weight	Modifier	Example
0 to 5	Trace	Trace sand
5 to 12	Trace to Some (or Little)	Trace to some sand
12 to 20	Some	Some sand
20 to 30	(ey) or (y)	Sandy
over 30	And (non-cohesive (cohesionless)) or With (cohesive)	Sand and Gravel / Silty Clay with sand / Clayey Silt with sand

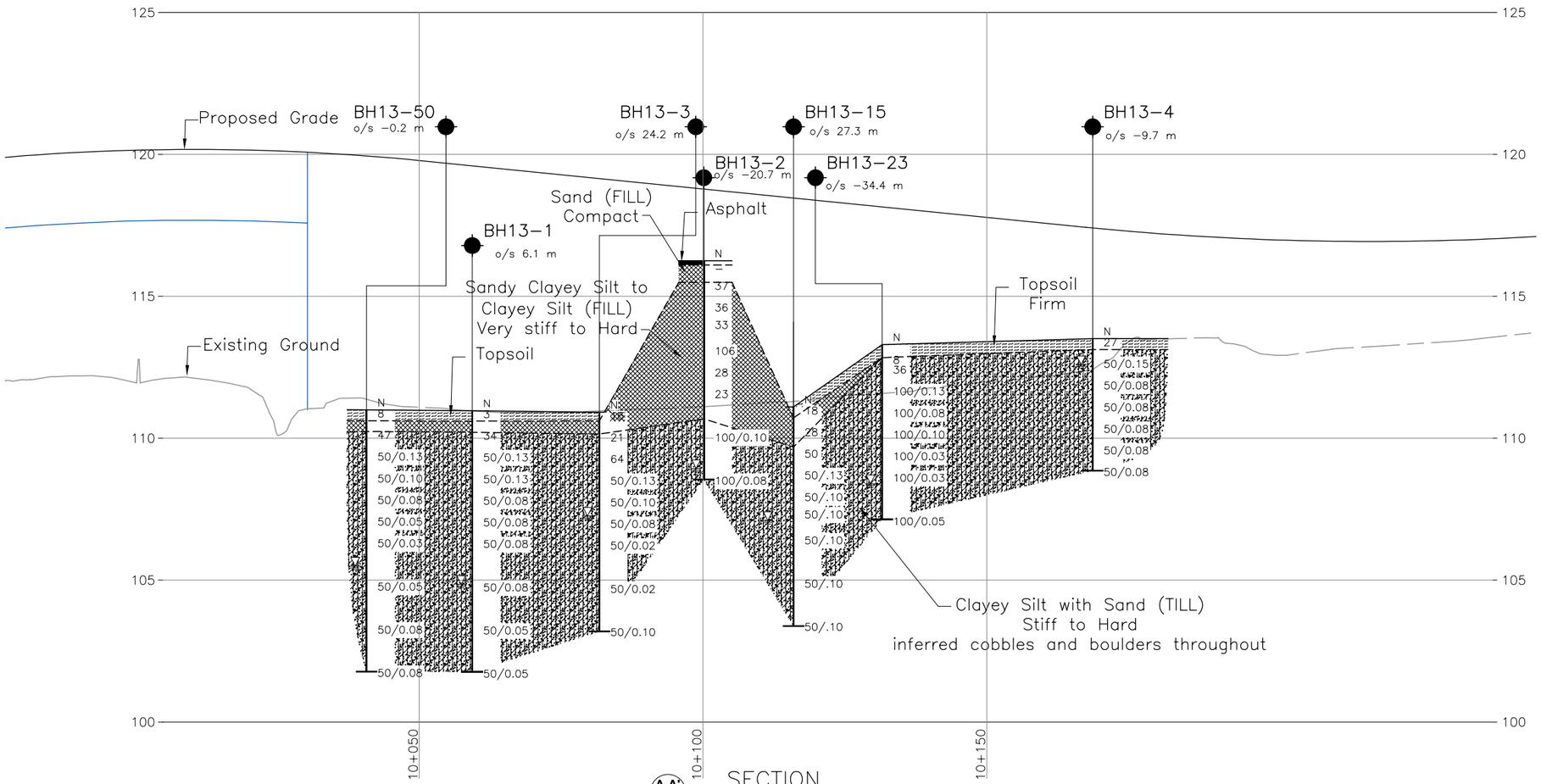
APPENDIX A

High Fill Area 1 - Holt Road, STA 10+050 to 10+170

MINISTRY OF TRANSPORTATION, ONTARIO



PLAN
SCALE
10 0 10 20 m



SECTION
A-A'
A1
HORIZONTAL SCALE
10 0 10 20 m
VERTICAL SCALE
2 0 2 4 m

PLOT DATE: January 21, 2014
FILENAME: T:\Projects\2009\09-1111-0019 (URS_Dangerfield)_CAD\ Holt Road_South-Service-Road_Ramps\\09111100190A01.dwg

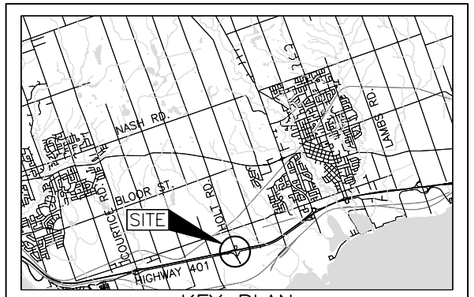
METRIC
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN.
STATIONS IN KILOMETRES + METRES.

CONT No.
GWP No. 2101-08-00

HIGHWAY 401
HIGH FILL AREA 1-HOLT ROAD
(STA 10+050 TO 10+170)
BOREHOLE LOCATIONS AND SOIL STRATA

SHEET

Golder Associates Ltd.
MISSISSAUGA, ONTARIO, CANADA



KEY PLAN
SCALE
2 0 2 4 km

LEGEND

- Borehole - Current Investigation
- N Standard Penetration Test Value
- 16 Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)
- WL during or upon completion of drilling

BOREHOLE CO-ORDINATES			
No.	ELEVATION	NORTHING	EASTING
BH13-1	111.0	4860691.2	367324.1
BH13-2	116.3	4860647.0	367303.2
BH13-3	110.9	4860654.6	367347.6
BH13-4	113.5	4860579.7	367324.9
BH13-15	111.1	4860637.2	367352.9
BH13-23	113.2	4860626.5	367292.1
BH13-50	111.0	4860695.1	367315.7

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 plan provided in digital format by URS, drawing file no. 2013-10-24-Hwy401-HoltRd_plan.dwg and 2013-10-24-Hwy401-HoltRd_profile.dwg, received October 23, 2013

NO.	DATE	BY	REVISION

Geocres No. 30M15-158

HWY. 401		PROJECT NO. 09-1111-0019	DIST.
SUBM'D.	CHKD. MWK	DATE: Oct. 2013	SITE: 21-159
DRAWN: JFC	CHKD. KJB	APPD. JMAC	DWG. A1

Golder Associates

RECORD OF BOREHOLE No BH13-1

SHEET 1 OF 1

METRIC

PROJECT 09-1111-0019
G.W.P. 2101-08-00
LOCATION N 4860691.2 ;E 367324.1
ORIGINATED BY JLC
DIST HWY 401
BOREHOLE TYPE 120 mm O.D. Continuous Flight Solid Stem Power Auger
COMPILED BY BM
DATUM Geodetic
DATE May 27, 2013
CHECKED BY MWK

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
111.0	GROUND SURFACE										
0.0 / 110.6	TOPSOIL		1	SS	3		110				
110.2	Clayey silt, some sand, trace gravel (FILL) Brown Moist										
0.8	CLAYEY SILT with SAND to some sand, trace to some gravel, inferred cobbles throughout (TILL) Hard Brown to grey Moist		2	SS	34						
			3	SS	50/0.13		109				3 15 49 33
			4	SS	50/0.13						12 39 37 12
			5	SS	50/0.08		108				
			6	SS	50/0.08		107				
			7	SS	50/0.08		106				
			8	SS	50/0.08	▽	105				
			9	SS	50/0.05		104				
			10	SS	50/0.05		103				
101.8							102				
9.2	END OF BOREHOLE										

NOTES:

1. Water level at a depth of 6.1 m below ground surface (Elev. 104.9 m) upon completion of drilling.

2. Borehole caved to a depth of 6.1 m below ground surface (Elev. 104.9 m) upon completion of dril

$+^{3}, \times^{3}$: Numbers refer to Sensitivity

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

Golder Associates

RECORD OF BOREHOLE No BH13-2

SHEET 1 OF 1

METRIC

PROJECT 09-1111-0019
G.W.P. 2101-08-00
DIST HWY 401
DATUM Geodetic

LOCATION N 4860647.0 ;E 367303.2
BOREHOLE TYPE 120 mm O.D. Continuous Flight Solid Stem Power Auger
DATE May 30, 2013

ORIGINATED BY JLC
COMPILED BY BM
CHECKED BY MWK

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
116.3	GROUND SURFACE										
0.0	ASPHALT (150 mm)										
0.2	Sand, some gravel, trace silt (FILL) Brown Moist		1	AS	-		116		○		
115.5											
0.8	Sandy clayey silt to clayey Silt, some sand, trace to some gravel, trace organics and containing rootlets (FILL) Very stiff to hard Brown to grey Moist		2	SS	37						
			3	SS	36		115		⊕		14 29 42 15
			4	SS	33		114				
			5	SS	106		113		○		0 18 65 17
			6	SS	28		112				
			7	SS	23		111				
110.7											
5.6	CLAYEY SILT with SAND trace to some gravel, inferred cobbles throughout (TILL) Hard Grey Wet		8	SS	100/0.10	▽	110		○		5 35 45 15
108.6			9	SS	100/0.08		109				
7.7	END OF BOREHOLE										

NOTES:

1. Water level at a depth of 7.3 m below ground surface (Elev. 109.0 m) during drilling.

2. Borehole caved at a depth of 7.6 m below ground surface (Elev. 108.7 m) upon completion of drilling.

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

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

Golder Associates

RECORD OF BOREHOLE No BH13-3

SHEET 1 OF 1

METRIC

PROJECT 09-1111-0019
G.W.P. 2101-08-00
LOCATION N 4860654.6 ;E 367347.6
ORIGINATED BY JLC
DIST HWY 401
BOREHOLE TYPE 120 mm O.D. Continuous Flight Solid Stem Power Auger
COMPILED BY BM
DATUM Geodetic
DATE May 28, 2013
CHECKED BY MWK

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
110.9	GROUND SURFACE								
0.0 / 110.6	TOPSOIL		1	SS	16				
0.3 / 110.1	Clayey silt, some sand, trace to some gravel (FILL) Very stiff Brown Moist		2	SS	21		110		
0.8	CLAYEY SILT with SAND, trace to some gravel, inferred cobbles and boulders at 4.6 m depth (TILL) Very stiff to hard Brown to grey Moist		3	SS	64		109		6 29 36 29
			4	SS	50/0.13				
			5	SS	50/0.10		108		
			6	SS	50/0.08	▽	107		
			7	SS	50/0.02				4 39 49 8
	Augers grinding on inferred cobbles and boulders						106		
			8	SS	50/0.02		105		
							104		
103.2 / 7.7			9	SS	50/0.10				4 35 45 16

DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100

SHEAR STRENGTH kPa
○ UNCONFINED + FIELD VANE
● QUICK TRIAXIAL × REMOULDED
20 40 60 80 100

PLASTIC LIMIT w_P | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w_L
WATER CONTENT (%)
10 20 30

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

GTA-MTO 001 09-1111-0019.GPJ GAL-GTA.GDT 01/21/14

Golder Associates

RECORD OF BOREHOLE No BH13-4

SHEET 1 OF 1 **METRIC**

PROJECT 09-1111-0019 | G.W.P. 2101-08-00 | LOCATION N 4860579.7 ;E 367324.9 | ORIGINATED BY JLC

DIST | HWY 401 | BOREHOLE TYPE 120 mm O.D. Continuous Flight Solid Stem Power Auger | COMPILED BY BM

DATUM Geodetic | DATE May 27, 2013 | CHECKED BY MWK

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
113.5	GROUND SURFACE										
0.0 / 113.1	TOPSOIL		1	SS	27		113				
0.4	CLAYEY SILT with SAND trace gravel, inferred cobbles and boulders (TILL) Hard Brown to grey Moist		2	SS	50/0.15	▽			○		16 38 34 12
			3	SS	50/0.08		112		○		9 43 38 10
	- - - - - - - - - - - - - - - Augers grinding on inferred cobbles and boulders between depths of 2.13 m and 4.6 m		4	SS	50/0.08		111				
			5	SS	50/0.08				○		
			6	SS	50/0.08		110				
	- - - - - - - - - - - - - - - Augers grinding on inferred cobbles and boulders at a depth of 3.8 m										
108.9			7	SS	50/0.08		109		○		
4.7	END OF BOREHOLE										

NOTES:

1. Water level at a depth of 0.9 m below ground surface (Elev. 112.6 m) during drilling.

2. Borehole caved to a depth of 3.4 m below ground surface (Elev. 110.1 m) upon completion of drilling.

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

Golder Associates

RECORD OF BOREHOLE No BH13-15 SHEET 1 OF 1 METRIC

PROJECT 09-1111-0019
G.W.P. 2101-08-00 LOCATION N 4860637.2 ;E 367352.9 ORIGINATED BY JLC
DIST HWY 401 BOREHOLE TYPE 120 mm O.D. Continuous Flight Solid Stem Power Auger COMPILED BY BM
DATUM Geodetic DATE May 31, 2013 CHECKED BY MWK

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
111.1	GROUND SURFACE										
0.0 / 110.7	TOPSOIL		1	SS	18		111				
0.4 / 109.7	Sandy clayey silt, trace gravel (FILL) Very stiff Brown Moist		2	SS	28		110				4 24 43 29
1.4	CLAYEY SILT with SAND trace to some gravel, inferred cobbles and boulders at 4.6 m depth (TILL) Hard Brown to grey Moist		3	SS	50		109				4 39 42 15
			4	SS	50/.13						
			5	SS	50/.10		108				
			6	SS	50/.10	▽					
	Augers grinding on inferred cobbles and boulders		7	SS	50/.10		107				
							106				
			8	SS	50/.10		105				
							104				
103.4			9	SS	50/.10						
7.7	END OF BOREHOLE										

NOTES:

1. Water level at a depth of 4.0 m below ground surface (Elev. 107.1 m) upon completion of drilling.

2. Borehole caved to a depth of 7.2 m below ground surface (Elev. 103.9 m) upon completion of dril

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

Golder Associates

RECORD OF BOREHOLE No BH13-23

SHEET 1 OF 1

METRIC

PROJECT 09-1111-0019
G.W.P. 2101-08-00
LOCATION N 4860626.5 ;E 367292.1
ORIGINATED BY JLC
DIST HWY 401
BOREHOLE TYPE 120 mm O.D. Continuous Flight Solid Stem Power Auger
COMPILED BY BM
DATUM Geodetic
DATE May 30, 2013
CHECKED BY MWK

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
113.2	GROUND SURFACE										
0.0	TOPSOIL Firm Dark brown Moist		1	SS	8		113		○		
112.7 0.5	CLAYEY SILT with SAND trace to some gravel, inferred cobbles and boulders throughout (TILL) Hard Brown to grey Moist		2	SS	36						
			3	SS	100/0.13		112		○ ⊢		20 47 22 11
			4	SS	100/0.08		111				
			5	SS	100/0.10				○ ⊢		3 43 37 17
			6	SS	100/0.03		110				
			7	SS	100/0.03	▽	109				
							108				
107.1			8	SS	100/0.06		107		○		
6.2	END OF BOREHOLE										

NOTE:

1. Water level in open borehole at a depth of 4.9 m below ground surface (Elev. 108.3 m) upon completion of drilling.

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

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

Golder Associates

RECORD OF BOREHOLE No BH13-50

SHEET 1 OF 1 **METRIC**

PROJECT 09-1111-0019
G.W.P. 2101-08-00
DIST ____ HWY 401
DATUM Geodetic
LOCATION N 4860695.0 ;E 367316.0
BOREHOLE TYPE 120 mm O.D. Continuous Flight Solid Stem Power Auger
DATE May 27, 2013
ORIGINATED BY JLC
COMPILED BY BM
CHECKED BY MWK

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
111.0	GROUND SURFACE										
0.0 / 110.6	TOPSOIL Loose Brown Moist		1	SS	8						
110.2 / 0.8	Clayey silt, some sand, trace gravel, trace organics (FILL) Dark brown Moist		2	SS	47		110				5 37 41 17
	CLAYEY SILT with SAND, trace to some gravel, occasional silt seams (TILL) Hard Brown to grey Moist		3	SS	50/0.13		109				2 39 44 15
			4	SS	50/0.10		108				10 42 35 13
			5	SS	50/0.08		107				
			6	SS	50/0.05		106				
	Auger grinding on inferred cobbles and boulders below 4.0 m depth		7	SS	50/0.03	▽	105				
			8	SS	50/0.06		104				
			9	SS	50/0.08		103				
101.8			10	SS	50/0.08		102				
9.2	END OF BOREHOLE										

NOTES:

1. Water level at a depth of 5.5 m below ground surface (Elev. 105.5 m) during drilling.

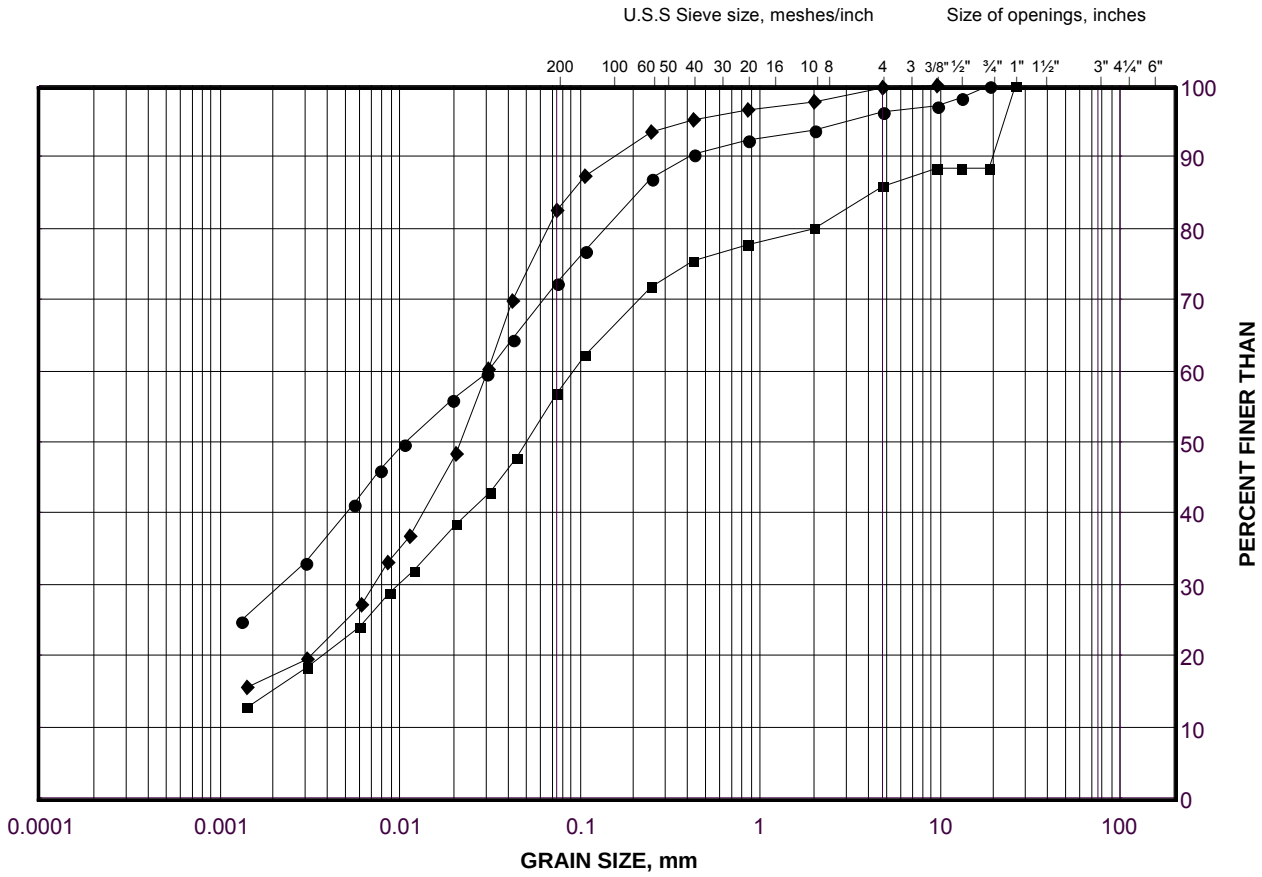
2. Borehole caved to a depth of 6.1 m below ground surface (Elev. 104.9 m) upon completion of drilling.

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

GRAIN SIZE DISTRIBUTION TEST RESULTS

Clayey Silt Fill

FIGURE A1



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	13-15	2	110.1
■	13-2	3	114.5
◆	13-2	5	113.0

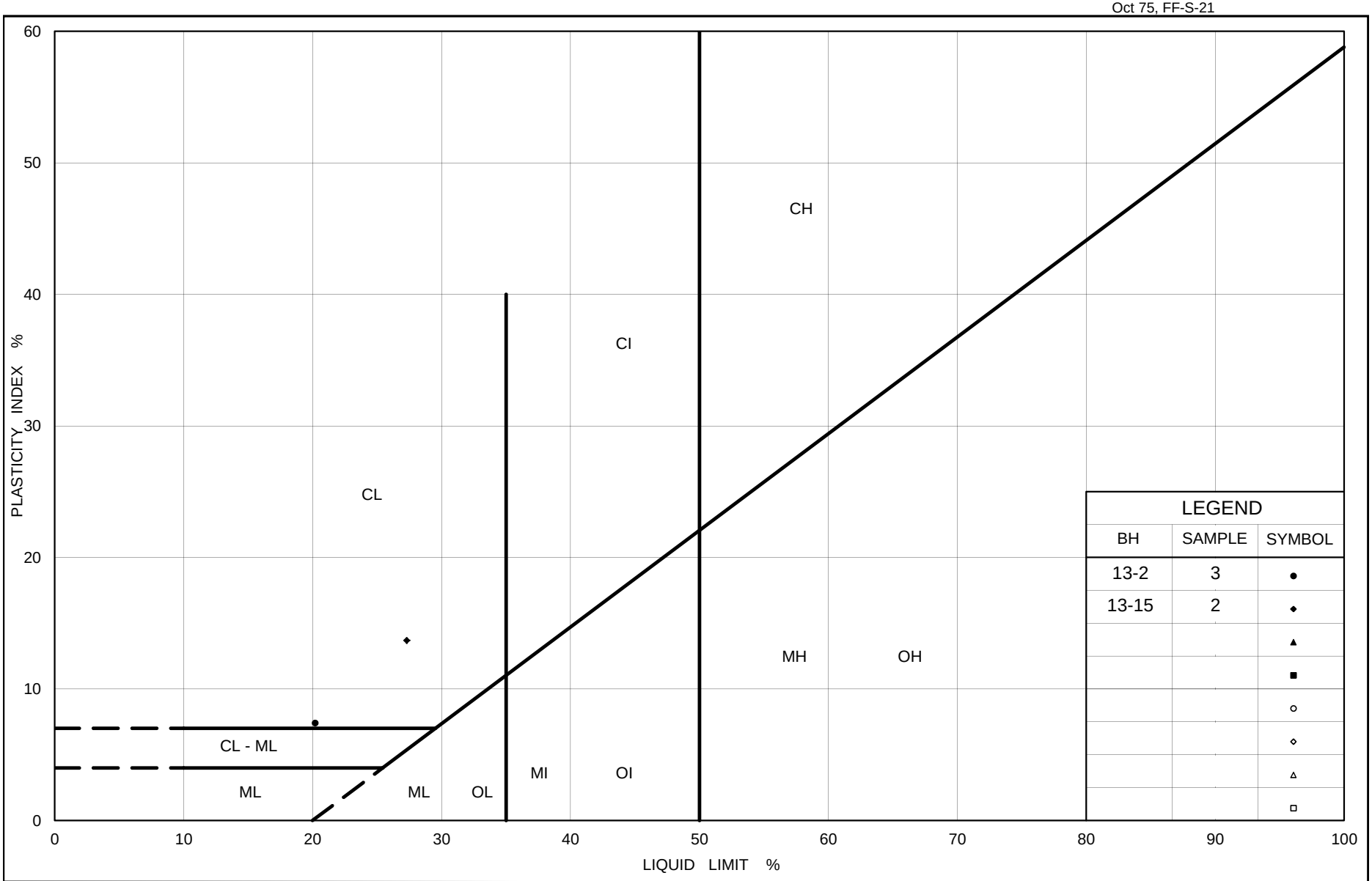
Project Number: 09-1111-0019

Checked By: _____

Golder Associates

Date: 01-Nov-13

Oct 75, FF-S-21



Ministry of Transportation

Ontario

PLASTICITY CHART
Clayey Silt (FILL)

Figure No. A2

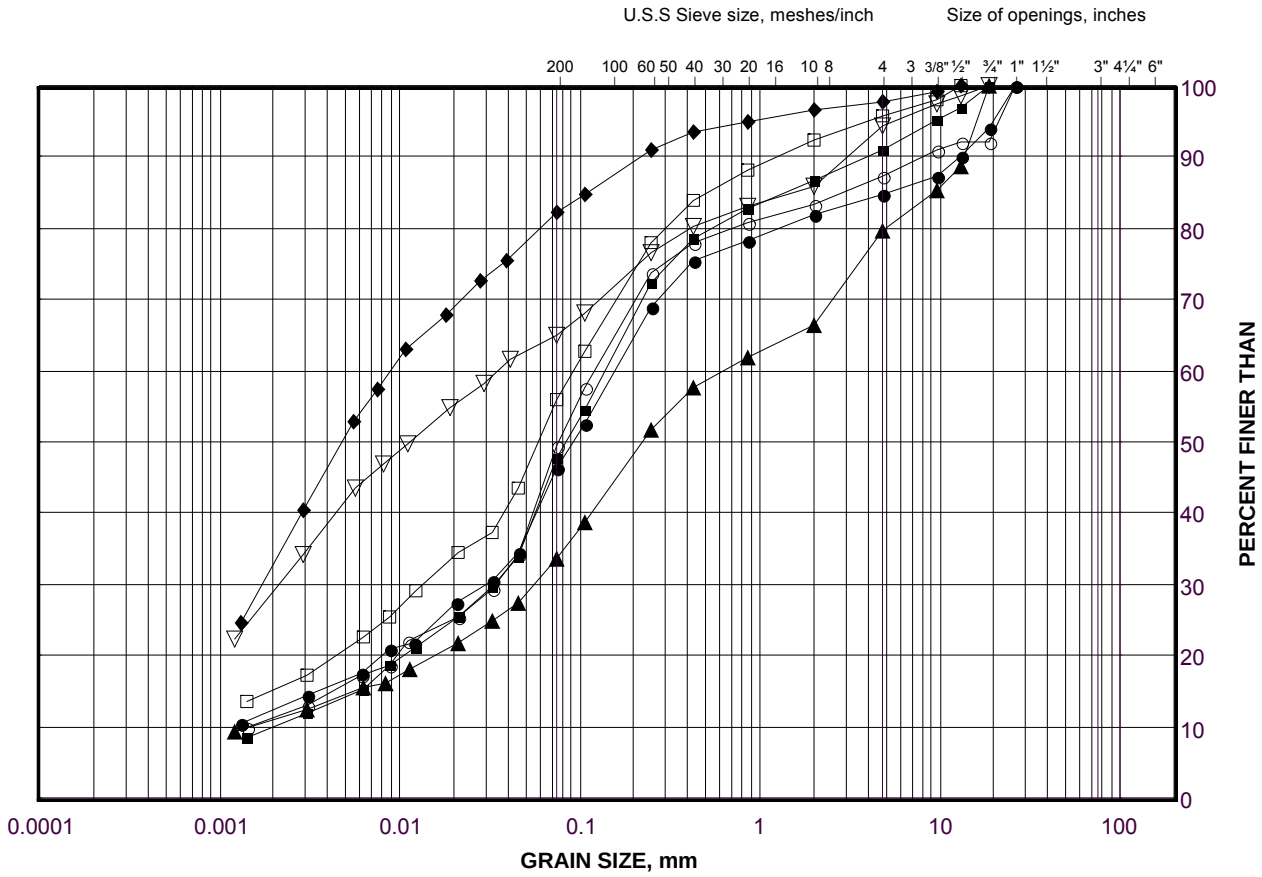
Project No. 09-1111-0019

Checked By:

GRAIN SIZE DISTRIBUTION TEST RESULTS

Clayey Silt (TILL)

FIGURE A3A



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	13-4	2	112.7
■	13-4	3	111.9
◆	13-1	3	109.4
▲	13-23	3	111.6
▽	13-3	3	109.2
❍	13-1	4	108.6
□	13-15	4	108.8

Project Number: 09-1111-0019

Checked By: _____

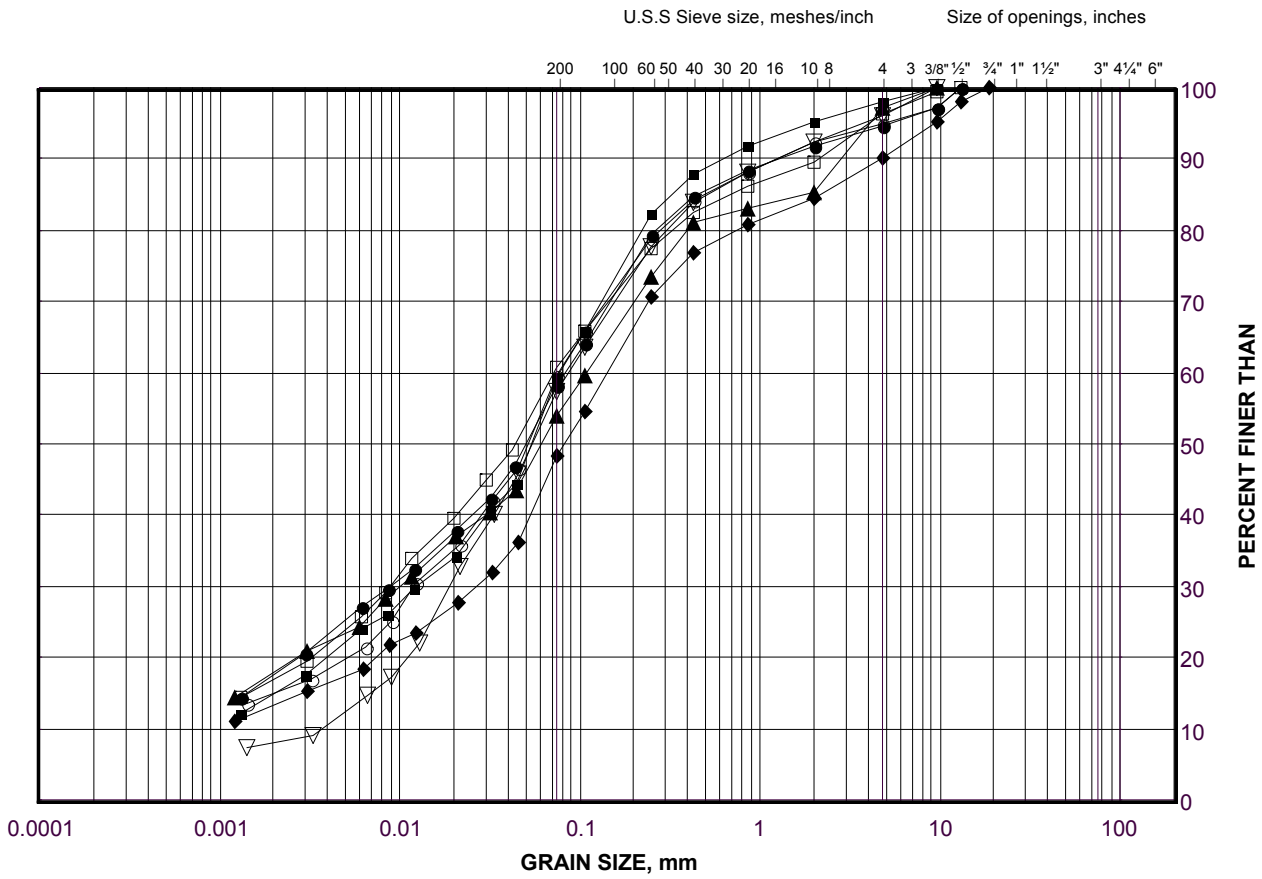
Golder Associates

Date: 06-Nov-13

GRAIN SIZE DISTRIBUTION TEST RESULTS

Clayey Silt (TILL)

FIGURE A3B



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	13-50	2	110.0
■	13-50	3	109.4
◆	13-50	5	107.9
▲	13-23	5	110.1
▽	13-3	7	106.4
❍	13-2	8	110.1
□	13-3	9	103.2

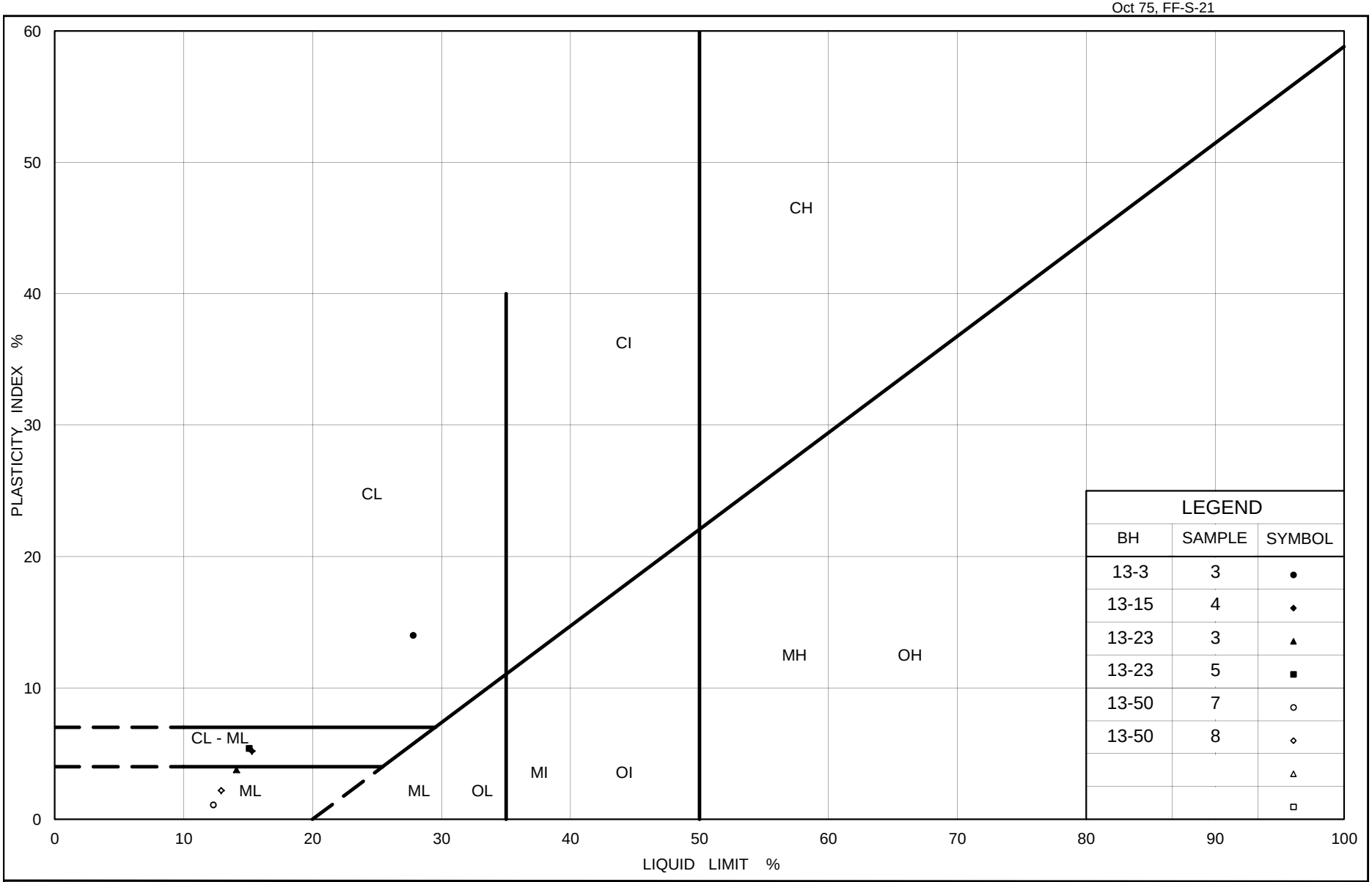
Project Number: 09-1111-0019

Checked By: _____

Golder Associates

Date: 12-Nov-13

Oct 75, FF-S-21



Ministry of Transportation

Ontario

PLASTICITY CHART
Clayey Silt (TILL)

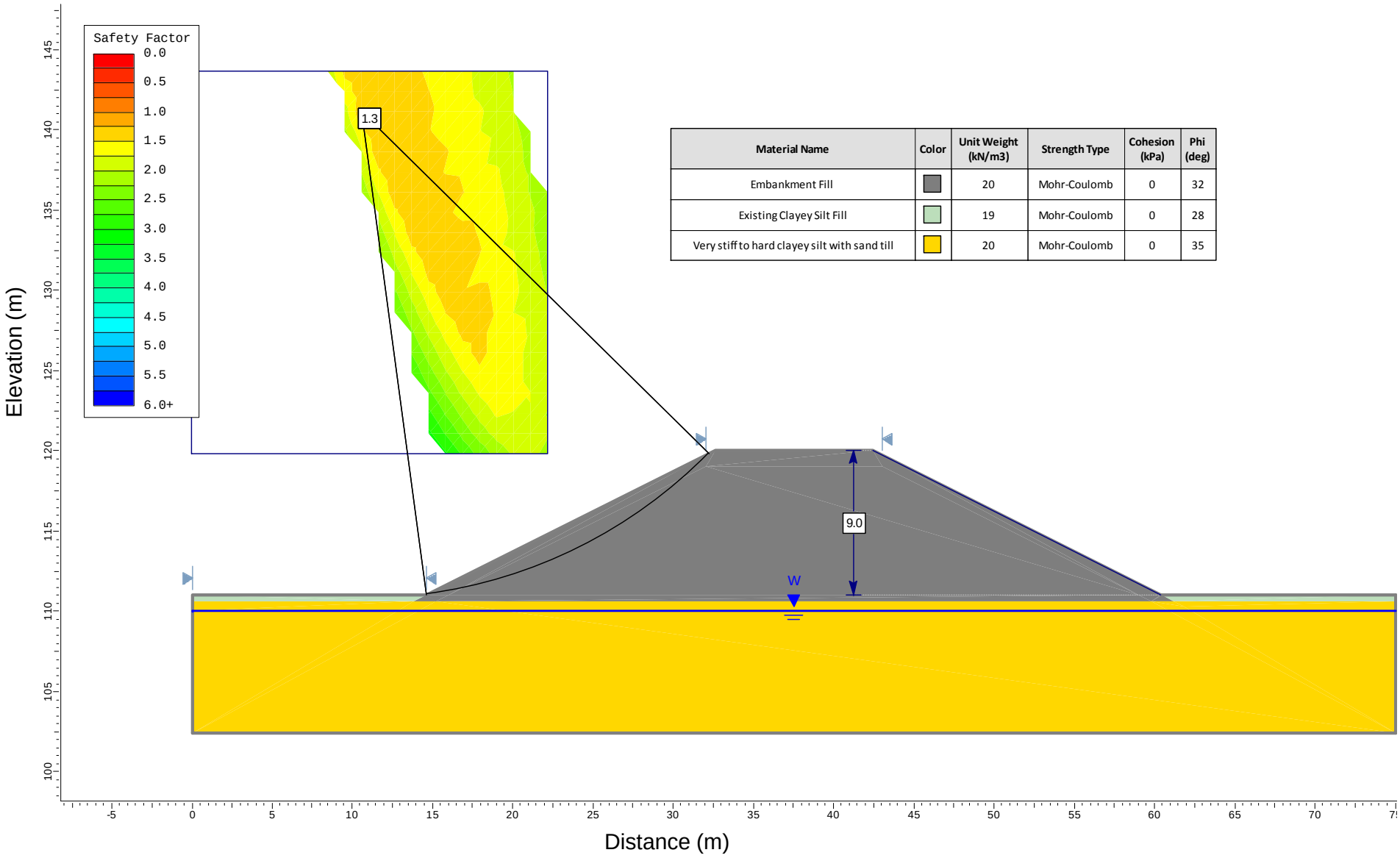
Figure No. A4

Project No. 09-1111-0019

Checked By:

Area 1 – Holt Road STA 10+050 to 10+170
Static Global Stability Analysis

Figure A5



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)
Embankment Fill		20	Mohr-Coulomb	0	32
Existing Clayey Silt Fill		19	Mohr-Coulomb	0	28
Very stiff to hard clayey silt with sand till		20	Mohr-Coulomb	0	35

Date: November 2013

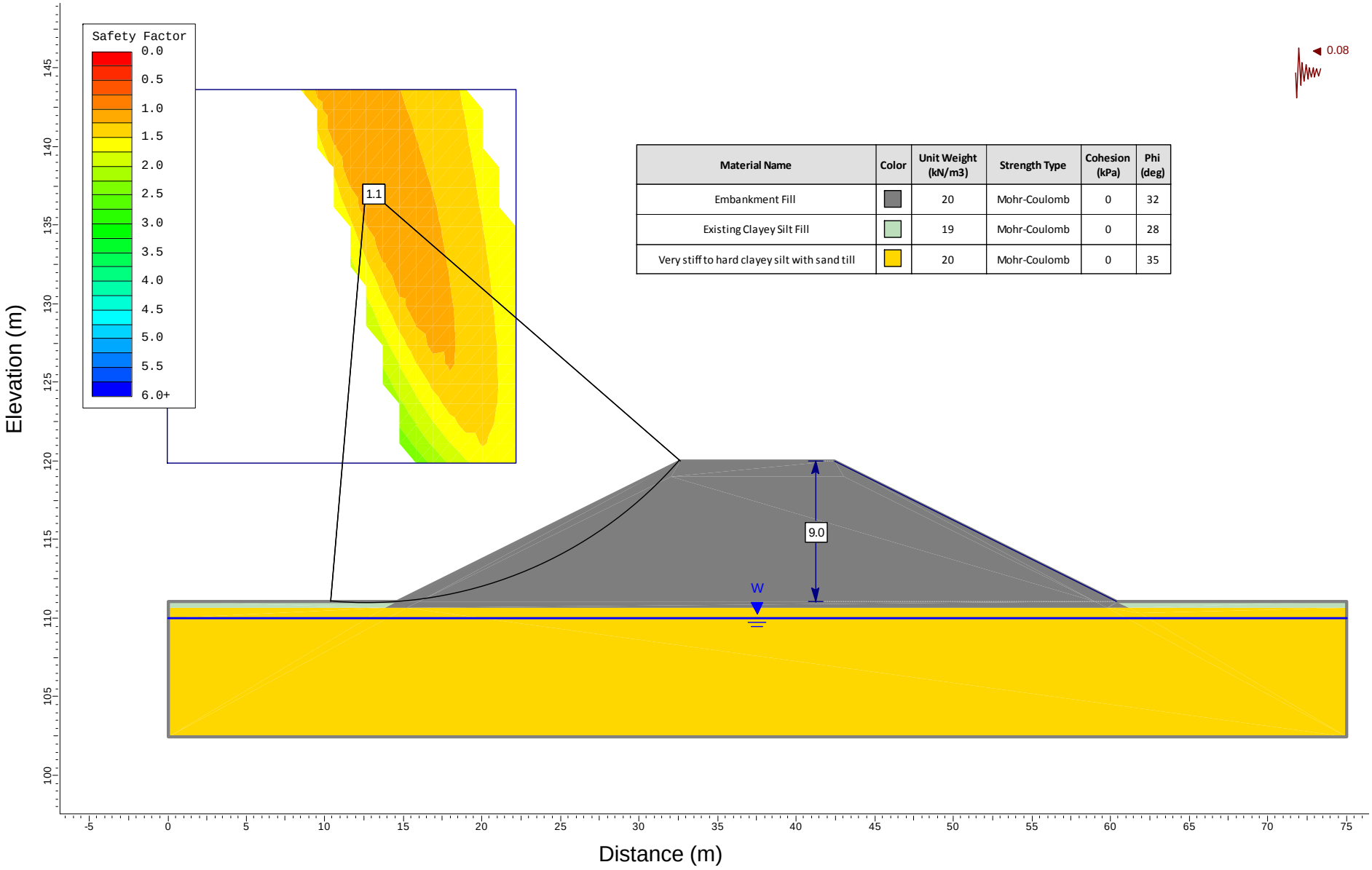
Project No: 09-1111-0019

Analysis By: MWK **Reviewed By:** KJB

Golder Associates

Area 1 – Holt Road STA 10+050 to 10+170
Seismic Global Stability Analysis

Figure A6



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)
Embankment Fill		20	Mohr-Coulomb	0	32
Existing Clayey Silt Fill		19	Mohr-Coulomb	0	28
Very stiff to hard clayey silt with sand till		20	Mohr-Coulomb	0	35

Date: November 2013

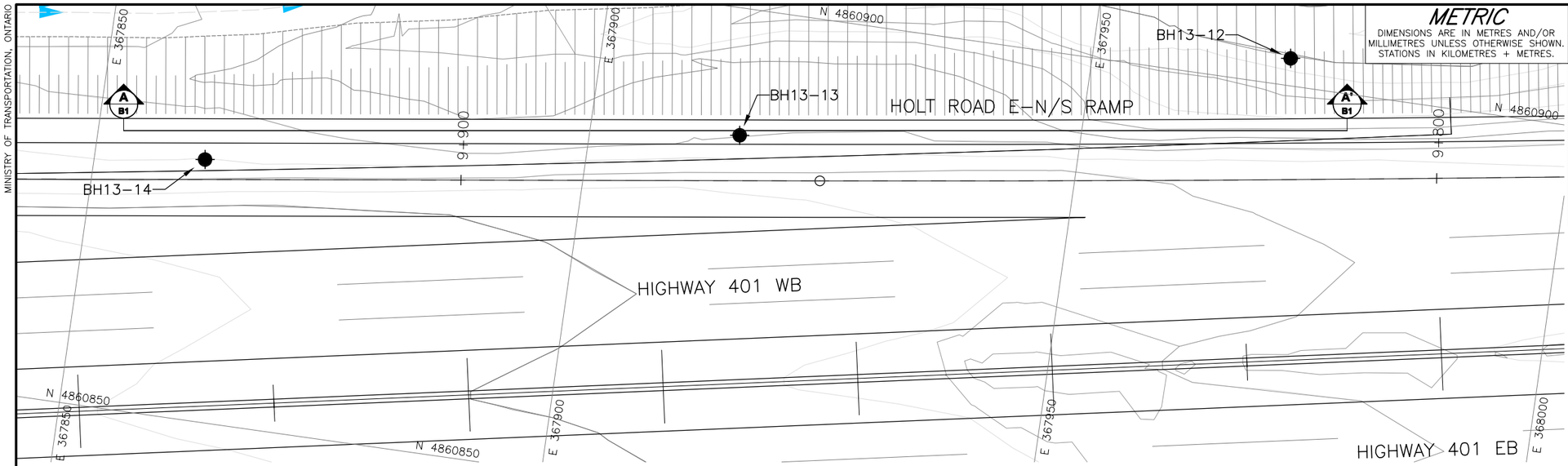
Project No: 09-1111-0019

Analysis By: MWK **Reviewed By:** KJB

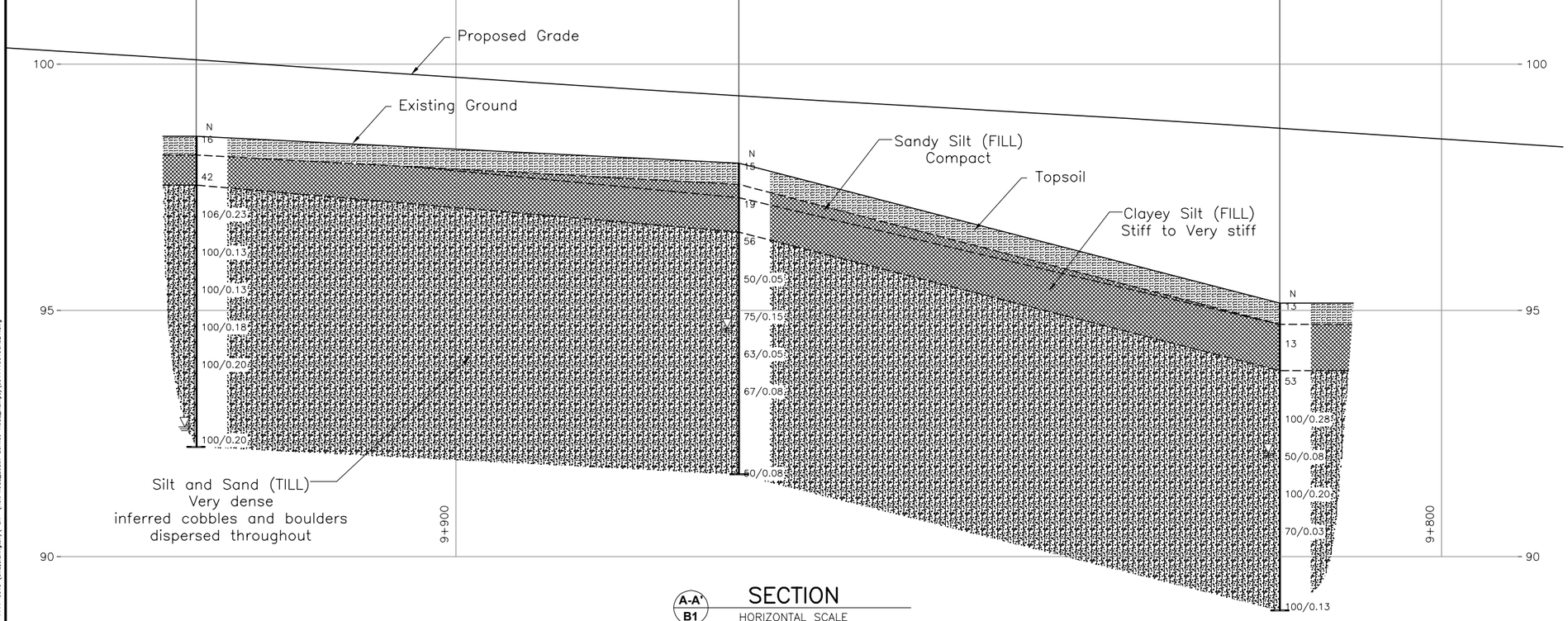
APPENDIX B

High Fill Area 2 - E-N/S Ramp, STA 9+850 to 9+970

MINISTRY OF TRANSPORTATION, ONTARIO



PLAN
SCALE
5 0 5 10 m



A-A' B1 SECTION
HORIZONTAL SCALE
5 0 5 10 m
1 0 1 2 m
HORIZONTAL SCALE

METRIC

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

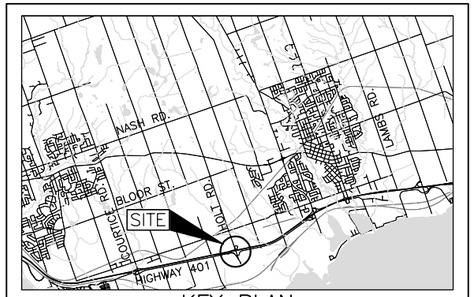
CONT No.
GWP No. 2101–08–00

N

SHEET

HIGHWAY 401
HIGH FILL AREA 2–HOLT ROAD E–N/S RAMP
(STA 9+850 TO 9+970)
BOREHOLE LOCATIONS AND SOIL STRATA

Golder Associates Ltd.
MISSISSAUGA, ONTARIO, CANADA



KEY PLAN
SCALE
2 0 2 4 km

LEGEND

- Borehole – Current Investigation
- N — Standard Penetration Test Value
- 16 — Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)
- WL during or upon completion of drilling

BOREHOLE CO–ORDINATES

No.	ELEVATION	NORTHING	EASTING
BH13–12	95.1	4860902.8	367970.2
BH13–13	98.0	4860887.0	367915.3
BH13–14	98.5	4860876.8	367861.3

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 plan provided in digital format by URS, drawing file no. 2013–10–24–Hwy401–HoltRd_plan.dwg and 2013–10–24–Hwy401–HoltRd_profile.dwg, received October 23, 2013

NO.	DATE	BY	REVISION

Geocres No. 30M15–158

HWY. 401	PROJECT NO. 09–1111–0019		DIST.
SUBM'D.	CHKD. MWK	DATE: Oct. 2013	SITE: 21–159
DRAWN: JFC	CHKD. KJB	APPD. JMAC	DWG. B1

PLOT DATE: January 21, 2014
FILENAME: T:\Projects\2009\09-1111-0019 (URS,Clarington)\--GA-- (Holt Road_South-Service-Road_Ramp)\091111001902A01.dwg

Golder Associates

RECORD OF BOREHOLE No BH13-12

SHEET 1 OF 1

METRIC

PROJECT 09-1111-0019
G.W.P. 2101-08-00
LOCATION N 4860902.8 ;E 367970.2
ORIGINATED BY JLC
DIST HWY 401
BOREHOLE TYPE 120 mm O.D. Continuous Flight Solid Stem Power Auger
COMPILED BY BM
DATUM Geodetic
DATE May 31, 2013
CHECKED BY MWK

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
95.1	GROUND SURFACE										
0.0 / 94.7	TOPSOIL		1A 1B	SS	13		95		○		
0.4 / 93.7	Clayey silt, some sand, trace gravel, containing organics (FILL) Stiff Brown Moist		2	SS	13		94				
1.4	SILT and SAND, trace to some gravel, trace to some clay, inferred cobbles and boulders throughout (TILL) Very dense Brown to grey Moist		3A 3B	SS	53		93				13 43 34 10
			4	SS	100/0.28				○		17 41 31 11
			5	SS	50/0.08	▽	92				
			6	SS	100/0.20				○		
			7	SS	70/0.03		91				
							90				
88.9			8	SS	100/0.13		89		○		
6.2	END OF BOREHOLE										

NOTES:

1. Water level at a depth of 3.0 m below ground surface (Elev. 92.1 m) during drilling.

2. Borehole caved at a depth of 4.9 m below ground surface (Elev. 90.2 m) upon completion of drilling.

+ ³, × ³: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

Golder Associates

RECORD OF BOREHOLE No BH13-13

SHEET 1 OF 1

METRIC

PROJECT 09-1111-0019
G.W.P. 2101-08-00
LOCATION N 4860887.0 ;E 367915.3
ORIGINATED BY JLC
DIST HWY 401
BOREHOLE TYPE 120 mm O.D. Continuous Flight Solid Stem Power Auger
COMPILED BY BM
DATUM Geodetic
DATE May 31, 2013
CHECKED BY MWK

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
98.0	GROUND SURFACE										
0.0	TOPSOIL										
97.6			1	SS	15						
97.3	Sandy silt, some gravel, trace clay, containing organics (FILL)										
0.7	Compact Dark brown Moist		2	SS	19		97				0 28 47 25
96.6	Clayey silt, some sand (FILL)										
1.4	Very stiff Brown Moist		3	SS	56						
	SILT and SAND, some gravel, some clay, inferred cobbles and boulders throughout (TILL) Very dense Brown to grey Moist		4	SS	50/0.05		96		○		13 45 35 7
			5	SS	75/0.15	▽	95		H		
			6	SS	63/0.05				○		
							94				
			7	SS	67/0.08				○		15 45 34 6
							93				
							92				
91.7			8	SS	50/0.08				○		19 46 29 6
6.3	END OF BOREHOLE										

NOTE:

1. Water level at a depth of 3.4 m below ground surface (Elev. 94.6 m) during drilling.

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

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

GTA-MTO 001 09-1111-0019.GPJ GAL-GTA.GDT 01/21/14

Golder Associates

RECORD OF BOREHOLE No BH13-14

SHEET 1 OF 1

METRIC

PROJECT 09-1111-0019
G.W.P. 2101-08-00
LOCATION N 4860876.8 ;E 367861.3
ORIGINATED BY JLC
DIST HWY 401
BOREHOLE TYPE 120 mm O.D. Continuous Flight Solid Stem Power Auger
COMPILED BY BM
DATUM Geodetic
DATE May 31, 2013
CHECKED BY MWK

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
98.5	GROUND SURFACE										
0.0 / 98.1	TOPSOIL		1	SS	16		98				
0.4 / 97.5	Clayey silt with sand, some sand, trace gravel (FILL) Very stiff Brown Moist		2A 2B	SS	42						5 44 37 14
1.0	SILT and SAND, trace to some gravel and clay, inferred cobbles and boulders throughout (TILL) Very dense Brown to grey Moist		3	SS	106/0.23		97				
			4	SS	100/0.13		96				9 45 35 11
			5	SS	100/0.13		95				
			6	SS	100/0.18		94				
			7	SS	100/0.20		93				
92.2			8	SS	100/0.20	▽					
6.3	END OF BOREHOLE										

NOTE:

1. Water level at a depth of 5.9 m below ground surface (Elev. 92.6 m) during drilling.

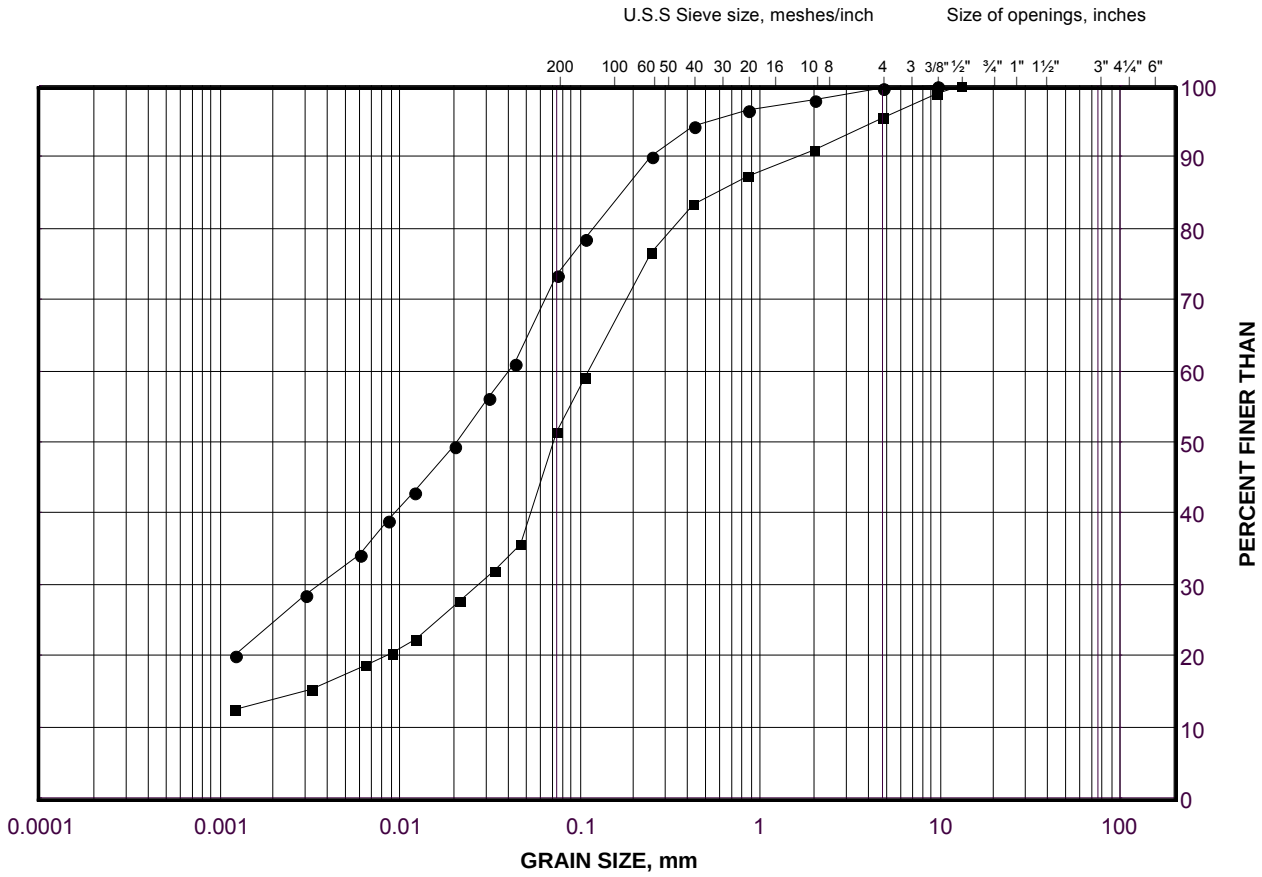
$+^3, \times^3$: Numbers refer to Sensitivity

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

GRAIN SIZE DISTRIBUTION TEST RESULTS

Clayey Silt (FILL)

FIGURE B1



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	13-13	2	97.0
■	13-14	2A	97.7

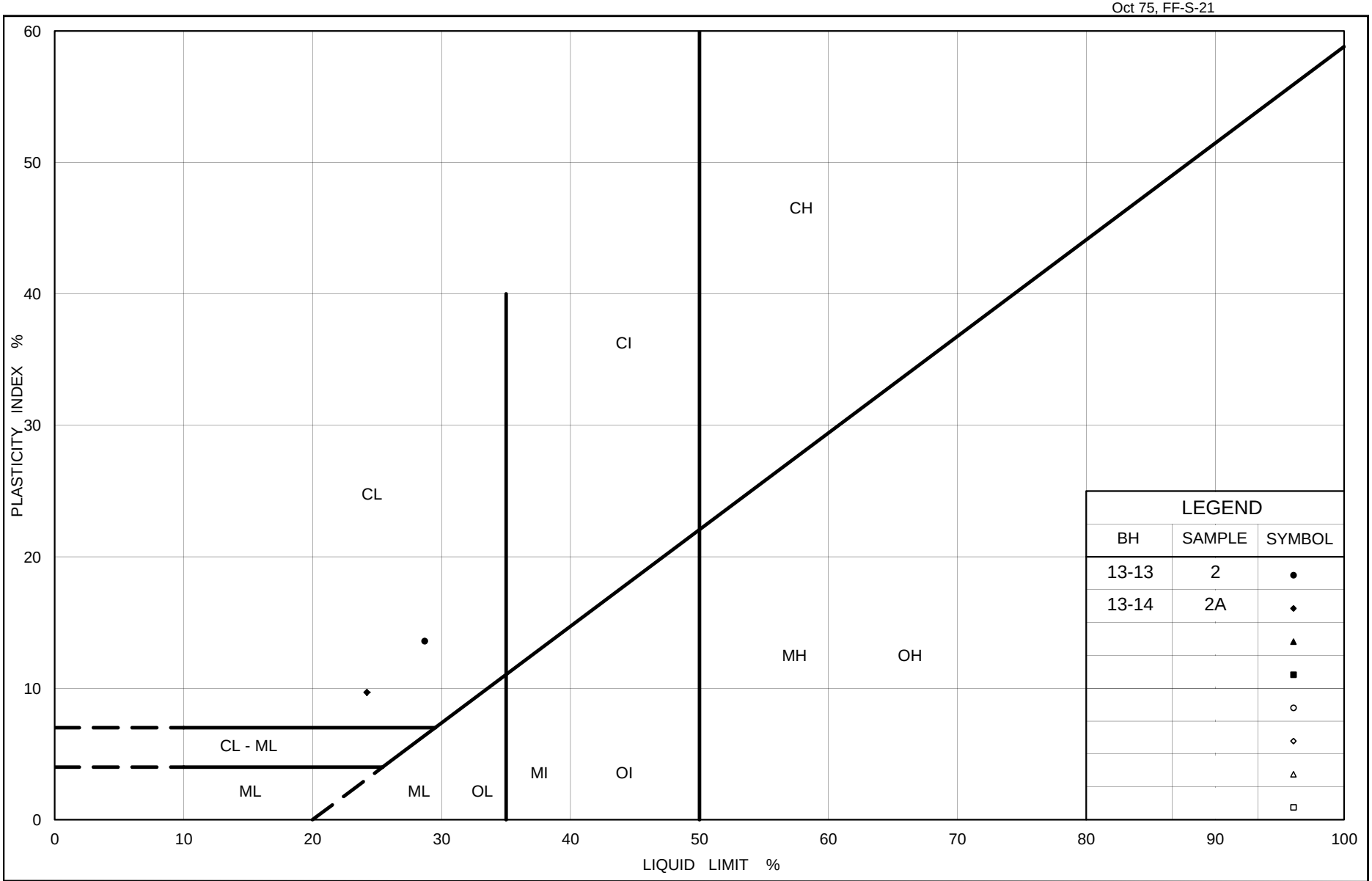
Project Number: 09-1111-0019

Checked By: _____

Golder Associates

Date: 01-Nov-13

Oct 75, FF-S-21



Ministry of Transportation

Ontario

PLASTICITY CHART
Clayey Silt (FILL)

Figure No. B2

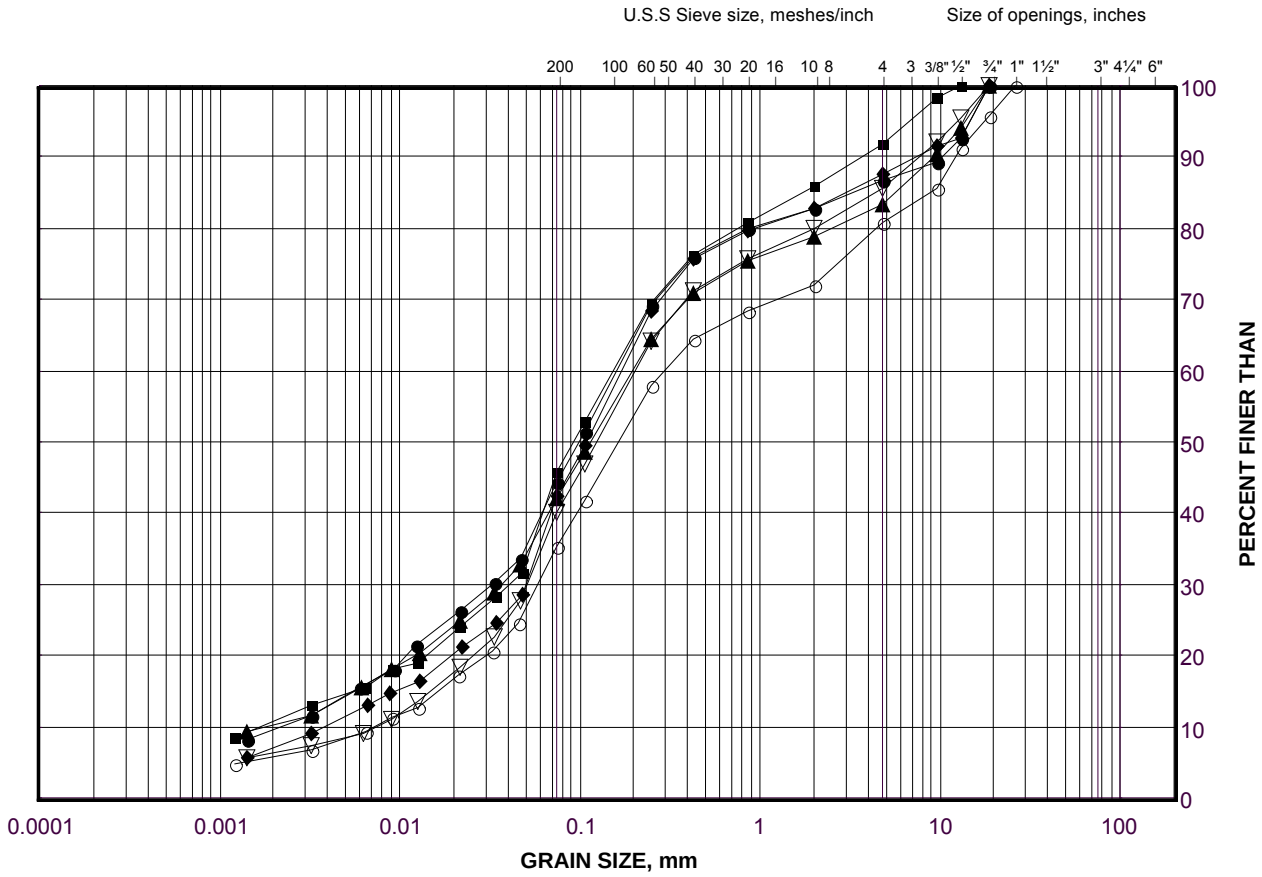
Project No. 09-1111-0019

Checked By:

GRAIN SIZE DISTRIBUTION TEST RESULTS

Silt and Sand (TILL)

FIGURE B3



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	13-12	3B	93.3
■	13-14	4	96.2
◆	13-13	4	95.7
▲	13-12	4	92.7
▽	13-13	7	93.4
❍	13-13	8	91.7

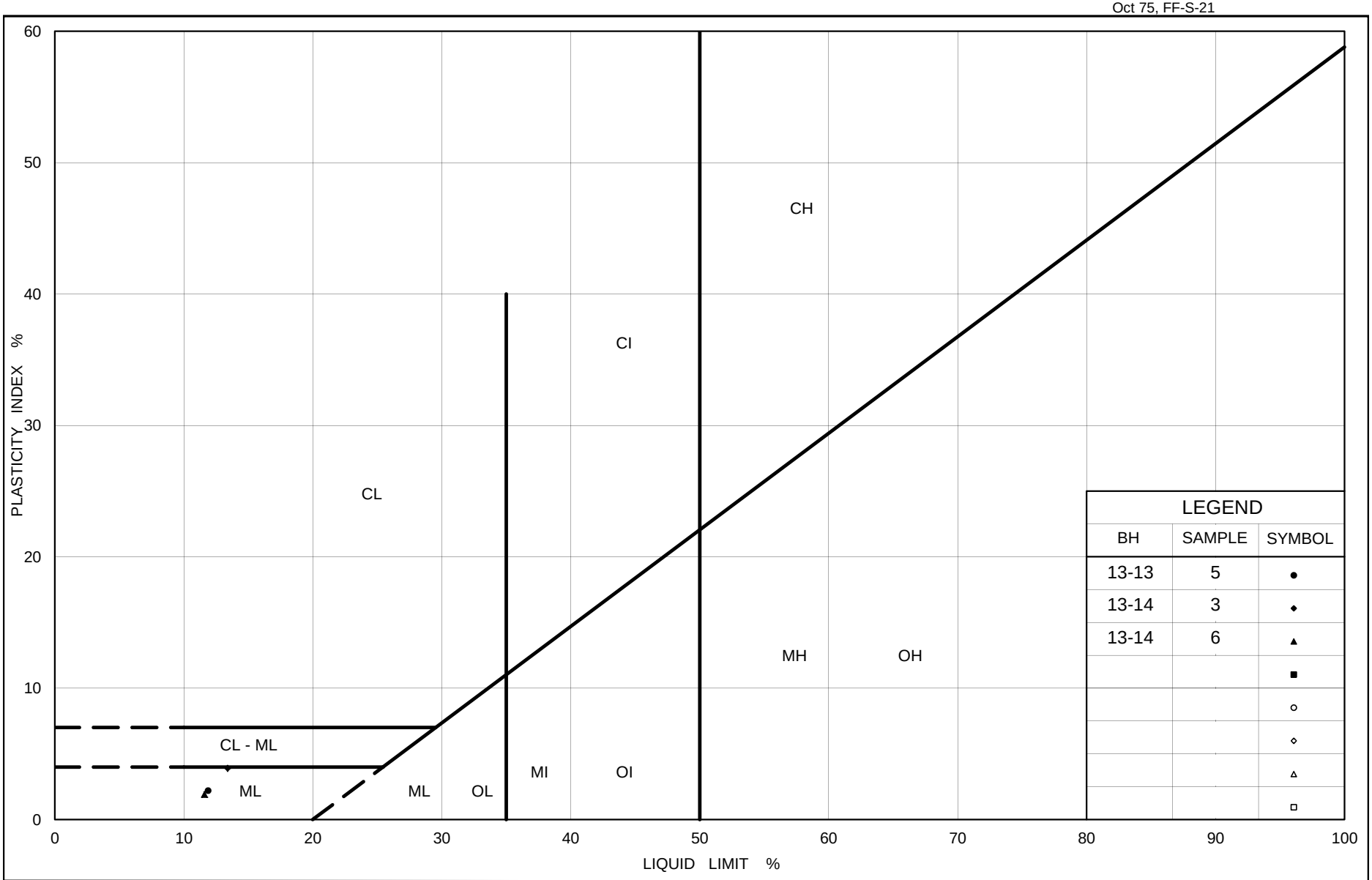
Project Number: 09-1111-0019

Checked By: _____

Golder Associates

Date: 01-Nov-13

Oct 75, FF-S-21



Ministry of Transportation

Ontario

PLASTICITY CHART
Silt and Sand (TILL)

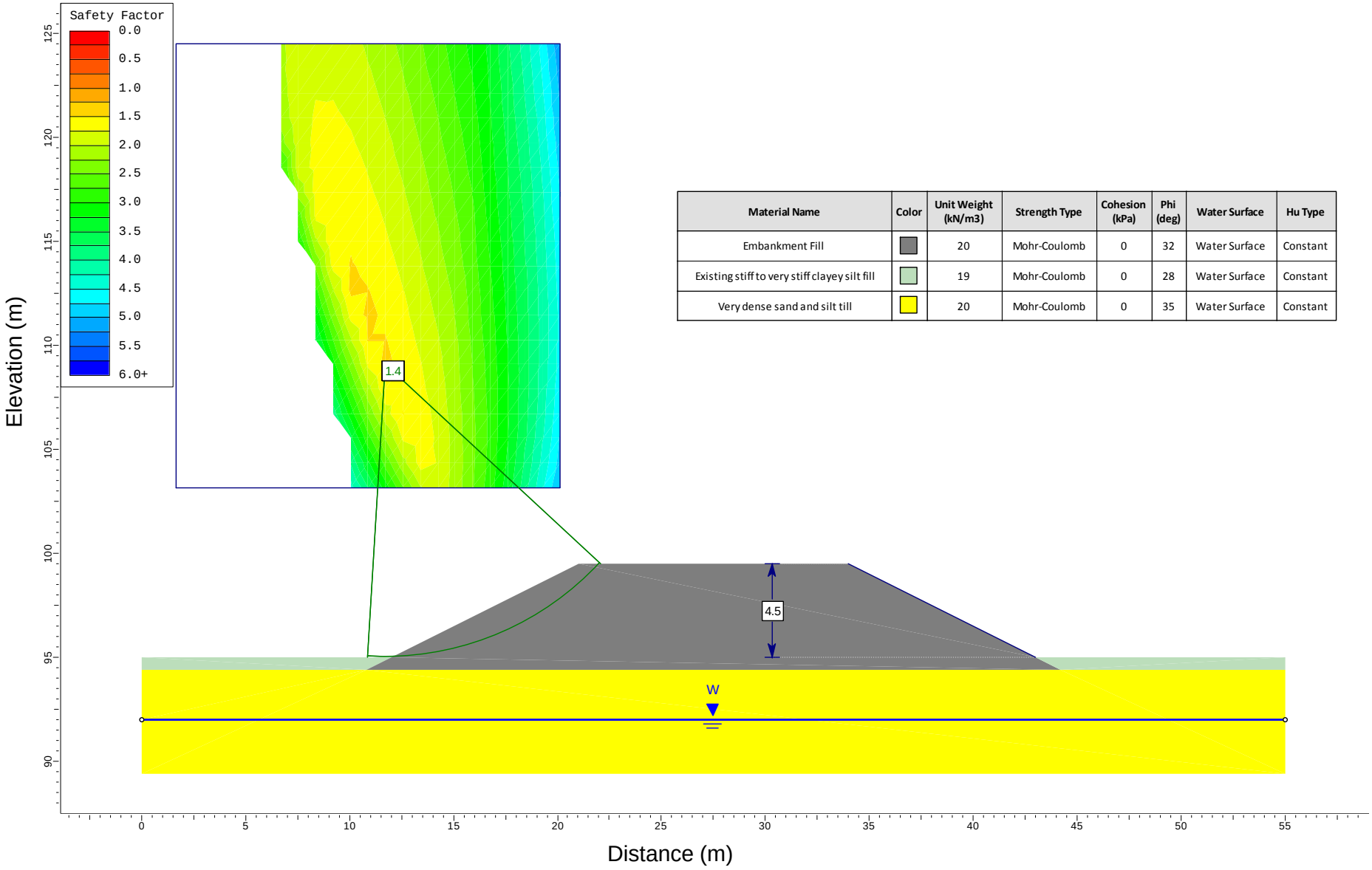
Figure No. B4

Project No. 09-1111-0019

Checked By:

Area 2 – Ramp – E-N/S STA 9+850 to 9+970
Static Global Stability Analysis

Figure B5



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Hu Type
Embankment Fill		20	Mohr-Coulomb	0	32	Water Surface	Constant
Existing stiff to very stiff clayey silt fill		19	Mohr-Coulomb	0	28	Water Surface	Constant
Very dense sand and silt till		20	Mohr-Coulomb	0	35	Water Surface	Constant

Date: November 2013

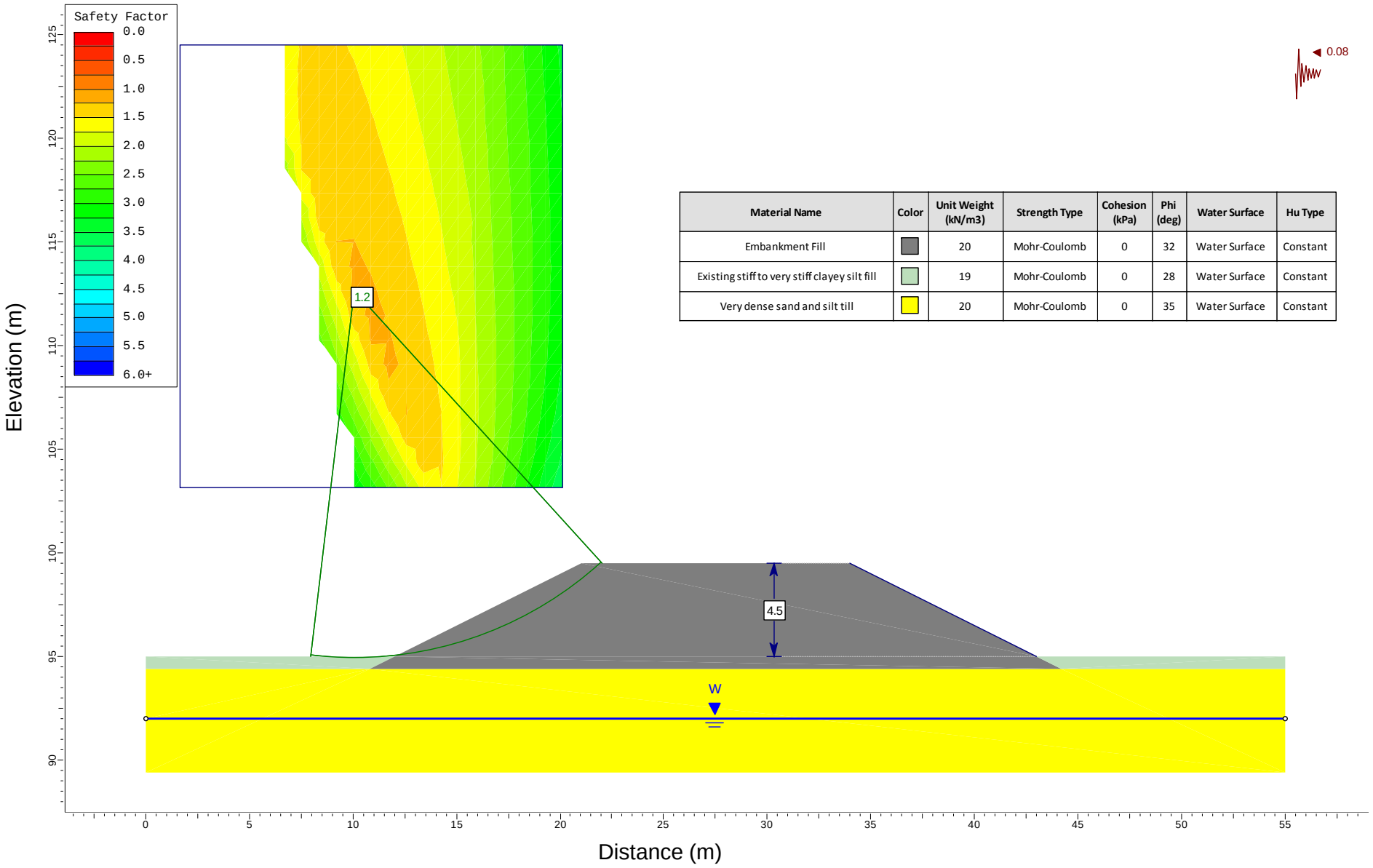
Project No: 09-1111-0019

Analysis By: MWK **Reviewed By:** KJB

Golder Associates

Area 2 – Ramp – E-N/S STA 9+850 to 9+970
Seismic Global Stability Analysis

Figure B6



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Hu Type
Embankment Fill		20	Mohr-Coulomb	0	32	Water Surface	Constant
Existing stiff to very stiff clayey silt fill		19	Mohr-Coulomb	0	28	Water Surface	Constant
Very dense sand and silt till		20	Mohr-Coulomb	0	35	Water Surface	Constant

Date: November 2013

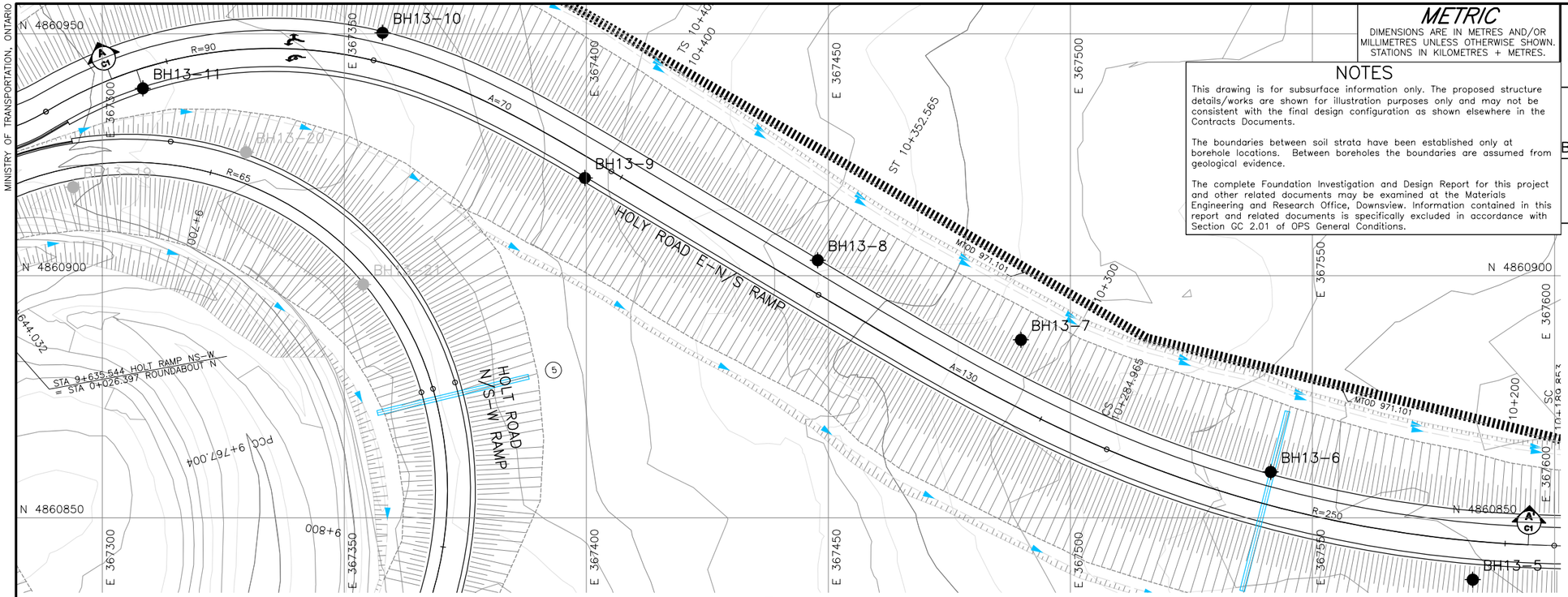
Project No: 09-1111-0019

Analysis By: MWK **Reviewed By:** KJB

APPENDIX C

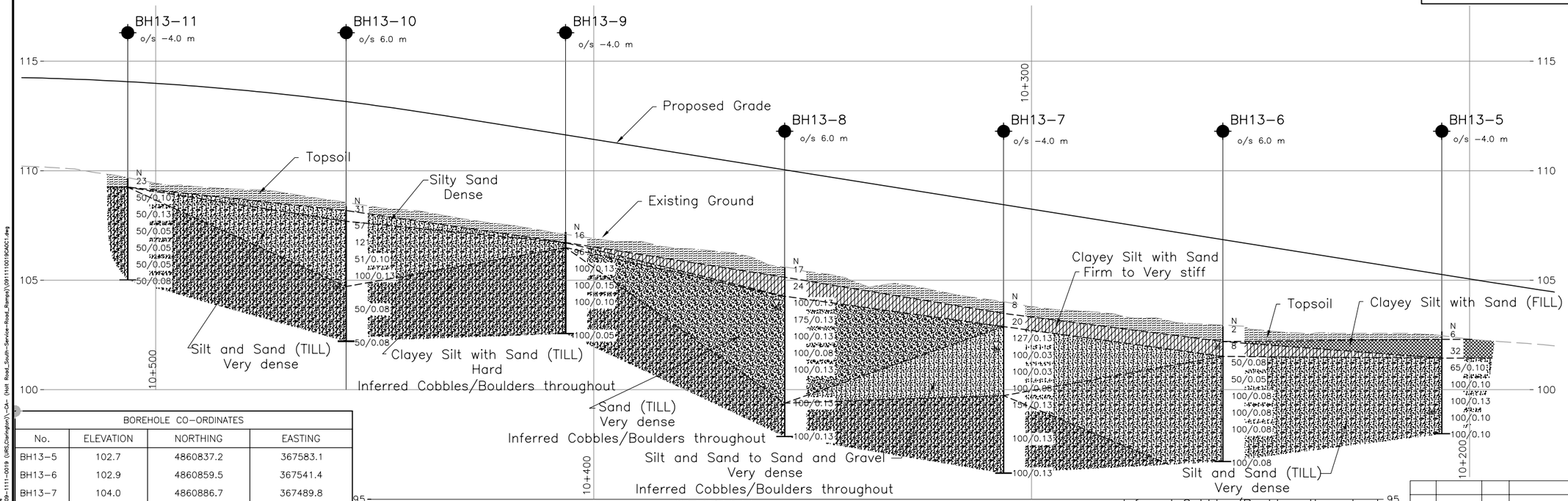
High Fill Area 3 - E-N/S Ramp, STA 10+200 to 10+500

MINISTRY OF TRANSPORTATION, ONTARIO



PLAN

SCALE
10 0 10 20 m



SECTION

A-A' C1

HORIZONTAL SCALE
10 0 10 20 m

VERTICAL SCALE
2 0 2 4 m

BOREHOLE CO-ORDINATES			
No.	ELEVATION	NORTHING	EASTING
BH13-5	102.7	4860837.2	367583.1
BH13-6	102.9	4860859.5	367541.4
BH13-7	104.0	4860886.7	367489.8
BH13-8	105.6	4860903.2	367447.8
BH13-9	107.2	4860920.2	367399.7
BH13-10	108.4	4860950.2	367357.9
BH13-11	109.7	4860938.7	367308.4

METRIC

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

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.

CONT No.
GWP No. 2101-08-00

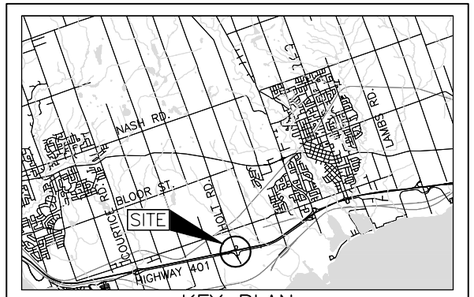
SHEET

HIGHWAY 401

HIGH FILL AREA 3-HOLT ROAD E-N/S RAMP
(STA 10+200 TO 10+500)

BOREHOLE LOCATIONS AND SOIL STRATA

Golder Associates Ltd.
MISSISSAUGA, ONTARIO, CANADA



KEY PLAN
SCALE
2 0 2 4 km

LEGEND

- Borehole - Current Investigation
- N Standard Penetration Test Value
- 16 Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)
- WL during or upon completion of drilling

REFERENCE

Base plan provided in digital format by URS, drawing file no. 2013-10-24-Hwy401-HoltRd_plan.dwg and 2013-10-24-Hwy401-HoltRd_profile.dwg, received October 23, 2013

NO.	DATE	BY	REVISION

Geocres No. 30M15-158

HWY. 401	PROJECT NO. 09-1111-0019		DIST.
SUBM'D.	CHKD. MWK	DATE: Oct. 2013	SITE: 21-159
DRAWN: JFC	CHKD. KJB	APPD. JMAC	DWG. C1

PLOT DATE: January 21, 2014
FILENAME: T:\Projects\2009\09-1111-0019 (URS,Darlington)\~Dwg (Holt Road_South-Service-Road_Ramps)\09111100190AGC1.dwg

Golder Associates

RECORD OF BOREHOLE No BH13-5

SHEET 1 OF 1 **METRIC**

PROJECT 09-1111-0019
G.W.P. 2101-08-00 LOCATION N 4860837.2 ;E 367583.1 ORIGINATED BY JLC
DIST HWY 401 BOREHOLE TYPE 120 mm O.D. Continuous Flight Solid Stem Power Auger COMPILED BY BM
DATUM Geodetic DATE May 31,2013 CHECKED BY MWK

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × REMOULDED)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
102.7	GROUND SURFACE										
0.0 / 102.4	TOPSOIL		1A / 1B	SS	6						
0.4 / 101.5	Clayey silt, with sand, some gravel, containing rootlets and trace organics (FILL) Firm to hard Brown		2	SS	32		102				5 32 43 20
1.2	Moist SILT and SAND, trace to some gravel, trace to some clay, inferred cobbles and boulders throughout (TILL) Very dense Brown to grey Moist		3	SS	65/0.10		101				
			4	SS	100/0.10						8 47 33 12
			5	SS	100/0.13		100				
			6	SS	100/0.10	▽	99				
98.0			7	SS	100/0.10						
4.7	END OF BOREHOLE										

NOTE:

1. Water level at a depth of 3.7 m below ground surface (Elev. 99.0 m) during drilling.

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

GTA-MTO 001 09-1111-0019.GPJ GAL-GTA.GDT 01/21/14

Golder Associates

RECORD OF BOREHOLE No BH13-6

SHEET 1 OF 1

METRIC

PROJECT 09-1111-0019
G.W.P. 2101-08-00
DIST HWY 401
DATUM Geodetic

LOCATION N 4860859.5 ;E 367541.4
BOREHOLE TYPE 120 mm O.D. Continuous Flight Solid Stem Power Auger
DATE June 3, 2013

ORIGINATED BY JLC
COMPILED BY BM
CHECKED BY MWK

ELEV / DEPTH	DESCRIPTION	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
102.9	GROUND SURFACE							
0.0	TOPSOIL	1	SS	2				
102.2								
0.7	Sandy CLAYEY SILT, trace gravel Firm to stiff Brown	2	SS	8	▽	102		0 21 47 32
101.5	Moist							
1.4	SILT and SAND, some gravel, trace to some clay, inferred cobbles and boulders throughout (TILL) Very dense Brown to grey Moist	3	SS	50/0.08				
		4	SS	50/0.05		101		15 41 34 10
		5	SS	100/0.08		100		
		6	SS	100/0.08		99		
		7	SS	100/0.08		98		18 46 27 9
96.7		8	SS	100/0.08		97		
6.2	END OF BOREHOLE							

NOTES:

1. Water level at a depth of 0.9 m below ground surface (Elev. 102.0 m) during drilling.

2. Borehole caved to a depth of 4.3 m below ground surface (Elev. 98.6 m) upon completion of drilling.

DYNAMIC CONE PENETRATION RESISTANCE PLOT
20 40 60 80 100

SHEAR STRENGTH kPa
○ UNCONFINED + FIELD VANE
● QUICK TRIAXIAL × REMOULDED
20 40 60 80 100

PLASTIC LIMIT w_P | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w_L
WATER CONTENT (%)
10 20 30

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

Golder Associates

RECORD OF BOREHOLE No BH13-7

SHEET 1 OF 1

METRIC

PROJECT 09-1111-0019

G.W.P. 2101-08-00 LOCATION N 4860886.7 ;E 367489.8 ORIGINATED BY JLC

DIST HWY 401 BOREHOLE TYPE 120 mm O.D. Continuous Flight Solid Stem Power Auger COMPILED BY BM

DATUM Geodetic DATE June 3, 2013 CHECKED BY MWK

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa: ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
104.0	GROUND SURFACE										
0.0 / 103.5	TOPSOIL		1	SS	8						
0.5 / 102.9	CLAYEY SILT, with SAND some gravel, trace organics and containing rootlets Very stiff Brown Moist		2A 2B	SS	20		103		○		13 31 38 18
1.1 / 101.8	SILT and SAND, trace to some clay, trace to some gravel, inferred cobbles and boulders throughout Very dense Brown Moist		3	SS	127/0.13	▽	102		○		6 45 37 12
2.2	SAND and GRAVEL, trace clay, trace silt Very dense Brown Moist		4	SS	100/0.03				○		
			5	SS	100/0.03		101				
99.7			6	SS	100/0.08				○		
4.3	CLAYEY SILT, trace to some sand, trace gravel, inferred cobbles and boulders throughout (TILL) Hard Grey Moist		7	SS	154/0.13		100		●		2 15 38 45
			8	SS	100/0.13		99				
96.2			9	SS	100/0.13		98		○		
7.8	END OF BOREHOLE						97				

NOTES:

1. Water level at a depth of 2.1 m below ground surface (Elev. 101.9 m) during drilling.

2. Borehole caved to a depth of 7.0 m below ground surface (Elev. 97.0 m) upon completion of drilling.

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

Golder Associates

RECORD OF BOREHOLE No BH13-8

SHEET 1 OF 1

METRIC

PROJECT 09-1111-0019
G.W.P. 2101-08-00
DIST HWY 401
DATUM Geodetic

LOCATION N 4860903.2 ;E 367447.8
BOREHOLE TYPE 120 mm O.D. Continuous Flight Solid Stem Power Auger
DATE June 3, 2013

ORIGINATED BY JLC
COMPILED BY BM
CHECKED BY MWK

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa: ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
105.6	GROUND SURFACE										
0.0 / 105.1	TOPSOIL		1	SS	17		105				
0.5 / 104.2	CLAYEY SILT, with SAND, some gravel, trace organics, inferred cobbles and boulders at 0.8 m depth Very stiff Brown to dark brown Moist		2	SS	24						2 31 37 30
1.4	SAND, some gravel to gravelly, trace to some silt, trace clay, inferred cobbles and boulders throughout (TILL) Very dense Brown Moist to wet		3	SS	100/0.13	▽	104				
			4	SS	175/0.13		103				
			5	SS	100/0.13						21 66 8 5
			6	SS	100/0.08		102				
			7	SS	100/0.13		101				
99.4			8	SS	100/0.13		100				
6.2	CLAYEY SILT, trace sand, trace gravel, inferred cobbles and boulders (TILL) Hard Grey Moist						99				
97.9			9	SS	100/0.13		98				
7.8	END OF BOREHOLE										

NOTES:

1. Water level at a depth of 1.8 m below ground surface (Elev. 103.8 m) during drilling.

2. Borehole caved to a depth of 2.3 m below ground surface (Elev. 103.3 m) upon completion of drilling.

+ 3, × 3: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

Golder Associates

RECORD OF BOREHOLE No BH13-9

SHEET 1 OF 1 **METRIC**

PROJECT 09-1111-0019
G.W.P. 2101-08-00
DIST ____ HWY 401
DATUM Geodetic

LOCATION N 4860920.2 ;E 367399.7
BOREHOLE TYPE 120 mm O.D. Continuous Flight Solid Stem Power Auger
DATE June 2, 2013

ORIGINATED BY JLC
COMPILED BY BM
CHECKED BY MWK

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
107.2	GROUND SURFACE										
0.0 / 106.7	TOPSOIL		1A, 1B	SS	16		107		○ ⊢		11 40 35 14
0.5	CLAYEY SILT with SAND trace to some gravel, inferred cobbles and boulders at 1.5 m to 4.6 m depth (TILL) Very stiff to hard Brown to grey Moist - - - - - - - - - - - - - - - Augers grinding on inferred cobbles and boulders at 1.5 m to 4.6 m depth		2	SS	96		106				
			3	SS	100/0.13						
			4	SS	100/0.15		105		○		3 43 46 8
			5	SS	100/0.10		104		⊢		
							103				
102.6			6	SS	100/0.05				○		
4.6	END OF BOREHOLE NOTES: 1. Borehole was dry upon completion of drilling. 2. Borehole caved at a depth of 3.9 m below ground surface (Elev. 103.3 m) upon completion of drilling.										

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

Golder Associates

RECORD OF BOREHOLE No BH13-10

SHEET 1 OF 1

METRIC

PROJECT 09-1111-0019
G.W.P. 2101-08-00
LOCATION N 4860950.2 ;E 367357.9
ORIGINATED BY JLC
DIST HWY 401
BOREHOLE TYPE 108 mm O.D. Continuous Flight Solid Stem Power Auger
COMPILED BY BM
DATUM Geodetic
DATE June 4, 2013
CHECKED BY MWK

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
108.4	GROUND SURFACE										
0.0	TOPSOIL										
0.2	Silty SAND, trace clay, trace gravel, containing rootlets		1	SS	31		108				
107.7	Dense										
0.7	Brown Moist SILT and SAND, trace to some clay, trace to some gravel (TILL) Very dense Brown Moist		2	SS	57		107				
			3	SS	121						
			4	SS	51/0.10		106				9 43 40 8
			5	SS	100/0.13						
104.7						▽	105				
3.7	CLAYEY SILT with SAND, some gravel (TILL) Hard Grey Moist to wet		6	SS	50/0.08		104				17 35 32 16
							103				
102.2			7	SS	50/0.08						
6.2	END OF BOREHOLE										

NOTE:

1. Water level at a depth of 3.7 m below ground surface (Elev. 104.7 m) during drilling.

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

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

Golder Associates

RECORD OF BOREHOLE No BH13-11

SHEET 1 OF 1 **METRIC**

PROJECT 09-1111-0019
G.W.P. 2101-08-00 LOCATION N 4860938.7 ;E 367308.4 ORIGINATED BY JLC
DIST HWY 401 BOREHOLE TYPE 108 mm O.D. Continuous Flight Solid Stem Power Auger COMPILED BY BM
DATUM Geodetic DATE June 4, 2013 CHECKED BY MWK

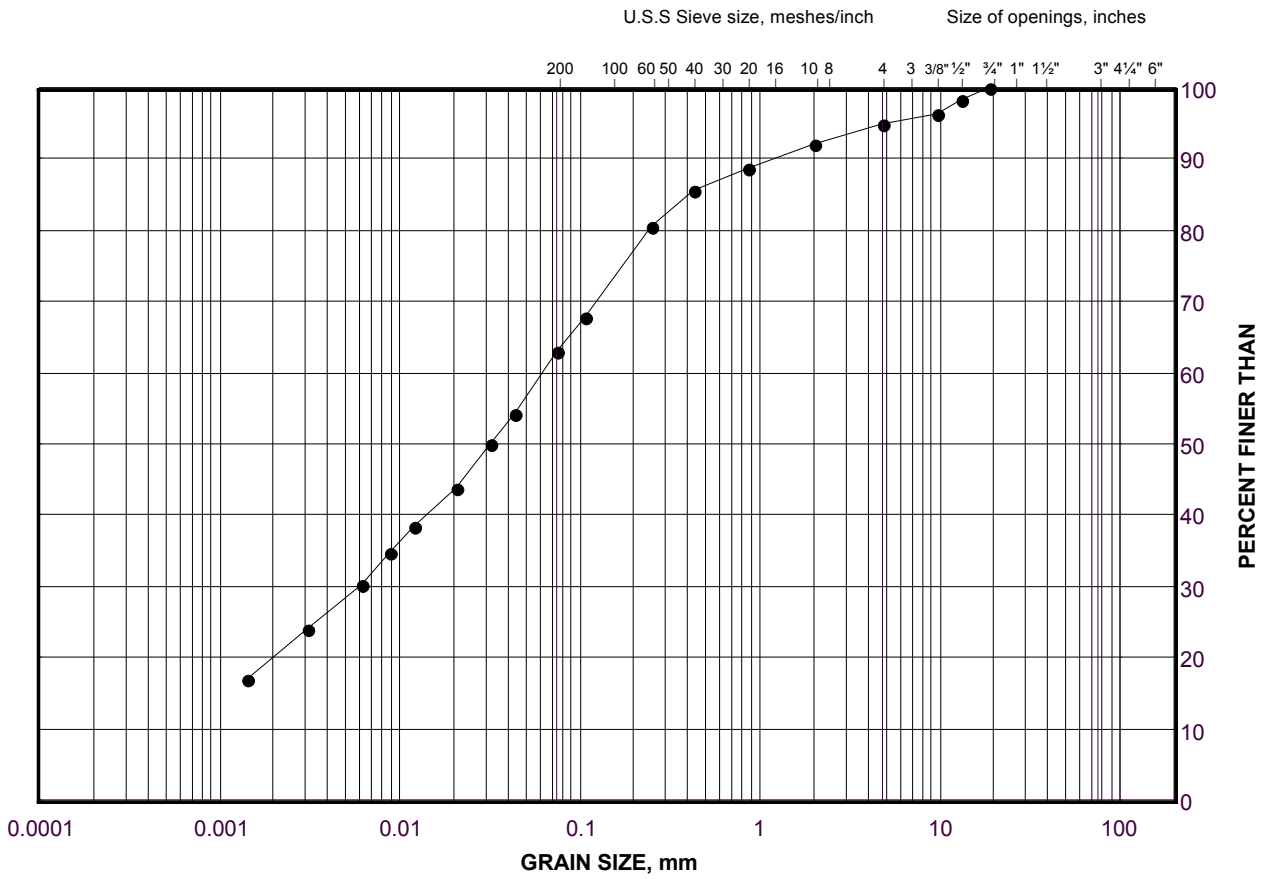
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
109.7	GROUND SURFACE										
0.0 / 109.3	TOPSOIL Very stiff Dark brown Moist		1	SS	23				○		
0.4	CLAYEY SILT with SAND, trace to some gravel, inferred cobbles and boulders at 1.5 m to 4.7 m depth (TILL) Hard Brown Moist		2	SS	50/0.10		109				
			3	SS	50/0.13		108		○		
	Augers grinding on inferred cobbles and boulders		4	SS	50/0.05				○		9 45 35 11
			5	SS	50/0.05		107		○		
			6	SS	50/0.05		106				
105.1			7	SS	50/0.08				○		9 41 35 15
4.7	END OF BOREHOLE NOTE: 1. Open borehole was dry upon completion of drilling.										

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

GRAIN SIZE DISTRIBUTION TEST RESULT

Clayey Silt with Sand (FILL)

FIGURE C1



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	13-5	2	101.7

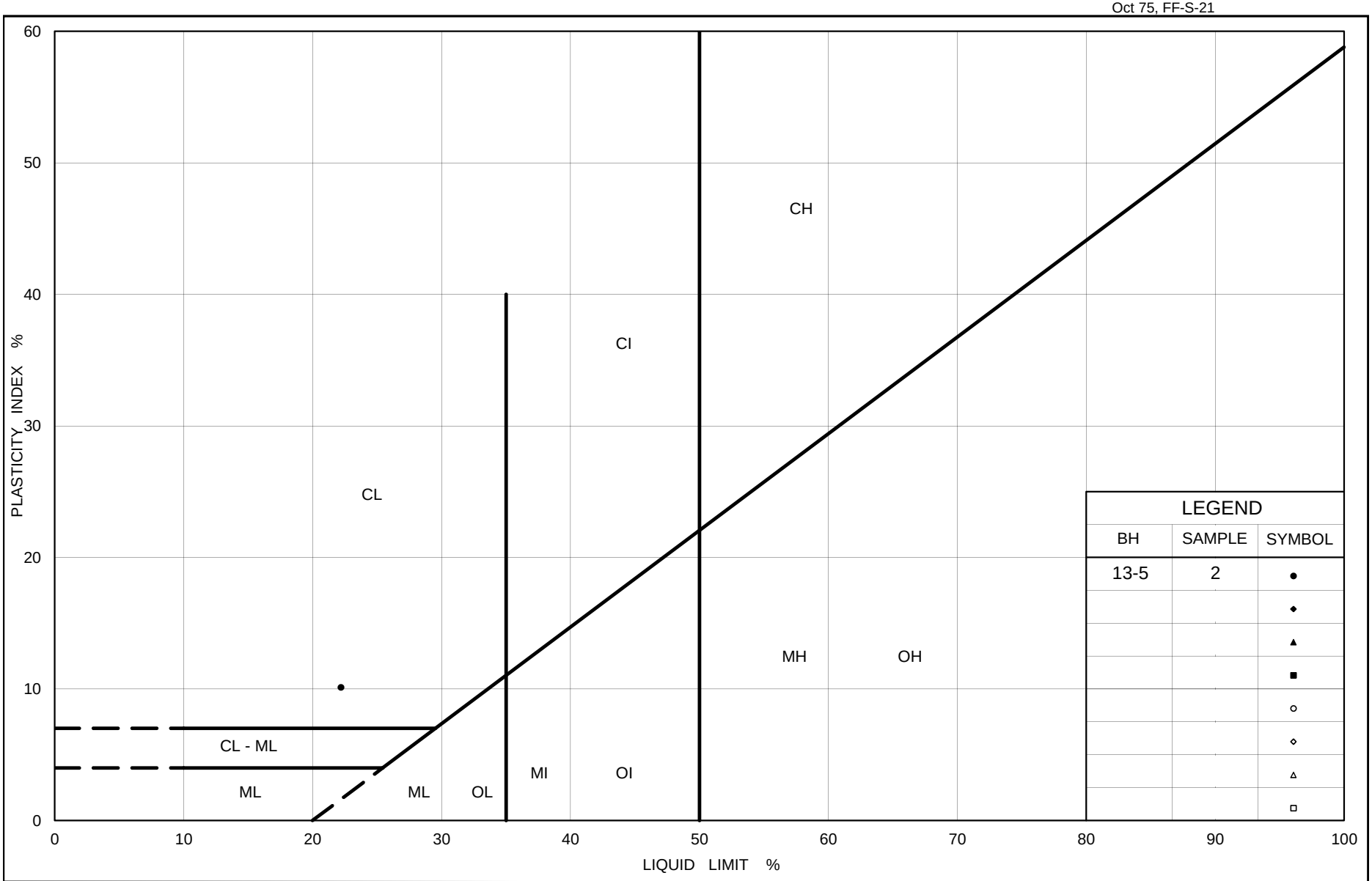
Project Number: 09-1111-0019

Checked By: _____

Golder Associates

Date: 01-Nov-13

Oct 75, FF-S-21



Ministry of Transportation

Ontario

PLASTICITY CHART
Clayey Silt (FILL)

Figure No. C2

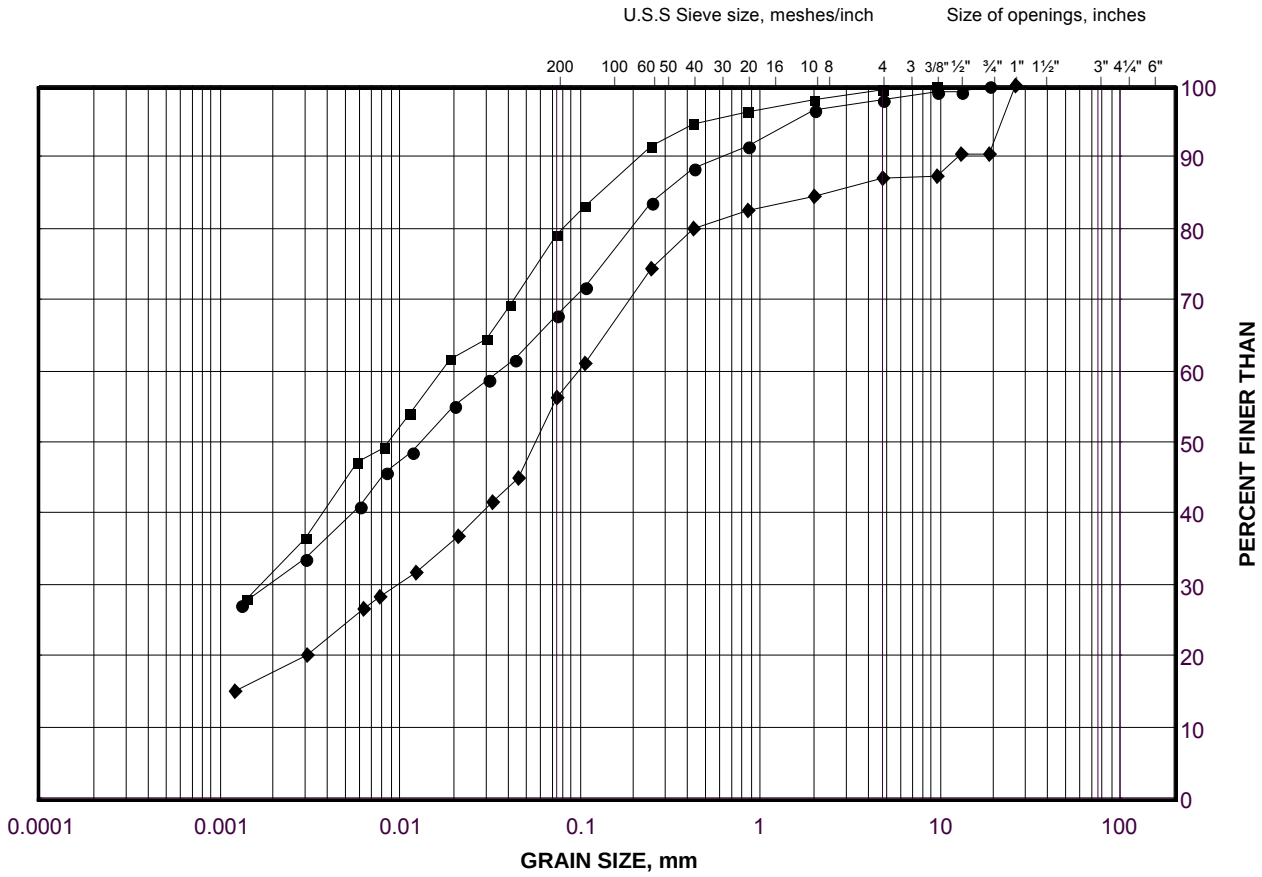
Project No. 09-1111-0019

Checked By:

GRAIN SIZE DISTRIBUTION TEST RESULTS

Clayey Silt

FIGURE C3



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	13-8	2	104.6
■	13-6	2	101.9
◆	13-7	2A	103.1

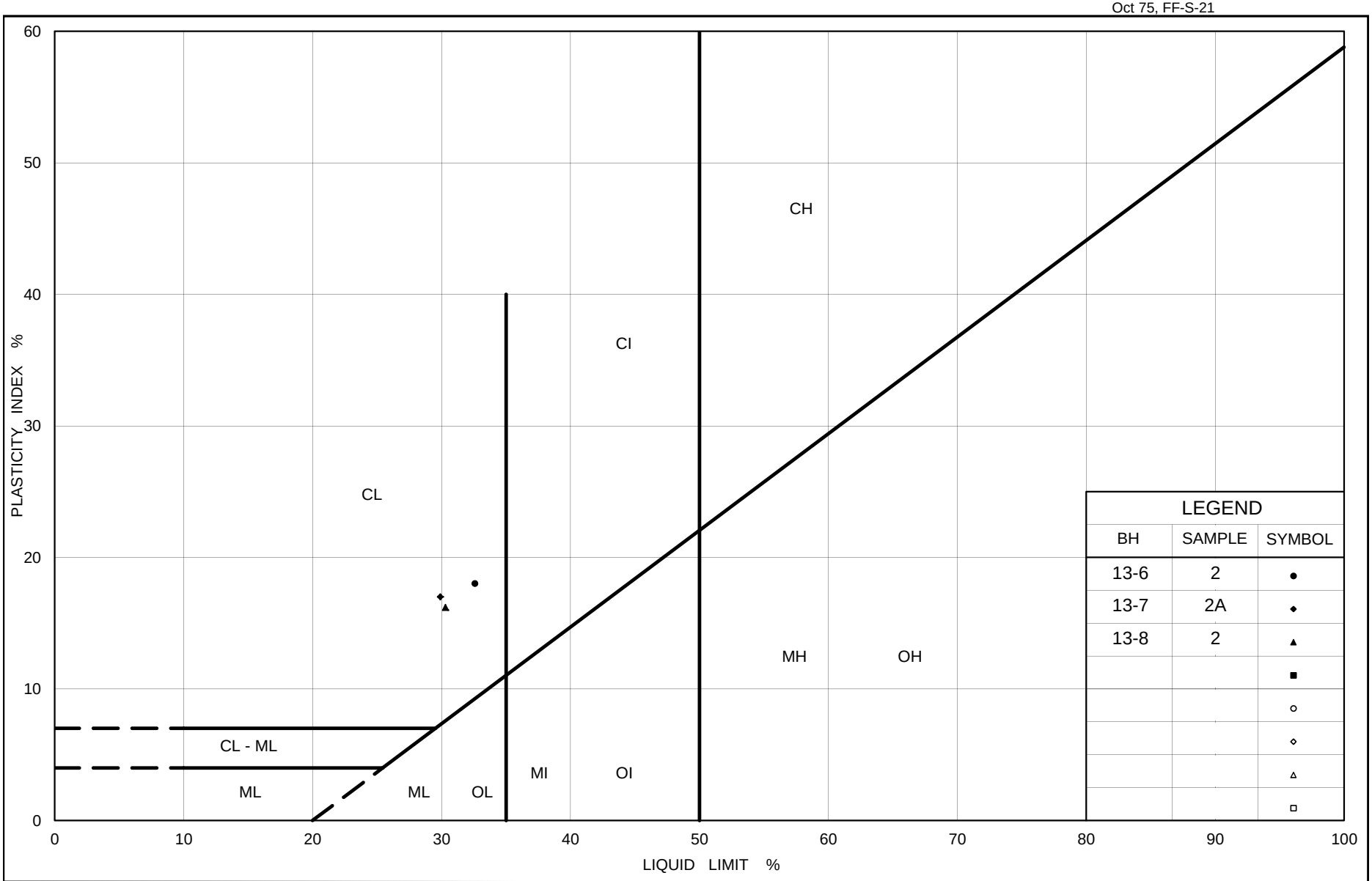
Project Number: 09-1111-0019

Checked By: _____

Golder Associates

Date: 01-Nov-13

Oct 75, FF-S-21



Ministry of Transportation

Ontario

PLASTICITY CHART
Clayey Silt

Figure No. C4

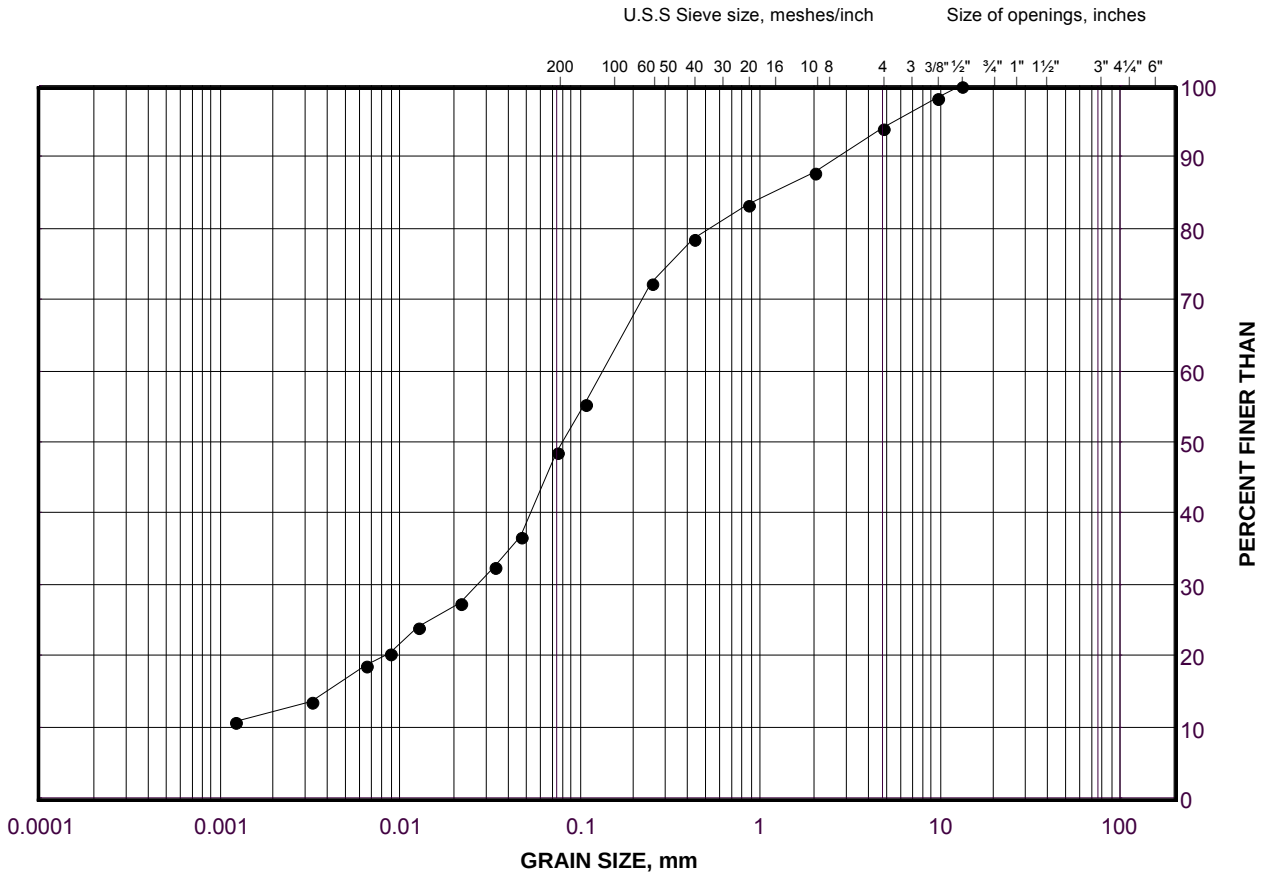
Project No. 09-1111-0019

Checked By:

GRAIN SIZE DISTRIBUTION TEST RESULT

Silt and Sand

FIGURE C5



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	13-7	3	102.4

Project Number: 09-1111-0019

Checked By: _____

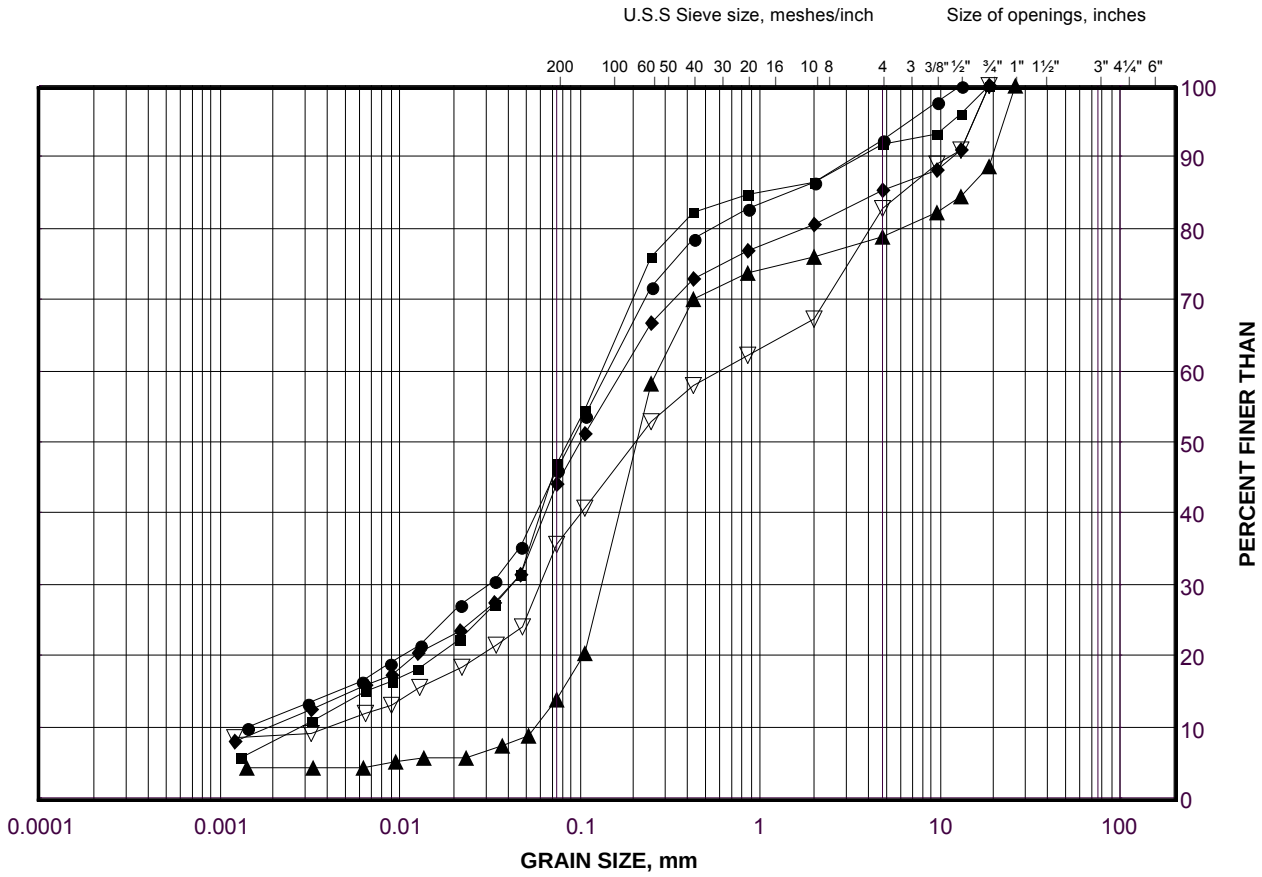
Golder Associates

Date: 01-Nov-13

GRAIN SIZE DISTRIBUTION TEST RESULTS

Sand to Silt and Sand (TILL)

FIGURE C6



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	13-5	4	100.3
■	13-10	4	106.1
◆	13-6	4	100.6
▲	13-8	5	102.5
▽	13-6	7	98.3

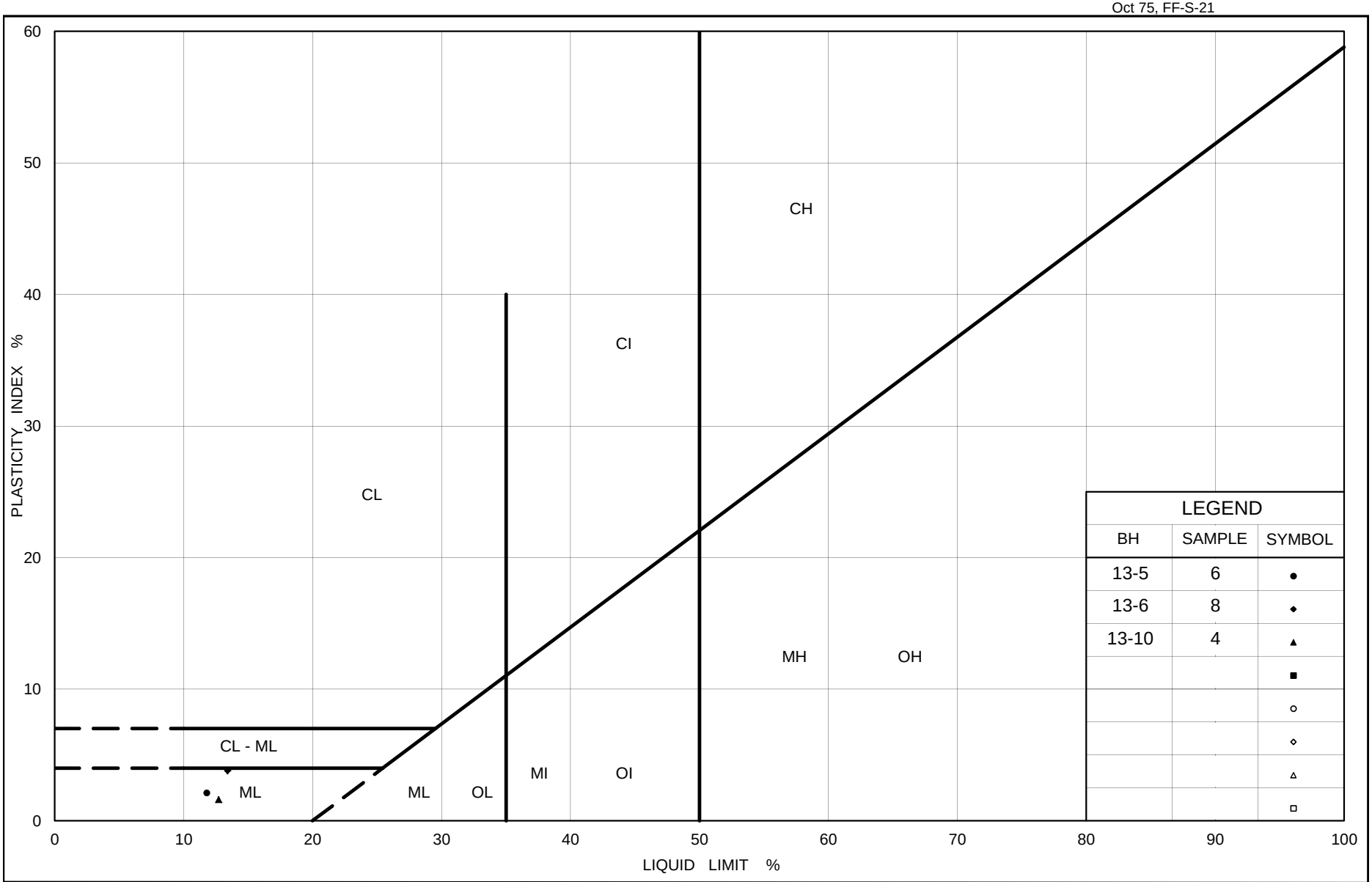
Project Number: 09-1111-0019

Checked By: _____

Golder Associates

Date: 01-Nov-13

Oct 75, FF-S-21



Ministry of Transportation

Ontario

PLASTICITY CHART
Silt and Sand (TILL)

Figure No. C7

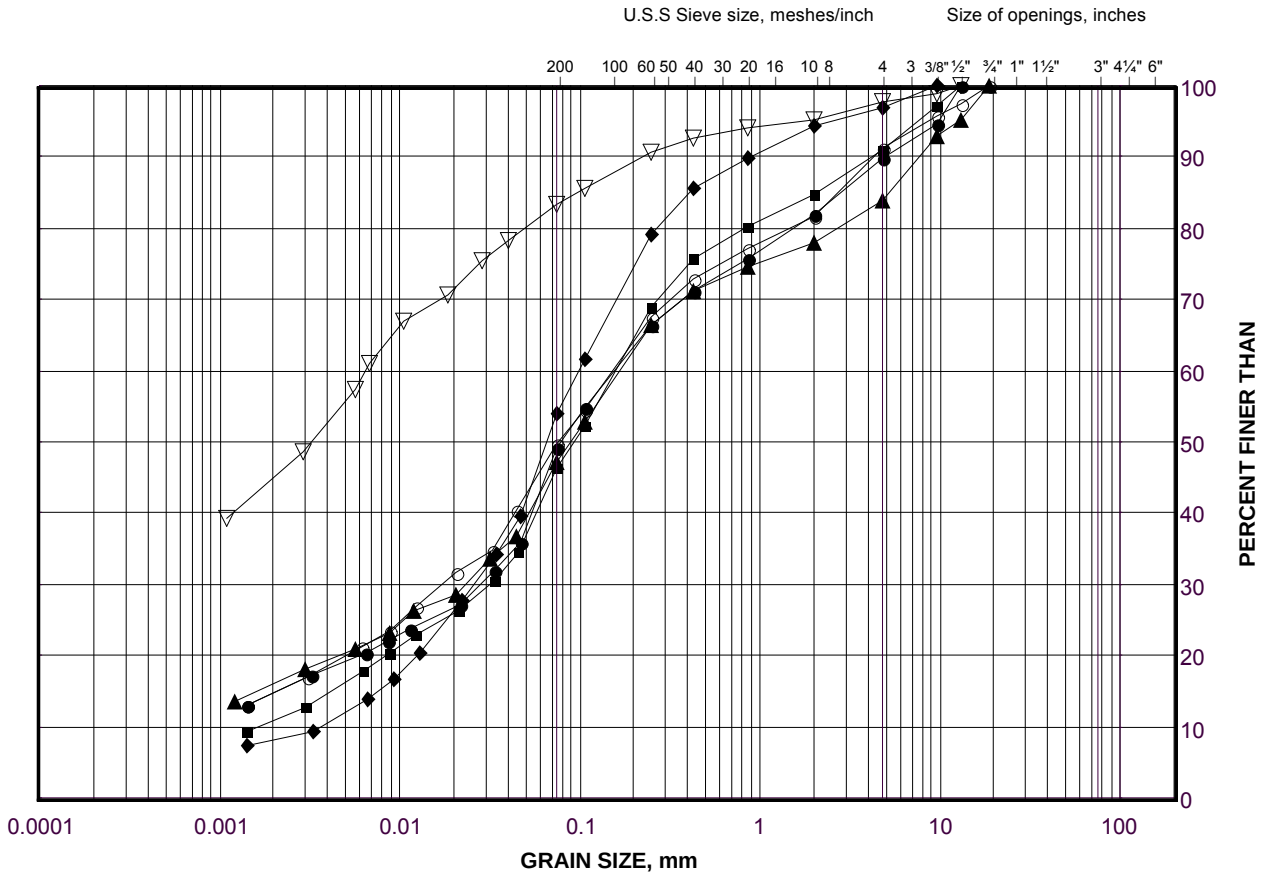
Project No. 09-1111-0019

Checked By:

GRAIN SIZE DISTRIBUTION TEST RESULTS

Clayey Silt (TILL)

FIGURE C8



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	13-9	1B	106.8
■	13-11	4	107.4
◆	13-9	4	104.8
▲	13-10	6	103.8
▽	13-7	7	99.3
❍	13-11	7	105.1

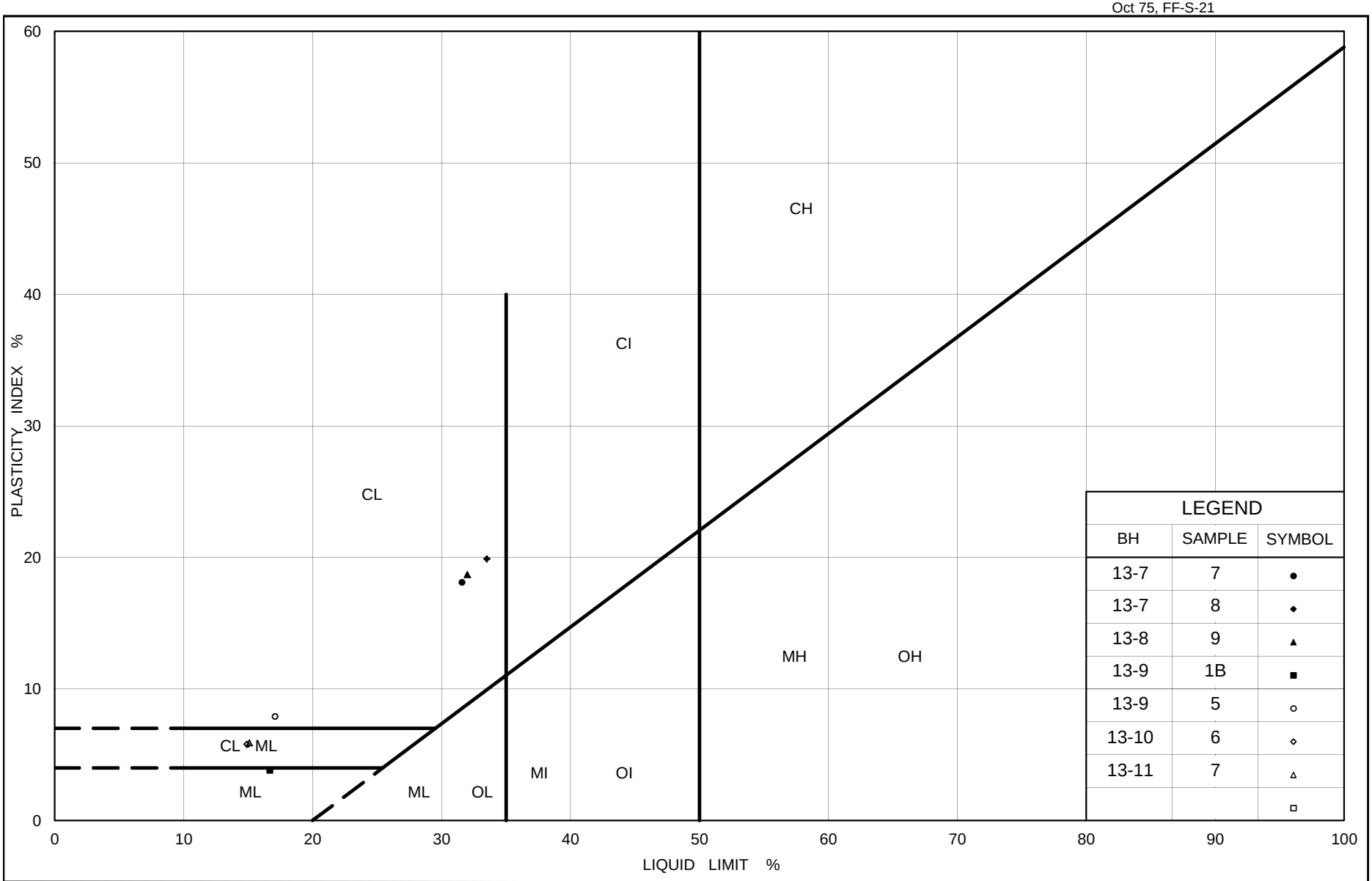
Project Number: 09-1111-0019

Checked By: _____

Golder Associates

Date: 01-Nov-13

Oct 75, FF-S-21



Ministry of Transportation

Ontario

PLASTICITY CHART
Clayey Silt (TILL)

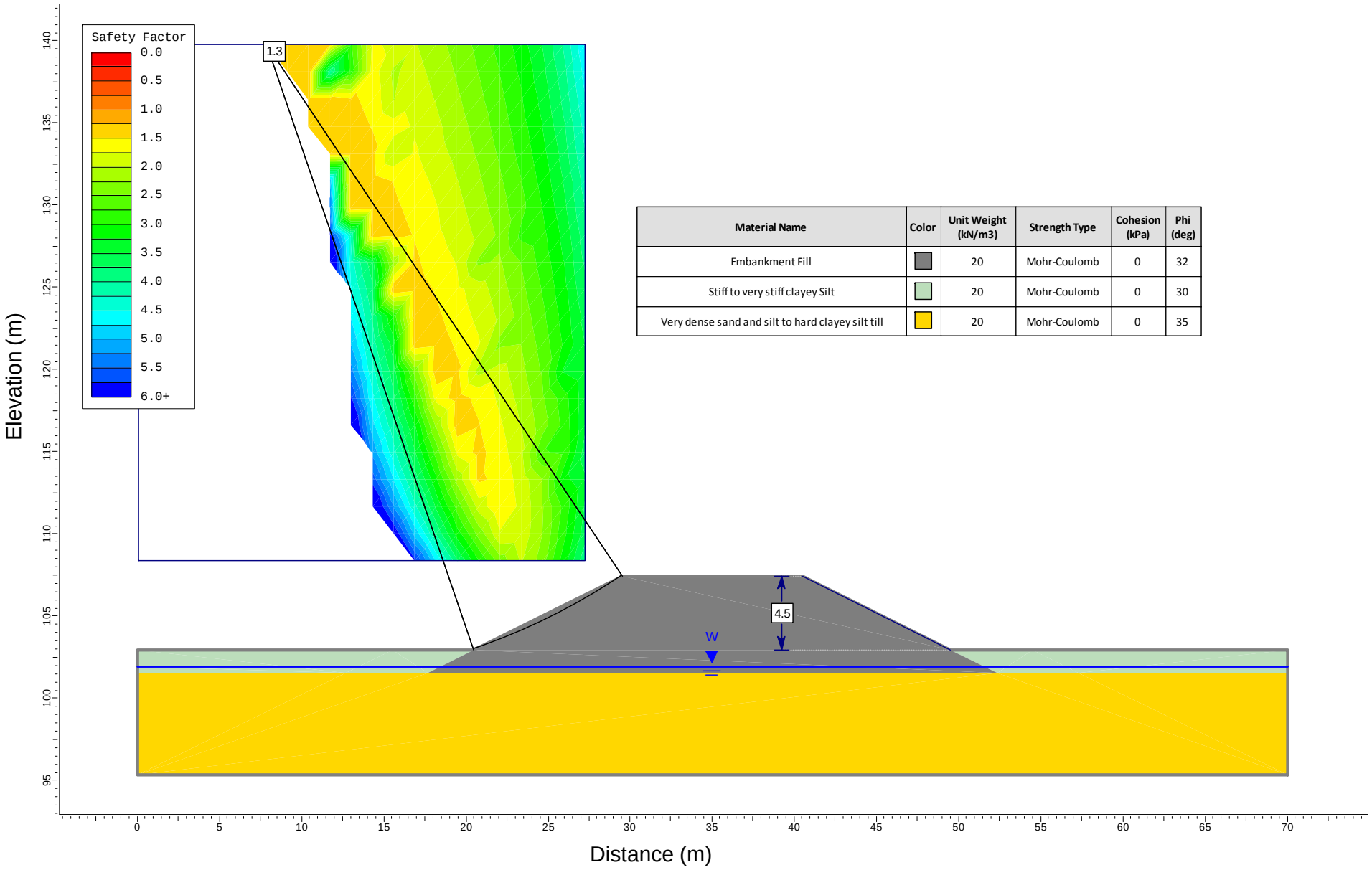
Figure No. C9

Project No. 09-1111-0019

Checked By:

Area 3 – Ramp – E-N/S STA 10+200 to 10+500
Static Global Stability Analysis

Figure C10



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)
Embankment Fill		20	Mohr-Coulomb	0	32
Stiff to very stiff clayey Silt		20	Mohr-Coulomb	0	30
Very dense sand and silt to hard clayey silt till		20	Mohr-Coulomb	0	35

Date: November 2013

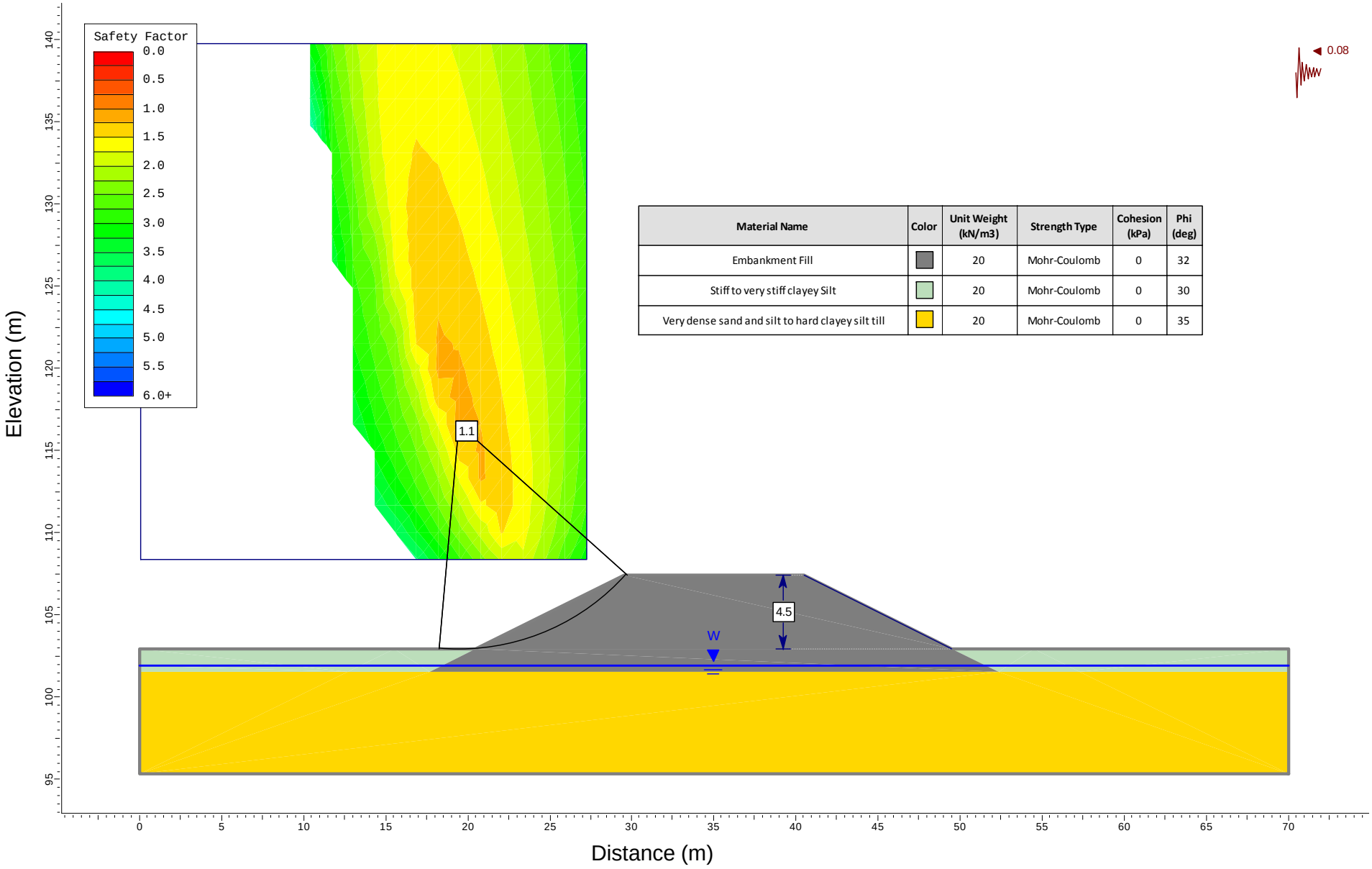
Project No: 09-1111-0019

Analysis By: MWK **Reviewed By:** KJB

Golder Associates

Area 3 – Ramp – E-N/S STA 10+200 to 10+500
Seismic Global Stability Analysis

Figure C11



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)
Embankment Fill		20	Mohr-Coulomb	0	32
Stiff to very stiff clayey Silt		20	Mohr-Coulomb	0	30
Very dense sand and silt to hard clayey silt till		20	Mohr-Coulomb	0	35

Date: November 2013

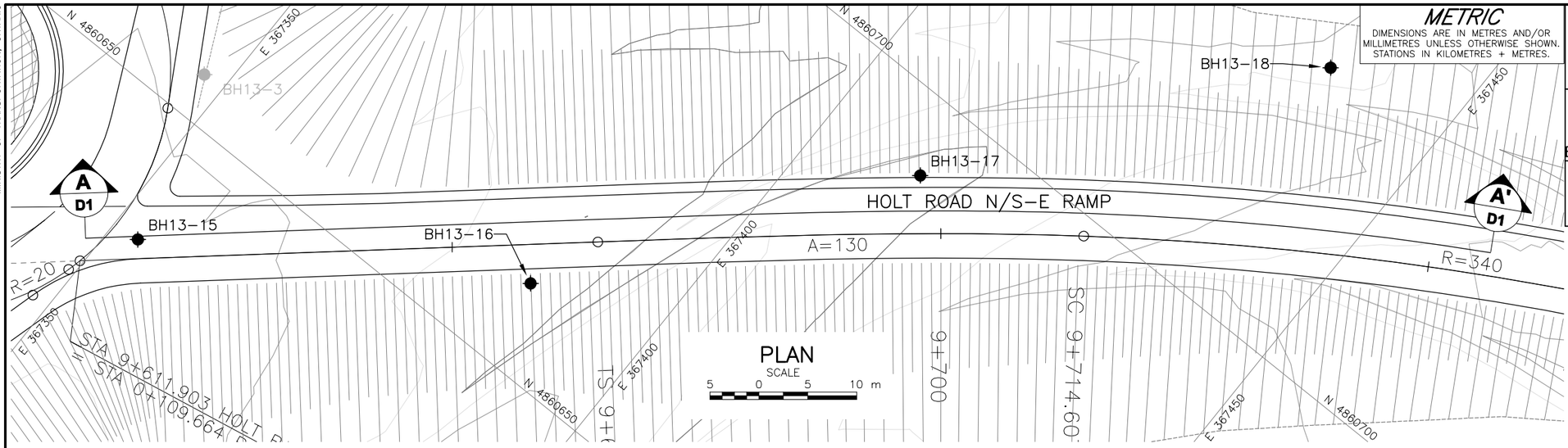
Project No: 09-1111-0019

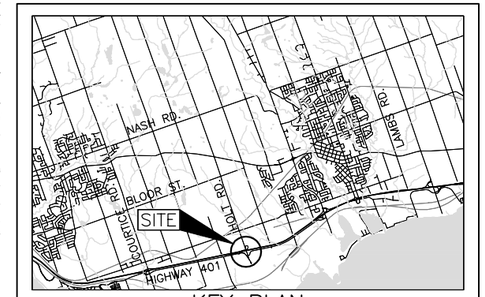
Analysis By: MWK **Reviewed By:** KJB

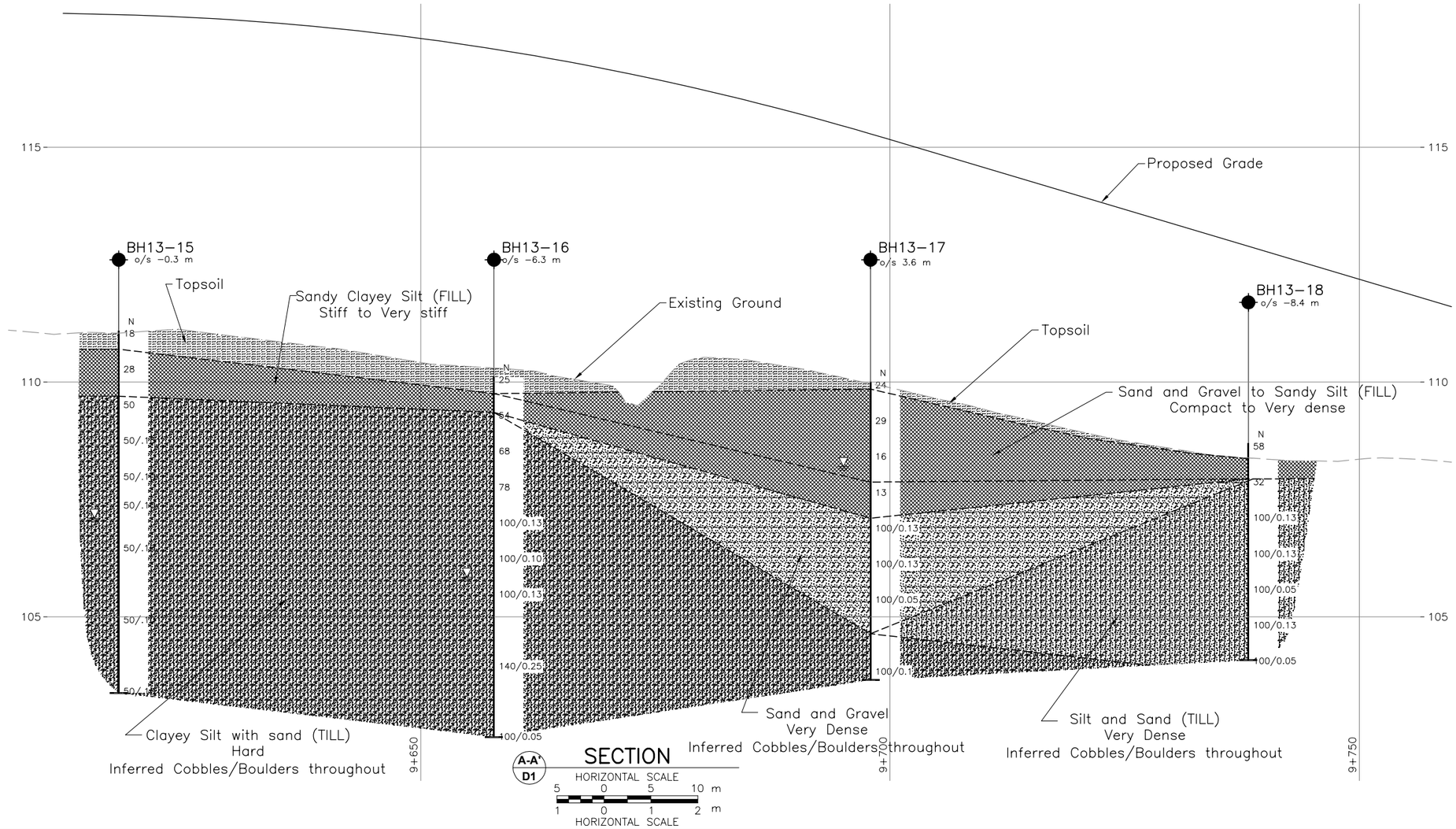
APPENDIX D

High Fill Area 4 - N/S-E Ramp, STA 9+610 to 9+740

MINISTRY OF TRANSPORTATION, ONTARIO







PLOT DATE: January 21, 2014
FILENAME: T:\Projects\2009\09-1111-0019 (URS/Donington)_CA- (Holt Road_South-Service-Road_Ramps)\09111001PGA01.dwg

METRIC

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

CONT No.
GWP No. 2101-08-00

SHEET

HIGHWAY 401

HIGH FILL AREA 4-HOLT ROAD N/S-E RAMP
(STA 9+610 TO 9+740)

BOREHOLE LOCATIONS AND SOIL STRATA

Golder Associates Ltd.
MISSISSAUGA, ONTARIO, CANADA

LEGEND

- Borehole – Current Investigation
- N — Standard Penetration Test Value
- 16 — Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)
- WL during or upon completion of drilling

BOREHOLE CO-ORDINATES			
No.	ELEVATION	NORTHING	EASTING
BH13-15	111.1	4860637.2	367352.9
BH13-16	110.1	4860658.9	367387.0
BH13-17	110.0	4860692.5	367411.1
BH13-18	108.7	4860727.4	367436.9

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 plan provided in digital format by URS, drawing file no. 2013-10-24-Hwy401-HoltRd_plan.dwg and 2013-10-24-Hwy401-HoltRd_profile.dwg, received October 23, 2013

NO.	DATE	BY	REVISION

Geocres No. 30M15-158

HWY. 401		PROJECT NO. 09-1111-0019	DIST.
SUBM'D.	CHKD. MWK	DATE: Oct. 2013	SITE: 21-159
DRAWN: JFC	CHKD. KJB	APPD. JMAC	DWG. D1

Golder Associates

RECORD OF BOREHOLE No BH13-15 SHEET 1 OF 1 METRIC

PROJECT 09-1111-0019
G.W.P. 2101-08-00 LOCATION N 4860637.2 ;E 367352.9 ORIGINATED BY JLC
DIST HWY 401 BOREHOLE TYPE 120 mm O.D. Continuous Flight Solid Stem Power Auger COMPILED BY BM
DATUM Geodetic DATE May 31, 2013 CHECKED BY MWK

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
111.1	GROUND SURFACE										
0.0 / 110.7	TOPSOIL		1	SS	18		111				
0.4 / 109.7	Sandy clayey silt, trace gravel (FILL) Very stiff Brown Moist		2	SS	28		110				4 24 43 29
1.4	CLAYEY SILT with SAND trace to some gravel, inferred cobbles and boulders at 4.6 m depth (TILL) Hard Brown to grey Moist		3	SS	50		109				4 39 42 15
			4	SS	50/.13						
			5	SS	50/.10		108				
			6	SS	50/.10	▽					
	Augers grinding on inferred cobbles and boulders		7	SS	50/.10		107				
							106				
			8	SS	50/.10		105				
							104				
103.4			9	SS	50/.10						
7.7	END OF BOREHOLE										

NOTES:

1. Water level at a depth of 4.0 m below ground surface (Elev. 107.1 m) upon completion of drilling.

2. Borehole caved to a depth of 7.2 m below ground surface (Elev. 103.9 m) upon completion of dril

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

Golder Associates

RECORD OF BOREHOLE No BH13-16

SHEET 1 OF 1

METRIC

PROJECT 09-1111-0019

G.W.P. 2101-08-00 LOCATION N 4860658.9 ;E 367387.0 ORIGINATED BY JLC

DIST HWY 401 BOREHOLE TYPE 120 mm O.D. Continuous Flight Solid Stem Power Auger COMPILED BY BM

DATUM Geodetic DATE May 30, 2013 CHECKED BY MWK

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa: ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
110.1	GROUND SURFACE										
0.0 / 109.7	TOPSOIL		1	SS	25		110				7 18 43 32
109.3 / 0.8	Clayey silt, some sand, trace to some gravel (FILL) Very stiff Brown Moist										
	CLAYEY SILT with SAND, trace to some gravel, inferred cobbles and boulders throughout (TILL) Hard Brown to grey Moist to wet		2	SS	54		109				
			3	SS	68						
			4	SS	78		108				
			5	SS	100/0.13		107				13 47 28 12
			6	SS	100/0.10	▽					
			7	SS	100/0.13		106				10 48 29 13
							105				
			8A 8B	SS	140/0.25		104				
							103				
102.4			9	SS	100/0.06						
7.7	END OF BOREHOLE										

NOTES:

1. Water level at a depth of 4.3 m below ground surface (Elev. 105.8 m) upon completion of drilling.

2. Borehole caved at a depth of 6.5 m below ground surface (Elev. 103.6 m) upon completion of dril

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

Golder Associates

RECORD OF BOREHOLE No BH13-17

SHEET 1 OF 1

METRIC

PROJECT 09-1111-0019

G.W.P. 2101-08-00 LOCATION N 4860692.5 ;E 367411.1 ORIGINATED BY JLC

DIST HWY 401 BOREHOLE TYPE 120 mm O.D. Continuous Flight Solid Stem Power Auger COMPILED BY BM

DATUM Geodetic DATE May 20, 2013 CHECKED BY MWK

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa: ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
110.0	GROUND SURFACE										
0.0	TOPSOIL										
0.2	Sand and gravel, trace to some silt, trace clay (FILL) Compact Brown Moist		1	SS	24						
			2	SS	29		109		○		
			3	SS	16	▽					
107.9							108				
2.1	Sandy clayey silt, trace gravel, inferred cobbles and boulders throughout (FILL) Stiff Brown Moist		4	SS	13				⊢○⊣		1 43 40 16
107.1											
2.9	SAND and GRAVEL, some silt, trace clay, inferred cobbles and boulders throughout Very dense Grey Wet		5	SS	100/0.13		107				
			6	SS	100/0.13		106		○		
			7	SS	100/0.05						
104.6							105				
5.4	CLAYEY SILT with SAND trace to some gravel, inferred cobbles and boulders throughout (TILL) Hard Grey Wet										
103.8			8	SS	100/0.1		104		○		7 44 39 10
6.2	END OF BOREHOLE										

NOTES:

1. Water level at a depth of 1.8 m below ground surface (Elev. 108.2 m) during drilling.

2. Borehole caved at a depth of 1.9 m below ground surface (Elev. 108.1 m) upon completion of drilling.

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

Golder Associates

RECORD OF BOREHOLE No BH13-18

SHEET 1 OF 1

METRIC

PROJECT 09-1111-0019
G.W.P. 2101-08-00
LOCATION N 4860727.4 ;E 367436.9
ORIGINATED BY JLC
DIST HWY 401
BOREHOLE TYPE 120 mm O.D. Continuous Flight Solid Stem Power Auger
COMPILED BY BM
DATUM Geodetic
DATE May 30, 2013
CHECKED BY MWK

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
108.7	GROUND SURFACE										
0.0 / 108.4	TOPSOIL		1	SS	58						
0.3 / 107.9	Sandy silt, trace gravel, trace organics (FILL) Very dense Brown Moist						108				
0.8	SILT and SAND, trace to some clay, trace to some gravel, inferred cobbles and boulders throughout (TILL) Dense to very dense Brown to grey Moist		2	SS	32			○	○		
			3	SS	100/0.13		107		○		
			4	SS	100/0.13				○ H		9 48 35 8
			5	SS	100/0.05		106				
			6	SS	100/0.13		105		○ H		9 46 38 7
104.1			7	SS	100/0.05						
4.6	END OF BOREHOLE										

NOTE:

1. Borehole dry upon completion of drilling.

2. Borehole caved at a depth of 4.3 m below ground surface (Elev. 104.4 m) upon completion of drilling.

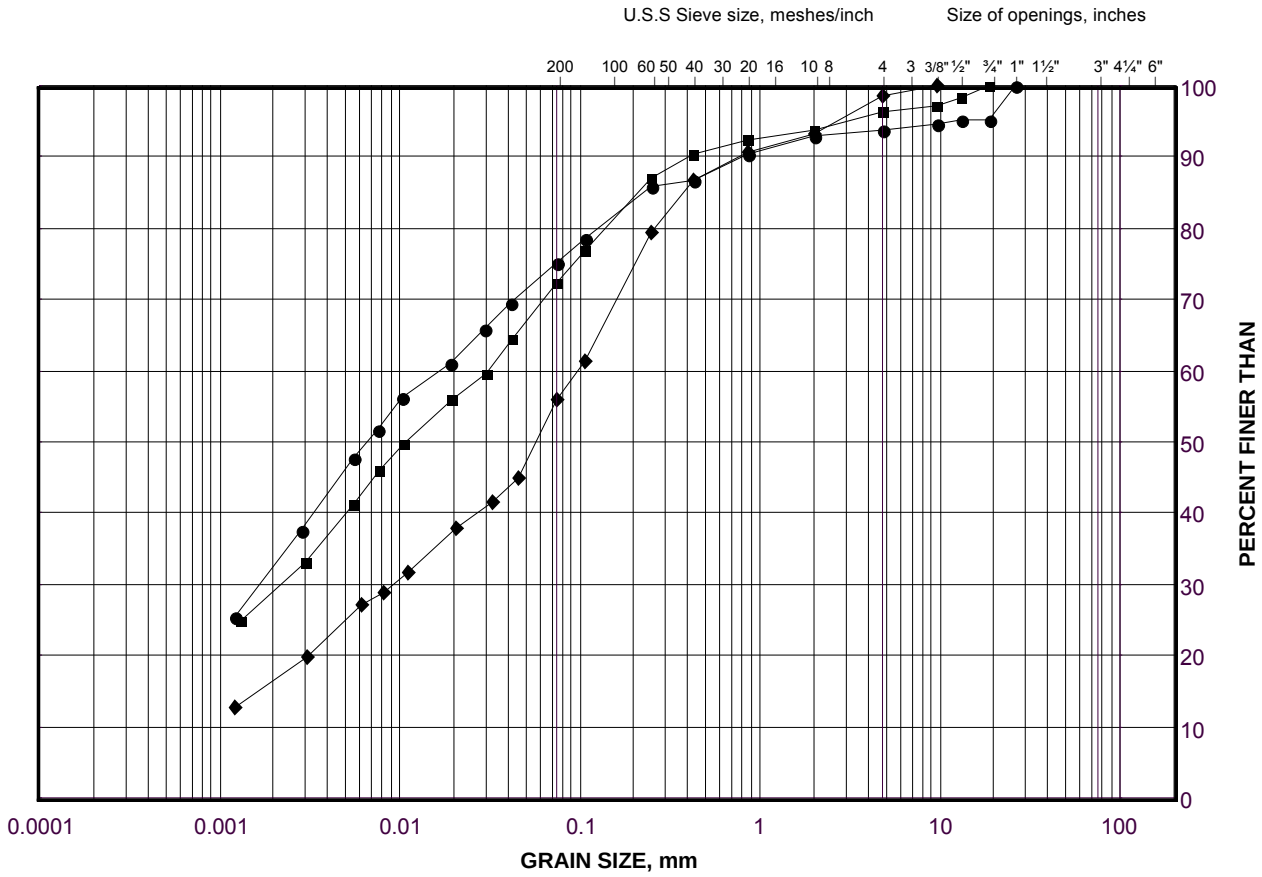
$+^3, \times^3$: Numbers refer to Sensitivity

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

GRAIN SIZE DISTRIBUTION TEST RESULTS

Clayey Silt (FILL)

FIGURE D1



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	13-16	1	109.6
■	13-15	2	110.1
◆	13-17	4	107.5

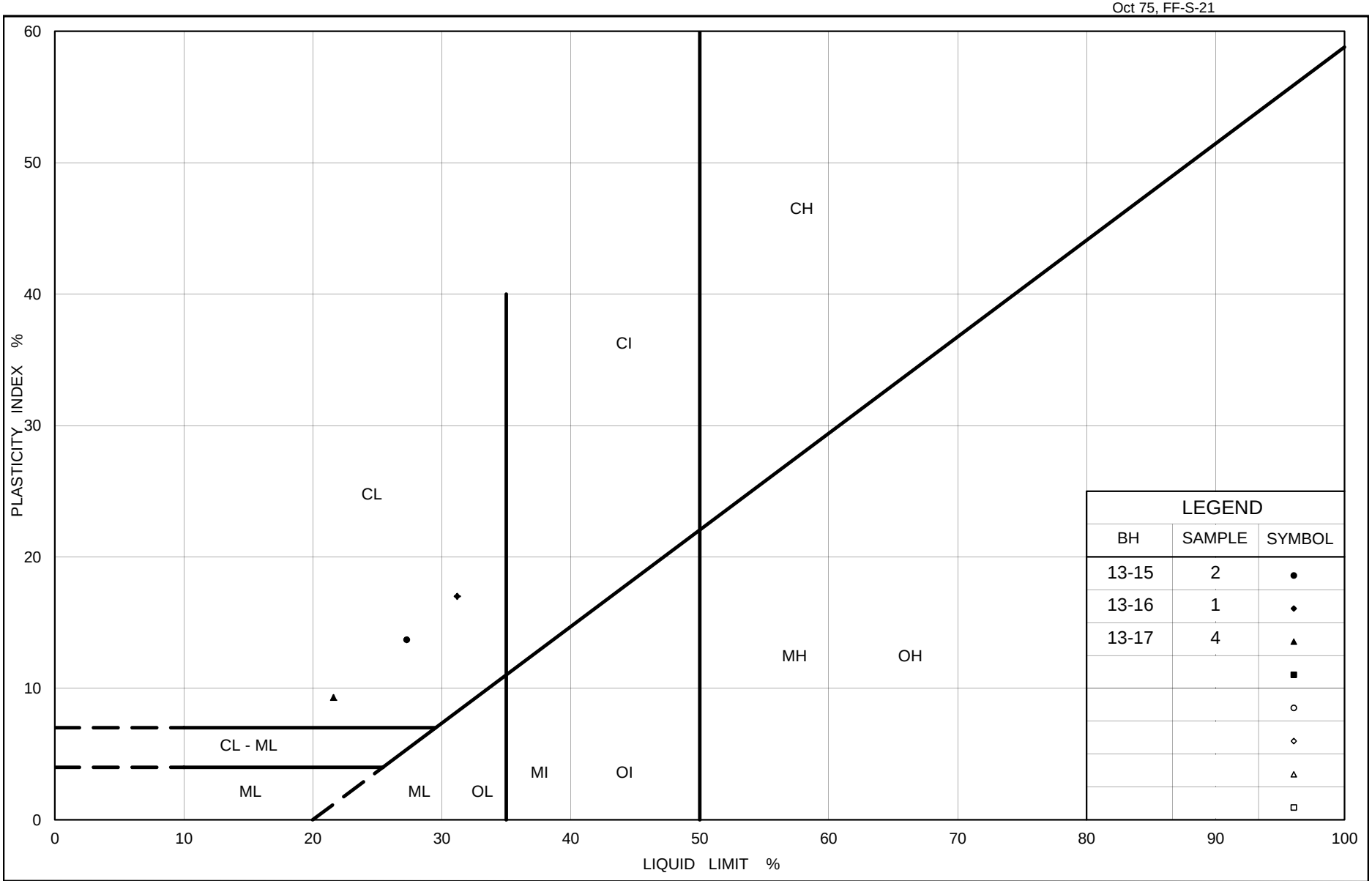
Project Number: 09-1111-0019

Checked By: _____

Golder Associates

Date: 01-Nov-13

Oct 75, FF-S-21



Ministry of Transportation

Ontario

PLASTICITY CHART
Clayey Silt (FILL)

Figure No. D2

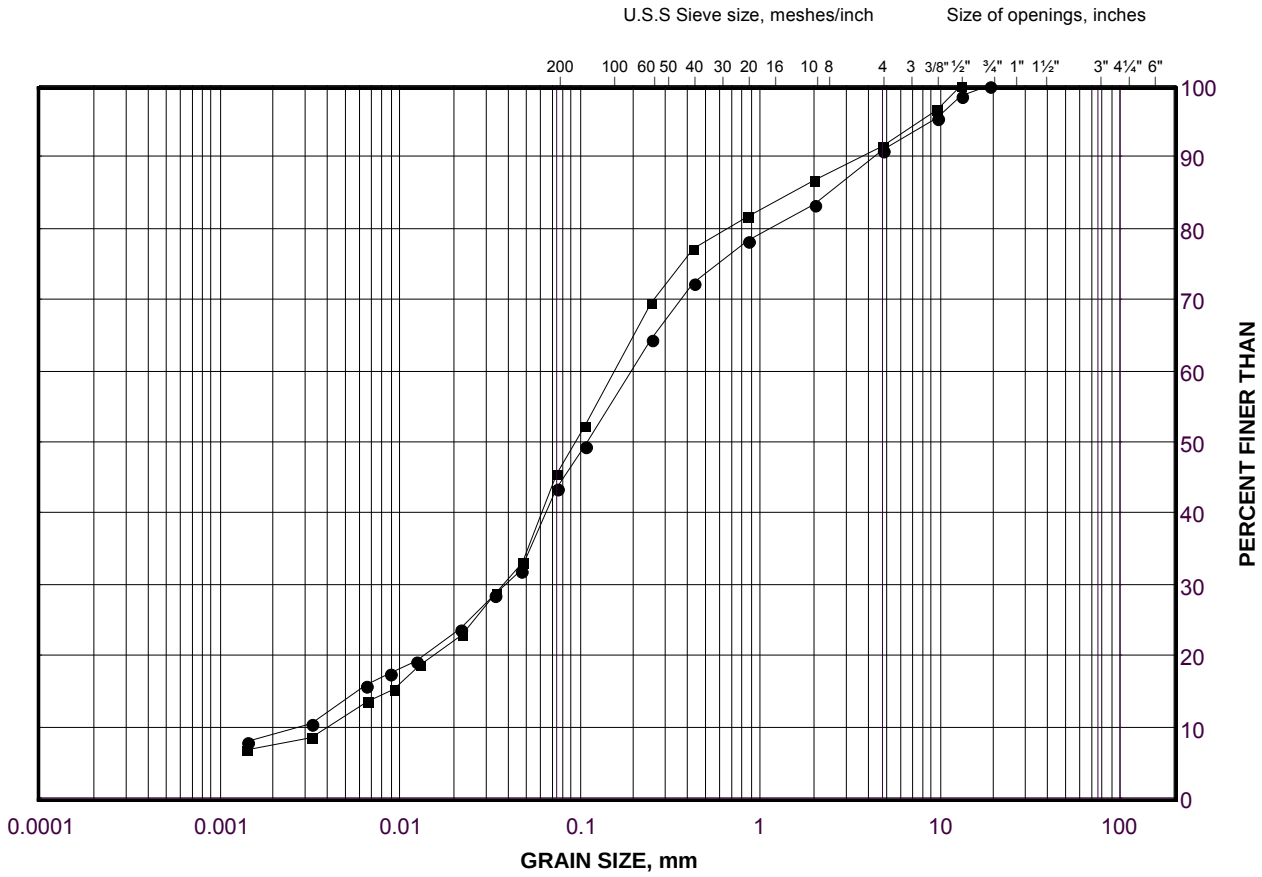
Project No. 09-1111-0019

Checked By:

GRAIN SIZE DISTRIBUTION TEST RESULTS

Silt and Sand (TILL)

FIGURE D3



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	13-18	4	106.3
■	13-18	6	104.8

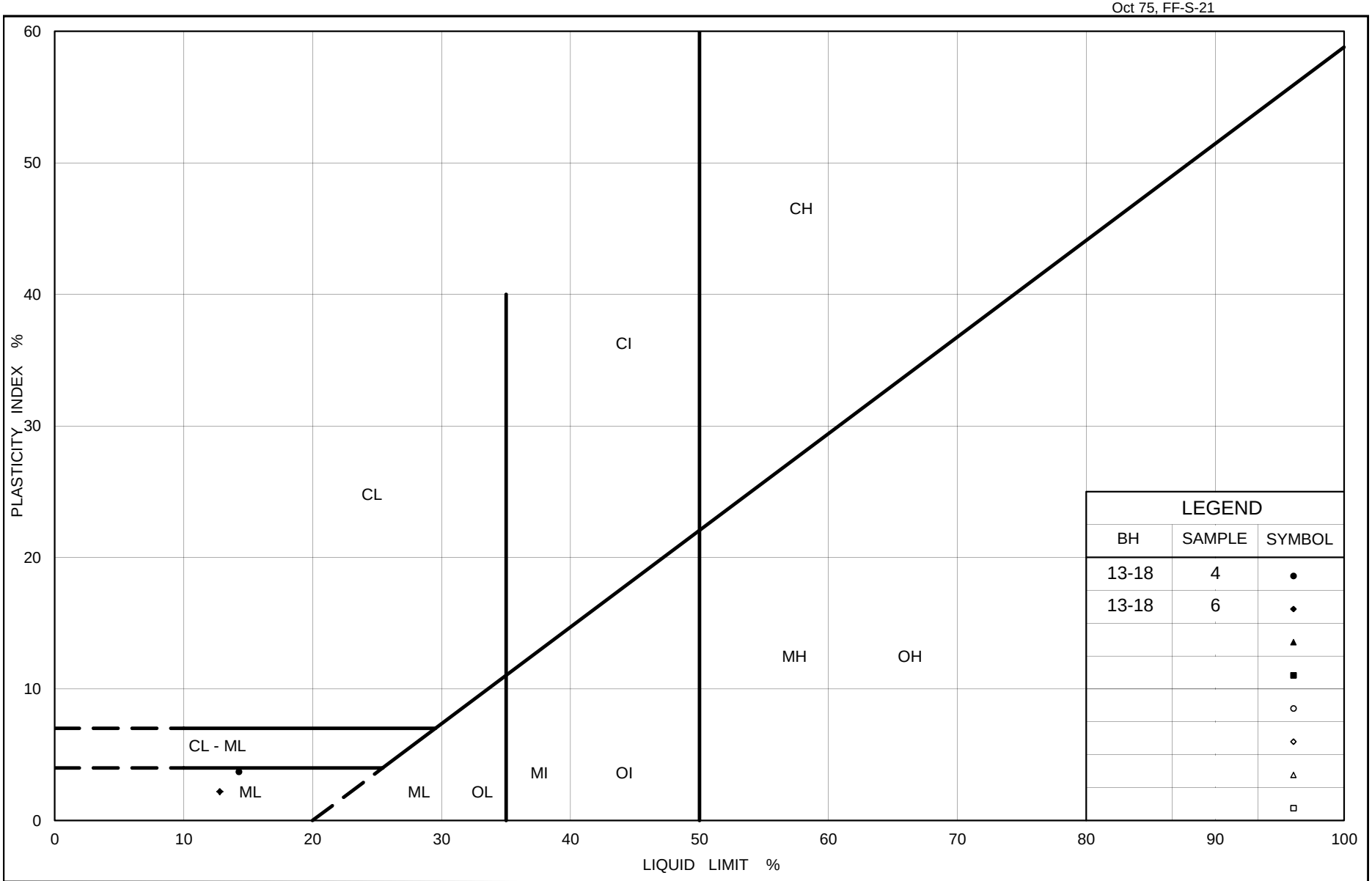
Project Number: 09-1111-0019

Checked By: _____

Golder Associates

Date: 06-Nov-13

Oct 75, FF-S-21



Ministry of Transportation

Ontario

PLASTICITY CHART
Silt and Sand (TILL)

Figure No. D4

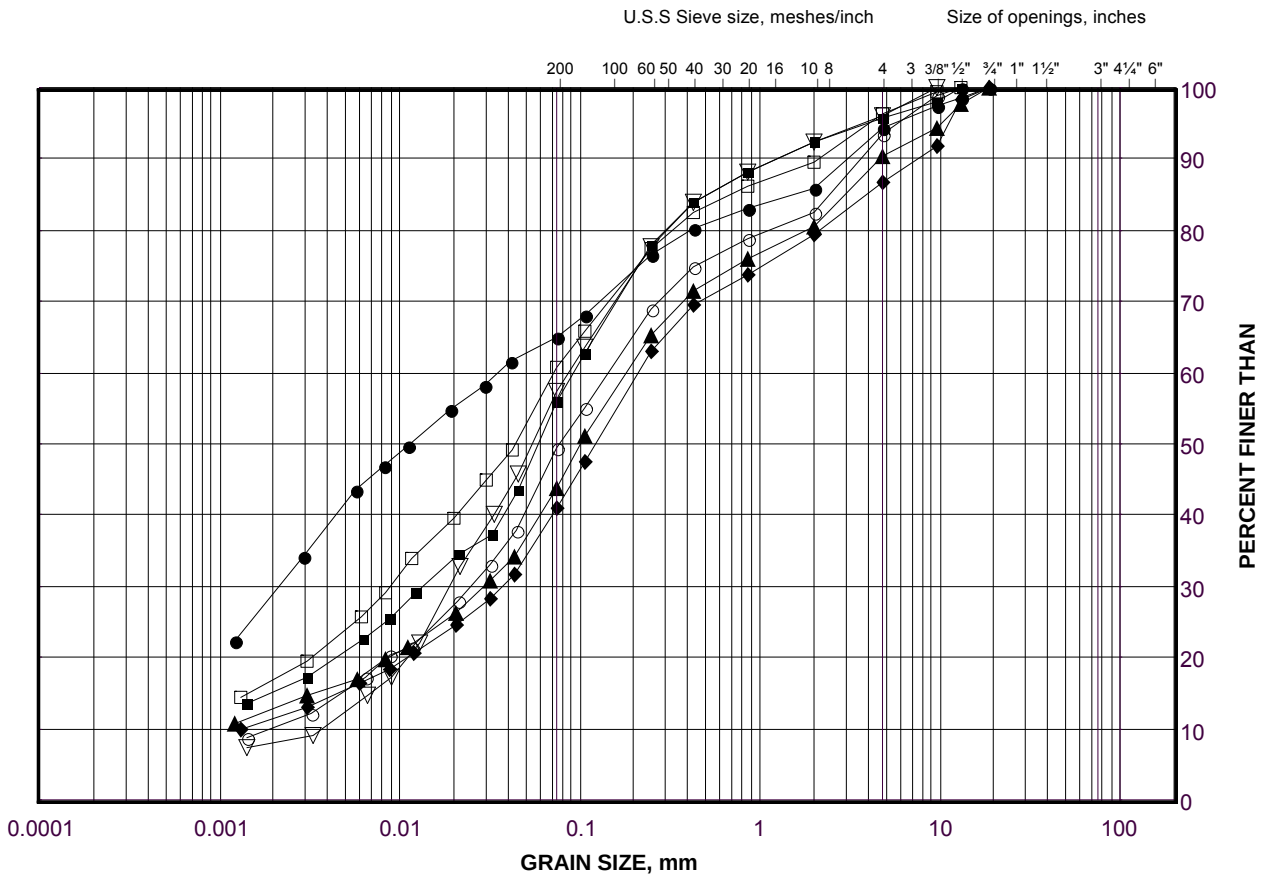
Project No. 09-1111-0019

Checked By:

GRAIN SIZE DISTRIBUTION TEST RESULTS

Clayey Silt (TILL)

FIGURE D5



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	13-3	3	109.2
■	13-15	4	108.8
◆	13-16	5	107.0
▲	13-16	7	105.5
▽	13-3	7	106.4
❍	13-17	8	103.8
□	13-3	9	103.2

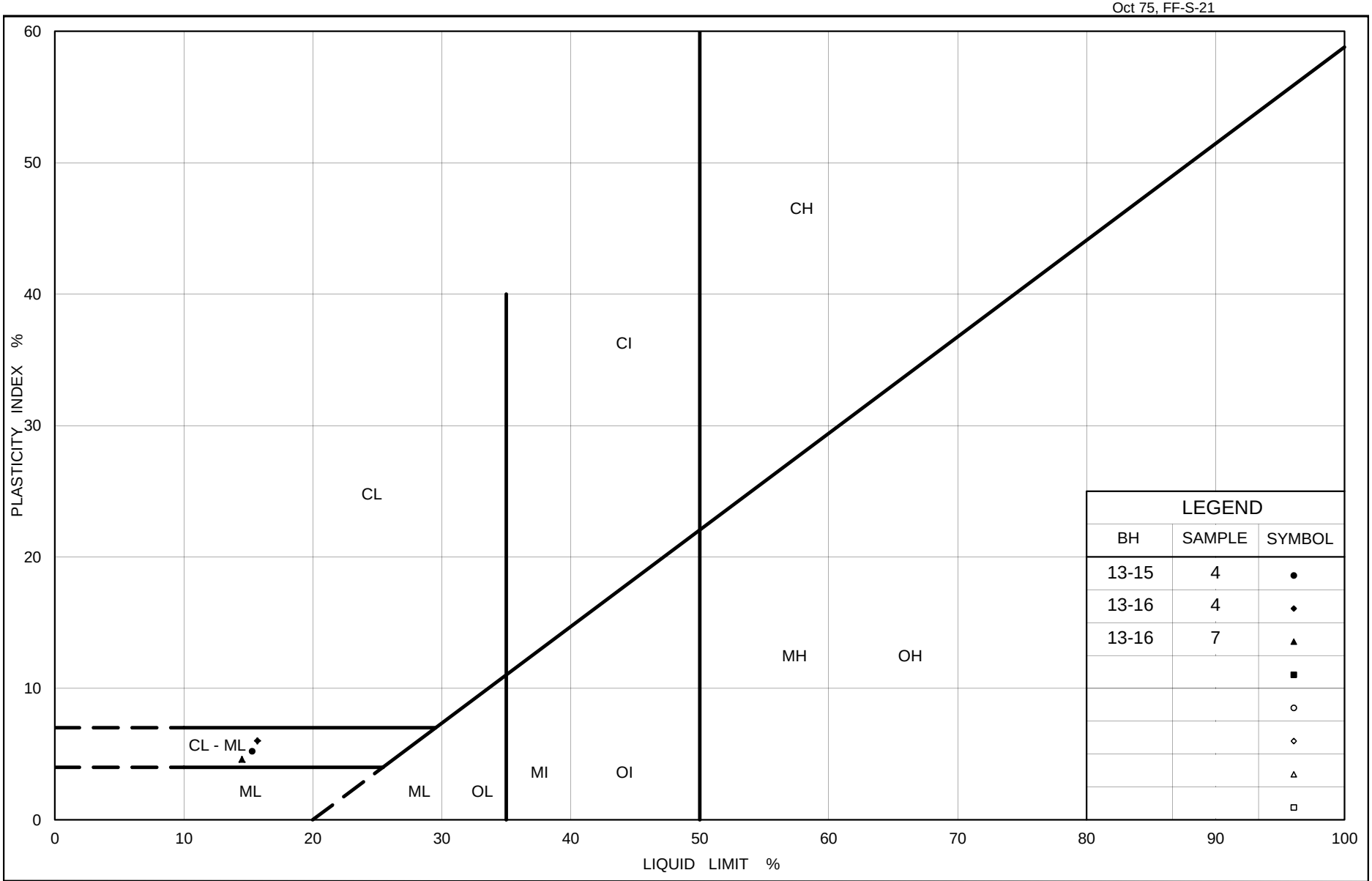
Project Number: 09-1111-0019

Checked By: _____

Golder Associates

Date: 06-Nov-13

Oct 75, FF-S-21



Ministry of Transportation

Ontario

PLASTICITY CHART
Clayey Silt (TILL)

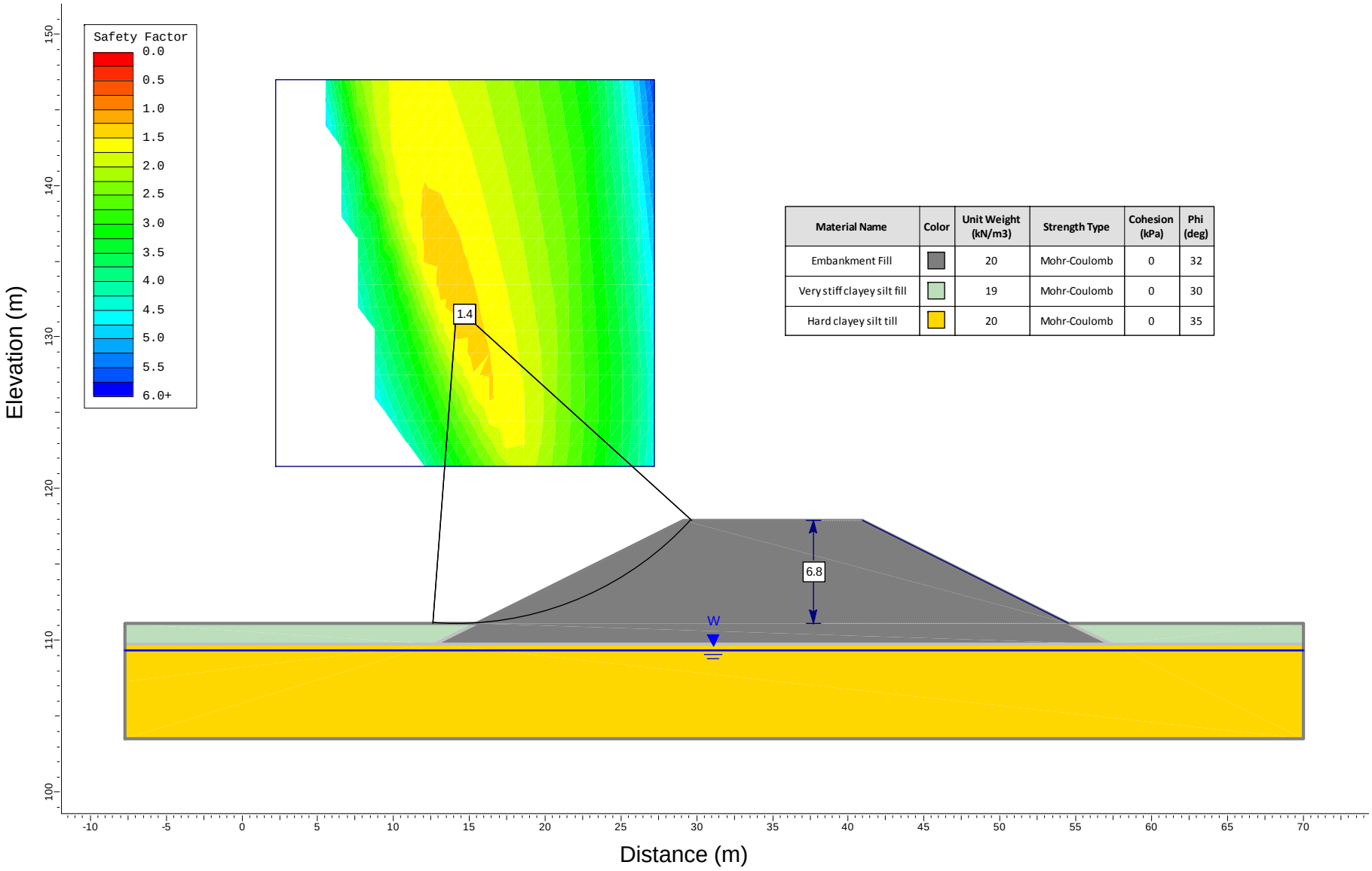
Figure No. D6

Project No. 09-1111-0019

Checked By:

Area 4 – Ramp – N/S-E STA 9+610 to 9+740
Static Global Stability Analysis

Figure D7



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)
Embankment Fill		20	Mohr-Coulomb	0	32
Very stiff clayey silt fill		19	Mohr-Coulomb	0	30
Hard clayey silt till		20	Mohr-Coulomb	0	35

Date: November 2013

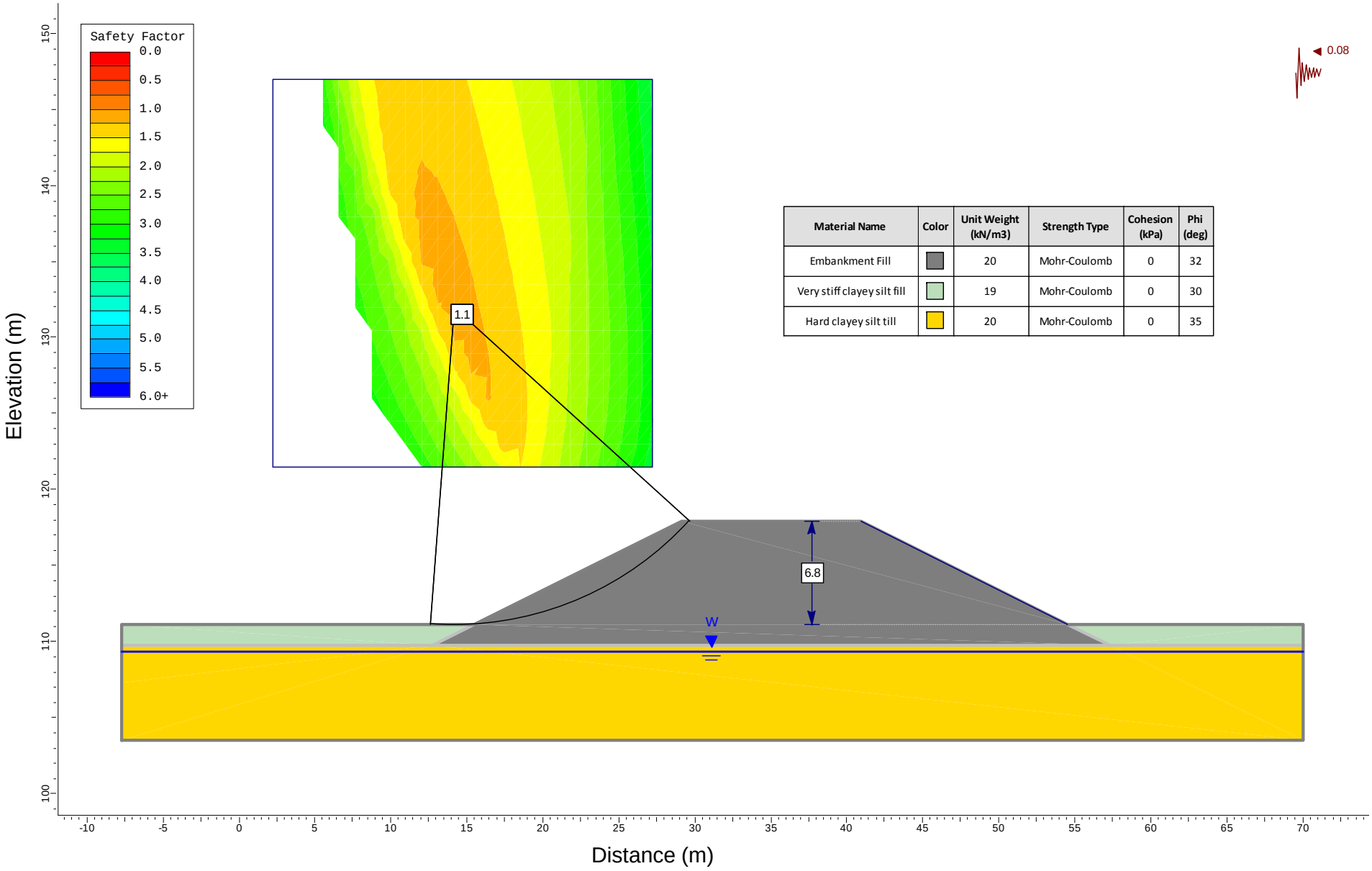
Project No: 09-1111-0019

Analysis By: MWK **Reviewed By:** KJB

Golder Associates

Area 4 – Ramp – N/S-E STA 9+610 to 9+740
Seismic Global Stability Analysis

Figure D8



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)
Embankment Fill		20	Mohr-Coulomb	0	32
Very stiff clayey silt fill		19	Mohr-Coulomb	0	30
Hard clayey silt till		20	Mohr-Coulomb	0	35

Date: November 2013

Project No: 09-1111-0019

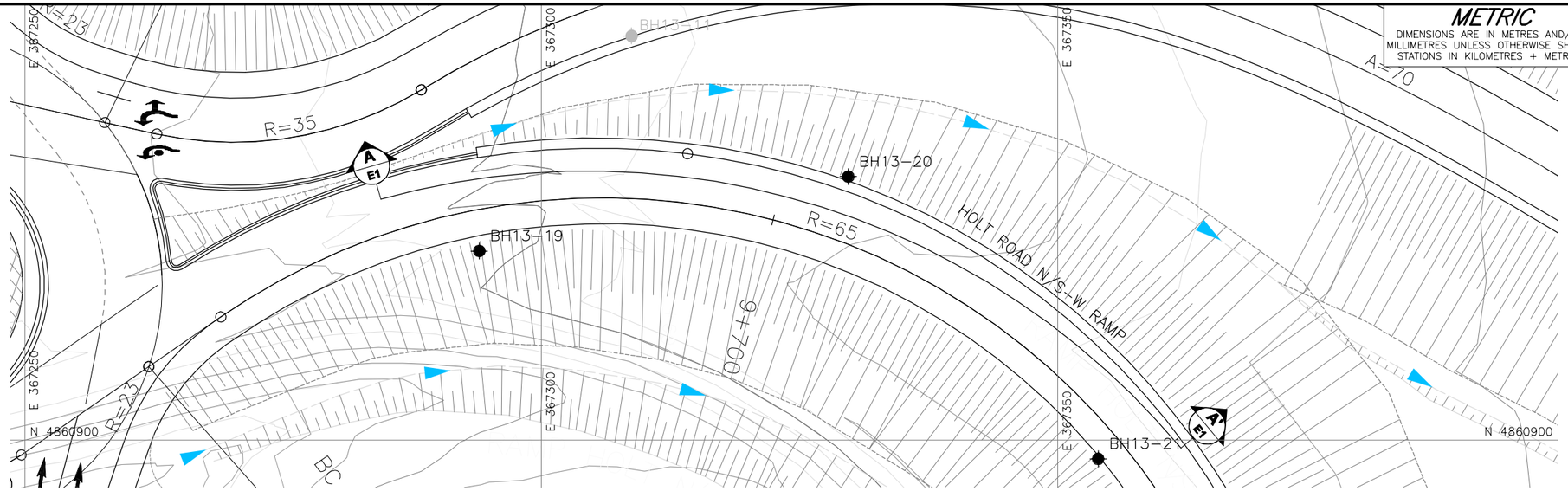
Analysis By: MWK **Reviewed By:** KJB

Golder Associates

APPENDIX E

High Fill Area 5 - N/S-W Ramp, STA 9+670 to 9+740

MINISTRY OF TRANSPORTATION, ONTARIO



PLAN
SCALE
5 0 5 10 m

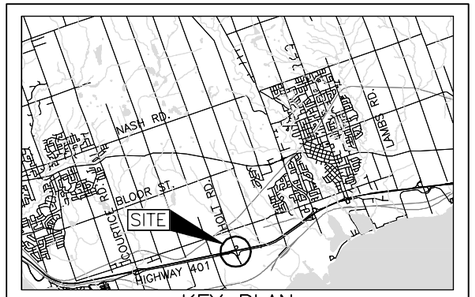
METRIC
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN. STATIONS IN KILOMETRES + METRES.

CONT No.
GWP No. 2101-08-00

HIGHWAY 401
HIGH FILL AREA 5-HOLT ROAD N/S-W RAMP
(STA 9+670 TO 9+740)
BOREHOLE LOCATIONS AND SOIL STRATA

SHEET

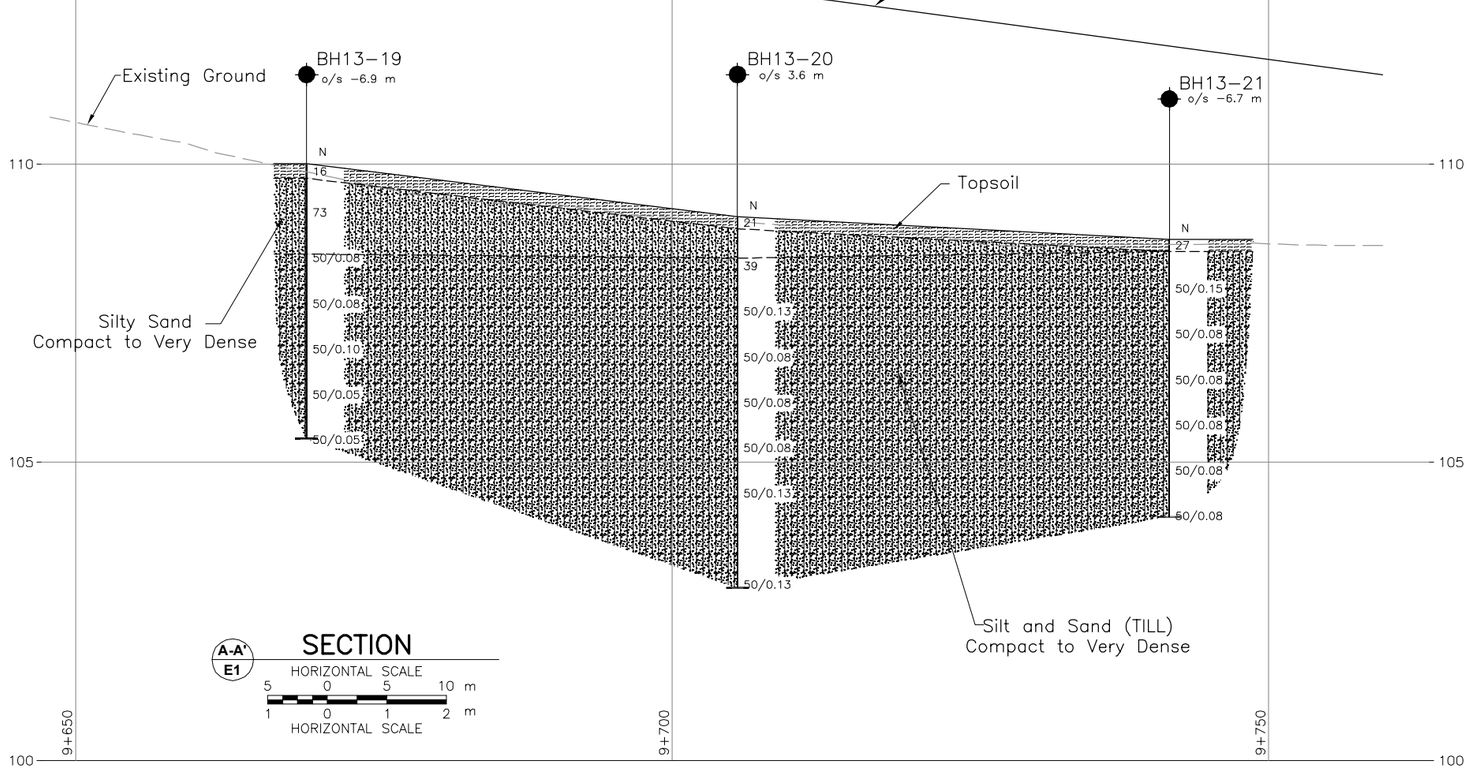
Golder Associates Ltd.
MISSISSAUGA, ONTARIO, CANADA



KEY PLAN
SCALE
2 0 2 4 km

LEGEND

- Borehole – Current Investigation
- N — Standard Penetration Test Value
- 16 — Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)



A-A'
E1

SECTION
HORIZONTAL SCALE
5 0 5 10 m
1 0 1 2 m
HORIZONTAL SCALE

BOREHOLE CO-ORDINATES			
No.	ELEVATION	NORTHING	EASTING
BH13-19	110.0	4860918.3	367294.0
BH13-20	109.1	4860925.5	367329.7
BH13-21	108.7	4860898.2	367353.9

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 plan provided in digital format by URS, drawing file no. 2013-10-24-Hwy401-HoltRd_plan.dwg and 2013-10-24-Hwy401-HoltRd_profile.dwg, received October 23, 2013

NO.	DATE	BY	REVISION

Geocres No. 30M15-158

HWY. 401		PROJECT NO. 09-1111-0019	DIST.
SUBM'D.	CHKD. MWK	DATE: Oct. 2013	SITE: 21-159
DRAWN: JFC	CHKD. KJB	APPD. JMAC	DWG. E1

PLOT DATE: January 21, 2014
FILENAME: T:\Projects\2009\09-1111-0019 (ORS;Donington)\-04- (Holt Road_South-Service-Road_Ramps)\09111901BASE1.dwg

Golder Associates

RECORD OF BOREHOLE No BH13-19

SHEET 1 OF 1

METRIC

PROJECT 09-1111-0019
G.W.P. 2101-08-00
DIST HWY 401
DATUM Geodetic

LOCATION N 4860918.3 ;E 367294.0
BOREHOLE TYPE 108 mm O.D. Continuous Flight Solid Stem Power Auger
DATE June 4, 2013

ORIGINATED BY JLC
COMPILED BY BM
CHECKED BY MWK

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (20 40 60 80 100): ○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × REMOULDED	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
110.0	GROUND SURFACE										
0.0	TOPSOIL										
0.3	Silty SAND, trace gravel, trace clay Compact to very dense Brown Moist		1	SS	16				○		
			2	SS	73		109				
108.5											
1.5	SILT and SAND, some clay, trace to some gravel, inferred cobbles and boulders at 4.0 m and 4.3 m depth (TILL) Very dense Brown Moist		3	SS	50/0.08				○		
			4	SS	50/0.08		108				
			5	SS	50/0.10		107		○		8 40 40 12
			6	SS	50/0.05						
	- - - - - - - - - - - - - - - Auger grinding on inferred cobbles and boulders						106				
105.4			7	SS	50/0.05				○		5 43 38 14
4.6	END OF BOREHOLE NOTE: 1. Open borehole was dry upon completion of drilling.										

+ 3, × 3: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

Golder Associates

RECORD OF BOREHOLE No BH13-20

SHEET 1 OF 1

METRIC

PROJECT 09-1111-0019

G.W.P. 2101-08-00 LOCATION N 4860925.5 ;E 367329.7 ORIGINATED BY JLC

DIST HWY 401 BOREHOLE TYPE 108 mm O.D. Continuous Flight Solid Stem Power Auger COMPILED BY BM

DATUM Geodetic DATE May 31, 2013 CHECKED BY MWK

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
109.1	GROUND SURFACE										
0.0	TOPSOIL										
0.2	Silty SAND, some gravel, trace clay, containing rootlets		1	SS	21		109				
108.4	Compact										
0.7	Brown Moist		2	SS	39		108		○	NP	2 46 45 7
	SILT and SAND, trace to some clay, trace to some gravel (TILL) Dense to very dense Brown Moist		3	SS	50/0.13						
			4	SS	50/0.08		107		○		
			5	SS	50/0.08		106				
			6	SS	50/0.08				○		
			7	SS	50/0.13		105				
							104				
102.9			8	SS	50/0.13		103		○		12 40 40 8
6.2	END OF BOREHOLE										

NOTE:

1. Open borehole was dry upon completion of drilling.

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

GTA-MTO 001 09-1111-0019.GPJ GAL-GTA.GDT 01/21/14

Golder Associates

RECORD OF BOREHOLE No BH13-21

SHEET 1 OF 1

METRIC

PROJECT 09-1111-0019
G.W.P. 2101-08-00
LOCATION N 4860898.2 ;E 367353.9
ORIGINATED BY JLC
DIST HWY 401
BOREHOLE TYPE 108 mm O.D. Continuous Flight Solid Stem Power Auger
COMPILED BY BM
DATUM Geodetic
DATE June 4, 2013
CHECKED BY MWK

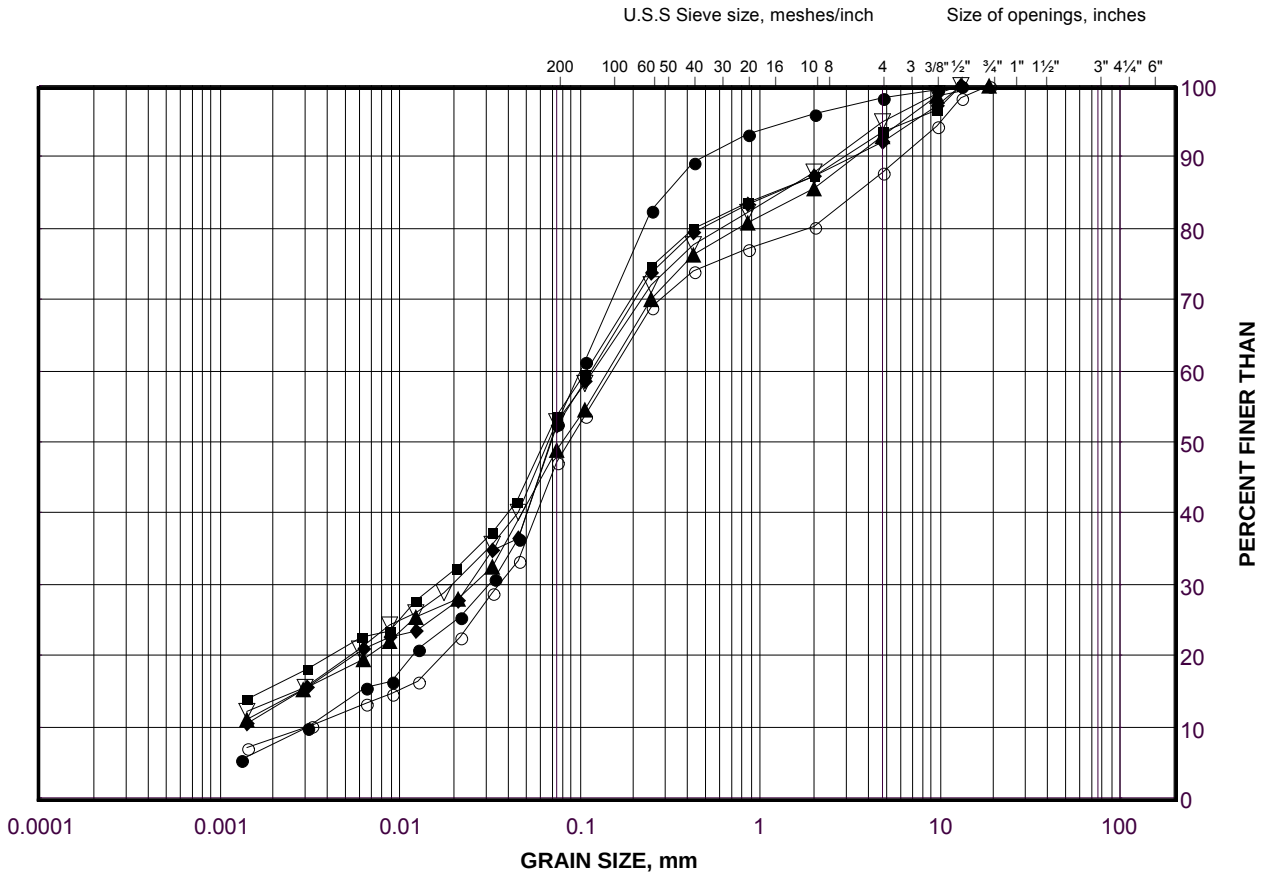
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (20 40 60 80 100): ○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × REMOULDED	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
108.7	GROUND SURFACE										
0.0	TOPSOIL										
0.2	SILT and SAND, trace to some gravel, some clay, inferred cobbles and boulders at 2.1 m to 4.6 m depth (TILL) Compact to very dense Brown Moist		1	SS	27		108		○		
			2	SS	50/0.15						
			3	SS	50/0.08		107		○		7 40 38 15
	- - - - - - - - - - - - - - - Auger grinding on inferred cobbles and bouldersat 2.1 m to 4.6 m depth		4	SS	50/0.08						
			5	SS	50/0.08		106		○		
			6	SS	50/0.08		105				
104.1			7	SS	50/0.08				○		8 43 36 13
4.7	END OF BOREHOLE NOTE: 1. Open borehole was dry upon completion of drilling.										

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

GRAIN SIZE DISTRIBUTION TEST RESULTS

Silt and Sand (TILL)

FIGURE E1



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	13-20	2	108.1
■	13-21	3	107.2
◆	13-19	5	106.9
▲	13-21	7	104.1
▽	13-19	7	105.4
❍	13-20	8	102.9

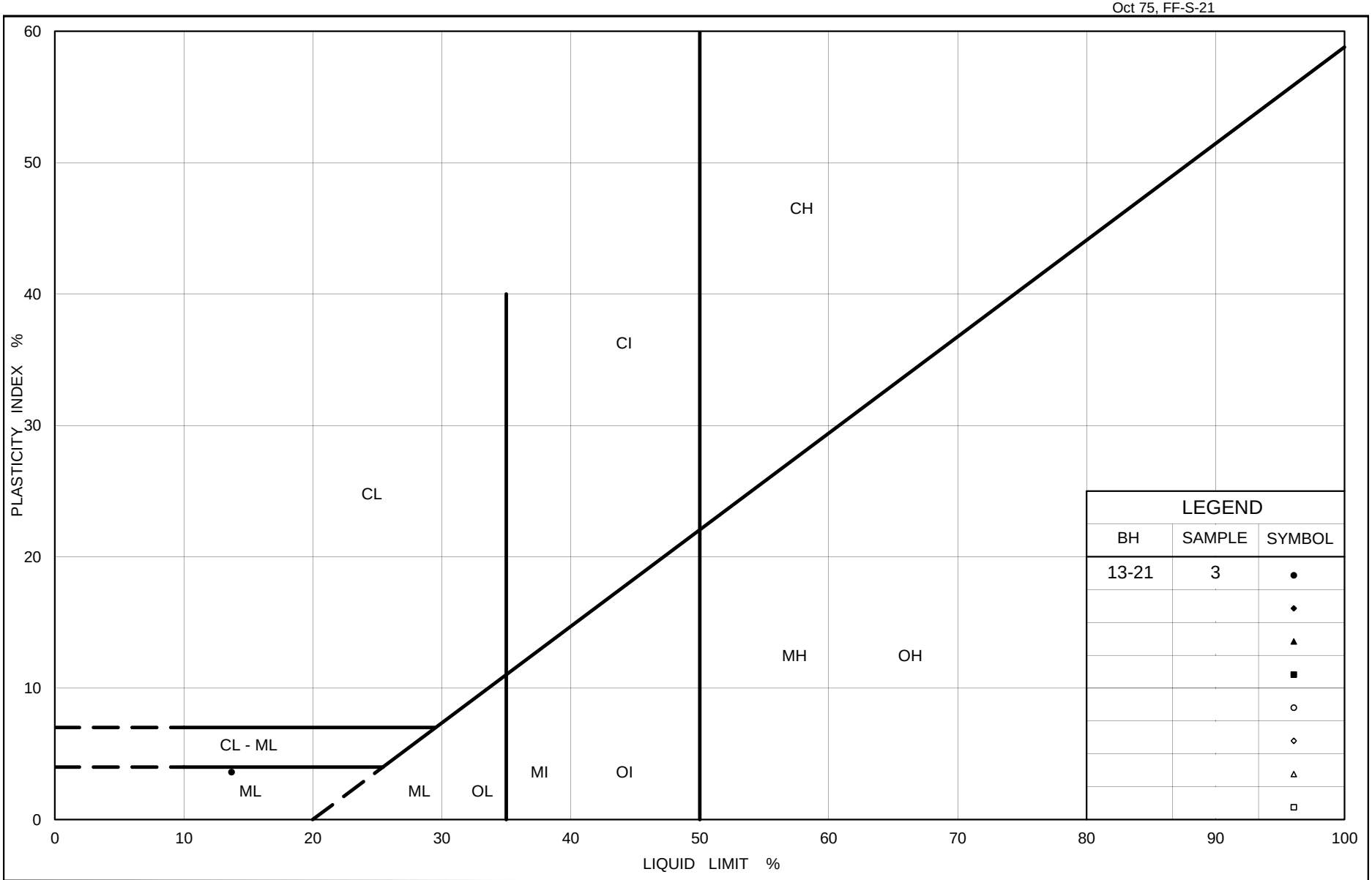
Project Number: 09-1111-0019

Checked By: _____

Golder Associates

Date: 01-Nov-13

Oct 75, FF-S-21



Ministry of Transportation

Ontario

PLASTICITY CHART
Silt and Sand (TILL)

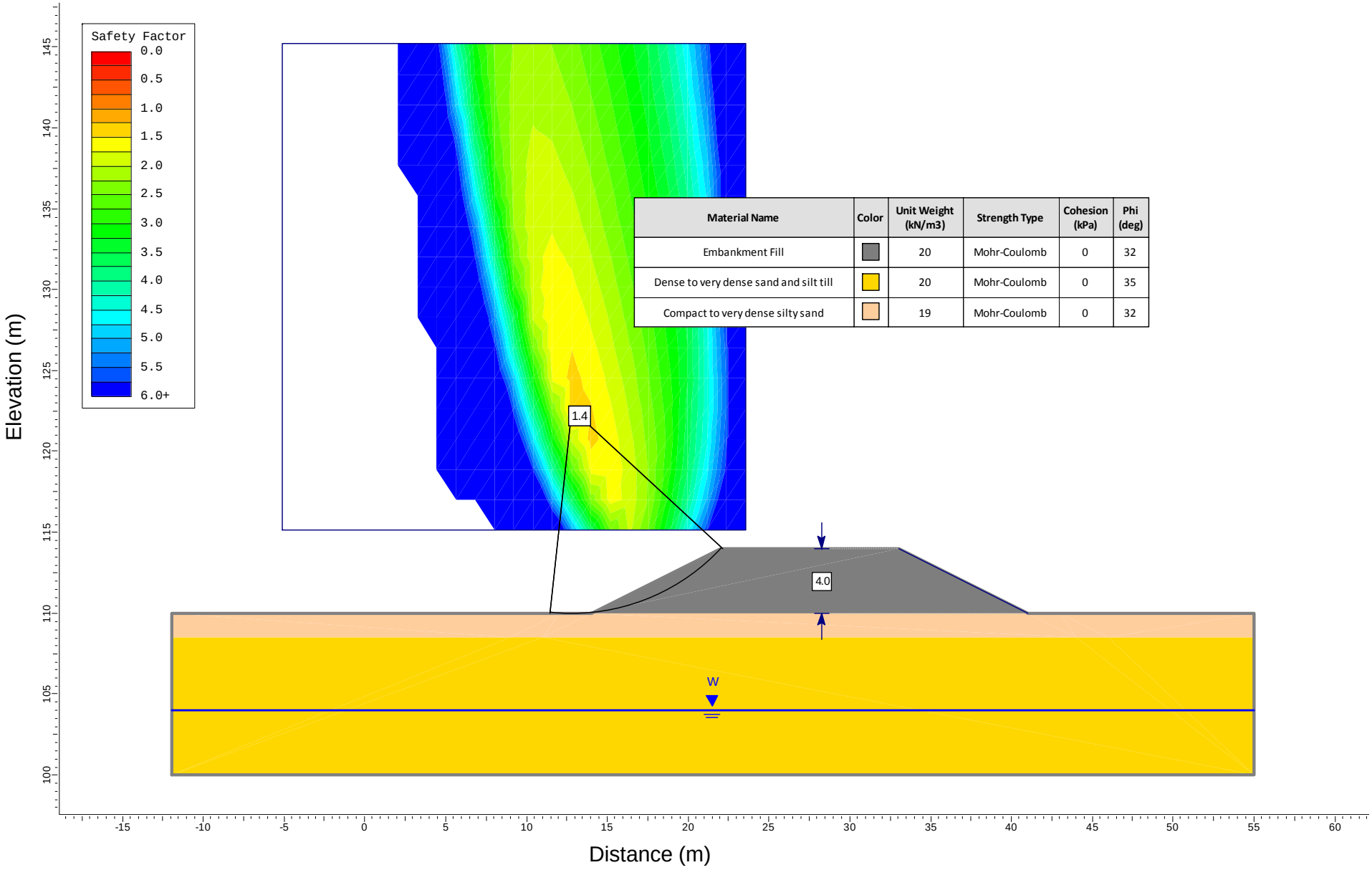
Figure No. E2

Project No. 09-1111-0019

Checked By:

Area 5 – Ramp – N/S-W STA 9+670 to 9+740
Static Global Stability Analysis

Figure E3



Date: November 2013

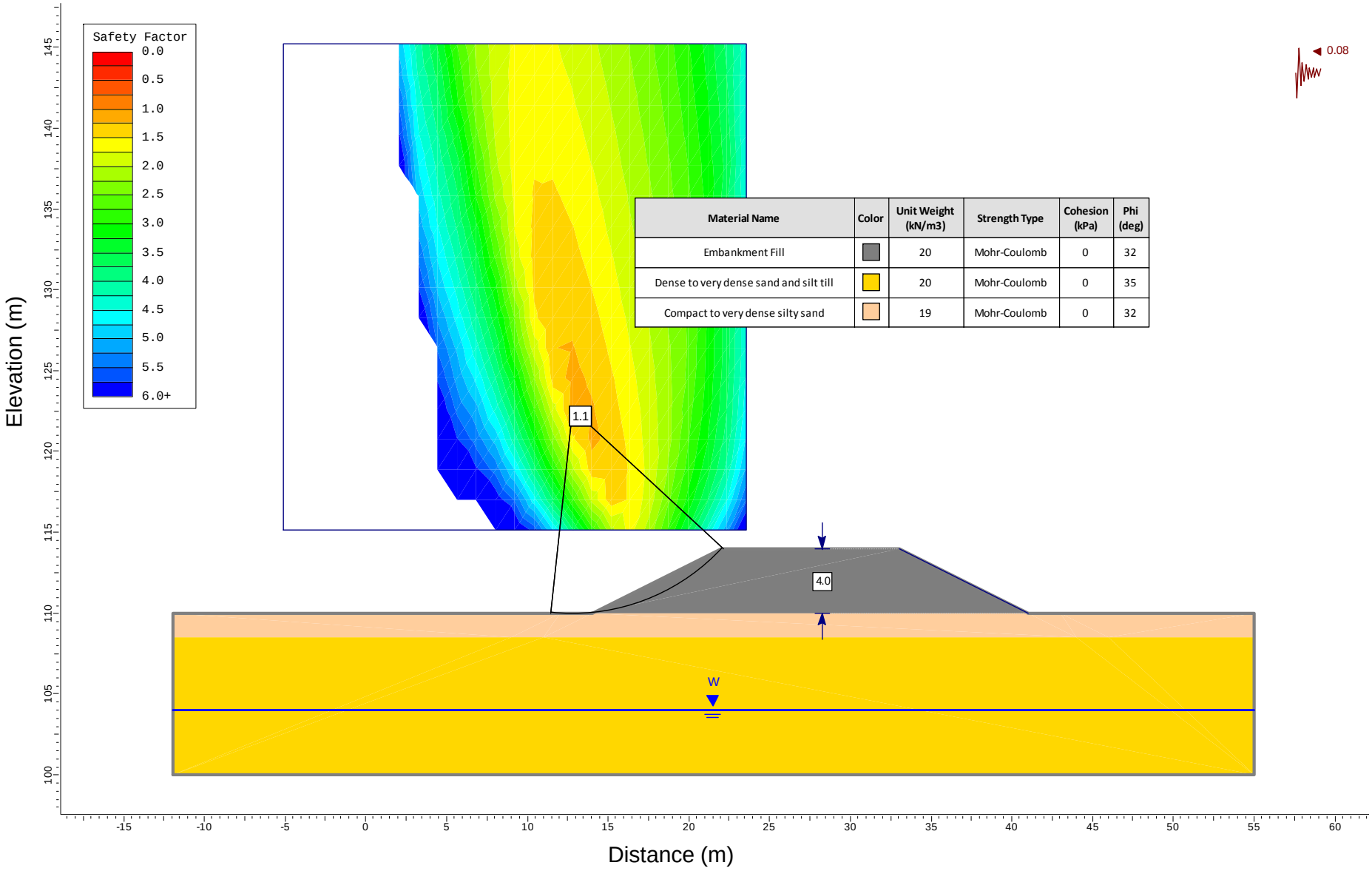
Project No: **09**-1111-0019

Analysis By: MWK **Reviewed By:** KJB

Golder Associates

Area 5 – Ramp – N/S-W STA 9+670 to 9+740
Seismic Global Stability Analysis

Figure E4



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)
Embankment Fill		20	Mohr-Coulomb	0	32
Dense to very dense sand and silt till		20	Mohr-Coulomb	0	35
Compact to very dense silty sand		19	Mohr-Coulomb	0	32

Date: November 2013

Project No: 09-1111-0019

Analysis By: MWK **Reviewed By:** KJB

APPENDIX F

High Fill Area 6 - W- N/S Ramp, STA 11+550 to 11+580

MINISTRY OF TRANSPORTATION, ONTARIO

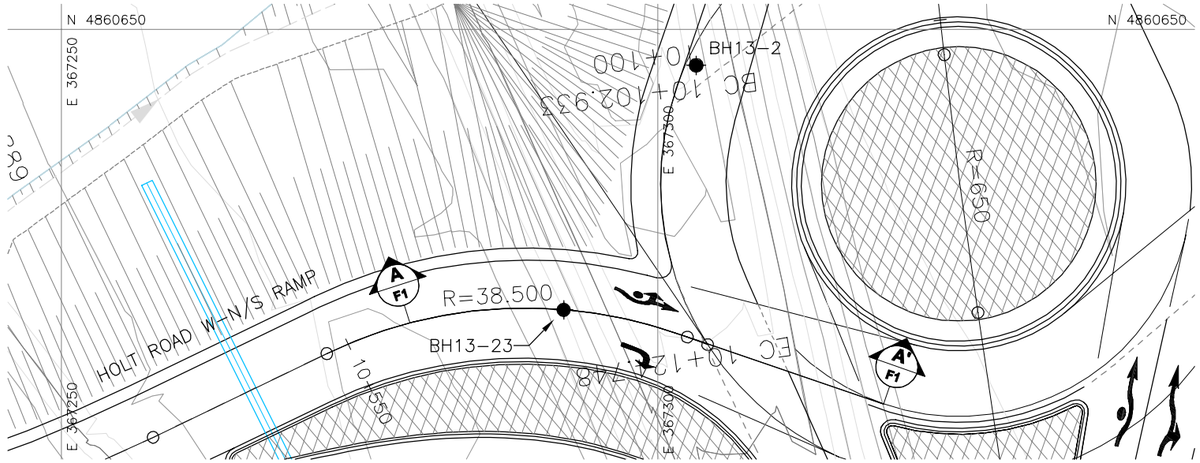
METRIC
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN.
STATIONS IN KILOMETRES + METRES.

CONT No.
GWP No. 2101-08-00

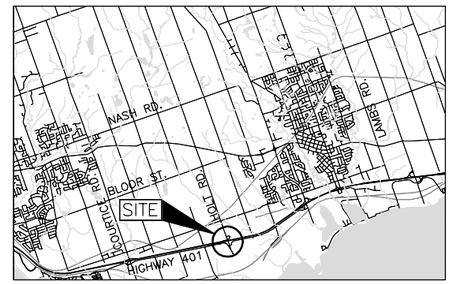
HIGHWAY 401
DEEP CUT AREA 6-HOLT ROAD W-N/S RAMP
(STA 10+550 TO 10+580)
BOREHOLE LOCATIONS AND SOIL STRATA

SHEET

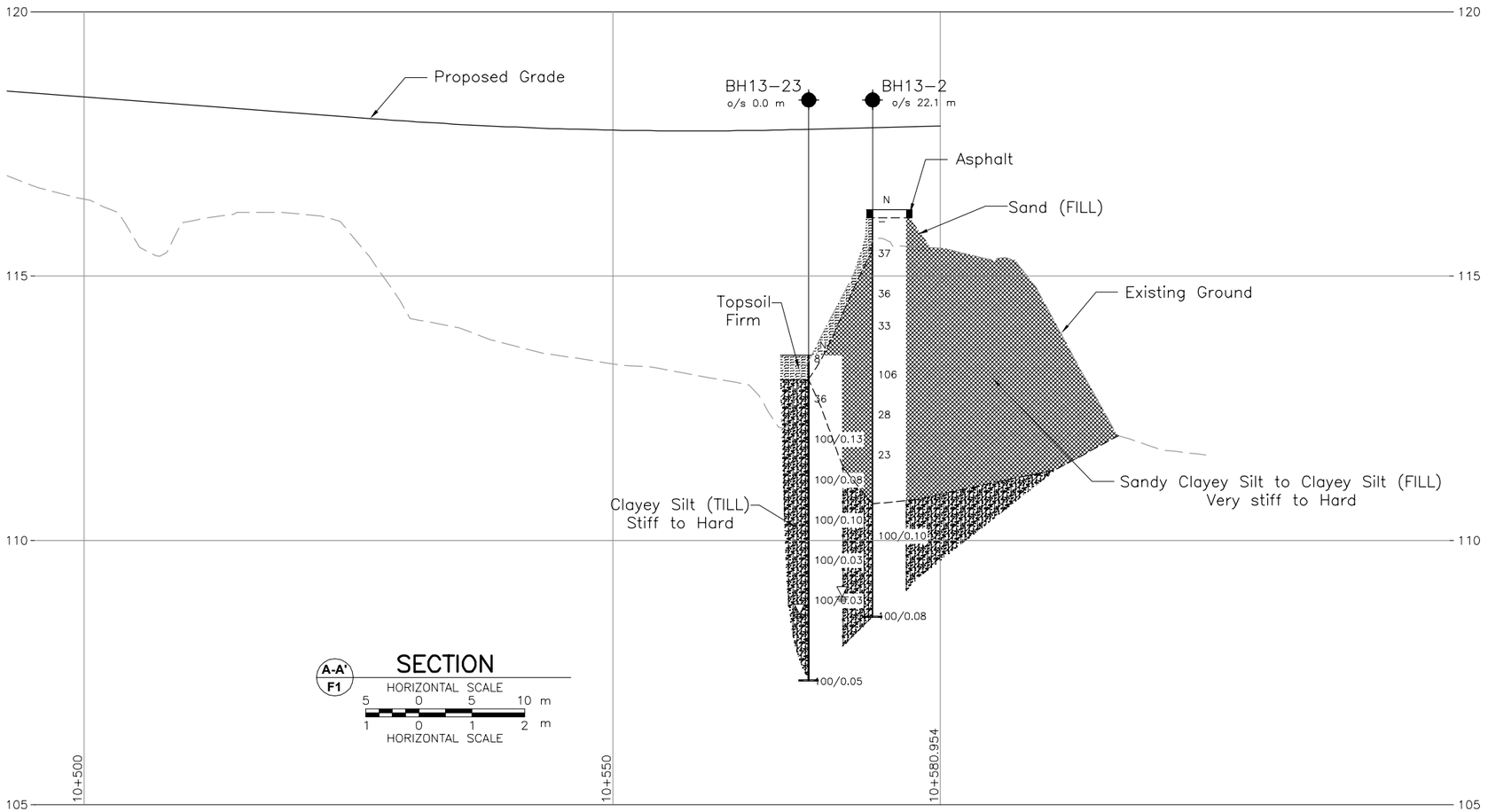
Golder Associates Ltd.
MISSISSAUGA, ONTARIO, CANADA



PLAN
SCALE
5 0 5 10 m



KEY PLAN
SCALE
2 0 2 4 km



A-A'
F1
SECTION
HORIZONTAL SCALE
5 0 5 10 m
HORIZONTAL SCALE
1 0 1 2 m

LEGEND

- Borehole – Current Investigation
- N — Standard Penetration Test Value
- 16 — Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)
- WL during or upon completion of drilling

BOREHOLE CO-ORDINATES			
No.	ELEVATION	NORTHING	EASTING
BH13-2	116.3	4860647.0	367303.2
BH13-23	113.2	4860626.5	367292.1

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 plan provided in digital format by URS, drawing file no. 2013-10-24-Hwy401-HoltRd_plan.dwg and 2013-10-24-Hwy401-HoltRd_profile.dwg, received October 23, 2013

NO.	DATE	BY	REVISION

Geocres No. 30M15-158

HWY. 401		PROJECT NO. 09-1111-0019	DIST.
SUBM'D.	CHKD. MWK	DATE: Oct. 2013	SITE: 21-159
DRAWN: JFC	CHKD. KJB	APPD. JMAC	DWG. F1

PLOT DATE: January 21, 2014
FILENAME: T:\Projects\2009\09-1111-0019 (URS_Clarington)_04- Holt Road_South-Service-Road_Ramps\\09111100190AF1.dwg

Golder Associates

RECORD OF BOREHOLE No BH13-2

SHEET 1 OF 1

METRIC

PROJECT 09-1111-0019
G.W.P. 2101-08-00
DIST HWY 401
DATUM Geodetic

LOCATION N 4860647.0 ;E 367303.2
BOREHOLE TYPE 120 mm O.D. Continuous Flight Solid Stem Power Auger
DATE May 30, 2013

ORIGINATED BY JLC
COMPILED BY BM
CHECKED BY MWK

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
116.3	GROUND SURFACE										
0.0	ASPHALT (150 mm)										
0.2	Sand, some gravel, trace silt (FILL) Brown Moist		1	AS	-		116		○		
115.5											
0.8	Sandy clayey silt to clayey Silt, some sand, trace to some gravel, trace organics and containing rootlets (FILL) Very stiff to hard Brown to grey Moist		2	SS	37						
			3	SS	36		115		⊕		14 29 42 15
			4	SS	33		114				
			5	SS	106		113		○		0 18 65 17
			6	SS	28		112				
			7	SS	23		111				
110.7											
5.6	CLAYEY SILT with SAND trace to some gravel, inferred cobbles throughout (TILL) Hard Grey Wet		8	SS	100/0.10	▽	110		○		5 35 45 15
108.6			9	SS	100/0.08		109				
7.7	END OF BOREHOLE										

NOTES:

1. Water level at a depth of 7.3 m below ground surface (Elev. 109.0 m) during drilling.

2. Borehole caved at a depth of 7.6 m below ground surface (Elev. 108.7 m) upon completion of drilling.

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

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

Golder Associates

RECORD OF BOREHOLE No BH13-23

SHEET 1 OF 1

METRIC

PROJECT 09-1111-0019
G.W.P. 2101-08-00
LOCATION N 4860626.5 ;E 367292.1
ORIGINATED BY JLC
DIST HWY 401
BOREHOLE TYPE 120 mm O.D. Continuous Flight Solid Stem Power Auger
COMPILED BY BM
DATUM Geodetic
DATE May 30, 2013
CHECKED BY MWK

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
113.2	GROUND SURFACE										
0.0	TOPSOIL Firm Dark brown Moist		1	SS	8		113		○		
112.7 0.5	CLAYEY SILT with SAND trace to some gravel, inferred cobbles and boulders throughout (TILL) Hard Brown to grey Moist		2	SS	36						
			3	SS	100/0.13		112		○ ⊢		20 47 22 11
			4	SS	100/0.08		111				
			5	SS	100/0.10				○ ⊢		3 43 37 17
			6	SS	100/0.03		110				
			7	SS	100/0.03	▽	109				
							108				
107.1			8	SS	100/0.06		107		○		
6.2	END OF BOREHOLE										

NOTE:

1. Water level in open borehole at a depth of 4.9 m below ground surface (Elev. 108.3 m) upon completion of drilling.

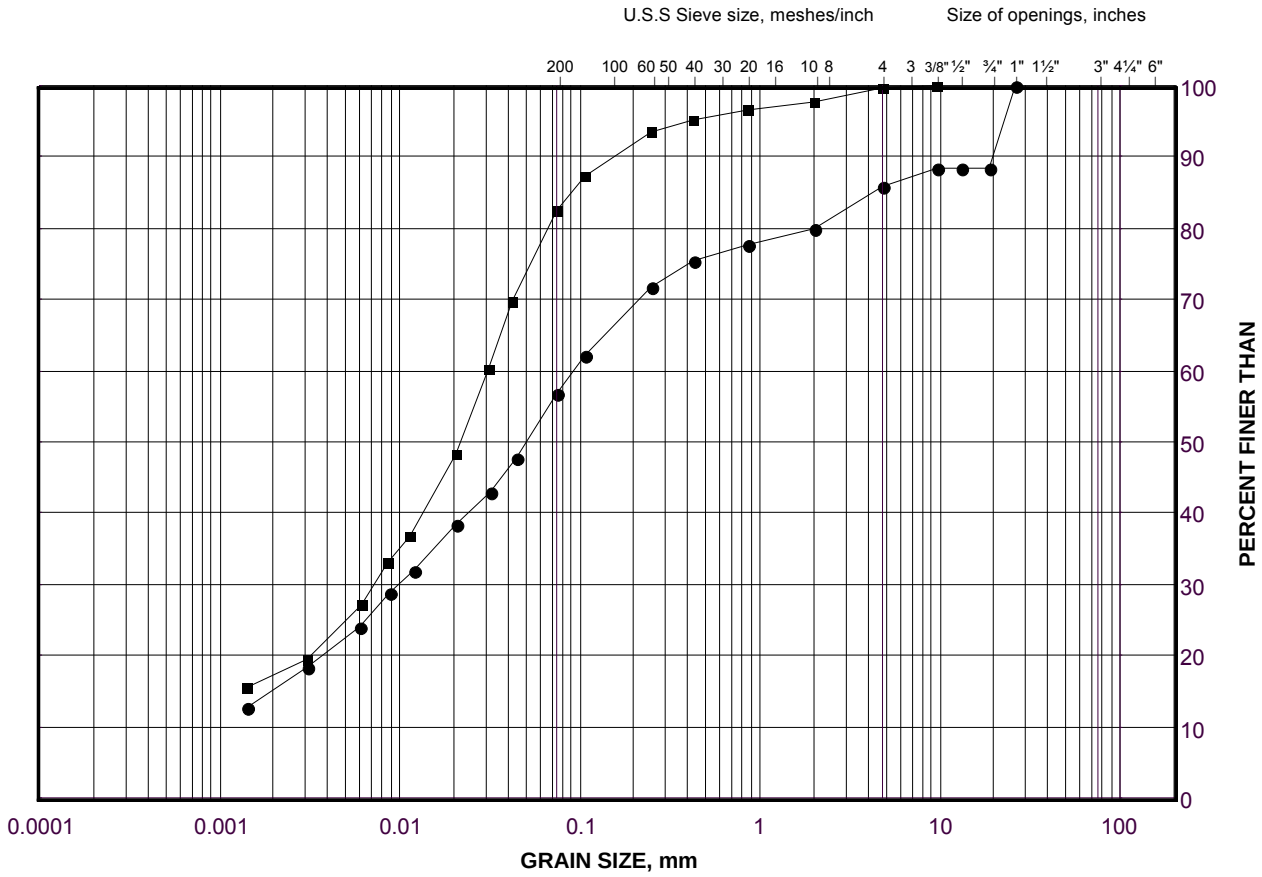
$+^3, \times^3$: Numbers refer to Sensitivity

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

GRAIN SIZE DISTRIBUTION TEST RESULTS

Clayey Silt (FILL)

FIGURE F1



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	13-2	3	114.5
■	13-2	5	113.0

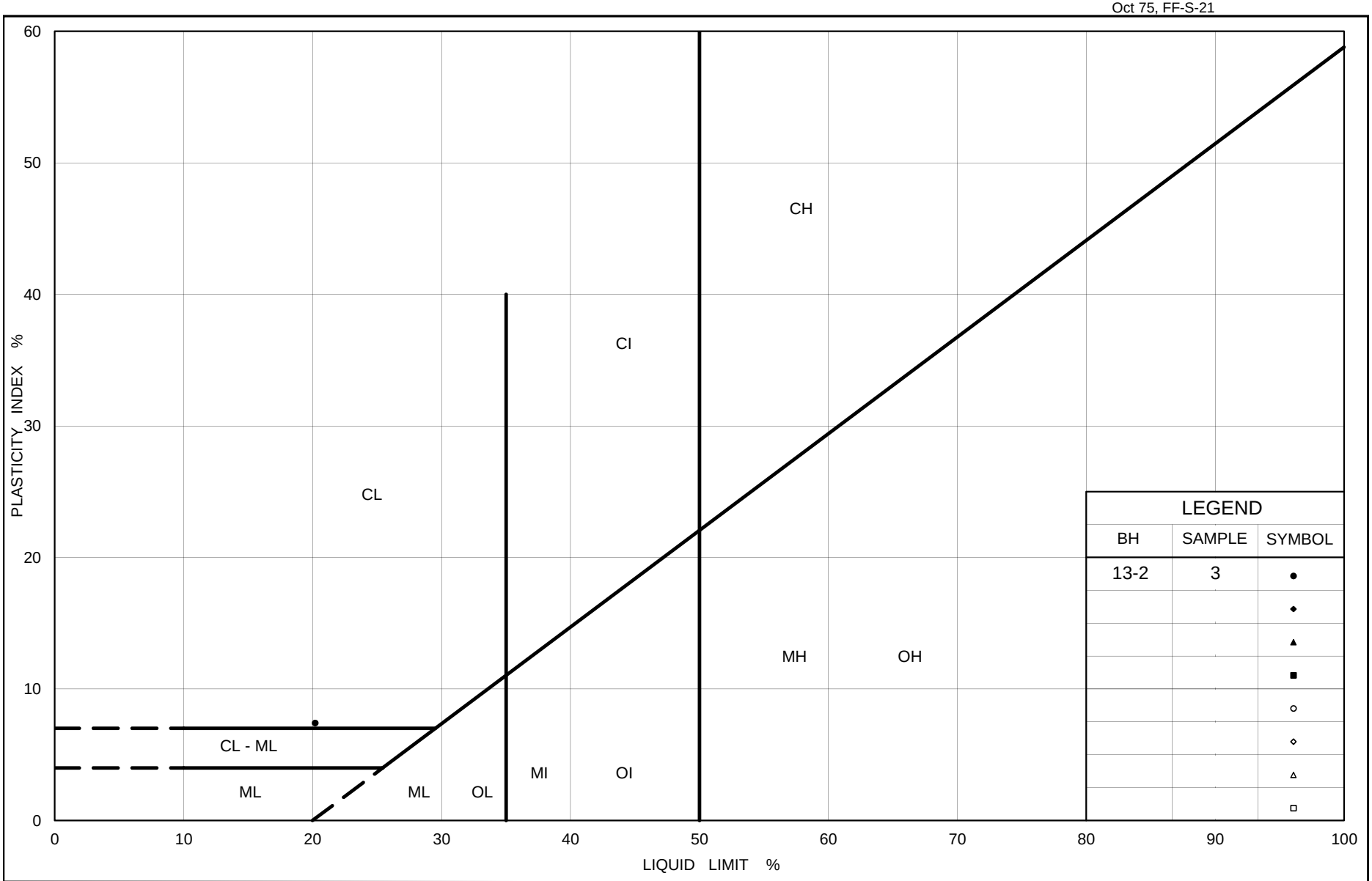
Project Number: 09-1111-0019

Checked By: _____

Golder Associates

Date: 01-Nov-13

Oct 75, FF-S-21



Ministry of Transportation

Ontario

PLASTICITY CHART
Clayey Silt (FILL)

Figure No. F2

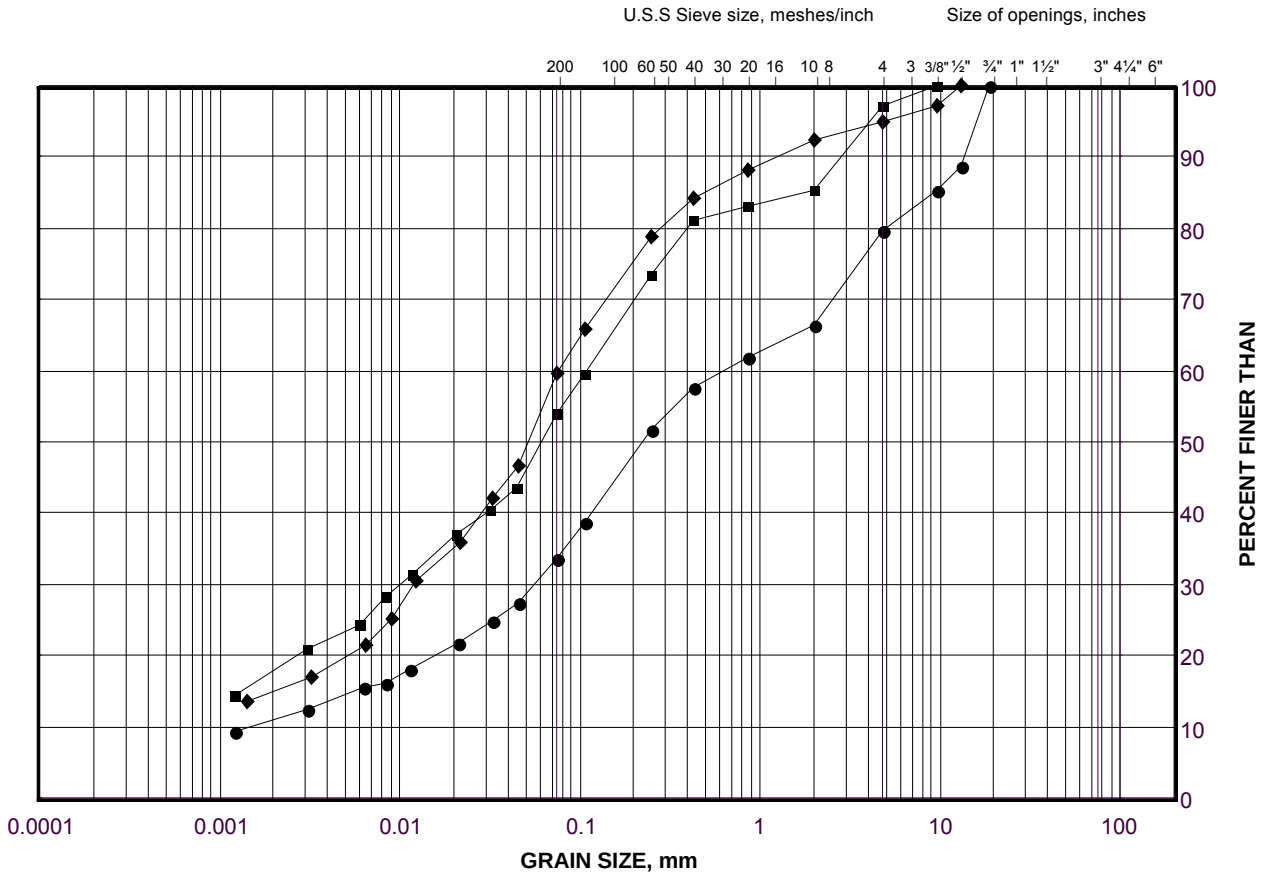
Project No. 09-1111-0019

Checked By:

GRAIN SIZE DISTRIBUTION TEST RESULTS

Clayey Silt (TILL)

FIGURE F3



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	13-23	3	111.6
■	13-23	5	110.1
◆	13-2	8	110.1

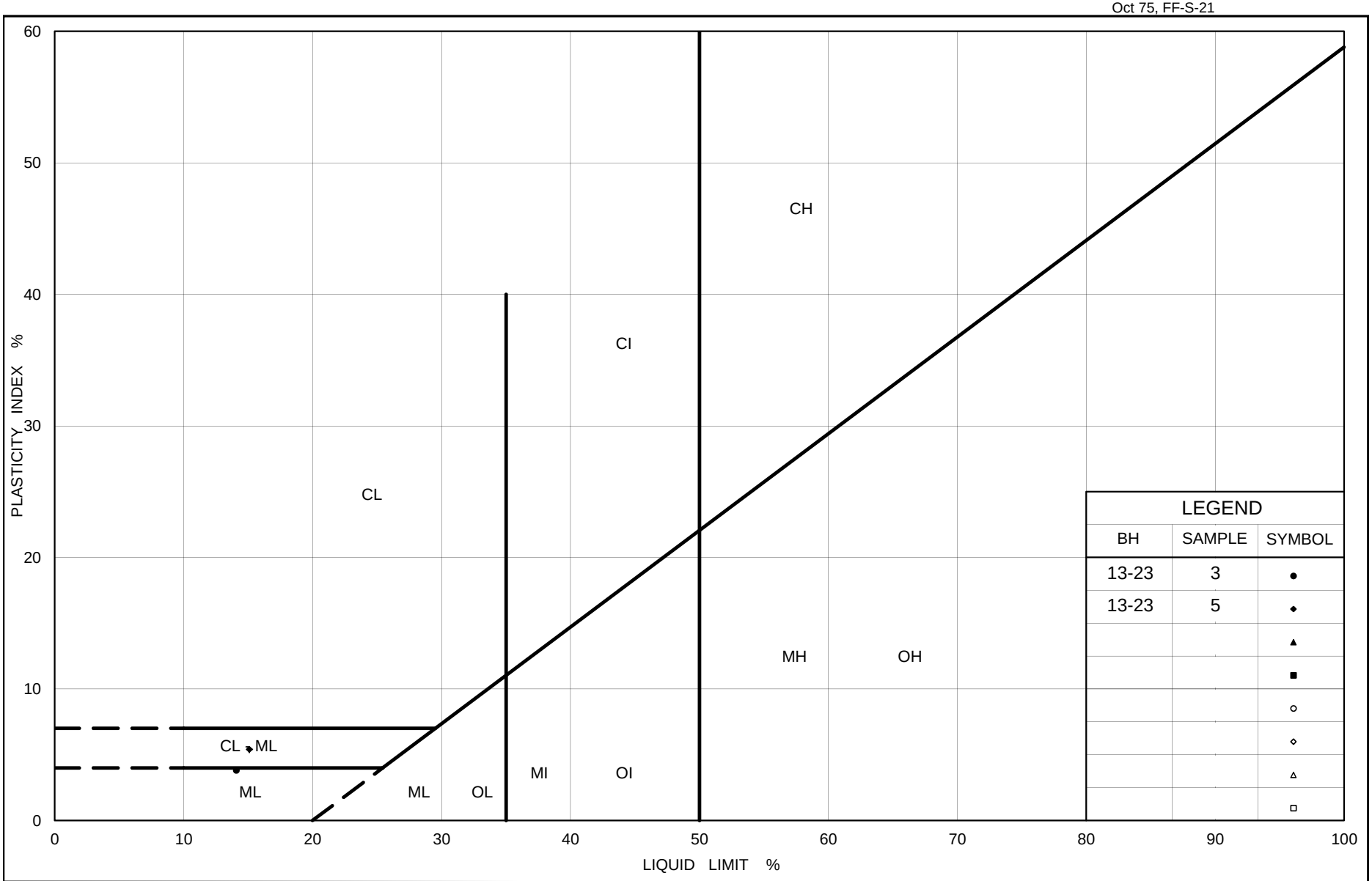
Project Number: 09-1111-0019

Checked By: _____

Golder Associates

Date: 06-Nov-13

Oct 75, FF-S-21



Ministry of Transportation

Ontario

PLASTICITY CHART
Silt (TILL)

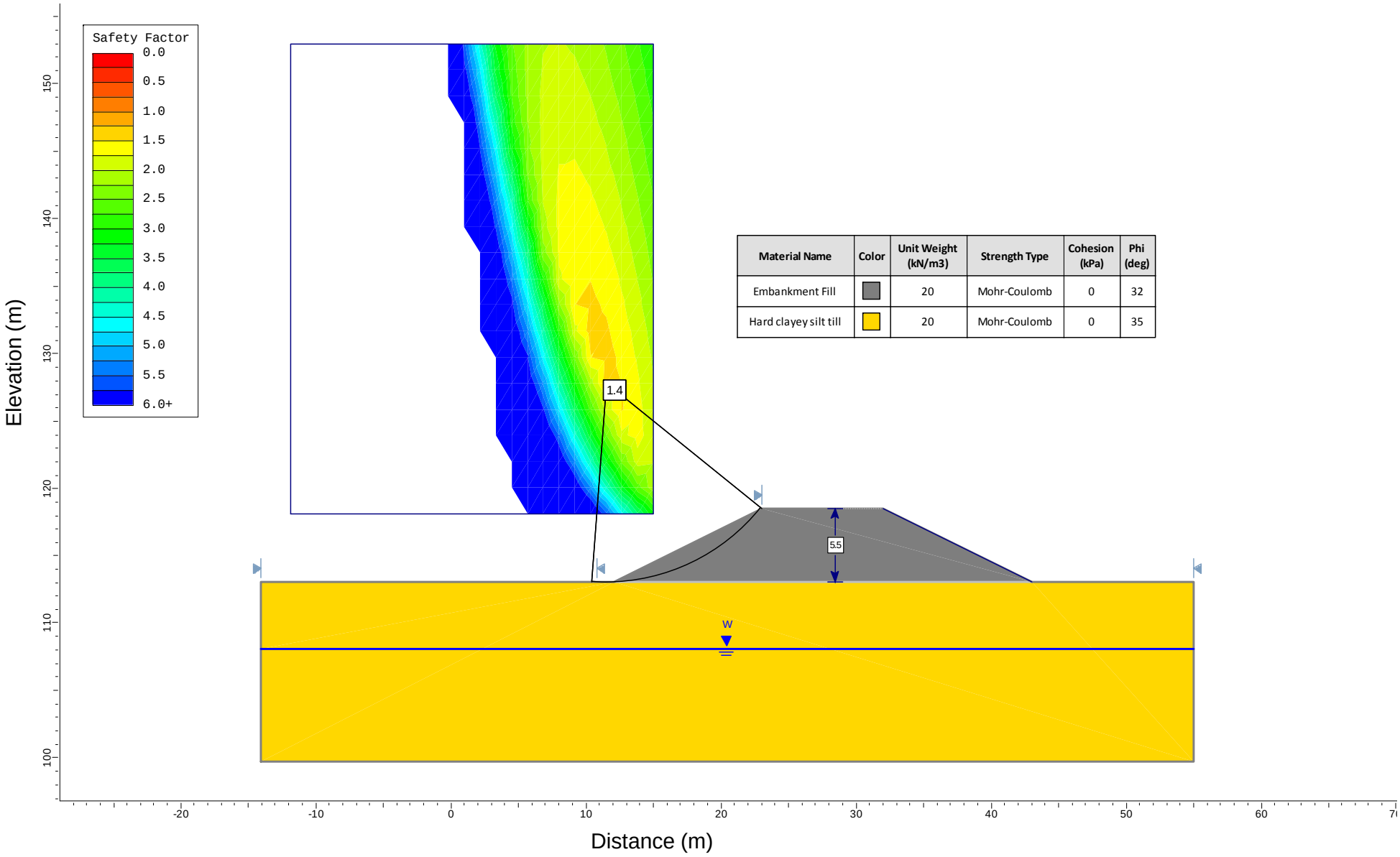
Figure No. F4

Project No. 09-1111-0019

Checked By:

Area 6 – Ramp –W- N/S STA 11+550 to 11+580
Static Global Stability Analysis

Figure F5



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)
Embankment Fill		20	Mohr-Coulomb	0	32
Hard clayey silt till		20	Mohr-Coulomb	0	35

Date: November 2013

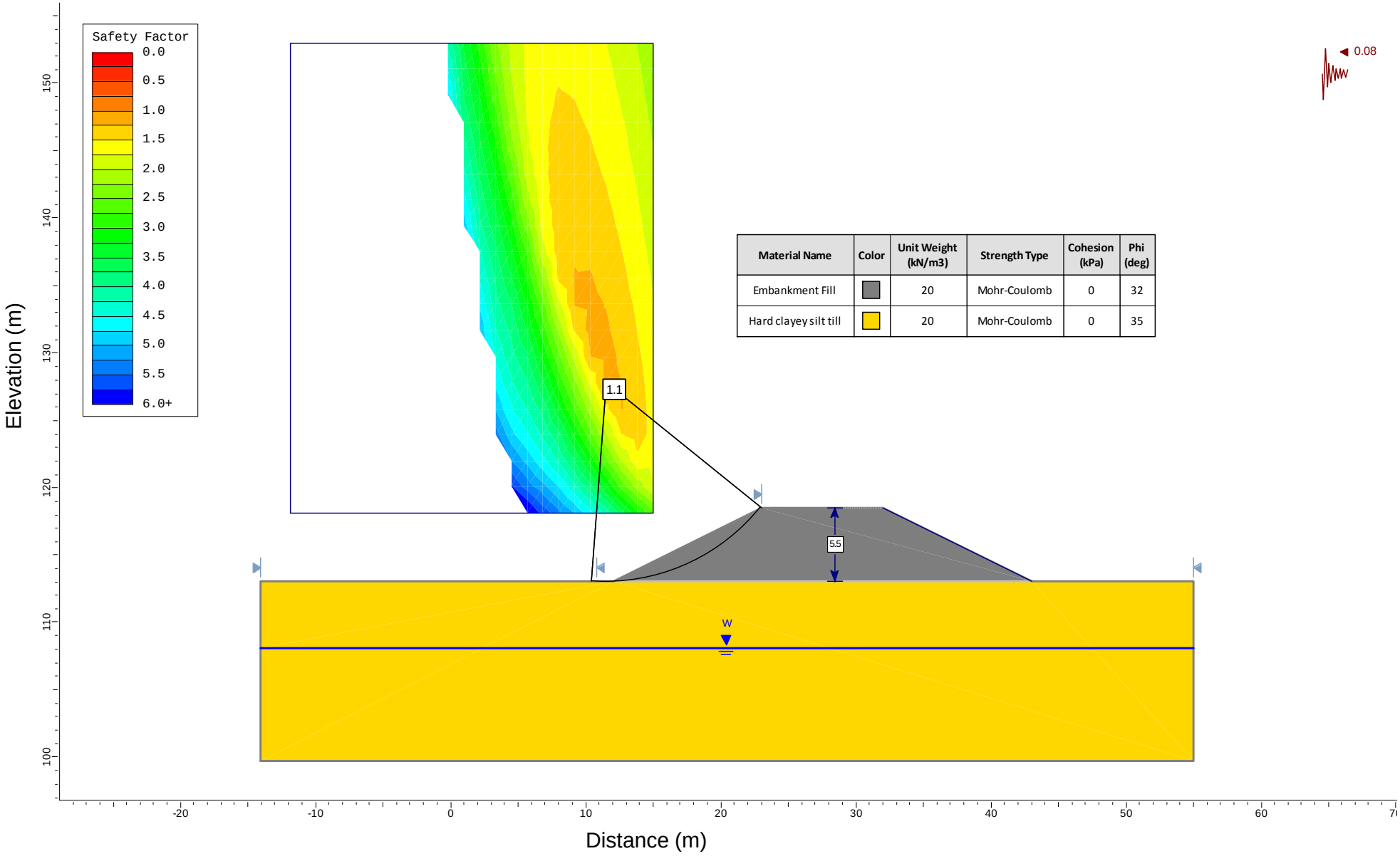
Project No: 09-1111-0019

Analysis By: MWK **Reviewed By:** KJB

Golder Associates

Area 6 – Ramp –W- N/S STA 11+550 to 11+580
Seismic Global Stability Analysis

Figure F6



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)
Embankment Fill		20	Mohr-Coulomb	0	32
Hard clayey silt till		20	Mohr-Coulomb	0	35

Date: November 2013

Project No: 09-1111-0019

Analysis By: MWK **Reviewed By:** KJB

Golder Associates

APPENDIX G

Deep Cut Area 7 - South Service Road, STA 13+160 to 13+265

MINISTRY OF TRANSPORTATION, ONTARIO

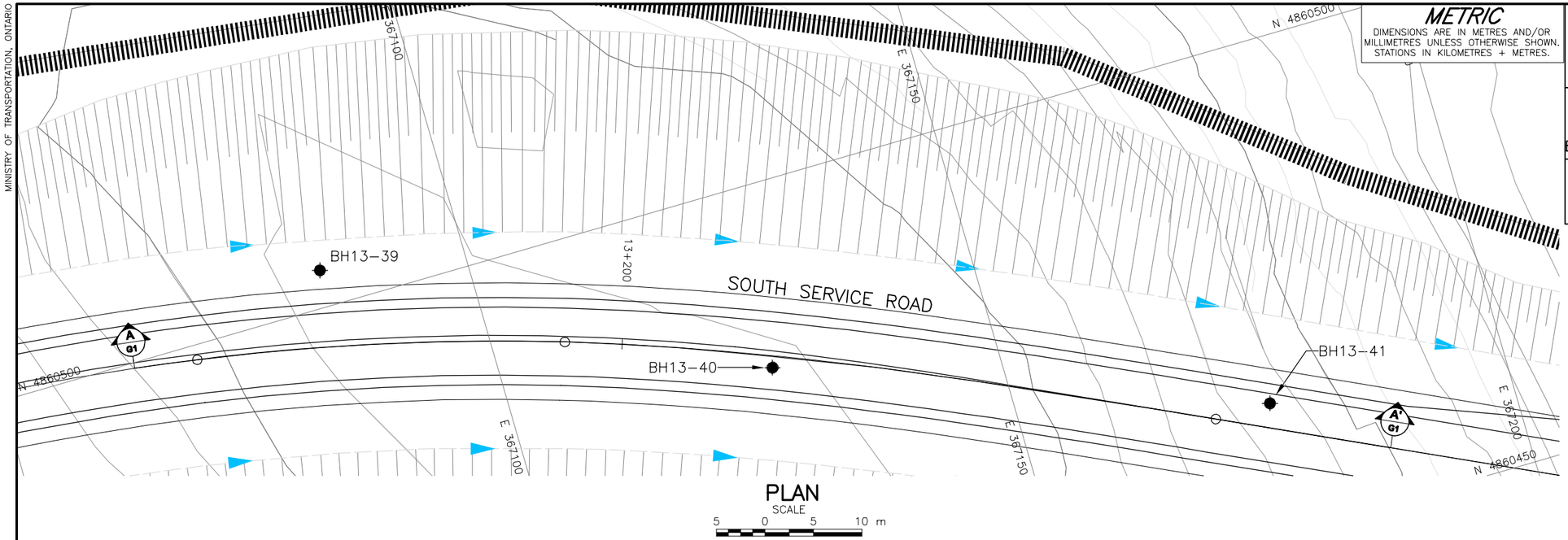
METRIC
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN.
STATIONS IN KILOMETRES + METRES.

CONT No.
GWP No.2101-08-00

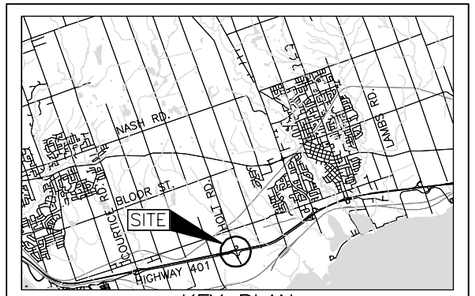
HIGHWAY 401
DEEP CUT AREA 7-SOUTH SERVICE ROAD
(STA 13+160 TO 13+265)
BOREHOLE LOCATIONS AND SOIL STRATA

SHEET

Golder Associates Ltd.
MISSISSAUGA, ONTARIO, CANADA



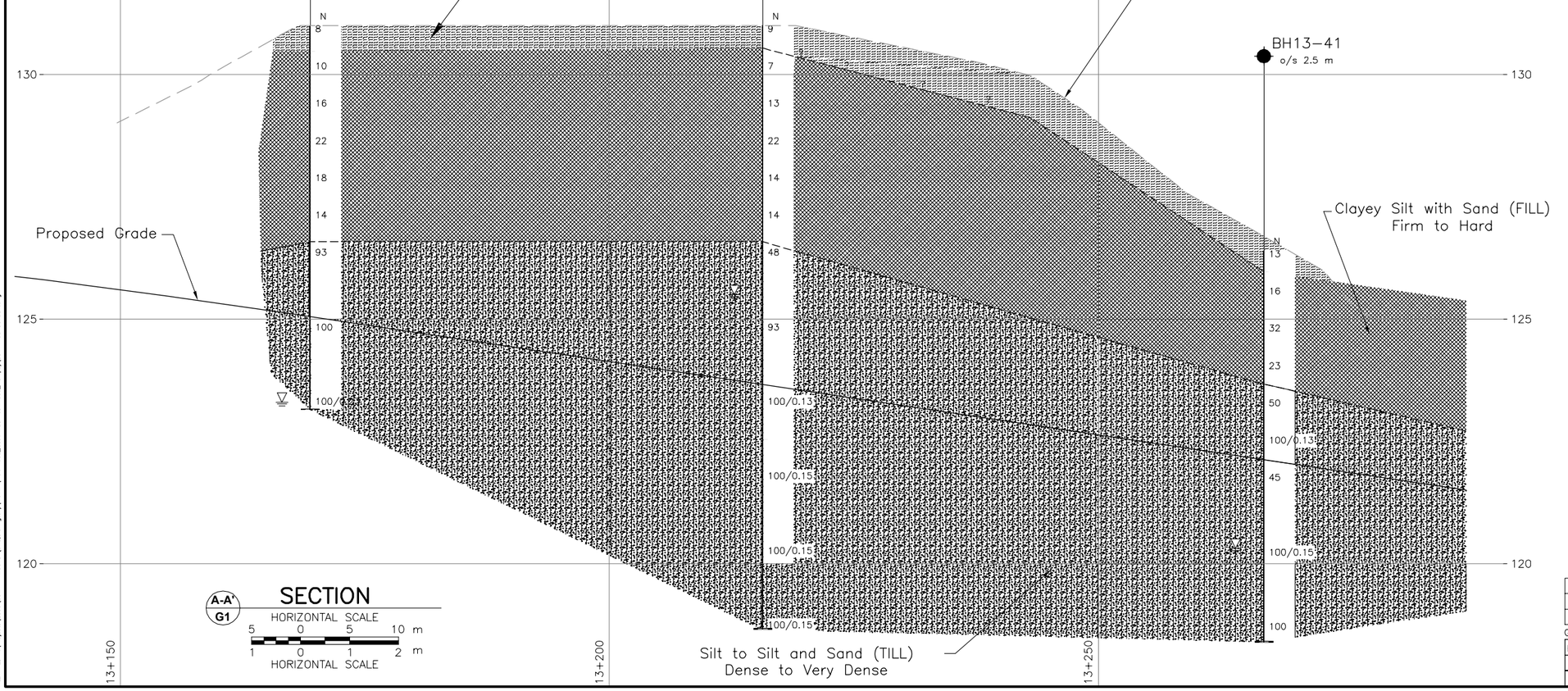
PLAN
SCALE
5 0 5 10 m



KEY PLAN
SCALE
2 0 2 4 km

LEGEND

- Borehole – Current Investigation
- N Standard Penetration Test Value
- 16 Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)
- WL during or upon completion of drilling



SECTION
A-A'
G1
HORIZONTAL SCALE
5 0 5 10 m
1 0 1 2 m
HORIZONTAL SCALE

BOREHOLE CO-ORDINATES			
No.	ELEVATION	NORTHING	EASTING
BH13-39	131.0	4860503.8	367085.2
BH13-40	131.0	4860481.2	367127.2
BH13-41	126.4	4860463.4	367175.4

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 plan provided in digital format by URS, drawing file no. 2013-10-24-Hwy401-HoltRd_plan.dwg,
2013-10-24-Hwy401-HoltRd_profile.dwg, received October 23, 2013 and Existing Ground Surface cut from Topo drawing file no. ACAD-X-base.dwg, received September 9, 2013.

NO.	DATE	BY	REVISION

Geocres No. 30M15-158

HWY. 401		PROJECT NO. 09-1111-0019	DIST.
SUBM'D.	CHKD. MWK	DATE: Oct. 2013	SITE: 21-159
DRAWN: JFC	CHKD. KJD	APPD. JMAC	DWG. G1

PLOT DATE: January 21, 2014
FILENAME: I:\Projects\2009\09-1111-0019 (GRS:Stonington)\-DA- (Holt Road_South-Service-Road_Ramps)\09111100190A01.dwg

Golder Associates

RECORD OF BOREHOLE No BH13-39 SHEET 1 OF 1 METRIC

PROJECT 09-1111-0019
G.W.P. 2101-08-00 LOCATION N 4860503.8 ;E 367085.2 ORIGINATED BY JLC
DIST HWY 401 BOREHOLE TYPE 120 mm O.D. Continuous Flight Solid Stem Power Auger COMPILED BY BM/MAS
DATUM Geodetic DATE June 18, 2013 CHECKED BY MWK

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED 20 40 60 80 100	PLASTIC LIMIT w_P NATURAL MOISTURE CONTENT w LIQUID LIMIT w_L WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
131.0	GROUND SURFACE										
0.0 / 130.5	TOPSOIL Firm Dark brown Moist		1	SS	8				○		
0.5	Clayey silt with sand, trace organics, inferred cobbles and boulders at 2.1 m depth (FILL) Stiff to very stiff Brown to dark brown Moist		2	SS	10		130				
			3	SS	16		129		○		0 36 41 23
	- - - - - - - - - - - - - - - Auger grinding on inferred cobbles and boulders at 2.1 m depth		4	SS	22						
			5	SS	18		128		○		
126.6			6	SS	14		127				
4.4	SILT and SAND, some gravel, some clay, inferred cobbles throughout (TILL) Very dense Brown to brown-grey Dry to moist		7	SS	93				○		
			8	SS	100		125		○ H		18 43 27 12
123.2			9	SS	100/0.23	▽	124				
7.9	END OF BOREHOLE										

NOTE:

1. Water level at a depth of 7.7 m below ground surface (Elev. 123.3 m) during drilling.

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

GTA-MTO 001 09-1111-0019.GPJ GAL-GTA.GDT 01/21/14

Golder Associates

RECORD OF BOREHOLE No BH13-40

SHEET 1 OF 1

METRIC

PROJECT 09-1111-0019 | G.W.P. 2101-08-00 | DIST | HWY 401 | DATUM Geodetic

LOCATION N 4860481.2 ;E 367127.2 | BOREHOLE TYPE 120 mm O.D. Continuous Flight Solid Stem Power Auger | DATE June 11, 2013

ORIGINATED BY JLC | COMPILED BY BM | CHECKED BY MWK

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
131.0	GROUND SURFACE										
0.0 130.5	TOPSOIL Stiff Dark brown Moist		1	SS	9		130				
0.5	Clayey silt with sand, trace gravel, trace organics (FILL) Firm to very stiff Dark brown to brown Moist		2	SS	7						
			3	SS	13		129				
			4	SS	22						0 30 46 24
			5	SS	14		128				
126.6			6	SS	14		127				1 37 44 18
4.4	SILT and SAND, trace to some clay, trace to some gravel, inferred cobbles and boulders throughout (TILL) Dense to very dense Grey to brown Dry to moist		7	SS	48	▽	126				
			8	SS	93		125				6 31 50 13
122.5			9	SS	100/0.13		124				
8.5	Sandy SILT, trace clay, trace gravel, inferred cobbles and boulders throughout (TILL) Very dense Brown Dry to moist		10	SS	100/0.15		123				
			11	SS	100/0.15		122				1 23 71 5
118.7			12	SS	100/0.15		121				
12.3	END OF BOREHOLE						120				
	NOTES: 1. Water level at a depth of 5.5 m below ground surface (Elev. 125.5 m) during drilling. 2. Borehole caved at a depth of 6.1 m below ground surface (Elev. 124.9 m) upon completion of drilling.						119				

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

GTA-MTO 001 09-1111-0019.GPJ GAL-GTA.GDT 01/21/14

Golder Associates

RECORD OF BOREHOLE No BH13-41

SHEET 1 OF 1

METRIC

PROJECT 09-1111-0019
G.W.P. 2101-08-00
DIST HWY 401
DATUM Geodetic

LOCATION N 4860463.4 ;E 367175.4
BOREHOLE TYPE 120 mm O.D. Continuous Flight Solid Stem Power Auger
DATE June 11, 2013

ORIGINATED BY JLC
COMPILED BY BM
CHECKED BY MWK

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
126.4	GROUND SURFACE										
0.0 / 126.0	TOPSOIL Stiff Dark brown Moist		1	SS	13		126		w = 18		
0.4	Clayey silt with sand, trace gravel, trace organics (FILL) Very stiff to hard Dark brown Moist		2	SS	16						
			3	SS	32		125		w = 18		3 56 26 15
123.7			4A 4B	SS	23		124				
2.7	SILT to Sandy SILT, trace to some sand, trace to some clay, containing cobbles (TILL) Dense to very dense Grey Moist		5	SS	50		123		w = 12		
			6	SS	100/0.13						
			7	SS	45		122		w = 14	NP	0 22 72 6
			8	SS	100/0.15	▽	121				
							120				
118.4			9	SS	100		119		w = 8		0 8 75 17
8.0	END OF BOREHOLE										

NOTES:

1. Water level at a depth of 6.1 m below ground surface (Elev. 120.3 m) during drilling.

2. Borehole caved at a depth of 6.4 m below ground surface (Elev. 120.0 m) upon completion of drilling.

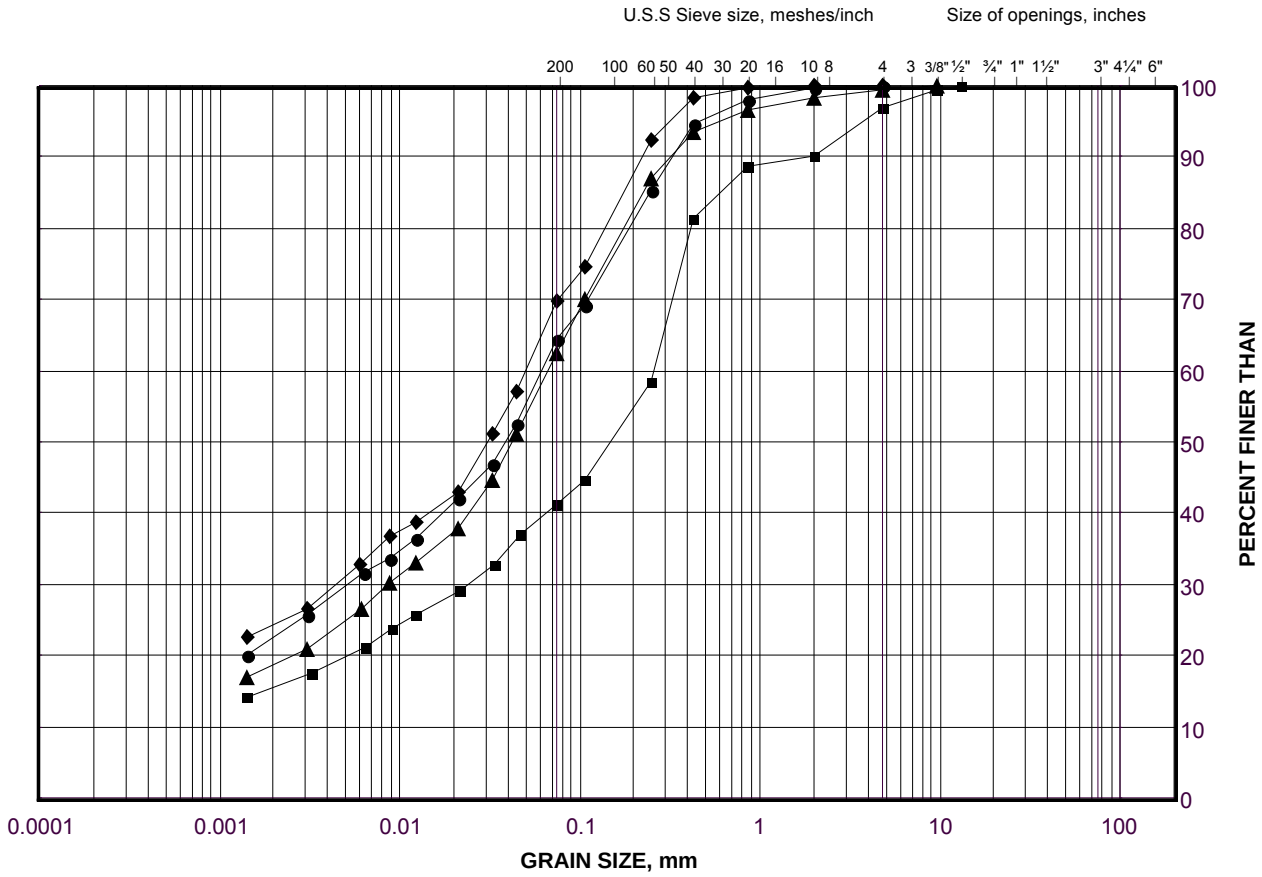
+ 3, × 3: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

GRAIN SIZE DISTRIBUTION TEST RESULTS

Clayey Silt (FILL)

FIGURE G1



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	13-39	3	129.3
■	13-41	3	124.7
◆	13-40	4	128.5
▲	13-40	6	126.9

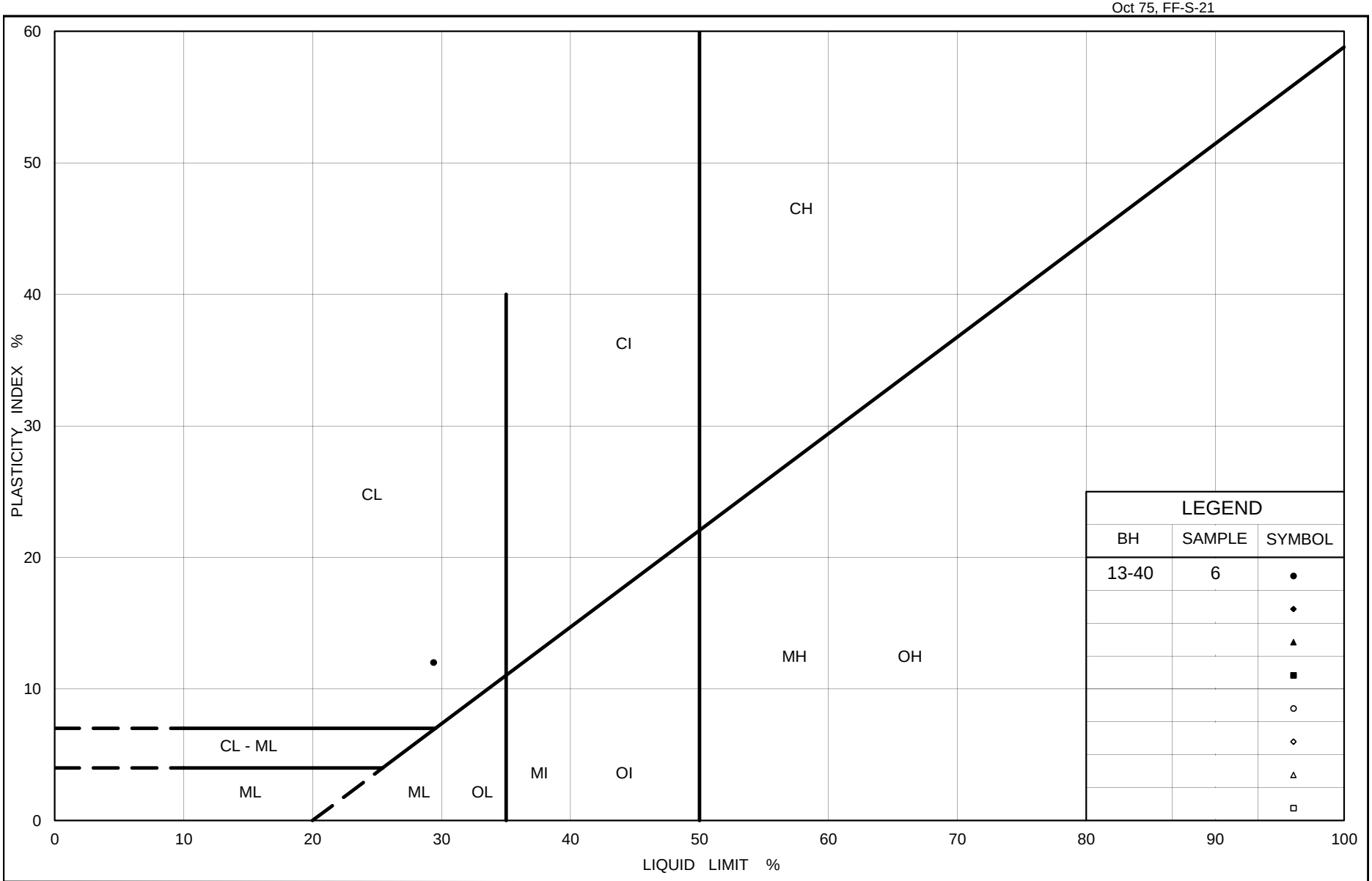
Project Number: 09-1111-0019

Checked By: _____

Golder Associates

Date: 06-Nov-13

Oct 75, FF-S-21



Ministry of Transportation

Ontario

PLASTICITY CHART
Clayey Silt (FILL)

Figure No. G2

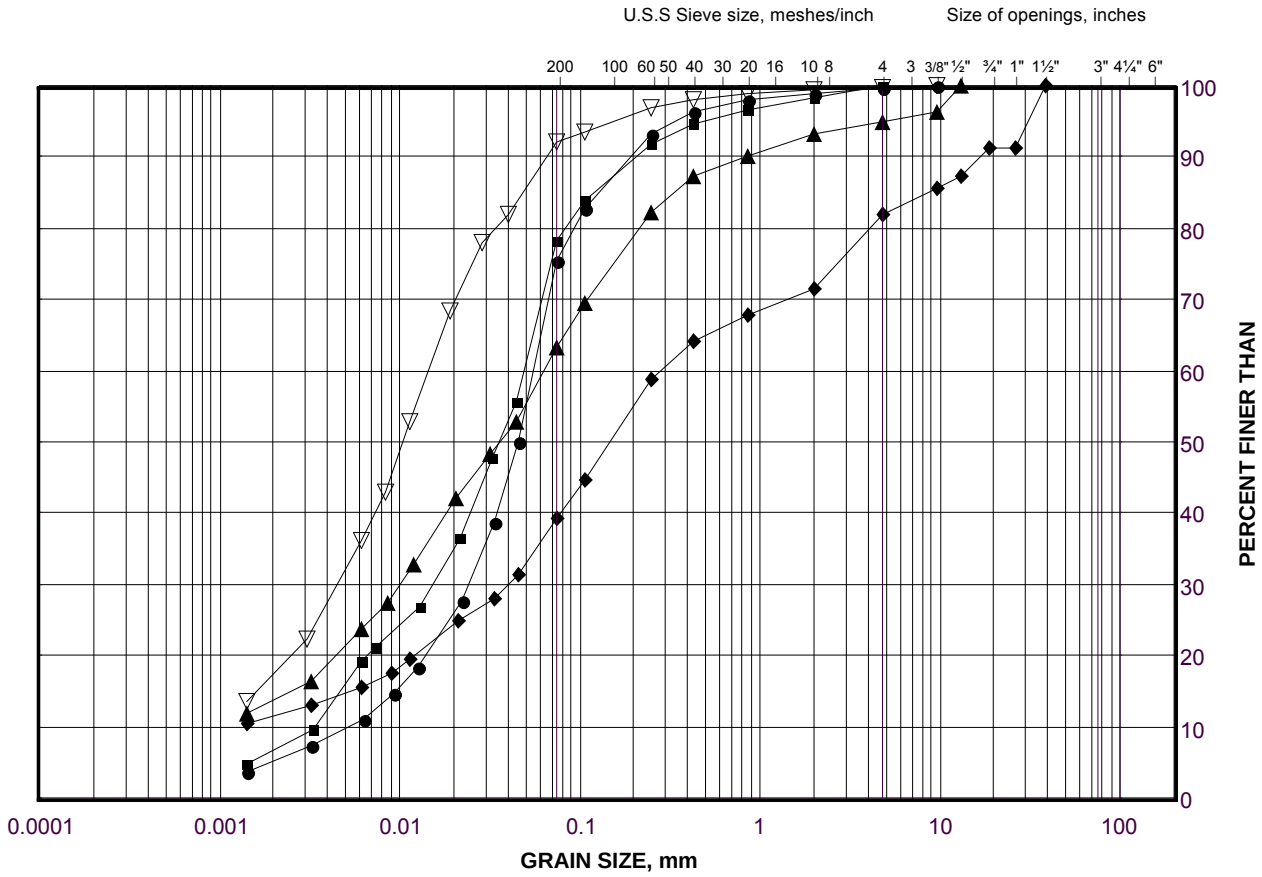
Project No. 09-1111-0019

Checked By:

GRAIN SIZE DISTRIBUTION TEST RESULTS

Silt to Silt and Sand (TILL)

FIGURE G3



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	13-40	11	120.3
■	13-41	7	121.6
◆	13-39	8	124.7
▲	13-40	8	124.7
▽	13-41	9	118.6

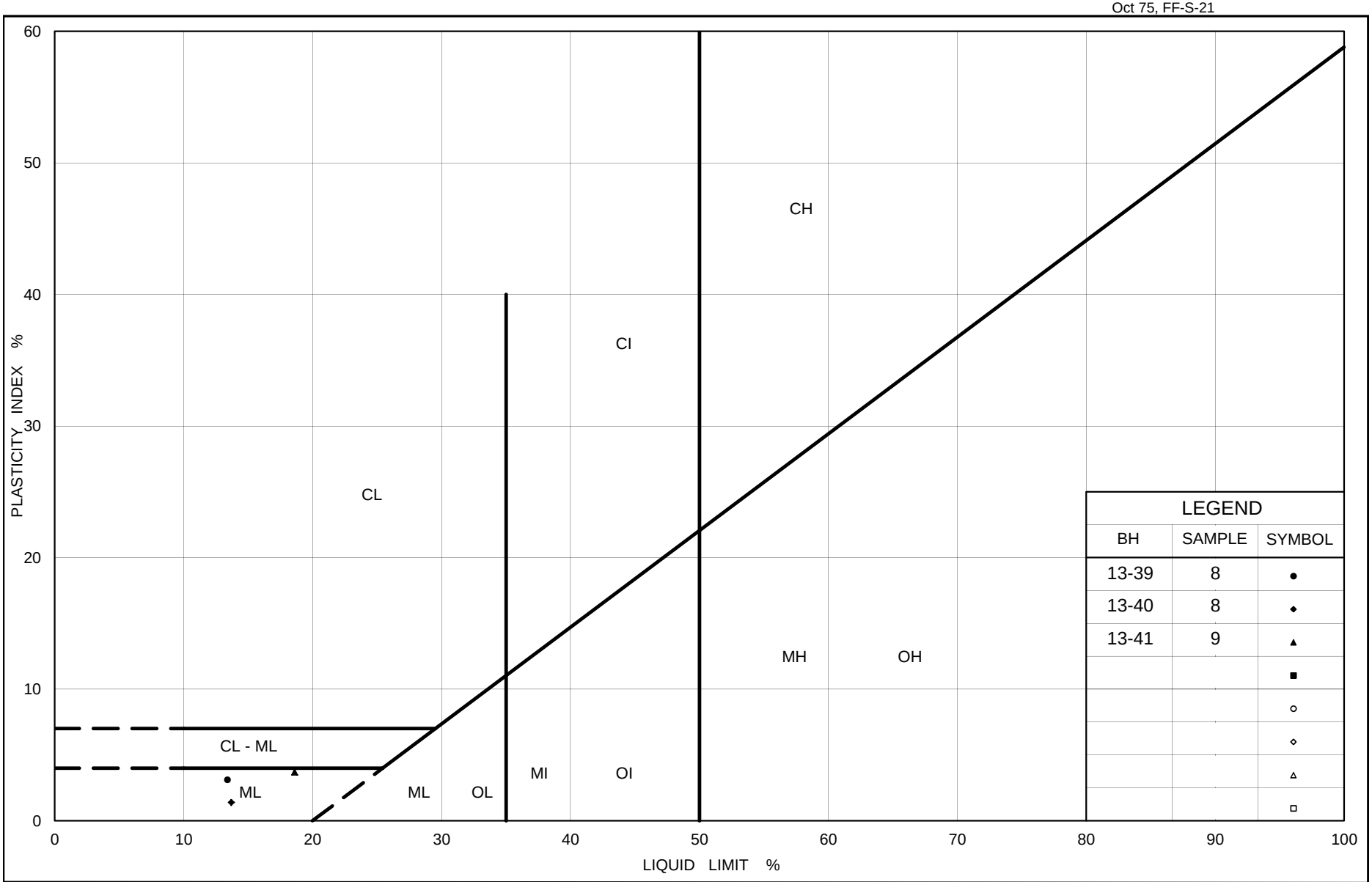
Project Number: 09-1111-0019

Checked By: _____

Golder Associates

Date: 01-Nov-13

Oct 75, FF-S-21



Ministry of Transportation

Ontario

PLASTICITY CHART
Silt to Silt and Sand (TILL)

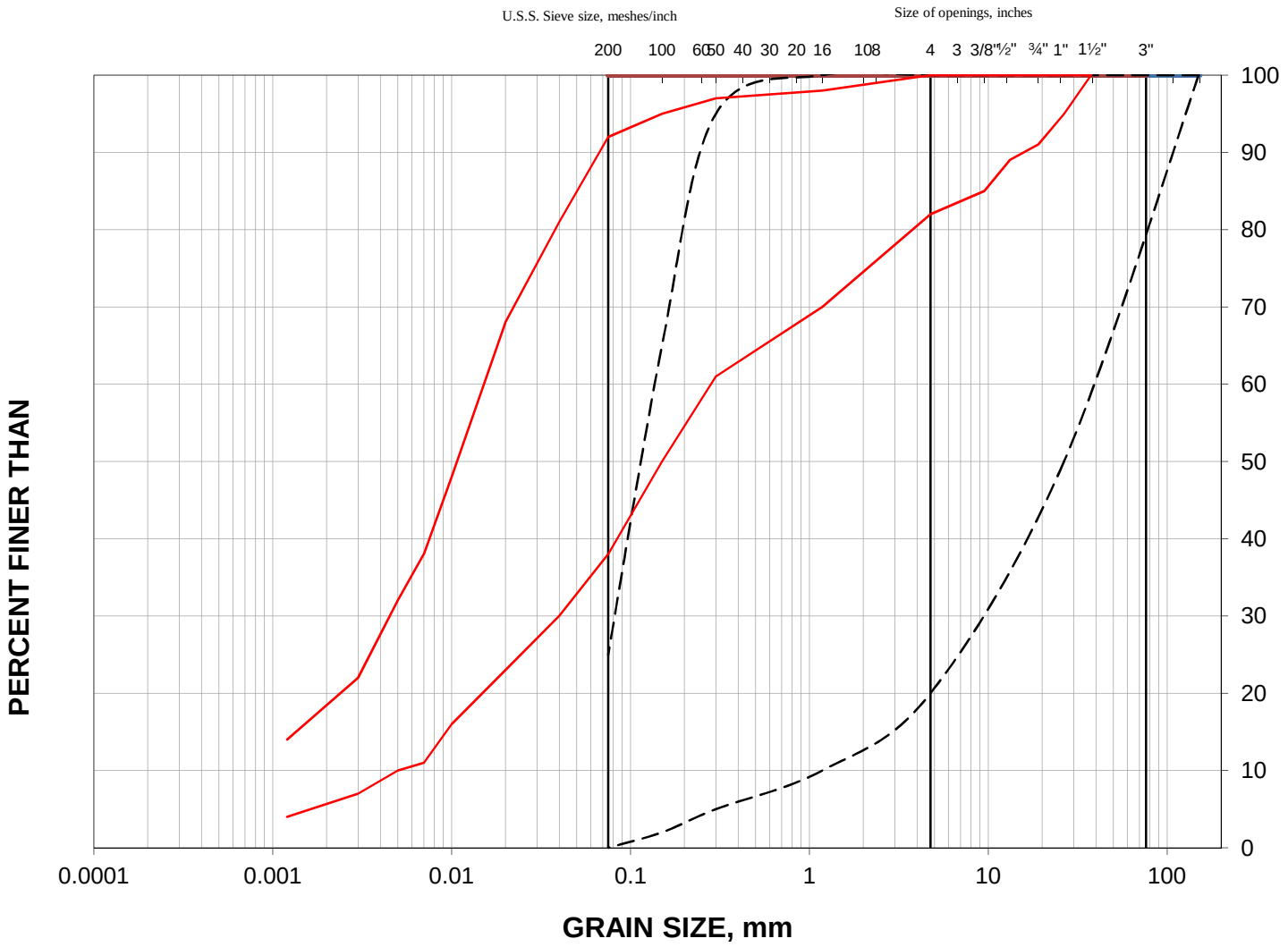
Figure No. G4

Project No. 09-1111-0019

Checked By:

COMPARISON OF GRAIN SIZE DISTRIBUTION ENVELOPE SILT TO SILT AND SAND (TILL) (AREA 7 DEEP CUT) TO SELECT SUBGRADE MATERIAL

FIGURE G5



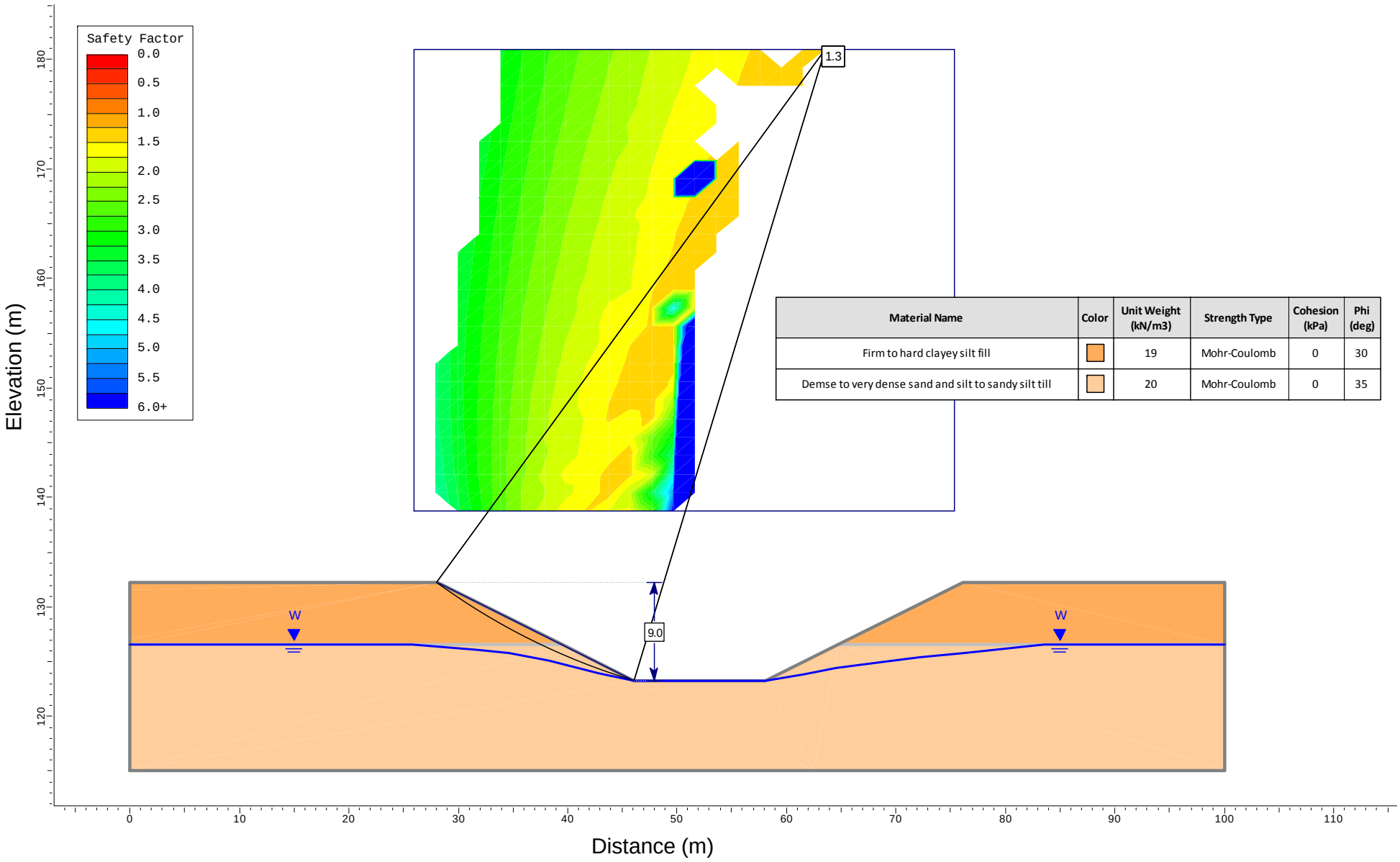
Date: Nov-13
Project: 09-1111-0019

Golder Associates

Drawn: MWK
Checked: JMAC

Area 7 – South Service Road West STA 13+160 to 13+265
Static Global Stability Analysis

Figure G6



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)
Firm to hard clayey silt fill		19	Mohr-Coulomb	0	30
Dense to very dense sand and silt to sandy silt till		20	Mohr-Coulomb	0	35

Date: November 2013

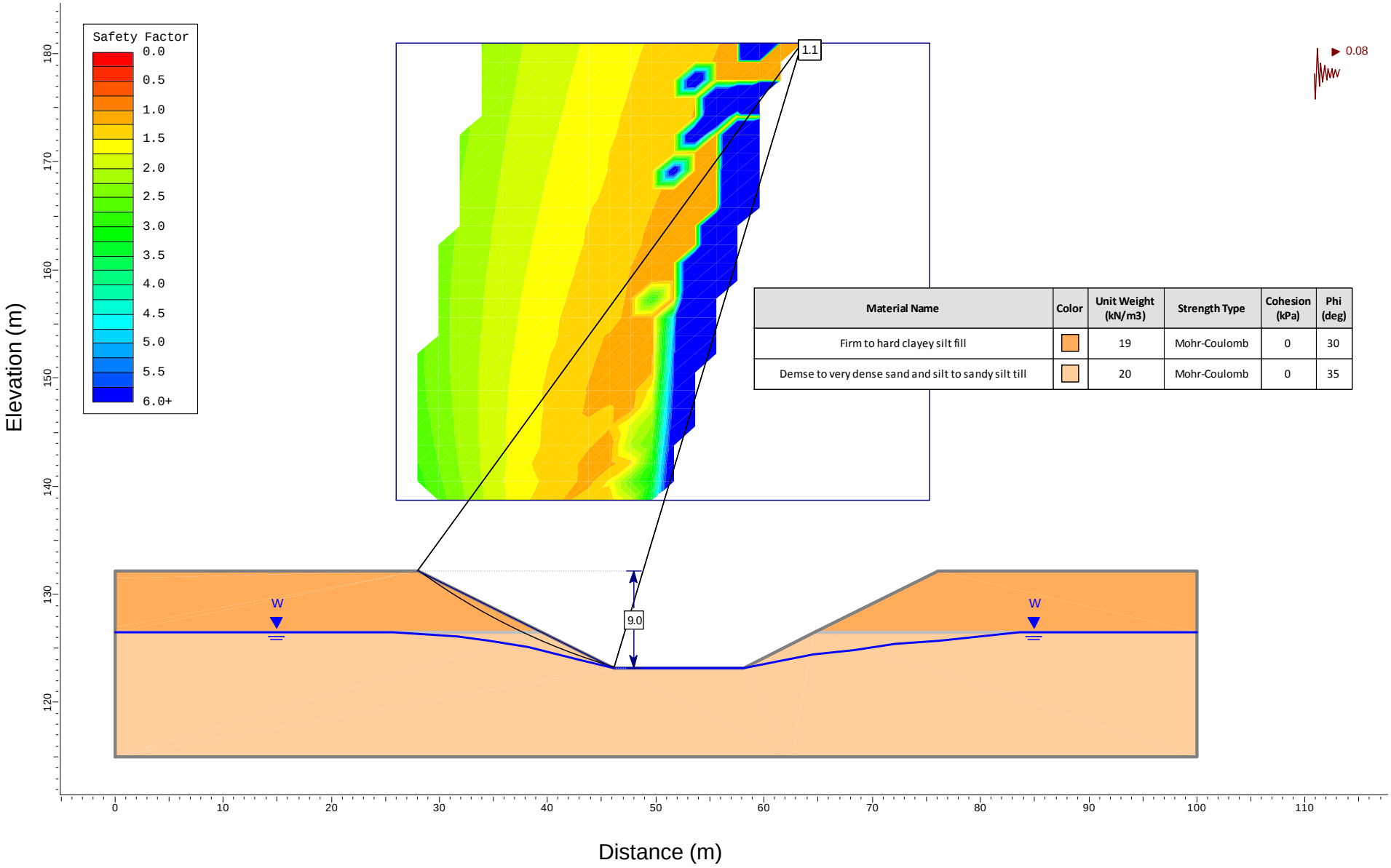
Project No: 09-1111-0019

Analysis By: MWK **Reviewed By:** KJB

Golder Associates

Area 7 – South Service Road West STA 13+160 to 13+265 Seismic Global Stability Analysis

Figure G7



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)
Firm to hard clayey silt fill		19	Mohr-Coulomb	0	30
Demse to very dense sand and silt to sandy silt till		20	Mohr-Coulomb	0	35

Date: November 2013

Project No: 09-1111-0019

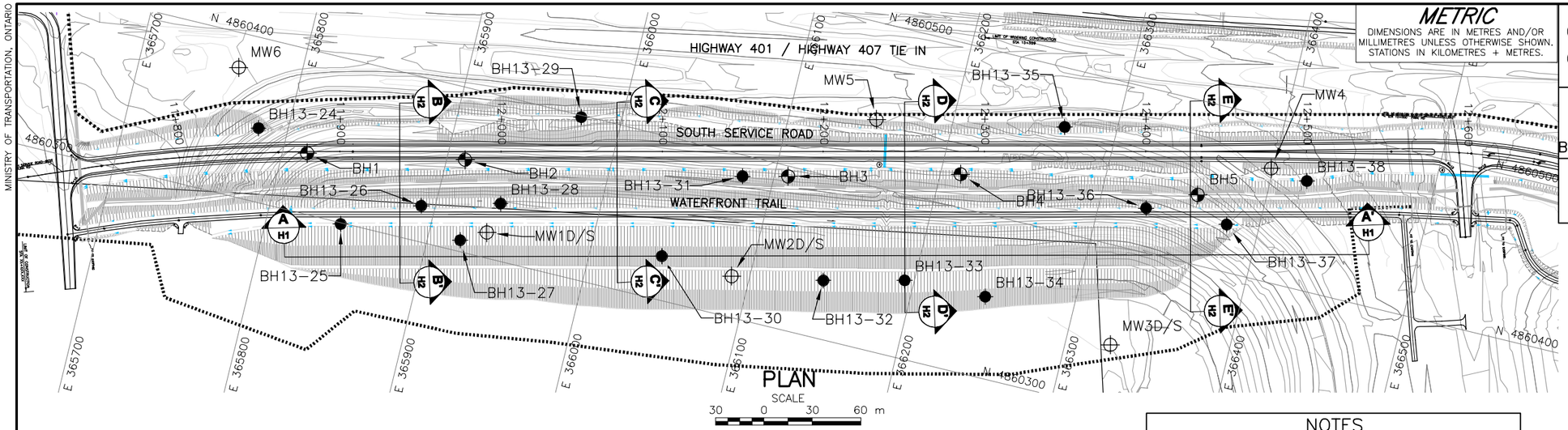
Analysis By: MWK **Reviewed By:** KJB

Golder Associates

APPENDIX H

Deep Cut Area 8 - South Service Road (Soil Disposal Mound), STA 11+850 to 12+500

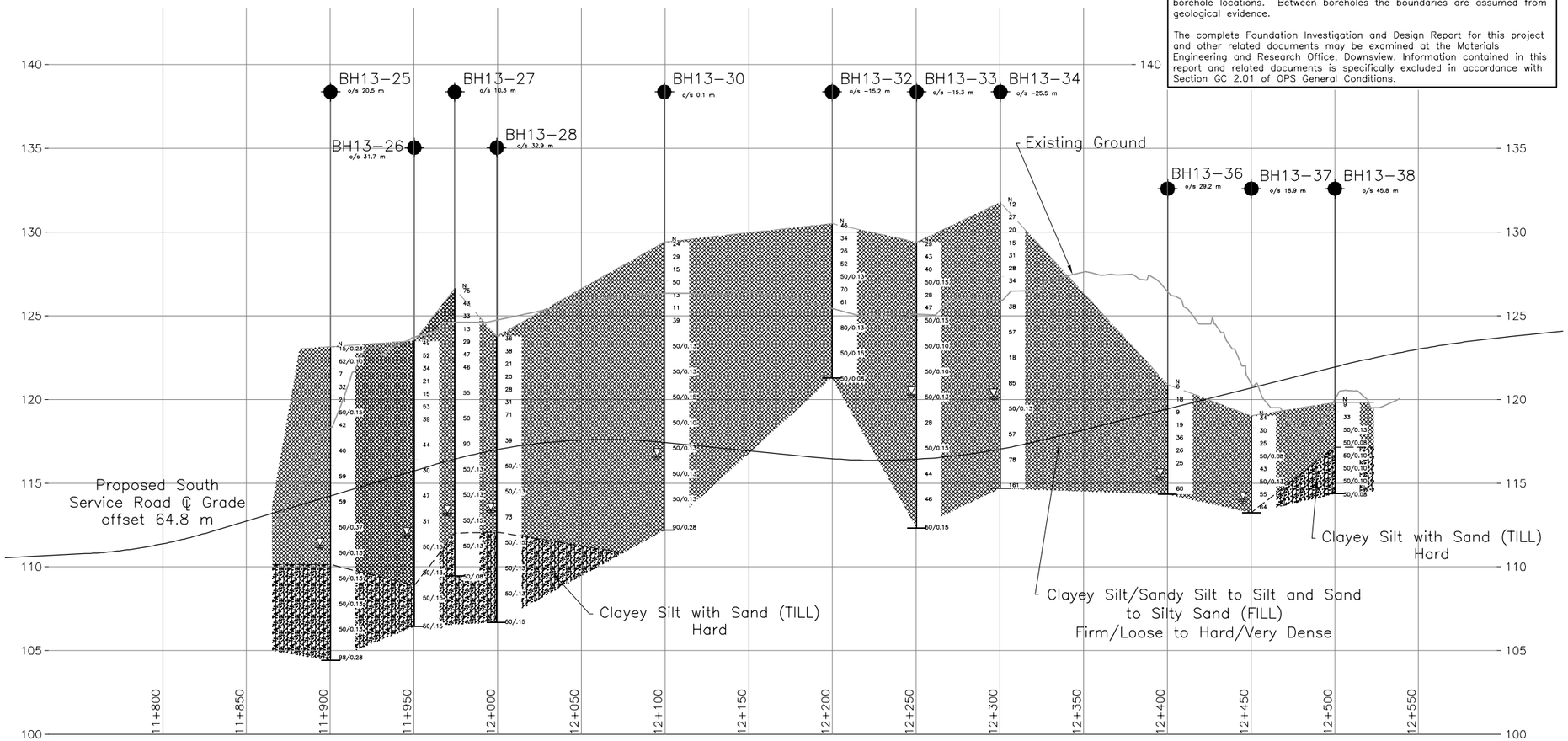
MINISTRY OF TRANSPORTATION, ONTARIO



PLAN

SCALE

30 0 30 60 m



SECTION

A-A' H1

HORIZONTAL SCALE

30 0 30 60 m

VERTICAL SCALE

6 0 6 12 m

METRIC

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

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.

CONT No.

GWP No. 2101-08-00

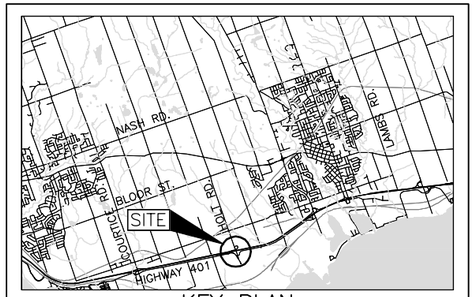
SHEET

HIGHWAY 401

DEEP CUT AREA 8-SOUTH SERVICE ROAD (STA 11+850 TO 12+500)

BOREHOLE LOCATIONS AND SOIL STRATA

Golder Associates Ltd.
MISSISSAUGA, ONTARIO, CANADA



KEY PLAN

SCALE

2 0 2 4 km

LEGEND

- Borehole – Current Investigation
- Existing Borehole (Ecoplans, 2010)
- Existing Monitoring Well (Ecoplans, 2010)
- N Standard Penetration Test Value
- 16 Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)
- WL during or upon completion of drilling

BOREHOLE CO-ORDINATES

No.	ELEVATION	NORTHING	EASTING
BH13-24	112.5	4860345.0	365782.0
BH13-25	123.2	4860299.2	365845.5
BH13-26	123.5	4860322.0	365891.5
BH13-27	126.6	4860307.0	365920.0
BH13-28	123.8	4860335.0	365939.0
BH13-29	113.1	4860399.0	365975.0
BH13-30	129.4	4860327.0	366044.0
BH13-31	118.9	4860387.0	366081.0
BH13-32	130.5	4860336.0	366145.0
BH13-33	129.4	4860348.0	366194.0
BH13-34	131.8	4860350.0	366245.0
BH13-35	117.9	4860464.0	366268.0
BH13-36	120.9	4860427.0	366329.0
BH13-37	119.0	4860429.0	366380.0
BH13-38	119.8	4860467.0	366422.0

REFERENCE

Base plan provided in digital format by URS, drawing file no. 2013-10-24-Hwy401-HoltRd_plan.dwg, 2013-10-24-Hwy401-HoltRd_profile.dwg, received October 23, 2013 and Existing Ground Surface cut from Topo drawing file no. ACAD-X-base.dwg, received September 9, 2013.

NO.	DATE	BY	REVISION

Geocres No. 30M15-158

HWY. 401		PROJECT NO. 09-1111-0019	DIST.
SUBM'D.	CHKD. MWK	DATE: 01/10/2013	SITE: 21-159
DRAWN: JFC/GY	CHKD. KJD	APPD. JMAC	DWG. H1

PLOT DATE: January 21, 2014
FILENAME: I:\Projects\2009\09-1111-0019 (URS\Orrington\-Ca- (Holt Road_South-Service-Road_Ramps)\09111001BASE1.dwg

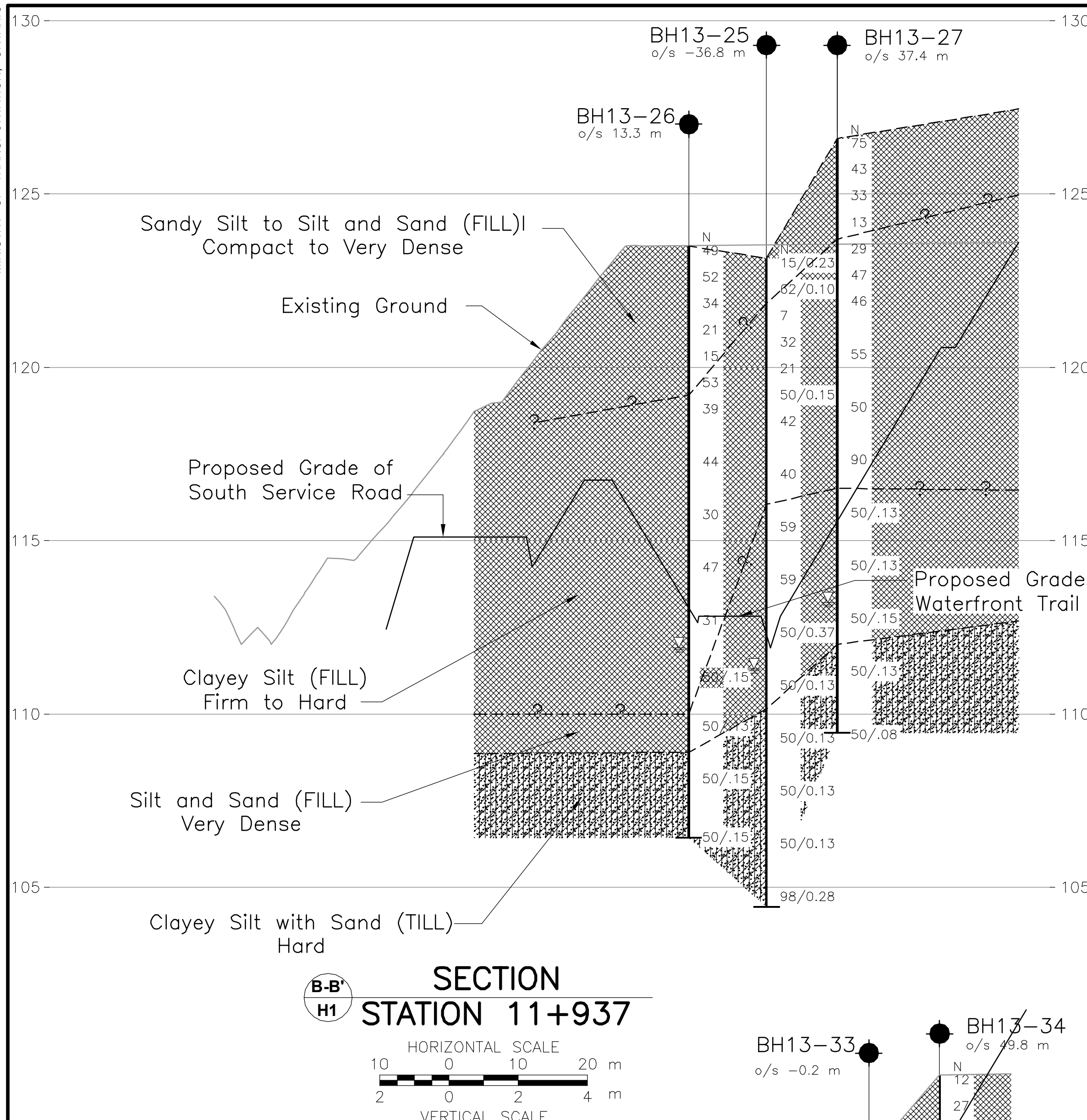
METRIC
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN. STATIONS IN KILOMETRES + METRES.

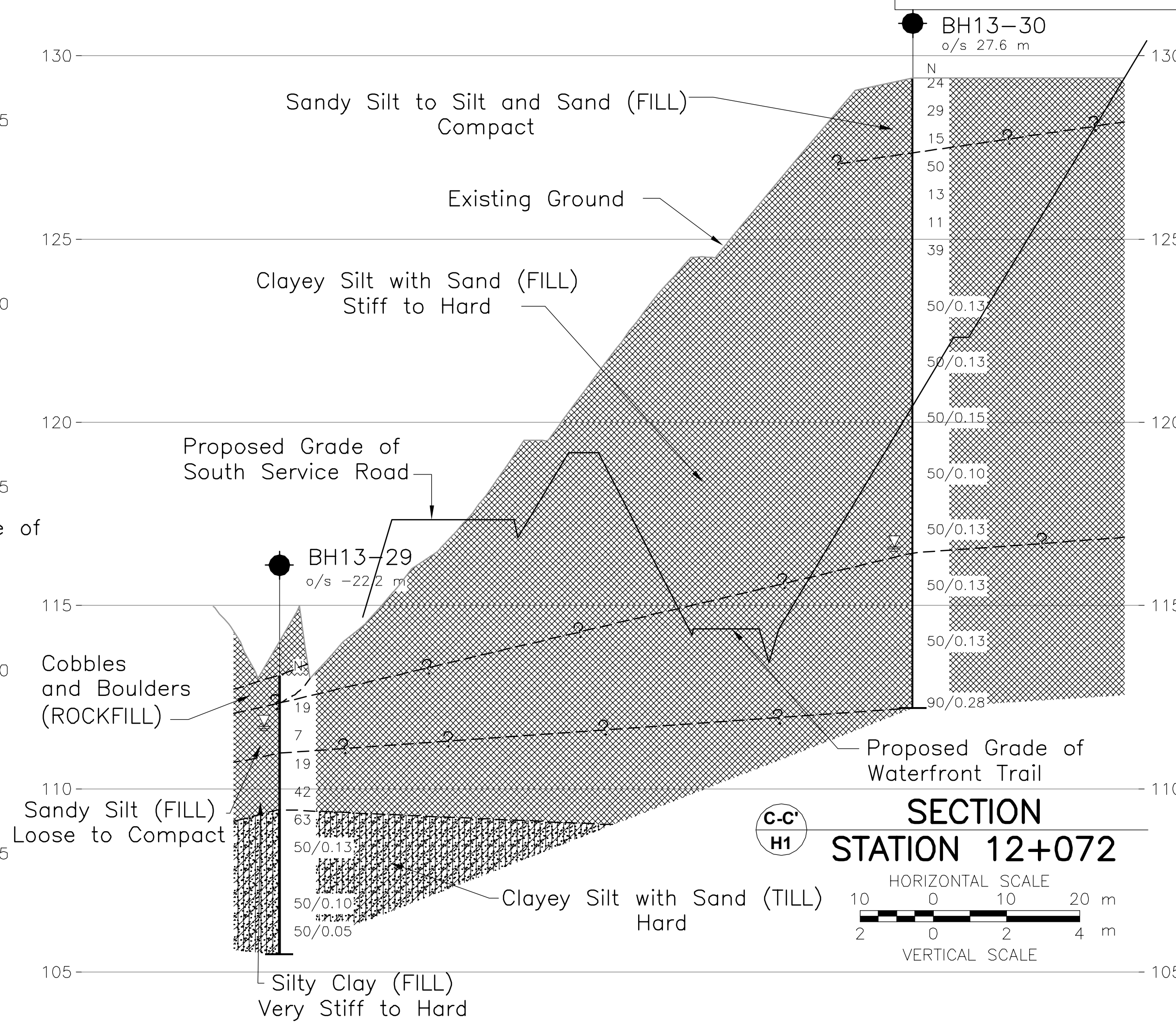
CONT No.
GWP No. 2101-08-00

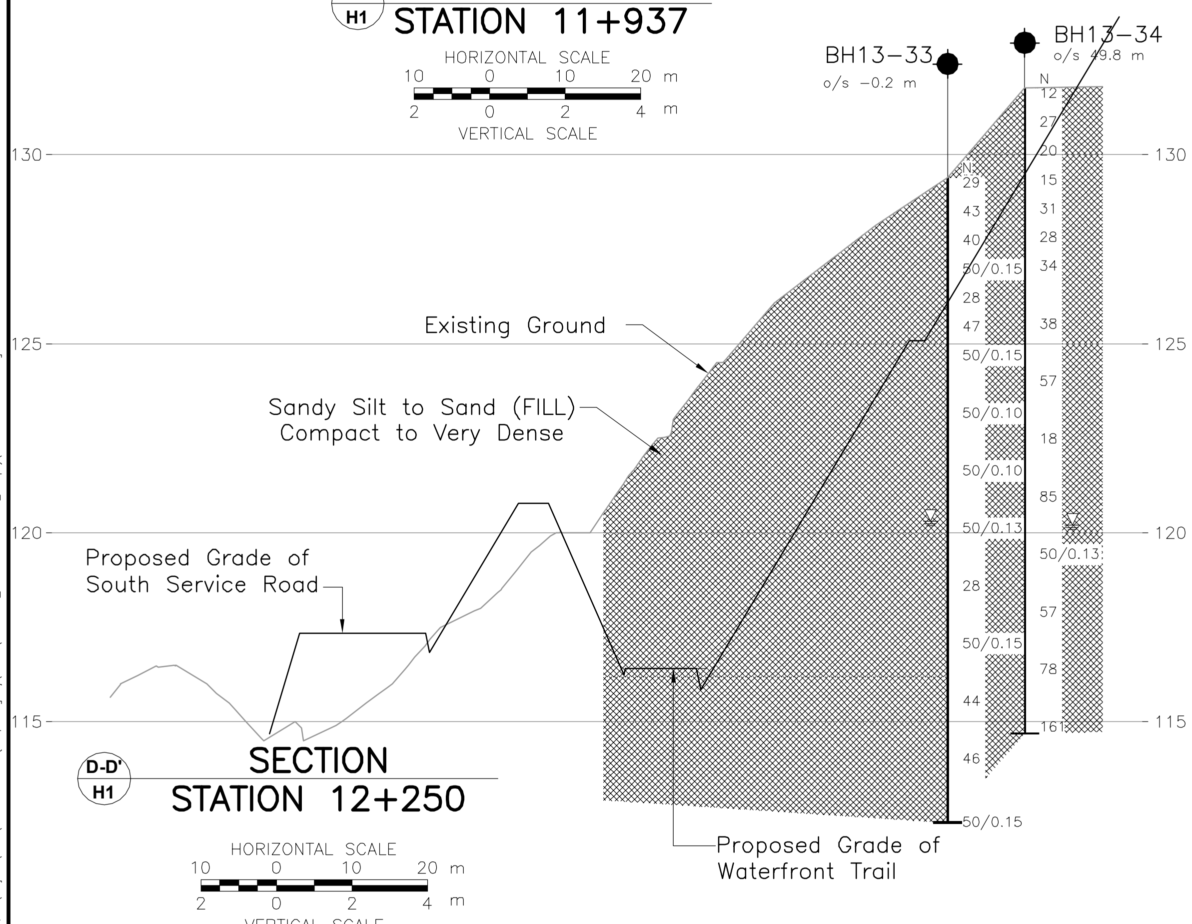
HIGHWAY 401
DEEP CUT AREA 8-SOUTH SERVICE ROAD
SOIL STRATA

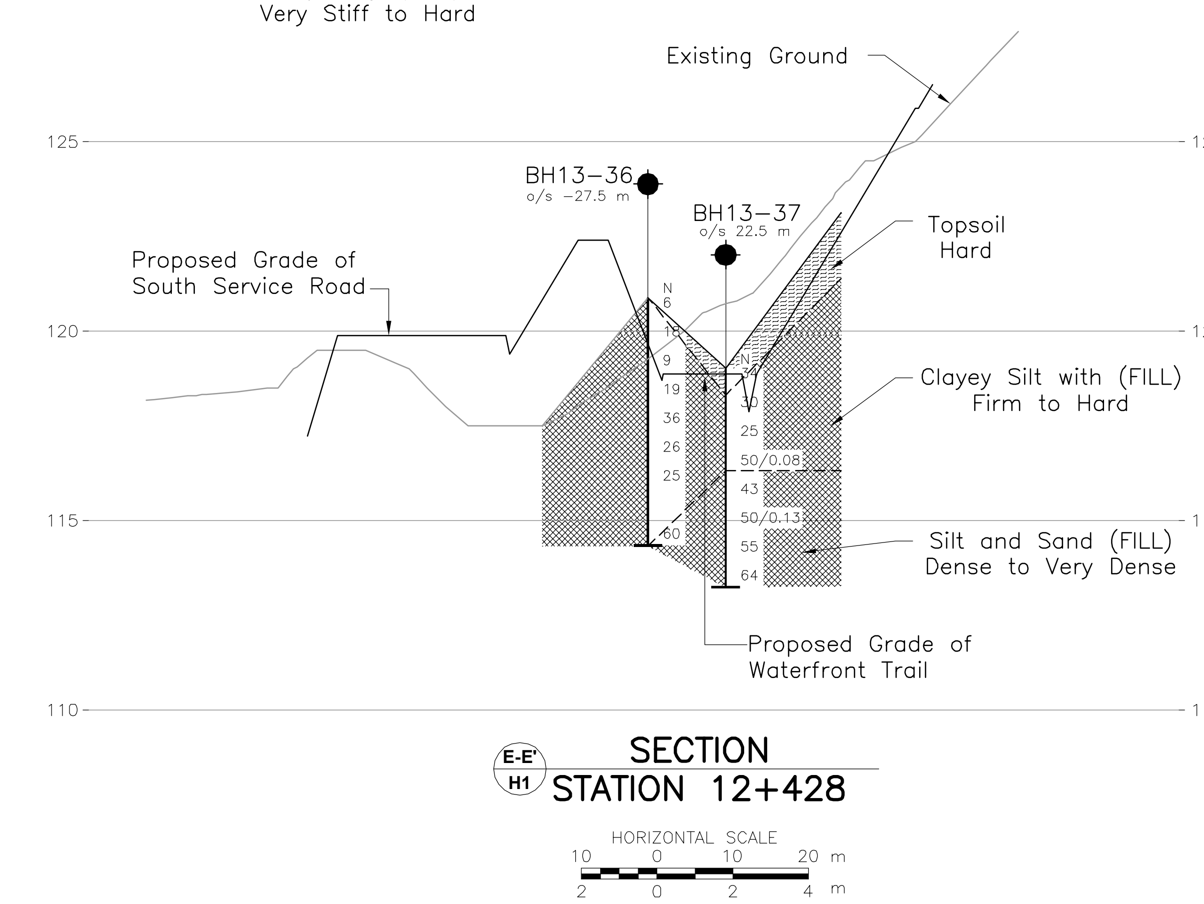
SHEET

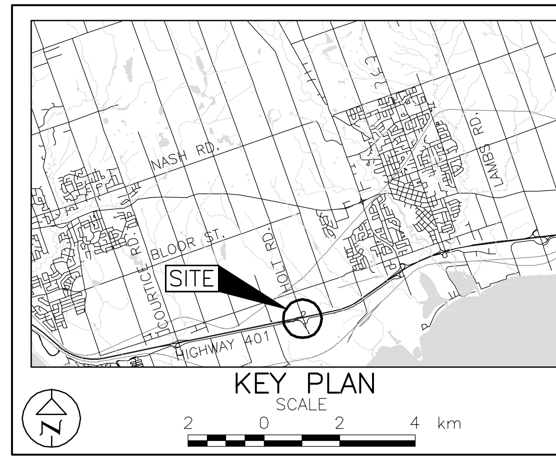
Golder Associates Ltd.
MISSISSAUGA, ONTARIO, CANADA











LEGEND

- Borehole – Current Investigation
- N — Standard Penetration Test Value
- 16 — Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)
- WL during or upon completion of drilling

BOREHOLE CO-ORDINATES

No.	ELEVATION	NORTHING	EASTING
BH13-25	123.2	4860299.2	365845.5
BH13-26	123.5	4860322.0	365891.5
BH13-27	126.6	4860307.0	365920.0
BH13-29	113.1	4860399.0	365975.0
BH13-30	129.4	4860327.0	366044.0
BH13-33	129.4	4860348.0	366194.0
BH13-34	131.8	4860350.0	366245.0
BH13-36	120.9	4860427.0	366329.0
BH13-37	119.0	4860429.0	366380.0

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

Orginal Ground Surface cut from digital file provided by URS ACAD-X-base.dwg, received September 9, 2013.

NO.	DATE	BY	REVISION

Geocres No. 30M15-158			
HWY. 401		PROJECT NO. 09-1111-0019	DIST.
SUBM'D.	CHKD. MWK	DATE: Oct. 2013	SITE: 21-159
DRAWN: JFC	CHKD. KJB	APPD. JMAC	DWG. H2

Golder Associates

RECORD OF BOREHOLE No BH13-24

SHEET 1 OF 1 **METRIC**

PROJECT 09-1111-0019
G.W.P. 2101-08-00
DIST HWY 401
DATUM Geodetic
LOCATION N 4860345.0 ;E 365782.0
BOREHOLE TYPE 150 mm O.D. Continuous Flight Solid Stem Power Auger
DATE August 15, 2013
ORIGINATED BY KT
COMPILED BY BM
CHECKED BY MWK

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (20 40 60 80 100): ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
112.5	GROUND SURFACE										
0.0	Silt and sand, some gravel, some clay, containing rootlets and trace organics (FILL) Compact to dense Greyish brown Moist		1	SS	20		112				
			2	SS	42				○		18 34 34 14
111.1											
1.4	CLAYEY SILT with sand, some gravel to gravelly (TILL) Hard Greyish brown Moist		3	SS	49		111		○		
			4	SS	82		110		○		
	Oxidation staining from 3.1 m to 8.1 m depths		5	SS	59						
			6	SS	50/0.05		109		○		
			7	SS	40		108		○		26 34 27 13
			8	SS	50/0.28		107		○		
			9	SS	50/0.28		106				
							105				
103.1			10	SS	50/0.13		104				
9.4	END OF BOREHOLE										

NOTE:

1. Open borehole dry upon completion of drilling.

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

Golder Associates

RECORD OF BOREHOLE No BH13-25 SHEET 1 OF 2 METRIC

PROJECT 09-1111-0019
G.W.P. 2101-08-00 LOCATION N 4860299.2 ;E 365845.5 ORIGINATED BY KT
DIST HWY 401 BOREHOLE TYPE 150 mm O.D. Continuous Flight Solid Stem Power Auger COMPILED BY BM
DATUM Geodetic DATE August 22, 2013 CHECKED BY MWK

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
123.2	GROUND SURFACE								
0.0	Sandy silt, trace gravel (FILL) Very dense Greyish brown Moist		1	SS	15/0.23		123		
			2	SS	62/0.10				
121.9							122		
1.3	Clayey silt, trace to some sand, trace to some gravel (FILL) Firm to hard Greyish brown to grey Moist		3	SS	7				
			4	SS	32		121		0 14 57 29
			5	SS	21		120		
			6	SS	50/0.15				13 9 53 25
			7	SS	42		119		
			8	SS	40		118		3 16 34 47
116.1							117		
7.1	Silt and sand, some clay, containing pockets of clayey silt (FILL) Very dense Grey Moist		9	SS	59		116		
			10	SS	59		115		
			11	SS	50/0.37	▽	114		
			12	SS	50/0.13		113	NP	0 39 45 16
110.2							112		
13.0	CLAYEY SILT with SAND some gravel (TILL) Hard Brownish grey Moist		13	SS	50/0.13		111		
							110		
							109		

DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100
SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED 20 40 60 80 100
PLASTIC LIMIT w_P NATURAL MOISTURE CONTENT w LIQUID LIMIT w_L
WATER CONTENT (%) 10 20 30

Continued Next Page

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

Golder Associates

PROJECT 09-1111-0019

RECORD OF BOREHOLE No BH13-25 SHEET 2 OF 2 METRIC

G.W.P. 2101-08-00 LOCATION N 4860299.2 ;E 365845.5 ORIGINATED BY KT

DIST HWY 401 BOREHOLE TYPE 150 mm O.D. Continuous Flight Solid Stem Power Auger COMPILED BY BM

DATUM Geodetic DATE August 22, 2013 CHECKED BY MWK

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (20 40 60 80 100): ○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × REMOULDED	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---										
	CLAYEY SILT with SAND some gravel (TILL) Hard Brownish grey Moist		14	SS	50/0.13		108		○		
							107				
			15	SS	50/0.13		106				
							105				
104.5			16	SS	98/0.28				○ ⊢		18 42 27 13
18.7	END OF BOREHOLE NOTE: 1. Water level in open borehole at a depth of 11.9 m below ground surface (Elev. 111.3 m) upon completion of drilling.										

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

Golder Associates

PROJECT 09-1111-0019

RECORD OF BOREHOLE No BH13-26 SHEET 1 OF 2 METRIC

G.W.P. 2101-08-00 LOCATION N 4860322.0 ;E 365891.5 ORIGINATED BY KT

DIST HWY 401 BOREHOLE TYPE 150 mm O.D. Continuous Flight Solid Stem Power Auger COMPILED BY BM

DATUM Geodetic DATE August 22, 2013 CHECKED BY MWK

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
123.5	GROUND SURFACE										
0.0	Silt and sand, trace clay to clayey, trace gravel, trace rootlets (FILL) Compact to very dense Greyish brown Moist		1	SS	49		123		○		
			2	SS	52						
			3	SS	34		122		○		
			4	SS	21		121				
			5	SS	15				○		2 31 45 22
119.2			6	SS	53		120				
4.3	Silty clay, some sand, trace gravel (FILL) Hard Grey Moist		7	SS	39		119		⊢○		0 18 34 48
			8	SS	44		118				
116.4							117				
7.1	Clayey silt, some sand (FILL) Hard Grey Moist to wet		9	SS	30		116		⊢○		0 20 57 23
			10	SS	47		115				
			11	SS	31		114		○		
			12	SS	50/.15	▽	113				
110.3							112				
13.2	Silt and sand, trace clay (FILL) Very dense Grey Moist to Wet		13	SS	50/.13		111		○		0 48 48 4
108.9							110				
14.6							109				

Continued Next Page

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

Golder Associates

PROJECT 09-1111-0019

RECORD OF BOREHOLE No BH13-26 SHEET 2 OF 2 METRIC

G.W.P. 2101-08-00 LOCATION N 4860322.0 ;E 365891.5 ORIGINATED BY KT

DIST HWY 401 BOREHOLE TYPE 150 mm O.D. Continuous Flight Solid Stem Power Auger COMPILED BY BM

DATUM Geodetic DATE August 22, 2013 CHECKED BY MWK

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED 20 40 60 80 100	PLASTIC LIMIT w_P NATURAL MOISTURE CONTENT w LIQUID LIMIT w_L WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
	--- CONTINUED FROM PREVIOUS PAGE ---										
	CLAYEY SILT with SAND trace gravel (TILL) Hard Brown to grey Moist		14	SS	50/.15		108 107				
106.4			15	SS	50/.15						
17.1	END OF BOREHOLE NOTE: 1. Water level encountered at a depth of 11.6 m below ground surface (Elev. 111.9 m) during drilling.										

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

Golder Associates

RECORD OF BOREHOLE No BH13-27 SHEET 1 OF 2 METRIC

PROJECT 09-1111-0019
G.W.P. 2101-08-00 LOCATION N 4860307.0 ;E 365920.0 ORIGINATED BY KT
DIST HWY 401 BOREHOLE TYPE 150 mm O.D. Continuous Flight Solid Stem Power Auger COMPILED BY BM
DATUM Geodetic DATE August 22, 2013 CHECKED BY MWK

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
126.6	GROUND SURFACE										
0.0	Clayey silt, trace to some sand, trace organics (rootlets) in upper 1.5 m, containing pockets of silty clay (FILL) Stiff to hard Brown to grey Moist to wet		1	SS	75		126				
			2	SS	43						
			3	SS	33		125				
			4	SS	13		124				0 5 58 37
			5	SS	29		123				
			6	SS	47						
			7	SS	46		122				
			8	SS	55		121				0 11 66 23
			9	SS	50		120				
			10	SS	90		119				
116.5							118				
10.1	Sandy silt, some clay (FILL) Very dense Brown to grey Moist to wet		11	SS	50/.13		117				
			12	SS	50/.13	▽	116				0 24 63 13
			13	SS	50/.15		115				
112.0							114				
14.6							113				
							112				

Continued Next Page

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

Golder Associates

RECORD OF BOREHOLE No BH13-27 SHEET 2 OF 2 METRIC

PROJECT 09-1111-0019
G.W.P. 2101-08-00
DIST HWY 401
DATUM Geodetic
LOCATION N 4860307.0 ;E 365920.0
BOREHOLE TYPE 150 mm O.D. Continuous Flight Solid Stem Power Auger
DATE August 22, 2013
ORIGINATED BY KT
COMPILED BY BM
CHECKED BY MWK

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa: ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---										
	CLAYEY SILT with SAND, trace to some gravel (TILL) Hard Brown to grey Moist to wet		14	SS	50/.13		111 110				12 43 31 14
109.5			15	SS	50/.08						
17.2	END OF BOREHOLE NOTE: 1. Water level encountered at a depth of 13.4 m (Elev. 113.2 m) below ground surface during drilling.										

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

Golder Associates

RECORD OF BOREHOLE No BH13-28

SHEET 1 OF 2

METRIC

PROJECT 09-1111-0019
G.W.P. 2101-08-00
LOCATION N 4860335.0 ;E 365939.0
ORIGINATED BY KT
DIST HWY 401
BOREHOLE TYPE 150 mm O.D. Continuous Flight Solid Stem Power Auger
COMPILED BY BM
DATUM Geodetic
DATE August 22, 2013
CHECKED BY MWK

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
123.8	GROUND SURFACE										
0.0	Clayey silt, some sand to sandy, trace gravel, trace organics to 1 m depth (FILL) Very stiff to hard Greyish brown Moist		1	SS	36		123	○	○		
			2	SS	38						
			3	SS	21		122		○		
			4	SS	20				○——		5 20 47 28
			5	SS	28		121		○		0 22 67 11
			6	SS	31						
			7	SS	71		120				
118.2							119		○		0 18 58 24
5.6	Sandy silt, some clay (FILL) Dense to very dense Brownish grey Moist to wet		8	SS	39		118				
			9	SS	50/.1		117				
			10	SS	50/.13		116		○		
			11	SS	73	▽	115				
112.1							114				
11.7	CLAYEY SILT with SAND trace gravel (TILL) Hard Brown to grey Moist		12	SS	50/.15		113				
			13	SS	50/.13		112		○——		4 44 36 16
							111				
							110				
							109				

Continued Next Page

+ 3, × 3: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

Golder Associates

RECORD OF BOREHOLE No BH13-28 SHEET 2 OF 2 METRIC

PROJECT 09-1111-0019 | G.W.P. 2101-08-00 | DIST | HWY 401 | DATUM Geodetic

LOCATION N 4860335.0 ;E 365939.0 | BOREHOLE TYPE 150 mm O.D. Continuous Flight Solid Stem Power Auger | DATE August 22, 2013

ORIGINATED BY KT | COMPILED BY BM | CHECKED BY MWK

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × REMOULDED)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---							20 40 60 80 100	10 20 30		
	CLAYEY SILT with SAND trace gravel (TILL) Hard Brown to grey Moist		14	SS	50/.13		108		○		
106.7			15	SS	50/.15		107				
17.1	END OF BOREHOLE NOTE: 1. Water level encountered at a depth of 10.4 m below ground surface (Elev. 113.4 m) during drilling.										

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

Golder Associates

RECORD OF BOREHOLE No BH13-29 SHEET 1 OF 1 METRIC

PROJECT 09-1111-0019
G.W.P. 2101-08-00
DIST HWY 401
DATUM Geodetic
LOCATION N 4860399.0 ;E 365975.0
BOREHOLE TYPE 150 mm O.D. Continuous Flight Solid Stem Power Auger
DATE August 22, 2013
ORIGINATED BY KT
COMPILED BY BM
CHECKED BY MWK

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
113.1	GROUND SURFACE						113				
0.0 / 112.3	Cobbles and boulders (ROCK FILL)										
0.8 / 111.0	Sandy silt, trace gravel, trace organics (FILL) Loose to compact Grey Wet		1	SS	19	▽	112				
			2	SS	7		111				
2.1 / 109.4	Silty clay, some sand (FILL) Very stiff to hard Brownish grey Moist		3	SS	19						0 12 40 48
			4	SS	42		110				
3.7 / 105.5	CLAYEY SILT with SAND some gravel to gravelly (TILL) Hard Brownish grey Moist		5	SS	63		109				
			6	SS	50/0.13						18 38 29 15
			7	SS	50/0.10		108				
			8	SS	50/0.05		107				22 42 24 12
7.6	END OF BOREHOLE						106				

NOTE:

1. Water level in open borehole at a depth of 1.4 m below ground surface (Elev. 111.7 m) during drilling.

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

Golder Associates

PROJECT 09-1111-0019

RECORD OF BOREHOLE No BH13-30 SHEET 1 OF 2 METRIC

G.W.P. 2101-08-00 LOCATION N 4860327.0 ;E 366044.0 ORIGINATED BY KT

DIST HWY 401 BOREHOLE TYPE 150 mm O.D. Continuous Flight Solid Stem Auger COMPILED BY MAS

DATUM Geodetic DATE August 19, 2013 CHECKED BY MWK

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
129.4	GROUND SURFACE										
0.0	Sandy Silt to silt and sand, some clay (FILL) Compact Brownish grey Moist		1	SS	24		129				
			2	SS	29						
			3	SS	15		128				0 33 60 7
127.1											
2.3	Clayey silt with sand to some sand, trace gravel (FILL) Stiff to hard Brownish grey Moist		4A 4B	SS	50		127				
			5	SS	13		126				3 45 34 18
			6	SS	11						
			7	SS	39		125				
			8	SS	50/0.13		124				0 17 75 8
			9	SS	50/0.13		123				
			10	SS	50/0.15		122				0 18 71 11
			11	SS	50/0.10		121				
			12	SS	50/0.13	▽	120				0 12 65 23
115.7	Becoming wet at 13.5m						119				
13.7	Silt and sand, trace to some clay (FILL) Very dense Brownish grey Moist to wet		13	SS	50/0.13		118				
							117				
							116				
							115				

Continued Next Page

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

Golder Associates

RECORD OF BOREHOLE No BH13-30 SHEET 2 OF 2 METRIC

PROJECT 09-1111-0019
G.W.P. 2101-08-00 LOCATION N 4860327.0 ;E 366044.0 ORIGINATED BY KT
DIST HWY 401 BOREHOLE TYPE 150 mm O.D. Continuous Flight Solid Stem Auger COMPILED BY MAS
DATUM Geodetic DATE August 19, 2013 CHECKED BY MWK

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---							20 40 60 80 100	10 20 30		
	Silt and sand, trace to some clay (FILL) Very dense Brownish grey Moist to wet		14	SS	50/0.13		114		○		0 32 64 4
							113				
112.2			15	SS	90/0.28						
17.2	END OF BOREHOLE NOTE: 1. Water level in open borehole at a depth of 12.8 m below ground surface (Elev. 116.6 m) upon completion of drilling.										

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

Golder Associates

RECORD OF BOREHOLE No BH13-31

SHEET 1 OF 1

METRIC

PROJECT 09-1111-0019
G.W.P. 2101-08-00
DIST HWY 401
DATUM Geodetic

LOCATION N 4860387.0 ;E 366081.0
BOREHOLE TYPE 150 mm O.D. Continuous Flight Solid Stem Auger
DATE August 23, 2013

ORIGINATED BY KT
COMPILED BY BM/MAS
CHECKED BY MWK

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
118.9	GROUND SURFACE										
0.0	Sandy silt, trace gravel (FILL) Compact to dense Greyish brown Moist		1	SS	22						
			2	SS	39		118	○	○		
117.5											
1.4	Clayey silt with to some sand, trace gravel (FILL) Very stiff to hard Brownish grey to grey Moist		3	SS	50		117				
			4	SS	35				○		0 23 64 13
			5	SS	17		116				
			6	SS	61	▽	115		○		
			7	SS	34						
							114				
			8	SS	33		113		○		0 18 71 11
							112				
			9	SS	29						
110.4							111				
8.5	CLAYEY SILT with SAND trace to some gravel (TILL) Hard Grey Moist						110				
109.3			10	SS	45				○		11 38 32 19
9.6	END OF BOREHOLE NOTE: 1. Water level in open borehole at a depth of 4.3 m below ground surface (Elev. 114.6 m) upon completion of drilling.										

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

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

Golder Associates

RECORD OF BOREHOLE No BH13-32 SHEET 1 OF 1 METRIC

PROJECT 09-1111-0019 | G.W.P. 2101-08-00 | LOCATION N 4860336.0 ;E 366145.0 | ORIGINATED BY KT

DIST | HWY 401 | BOREHOLE TYPE 150 mm O.D. Continuous Flight Solid Stem Auger | COMPILED BY BM/MAS

DATUM Geodetic | DATE August 19, 2013 | CHECKED BY MWK

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
130.5	GROUND SURFACE										
0.0	Sandy clayey silt, trace gravel (FILL) Stiff Brownish grey Moist		1	SS	46		130				
			2	SS	34						1 21 45 33
			3	SS	26		129				
			4	SS	52		128				
127.0			5	SS	50/0.13						
3.5	Silt and sand, trace clay (FILL) Very dense brownish grey Moist		6	SS	70		127				0 32 57 11
			7	SS	61		126				
			8	SS	80/0.13		125				
			9	SS	50/0.15		124				0 50 43 7
121.3			10	SS	50/0.08		123				
9.2	END OF BOREHOLE						122				

NOTE:

1. Open borehole dry upon completion of drilling.

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

Golder Associates

RECORD OF BOREHOLE No BH13-33 SHEET 1 OF 2 METRIC

PROJECT 09-1111-0019
G.W.P. 2101-08-00 LOCATION N 4860348.0 ;E 366194.0 ORIGINATED BY KT
DIST HWY 401 BOREHOLE TYPE 150 mm O.D. Continuous Flight Solid Stem Auger COMPILED BY MAS
DATUM Geodetic DATE August 16, 2013 CHECKED BY MWK

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
129.4	GROUND SURFACE										
0.0	Sandy silt, trace to some clay, trace to some gravel, containing pockets of clayey silt (FILL) Compact to very dense Grey to brownish grey Moist		1	SS	29		129				
			2	SS	43				○		19 21 42 18
			3	SS	40		128				
			4	SS	50/0.15		127				
			5	SS	28				○		
			6	SS	47		126				
			7	SS	50/0.15		125		○		0 28 65 7
			8	SS	50/0.10		124				
			9	SS	50/0.10		123				
			10	SS	50/0.13	▽	122		○		
			11	SS	28		121				
			12	SS	50/0.15		120		○		
			13	SS	44		119				
							118				
							117				
							116		○		0 20 70 10
							115				

Continued Next Page

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

Golder Associates

RECORD OF BOREHOLE No BH13-33 SHEET 2 OF 2 METRIC

PROJECT 09-1111-0019 | G.W.P. 2101-08-00 | LOCATION N 4860348.0 ;E 366194.0 | ORIGINATED BY KT

DIST | HWY 401 | BOREHOLE TYPE 150 mm O.D. Continuous Flight Solid Stem Auger | COMPILED BY MAS

DATUM Geodetic | DATE August 16, 2013 | CHECKED BY MWK

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---										
	Sandy silt, trace to some clay, trace to some gravel, containing pockets of clayey silt (FILL) Compact to very dense Grey to brownish grey Moist		14	SS	46		114				
							113				
112.3			15	SS	50/0.15						0 22 59 19
17.1	END OF BOREHOLE NOTE: 1. Water level in open borehole at a depth of 9.1 m below ground surface (Elev. 120.3 m) upon completion of drilling.										

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

Golder Associates

RECORD OF BOREHOLE No BH13-34 SHEET 1 OF 2 METRIC

PROJECT 09-1111-0019
G.W.P. 2101-08-00 LOCATION N 4860350.0 ;E 366245.0 ORIGINATED BY KT
DIST HWY 401 BOREHOLE TYPE 150 mm O.D. Continuous Flight Solid Stem Auger COMPILED BY BM/MAS
DATUM Geodetic DATE August 15, 2013 CHECKED BY MWK

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED 20 40 60 80 100	PLASTIC LIMIT w_P NATURAL MOISTURE CONTENT w LIQUID LIMIT w_L WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
131.8	GROUND SURFACE										
0.0	Sandy silt to silty sand, trace gravel, some clay (FILL) Compact to dense Brownish grey Moist		1	SS	12		131				
			2	SS	27						
			3	SS	20		130				
			4	SS	15		129				
			5	SS	31						
			6	SS	28		128				
127.4											
4.4	Sand, trace to some silt, trace clay (FILL) Compact to very dense Brownish grey Moist		7	SS	34		127				
			8	SS	38		126				
			9	SS	57		125				
			10	SS	18		124				
			11	SS	85		123				
120.2						▽	122				
11.6	Sandy silt, trace clay, contains pockets of clayey silt (FILL) Very dense Grey Moist		12	SS	50/0.13		121				
			13	SS	57		120				
117.0							119				
14.8							118				
							117				

Continued Next Page

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

Golder Associates

RECORD OF BOREHOLE No BH13-34 SHEET 2 OF 2 METRIC

PROJECT 09-1111-0019
G.W.P. 2101-08-00
DIST HWY 401
DATUM Geodetic
LOCATION N 4860350.0 ;E 366245.0
BOREHOLE TYPE 150 mm O.D. Continuous Flight Solid Stem Auger
DATE August 15, 2013
ORIGINATED BY KT
COMPILED BY BM/MAS
CHECKED BY MWK

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---										
	Silty sand (FILL) Very dense Grey Moist to wet		14	SS	78		116				
114.7			15	SS	161		115				
17.1	END OF BOREHOLE NOTE: 1. Water level in open borehole at a depth of 11.6 m below ground surface (Elev. 120.2 m) upon completion of drilling.										

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

Golder Associates

RECORD OF BOREHOLE No BH13-35

SHEET 1 OF 1

METRIC

PROJECT 09-1111-0019
G.W.P. 2101-08-00
DIST HWY 401
DATUM Geodetic

LOCATION N 4860464.0 ;E 366268.0
BOREHOLE TYPE 150 mm O.D. Continuous Flight Solid Stem Auger
DATE August 15, 2013

ORIGINATED BY KT
COMPILED BY MAS
CHECKED BY MWK

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
117.9	GROUND SURFACE										
0.0	Silt and sand, some clay, trace gravel, trace and containing rootlets (FILL) Compact Brown to dark brown Moist		1	SS	15						
			2	SS	22		117				
	Trace wood fragments from 1.5 m to 2.0 m depth		3	SS	15		116		49.5		1 43 41 15
			4	SS	25						
115.0							115				
2.9	CLAYEY SILT with SAND some gravel (TILL) Hard Brownish grey Moist		5	SS	30						
			6	SS	50/0.13		114				18 44 25 13
			7	SS	50/0.13	▽	113				
							112				
111.5			8	SS	50/0.13						
6.4	END OF BOREHOLE NOTE: 1. Water level in open borehole at a depth of 4.6 m below ground surface (Elev. 113.3 m) upon completion of drilling.										

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

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

Golder Associates

RECORD OF BOREHOLE No BH13-36

SHEET 1 OF 1

METRIC

PROJECT 09-1111-0019

G.W.P. 2101-08-00 LOCATION N 4860427.0 ;E 366329.0 ORIGINATED BY KT

DIST HWY 401 BOREHOLE TYPE 150 mm O.D. Continuous Flight Solid Stem Auger COMPILED BY MAS

DATUM Geodetic DATE August 14, 2013 CHECKED BY MWK

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (20 40 60 80 100): ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
120.9	GROUND SURFACE										
0.0	Clayey silt, some sand, trace gravel (FILL) Firm to hard Brown to grey Moist to wet		1	SS	6		120				
			2	SS	18				○		0 16 71 13
			3	SS	9		119				
			4	SS	19				○		
			5	SS	36		118				
			6	SS	26		117		○		1 18 56 25
			7	SS	25		116				
						▽					
114.4			8	SS	60		115		○		
6.6	END OF BOREHOLE NOTE: 1. Water level in open borehole at a depth of 5.5 m below ground surface (Elev. 115.4 m) upon completion of drilling.										

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

Golder Associates

RECORD OF BOREHOLE No BH13-37

SHEET 1 OF 1

METRIC

PROJECT 09-1111-0019
G.W.P. 2101-08-00
LOCATION N 4860429.0 ;E 366380.0
ORIGINATED BY KT
DIST HWY 401
BOREHOLE TYPE 150 mm O.D. Continuous Flight Solid Stem Auger
COMPILED BY MAS
DATUM Geodetic
DATE August 14, 2013
CHECKED BY MWK

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
119.0	GROUND SURFACE										
0.0	TOPSOIL Hard Dark brown		1	SS	34				○		
118.3	Moist										
0.7	Clayey silt, trace to some sand, trace gravel (FILL) Very stiff to hard Brownish grey Moist		2	SS	30		118				
			3	SS	25		117		⊢○⊣		1 18 53 28
			4	SS	50/0.08						
116.3											
2.7	Silt and sand, some clay, some gravel (FILL) Dense to very dense Brownish grey Moist		5	SS	43		116				
			6	SS	50/0.13		115		○		18 38 32 12
			7	SS	55	▽	114				
113.2			8	SS	64				○		
5.8	END OF BOREHOLE										

NOTES:

1. Water level in open borehole at a depth of 5.0 m below ground surface (Elev. 114.0 m) upon completion of drilling.

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

$○^{3\%}$ STRAIN AT FAILURE

Golder Associates

RECORD OF BOREHOLE No BH13-38

SHEET 1 OF 1

METRIC

PROJECT 09-1111-0019

G.W.P. 2101-08-00 LOCATION N 4860467.0 ;E 366422.0 ORIGINATED BY KT

DIST HWY 401 BOREHOLE TYPE 150 mm O.D. Continuous Flight Solid Stem Auger COMPILED BY MAS

DATUM Geodetic DATE August 14, 2013 CHECKED BY MWK

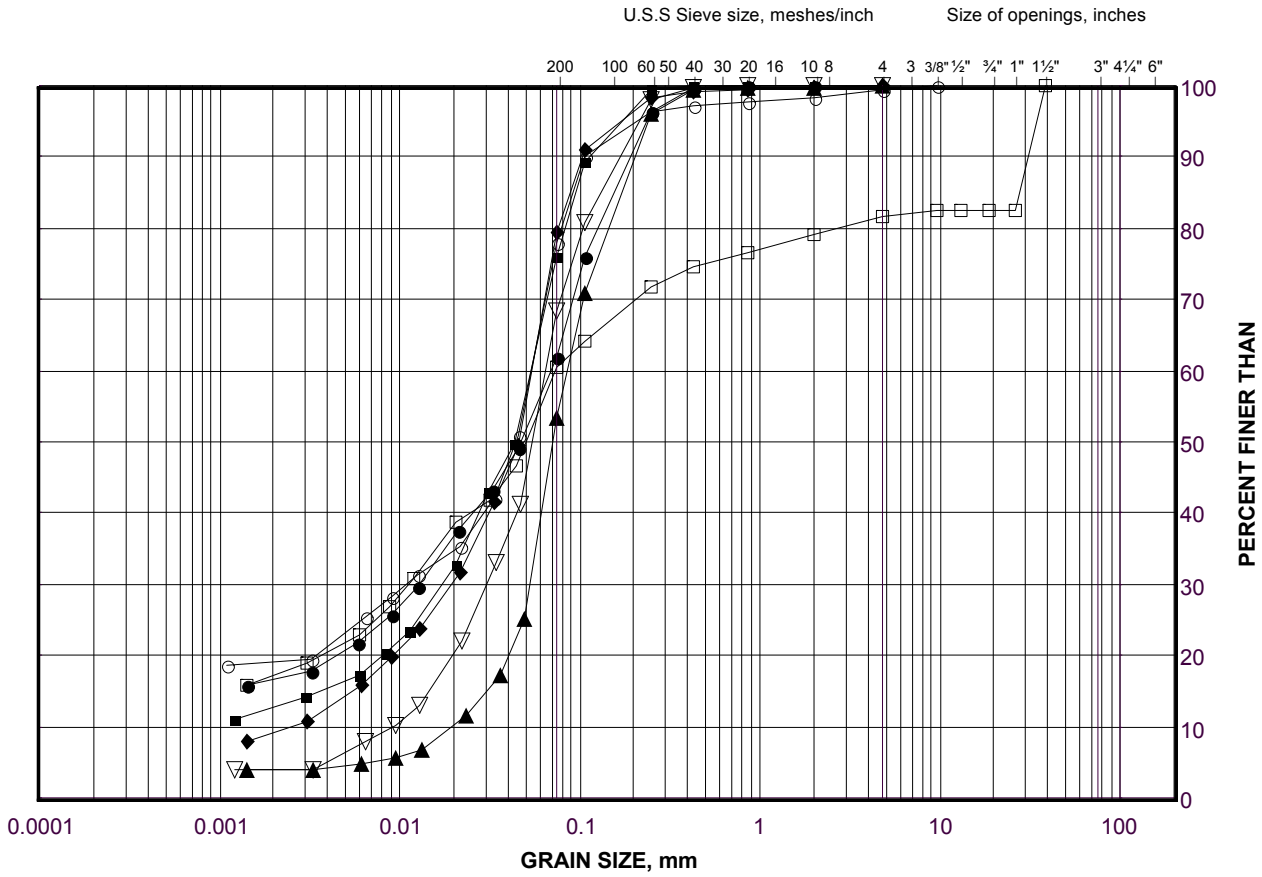
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa: ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
119.8	GROUND SURFACE										
0.0 / 119.3	TOPSOIL Stiff Dark brown Moist		1	SS	9				○		
0.5	Silt and sand, some clay, trace gravel (FILL) Dense to very dense Brown to brownish grey Moist		2	SS	33		119				
			3	SS	50/0.13		118		○		5 38 39 18
117.1			4	SS	50/0.08						
2.7	CLAYEY SILT with SAND trace gravel (TILL) Hard Brownish grey to grey Moist		5	SS	50/0.10		117				
			6	SS	50/0.10		116		○		4 45 39 12
			7	SS	50/0.10		115				
114.3			8	SS	50/0.08				○		
5.5	END OF BOREHOLE NOTES: 1. Open borehole dry upon completion of drilling.										

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

GRAIN SIZE DISTRIBUTION TEST RESULTS

Sandy Silt to Silt and Sand (FILL)

FIGURE H1A



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	13-25	12	110.9
■	13-27	12	114.4
◆	13-33	13	115.4
▲	13-26	13	109.8
▽	13-30	14	114.1
❍	13-33	15	112.4
□	13-33	2	128.4

Project Number: 09-1111-0019

Checked By: _____

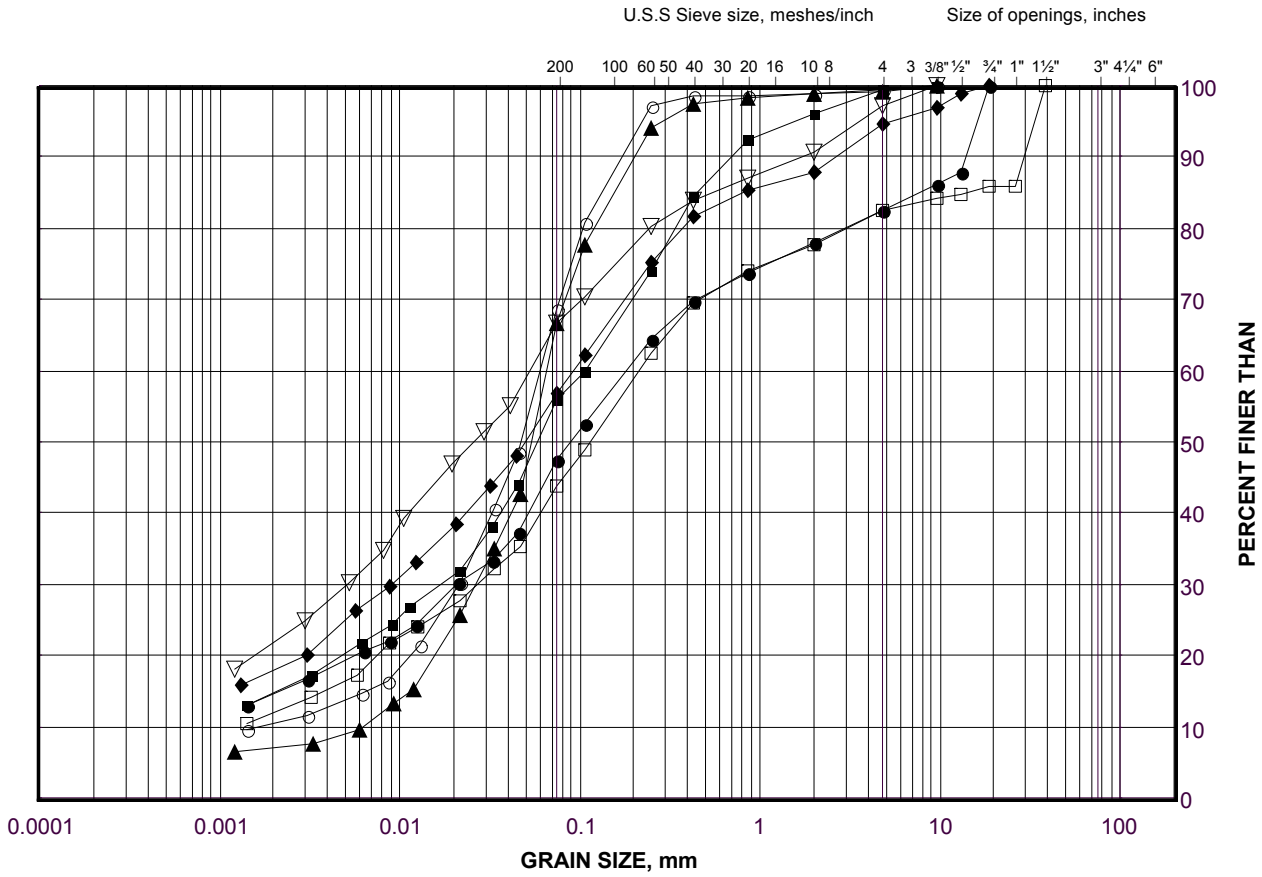
Golder Associates

Date: 12-Nov-13

GRAIN SIZE DISTRIBUTION TEST RESULTS

Sandy Silt to Silt and Sand (FILL)

FIGURE H1B



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	13-24	2	111.5
■	13-35	3	116.2
◆	13-38	3	118.2
▲	13-30	3	127.7
▽	13-26	5	120.2
❍	13-32	6	126.5
□	13-37	6	115.2

Project Number: 09-1111-0019

Checked By: _____

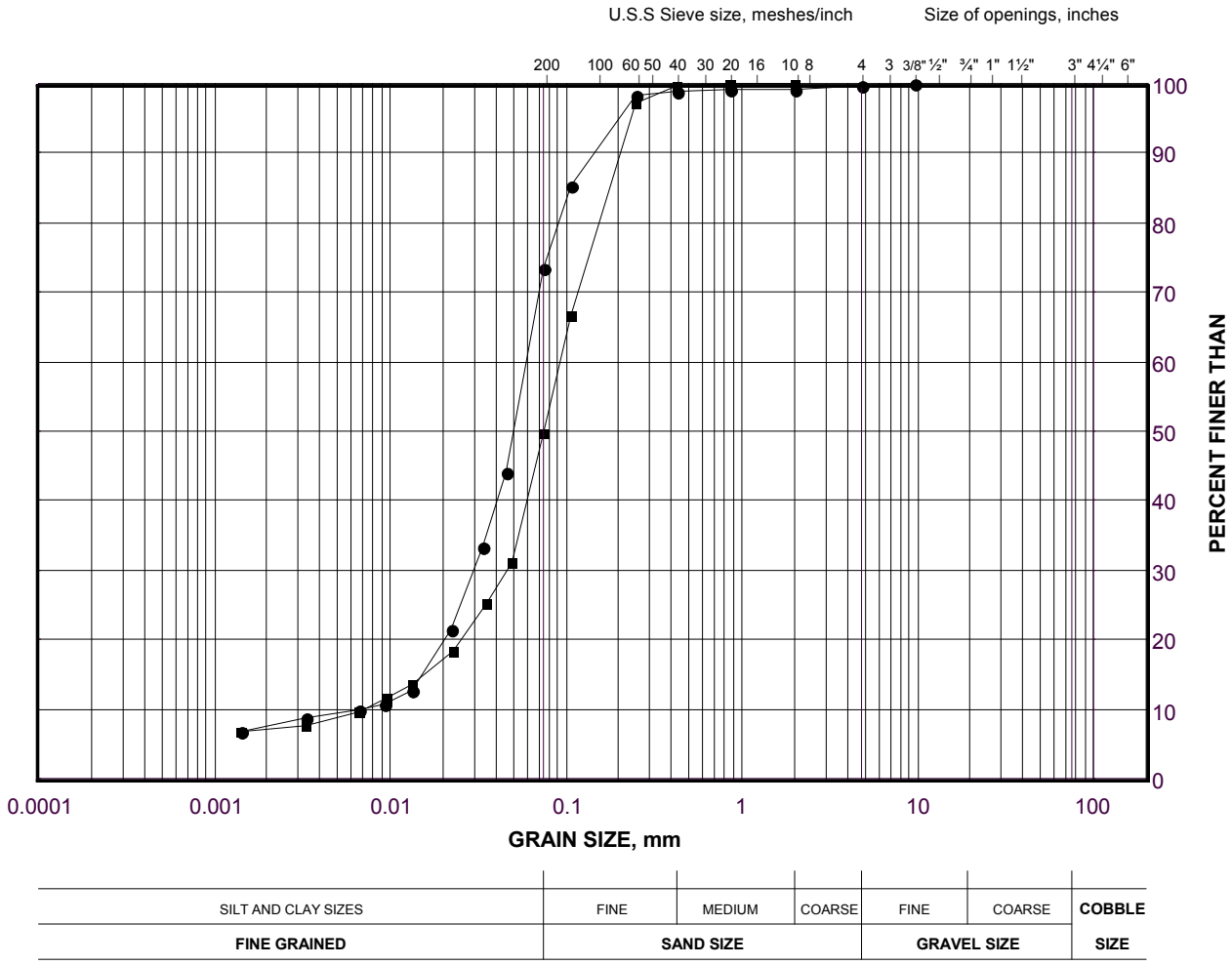
Golder Associates

Date: 12-Nov-13

GRAIN SIZE DISTRIBUTION TEST RESULTS

Sandy Silt to Silt and Sand (FILL)

FIGURE H1C



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	13-33	7	124.7
■	13-32	9	122.8

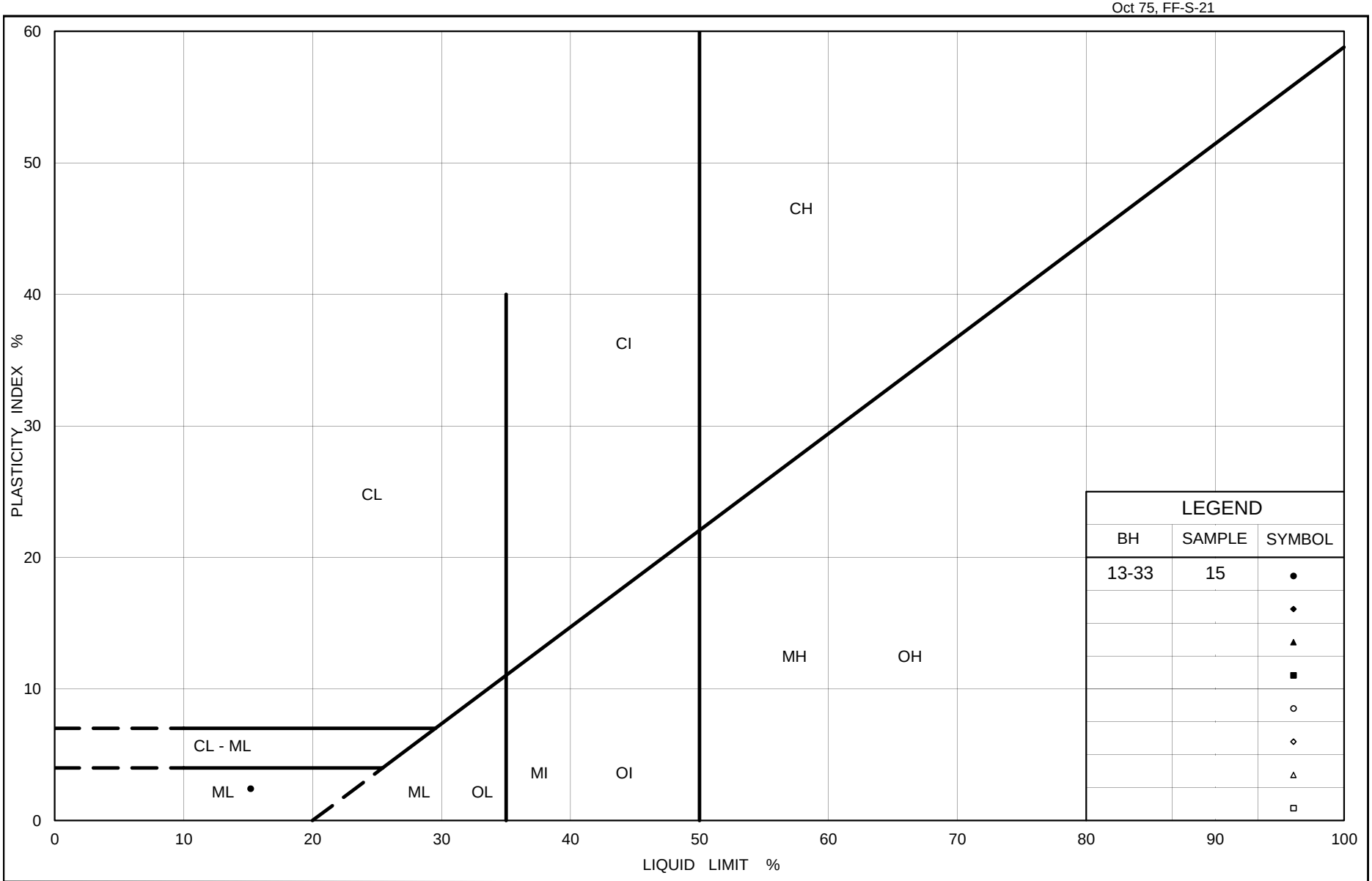
Project Number: 09-1111-0019

Checked By: _____

Golder Associates

Date: 12-Nov-13

Oct 75, FF-S-21



Ministry of Transportation

Ontario

PLASTICITY CHART
Sandy Silt (FILL) (Soil Disposal Mound)

Figure No. H2

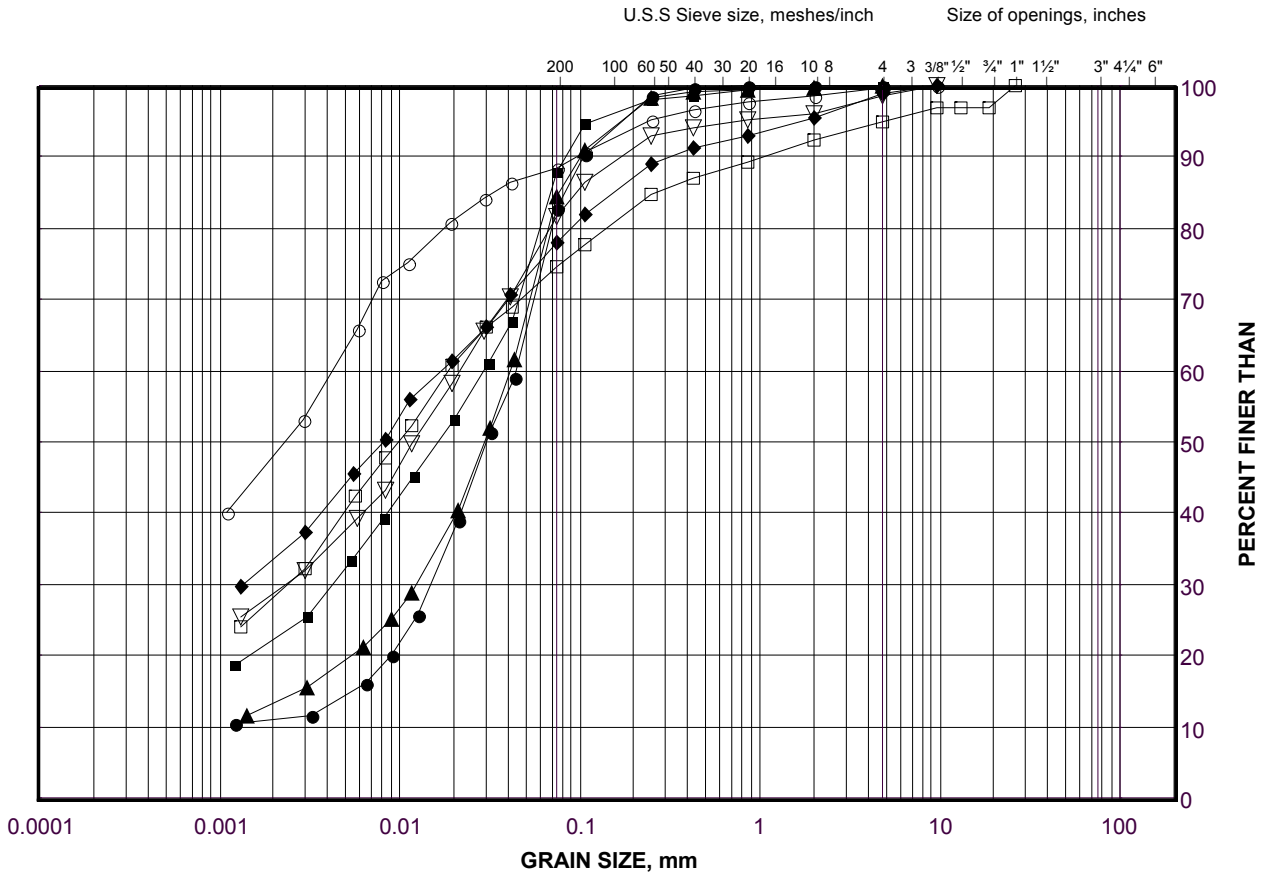
Project No. 09-1111-0019

Checked By:

GRAIN SIZE DISTRIBUTION TEST RESULTS

Clayey Silt (FILL)

FIGURE H3A



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	13-30	10	120.2
■	13-30	12	117.2
◆	13-32	2	129.5
▲	13-36	2	119.9
▽	13-37	3	117.3
❍	13-29	3	110.6
□	13-28	4	121.3

Project Number: 09-1111-0019

Checked By: _____

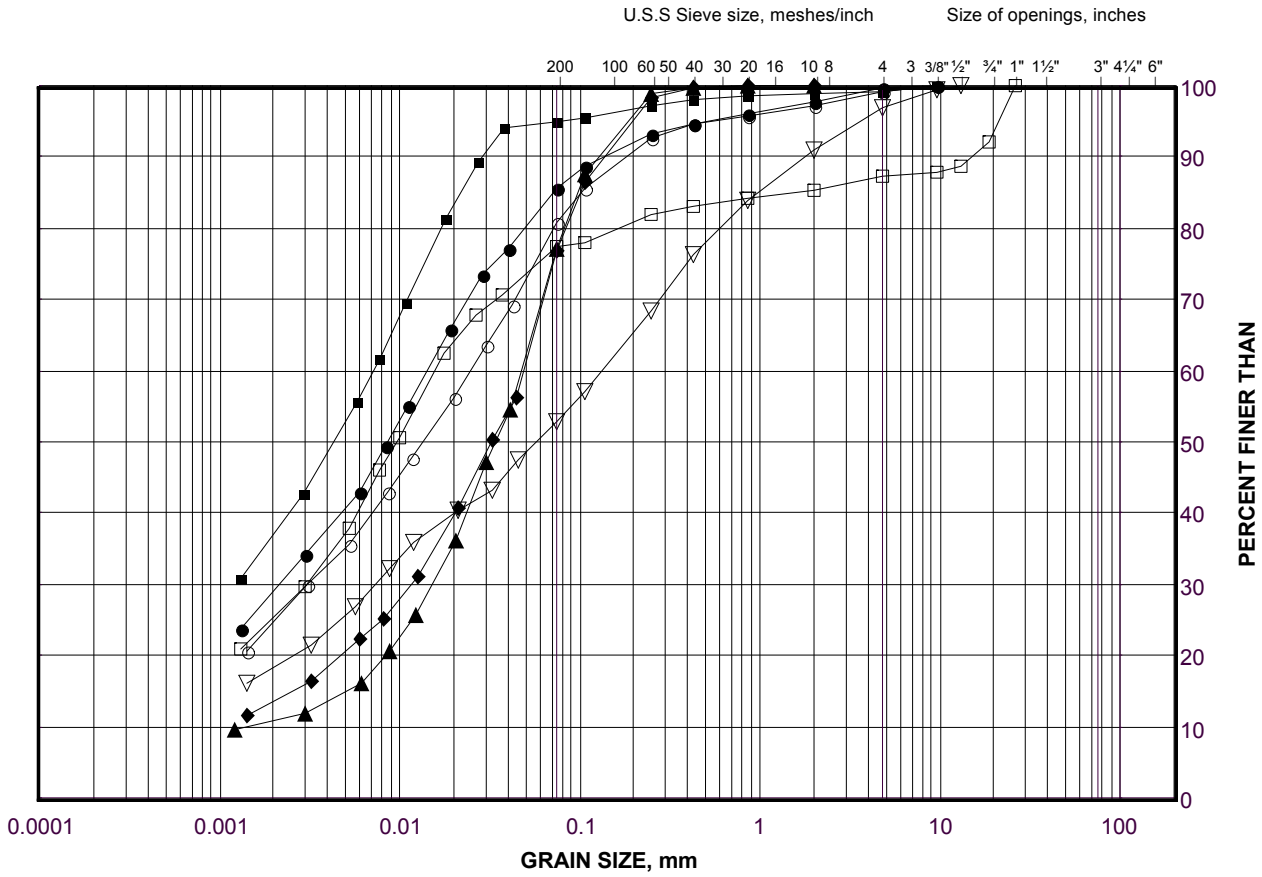
Golder Associates

Date: 12-Nov-13

GRAIN SIZE DISTRIBUTION TEST RESULTS

Clayey Silt (FILL)

FIGURE H3B



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	13-25	4	120.7
■	13-27	4	124.1
◆	13-31	4	116.4
▲	13-28	5	120.5
▽	13-30	5	126.1
❍	13-36	6	116.8
□	13-25	6	119.3

Project Number: 09-1111-0019

Checked By: _____

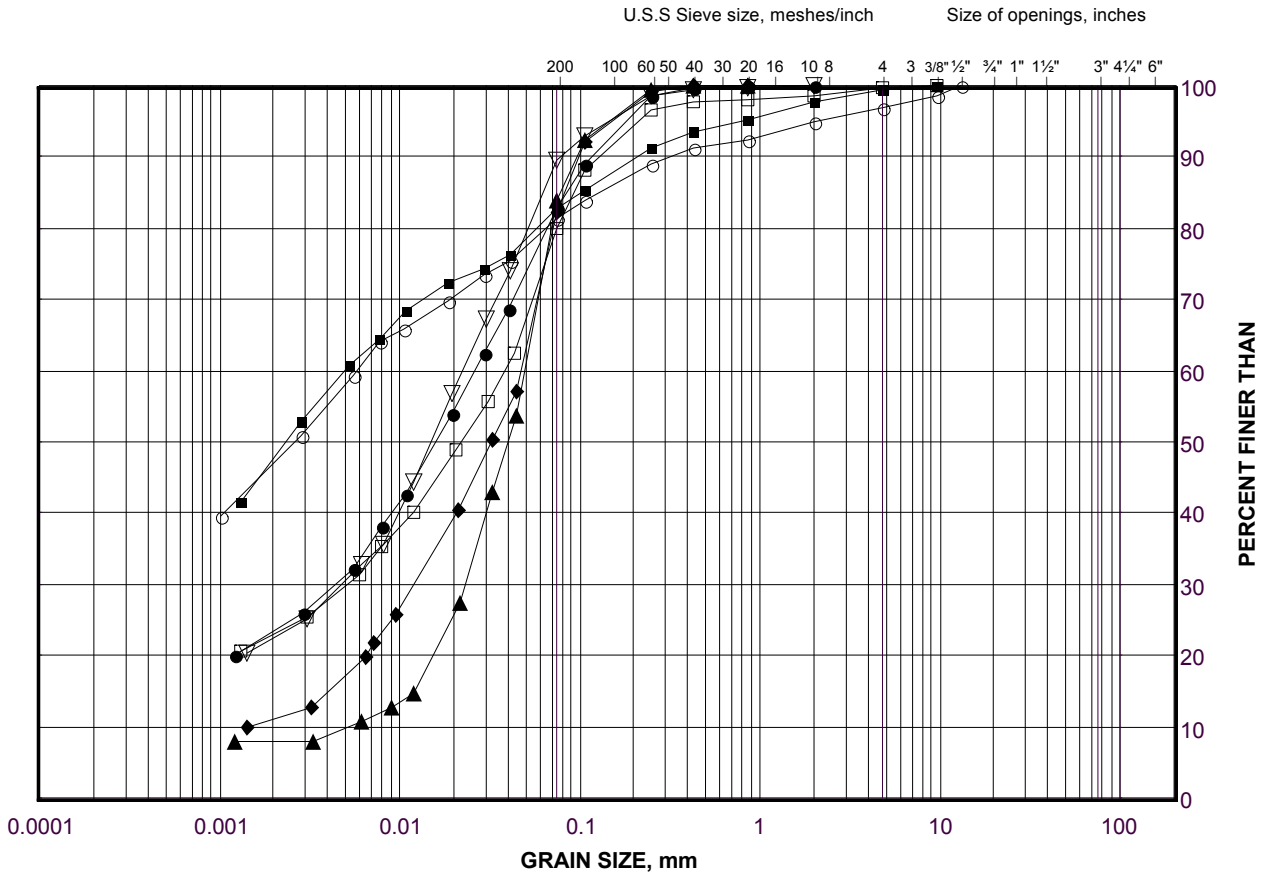
Golder Associates

Date: 12-Nov-13

GRAIN SIZE DISTRIBUTION TEST RESULTS

Clayey Silt (FILL)

FIGURE H3C



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	13-28	7	119.0
■	13-26	7	118.7
◆	13-31	8	112.6
▲	13-30	8	123.2
▽	13-27	8	120.3
❍	13-25	8	116.8
□	13-26	9	115.7

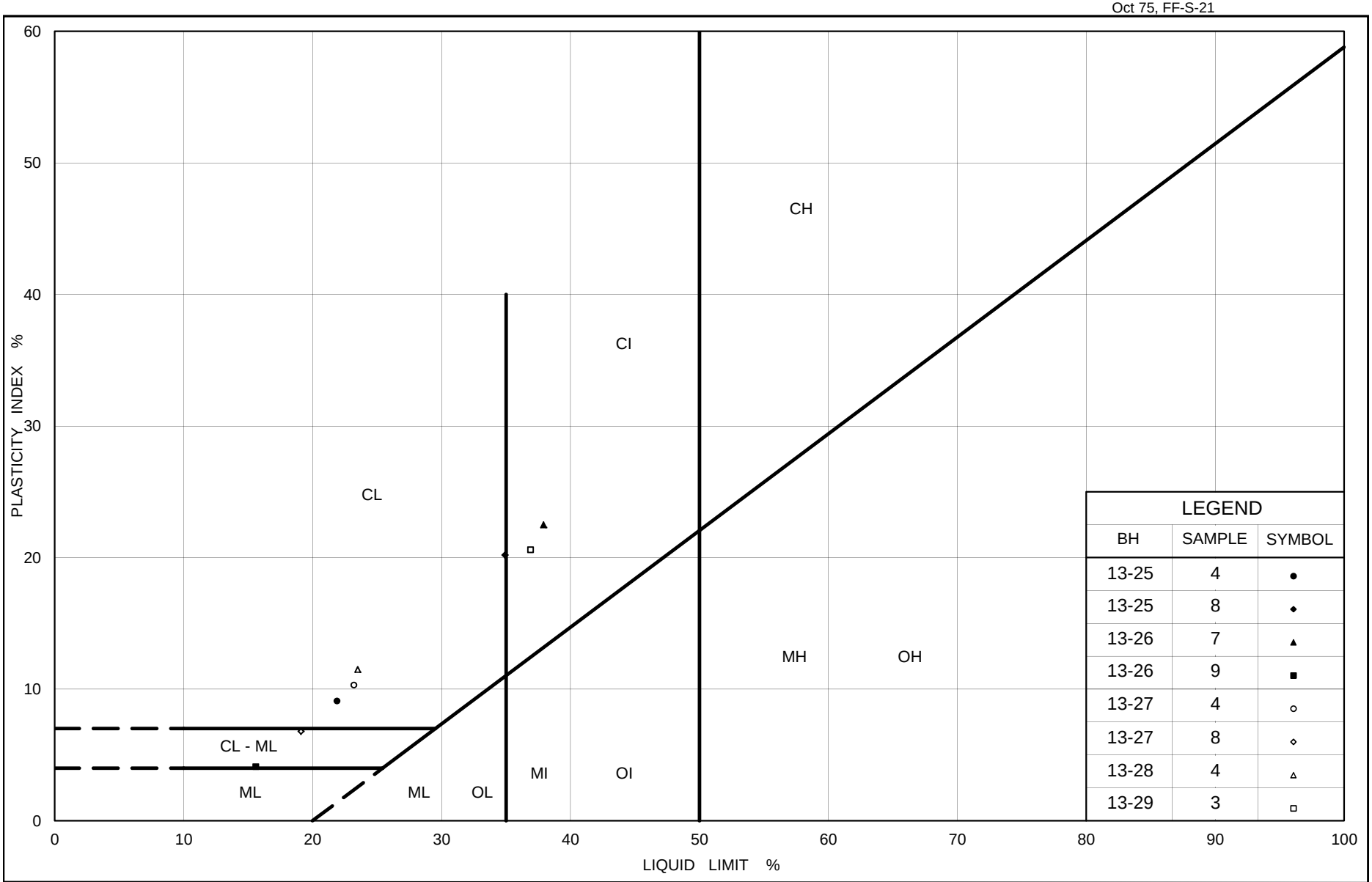
Project Number: 09-1111-0019

Checked By: _____

Golder Associates

Date: 12-Nov-13

Oct 75, FF-S-21



Ministry of Transportation

Ontario

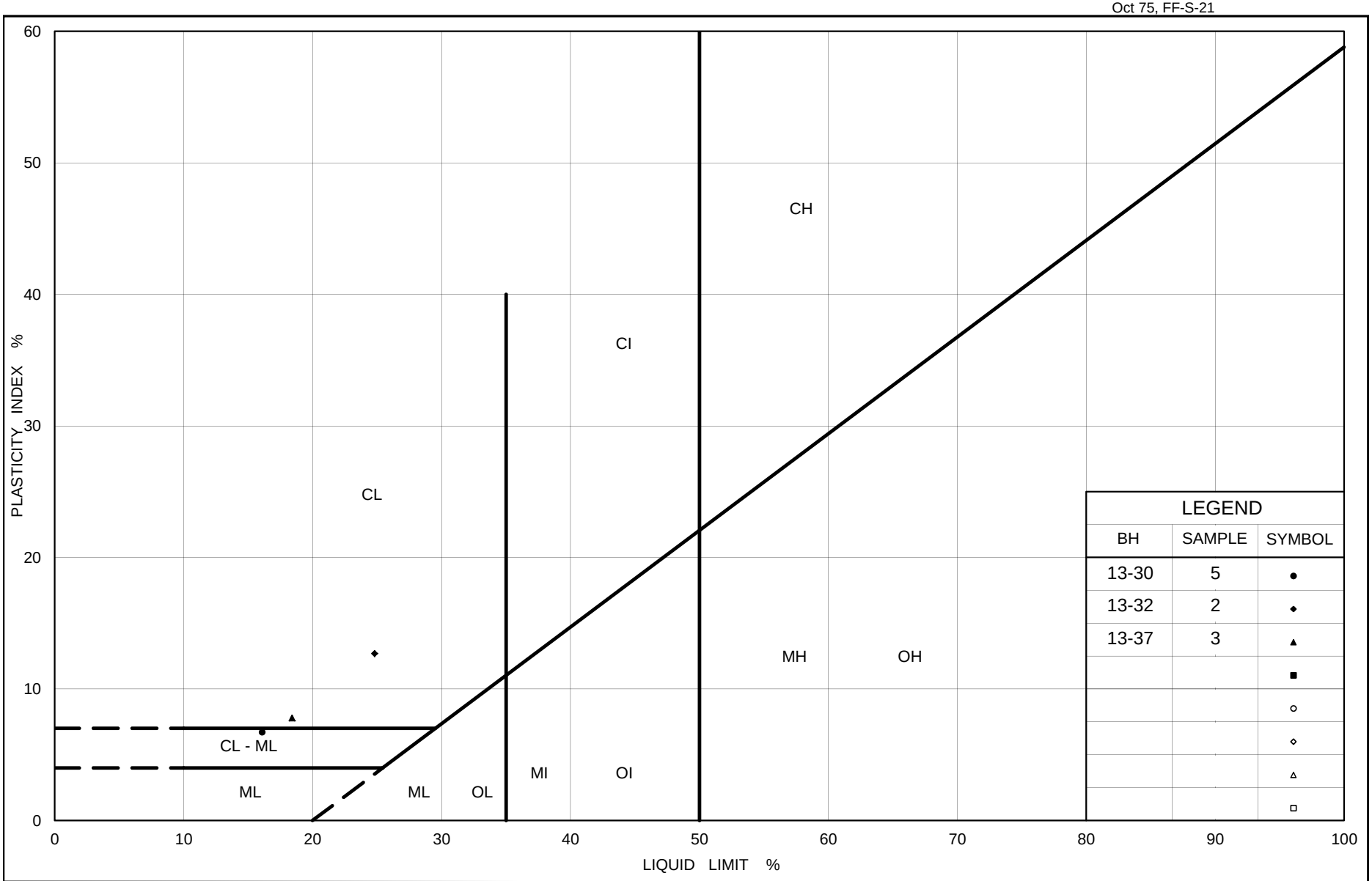
PLASTICITY CHART
Clayey Silt to Silty Clay (FILL)

Figure No. H4A

Project No. 09-1111-0019

Checked By:

Oct 75, FF-S-21



Ministry of Transportation

Ontario

PLASTICITY CHART
Clayey Silt to Silty Clay (FILL)

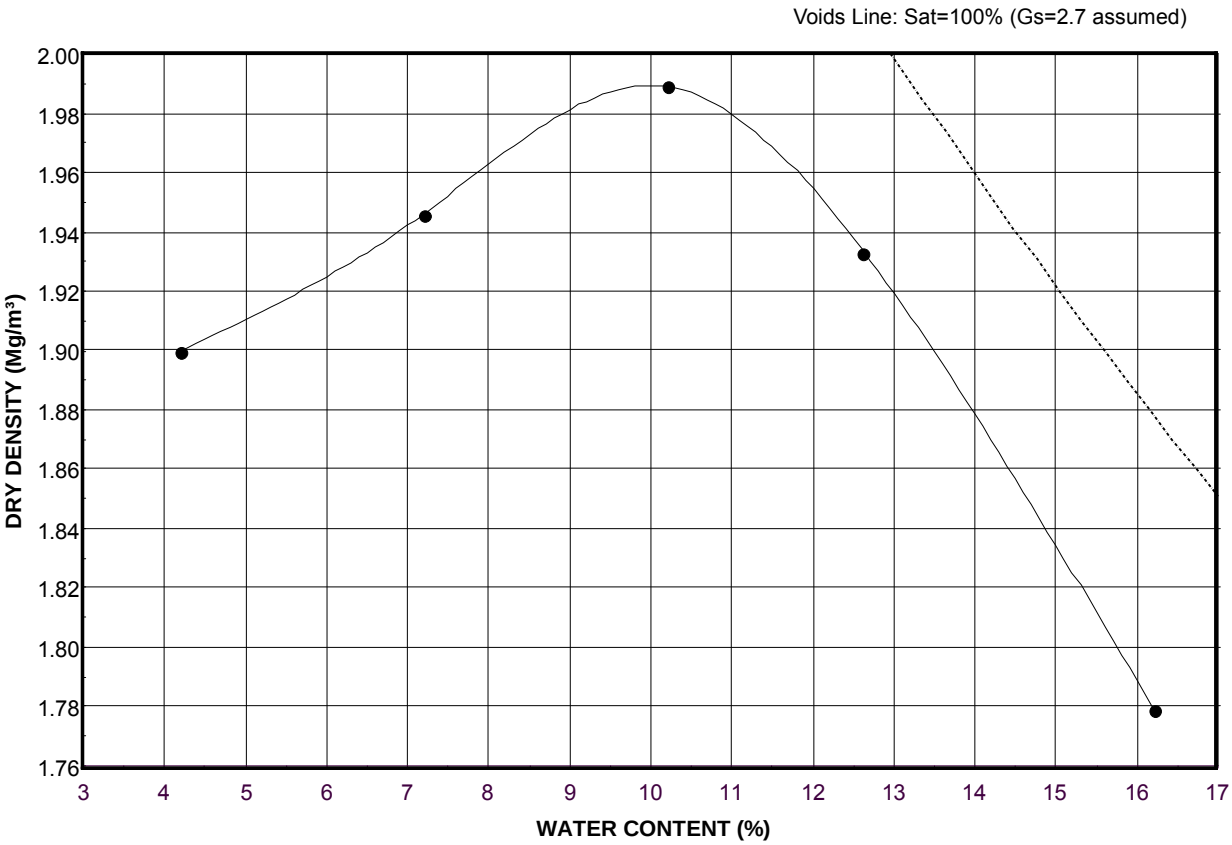
Figure No. H4B

Project No. 09-1111-0019

Checked By:

LABORATORY COMPACTION TEST
Soil Disposal Mound Fill

FIGURE H5



Standard Proctor Test Results	Sample: Combined Samples	Source: Unknown
Max Dry Density: 1.989 Mg/m³	Optimum Water Content: 10.1%	Natural Water Content: 11.1%

Project Number: 09-1111-0019
Checked By: _____

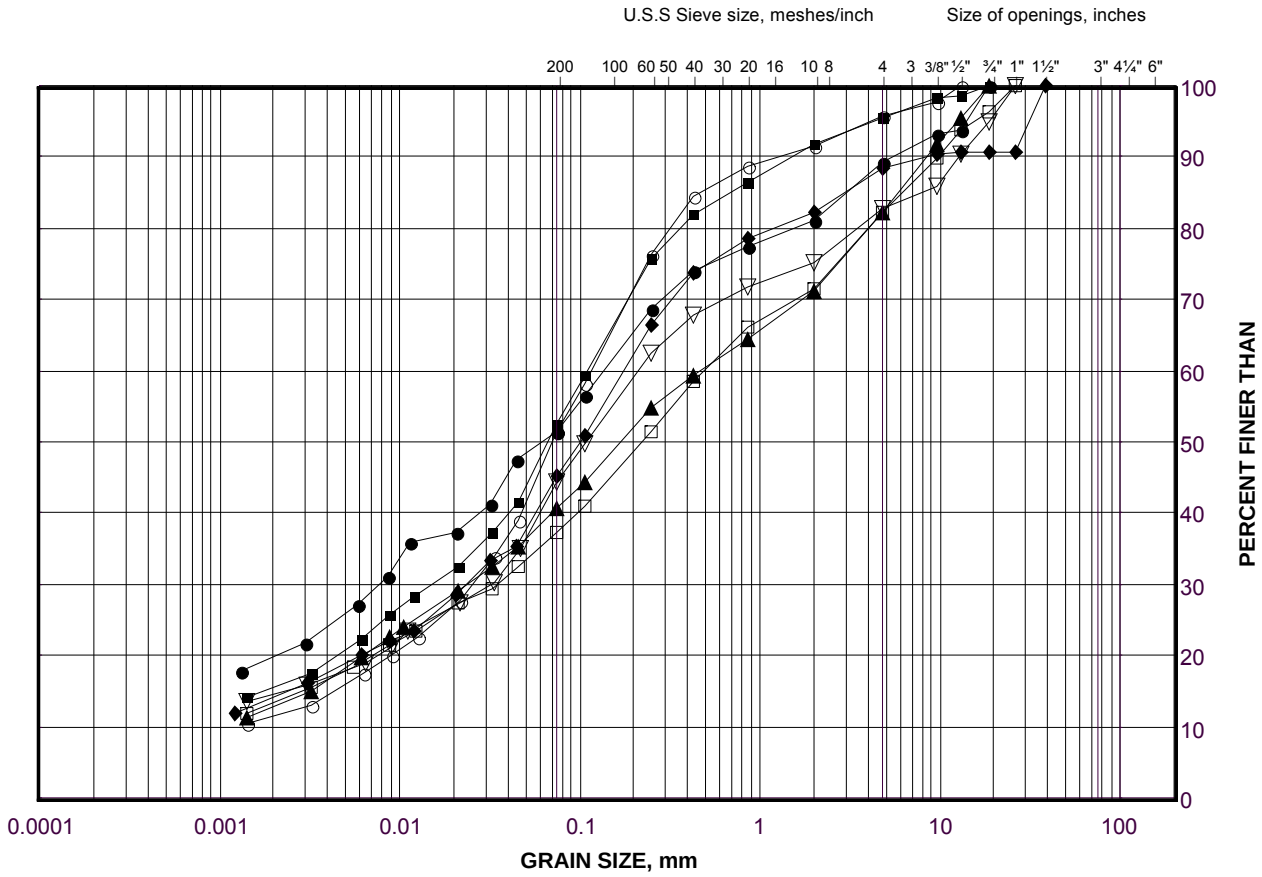
Golder Associates

LABID: 13-1354
Date: 10-Oct-13

GRAIN SIZE DISTRIBUTION TEST RESULTS

Clayey Silt (TILL)

FIGURE H6A



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	13-31	10	109.5
■	13-28	12	111.5
◆	13-27	14	111.3
▲	13-25	16	104.7
▽	13-29	6	108.5
❍	13-38	6	116.0
□	13-35	6	114.0

Project Number: 09-1111-0019

Checked By: _____

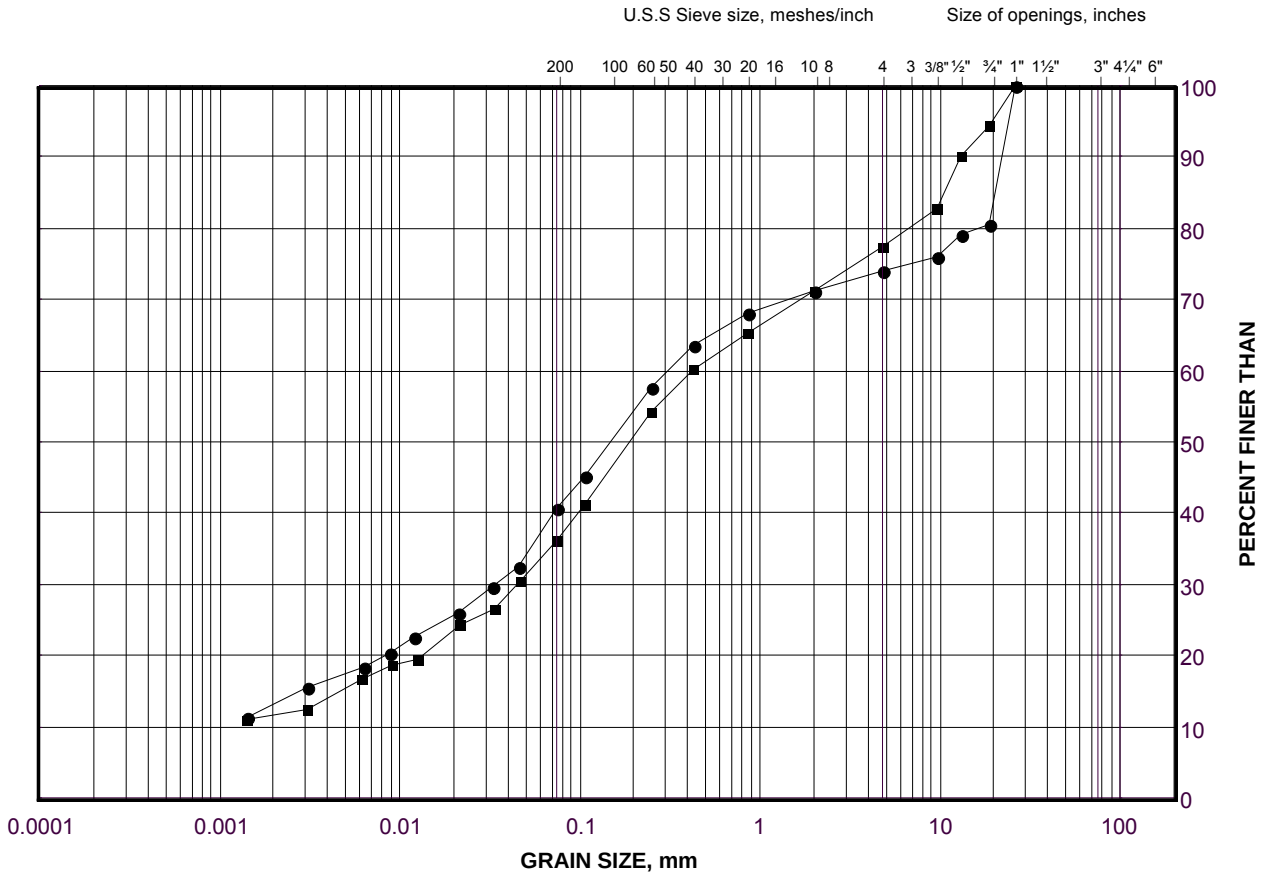
Golder Associates

Date: 12-Nov-13

GRAIN SIZE DISTRIBUTION TEST RESULTS

Clayey Silt (TILL)

FIGURE H6B



LEGEND

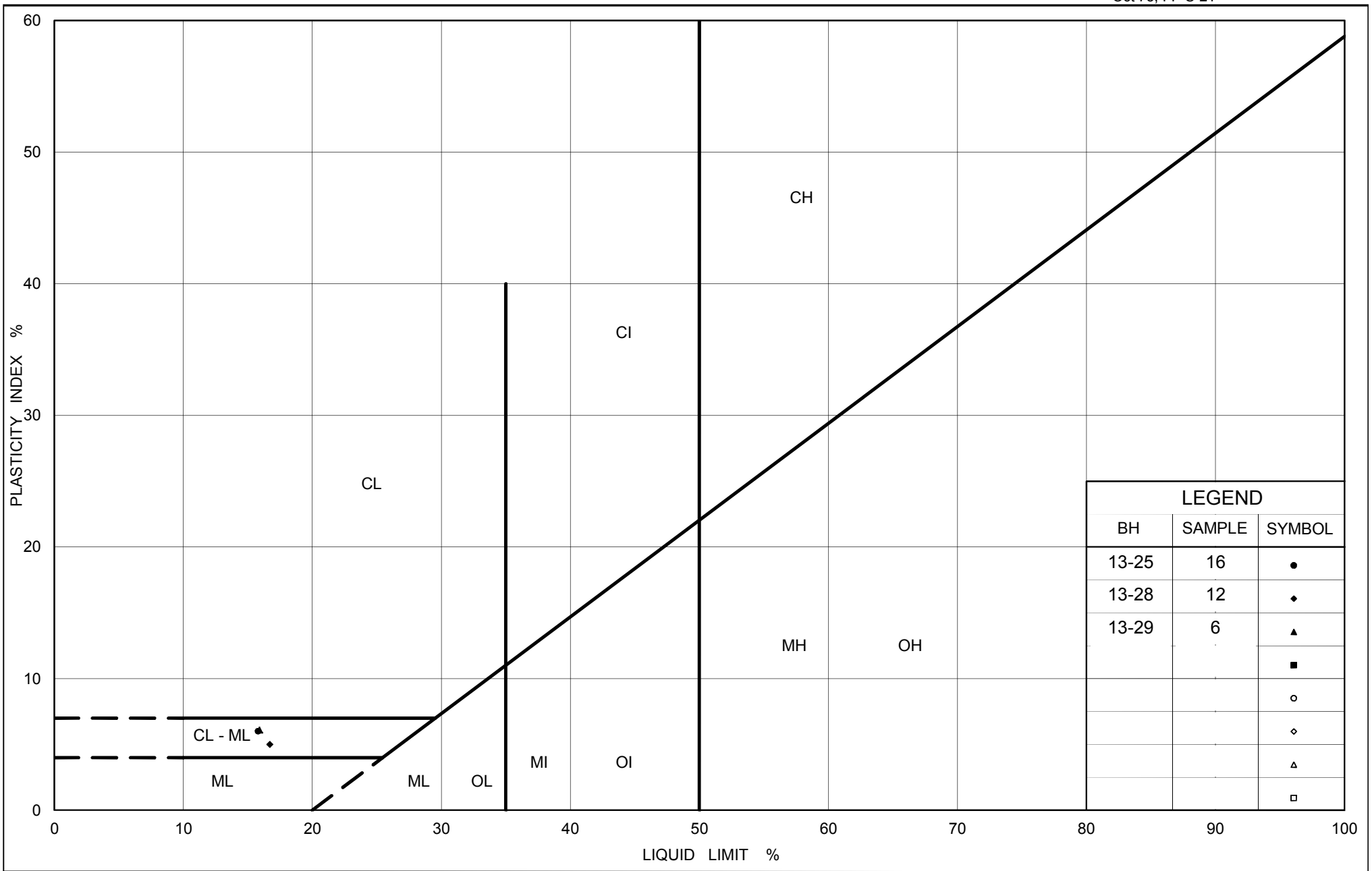
SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	13-24	7	107.7
■	13-29	8	106.2

Project Number: 09-1111-0019

Checked By: _____

Golder Associates

Date: 12-Nov-13



Ministry of Transportation

Ontario

PLASTICITY CHART
Clayey Silt (TILL)

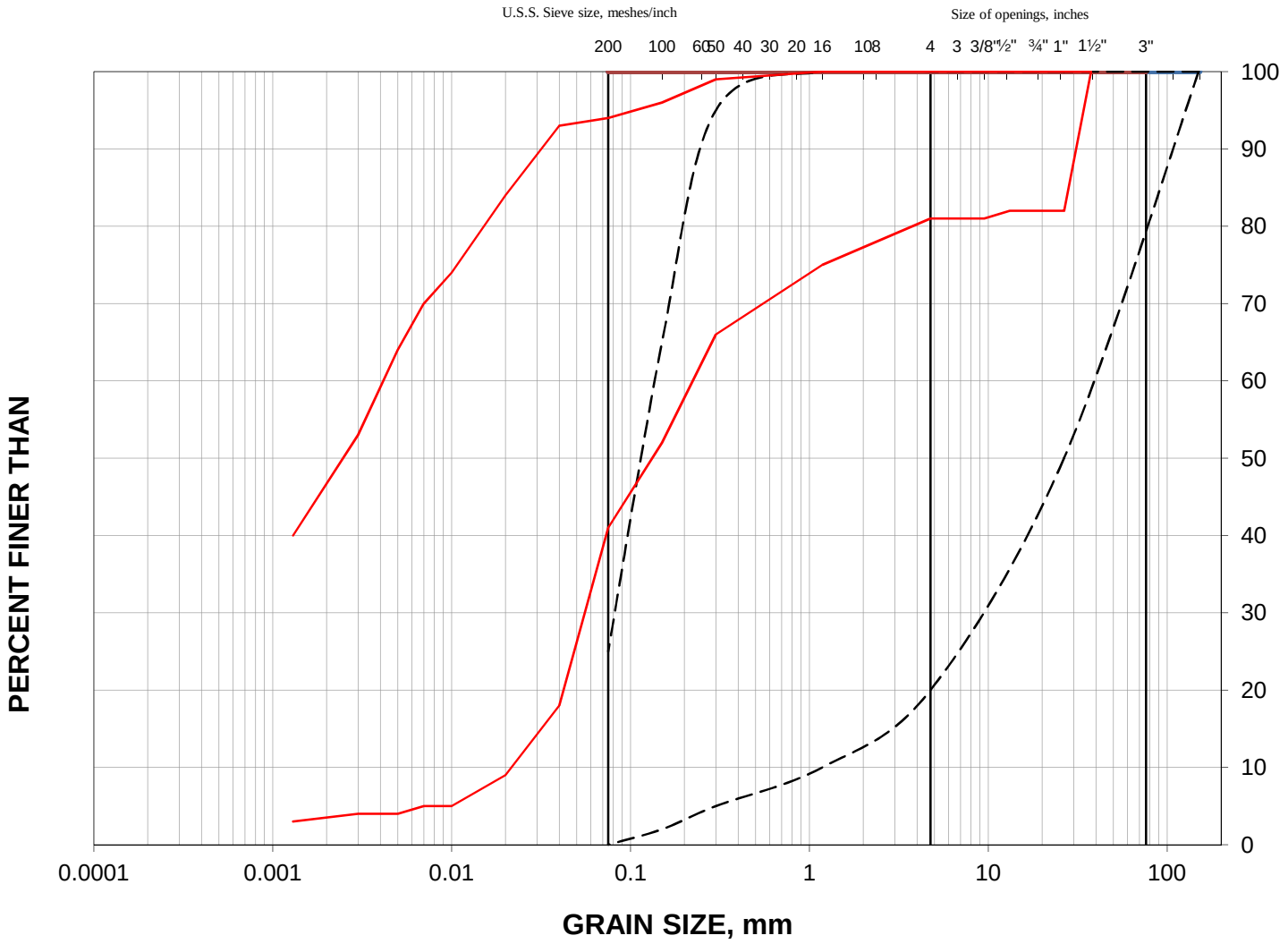
Figure No. H7

Project No. 09-1111-0019

Checked By:

COMPARISON OF GRAIN SIZE DISTRIBUTION ENVELOPE
SOIL DISPOSAL MOUND EXISTING FILL
TO SELECT SUBGRADE MATERIAL

FIGURE H8



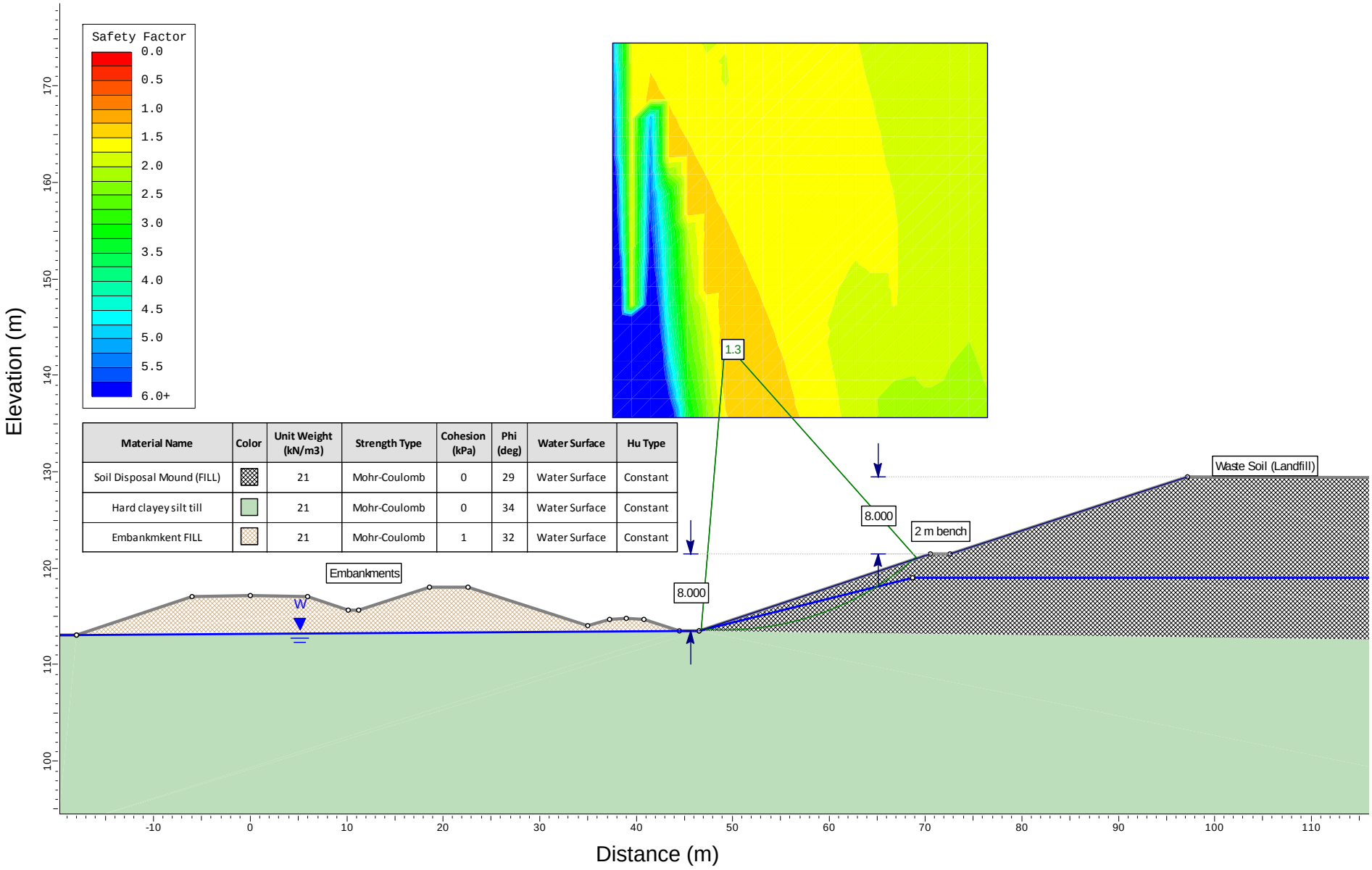
Date: Nov-13
Project: 09-1111-0019

Golder Associates

Drawn: MWK
Checked: JMAC

Area 8 – South Service Road West STA 11+850 to 12+500
Static Global Stability Analysis

Figure H9



Date: November 2013

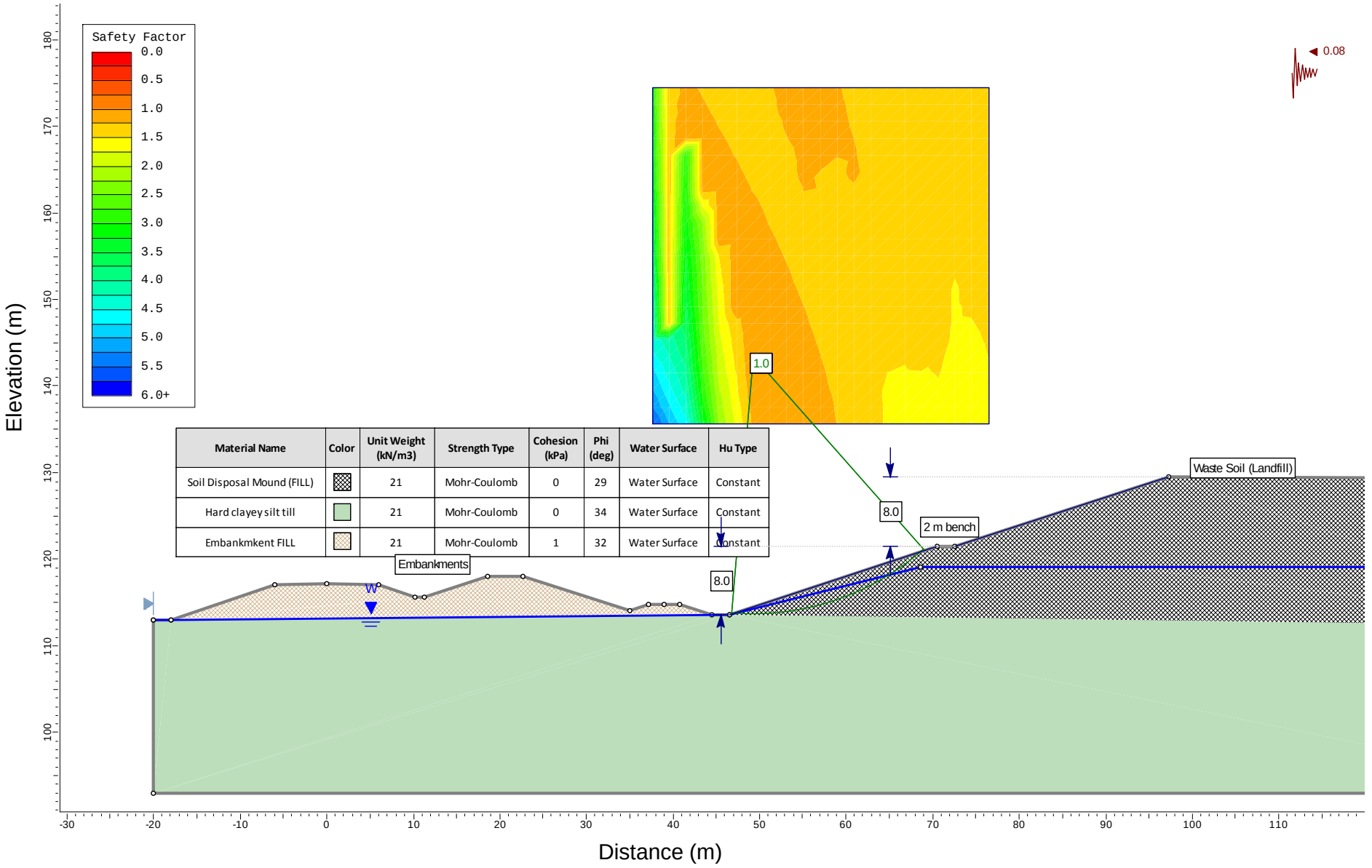
Project No: 09-1111-0019

Analysis By: MWK **Reviewed By:** KJB

Golder Associates

Area 8 – South Service Road West STA 11+850 to 12+500
Seismic Global Stability Analysis

Figure H10



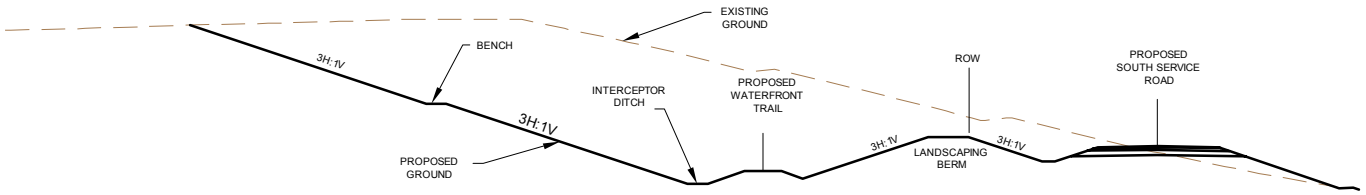
Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Hu Type
Soil Disposal Mound (FILL)		21	Mohr-Coulomb	0	29	Water Surface	Constant
Hard clayey silt till		21	Mohr-Coulomb	0	34	Water Surface	Constant
Embankmkent FILL		21	Mohr-Coulomb	1	32	Water Surface	Constant

Date: November 2013

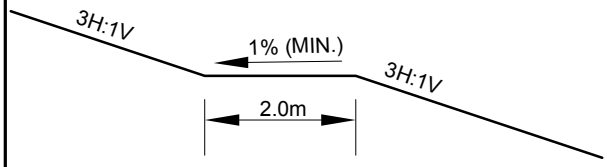
Project No: 09-1111-0019

Analysis By: MWK **Reviewed By:** KJB

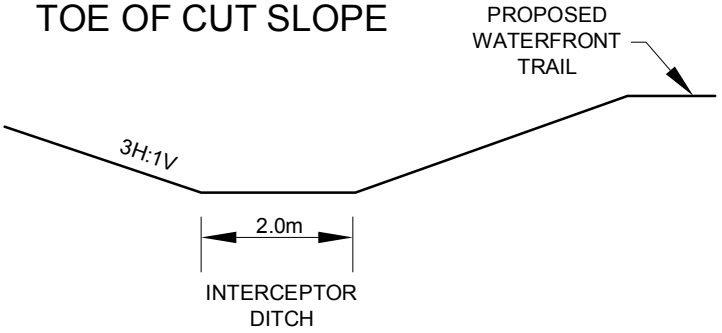
Golder Associates



MID HEIGHT BENCH



INTERCEPTOR DITCH TOE OF CUT SLOPE



PROJECT

CLIENT NAME
PROJECT/REPORT TITLE
TOWNSHIP, COUNTY, PROVINCE

TITLE

DEEP CUT AREA 8
TYPICAL SLOPE SECTION

Golder Associates
Mississauga, Ontario, Canada

PROJECT No.		091111-0019	FILE No. 0911110019DAH11.dwg	
DESIGN			SCALE N.T.S.	REV. A
CAD	JFC	2/13/2014	DRAWING No.	
CHECK	MWK	2/13/2014	**H11**	
REVIEW		2/13/2014		

PLOT DATE: February 13, 2014
FILENAME: T:\Projects\2009\09-1111-0019 (URS,Clarington)\-DA- Deep Cut Area 8\0911110019DAH11.dwg

APPENDIX I

Analytical Test Results

AGAT Laboratories

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
TEL (905)712-5100
FAX (905)712-5122
http://www.agatlabs.com

CLIENT NAME: GOLDER ASSOCIATES LTD.
100 SCOTIA COURT
WHITBY, ON L1N8Y6
(905) 723-2727

ATTENTION TO: Robin Nowensky

PROJECT NO: Holt Rd

AGAT WORK ORDER: 13T735876

SOIL ANALYSIS REVIEWED BY: Anthony Dapaah, PhD (Chem), Inorganic Lab Manager

DATE REPORTED: Jul 24, 2013

PAGES (INCLUDING COVER): 4

VERSION*: 1

Should you require any information regarding this analysis please contact your client services representative at (905) 712-5100

*NOTES

All samples will be disposed of within 30 days following analysis. Please contact the lab if you require additional sample storage time.

AGAT Laboratories

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
TEL (905)712-5100
FAX (905)712-5122
http://www.agatlabs.com

Certificate of Analysis

AGAT WORK ORDER: 13T735876

PROJECT NO: Holt Rd

CLIENT NAME: GOLDER ASSOCIATES LTD.

ATTENTION TO: Robin Nowensky

O. Reg. 558 Metals and Inorganics

DATE RECEIVED: 2013-07-12

DATE REPORTED: 2013-07-24

		SAMPLE DESCRIPTION:		DRUM 1	DRUM 2	DRUM 3
		SAMPLE TYPE:		Soil	Soil	Soil
		DATE SAMPLED:		7/5/2013	7/5/2013	7/5/2013
Parameter	Unit	G / S	RDL	4545308	4545309	4545310
Arsenic Leachate	mg/L	2.5	0.010	<0.010	<0.010	<0.010
Barium Leachate	mg/L	100	0.100	0.287	0.277	0.380
Boron Leachate	mg/L	500	0.050	<0.050	<0.050	<0.050
Cadmium Leachate	mg/L	0.5	0.010	<0.010	<0.010	<0.010
Chromium Leachate	mg/L	5.0	0.010	<0.010	<0.010	<0.010
Lead Leachate	mg/L	5.0	0.010	<0.010	<0.010	<0.010
Mercury Leachate	mg/L	0.1	0.01	<0.01	<0.01	<0.01
Selenium Leachate	mg/L	1.0	0.010	<0.010	<0.010	<0.010
Silver Leachate	mg/L	5.0	0.010	<0.010	<0.010	<0.010
Uranium Leachate	mg/L	10.0	0.050	<0.050	<0.050	<0.050
Fluoride Leachate	mg/L	150	0.05	0.07	0.07	0.09
Cyanide Leachate	mg/L	20.0	0.05	<0.05	<0.05	<0.05
(Nitrate + Nitrite) as N Leachate	mg/L	1000	0.70	<0.70	<0.70	<0.70

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard: Refers to Regulation 558

Certified By:

AGAT Laboratories

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
TEL (905)712-5100
FAX (905)712-5122
http://www.agatlabs.com

Quality Assurance

CLIENT NAME: GOLDER ASSOCIATES LTD.

AGAT WORK ORDER: 13T735876

PROJECT NO: Holt Rd

ATTENTION TO: Robin Nowensky

Soil Analysis

RPT Date: Jul 24, 2013			DUPLICATE				REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD	Method Blank	Measured Value	Acceptable Limits		Recovery	Acceptable Limits		Recovery	Acceptable Limits	
								Lower	Upper		Lower	Upper		Lower	Upper
O. Reg. 558 Metals and Inorganics															
Arsenic Leachate	1		< 0.010	< 0.010	0.0%	< 0.010	100%	90%	110%	97%	80%	120%	98%	70%	130%
Barium Leachate	1		0.835	0.789	5.7%	< 0.100	99%	90%	110%	99%	80%	120%	106%	70%	130%
Boron Leachate	1		< 0.050	< 0.050	0.0%	< 0.050	105%	90%	110%	80%	80%	120%	80%	70%	130%
Cadmium Leachate	1		< 0.010	< 0.010	0.0%	< 0.010	102%	90%	110%	110%	80%	120%	113%	70%	130%
Chromium Leachate	1		< 0.010	< 0.010	0.0%	< 0.010	100%	90%	110%	93%	80%	120%	84%	70%	130%
Lead Leachate	1		0.015	0.012	22.2%	< 0.010	97%	90%	110%	104%	80%	120%	108%	70%	130%
Mercury Leachate	1		< 0.01	< 0.01	0.0%	< 0.01	92%	90%	110%	94%	80%	120%	95%	70%	130%
Selenium Leachate	1		< 0.010	< 0.010	0.0%	< 0.010	101%	90%	110%	105%	80%	120%	106%	70%	130%
Silver Leachate	1		< 0.010	< 0.010	0.0%	< 0.010	101%	90%	110%	107%	80%	120%	111%	70%	130%
Uranium Leachate	1		< 0.050	< 0.050	0.0%	< 0.050	102%	90%	110%	95%	80%	120%	98%	70%	130%
Fluoride Leachate	1		0.12	0.12	0.0%	< 0.05	106%	90%	110%	107%	90%	110%	94%	70%	130%
Cyanide Leachate	1		< 0.05	< 0.05	0.0%	< 0.05	99%	90%	110%	95%	90%	110%	105%	70%	130%
(Nitrate + Nitrite) as N Leachate	1		< 0.70	< 0.70	0.0%	< 0.70	94%	80%	120%	105%	80%	120%	98%	70%	130%

Certified By:

AGAT Laboratories

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
TEL (905)712-5100
FAX (905)712-5122
http://www.agatlabs.com

Method Summary

CLIENT NAME: GOLDER ASSOCIATES LTD.

AGAT WORK ORDER: 13T735876

PROJECT NO: Holt Rd

ATTENTION TO: Robin Nowensky

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Soil Analysis			
Arsenic Leachate	MET-93-6103	EPA SW-846 1311 & 3010A & 6020A	ICP-MS
Barium Leachate	MET-93-6103	EPA SW-846 1311 & 3010A & 6020A	ICP-MS
Boron Leachate	MET-93-6103	EPA SW-846 1311 & 3010A & 6020A	ICP-MS
Cadmium Leachate	MET-93-6103	EPA SW-846 1311 & 3010A & 6020A	ICP-MS
Chromium Leachate	MET-93-6103	EPA SW-846 1311 & 3010A & 6020A	ICP-MS
Lead Leachate	MET-93-6103	EPA SW-846 1311 & 3010A & 6020A	ICP-MS
Mercury Leachate	MET-93-6103	EPA SW-846 1311 & 3010A & 6020A	ICP-MS
Selenium Leachate	MET-93-6103	EPA SW-846 1311 & 3010A & 6020A	ICP-MS
Silver Leachate	MET-93-6103	EPA SW-846 1311 & 3010A & 6020A	ICP-MS
Uranium Leachate	MET-93-6103	EPA SW-846 1311 & 3010A & 6020A	ICP-MS
Fluoride Leachate	INOR-93-6018	EPA SW-846-1311 & SM4500-F- C	ION SELECTIVE ELECTRODE
Cyanide Leachate	INOR-93-6052	EPA SW-846-1311 & MOE 3015 & SM 4500 CN- I	TECHNICON AUTO ANALYZER
(Nitrate + Nitrite) as N Leachate	INOR-93-6053	EPA SW 846-1311 & SM 4500 - NO3- I	LACHAT FIA

AGAT Laboratories

5835 Coopers Avenue
Mississauga, ON
L4Z 1Y2
www.agatlabs.com · webearth.agatlabs.com

P: 905.712.5100 · F: 905.712.5122 · TF: 800.856.6261

Chain of Custody Record

Laboratory Use Only
Arrival Temperature: 3.7 4.1 4.2
AGAT WO #:
Lab Temperature: ~~2.5~~ 3.6 3.5
Notes:

Client Information
Company: GOLDER ASSOC.
Contact: ROBIN NOWENSKY
Address: WHITBY
Phone: 905 723 2727 Fax:
Project: HOLT RD. (SOIL ~~80~~ DRUMS)
AGAT Quotation #:
Please note, if quotation number is not provided, client will be billed full price for analysis.

Regulatory Requirements
☑ Regulation 153/04 (reg. 511 Amend.) Table 1 (Indicate one) ☐ Ind/Com ☐ Res/Park ☐ Agriculture
Soil Texture (check one) ☐ Coarse ☐ Fine
☐ Sewer Use Region (Indicate one) ☐ Sanitary ☐ Storm
☐ Regulation 558 ☐ CCME ☐ Other (specify) ☐ Prov. Water Quality Objectives (PWQO) ☐ None

Turnaround Time Required (TAT) Required*
Regular TAT 13T735876
☒ 5 to 7 Working Days
Rush TAT (please provide prior notification)
Rush Surcharges Apply
☐ 3 Working Days ☐ 2 Working Days ☐ 1 Working Day
OR
Date Required (Rush surcharges may apply):
*TAT is exclusive of weekends and statutory holidays

Invoice To
Same: Yes ☑ No ☐
Company:
Contact:
Address:

Is this a drinking water sample? (potable water intended for human consumption) ☐ Yes ☒ No
If "Yes", please use the *Drinking Water Chain of Custody Form*

Is this submission for a **Record of Site Condition**? ☐ Yes ☒ No

Legend Matrix
GW Ground Water O Oil
SW Surface Water P Paint
SD Sediment S Soil

Report Information – reports to be sent to:
1. Name: Robin Nowensky
   Email:
2. Name: Devon Witheridge
   Email:

Sample Identification	Date Sampled	Time Sampled	Sample Matrix	# of Containers	Comments Site/Sample Information	Metals and Inorganics	Metal Scan	Hydride Forming Metals	Client Custom Metals	ORPs: ☐ B-HWS ☐ Cl- ☐ CN- ☐ EC ☐ FOC ☐ Cr+6- ☐ SAR ☐ NO_3/NO_2 ☐ N- Total ☐ Hg ☐ pH	Nutrients: ☐ TP ☐ NH_3 ☐ TKN ☐ NO_3 ☐ NO_2 ☐ NO_3/NO_2	VOC: ☐ VOC ☐ THM ☐ BTEX	CCME Fractions 1 to 4	ABNs	PAHs	Chlorophenols	PCBs	Organochlorine Pesticides	TCLP Metals/Inorganics	Sewer Use
DRUM 1	July 5	1400	S	1															X	
DRUM 2	↓	↓	↓	1															X	
DRUM 3	↓	↓	↓	1															X	

Samples Relinquished By (Print Name and Sign)	Date/Time	Samples Received By (Print Name and Sign):	Date/Time
D. Witheridge	July 12/13 1000	H. Stamatis 7.12.13	1000
Samples Relinquished By (Print Name and Sign):	Date/Time	Samples Received By (Print Name and Sign):	Date/Time
			3:50

Pink Copy - Client
Yellow Copy - AGAT
White Copy- AGAT

Page 1 of 1
N°: 185555

Document ID: DIV-78-1511.007
Date issued: July 23, 2012

APPENDIX J

Borehole Records - Previous Investigation

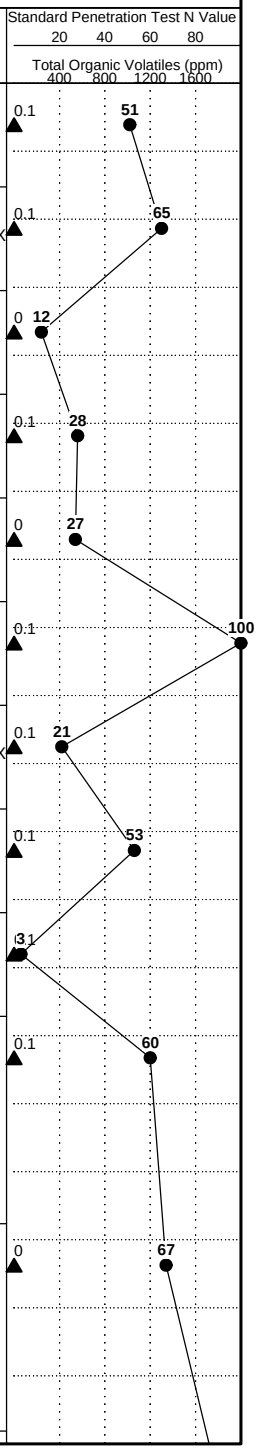
Figure No. **A-1**

LOG OF BOREHOLE MW1D

Project No. **550286**
Project: **Highway 407 East Extension**
Location: **OPG Darlington Soil Mound**
Date Drilled: **1/21/10**
Drill Type: **CME 75 - Track Mount**
Drilling Contractor: **Lantech Drilling Services Inc.**

● SPT (N) Value
▲ Total Organic Volatiles (ppm)

DEPTH (m bgs)	SYMBOL	SOIL DESCRIPTION	WELL	GROUNDWATER	SOIL SAMPLE NAME	SOIL SAMPLE TEST
128.09						
127.79		**SILTY CLAY FILL** - brown/grey - trace gravel - trace organics - dense - low plasticity - moist.			MW1D (0-2.5')	
		SILTY SAND FILL - brown/grey - trace organics - fine grained - low plasticity - moist.			MW1D (2.5-5')	metals, PHCs, BTEX
					MW1D (5-7.5')	
125.66		**SAND FILL** - grey - trace silt - loose - fine grained - low plasticity - dry			MW1D (7.5-10')	
124.74					MW1D (10-12.5')	
124.59		- seam of silty clay - highly oxidized - moist			MW1D (12.5-15')	
123.52					MW1D (15-17.5')	metals, PHCs, BTEX
122.76					MW1D (17.5-20')	
122.70		- rock fragments - wet			MW1D (20-22.5')	
					MW1D (22.5-27.5')	
					MW1D (27.5-32.5')	



ECOPLANS MW REPORT BHLOGS - OPG.GPJ GINT STD CANADA LAB.GDT 7/15/10

Figure No. **A-1**

LOG OF BOREHOLE MW1D

Project No. **550286**
Project: **Highway 407 East Extension**
Location: **OPG Darlington Soil Mound**
Date Drilled: **1/21/10**
Drill Type: **CME 75 - Track Mount**
Drilling Contractor: **Lantech Drilling Services Inc.**

● SPT (N) Value

DEPTH (m bgs)	SYMBOL	SOIL DESCRIPTION	WELL	GROUNDWATER	SOIL SAMPLE NAME	SOIL SAMPLE TEST	Standard Penetration Test N Value (20 40 60 80) / Total Organic Volatiles (ppm) (400 800 1200 1600)
118.09		- wet *(continued)*			MW1D (32.5-37.5')	BNAs, PCBs, metals, PHCs, BTEX, radionuclides	0 ▲ 89 ●
					MW1D (37.5-42.5')		0 ▲ 26 ●
115.34			▼		MW1D (42.5-47.5')		0 ▲ 83 ●
					MW1D (47.5-52.5')	metals, PHCs, BTEX	0.1 ▲ 100 ●
					MW1D (52.5-57.5')		0 ▲ 92 ●
111.03		**SILT TILL** - brown - trace cobbles - trace shiny gravel - dense - low plasticity - dry			MW1D (57.5-62.5')	metals, PHCs, BTEX	0 ▲ 100 ●
109.81		End of borehole at 18.3 m					

ECOPLANS MW REPORT BHLOGS - OPG.GPJ GINT STD CANADA LAB.GDT 7/15/10

Figure No. **A-2**

LOG OF BOREHOLE MW1S

Project No. **550286**
Project: **Highway 407 East Extension**
Location: **OPG Darlington Soil Mound**
Date Drilled: **1/21/10**
Drill Type: **CME 75 - Track Mount**
Drilling Contractor: **Lantech Drilling Services Inc.**

● SPT (N) Value
▲ Total Organic Volatiles (ppm)

DEPTH (m bgs)	SYMBOL	SOIL DESCRIPTION	WELL	GROUNDWATER	SOIL SAMPLE NAME	SOIL SAMPLE TEST	Standard Penetration Test N Value (20 40 60 80) / Total Organic Volatiles (ppm) (400 800 1200 1600)
128.08							
127.77		**SILTY CLAY FILL** - brown/grey - trace gravel - trace organics - dense - low plasticity - moist.			MW1D (0-2.5')		▲0.1 ●51
		SILTY SAND FILL - brown/grey - trace organics - fine grained - low plasticity - moist.			MW1D (2.5-5')	metals, PHCs, BTEX	▲0.1 ●65
					MW1D (5-7.5')		▲0 ●12
125.64		**SAND FILL** - grey - trace silt - loose - fine grained - low plasticity - dry			MW1D (7.5-10')		▲0.1 ●28
124.73					MW1D (10-12.5')		▲0 ●27
124.57		- seam of silty clay - highly oxidized - moist			MW1D (12.5-15')		▲0.1 ●100
123.51					MW1D (15-17.5')	metals, PHCs, BTEX	▲0.1 ●21
122.75					MW1D (17.5-20')		▲0.1 ●53
122.68		- rock fragments - wet			MW1D (20-22.5')		▲31
					MW1D (22.5-27.5')		▲0.1 ●60
					MW1D (27.5-32.5')		▲0 ●67

ECOPLANS MW REPORT BHLOGS - OPG.GPJ GINT STD CANADA LAB.GDT 7/15/10

Figure No. **A-2**

LOG OF BOREHOLE MW1S

Project No. **550286**
Project: **Highway 407 East Extension**
Location: **OPG Darlington Soil Mound**
Date Drilled: **1/21/10**
Drill Type: **CME 75 - Track Mount**
Drilling Contractor: **Lantech Drilling Services Inc.**

● SPT (N) Value

DEPTH (m bgs)	SYMBOL	SOIL DESCRIPTION	WELL	GROUNDWATER	SOIL SAMPLE NAME	SOIL SAMPLE TEST	Standard Penetration Test N Value (20, 40, 60, 80) / Total Organic Volatiles (ppm) (400, 800, 1200, 1600)
118.08		- wet *(continued)*			MW1D (32.5-37.5')	BNAs, PCBs, metals, PHCs, BTEX, radionuclides	0 ▲ ● 89
116.72							
114.36		End of borehole at 13.7 m					

ecoplans Limited

Figure No. **A-3**

LOG OF BOREHOLE MW2D

Project No. **550286**
Project: **Highway 407 East Extension**
Location: **OPG Darlington Soil Mound**
Date Drilled: **1/19/10**
Drill Type: **CME 75 - Track Mount**
Drilling Contractor: **Lantech Drilling Services Inc.**

● SPT (N) Value
▲ Total Organic Volatiles (ppm)

DEPTH (m bgs)	SYMBOL	SOIL DESCRIPTION	WELL	GROUNDWATER	SOIL SAMPLE NAME	SOIL SAMPLE TEST	Standard Penetration Test N Value (20 40 60 80) / Total Organic Volatiles (ppm) (400 800 1200 1600)
130.90		**SILTY CLAY FILL** - grey/brown - trace gravel - trace organics for 5' - dense - low plasticity - dry to moist.			MW2D (0-2.5')		0 ▲ 39 ●
					MW2D (2.5-5')		0 ▲ 23 ●
					MW2D (5-7.5')	PHCs, BTEX, metals	0 ▲ 24 ●
128.61		**SAND FILL** - grey - trace silt - fine grained - loose - low plasticity - dry to moist.			MW2D (7.5-10')		0 ▲ 50 ●
					MW2D (10-12.5')		0 ▲ 21 ●
127.09		- silty sand			MW2D (12.5-15')		0 ▲ 30 ●
					MW2D (15-17.5')		0 ▲ 39 ●
125.72		- dry			MW2D (17.5-20')		0 ▲ 53 ●
					MW2D (20-22.5')	PHCs, BTEX, metals	0 ▲ 40 ●
					MW2D (22.5-27.5')		0 ▲ 60 ●
					MW2D (27.5-32.5')		0 ▲ 48 ●
121.76		- moist					

ECOPLANS MW REPORT BHLOGS - OPG.GPJ GINT STD CANADA LAB.GDT 7/15/10

Figure No. **A-3**

LOG OF BOREHOLE MW2D

Project No. **550286**
Project: **Highway 407 East Extension**
Location: **OPG Darlington Soil Mound**
Date Drilled: **1/19/10**
Drill Type: **CME 75 - Track Mount**
Drilling Contractor: **Lantech Drilling Services Inc.**

● SPT (N) Value

DEPTH (m bgs)	SYMBOL	SOIL DESCRIPTION	WELL	GROUNDWATER	SOIL SAMPLE NAME	SOIL SAMPLE TEST	Standard Penetration Test N Value (20 40 60 80) / Total Organic Volatiles (ppm) (400 800 1200 1600)
120.90		- moist *(continued)*			MW2D (32.5-37.5')	PHCs, BTEX, metals	0, 72
120.23		- wet			MW2D (37.5-42.5')		0, 48
118.69					MW2D (42.5-47.5')	PHCs, BTEX, metals	0, 82
					MW2D (47.5-52.5')		0
					MW2D (52.5-57.5')		0, 71
					MW2D (57.5-62.5')	BNAs, PCBs, PHCs, BTEX, metals	0, 60
111.39		**SILT TILL** - brown - trace cobbles			MW2D (62.5-67.5')	radionuclides	0, 22

ECOPLANS MW REPORT BHLOGS - OPG.GPJ GINT STD CANADA LAB.GDT 7/15/10

ecoplans Limited

Figure No. **A-3**

LOG OF BOREHOLE MW2D

Project No. **550286**
Project: **Highway 407 East Extension**
Location: **OPG Darlington Soil Mound**
Date Drilled: **1/19/10**
Drill Type: **CME 75 - Track Mount**
Drilling Contractor: **Lantech Drilling Services Inc.**

● SPT (N) Value

DEPTH (m bgs)	SYMBOL	SOIL DESCRIPTION	WELL	GROUNDWATER	SOIL SAMPLE NAME	SOIL SAMPLE TEST	Standard Penetration Test N Value (20 40 60 80) / Total Organic Volatiles (ppm) (400 800 1200 1600)
110.90		- dense - low plasticity - dry. End of borehole at 19.8 m					

ECOPLANS MW REPORT BHLOGS - OPG.GPJ GINT STD CANADA LAB.GDT 7/15/10

ecoplans Limited

Figure No. **A-4**

LOG OF BOREHOLE MW2S

Project No. **550286**
Project: **Highway 407 East Extension**
Location: **OPG Darlington Soil Mound**
Date Drilled: **1/20/10**
Drill Type: **CME 75 - Track Mount**
Drilling Contractor: **Lantech Drilling Services Inc.**

● SPT (N) Value
▲ Total Organic Volatiles (ppm)

DEPTH (m bgs)	SYMBOL	SOIL DESCRIPTION	WELL	GROUNDWATER	SOIL SAMPLE NAME	SOIL SAMPLE TEST	Standard Penetration Test N Value (20 40 60 80) / Total Organic Volatiles (ppm) (400 800 1200 1600)
130.96		**SILTY CLAY FILL** - grey/brown - trace gravel - trace organics for 5' - dense - low plasticity - dry to moist.			MW2D (0-2.5')		0 ▲ 39 ●
					MW2D (2.5-5')		0 ▲ 23 ●
					MW2D (5-7.5')	PHCs, BTEX, metals	0 ▲ 24 ●
128.68		**SAND FILL** - grey - trace silt - fine grained - loose - low plasticity - dry to moist.			MW2D (7.5-10')		0 ▲ 50 ●
					MW2D (10-12.5')		0 ▲ 21 ●
127.15		- silty sand			MW2D (12.5-15')		0 ▲ 30 ●
					MW2D (15-17.5')		0 ▲ 39 ●
125.78		- dry			MW2D (17.5-20')		0 ▲ 53 ●
					MW2D (20-22.5')	PHCs, BTEX, metals	0 ▲ 40 ●
					MW2D (22.5-27.5')		0 ▲ 60 ●
					MW2D (27.5-32.5')		0 ▲ 48 ●
121.82		- moist					

ECOPLANS MW REPORT BHLOGS - OPG.GPJ GINT STD CANADA LAB.GDT 7/15/10

ecoplans Limited

Figure No. **A-4**

LOG OF BOREHOLE MW2S

Project No. **550286**
Project: **Highway 407 East Extension**
Location: **OPG Darlington Soil Mound**
Date Drilled: **1/20/10**
Drill Type: **CME 75 - Track Mount**
Drilling Contractor: **Lantech Drilling Services Inc.**

● SPT (N) Value

DEPTH (m bgs)	SYMBOL	SOIL DESCRIPTION	WELL	GROUNDWATER	SOIL SAMPLE NAME	SOIL SAMPLE TEST	Standard Penetration Test N Value (20 40 60 80) / Total Organic Volatiles (ppm) (400 800 1200 1600)
120.96		- moist *(continued)*			MW2D (32.5-37.5')	PHCs, BTEX, metals	0 ▲ 72 ●
120.30		- wet					
					MW2D (37.5-42.5')		0 ▲ 48 ●
118.75							
118.01		End of borehole at 13.0 m					

ECOPLANS MW REPORT BHLOGS - OPG.GPJ GINT STD CANADA LAB.GDT 7/15/10

ecoplans Limited

Figure No. **A-5**

LOG OF BOREHOLE MW3D

Project No. **550286**
Project: **Highway 407 East Extension**
Location: **OPG Darlington Soil Mound**
Date Drilled: **1/18/10**
Drill Type: **CME 75 - Track Mount**
Drilling Contractor: **Lantech Drilling Services Inc.**

● SPT (N) Value
▲ Total Organic Volatiles (ppm)

DEPTH (m bgs)	SYMBOL	SOIL DESCRIPTION	WELL	GROUNDWATER	SOIL SAMPLE NAME	SOIL SAMPLE TEST	Standard Penetration Test N Value (20 40 60 80) / Total Organic Volatiles (ppm) (400 800 1200 1600)
132.43		**SILTY CLAY FILL** - brown/grey - trace organics - dense - low plasticity - moist.			MW3D (0-2.5')		0 ▲, 70 ●
131.67		**SAND FILL** - grey - trace silt - loose - fine grained - low plasticity - dry.			MW3D (2.5-5')	PHCs, BTEX, metals	0.1 ▲, 38 ●
					MW3D (5-7.5')		0 ▲, 33 ●
					MW3D (7.5-10')		0 ▲, 40 ●
					MW3D (10-12.5')	PHCs, BTEX, metals	0.1 ▲, 31 ●
					MW3D (12.5-15')		0 ▲, 31 ●
127.86		- silty sand - dry to moist			MW3D (15-17.5')		0 ▲, 23 ●
					MW3D (17.5-20')	BNAs, PCBs, metals	0 ▲, 12 ●
					MW3D (20-22.5')		0 ▲, 21 ●
					MW3D (22.5-25')	PHCs, BTEX	0.1 ▲, 23 ●
124.81		- dry			MW3D (25-27.5')		0 ▲, 36 ●
					MW3D (27.5-30')		0 ▲, 38 ●
123.29		- sand			MW3D (30-32.5')		0 ▲, 26 ●

ECOPLANS MW REPORT BHLOGS - OPG.GPJ GINT STD CANADA LAB.GDT 7/15/10

Figure No. **A-5**

LOG OF BOREHOLE MW3D

Project No. **550286**
Project: **Highway 407 East Extension**
Location: **OPG Darlington Soil Mound**
Date Drilled: **1/18/10**
Drill Type: **CME 75 - Track Mount**
Drilling Contractor: **Lantech Drilling Services Inc.**

● SPT (N) Value

DEPTH (m bgs)	SYMBOL	SOIL DESCRIPTION	WELL	GROUNDWATER	SOIL SAMPLE NAME	SOIL SAMPLE TEST	Standard Penetration Test N Value (20 40 60 80) / Total Organic Volatiles (ppm) (400 800 1200 1600)
122.43		- sand *(continued)*			MW3D (32.5-35')		0 39
121.76		- wet			MW3D (35-37.5')		0 19
120.47					MW3D (37.5-40')	radionuclides, PHCs, BTEX, metals	0 12
					MW3D (40-45')		0 7
					MW3D (45-50')		0 21
					MW3D (50-55')		0 13
115.67		**SILT TILL** - brown - trace cobbles - dense - low plasticity - dry.			MW3D (55-60')	PHCs, BTEX, metals	0 74
					MW3D (60-65')		0 89
112.92		End of borehole at 19.5 m					

ECOPLANS MW REPORT BHLOGS - OPG.GPJ GINT STD CANADA LAB.GDT 7/15/10

ecoplans Limited

Figure No. **A-6**

LOG OF BOREHOLE MW3S

Project No. **550286**
Project: **Highway 407 East Extension**
Location: **OPG Darlington Soil Mound**
Date Drilled: **1/18/10**
Drill Type: **CME 75 - Track Mount**
Drilling Contractor: **Lantech Drilling Services Inc.**

● SPT (N) Value
▲ Total Organic Volatiles (ppm)

DEPTH (m bgs)	SYMBOL	SOIL DESCRIPTION	WELL	GROUNDWATER	SOIL SAMPLE NAME	SOIL SAMPLE TEST	Standard Penetration Test N Value (20 40 60 80) / Total Organic Volatiles (ppm) (400 800 1200 1600)
132.47		**SILTY CLAY FILL** - brown/grey - trace organics - dense - low plasticity - moist.			MW3D (0-2.5')		0 ▲ 70 ●
131.71		**SAND FILL** - grey - trace silt - loose - fine grained - low plasticity - dry.			MW3D (2.5-5')	PHCs, BTEX, metals	0.1 ▲ 38 ●
					MW3D (5-7.5')		0 ▲ 33 ●
					MW3D (7.5-10')		0 ▲ 40 ●
					MW3D (10-12.5')	PHCs, BTEX, metals	0.1 ▲ 31 ●
					MW3D (12.5-15')		0 ▲ 31 ●
127.90		- silty sand - dry to moist			MW3D (15-17.5')		0 ▲ 23 ●
					MW3D (17.5-20')	BNAs, PCBs, metals	0 ▲ 12 ●
					MW3D (20-22.5')		0 ▲ 21 ●
					MW3D (22.5-25')	PHCs, BTEX	0.1 ▲ 23 ●
124.85		- dry			MW3D (25-27.5')		0 ▲ 36 ●
					MW3D (27.5-30')		0 ▲ 38 ●
123.33		- sand			MW3D (30-32.5')		0 ▲ 26 ●

ECOPLANS MW REPORT BHLOGS - OPG.GPJ GINT STD CANADA LAB.GDT 7/15/10

ecoplans Limited

Figure No. **A-6**

LOG OF BOREHOLE MW3S

Project No. **550286**
Project: **Highway 407 East Extension**
Location: **OPG Darlington Soil Mound**
Date Drilled: **1/18/10**
Drill Type: **CME 75 - Track Mount**
Drilling Contractor: **Lantech Drilling Services Inc.**

● SPT (N) Value

DEPTH (m bgs)	SYMBOL	SOIL DESCRIPTION	WELL	GROUNDWATER	SOIL SAMPLE NAME	SOIL SAMPLE TEST	Standard Penetration Test N Value (20 40 60 80) / Total Organic Volatiles (ppm) (400 800 1200 1600)
122.47		- sand *(continued)*			MW3D (32.5-35')		0 **39**
121.80		- wet			MW3D (35-37.5')		0 **19**
120.52					MW3D (37.5-40')	radionuclides, PHCs, BTEX, metals	0.1 **12**
120.28		End of borehole at 12.2 m					

ECOPLANS MW REPORT BHLOGS - OPG.GPJ GINT STD CANADA LAB.GDT 7/15/10

Figure No. **A-7**

LOG OF BOREHOLE MW4

Project No. **550286**
Project: **Highway 407 East Extension**
Location: **OPG Darlington Soil Mound**
Date Drilled: **1/26/10**
Drill Type: **CME 75 - Track Mount**
Drilling Contractor: **Lantech Drilling Services Inc.**

● SPT (N) Value
▲ Total Organic Volatiles (ppm)

DEPTH (m bgs)	SYMBOL	SOIL DESCRIPTION	WELL	GROUNDWATER	SOIL SAMPLE NAME	SOIL SAMPLE TEST	Standard Penetration Test N Value (20 40 60 80) / Total Organic Volatiles (ppm) (400 800 1200 1600)
121.02							
120.87		**TOPSOIL** - dark brown - trace organics - loose - low plasticity - moist.			MW4 (0-2.5')		0 ▲ 23 ●
119.50		**SAND** - dark brown - trace silt - fine grained - loose - moist. - trace organics.			MW4 (2.5-5')	metals, PHCs, BTEX	0 ▲ 18 ●
119.04		- wet.			MW4 (5-7.5')	metals	0 ▲ 11 ●
118.74							
118.49		**SAND AND GRAVEL** - brown - coarse grained - loose - wet.			MW4 (7.5-10')	BNAs, PCBs, PHCs, BTEX	0 ▲ 30 ●
117.67					MW4 (10-12.5')	metals	0 ▲ 100 ●
117.21		**SILT TILL** - brown - trace cobbles - dense - low plasticity - dry.			MW4 (12.5-15')	PHCs, BTEX	0 ▲ 100 ●
		End of borehole at 4.6 m					

Figure No. **A-8**

LOG OF BOREHOLE MW5

Project No. **550286**
Project: **Highway 407 East Extension**
Location: **OPG Darlington Soil Mound**
Date Drilled: **1/26/10**
Drill Type: **CME 75 - Track Mount**
Drilling Contractor: **Lantech Drilling Services Inc.**

● SPT (N) Value
▲ Total Organic Volatiles (ppm)

DEPTH (m bgs)	SYMBOL	SOIL DESCRIPTION	WELL	GROUNDWATER	SOIL SAMPLE NAME	SOIL SAMPLE TEST	Standard Penetration Test N Value (20 40 60 80) / Total Organic Volatiles (ppm) (400 800 1200 1600)
117.16		**TOPSOIL** - dark brown - trace rock - trace organics - loose - low plasticity - moist.			MW5 (0-2.5')		0 ▲ 36 ●
116.55		**SILTY SAND** - dark brown - trace rock - fine grained - loose - low plasticity - moist.			MW5 (2.5-5')	metals, PHCs, BTEX	0 ▲ 19 ●
115.33		- brown			MW5 (5-7.5')	PHCs, BTEX	0 ▲ 15 ●
114.87							
114.72		- grey					
114.57		- black seam for 6"			MW5 (7.5-10')	BNAs, PCBs, metals	0 ▲ 10 ●
114.42							
114.33		**SILT TILL** - brown - trace cobbles - dense - low plasticity - moist.			MW5 (10-12.5')	metals, PHCs, BTEX	0 ▲ 65 ●
113.81		- dry					
113.35		End of borehole at 3.8 m					

Figure No. **A-9**

LOG OF BOREHOLE MW6

Project No. **550286**
Project: **Highway 407 East Extension**
Location: **OPG Darlington Soil Mound**
Date Drilled: **1/27/10**
Drill Type: **CME 75 - Track Mount**
Drilling Contractor: **Lantech Drilling Services Inc.**

● SPT (N) Value
▲ Total Organic Volatiles (ppm)

DEPTH (m bgs)	SYMBOL	SOIL DESCRIPTION	WELL	GROUNDWATER	SOIL SAMPLE NAME	SOIL SAMPLE TEST	Standard Penetration Test N Value (20 40 60 80) / Total Organic Volatiles (ppm) (400 800 1200 1600)
116.27		**TOPSOIL** - dark brown - trace organics - loose to dense - low plasticity - moist.			MW6 (0-2.5')	metals, PHCs, BTEX	0 ▲ 34 ●
115.66		**SILTY SAND** - dark brown - trace organics for 3' - fine grained - loose - low plasticity - moist.			MW6 (2.5-5')		0 ▲ 33 ●
					MW6 (5-7.5')	BNAs, PCBs, metals, PHCs, BTEX	0 ▲ 17 ●
113.83		- brown - trace rock			MW6 (7.5-10')		0 ▲ 37 ●
113.22		- wet					
112.91		**SILT TILL** - brown - trace cobbles - dense - low plasticity - moist.			MW6 (10-12.5')	metals, PHCs, BTEX	0 ▲ 44 ●
112.30							
112.07		-dry			MW6 (12.5-15')		0 ▲ 100 ●
111.69		End of borehole at 4.6 m					

ecoplans Limited

Figure No. **A-10**

LOG OF BOREHOLE MW7

Project No. **550286**
Project: **Highway 407 East Extension**
Location: **OPG Darlington Soil Mound**
Date Drilled: **1/27/10**
Drill Type: **CME 75 - Track Mount**
Drilling Contractor: **Lantech Drilling Services Inc.**

● SPT (N) Value
▲ Total Organic Volatiles (ppm)

DEPTH (m bgs)	SYMBOL	SOIL DESCRIPTION	WELL	GROUNDWATER	SOIL SAMPLE NAME	SOIL SAMPLE TEST	Standard Penetration Test N Value (20 40 60 80) / Total Organic Volatiles (ppm) (400 800 1200 1600)
110.95							
110.80		**TOPSOIL** - dark brown - trace organics - dense to loose - low plasticity - moist.			MW7 (0-2.5')		0 ▲ 26 ●
		SILTY SAND - dark brown to brown - trace oraganics for 4' - trace rock for 4' - fine grained - loose - low plasticity - moist.			MW7 (2.5-5')		0 ▲ 32 ●
					MW7 (5-7.5')	metals, PHCs, BTEX	0 ▲ 11 ●
108.66							
108.51		- wet					
		SAND - grey - medium grained - loose - low plasticity - wet.			MW7 (7.5-10')		0 ▲ 37 ●
107.83							
107.75		**SILT** - brown - trace rock - low plasticity - moist.			MW7 (10-12.5')	metals, PHCs, BTEX	0 ▲ 62 ●
107.44							
106.99		**SAND AND COBBLES** - grey - coarse grained - low plasticity - wet.			MW7 (12.5-15')	metals, PHCs, BTEX	0 ▲ 100 ●
		SAND - brown - trace silt - fine grained - dense - low plasticity - wet.			MW7 (15-17.5')		0 ▲ 100 ●
105.62							
		End of borehole at 4.6 m					

ECOPLANS MW REPORT BHLOGS - OPG.GPJ GINT STD CANADA LAB.GDT 7/15/10

ecoplans Limited

Figure No. **A-11**

LOG OF BOREHOLE BH1

Project No. **550286**

Project: **Highway 407 East Extension**

Location: **OPG Darlington Soil Mound** Co-ordinates **681476E,4861023N**

Date Drilled: **1/25/10** Logged By:

Drill Type: **CME 75 - Track Mount** Checked By:

Drilling Contractor **Lantech Drilling Services Inc.**

● SPT (N) Value

▲ Total Organic Volatiles (ppm)

DEPTH (m bgs) (m asl)	LITHOLOGY	SOIL DESCRIPTION	SOIL SAMPLE NAME	SOIL SAMPLE TEST	Standard Penetration Test N Value (20 40 60 80) / Total Organic Volatiles (ppm) (400 800 1200 1600)
0.30		**SANDY SILT FILL** - brown/grey - trace organics - trace gravel - fine grained - loose to dense - low plasticity - wet.	BH1 (0-2.5')		0 ▲ ● 17
			BH1 (2.5-5')	PHCs, BTEX	0 ▲ ● 38
1.83		**SAND FILL** - grey - trace silt - trace gravel - fine grained - loose - low plasticity - wet.	BH1 (5-7.5')	metals	0 ▲ ● 10
2.44		**SANDY SILT FILL** - grey - fine grained - dense - low plasticity - moist.	BH1 (7.5-10')		0 ▲ ● 37
3.05		**SILT FILL** - brown - trace gravel - dense - low plasticity - moist.	BH1 (10-12.5')	radionuclides	0 ▲ ● 13
4.27		**SILTY SAND FILL** - grey - fine grained - loose - low plasticity - wet.	BH1 (12.5-15')	metals, PHCs, BTEX	0 ▲ ● 13
4.57		**SILT FILL** - brown - trace gravel - dense - low plasticity - moist.	BH1 (15-17.5')	PHCs, BTEX	0 ▲ ● 100
		SAND FILL - grey - trace silt - fine grained - loose - low plasticity - wet.	BH1 (17.5-20')		0 ▲ ● 45
6.40		**SAND AND GRAVEL** - brown - coarse grained - loose - low plasticity - wet.	BH1 (20-22.5')	BNAs, PCBs, metals	0 ▲ ● 80
6.86		**SILT TILL** - brown - trace cobbles - dense - low plasticity - dry	BH1 (22.5-25')	metals, PHCs, BTEX	0 ▲ ● 100
7.62		End of borehole at 7.62 m			

ECOPLANS BH REPORT BHLOGS - OPG.GPJ GINT STD CANADA LAB.GDT 7/15/10

ecoplans Limited

Figure No. **A-12**

LOG OF BOREHOLE BH2

Project No. **550286**

Project: **Highway 407 East Extension**

Location: **OPG Darlington Soil Mound** Co-ordinates **681626E,4861070N**

Date Drilled: **1/25/10** Logged By:

Drill Type: **CME 75 - Track Mount** Checked By:

Drilling Contractor **Lantech Drilling Services Inc.**

● SPT (N) Value

▲ Total Organic Volatiles (ppm)

DEPTH (m bgs) (m asl)	LITHOLOGY	SOIL DESCRIPTION	SOIL SAMPLE NAME	SOIL SAMPLE TEST	Standard Penetration Test N Value (20 40 60 80) / Total Organic Volatiles (ppm) (400 800 1200 1600)
		SILT FILL - brown - trace gravel - trace rock - dense - low plasticity - wet.	BH2 (0-2.5')		0 ▲ 30 ●
			BH2 (2.5-5')	metals, PHCs, BTEX	0 ▲ 14 ●
1.83		**SAND FILL** - brown/grey - trace silt - fine grained - loose - low plasticity - wet.	BH2 (5-7.5')		0 ▲ 14 ●
			BH2 (7.5-10')		0 ▲ 11 ●
			BH2 (10-12.5')		0 ▲ 27 ●
			BH2 (12.5-15')	metals, PHCs, BTEX	0 ▲ 26 ●
			BH2 (15-17.5')		0 ▲ 32 ●
			BH2 (17.5-20')	BNAs, PCBs, metals, PHCs, BTEX	0 ▲ 81 ●
6.10		- brown - trace gravel	BH2 (20-22.5')	radionuclides	0 ▲ 93 ●
7.32		- silty sand	BH2 (22.5-25')		0 ▲ 89 ●
7.62		**SILT TILL** - brown - dense - low plasticity - dry.	BH2 (25-27.5')	metals, PHCs, BTEX	0 ▲ 100 ●
8.38		End of borehole at 8.38 m			

ECOPLANS BH REPORT BHLOGS - OPG.GPJ GINT STD CANADA LAB.GDT 7/15/10

ecoplans Limited

Figure No. **A-13**

LOG OF BOREHOLE BH3

Project No. **550286**

Project: **Highway 407 East Extension**

Location: **OPG Darlington Soil Mound** Co-ordinates **681786E,4861104N**

Date Drilled: **1/25/10** Logged By:

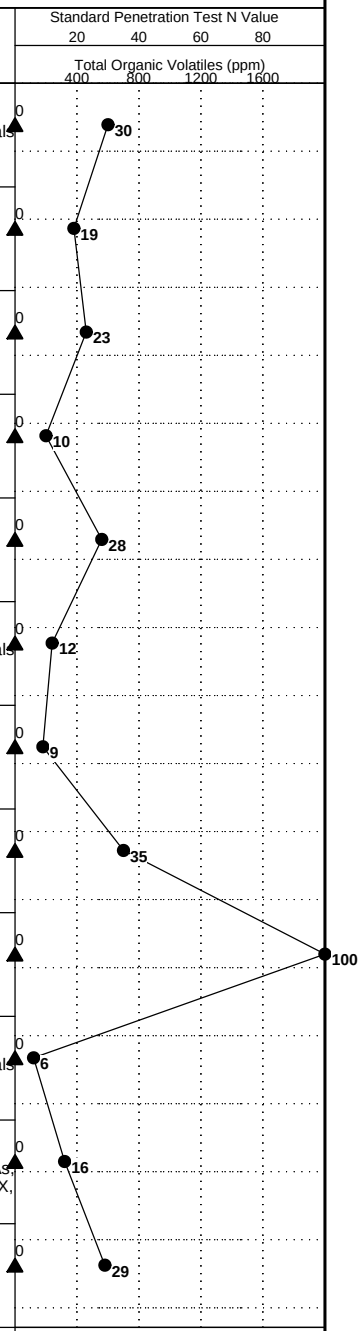
Drill Type: **CME 75 - Track Mount** Checked By:

Drilling Contractor **Lantech Drilling Services Inc.**

● SPT (N) Value

▲ Total Organic Volatiles (ppm)

DEPTH (m bgs) (m asl)	LITHOLOGY	SOIL DESCRIPTION	SOIL SAMPLE NAME	SOIL SAMPLE TEST
0.61		**SILTY SAND FILL** - brown - trace organics - loose to dense - low plasticity - wet.	BH3 (0-2.5')	PHCs, BTEX, metals
		SAND FILL - brown - trace silt - fine grained - loose - low plasticity - wet.	BH3 (2.5-5')	
			BH3 (5-7.5')	
2.74			BH3 (7.5-10')	
		- silty sand - brown/grey - moist.		
3.35			BH3 (10-12.5')	
		- sand - grey - wet.	BH3 (12.5-15')	PHCs, BTEX, metals
			BH3 (15-17.5')	
			BH3 (17.5-20')	
			BH3 (20-22.5')	
			BH3 (22.5-25')	PHCs, BTEX, metals
7.92			BH3 (25-27.5')	radionuclides, BNAs, PCBs, PHCs, BTEX, metals
		- silty sand - dense.		
8.38		**SILT TILL** - brown - trace cobbles - dense - low plasticity - dry.	BH3 (27.5-30')	
9.14		End of borehole at 9.14 m		



ECOPLANS BH REPORT BHLOGS - OPG.GPJ GINT STD CANADA LAB.GDT 7/15/10

ecoplans Limited

Figure No. **A-14**

LOG OF BOREHOLE BH4

Project No. **550286**

Project: **Highway 407 East Extension**

Location: **OPG Darlington Soil Mound** Co-ordinates **681923E,4861134N**

Date Drilled: **1/26/10** Logged By:

Drill Type: **CME 75 - Track Mount** Checked By:

Drilling Contractor **Lantech Drilling Services Inc.**

● SPT (N) Value

▲ Total Organic Volatiles (ppm)

DEPTH (m bgs) (m asl)	LITHOLOGY	SOIL DESCRIPTION	SOIL SAMPLE NAME	SOIL SAMPLE TEST	Standard Penetration Test N Value (20 40 60 80) / Total Organic Volatiles (ppm) (400 800 1200 1600)
0.15		**SANDY SILT FILL** - brown - trace organics - dense to loose - low plasticity - moist.	BH4 (0-2.5')		0 ▲ 26 ●
		SAND FILL - brown/grey - trace silt - fine grained - loose - low plasticity - moist.	BH4 (2.5-5')	metals, PHCs, BTEX	0 ▲ 52 ●
			BH4 (5-7.5')		0 ▲ 25 ●
2.44		- wet	BH4 (7.5-10')		0 ▲ 23 ●
			BH4 (10-12.5')	metals, PHCs, BTEX	0 ▲ 10 ●
			BH4 (12.5-15')		0 ▲ 10 ●
			BH4 (15-17.5')	BNAs, PCBs, metals, PHCs, BTEX	0.1 ▲ 7 ●
5.49					
5.64		**SANDY SILT** - black - trace organics - dense - low plasticity - moist.	BH4 (17.5-20')	radionuclides	0 ▲ 18 ●
5.94		**SAND AND GRAVEL** - brown/black - low plasticity - moist.	BH4 (20-22.5')	metals, PHCs, BTEX	0 ▲ 17 ●
		SILT TILL - brown - trace cobbles - dense - low plasticity - dry.	BH4 (22.5-25')		0 ▲ 79 ●
7.62		End of borehole at 7.62 m			

ECOPLANS BH REPORT BHLOGS - OPG.GPJ GINT STD CANADA LAB.GDT 7/15/10

ecoplans Limited

Figure No. **A-15**

LOG OF BOREHOLE BH5

Project No. **550286**

Project: **Highway 407 East Extension**

Location: **OPG Darlington Soil Mound** Co-ordinates **682052E,4861159N**

Date Drilled: **1/26/10** Logged By:

Drill Type: **CME 75 - Track Mount** Checked By:

Drilling Contractor **Lantech Drilling Services Inc.**

● SPT (N) Value

▲ Total Organic Volatiles (ppm)

DEPTH (m bgs) (m asl)	LITHOLOGY	SOIL DESCRIPTION	SOIL SAMPLE NAME	SOIL SAMPLE TEST	Standard Penetration Test N Value (20 40 60 80) / Total Organic Volatiles (ppm) (400 800 1200 1600)
0.15		**SILT FILL** - dark brown - trace gravel - trace organics - dense - low plasticity - moist.	BH5 (0-2.5')		0 ▲ ● 17
		SILTY SAND FILL - brown - loose - low plasticity - moist	BH5 (2.5-5')		0 ▲ ● 24
			BH5 (5-7.5')	metals, PHCs, BTEX	0 ▲ ● 14
2.29		- trace rock - wet.	BH5 (7.5-10')	radionuclides	0 ▲ ● 29
2.74		- sandy silt			
3.35			BH5 (10-12.5')	BNAs, PCBs, metals PHCs, BTEX	0 ▲ ● 100
3.51		- black seam of sandy silt			
3.66		**SILT TILL** - brown - trace cobbles - dense - low plasticity - dry.	BH5 (12.5-15')	metals, PHCs, BTEX	0 ▲ ● 58
4.57		End of borehole at 4.57 m			

ECOPLANS BH REPORT BHLOGS - OPG.GPJ GINT STD CANADA LAB.GDT 7/15/10

APPENDIX K

Non-Standard Special Provision

DEWATERING AT DEEP CUT AREAS - Item No.

Non-Standard Special Provision

Scope

Deep Cut Areas – The contractor shall be alerted that the groundwater level at the Deep Cut Area within the existing soil disposal mound (South Service Road West STA 11+850 to 12+500) was measured to be at about Elevation 117 m at the west limit to about Elevation 121 m at the east limit of the soil disposal mound. It is estimated that the proposed South Service Road West subgrade profile will be constructed to depths up to about 6 m below the groundwater levels measured in the piezometers at this deep cut area. In addition, possible perched water could also be present within the existing cohesive fill material. The cut slopes consist of water-bearing silty sand, sandy silt, sand and silt and clayey silt layers at varying depths and thicknesses. Dewatering ahead of deep cut excavations at these locations will be required and the excavation shall be kept stable during the work. If excavation operations are to progress during wet periods of the year (i.e. Spring and Fall), erosion control measures may be required to be implemented to groundwater seepage.

If sufficient time is not available in the construction schedule to allow for gravity drainage of the groundwater within the deep cut, a dewatering program should be implemented prior to the start of excavation below the water table. The dewatering system could consist of pumping from either drilled well points or properly filtered sumps excavated in a line along the slope face immediately upslope of where the proposed excavation grade meets the elevation of the existing water table (i.e. 117 m to 121 m).

Basis of Payment

Payment at the contract price for the above tender item shall be full compensation for all labour, equipment and materials required to do the work.

END OF SECTION

At Golder Associates we strive to be the most respected global group of companies specializing in ground engineering and environmental services. Employee owned since our formation in 1960, we have created a unique culture with pride in ownership, resulting in long-term organizational stability. Golder professionals take the time to build an understanding of client needs and of the specific environments in which they operate. We continue to expand our technical capabilities and have experienced steady growth with employees now operating from offices located throughout Africa, Asia, Australasia, Europe, North America and South America.

Africa	+ 27 11 254 4800
Asia	+ 852 2562 3658
Australasia	+ 61 3 8862 3500
Europe	+ 356 21 42 30 20
North America	+ 1 800 275 3281
South America	+ 55 21 3095 9500

solutions@golder.com
www.golder.com

Golder Associates Ltd.
6925 Century Avenue, Suite #100
Mississauga, Ontario, L5N 7K2
Canada
T: +1 (905) 567 4444

Golder Associates