REVISED REPORT

January 2011
Revised February 2011

FOUNDATION INVESTIGATION AND DESIGN REPORT

Retained Soil System Walls
Widening of Highway 7/8
From 1.9 km West of Fischer-Hallman Road Interchange
Easterly to 0.8 km East of Courtland Avenue Interchange
Kitchener
GWP 131-98-00
Ministry of Transportation, Ontario - West Region

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Report Number: 08-1132-084-1-R10
Geocres No. 40P8-191
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PART A

FOUNDATION INVESTIGATION REPORT

RETAINED SOIL SYSTEM WALLS
WIDENING OF HIGHWAY 7/8
FROM 1.9 KM WEST OF FISCHER-HALLMAN ROAD INTERCHANGE EASTERLY TO 0.8 KM EAST OF COURTLAND AVENUE INTERCHANGE, KITCHENER
GWP 131-98-00
MINISTRY OF TRANSPORTATION, ONTARIO - WEST REGION

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Golder Associates

1.0 INTRODUCTION

Golder Associates Ltd. (Golder Associates) has been retained by Dillon Consulting Limited (Dillon) on behalf of the Ministry of Transportation, Ontario (MTO) to carry out foundation investigations as part of the detail design work for GWP 131-98-00, the reconstruction and widening of Highway 7/8. This report presents the results of the foundation investigation conducted for the proposed six sections of retained soil system (RSS) walls located between Westmount Road and the Courtland Avenue interchange along Highway 7/8.

The purpose of the foundation investigation is to determine the subsurface conditions at the locations of the proposed RSS walls by drilling boreholes and carrying out in situ testing and laboratory testing on selected samples. The terms of reference for the scope of work are outlined in the MTO's Request for Proposal, Golder Associates' proposal P81-3002 dated April 8, 2008, our letters dated July 21 and 22, 2008 and our revised scope of work letter dated April 13, 2010. The work was carried out in accordance with our Quality Control Plan for Foundation Engineering dated July 4, 2008.

Dillon provided Golder Associates with preliminary drawings showing the approximate locations of the walls in digital format.

2.0 SITE DESCRIPTION

2.1 General

The project area of Highway 7/8 is located in the south-central portion of Kitchener, Ontario. The site extends from 1.9 km west of Fischer-Hallman Road easterly to 0.8 km east of Courtland Avenue. The location of the project is shown on the Key Plan, Figure 1.

This section of Highway 7/8 is currently a four lane divided highway oriented generally east-west. Four overpass structures at Westmount Road, Homer Watson Boulevard, Ottawa Street South and Courtland Avenue East, one underpass structure at Fischer-Hallman Road, and an overhead structure at the Canadian National Railway (CNR) tracks are situated within the project limits.

Land use adjacent to this site is typically urban residential north of Highway 7/8 with predominantly industrial, commercial and with occasional residential areas to the south.

The proposed retained soil system walls to be constructed for the roadway platform widening are between Stations 14+180 and 16+889 along Highway 7/8 and are as follows:

1. Station 14+180 LT to Station 14+300 LT
2. Station 14+185 RT to Station 14+300 RT
3. Station 16+028 LT to Station 16+592 LT
4. Station 16+350 RT to Station 16+635 RT
5. Station 16+655 LT to Station 16+866 LT
6. Station 16+665 RT to Station 16+889 RT

2.2 Site Geology

This project lies within the physiographic region of southwestern Ontario known as the Waterloo Hills[1]. The soils generally consist of sandy hills; some consist of sandy till while others are kames or kame moraines, with outwash sands deposited in the valleys. Adjoining the sandy hills is the Grand River spillway system comprised of alluvial terraces of sand and gravel.

Based on the Ministry of Natural Resources (MNR) Quaternary Geology Maps 2508 and 2559 for the Cambridge and Stratford Areas, respectively, of Southern Ontario, the topography is hummocky and the site lies in an area of primarily ice contact sands deposited during the Pleistocene era. Stream alluvium, consisting of gravel, sand,

[1] L.J. Chapman and D.F. Putnam: The Physiography of Southern Ontario, Third Edition. Ontario Geological Survey, Special Volume 2, 1984.

silt and clay is reported to be present along Schneider Creek and Shoemaker Creek just west of Westmount Road.

The Geologic Survey of Canada Map 1263A entitled “Geology, Toronto-Windsor Area, Ontario” indicates that the subcropping bedrock in the area of site is dolomite and mudstone of the Salina formation of Upper Silurian age. Based on the MNR Map P.1985 entitled “Bedrock Topography Series, Cambridge Area, Southern Ontario”, the bedrock surface from just west of the CNR Overhead to the Courtland Interchange subcrops at about elevation 267 to 275 metres or some 70 to 78 metres below ground surface. MNR Map P.168 entitled “Bedrock Topography Series, Stratford Area, Southern Ontario”, indicates that, in the area of the Westmount Road Overpass, the bedrock surface is near elevation 259 metres or some 78 to 79 metres below the ground surface.

3.0 INVESTIGATION PROCEDURES

The foundation investigation field work for the design of the retained soil system walls was carried out between May 10 and 27, 2010 during which time sixteen boreholes were drilled along Highway 7/8 between Westmount Road and the Courtland Avenue interchange in the areas shown on the Key Plan, Figure 1. The borehole locations are shown on the Borehole Location Plans, Drawings 1 to 6.

In total, sixteen boreholes (901 to 915 and 903A) were advanced to depths of 9.1 to 14.2 metres at or within the immediate vicinity of the proposed RSS retaining walls. This information was supplemented with thirteen boreholes advanced for other components of this project as follows:

- Borehole 105 (Geocres No. 40P8-173)
- Boreholes 307 and 309 (Geocres No. 40P7-55)
- Boreholes 406 and 409 (Geocres No. 40P8-176)
- Boreholes 502, 503, 506 and 507 (Geocres No. 40P8-175)
- Boreholes 511, 512 and 513 (Geocres No. 40P9-193)
- Borehole 925 (Geocres No. 40P8-185)

The subsurface conditions for each section of the proposed RSS walls are presented on Drawings 1 to 6. It should be noted that the soil profiles are based on the foundation investigation information presented on the Record of Borehole sheets and these include the subsurface conditions obtained for deeper boreholes drilled for other components of this project. For the design of the retained soil system walls, the stratigraphy below depths of 11 to 15 metres below ground surface or elevations 310 to 324 metres in boreholes 105, 309, 406, 409, 502, 503, 506 and 507 has been omitted from the soil profiles. Similarly, grain size distribution data and the Atterberg limits data for these boreholes deeper than 11 to 15 metres below ground surface have not been included in Appendix A. The complete stratigraphy for the deeper boreholes are presented in the Record of Borehole sheets.

The table below summarizes the borehole locations, ground surface elevations at the borehole locations and the borehole depths:

Borehole	Location (m)		Ground Surface Elevation	Borehole Depth
	Northing	Easting	(m)	(m)
105	4 810 336	225 380	331.14	29.05
307	4 809 744	223 644	338.45	15.70
309	4 809 772	223 638	338.36	19.51
406	4 810 501	226 211	321.99	40.08
409	4 810 530	226 174	322.86	18.75

Borehole	Location (m)		Ground Surface Elevation	Borehole Depth
	Northing	Easting	(m)	(m)
502	4 810 488	225 983	326.23	21.79
503	4 810 477	225 941	326.75	18.75
506	4 810 456	225 966	326.32	41.39
507	4 810 466	226 013	325.80	21.79
511	4 810 419	225 835	327.62	9.60
512	4 810 442	225 916	326.92	11.13
513	4 810 406	225 793	328.00	9.60
901	4 809 787	223 688	337.83	9.60
902	4 809 802	223 736	337.27	9.60
903	4 809 755	223 682	337.86	11.28
903A	4 809 755	223 683	337.86	14.17
904	4 809 772	223 737	337.34	10.36
905	4 810 357	225 450	330.61	9.60
906	4 810 372	225 512	330.22	9.60
907	4 810 391	225 585	329.61	9.14
908	4 810 408	225 659	328.96	9.60
909	4 810 423	225 730	328.39	9.60
910	4 810 442	225 802	327.80	9.60
911	4 810 391	225 746	328.36	9.60
912	4 810 506	226 048	325.28	9.60
913	4 810 519	226 110	324.15	9.60
914	4 810 480	226 083	324.33	9.60
915	4 810 489	226 142	323.20	9.60
925	4 810 460	225 872	327.21	9.60

The field work was carried out using truck mounted and track mounted CME 45 power augers supplied and operated by a specialist drilling contractor. In the boreholes, samples of the overburden were obtained at 0.75 and 1.5 metre intervals of depth using 50 millimetre outside diameter split spoon sampling equipment in accordance with the standard penetration test (SPT) procedures. The samplers used in the investigations limit the maximum particle size that can be sampled and tested to about 40 millimetres. Therefore, particles or objects that may exist within the soils that are larger than this dimension will not be sampled or represented in the grain size distributions. Larger particle sizes, including cobbles and boulders, are known to be present in the glacial till deposits as discussed in the text of this report. In addition, two dynamic cone penetration tests were carried out adjacent to boreholes 903 and 903A to further characterize the soils at these locations.

The groundwater conditions were observed in the boreholes throughout the drilling operations and following completion of the field work. During the foundation investigation field work, 12.5 millimetre diameter slotted section standpipes were installed in boreholes 907 and 911 to monitor the groundwater conditions. The groundwater observations are noted on the Record of Borehole sheets and are shown on the sections on Drawings 1 to 6. The boreholes were backfilled in accordance with current MTO procedures and Ontario Regulation 372/07.

The field work was monitored on a full-time basis by experienced members of our engineering staff who located the boreholes in the field, monitored the drilling, sampling and in situ testing operations, logged the boreholes and surveyed the borehole locations and elevations. The samples were identified in the field, placed in labelled containers and transported to our London laboratory for further examination and testing. Index and classification tests consisting of water content determinations, grain size distribution analyses and Atterberg limits determinations were carried out on selected samples. The results of the testing are shown on the Record of Borehole sheets and are provided in Appendix A.

4.0 SUBSURFACE CONDITIONS

4.1 Site Stratigraphy – General

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

The boreholes drilled at the site generally encountered highly variable ground conditions, ranging from surficial topsoil and / or variable layers of fill underlain by clayey silt, clayey silt till, silty clay, silt, silty sand, sand, sandy silt and sand and gravel.

Materials designated as topsoil in this report were classified solely based on visual and textural evidence. Testing of organic content or for other nutrients was not carried out. Therefore, the use of materials classified as topsoil cannot be relied upon for support and growth of landscaping vegetation.

The borehole locations are shown on Drawings 1 to 6. A detailed description of the subsurface conditions encountered in the boreholes is provided on the Record of Borehole sheets and a summary for each section of wall is provided below.

4.2 Station 14+180 to Station 14+300 LT

Boreholes 309, 901 and 902 were advanced to determine the subsurface conditions for the design of the retained soil system wall proposed between the east end of the Westmount Road overpass structure and Station 14+300 LT, along Highway 7/8. For clarity, the soil conditions below a depth of 15 metres or below elevation 324.0 metres from borehole 309 have not been discussed. The borehole locations and the soil profile are presented on Drawing 1.

4.2.1 Pavements

Asphaltic concrete was encountered at the ground surface in all boreholes. The thickness of the asphalt ranged from 90 to 180 millimetres. In borehole 309, asphalt fragments were also found within the granular fill between elevations 333.2 and 333.8 metres.

The asphalt at all borehole locations was underlain by granular base materials 180 to 220 millimetres thick and then by granular subbase materials 250 to 330 millimetres thick. The granular subbase in borehole 309 contained cobbles.

4.2.2 Fill

Fill was encountered underlying the roadbase materials in all boreholes from elevations 336.6 to 337.7 metres. In boreholes 309 and 902, the fill was typically comprised of cohesive fill with a layer of granular fill near elevation 334 metres. In borehole 901, a 2.4 metre thick layer of cohesive fill was found overlying the predominantly granular fill. The thickness of the embankment fill ranged from 6.0 to 7.2 metres. The thickness of the cohesive fill layers varied from 1.5 to 3.8 metres in all boreholes. The granular fill layers ranged from 0.3 to 3.0 metres in thickness.

The granular fill was predominantly comprised of sand and gravel, sandy silt and sand with intermittent layers of topsoil being found in borehole 901. The granular fill was loose to compact with N values ranging from 7 to 26 blows per 0.3 metres and the water contents generally varied from 4 to 17 per cent.

The cohesive fill was typically comprised of clayey silt and was firm to very stiff with N values ranging from 5 to 21 blows per 0.3 metres. The water contents varied from 10 to 21 per cent. The cohesive fill is of low plasticity based on the Atterberg limits test data. The plastic limit, liquid limit and plasticity index ranges were 13 to 16, 18 to 20 and 5 to 7 per cent, respectively. The Atterberg limits results for the test performed on the cohesive fill layers are presented on Figure A-14, Appendix A.

Layers of topsoil fill were encountered in borehole 901 at elevations 331.9 and 330.7 metres. The average thickness of the topsoil fill layers was 0.3 metres. The topsoil fill was inferred to be compact to dense and had water contents of 9 to 13 per cent.

The results of the grain size testing conducted on samples of the granular and cohesive fill layers are presented on Figures A-2 and A-5, respectively.

4.2.3 Topsoil

An approximately 460 millimetre thick layer of topsoil was found beneath the fill in boreholes 901 and 902. In addition, traces of topsoil were also found in the fill layers in these boreholes. The topsoil was encountered from elevations 329.7 and 330.1 metres.

The topsoil had N values of 9 to 26 blows per 0.3 metres with water contents of 28 to 32 per cent.

4.2.4 Silty Sand

A 3.0 metre thick layer of very loose to dense silty fine sand was encountered beneath the fill in borehole 309 from elevation 331.7 metres.

The silty sand had N values from 2 to 41 blows per 0.3 metres with the silty sand being generally compact above the groundwater level and loose below the groundwater level. Water contents of the silty sand samples were 13 to 22 per cent.

The gradation of a sample of silty fine sand is presented on Figure A-10.

4.2.5 Sand and Gravel

A layer of very dense sand and gravel was encountered underlying the topsoil in borehole 901 from elevation 329.6 metres. The thickness of the sand and gravel was 0.8 metres.

The sand and gravel was very dense with an N value of 57 blows per 0.3 metres. The sand and gravel had a water content of 11 per cent.

4.2.6 Organic Silt

A soft to very stiff layer of organic silt was encountered underlying the silty fine sand in borehole 309 at elevation 328.6 metres. The organic silt was approximately 1.3 metres thick.

The organic silt had N values of 2 to 19 blows per 0.3 metres with water contents of 32 to 52 per cent.

4.2.7 Sandy Silt

A layer of sandy silt was found underlying the organic silt in borehole 309 at elevation 327.3 metres. The thickness of the sandy silt layer is approximately 0.6 metres. The sandy silt is compact based on an inferred standard penetration test N value of 19 blows per 0.3 metres.

4.2.8 Clayey Silt

Layers of clayey silt were encountered in boreholes 309 and 902 from elevations 326.8 and 329.2 metres, respectively. The clayey silt was found underlying the sandy silt in borehole 309 and underlying the topsoil in

borehole 902. The thickness of the clayey silt was 6.1 metres in borehole 309. Borehole 902 was terminated in clayey silt after exploring the layer for 1.5 metres.

The clayey silt layers were stiff to very stiff above elevation 324 metres and had N values of 14 to 19 blows per 0.3 metres. The water contents for clayey silt layers were 17 to 18 per cent. The clayey silt is of low plasticity based on the Atterberg limits test data. The plastic limits, liquid limits and plasticity indices were 16 and 17, 32 and 34 and 16 and 18 per cent, respectively. The Atterberg limits results for test performed on samples of the clayey silt are shown on Figure A-15.

The results of the grain size testing conducted on selected clayey silt samples obtained during standard penetration testing are presented on Figure A-6.

4.2.9 Clayey Silt Till

Clayey silt till was encountered in borehole 901 at elevation 328.8 metres. The clayey silt till was found underlying a layer of sand and gravel. Borehole 901 was terminated in the clayey silt till after exploring the layer for 0.6 metres.

The very stiff clayey silt till had an N value of 25 blows per 0.3 metres and a water content of 15 per cent.

Although not specifically encountered in borehole 901, cobbles and boulders should be anticipated in the clayey silt till due to the depositional history of this material.

4.2.10 Groundwater Conditions

The groundwater conditions in the boreholes were monitored during drilling. The observed groundwater conditions are noted on the Record of Borehole sheets and on Drawing 1 and are summarized in the following text and table.

Summary of Encountered Groundwater Levels

Borehole	Ground Surface Elevation	Encountered Groundwater Level	
		Depth	Elevation
	(m)	(m)	(m)
309	338.36	9.1	329.3
901	337.83	Dry	-
902	337.27	Dry	-

Groundwater was encountered at elevation 329.3 metres in borehole 309. Boreholes 901 and 902 were dry during drilling. Grey soils were encountered in boreholes 901 and 902. The elevations of the encountered grey soils were comparable with the water level observed in borehole 309.

The inferred groundwater level at this site is at elevation 329.0 metres. The above-noted encountered groundwater levels not are considered to be representative of the long-term, stabilized groundwater conditions as the readings were taken for a short duration only. The inferred groundwater level is based on encountered groundwater levels and the colour change from brown to grey soils. The groundwater levels are expected to fluctuate due to climatic and seasonal variations.

4.3 Station 14+185 to Station 14+300 RT

Boreholes 307, 903, 903A and 904, located at approximately 50 metres intervals, were drilled to determine the subsurface conditions for the design of the retained soil system wall proposed between the east end of the Westmount Road overpass structure and Station 14+300 RT along Highway 7/8. It should be noted that, due to the poor quality of fill at the location of borehole 903, this borehole was extended deeper (903A) to further assess the native soils at depth. The soil profile is presented on Drawing 2.

4.3.1 Pavements

Asphaltic concrete was encountered at the ground surface in boreholes 307, 903 and 904. The thickness of the asphalt ranged from 120 to 150 millimetres. The asphalt was underlain by granular base and subbase materials 390 to 550 millimetres thick. The subbase materials in boreholes 903 and 904 contained cobbles.

4.3.2 Fill

Fill was encountered underlying the roadbase granular in all boreholes between elevations 336.7 and 337.8 metres. With the exception of borehole 307, the fill was typically comprised of variable layers of granular and cohesive fill. The fill in borehole 307 was comprised of cohesive material. The granular fill layers were between 0.8 and 2.3 metres thick in borehole 903 and between 0.5 and 1.3 metres thick in borehole 904. The thicknesses of the cohesive fill layers are 7.5 metres in borehole 307, 0.4 to 2.2 metres in borehole 903 and 0.7 to 3.3 metres in borehole 904.

Topsoil fill was found at elevation 331.2 metres in borehole 903. The topsoil fill layer was 0.8 metres thick, had an N value of 7 blows per 0.3 metres and a water content of 27 per cent.

The granular fill was predominantly comprised of silty sand, sandy silt and sand with traces of topsoil. Clay tile fragments were encountered in borehole 903 between elevations 328.1 and 329.5 metres. The fill was loose to

compact with N values between 3 and 29 blows per 0.3 metres and water contents ranging from 5 to 19 per cent.

The cohesive fill was typically comprised of soft to hard clayey silt and had N values that ranged from 3 to 33 blows per 0.3 metres. The water contents were 10 to 20 per cent. The cohesive fill layer is of low plasticity based on the Atterberg limits test data. The plastic limit, liquid limit and plasticity index ranges were 13 to 17 per cent, 22 to 30 per cent and 7 to 13 per cent, respectively.

An Atterberg limits test was carried out on a silt/sand layer within the clayey silt fill in borehole 307, which confirmed that the fill near elevation 335 metres was non-plastic. The Atterberg limits results for the tests performed on the cohesive fill materials are presented on Figure A-14.

The results of the grain size testing conducted on samples of the granular and cohesive fill layers are presented on Figures A-2, A-3 and A-5.

4.3.3 Topsoil

A layer of buried topsoil was found in borehole 904 underlying the fill from elevation 329.7 metres. The topsoil was approximately 0.6 metres thick.

The topsoil had an N value of 9 blows per 0.3 metres and a water content of 21 per cent.

4.3.4 Sandy Silt

A layer of sandy silt was found in borehole 307 from elevation 330.2 metres. The sandy silt contained thin peat layers below elevation 329.5 metres. The 1.8 metre thick layer of sandy silt was found underlying layers of fill.

The sandy silt was dense to very dense with N values of 45 and 51 blows per 0.3 metres. A water content of 40 per cent was measured on a sample of the sandy silt containing thin layers of peat.

4.3.5 Silty Sand

Layers of loose to dense silty fine sand were encountered in boreholes 307 and 903A from elevations 328.4 metres and 328.1 metres, respectively. The silty fine sand was found underlying sandy silt in borehole 307 and underlying fill in borehole 903A. The silty fine sand layers were 1.7 and 3.1 metres thick.

The silty sand had N values of 6 to 46 blows per 0.3 metres. The water contents ranged from 9 to 18 per cent.

The results of grain size testing conducted on silty sand samples obtained during standard penetration testing are presented on Figure A-10.

4.3.6 Clayey Silt Till

Clayey silt till was encountered in borehole 904 at elevation 329.1 metres beneath the buried topsoil. The thickness of the clayey silt till layer was 1.5 metres.

The stiff to very stiff clayey silt till had N values of 11 and 20 blows per 0.3 metres and a water content of 14 per cent. The results of the Atterberg limits tests indicate that the clayey silt till is of low plasticity. The plastic limit, liquid limit and plasticity index for a clayey silt till sample were 14, 24 and 10 per cent, respectively. The Atterberg limits results for the test performed on the clayey silt till are shown on Figure A-15.

The gradation of a clayey silt till sample recovered from the standard penetration testing is shown on Figure A-7. Although not specifically encountered in the borehole, cobbles and boulders should be anticipated in the clayey silt till due to the depositional history of this material.

4.3.7 Sand

Loose to compact sand layers were encountered in boreholes 307, 903 and 904 at elevations 323.8, 328.1 and 327.6 metres, respectively. The sand was found underlying clayey silt in borehole 307, underlying layers of fill in borehole 903 and underlying clayey silt till in borehole 904. Boreholes 307, 903 and 904 were terminated in the sand after exploring the layer for 0.6 to 1.5 metres.

The N values in the sand ranged from 6 to 19 blows per 0.3 metres with water contents of 13 to 16 per cent.

4.3.8 Sand and Gravel

A 1.1 metre thick layer of sand and gravel was encountered in borehole 903A at elevation 326.4 metres. The loose to compact sand and gravel was found underlying silty fine sand.

The sand and gravel had N values of 6 to 24 blows per 0.3 metres.

4.3.9 Clayey Silt

Layers of clayey silt were encountered in boreholes 307 and 903A at elevations 325.3 and 325.4 metres, respectively. The clayey silt was encountered beneath silty fine sand in borehole 307 and underlying sand and gravel in borehole 903A. Where fully penetrated, the thickness of the clayey silt was 1.5 metres. Borehole 903A was terminated in the clayey silt after exploring the layer for 1.7 metres.

The clayey silt was firm to very stiff with N values of 6 to 27 blows per 0.3 metres. The water content was 15 per cent. The clayey silt is of low plasticity based on the Atterberg limits test data, giving a plastic limit, a liquid limit and a plasticity index of 12, 19 and 7 per cent, respectively. The Atterberg limits results for the test performed on a sample of the clayey silt are shown on Figure A-15.

The results of the grain size testing conducted on a clayey silt sample are presented on Figure A-6.

4.3.10 Groundwater Conditions

The groundwater conditions in the boreholes were monitored during drilling. The observed groundwater conditions are noted on the Record of Borehole sheets and on Drawing 2 and are summarized in the following text and table.

Borehole	Ground Surface Elevation	Encountered Groundwater Level	
		Depth	Elevation
	(m)	(m)	(m)
307	338.45	10.7	327.8
903	337.86	8.4	329.5
903A	337.86	11.3	326.6
904	337.34	9.8	327.5

The groundwater was encountered in the boreholes between elevations 326.6 and 329.5 metres.

The inferred groundwater level at this site is at elevation 329.0 metres. The above-noted encountered groundwater levels are not considered to be representative of the long-term, stabilized groundwater conditions as the readings were taken for a short duration only. The inferred groundwater level is based on encountered groundwater levels. The groundwater levels are expected to fluctuate due to climatic and seasonal variations.

4.4 Station 16+028 to Station 16+592 LT

Boreholes 105, 503, 905 through 910 and 925 were advanced to determine the subsurface conditions for the design of the proposed RSS retaining wall between the Ottawa Street South overpass structure and the CNR Overhead structure, between Stations 16+028 and 16+592 LT, along Highway 7/8. For clarity, the soil conditions below 11 to 15 metres or below elevation 316.0 metres from boreholes 105 and 503 are not discussed. The soil profile is presented on Drawing 3.

4.4.1 Pavements

Asphaltic concrete was encountered at the ground surface in boreholes 105, 503, 909, 910 and 925. The thickness of the asphalt ranged from 80 to 150 millimetres. The asphaltic concrete at all five borehole locations was underlain by granular base and subbase materials that varied in thickness from 220 to 400 millimetres. A granular subbase layer 850 millimetres thick was found beneath the granular base in borehole 105 at elevation 330.6 metres. The subbase material was compact with an N value of 18 blows per 0.3 metres.

4.4.2 Topsoil

Topsoil was encountered at the ground surface in boreholes 905 through 908. Layers of buried topsoil were also encountered at depth underlying layers of fill in boreholes 503 and 925 at elevations 318.1 and 321.0 metres, respectively. The thickness of the topsoil ranged from 90 to 490 millimetres. Further, traces of topsoil were also encountered within the fill layers in borehole 503 at elevation 319.3 metres, borehole 907 at elevation 329.2 metres, borehole 909 at elevations 323.4 and 325.3 metres and borehole 925 at elevations 322.0 and 324.3 metres. The water contents of samples of the topsoil were 14 and 16 per cent.

4.4.3 Fill

Fill was encountered underlying the asphaltic concrete or topsoil in all boreholes from elevations 326.4 to 330.2 metres. The thickness of the fill ranged from 1.8 metres in borehole 105 to 8.3 metres in borehole 503. The fill generally comprised layers of sand and gravel, sand, sandy silt, silty sand and silt. In borehole 503, layers of cohesive fill was found between layers of the granular fill. In borehole 909, a layer of cohesive fill was found within the granular fill at elevation 323.7 metres. The granular fill layers were 0.9 to 6.3 metres thick and the cohesive fill layers were 0.3 to 1.5 metres thick.

The granular fill was very loose to very dense with N values varying from 2 to 60 blows per 0.3 metres and water contents of 3 to 20 per cent.

The cohesive fill was typically stiff to hard clayey silt with N values ranging from 10 to 36 blows per 0.3 metres. Water contents varied from 7 to 26 per cent. The lowest water content was measured in a cohesive fill sample containing some gravel.

The results of the grain size testing conducted on samples of the granular fill layers are presented on Figures A-1 and A-3.

4.4.4 Silty Clay

Layers of silty clay were encountered in boreholes 907, 910 and 925 from elevations 320.5 to 326.6 metres. The silty clay was found underlying layers of fill and/or topsoil. The silty clay layers were 0.8 to 2.1 metres thick.

The N values in the very stiff to hard silty clay ranged from 18 to 35 blows per 0.3 metres. The water contents were 16 to 21 per cent. The silty clay is of intermediate plasticity based on plastic limit, liquid limit and plasticity index ranges of 20 to 22, 39 to 41 and 19 to 21 per cent, respectively. The results of the Atterberg limits tests are presented on Figure A-15.

The grain size distribution curves for the silty clay deposits are shown on Figure A-8.

4.4.5 Sand

Compact to very dense sand layers were encountered between elevations 319.7 and 328.3 metres in all boreholes with the exception of boreholes 503 and 910. The sand layers were found beneath layers of fill in boreholes 105, 905, 906, 908 and 909 and underlying the silty clay in boreholes 907 and 925. In boreholes 905 and 906, the sand was interlayered with clayey silt or clayey silt till and, in boreholes 105 and 908, the sand was interlayered with sand and gravel. Where fully penetrated, the sand layers ranged from 0.8 to 7.2 metres in thickness. Boreholes 906 through 909 were terminated in sands after exploring the layers for 1.1 to 3.7 metres.

N values in the compact to very dense sand layers varied between 17 and 85 blows per 0.3 metres. The sand had water contents of 3 to 18 per cent, with the exception of a sample with a water content of 25 per cent in borehole 907 below the groundwater level at elevation 321.8 metres.

The grain size distribution curves for selected sand samples are shown on Figure A-11.

4.4.6 Clayey Silt Till

A 1.2 metre thick layer of clayey silt till was encountered in borehole 906 from elevation 325.5 metres. The clayey silt till was found between layers of sand.

The hard clayey silt till had N values of 37 and 40 blows per 0.3 metres and a water content of 13 per cent. Although not specifically encountered in borehole 906, cobbles and boulders should be anticipated in the clayey silt till due to the depositional history of this material.

4.4.7 Clayey Silt

Layers of clayey silt were encountered in boreholes 503, 905, 906, 910 and 925 from elevations 317.9 to 325.1 metres. The clayey silt was encountered underlying a layer of buried topsoil in borehole 503. In boreholes 905, 906 and 925, the clayey was found below sand layers. The thickness of the clayey silt layers ranged from 0.4 to 2.0 metres. Borehole 925 was terminated in a clayey silt layer after exploring it for 0.5 metres.

The very stiff to hard clayey silt deposits had N values of 16 to 70 blows per 0.3 metres with water contents of 15 to 18 per cent. The clayey silt was of low plasticity based on the Atterberg limits test data with plastic limits, liquid limits and plasticity indices of 16 and 18, 33 and 35 and 16 and 19 per cent, respectively. The Atterberg limits results for the tests performed on clayey silt samples are shown on Figure A-15.

The results of the grain size testing conducted on selected clayey silt samples obtained during standard penetration testing are presented on Figure A-6.

4.4.8 Silt

Compact to very dense layers of silt were encountered in boreholes 105, 503 and 905 from elevations 316.7 to 322.4 metres. The silt was found underlying the sand in boreholes 105 and 905 and underlying the clayey silt in borehole 503. The thicknesses of the silt layers were 0.4 to 3.7 metres.

The compact to very dense silt had N values of 23 to greater than 100 blows per 0.3 metres with a water content of 20 per cent.

A grain size distribution curve for a silt sample is shown on Figure A-9.

4.4.9 Sand and Gravel

Layers of compact to very dense silty sand and gravel to sand and gravel were encountered in boreholes 105 and 908 from elevations 320.4 and 322.3 metres, respectively. The sand and gravel was found overlying sand in both boreholes. The thickness of the sand and gravel layers were 2.3 and 1.5 metres in boreholes 105 and 908, respectively.

The N values for the sand and gravel ranged from 23 blows to greater than 100 blows per 0.3 metres. Water contents of 9 to 11 per cent were measured on the sand and gravel samples.

The grain size distribution curves for sand and gravel samples obtained during standard penetration testing are presented on Figure A-13.

4.4.10 Silty Sand

Layers of compact to dense silty fine sand were encountered in boreholes 905 and 910 at elevations 321.6 and 319.2 metres, respectively. The silty sand was found at depth underlying the silt in borehole 905 and underlying the clayey silt in borehole 910. Both boreholes were terminated in the silty sand after exploring the layers for 0.6 to 1.0 metres.

The silty sand had N values from 15 to 40 blows per 0.3 metres.

4.4.11 Sandy Silt

A layer of sandy silt was found beneath the silty clay in borehole 910 from elevation 319.8 metres. The thickness of the stratum was 0.2 metres.

The compact sandy silt had an inferred N value of 21 blows per 0.3 metres with a water content of 18 per cent.

4.4.12 Groundwater Conditions

The groundwater conditions in all of these boreholes were monitored during and upon completion of drilling. The observed groundwater conditions are noted on the Record of Borehole sheets and on Drawing 3 and are summarized in the following text and tables.

Summary of Encountered Groundwater Levels

Borehole	Ground Surface Elevation	Encountered Groundwater Level	
		Depth	Elevation
	(m)	(m)	(m)
105*	331.14	-	-
503	326.75	10.0	316.8
905	330.61	Dry	Below 321.0
906	330.22	Dry	Below 320.6
907	329.61	6.1	323.5
908	328.96	6.9	322.1
909	328.39	6.1	322.3
910	327.80	8.0	319.8
925	327.21	8.4	318.8

*Due to the use of wash boring techniques, the groundwater level could not be established at borehole 105.

Summary of Measured Groundwater Levels

Borehole	Ground Surface Elevation (m)	Installation	Measured Groundwater Elevation (m)			
			Following Installation	Jun 02/10	June 30/10	Nov 25, 2010
907	329.61	Standpipe	322.42	323.69	323.54	323.01

The groundwater level in borehole 105 could not be established due to the use of washboring techniques. Boreholes 905 and 906 were dry during drilling. The groundwater levels in boreholes 905 and 906 was assumed to be below the base of those boreholes since grey soils were not encountered. Groundwater was encountered in the remaining boreholes between elevation 316.8 and 323.5 metres.

A 12.5 millimetre diameter standpipe was installed in borehole 907. Post drilling groundwater monitoring for borehole 907 commenced on June 2, 2010 and the final most recent reading was obtained on November 25, 2010.

The inferred groundwater level at this site varies from elevation 323.0 metres at Ottawa Street South decreasing to elevation 317.0 metres towards the CNR Overhead structure. The above-noted encountered groundwater levels are not considered to be representative of the long-term, stabilized groundwater conditions as the readings were taken for a short duration only. The inferred groundwater levels are based on the encountered and measured groundwater levels. The groundwater levels are expected to fluctuate due to climatic and seasonal variations.

4.5 Station 16+350 to Station 16+635 RT

Boreholes 506, 511, 512, 513 and 911 were drilled along the proposed RSS retaining wall between Station 16+350 and the CNR Overhead, Station 16+635 RT. For clarity, the soil conditions from borehole 506 have been omitted below a depth of 14 metres or below elevation 312.0 metres. The soil profile is presented on Drawing 4.

4.5.1 Pavements

Asphaltic concrete was encountered from the ground surface in all boreholes with the exception of borehole 911. The thickness of the asphalt ranged from 100 to 150 millimetres. The asphalt was underlain by granular base and subbase materials 300 to 550 millimetres thick. Granular roadbase was also encountered beneath the topsoil in borehole 911.

4.5.2 Topsoil

An 80 millimetre thick layer of topsoil was encountered at the ground surface in borehole 911. Traces of topsoil were also found in the fill materials in boreholes 506 at elevation 316.8 metres and borehole 512 at elevations 323.3 and 319.9 metres.

4.5.3 Fill

Fill between 3.0 and 9.1 metres thick was encountered underlying the pavement structure or topsoil in all boreholes from elevations to 325.6 to 327.9 metres. The fill was generally comprised of layers of sand and gravel, silty sand, sand and sandy silt. In boreholes 506 and 512, a thin layer of cohesive fill was found underlying the granular fill. The granular fill layers ranged from 3.0 to 8.8 metres thick. The cohesive fill layers were generally 0.3 metres thick.

The granular fill was loose to very dense with N values of 10 to greater than 100 blows per 0.3 metres and water contents of 2 to 19 per cent. A sand and gravel fill layer in borehole 506 at elevation 318.5 metres, which contained wood fragments, had a water content of 35 per cent.

The cohesive fill was generally comprised of very stiff clayey silt with N values of 16 and 27 blows per 0.3 metres. Water contents were 5 and 14 per cent. The cohesive fill layer is of low plasticity based on an Atterberg limits determination with a plastic limit, a liquid limit and a plasticity index of 17, 27 and 10 per cent, respectively. The Atterberg limits results for the test performed on the cohesive fill sample are presented on Figure A-14.

The results of the grain size testing conducted on granular fill layers are presented on Figures A-2 and A-3.

4.5.4 Sand and Gravel

A layer of compact sand and gravel was encountered in borehole 513 at elevation 324.5 metres. The 0.7 metre thick layer was found underlying the fill.

The sand and gravel stratum had an N value of 18 blows per 0.3 metres.

4.5.5 Sandy Silt

The fill in borehole 911 was underlain by a 2.3 metre thick layer of sandy silt from elevation 323.9 metres. The sandy silt layer is loose to compact with N values of 9 to 13 blows per 0.3 metres and water contents of 13 to 23 per cent.

4.5.6 Silty Sand

Layers of compact silty sand were encountered in boreholes 511 and 513 at elevations 322.1 and 323.8 metres, respectively. The silty sand was found underlying clayey silt in borehole 511 and underlying sand and gravel in borehole 513. The thickness of the silty sand layers were 1.5 and 2.5 metres in boreholes 511 and 513, respectively.

The silty sand had N values from 10 to 25 blows per 0.3 metres with water contents of 8 to 9 per cent.

The results of grain size testing conducted on silty sand samples obtained during standard penetration testing are presented on Figure A-10.

4.5.7 Clayey Silt Till

A layer of clayey silt till was encountered in borehole 512 at elevation 319.6 metres. The clayey silt till layer was 1.1 metres thick and was found underlying layers of granular fill.

The hard clayey silt till had an N value of 30 blows per 0.3 metres and a water content of 14 per cent. The Atterberg limits tests indicated the clayey silt till to be of low plasticity based on a plastic limit, a liquid limit and a plasticity index of 15, 25 and 10 per cent, respectively. The Atterberg limits results for the test performed on the clayey silt till sample are shown on Figure A-15.

The results of the grain size testing conducted on a clayey silt till sample are presented on Figure A-7. Although not specifically encountered in borehole 512, cobbles and boulders should be anticipated in the clayey silt till due to the depositional history of this material.

4.5.8 Sand

Compact to very dense sand layers were encountered in all boreholes, with the exception of borehole 506, from elevations 318.5 to 321.7 metres. The sand was encountered underlying the silty sand in boreholes 511 and 513, underlying the clayey silt till in borehole 512 and underlying the sandy silt in borehole 911. The thickness of the sand was 1.7 and 1.2 metres for boreholes 512 and 911, respectively. Boreholes 511, 512 (lower layer) and 513 were terminated in sand after exploring the layers for 2.6, 0.2 and 2.9 metres, respectively.

The N values in the sand layers varied from 11 to 63 blows per 0.3 metres with a water content of 14 per cent.

The grain size distribution curve for a sample of sand obtained during standard penetration testing is presented on Figure A-11.

4.5.9 Clayey Silt

Layers of clayey silt were encountered in boreholes 506, 511 and 911 at elevations 316.6, 322.4 and 321.7 metres, respectively. The clayey silt was encountered beneath layers of fill in boreholes 506 and 511. The clayey silt in borehole 506 is also interlayered with silt. The clayey silt in borehole 911 was found beneath a sand layer. The clayey silt layers were 0.4 to 1.8 metres thick.

The stiff to very stiff clayey silt layers had N values of 13 and 26 blows per 0.3 metres with water contents of 19 to 22 per cent. The clayey silt is of low plasticity based on the Atterberg limits determinations with plastic limits, liquid limits and plasticity indices of 11 and 15, 24 and 27 and 12 and 13 per cent, respectively. The results of the Atterberg limits determinations performed on clayey silt samples are shown on Figure A-15.

The gradation of samples of clayey silt from borehole 506 are presented on Figure A-6.

4.5.10 Silty Clay

The clayey silt in borehole 911 was underlain by a layer of silty clay from elevation 320.1 metres. Borehole 911 was terminated in the silty clay after exploring the layer for 1.4 metres.

The N values in the very stiff silty clay were 23 and 28 blows per 0.3 metres.

4.5.11 Silt

Layers of dense to very dense silt were encountered in boreholes 506 and 512 at elevations 314.7 and 316.9 metres, respectively. The silt was interlayered with clayey silt in borehole 506 and sand in borehole 512. The thickness of the silt layers were 1.5 and 0.9 metres in borehole 506 and 512, respectively.

The silt had an N value of 33 blows per 0.3 metres in borehole 506 and was inferred to be very dense based on the N value for the full sample near elevation 316 metres in borehole 512. A water content of 26 per cent was measured on a silt sample.

The gradation of a silt sample is shown on Figure A-9.

4.5.12 Groundwater Conditions

The groundwater conditions in all of these boreholes were monitored during and upon completion of drilling. The observed groundwater conditions are noted on the Record of Borehole sheets and on Drawing 4 and are summarized in the following text and tables.

Summary of Encountered Groundwater Levels

Borehole	Ground Surface Elevation	Encountered Groundwater Level	
		Depth	Elevation
	(m)	(m)	(m)
506	326.32	8.2	318.1
511	327.62	7.3	320.3
512	326.92	8.4	318.5
513	328.00	6.7	321.3
911	328.36	5.2	323.2

Summary of Measured Groundwater Levels

Borehole	Ground Surface Elevation (m)	Installation	Measured Groundwater Elevation (m)			
			Following Installation	Jun 02/10	June 30/10	Nov 25, 2010
911	328.36	Standpipe	320.44	322.21	322.16	321.98

The groundwater level was encountered in all boreholes between elevations 318.1 and 323.2 metres.

A 12.5 millimetre diameter standpipe was installed in borehole 911. Post drilling groundwater monitoring for borehole 911 commenced on June 2, 2010 and the most recent reading was obtained on November 25, 2010.

The inferred groundwater level at this site varies from elevation 322.0 metres at about Station 16+400 RT decreasing to elevation 317.0 metres at the CNR Overhead structure. The above encountered groundwater levels are not considered to be representative of the long-term, stabilized groundwater conditions as the readings were taken for a short duration only. The inferred groundwater levels are based on encountered and measured groundwater levels. The groundwater levels are expected to fluctuate due to climatic and seasonal variations.

4.6 Station 16+655 to Station 16+886 LT

Boreholes 409, 502, 912 and 913 were advanced to determine the subsurface conditions for the design of the RSS wall between the CNR Overhead and the Courtland Avenue interchange (Station 16+655 LT to 16+866 LT). For clarity, the soil conditions below a depth of 11 to 15 metres or below elevation 312.0 metres from borehole 409 and 502 have not been discussed. The soil profile is presented on Drawing 5.

4.6.1 Pavements

Asphaltic concrete was encountered from the ground surface in all boreholes. The thickness of the asphalt ranged from 90 to 150 millimetres. The asphalt in boreholes 502, 912 and 913 was underlain by 250 to 310 millimetres of granular base and subbase. Asphalt fragments were also noted in the fill layer at elevation 321.8 metres in borehole 502.

4.6.2 Fill

Fill 4.2 to 10.2 metres thick was encountered underlying the asphaltic concrete and/or granular base and subbase in all boreholes from elevations 322.7 to 325.8 metres. The fill was generally comprised of granular material consisting of silty fine sand, sandy silt and sand with occasional clayey silt and silty clay layers. The granular fill layers were 1.7 to 7.1 metres thick and the cohesive fill layers were 0.4 to 1.5 metres thick.

The granular fill was loose to very dense with N values of 9 to 100 blows per 0.3 metres and water contents varying from 4 to 18 per cent.

The stiff to hard cohesive fill had N values of 13 to 30 blows per 0.3 metres with water contents of 14 to 19 per cent. The cohesive fill layer is of low plasticity based on the Atterberg limits determinations with plastic limits, liquid limits and plasticity indices of 13 and 15, 20 and 26 and 7 to 12 per cent, respectively. The results of the Atterberg limits determinations performed on the cohesive fill samples are presented on Figure A-14.

The results of the grain size testing conducted on samples of the fill layers are presented on Figures A-1, A-3 and A-5.

4.6.3 Topsoil

Topsoil layers were encountered in all of the boreholes, with the exception of borehole 912, from elevations 313.7 to 319.6 metres. The topsoil layers were 0.4 to 0.9 metres thick. Traces of topsoil were also encountered in the fill in borehole 502 at elevation 316.9 metres, in borehole 912 at elevation 324.9 metres and in borehole 913 at elevation 322.9 metres.

The topsoil had N values of 7 to 26 blows per 0.3 metres with water contents of 16 and 74 per cent.

4.6.4 Silty Fine Sand

Compact to very dense silty fine sand was encountered underlying the topsoil in borehole 913 from elevation 318.8 metres. Borehole 913 was terminated in the silty fine sand after exploring the layer for 4.3 metres.

The silty sand had N values from 16 to 70 blows per 0.3 metres with water contents of 7 to 13 per cent.

A grain size curve for a silty sand sample from borehole 913 is shown on Figure A-10.

4.6.5 Sand

Dense to very dense sand was encountered beneath the fill in borehole 912 at elevation 317.8 metres. Borehole 912 was terminated in sand after exploring the layer for 2.1 metres.

N values in the sand layer ranged from 46 to 89 blows per 0.3 metres.

4.6.6 Silt

Compact layers of silt were found in borehole 502 at elevations 313.0 and 315.2 metres. The silt layers were interlayered with clayey silt and were 0.3 and 0.9 metres in thickness.

The silt had inferred N values of 23 and 26 blows per 0.3 metres with a water content of 20 per cent.

The grain size distribution curve for a silt sample is shown on Figure A-9.

4.6.7 Clayey Silt

Layers of clayey silt were encountered in boreholes 409 and 502 at elevations 312.8 and 315.0 metres, respectively. The clayey silt layers were interlayered with silt in borehole 502 and were found underlying the topsoil in borehole 409. The thickness of the clayey silt layers were 6.1 and 2.0 metres in boreholes 409 and 502, respectively.

The stiff to very stiff clayey silt layers had N values of 13 to 20 blows per 0.3 metres and water contents of 19 and 20 per cent. The clayey silt is of low plasticity based on the Atterberg limits determinations with plastic limits, liquid limits and plasticity indices of 15 to 16, 26 to 27 and 10 to 12 per cent, respectively. The Atterberg limits data for these clayey silt samples are shown on Figure A-15.

The gradation of selected clayey silt samples from borehole 502 are presented on Figure A-6.

4.6.8 Groundwater Conditions

The groundwater conditions in the boreholes were monitored during drilling. The observed groundwater conditions are noted on the Record of Borehole sheets and on Drawing 5 and are summarized in the following text and table.

Summary of Encountered Groundwater Levels

Borehole	Ground Surface Elevation	Encountered Groundwater Level	
		Depth	Elevation
	(m)	(m)	(m)
409	322.86	10.7	312.2
502	326.23	13.1	313.1
912	325.28	Dry	Below 315.7
913	324.15	9.3	314.9

The groundwater level was encountered between elevations 312.2 and 314.9 metres in all of these boreholes except borehole 912. Borehole 912 was dry during drilling and the groundwater level in borehole 912 was assumed to be below the base of the borehole since grey soils were not encountered.

The inferred groundwater level at this site ranges from elevation 312.0 metres adjacent to the Courtland Avenue Interchange increasing to 315.0 metres at the CNR Overhead Structure. The above encountered groundwater levels not are considered to be representative of the long-term, stabilized groundwater conditions as the readings were taken for a short duration only. The inferred groundwater levels are based on encountered groundwater levels. The groundwater levels are expected to fluctuate due to climatic and seasonal variations.

4.7 Station 16+665 to Station 16+889 RT

Boreholes 406, 507, 914 and 915 were drilled to determine the subsurface conditions for the design of the proposed RSS retaining wall between the CNR Overhead and the Courtland Avenue Interchange, Station 16+665 to Station 16+889 RT, along Highway 7/8. For clarity, the soil conditions below a depth of 12 to 15 metres or below elevation 310.0 metres from boreholes 406 and 507 have not been discussed. The soil profile is presented on Drawing 6.

4.7.1 Pavements

Asphaltic concrete was encountered at the ground surface in all boreholes. The thickness of the asphalt ranged from 90 to 150 millimetres. The asphalt was underlain by granular base and subbase material between 310 and 520 millimetres thick. Granular subbase material was found beneath the base granular at borehole 906. The granular subbase was 490 millimetres thick at this location and was loose with an N value of 7 blows per 0.3 metres.

4.7.2 Fill

Fill layers 7.4 to 10.3 metres thick were encountered underlying the pavement structure in all boreholes from elevations 320.9 to 325.3 metres. The fill was generally granular and comprised of sand and gravel, silty sand, sandy silt and sand. Cobbles were encountered in the fill in borehole 914 from elevations 320.5 to 316.3 metres. The granular fill layers were 1.1 to 10.3 metres thick. A 1.1 metre thick layer of cohesive fill was found within the granular fill layers in borehole 915 at elevation 321.4 metres.

The loose to very dense granular fill had N values of 5 to greater than 100 blows per 0.3 metres with water contents of 5 to 21 per cent.

The cohesive fill was comprised of firm to stiff clayey silt and had N values of 7 to 9 blows per 0.3 metres with water contents of 10 and 15 per cent. The cohesive fill layer is of low plasticity based on an Atterberg limits determination with a plastic limit, a liquid limit and a plasticity index of 16, 23 and 8 per cent, respectively. The Atterberg limits results for the test performed on the cohesive fill sample are presented on Figure A-14.

The results of the grain size testing conducted on granular and cohesive fill layers are presented on Figures A-1, A-2, A-4 and A-5.

4.7.3 Topsoil

The fill in boreholes 406 and 914 was underlain by layers of topsoil at elevations 313.5 and 316.0 metres, respectively. The thickness of the topsoil layers were 1.4 and 1.1 metres in boreholes 406 and 914, respectively. Traces of topsoil were also encountered in the fill in boreholes 507, 914 and 915 at elevations 316.8, 316.3 and 315.0 metres, respectively.

The topsoil had N values of 4 to 15 blows per 0.3 metres and water contents of 17 and 29 per cent.

4.7.4 Silt

Compact to dense layers of silt were encountered in boreholes 406 and 507 at elevations 312.1 and 315.1 metres, respectively. The silt is generally overlain by layers of fill and topsoil and is interlayered with clayey silt. The silt layers were 1.7 and 2.4 metres thick in boreholes 406 and 507, respectively.

The silt had N values of 26 to 34 blows per 0.3 metres with a water content of 18 per cent.

The grain size distribution curve for a silt sample recovered during standard penetration testing is shown on Figure A-9.

4.7.5 Silty Clay

Layers of silty clay were encountered in boreholes 914 and 915 at elevations 314.8 and 314.2 metres, respectively. The silty clay was found underlying layers of fill and/or topsoil. Boreholes 914 and 915 were terminated in the silty clay after exploring the layers for 0.1 and 0.6 metres, respectively.

The stiff silty clay had an N value of 11 blows per 0.3 metres.

4.7.6 Clayey Silt

The silt in borehole 507 was underlain by clayey silt from elevation 312.7 metres. The clayey silt was interlayered with silt and was 4.6 metres in thickness.

The stiff clayey silt had N values of 12 and 14 blows per 0.3 metres.

4.7.7 Groundwater Conditions

The groundwater conditions in all of these boreholes were monitored during and upon completion of drilling. The observed groundwater conditions are noted on the Record of Borehole sheets and on Drawing 6 and are summarized in the following text and table.

Summary of Encountered Groundwater Levels

Borehole	Ground Surface Elevation	Encountered Groundwater Level	
		Depth	Elevation
	(m)	(m)	(m)
406	321.99	36.9	285.1
507	325.80	8.5 10.7	317.3 315.1
914	324.33	Dry	Below 314.7
915	323.20	Dry	Below 313.6

The groundwater level was encountered between elevations 285.1 and 317.3 metres in all boreholes except boreholes 914 and 915. Boreholes 914 and 915 were dry during drilling and the groundwater level in these boreholes was assumed to be below the base of the boreholes since grey soils were not intercepted.

The groundwater level encountered at elevation 317.3 metres in borehole 507 is considered to represent perched groundwater in the fill. A deep groundwater level at elevation 285.1 was encountered in borehole 406 which probably represents a deeper water level below the deep cohesive soils in this borehole.

The inferred groundwater level at this site varies from elevations 313.0 metres adjacent to Schneider Creek to 315.0 metres at the CNR Overhead structure. The above-noted encountered groundwater levels are not considered to be representative of the long-term, stabilized groundwater conditions as the readings were taken for a short duration only. The inferred groundwater levels are based on encountered groundwater levels. The groundwater levels are expected to fluctuate due to climatic and seasonal variations.

5.0 MISCELLANEOUS

This investigation was carried out using equipment supplied and operated by Aardvark Drilling Ltd., who is an Ontario Ministry of Environment licensed well contractor. The field operations were supervised by Mr. Michael Arthur, Mr. Matthew Rhody and Mr. Mathew Riopelle under the direction of Mr. David J. Mitchell.

The laboratory testing was carried out at Golder Associates' London laboratory under the direction of Mr. Chris M. Sewell. The laboratory is an accredited participant in the MTO Soil and Aggregate Proficiency Program and is certified by the Canadian Council of Independent Laboratories for testing Types C and D aggregates. This report was prepared by the Project Engineer, Ms. Dirka U. Prout, P.Eng., under the direction of the Team Leader, Mr. Philip R. Bedell, P.Eng. This report was reviewed by Mr. Fintan J. Heffernan, P.Eng., the Designated MTO Contact and Quality Control Auditor for this assignment.

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PART B

FOUNDATION DESIGN REPORT

RETAINED SOIL SYSTEM WALLS
WIDENING OF HIGHWAY 7/8
FROM 1.9 KM WEST OF FISCHER-HALLMAN ROAD INTERCHANGE
EASTERLY TO 0.8 KM EAST OF COURTLAND AVENUE INTERCHANGE
KITCHENER
GWP 131-98-00
MINISTRY OF TRANSPORTATION, ONTARIO - WEST REGION

January 2011
Revised February 2011
Report No. 08-1132-084-1-R10

Golder Associates

6.0 ENGINEERING RECOMMENDATIONS

6.1 General

This section of the report provides our recommendations on the foundation aspects of the design of six segments of Retained Soils System (RSS) retaining walls to be constructed along Highway 7/8 between Westmount Road and the Courtland Avenue Interchange. The recommendations are based on our interpretation of the factual information obtained during the investigation. It should be noted that the interpretation and recommendations are intended for use only by the design engineer. Where comments are made on construction they are provided only in order to highlight those aspects which could affect the design of the project. Those requiring information on aspects of construction should make their own interpretation of the factual information provided as it may affect equipment selection, proposed construction methods and scheduling.

The widening of the Highway 7/8 roadway platform within the project limits is challenging due to the toes of the existing embankments being in close proximity to the limits of the right-of-way (ROW). The results of a foundation engineering review and analysis of the potential options for widening and raising of the Highway 7/8 embankments were presented in a draft technical memorandum dated March 24, 2010. This memorandum is attached in Appendix B.

The results of the review and analysis, as summarized in Table I of the memorandum, concluded that an RSS wall at the top of the slope was the preferred foundation engineering option given for the proposed work. As a result, this foundation investigation and design report was initiated and addresses only the preferred option. Conventional embankment widening will result in the embankment extending beyond the ROW limits as shown in the cross sections in Appendix B. The typical embankment sections are characterized by embankments 5.0 and 8.5 metres high, with the face of wall/toe of slope set 0.5 metres behind the ROW limit. Finished slope inclinations of 2 horizontal to 1 vertical with a 2 metre wide bench at mid-height for slopes equal to or higher than 8 metres have been assumed. The embankment modifications result in additional fill depths of about one metre at a point 0.5 metres behind the ROW limit and representative grade raise and embankment widening of 0.5 and 1.5 to 5 metres, respectively, at the crest of the existing embankment.

Acquisition of additional property may be very difficult and costly due to the proximity of the adjacent developments. As a result, the use of retaining walls has been proposed to accommodate the required modifications to the existing high fill embankments. Six segments of RSS walls have been proposed for the project area:

- Station 14+180 to Station 14+300 LT
- Station 14+185 to Station 14+300 RT
- Station 16+028 to Station 16+592 LT
- Station 16+350 to Station 16+635 RT

- Station 16+655 to Station 16+866 LT
- Station 16+665 to Station 16+889 RT

The RSS walls will be constructed at the top of the slope and will require a normal wall cross-section. There is an option for a larger wall to be constructed that could accommodate a future widening to eight lanes. A section is presented in Appendix B.

6.2 Foundation Design

6.2.1 Subsurface Conditions

Station 14+180 to Station 14+300 LT

The subsurface conditions encountered in the three boreholes advanced at this RSS wall location typically consist of embankment fill to elevation 332 metres adjacent to the Westmount Road Overpass structure and fill to elevation 330 metres east of approximately Station 14+250. The 7 to 8 metre high embankment fills consist predominantly of firm to very stiff clayey silt with layers of compact sand and gravel, loose to compact sandy silt, compact to dense sand and topsoil fill. East of approximately Station 14+250, the fill is underlain by about 0.5 metres of topsoil. West of the Shoemaker Creek culvert, the fill and topsoil is underlain by very loose to dense silty fine sand or very dense sand and gravel to elevation 329 metres. In the vicinity of Station 14+200, the silty fine sand is underlain by organic silt to elevation 327 metres. The organic silt, silty sand and sand and gravel is underlain by stiff to very stiff clayey silt interlayered with sandy silt or clayey silt till. The inferred groundwater level in this area is at elevation 329 metres.

Station 14+185 to Station 14+300 RT

The subsurface conditions along this segment of retaining wall generally consist of embankment fill to elevation 328 to 330 metres. The 8 to 10 metre high embankment fills generally consist of stiff to hard clayey silt near Station 14+200. East of Station 14+200, the fill material is quite variable with layers of soft to very stiff clayey silt, very loose to compact silty sand, sandy silt or sand and topsoil fill. The fill is underlain by topsoil to elevation 329 metres east of the Shoemaker Creek culvert. West of the culvert, the fill is underlain by loose to very dense granular deposits of sandy silt, silty fine sand, sand and sand and gravel to elevation 325 metres. These granular deposits are underlain by very stiff clayey silt. East of the culvert, the topsoil is underlain by stiff to very stiff clayey silt till to elevation 328 metres and then by compact sand. The inferred groundwater level in this area is at elevation 329 metres.

Station 16+028 to Station 16+592 LT

The subsurface conditions along this segment of retaining wall consist of embankment fill overlying compact to very dense sand, silty fine sand and sand and gravel interlayered with compact to very dense silts and very stiff to hard silty clay to clayey silt and clayey silt till. The embankment height varies from 3 metres adjacent to the Ottawa Street South Overpass structure to about 9 metres in the vicinity of the CNR Overhead structure. The embankment fill is primarily granular and is very loose to dense with infrequent layers of very stiff clayey silt. The groundwater level was inferred at elevation 323 metres between Stations 16+000 and 16+400 and varies from elevation 322 metres at Station 16+400 to elevation 317.0 metres at Station 16+630 adjacent to the CNR Overhead structure.

Station 16+350 to Station 16+635 RT

The subsurface conditions encountered in the five boreholes advanced along this section of retaining wall consisted of embankment fill which extended to approximately elevation 324 metres near Station 16+350 to elevation 317 metres adjacent to the CNR Overhead structure. The embankment height varied from 3 to 4 metres at the west end to 10 metres at the east end. The embankment fill consisted of compact to very dense silty sand, sand, sand and gravel and sandy silt with occasional layers of very stiff clayey silt. West of about Station 16+600, the fill is underlain by predominantly loose to dense granular deposits consisting of sandy silt, silty sand, sand and gravel and sand with layers of very stiff silty clay and/or clayey silt. East of Station 16+600, the fill is underlain by stiff to very stiff clayey silt interlayered with dense to very dense silt. The inferred groundwater level varies from elevation 322 metres at Station 16+350 to 317 metres at Station 16+630 adjacent to the CNR Overhead structure.

Station 16+665 to Station 16+866 LT

The subsurface conditions along this segment of retaining wall consist of embankment fill to elevation 314 to 320 metres. The embankment height is 11 metres adjacent to the CNR Structure, 9 metres adjacent to Schneider Creek and the Courtland Avenue Overpass structure and 5 to 8 metres between the two structures. The embankment fill is primarily granular and is loose to very dense with infrequent layers of hard silty clay and stiff to very stiff clayey silt. The fill is underlain by stiff to very stiff clayey silt interlayered with compact silt in the vicinity of the CNR Overhead and Schneider Creek and compact to very dense sand and silty fine sand between these two locations. The inferred groundwater level is near elevation 315 metres from Station 16+650 adjacent to the CNR Overhead structure to Station 16+785 and at elevation 312 metres at Station 16+850, adjacent to Schneider Creek.

Station 16+665 to Station 16+889 RT

The subsurface conditions encountered in the four boreholes advanced along this section of retaining wall generally consist of embankment fill which extended to elevations 313 to 316 metres. The embankment height varies between 11 metres adjacent to the CNR Overhead structure to 8 to 9 metres east of the structure. The embankment fill was primarily constructed with compact to dense granular materials comprised of sandy silt, sand and silty sand with a layer of firm to stiff clayey silt encountered near Station 16+810. The fill is underlain

by topsoil near Stations 16+750 and 16+880. The topsoil and/or fill is underlain by compact to dense silt interlayered with stiff clayey silt near the Courtland and CNR structures and by stiff silty clay between the structures. The inferred groundwater level varies from elevation 315 metres at Station 16+670 adjacent to the CNR structure to elevation 313 metres at Station 16+880 adjacent to Schneider Creek.

6.2.2 Proposed Embankment Modifications

RSS walls are to be constructed along the crests of the existing embankments slopes using a normal wall cross-section and uniaxial geogrid reinforcement or metallic strips or grids. At the overhead sign (OHS) locations, the walls will be built out to provide a 1.9 metre clearance between the centre of the footings and the rear face of the RSS wall. Schematic diagrams showing the proposed wall configurations for a 5 metre high and 9 metre high fill are shown in Appendix B. The proposed RSS walls will range in height from approximately 2.5 to 6 metres with 2 horizontal to 1 vertical embankment sideslopes below the walls sections. In areas where the embankment height is 8 metres or greater, a 2 metre wide bench will be provided at mid-height. It is anticipated that the reinforced width of the RSS wall would be approximately 75 per cent of the wall height. For the purposes of this report, the wall height has been defined as the vertical distance between the top of finished grade behind the wall and the top of the levelling pad at the base of the wall.

The schematic sections presented in Appendix B, consider future eight laning with the construction of a new wall outside the currently proposed RSS wall. The discussion in this report focuses solely on a wall configuration suitable to provide a 6 lane cross-section. The design of the embankment modifications was ongoing at the time of preparation of this report. Therefore, where design information was incomplete or unavailable, general comments and recommendations have been provided for design guidance.

6.2.3 Geotechnical Resistances – Shallow Foundations

RSS wall footings designed with the geotechnical resistances given below may be founded on a 0.3 metre thick compacted Granular A levelling pad constructed in the fill. The Serviceability Limit States (SLS) value allows for 25 millimetres of settlement. Some minor additional settlement will occur as a result of the embankment widening. Reduced geotechnical resistances have been provided for locations where zones of firm cohesive or loose gravel fills are present below the anticipated founding elevation.

Station 14+180 to Station 14+300 LT

The design information indicates that this segment of wall will extend from approximately Station 14+180 LT at the northeast quadrant of the Westmount Road overpass to Station 14+300 LT. The proposed RSS retaining wall will be 2.0 to 2.5 metres high. The wall can be founded in the existing embankment fill using the following geotechnical resistances:

Location	Maximum Founding Elevation (m)	Anticipated Founding Conditions	Geotechnical Resistance (kPa)	
			Factored ULS	SLS
14+180 to 14+300 LT	336.5 to 335.5	Fill – stiff to very stiff clayey silt / compact sandy silt	150	100

Station 14+185 to Station 14+300 RT

The design information indicates that this segment of wall will extend from approximately Station 14+185 RT at the southeast quadrant of the Westmount Road overpass to Station 14+300 RT. The proposed RSS retaining wall will be 2.0 to 2.5 metres high. The wall can be founded in the existing embankment fill using the following geotechnical resistances:

Location	Maximum Founding Elevation (m)	Anticipated Founding Conditions	Geotechnical Resistance (kPa)	
			Factored ULS	SLS
14+185 to 14+300 RT	336.5 to 335.5	Fill – stiff to very stiff clayey silt	150	100

Station 16+028 to Station 16+592 LT

This wall will be constructed between the northeast quadrant of the Ottawa Street South overpass to the northwest quadrant of the CNR overhead. The wall height will generally be between 1.5 and 3.5 metres except at the locations of OHSs 33-820-S-W and 33-819-S-W at Stations 16+048 LT and 16+543 LT, respectively. The RSS wall will have wall heights of 4.0 and 5.5 metres at OHSs 33-820-S-W and 33-819-S-W, respectively. The wall foundations can be placed in the existing embankment fill.

Location	Maximum Founding Elevation (m)	Anticipated Founding Conditions	Geotechnical Resistance (kPa)	
			Factored ULS	SLS
16+028 to 16+350 LT	329.0 to 328.0	Fill – loose to compact sandy silt / sand / silty sand	150	100
16+350 to 16+592 LT	328.0 to 325.5	Fill – loose to compact silty sand to compact to dense sandy silt	250	175

Station 16+350 to Station 16+635 RT

This segment of RSS retaining wall will be constructed along the crest of the embankment above CNR Overhead retaining wall D from Station 16+350 RT to approximately Station 16+635 RT. The wall height will range from 1.5 to 2.5 metres and will be approximately 2.1 metres at Station 16+450 (the location of OHS 33-825-S-E). The wall can be founded in the existing embankment fill using the following geotechnical resistances:

Location	Maximum Founding Elevation (m)	Anticipated Founding Conditions	Geotechnical Resistance (kPa)	
			Factored ULS	SLS
16+400 to 16+475 RT	326.0 to 325.5	Fill – Compact to dense silty fine sand	225	150
16+475 to 16+635 RT	325.5 to 325.0	Fill – compact to dense silty fine sand / sandy silt / sand	225	150

Station 16+655 to Station 16+866 LT

The design information indicates that this segment of wall will extend from Station 16+655 LT in the northeast quadrant of the CNR Overhead structure to Station 16+866 LT at the northwest corner of the Courtland Avenue Overpass structure. The proposed RSS retaining wall will be 3.0 to 5.0 metres high. It is anticipated that the wall can be founded in the existing embankment fill using the following geotechnical resistances:

Location	Maximum Founding Elevation (m)	Anticipated Founding Conditions	Geotechnical Resistance (kPa)	
			Factored ULS	SLS
16+655 to 16+866 LT	324.0 to 321.0	Fill – loose to dense sandy silt / silty fine sand	225	150

Station 16+665 to Station 16+889 RT

The limits of this RSS retaining wall are Station 16+665 RT on the west end and Station 16+889 RT. The wall height will generally be between 3.0 and 4.5 metres. It is anticipated that the wall can be founded in the existing embankment fill using the following geotechnical resistances:

Location	Maximum Founding Elevation (m)	Anticipated Founding Conditions	Geotechnical Resistance (kPa)	
			Factored ULS	SLS
16+665 to 16+889 RT	324.0 to 320.5	Fill – compact to dense sandy silt / silty fine sand	150	100

A surficial slope failure has occurred between Stations 16+770 and 16+780 RT and deformations of the existing slope were noted between Stations 16+680 and 16+850. This failure is discussed in section 6.8.

6.2.4 Frost Protection and Embedment

All RSS retaining wall foundations consisting of strip footings should be provided with adequate embedment and frost protection comprised of 1.4 metres of soil cover or thermal equivalent. The RSS walls founded on levelling pads should also have sufficient embedment. The embedment depth, defined as the distance from the top of the levelling pad to the top of the adjoining finished grade at the toe of the wall should be the maximum of:

- 0.5 metres;
- The minimum depth required for overall stability;
- H/20 – if the area in front of the wall is horizontal; or
- H/7 – if the area in front of the wall slopes at 2 horizontal to 1 vertical.

where H is the total wall height.[2]

In general, the embankment slope in front of the wall will be sloped at 2 horizontal to 1 vertical. To improve resistance to general bearing failure and to provide access for future maintenance and repairs, each RSS retaining wall should be provided with a bench in front of the wall with a minimum width of 1.0 metres measured from the face of the wall.

6.3 Resistance to Lateral Forces

The lateral pressures acting on the RSS retaining walls will depend on the backfill soils, the type and method of placement of the backfill materials behind the walls and the subsequent lateral movement of the structures.

The resistance to lateral forces/sliding resistance between the compacted granular fill (assumed to be Granular B Type III) and the subgrade soils should be calculated in accordance with Section 6.7.5 of the Canadian Highway Bridge Design Code (CHBDC). Each retaining wall shall be checked for overturning. Assuming that the founding soils are not loosened/disturbed during excavation and footing construction, the following angle of friction and corresponding unfactored coefficient of friction, tan δ, may be used for the interaction between the base of the RSS wall (Granular A levelling pad) and the founding soil (existing fill):

RSS wall levelling pad on existing fill	angle of friction	30°
	tan δ	0.58

In accordance with the CHBDC, a factor of 0.8 is to be applied in calculating the horizontal resistance.

[2] FHWA (2001). Mechanically Stabilized Earth Walls and Reinforced Soil Slopes: Design and Construction Guidelines. FHWA-NHI-00-043. Federal Highway Administration, Washington, D.C., USA.

6.4 Stability

The internal stability of the mechanically-reinforced soil walls should be verified by the RSS supplier/designer. The external (global) stability of a typical RSS retaining wall height of 3 metres and one with the maximum proposed wall height of 6 metres were assessed assuming a reinforcement length of 0.8 times the wall height. The walls were found to be stable and satisfied the required Factors of Safety of 1.5 for sliding and 2.0 for eccentricity/overturning and bearing.

Slope stability analyses were conducted using Slope-W, limit equilibrium slope stability software, to assess deep-seated rotational failures which pass through, under and behind the reinforced zone. It was assumed that a vertical retaining wall was constructed on a 2 horizontal to 1 vertical embankment sideslope with reinforcing fabric spaced at 0.5 metre intervals. The Factor of Safety related to the global stability under static loading for properly designed and constructed RSS walls at this site is greater than 1.3. Upon completion of the detail design, the RSS wall designer/supplier should provide analyses of the internal, external, global and compound stability confirming that the RSS retaining walls to be constructed at this site will be stable.

6.5 Lateral Earth Pressures

The lateral pressures acting on the retaining wall will depend on the type and method of placement of the backfill materials, on the nature of the soils behind the backfill, on the freedom of lateral movement of the structure, and on the drainage conditions behind the walls. The following recommendations are made concerning the design of the retaining wall in accordance with the CHBDC:

Select, free-draining granular fill meeting the specifications of MTO Special Provision (SP) 110S13 Granular A or Granular B Type III but with less than 5 per cent passing the 75 micron sieve should be used as backfill behind the wall. The granular fill should be placed in accordance with Ontario Provincial Standard Drawing (OPSD) 3121.150 and compacted in loose lifts not greater than 200 millimetres in thickness in accordance with OPSS 501. Longitudinal drains and weep holes should be installed to provide positive drainage of the granular backfill. Other aspects of the granular backfill requirements with respect to subdrains should be in accordance with OPSD 3190.100.

A compaction surcharge equal to 12 kilopascals should be included in the lateral earth pressures for the structural design of the retaining walls, in accordance with CHBDC, Figure 6.6. Compaction equipment should be used in accordance with SP 105S10.

The granular fill may be placed either in a zone with a width equal to at least 1.4 metres behind the back of the reinforced mass (Case (a) from Commentary on CHBDC Figure C6.20) or within the wedge-shaped zone defined by a line drawn at a maximum 1 horizontal to 1 vertical slope extending up and back from the rear face of the reinforced mass (Case (b) from Commentary on CHBDC Figure C6.20).

For Case (a), the pressures are based on the embankment fill consisting of Select Subgrade Material (SSM) and the following parameters (unfactored) may be assumed:

Soil unit weight: 18.5 kN/m³

Coefficients of lateral earth pressure:

Active, K_a 0.33

At rest, K_o 0.50

Passive, K_p 3.0

For Case (b), the pressures are based on the granular fill as placed and the following parameters (unfactored) may be assumed:

	GRANULAR A	GRANULAR B (Type III)
Soil unit weight:	22 kN/m³	21 kN/m³
Coefficients of lateral earth pressure:		
Active, K_a	0.27	0.31
At rest, K_o	0.43	0.47
Passive, K_p	3.7	3.3

If the wall support allows lateral yielding, active earth pressures may be used in the geotechnical design of the structure. If the wall support does not allow lateral yielding, at-rest earth pressures should be assumed for geotechnical design.

It should be noted that the above design parameters assume that the ground in front of and behind the wall are level. In most cases, although the backfill behind the wall is level, the embankment slope in front of the wall will be inclined at 2 horizontal to 1 vertical. Therefore, assuming that the embankment widening fill will consist of Granular B Type III, the following adjusted coefficient of lateral earth pressure should be used in the analysis of passive earth pressures in front of the wall:

Backfill Material	Coefficient of Passive Earth Pressure, K_P
Granular B (Type III)	1.2

6.6 Settlement

The magnitude of the grade raise along all six segments of RSS retaining walls is expected to be less than 1 metre. With the exception of overhead sign locations, where the walls will be built out to minimize the lateral loads on the walls resulting from movement of the overhead sign supports, the volume of additional fill to be placed will be relatively small. Therefore, it is anticipated that the total settlement resulting from placement of the additional fill will be negligible (less than 10 millimetres) due to the limited placement of additional fill and the

presence of predominantly compact to dense granular and stiff to hard cohesive soils beneath the existing embankment fills. Settlement of the existing embankment fill will be additional.

The following discussion outlines the general extent of widening and grade raise for each segment and highlights areas where additional checks were made to confirm that excessive settlement would not occur due to the presence of organic soils and/or high fills.

6.6.1 Station 14+180 to Station 14+300 LT

It is proposed to raise the grade between 0.5 and 0.6 metres and widen the embankment approximately 1 to 1.8 metres in this area. Examination of the preliminary design drawings indicate that the fill to be placed to construct the proposed RSS retaining wall, in addition to the fills required for the grade raise, will be limited in extent. The new construction is not expected to have any significant effect or result in any serviceability issues related to the presence of the approximately 1.3 metre thick layer of organic silt near Station 14+200 LT, the approximately 0.5 metre thick topsoil layer underlying the existing embankment fill east of approximately Station 14+255 LT or the existing twin culverts which cross beneath the wall near Station 14+270.

6.6.2 Station 14+185 to Station 14+300 RT

The proposed grade raise along this segment of wall will range between 0.5 and 0.6 metres and the roadway platform will be widened about 1 to 1.8 metres. The settlement resulting from construction of this segment of retaining wall is expected to be negligible due to the limited amount of additional fill being placed.

6.6.3 Station 16+028 to Station 16+592 LT

A grade raise of 0.2 to 0.8 metres has been proposed along this section of wall. Generally, the roadway platform will be widened 5 to 6 metres except at the locations of OHS 33-820-S-W and OHS 33-819-S-W where placement of additional fill materials will be the most extensive. Based on the findings of borehole 105 advanced at the former location, the embankment fill is underlain by compact to very dense sand. Although the embankment fill at the latter location is underlain by about 0.5 metres of topsoil, the underlying native soils are hard or dense to very dense. Settlement analyses have indicated that the settlement at the overhead sign locations will be less than 10 millimetres.

6.6.4 16+350 to Station 16+635 RT

A grade raise of 0.2 to 0.8 metres has been proposed along this section of wall. Generally, the roadway platform will be widened 2.5 to 5.0 metres. Fill placement will be most extensive at the location of OHS 33-825-S-E at Station 16+450 RT. Settlement will be negligible at the overhead sign location as the embankment fill is underlain by compact granular material.

6.6.5 Station 16+655 to Station 16+866 LT

The proposed grade raise along this segment of wall will range between 0.5 and 0.6 metres and the roadway platform will be widened about 2.5 to 4.5 metres. The existing embankment fill is underlain by stiff peaty topsoil 0.4 metres thick adjacent to the CNR Overhead structure and a loose to compact topsoil layer 0.8 to 0.9 metres thick east of approximately Station 17+550 LT. The settlement resulting from construction of this segment of retaining wall is expected to be negligible due to the limited amount of additional fill being placed.

6.6.6 Station 16+665 to Station 16+889 RT

A grade raise of 0.5 to 0.6 metres has been proposed along this section of wall. The road platform in this area will be widened 2 to 5 metres. The embankment fill was found to be underlain by compact topsoil layers 1.1 metres thick in the vicinity of Station 16+750 RT and 1.4 metres thick of loose sandy silt topsoil adjacent to Schneider Creek. Since the topsoil layers are located at about 6 to 7 metres below the anticipated founding depth of the RSS retaining wall, the resulting settlement is expected to be negligible due to the limited amount of additional fill being placed.

The embankment sideslope in this area are slightly steeper than 2H:1V and a slope failure has occurred between 16+770 and 16+780 RT and slope deformations were observed in this general area. As noted in section 6.8, slope regrading and repair of the failure is required prior to widening of the existing embankment in this area.

6.6.7 Differential Settlement

The existing embankment fill is generally competent, but does vary considerably along the length of each wall segment in composition and depth. Some minor differential settlements along the retaining wall segments should be expected due to this variability particularly in areas where the embankment fill is loose and/or underlain by organic materials. The differential settlement along the wall is expected to be less than 1 per cent of the wall length. Therefore, pre-cast concrete panels or block facings can be used.

Differential settlement(s) will also occur where RSS retaining walls meet existing cast-in-place structures such as the overpass structures at Westmount Road and Courtland Avenue. The RSS wall design must accommodate the anticipated differential settlements and prevent loss of fines.

6.7 Additional Design Considerations

The RSS retaining walls are to be designed for high performance and appearance in accordance with MTO Special Provision (SP) 599S22 and the Non-Standard Special Provision for the design and construction of RSS walls dated September 2005.

Stepped footings, if required, should not exceed 0.5 metres in height with at least 1 metre long sections on each side of the step.

6.7.1 Drainage

The design must incorporate subsurface and surface drainage elements. Particularly if metallic reinforcement will be utilized, it is recommended that an impervious barrier be placed between the pavement structure and reinforcement fill to protect from damage by de-icing salts.

6.7.2 Utilities and Highway Infrastructure

It is preferred that utilities with alignments parallel to the wall face not be placed within the reinforcement zone. It has been proposed to construct overhead signs adjacent to the proposed RSS retaining wall at Stations 16+048LT, 16+450RT and 16+543 LT. In addition, existing Noise Barrier Wall 3 and proposed Noise Barrier Wall 2 will be constructed along the retaining wall segments between the Westmount Road Overpass and Station 14+300. The design of the RSS retaining walls must consider the proposed highway infrastructure such as culverts, overhead signs and noise barrier walls. This may require construction of a structural frame around the obstruction or splaying or full or partial omission of reinforcement in the area of the obstruction. The adjacent reinforcement must be designed to accommodate the additional loading resulting from removal of reinforcing elements in the area of the obstruction.

6.7.3 Surcharge Loading on Existing CNR Overhead Retaining Wall D

Construction of a new RSS retaining wall between 16+400 RT and the CNR Overhead structure will induce additional surcharge loads on the existing concrete cantilever retaining wall, Retaining Wall D. These surcharge

loads should be evaluated and considered in the assessment of the stability of the CNR retaining wall D and in the design of any tiebacks/earth anchors used to reinforce this wall.

6.8 Construction Considerations

The RSS retaining walls are to be inspected and the component materials tested in accordance with SP599S23. Care should be taken during construction to minimize disturbance of the sandy subgrade. The cleaned excavation base should be inspected by a Quality Verification Engineer (QVE) qualified in geotechnical engineering prior to construction of the levelling pad and placement of the first lift of backfill in the reinforced zone. It is recommended that the footing excavation be carried out such that the final 0.5 metres of excavation is completed with the geotechnical personnel on site.

If soft or very loose materials, wet or other deleterious materials are found at the foundation level, these materials should be removed and replaced with compacted Granular A. It is not considered necessary to remove the organic materials that are beneath the existing embankment fills. However, if discrete pockets of organic materials are encountered within the foundation excavation for the RSS walls, they should be sub-excavated and replaced with compacted Granular A.

It should be noted that a surficial slope failure has occurred in the area between Station 16+770 and 16+780 RT (see Photograph, Appendix C) and visual examination of the embankment side slopes between Stations 16+680 and 16+850 indicate deformations of the slope surfaces considered consistent with limited post construction instability. Based on the results of the foundation investigation and slope stability analyses, it is considered that these movements are related to slopes slightly steeper than 2H:1V and the layered granular and cohesive fill materials in the embankment. Seasonally high groundwater levels in the fine grained granular fill strata combined with freeze-thaw events would lead to shallow, localized movements. It is therefore essential that these slopes be properly regraded to inclinations no steeper than 2H:1V and these repairs, where required, effected prior to construction of the RSS retaining walls.

6.9 Excavations and Temporary Cut Slopes

Excavations for the retaining wall footings will generally be terminated in the existing embankment fill materials. The footing excavations are not expected to intercept the groundwater level. However, due to the predominantly granular nature of the fill, and the presence of near surface native cohesive soils, perched groundwater may be encountered following periods of high precipitation. Groundwater at this site may be adequately controlled using properly filtered sumps. Sumps should be maintained outside of the actual footing limits. Surface water runoff should be directed away from the excavations at all times. The appropriate Non Standard Special Provision (NSSP) for the control of surface and subsurface water flows should be included in the contract documents.

All excavations should be carried out in accordance with the guidelines outlined in the latest edition of the Ontario Occupational Health and Safety Act and Regulations for Construction Projects. The fill materials at this

site would be classified as Type 3 soils as would any cohesionless materials below the groundwater level. The native silty clay and cohesionless materials above the groundwater level would be classified as Type 2 soils.

Temporary open cut slopes within the fill materials should be maintained no steeper than 1 horizontal to 1 vertical. Where space is restricted and will not permit open cuts, a temporary roadway protection support system should be installed to support the sides of the excavation and permit the use of vertical cuts. The temporary support system could consist of soldier piles and lagging where the H-piles would be driven to a suitable depth and horizontal lagging installed as the excavation proceeds or driven steel sheet piling. Support to the system could be in the form of struts and walers in the case of footing excavations or rakers and anchors in the case of roadway protection.

Passive toe restraint to the soldier piles may be determined using a triangular pressure distribution acting over an equivalent width equal to three times the pile socket diameter.

The unfactored triangular earth pressure distribution (p in kN/m^2; increasing with depth), can be calculated as follows:

$$p = K_a (\gamma H + q)$$

where H = the height of the excavation at any point in metres
K_a = active coefficient of earth pressure
γ = soil unit weight
q = surcharge for traffic and other loading

For the granular fill and native materials, the unfactored rectangular earth pressure distribution (p in kN/m^2; constant with depth), can be calculated as follows:

$$p = 0.65\, K_a(\gamma H + q)$$

where H = the total height of the excavation
K_a = active coefficient of earth pressure
γ = soil unit weight
q = surcharge for traffic and other loading

For the cohesive native materials, the unfactored trapezoidal earth pressure distribution (p in kN/m^2; varying with depth); can be calculated as follows:

$$p = 0.2\gamma H_T \text{ to } 0.4\gamma H_T$$

where H_T = the total height of the excavation

γ = soil unit weight

q = surcharge for traffic and other loading

The support systems may be designed using the following parameters:

Soil Type	Coefficient of Earth Pressure			Angle Of Internal Friction	Unit Weight
	Active, K_a	At Rest, K_o	Passive, K_p	(degrees)	(kNm^{-3})
Granular Fill	0.33	0.50	3.0	30	21.0
Clayey Silt and Silty Clay	0.38	0.55	2.7	27	19.0
Silt, Sandy Silt and Silty Sand	0.33	0.50	3.0	30	20.0
Clayey Silt Till	0.33	0.50	3.0	30	21.0

The earth pressure coefficients noted above are based on a horizontal surface adjacent to the excavation. If sloped surfaces are present, the coefficients should be adjusted accordingly.

The raker/anchor support must be designed to accommodate the loads applied from pressures and surcharge pressures from area, line or point loads as well as the impact of sloping ground behind the system.

The temporary excavation support system should be designed and constructed in accordance with OPSS 539. The lateral movement of the temporary shoring system should meet Performance Level 2.

7.0 MISCELLANEOUS

This report was prepared by Ms. Dirka U. Prout, P.Eng. under the direction of the Team Leader, Mr. Philip R. Bedell, P. Eng. This report was reviewed by Mr. Fintan J. Heffernan, P.Eng., the Designated MTO Contact and Quality Control Auditor for this assignment.

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LIST OF ABBREVIATIONS

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

I. SAMPLE TYPE

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

II. PENETRATION RESISTANCE

Standard Penetration Resistance (SPT), N:

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

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) 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.

LIST OF SYMBOLS

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

I. General

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

II. STRESS AND STRAIN

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

III. SOIL PROPERTIES

(a) Index Properties

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

(a) Index Properties (continued)

w	water content
w_1	liquid limit
w_p	plastic limit
I_p	plasticity index = $(w_1 - w_p)$
w_s	shrinkage limit
I_L	liquidity index = $(w - w_p)/I_p$
I_C	consistency index = $(w_1 - w)/I_p$
e_{max}	void ratio in loosest state
e_{min}	void ratio in densest state
I_D	density index = $(e_{max} - e)/(e_{max} - e_{min})$ (formerly relative density)

(b) Hydraulic Properties

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

(c) Consolidation (one-dimensional)

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

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

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London, Ontario

RECORD OF BOREHOLE No 105

1 OF 2

METRIC

PROJECT 08-1132-084-1
W.P. 131-98-00
DIST _____ HWY 7/8
DATUM GEODETIC
LOCATION N 4810336.3 ;E 225380.0
BOREHOLE TYPE POWER AUGER / ROTARY DRILLING
DATE October 30, 2008 - November 3, 2008
ORIGINATED BY MA/DB
COMPILED BY LMK/SL
CHECKED BY _____

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 × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
331.14	PAVEMENT SURFACE						331				
0.00	ASPHALT										
0.12	FILL, sand and gravel, crushed, trace silt Brown										
330.62											
0.52	FILL, sand and gravel, trace silt Compact Brown		1	SS	18		330				
329.77											
1.37	FILL, sandy silt Loose to compact Brown		2	SS	16				○		0 47 47 6
			3	SS	5		329				
328.09											
3.05	FILL, silt, some clay, trace sand Compact Brown		4	SS	17		328				
3.17	SAND, fine to medium, trace to some silt, trace clay Compact to Very dense Brown		5	SS	35		327				
			6	SS	55						
			7	SS	51		326				
			8	SS	50		325		○		0 80 16 4
							324				
			9	SS	41						
							323				
			10	SS	85		322				
320.78											
10.36	SILT, some clay, trace gravel, with clayey silt partings Very dense Brown		11	SS	81/150mm		321				
320.35											
10.79	SILTY SAND AND GRAVEL Very dense Grey						320				
319.56											
11.58	SAND AND GRAVEL, trace silt, trace clay Very dense Grey		12	SS	67		319		○		25 67 5 3
318.04											
13.10	SAND, fine to medium, trace silt, trace gravel Very dense		13	SS	74		318				
							317				

Continued Next Page

+ 3, × 3: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

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London, Ontario

RECORD OF BOREHOLE No 105

2 OF 2 **METRIC**

PROJECT 08-1132-084-1 | W.P. 131-98-00 | LOCATION N 4810336.3 ;E 225380.0 | ORIGINATED BY MA/DB

DIST | HWY 7/8 | BOREHOLE TYPE POWER AUGER / ROTARY DRILLING | COMPILED BY LMK/SL

DATUM GEODETIC | DATE October 30, 2008 - November 3, 2008 | CHECKED BY

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 × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	SAND, fine to medium, trace silt, trace gravel Very dense		14	SS	84		316				
315.29											
15.85	SILTY CLAY TILL, trace sand, trace gravel Hard Grey		15	SS	100		315				0 5 44 51
			16	SS	88		314				
			17	SS	103		313				
			18	SS	90		312				
			19	SS	62		311				0 1 28 71
			20	SS	78		310				
305.99							309				
25.15	SANDY SILT TILL, some clay, trace to some gravel Very dense Grey		21	SS	100/75mm		308		49		
			22	SS	100/150mm		307				6 44 39 11
302.09			23	SS	100/75mm		306				
29.05	END OF BOREHOLE Groundwater level not established.						305				
							304				
							303				

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

LDN_MTO_06 08-1132-084-1.GPJ LDN_MTO.GDT 12/01/11

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RECORD OF BOREHOLE No 307

1 OF 2

METRIC

PROJECT 08-1132-084-1
W.P. 131-98-00
DIST _____ HWY 7/8
DATUM GEODETIC
LOCATION N 4809744.1 ;E 223643.8
BOREHOLE TYPE POWER AUGER / HOLLOW STEM
DATE November 19, 2008
ORIGINATED BY JB
COMPILED BY LMK
CHECKED BY _____

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 × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
338.45	PAVEMENT SURFACE										
0.00	ASPHALT										
0.15	FILL, sand and gravel Brown										
337.84											
0.61	FILL, clayey silt, trace sand, trace gravel, with silt and sand layers Stiff to hard Brown		1	SS	15		338				
			2	SS	13		337				
			3	SS	23		336				
			4	SS	12		335		○ non-plastic		0 40 44 16
			5	SS	10		334				
			6	SS	20		333				
			7	SS	18		332				
			8	SS	26		331				
			9	SS	24		330		⊢○⊣		0 16 56 28
330.22			10	SS	33		329				
8.23	SANDY SILT Dense Grey		11	SS	45		328				
329.46							327				
8.99	SANDY SILT, with peat layers, trace gravel Very dense Grey and black		12	SS	51		326				
328.39							325				
10.06	SILTY FINE SAND, trace silt, trace clay Dense Grey		13	SS	38	▽	324				
			14	SS	46				○		0 51 42 7
325.34											
13.11	CLAYEY SILT, trace sand, with silt partings Very stiff Grey		15	SS	23						
323.82											
14.63											

Continued Next Page

+ 3, × 3: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

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London, Ontario

RECORD OF BOREHOLE No 307

2 OF 2 **METRIC**

PROJECT 08-1132-084-1
W.P. 131-98-00
DIST _____ HWY 7/8
DATUM GEODETIC
LOCATION N 4809744.1 ;E 223643.8
BOREHOLE TYPE POWER AUGER / HOLLOW STEM
DATE November 19, 2008
ORIGINATED BY JB
COMPILED BY LMK
CHECKED BY _____

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 + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
322.75	SAND, fine to medium, trace silt, some gravel Compact Grey		16	SS	10		323				
15.70	END OF BOREHOLE Groundwater encountered at about elev. 327.8m during drilling on November 19, 2008.										

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

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RECORD OF BOREHOLE No 309

1 OF 2

METRIC

PROJECT 08-1132-084-1
W.P. 131-98-00
DIST _____ HWY 7/8
DATUM GEODETIC

LOCATION N 4809771.7 ;E 223638.0
BOREHOLE TYPE POWER AUGER / HOLLOW STEM
DATE June 2, 2009

ORIGINATED BY MA
COMPILED BY DMB
CHECKED BY _____

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 × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
338.36	GROUND SURFACE										
0.00	ASPHALT										
0.18	FILL, sand and gravel, crushed										
0.40 / 337.63	FILL, sand and gravel, with cobbles Brown										
0.73	FILL, clayey silt, trace to some sand, trace gravel, with silt layers Firm to very stiff Brown		1	SS	13						
			2	SS	15						
			3	SS	15						
			4	SS	6						
			5	SS	13						0 20 58 22
333.79											
4.57	FILL, sand and gravel, trace silt, asphalt fragments Compact Grey		6	SS	26						
333.18											
5.18	FILL, clayey silt, trace sand, trace gravel, with silt layers Very stiff Brown		7	SS	21						
			8	SS	19						
331.65											
6.71	SILTY FINE SAND, trace gravel, trace clay Very loose to dense Brown		9	SS	28						
			10	SS	41						
			11	SS	14	▽					1 60 34 5
			12	SS	2						
328.61											
9.75	ORGANIC SILT Soft to very stiff Grey		13	SS	2				52		
			14	SS	19						
327.33											
11.03	SANDY SILT, trace clay Compact Grey										
326.78											
11.58	CLAYEY SILT, trace to some sand, trace gravel Stiff to very stiff		15	SS	19						1 14 50 35
			16	SS	14						

Continued Next Page

+ 3, × 3: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

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London, Ontario

RECORD OF BOREHOLE No 309

2 OF 2 **METRIC**

PROJECT 08-1132-084-1 | W.P. 131-98-00 | DIST | HWY 7/8 | DATUM GEODETIC

LOCATION N 4809771.7 ;E 223638.0 | BOREHOLE TYPE POWER AUGER / HOLLOW STEM | DATE June 2, 2009

ORIGINATED BY MA | COMPILED BY DMB | CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	CLAYEY SILT, trace to some sand, trace gravel Stiff to very stiff		17	SS	15		323				1 2 47 50
							322				
			18	SS	14						
320.68						▽	321				
17.68	SANDY SILT, trace clay Compact Grey		19	SS	10		320				0 47 46 7
319.13			20	SS	7						
19.23	CLAYEY SILT, trace sand Firm Grey						319				
19.51	END OF BOREHOLE Groundwater encountered at about elev. 329.3m and elev. 320.7m during drilling on June 2, 2009.										

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

LDN_MTO_06 08-1132-084-1.GPJ LDN_MTO.GDT 12/01/11

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RECORD OF BOREHOLE No 406

1 OF 3

METRIC

PROJECT 08-1132-084-1
W.P. 131-98-00
LOCATION N 4810501.2 ;E 226211.1
ORIGINATED BY MA
DIST HWY 7/8
BOREHOLE TYPE POWER AUGER / ROTARY DRILLING / TRICONE
COMPILED BY LMK
DATUM GEODETIC
DATE November 17, 2008 - November 27, 2008
CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
321.99	PAVEMENT										
0.09	ASPHALT										
321.38	FILL, sand and gravel, trace silt Crushed Brown										
0.61	FILL, sand and gravel, trace silt Loose Brown		1	SS	7		321				
320.89	FILL, silty fine sand, trace gravel Loose to compact Brown		2	SS	10		320				
1.10											
319.86			3	SS	14		319				
2.13	FILL, sand, fine to medium, trace to some silt, trace clay, trace to some gravel Compact to very dense Brown		4	SS	13				○		12 75 10 3
			5	SS	31		318				
			6	SS	56		317				
			7	SS	31		316				
			8	SS	46		315				
314.98											
7.01	FILL, sandy silt, trace gravel, some clay Loose Brown		9	SS	5		314		○		5 31 51 13
313.46											
8.53	TOPSOIL, sandy silt Loose Black		10	SS	4		313				
312.08											
9.91	SILT, trace sand, trace clay, with clayey silt partings Compact Grey		11	SS	26		312				
310.41							311				
11.58	CLAYEY SILT, trace sand, with silt layers Stiff Grey		12	SS	12		310				
308.88							309				
13.11	SILT, trace sand, trace clay, with clayey silt layers Compact to very dense Grey		13	SS	15		308				
							307				

Continued Next Page

+ 3, × 3: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

Golder Associates
London, Ontario

RECORD OF BOREHOLE No 406

2 OF 3 **METRIC**

PROJECT 08-1132-084-1 | W.P. 131-98-00 | DIST _____ HWY 7/8 | DATUM GEODETIC

LOCATION N 4810501.2 ;E 226211.1 | BOREHOLE TYPE POWER AUGER / ROTARY DRILLING / TRICONE | DATE November 17, 2008 - November 27, 2008

ORIGINATED BY MA | COMPILED BY LMK | CHECKED BY _____

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 × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	SILT, trace sand, trace clay, with clayey silt layers Compact to very dense Grey		14	SS	53		306				
			15	SS	48		305				
			16	SS	44		304				
			17	SS	60		303				
301.26							302				
20.73	CLAYEY SILT, trace sand, with silt layers Stiff to very stiff Grey		18	SS	13		301				0 1 59 40
			19	SS	24		300				
298.22							299				
23.77	CLAYEY SILT TILL, trace sand, trace gravel Hard Grey		20	SS	42		298				
			21	SS	69		297				
295.17							296				
26.82	SILTY FINE SAND, trace clay, with silt layers Very dense Grey		22	SS	100		295				0 54 41 5
293.64							294				
28.35	SAND, some gravel, trace silt Dense Grey		23	SS	46		293				
292.12							292				

Continued Next Page

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

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London, Ontario

RECORD OF BOREHOLE No 406

3 OF 3 **METRIC**

PROJECT 08-1132-084-1
W.P. 131-98-00 LOCATION N 4810501.2 ;E 226211.1 ORIGINATED BY MA
DIST HWY 7/8 BOREHOLE TYPE POWER AUGER / ROTARY DRILLING / TRICONE COMPILED BY LMK
DATUM GEODETIC DATE November 17, 2008 - November 27, 2008 CHECKED BY

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 × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
29.87	SILTY CLAY Hard Grey										
			24	SS	41		291				
			25	SS	48		290				
			26	SS	43		289		53		0 0 32 68
			27	SS	47		288				
285.11			28	SS	103	▽	287				
36.88	SILT, some clay Very dense Grey						286				
284.50							285				
37.49	SILTY FINE SAND, trace clay, layered Very dense Grey		29	SS	100		284				0 72 25 3
281.91			30	SS	114		283				
40.08	END OF BOREHOLE Groundwater encountered at about elev. 285.1m during drilling on November 27, 2008.						282				

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

LDN_MTO_06 08-1132-084-1.GPJ LDN_MTO.GDT 12/01/11

Golder Associates
London, Ontario

RECORD OF BOREHOLE No 409

1 OF 2

METRIC

PROJECT 08-1132-084-1
W.P. 131-98-00
DIST _____ HWY 7/8
DATUM GEODETIC

LOCATION N 4810530.0 ;E 226173.6
BOREHOLE TYPE POWER AUGER / HOLLOW STEM
DATE November 27, 2008

ORIGINATED BY JM
COMPILED BY LMK
CHECKED BY _____

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 × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
322.86	PAVEMENT										
0.00	ASPHALT										
0.15	FILL, sandy silt, trace gravel Compact Brown		1	SS	20		322				
321.49											
1.37	FILL, silty fine sand, trace clay, trace gravel Dense to very dense Brown		2	SS	38		321		○		1 59 34 6
			3	SS	100						
			4	SS	60		320				
			5	SS	39		319				
318.29											
4.57	FILL, sandy silt Dense Brown		6	SS	43		318				
			7	SS	31						
316.92							317				
5.94	FILL, clayey silt, trace to some sand, trace gravel Very stiff Brown		8	SS	25				⊢○⊣		1 13 58 28
			9	SS	15		316				
315.39											
7.47	FILL, sand, fine to medium, some gravel, trace silt Compact to very dense Brown		10	SS	54		315				
			11	SS	20						
313.72							314				
9.14	TOPSOIL, silty sand Compact Black		12	SS	13						
312.80							313				
10.06	CLAYEY SILT, trace sand, with silt layers Stiff to very stiff Grey		13	SS	20	▽	312				
			14	SS	8		311				
			15	SS	23		310				
							309		⊢○⊣		0 2 73 25
							308				

Continued Next Page

+ 3, × 3: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

Golder Associates
London, Ontario

RECORD OF BOREHOLE No 409

2 OF 2 **METRIC**

PROJECT 08-1132-084-1 | W.P. 131-98-00 | DIST | HWY 7/8 | DATUM GEODETIC

LOCATION N 4810530.0 ;E 226173.6 | BOREHOLE TYPE POWER AUGER / HOLLOW STEM | DATE November 27, 2008

ORIGINATED BY JM | COMPILED BY LMK | CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (20 40 60 80 100): ○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	CLAYEY SILT, trace sand, with silt layers Stiff to very stiff Grey		16	SS	27		307			
306.71										
16.15	SILT, with clayey silt layers, trace clay, trace sand Dense Grey		17	SS	36		306			
305.18							305			
17.68	SILTY CLAY TILL, trace sand, with silt layers Hard Grey		18	SS	30					
304.11										
18.75	END OF BOREHOLE Groundwater encountered at about elev. 312.2m during drilling on November 27, 2008.									

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

Golder Associates
London, Ontario

RECORD OF BOREHOLE No 502

1 OF 2

METRIC

PROJECT 08-1132-084-1
W.P. 131-98-00
DIST _____ HWY 7/8
DATUM GEODETIC
LOCATION N 4810488.1 ;E 225983.2
BOREHOLE TYPE POWER AUGER
DATE October 20, 2008
ORIGINATED BY MA
COMPILED BY LMK
CHECKED BY _____

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 × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
326.23	ROAD SURFACE						326				
0.00	ASPHALT										
0.15 / 325.77	FILL, sand and gravel, crushed										
0.46	FILL, sandy silt, trace clay, trace gravel, clayey silt pockets Loose to dense Brown		1	SS	25		325				
			2	SS	9						
			3	SS	44		324		○		3 56 33 8
322.57			4	SS	36		323		○		0 42 53 5
3.66	FILL, silty clay, trace sand Hard Grey		5	SS	30		322				
321.81											
4.42	FILL, silty sand, fine to medium, trace clay, trace to some gravel, asphalt fragments Compact to very dense Brown		6	SS	23		321				
			7	SS	21						
			8	SS	21		320				
			9	SS	50		319		○		1 58 37 4
318.37			10	SS	30						
7.86 / 318.00	FILL, sandy silt, trace clay, trace gravel Dense Brown						318				
8.23	FILL, sand, fine to medium, trace silt, trace gravel, with silt layers Compact to very dense Brown		11	SS	60						
316.90			12	SS	13		317				
9.33	FILL, clayey silt, trace to some sand, trace topsoil Stiff Brown		13	SS	14		316		○		0 18 58 24
315.56											
10.67 / 315.20	TOPSOIL, peaty Very stiff		14	SS	26					74	
11.03	Black						315				
11.28	SILT, trace topsoil, trace clay Compact Brown		15	SS	13				○		0 2 71 28
	CLAYEY SILT, trace sand Stiff Brown		16	SS	15		314		○		0 1 67 32
312.98						▽					
13.25	SILT, trace clay, trace sand Compact Brown		17	SS	23		313		○		0 1 95 4
312.09											
14.14	CLAYEY SILT, trace sand, with silt layers Stiff to very stiff Grey						312				

Continued Next Page

+ 3, × 3: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

Golder Associates
London, Ontario

RECORD OF BOREHOLE No 502

2 OF 2 **METRIC**

PROJECT 08-1132-084-1 | W.P. 131-98-00 | LOCATION N 4810488.1 ;E 225983.2 | ORIGINATED BY MA
DIST | HWY 7/8 | BOREHOLE TYPE POWER AUGER | COMPILED BY LMK
DATUM GEODETIC | DATE October 20, 2008 | CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (20 40 60 80 100): ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	CLAYEY SILT, trace sand, with silt layers Stiff to very stiff Grey		18	SS	11		311				
							310				
			19	SS	12						0 1 70 29
							309				
307.58			20	SS	18		308				
18.65	SILT, trace clay, trace sand, with clayey silt layers Compact Brown					▽	307				
			21	SS	16		306				
							305				
304.44			22	SS	26						
21.79	END OF BOREHOLE Groundwater encountered at about elev. 313.1m and elev. 306.8m during drilling on October 20, 2008.										

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

Golder Associates
London, Ontario

RECORD OF BOREHOLE No 503

1 OF 2

METRIC

PROJECT 08-1132-084-1
W.P. 131-98-00
DIST _____ HWY 7/8
DATUM GEODETIC
LOCATION N 4810477.1 ;E 225940.5
BOREHOLE TYPE POWER AUGER
DATE October 21, 2008
ORIGINATED BY MA
COMPILED BY LMK
CHECKED BY _____

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 × LAB VANE)	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
326.75	ROAD SURFACE										
0.10	ASPHALT										
0.34	FILL, sand and gravel, crushed Brown										
	FILL, sandy silt, some clay, trace gravel Compact to dense Brown		1	SS	16		326				
			2	SS	14		325				
			3	SS	26						0 42 45 13
			4	SS	24		324				
322.33			5	SS	40		323				
4.42	FILL, clayey silt, some sand, trace gravel Stiff to very stiff Brown		6	SS	16		322				
320.81			7	SS	10		321				
5.94	FILL, silty sand, trace clay Compact Brown		8	SS	19						0 69 27 4
319.28			9	SS	12		320				0 74 20 6
7.47	FILL, clayey silt, trace sand, trace gravel, trace topsoil Stiff to hard Brown		10	SS	36		319				
318.07			11	SS	14		318				
8.68	TOPSOIL, silty Compact Black										
8.90	CLAYEY SILT, trace sand, with silt layers Very stiff Brown		12	SS	16		317				
316.72			13	SS	26	▽					
10.03	SILT, some clay, trace sand Compact Brown to grey at about elev. 316.3m		14	SS	23		316				0 5 78 17
			15	SS	16		315				
313.00							314				
13.75	CLAYEY SILT, trace to some sand, trace gravel, with silt layers Stiff to hard Grey		16	SS	12		313				
							312				

Continued Next Page

+ 3, × 3: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

Golder Associates
London, Ontario

RECORD OF BOREHOLE No 503

2 OF 2 **METRIC**

PROJECT 08-1132-084-1 | W.P. 131-98-00 | LOCATION N 4810477.1 ;E 225940.5 | ORIGINATED BY MA
DIST | HWY 7/8 | BOREHOLE TYPE POWER AUGER | COMPILED BY LMK
DATUM GEODETIC | DATE October 21, 2008 | CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (20 40 60 80 100): ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	CLAYEY SILT, trace to some sand, trace gravel, with silt layers Stiff to hard Grey										
			17	SS	15		311				0 3 62 35
			18	SS	19		310				3 14 55 28
308.00			19	SS	54		309				
18.75	END OF BOREHOLE Groundwater encountered at about elev. 316.8m during drilling on October 21, 2008.						308				

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

Golder Associates
London, Ontario

RECORD OF BOREHOLE No 506

1 OF 3

METRIC

PROJECT 08-1132-084-1
W.P. 131-98-00
DIST HWY 7/8
DATUM GEODETIC
LOCATION N 4810455.9 ;E 225966.2
BOREHOLE TYPE POWER AUGER / TRICONE
DATE November 24, 2008, May 31 and June 1, 2009.
ORIGINATED BY MA
COMPILED BY DMB
CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
326.32	GROUND SURFACE						326				
0.00	ASPHALT										
0.15											
325.86	FILL, sand and gravel, crushed Brown										
0.46											
0.70	FILL, sand and gravel Brown										
	FILL, sand, fine to medium, trace to some gravel, sandy silt pockets Compact to very dense Brown		1	SS	22		325				
			2	SS	41						
			3	SS	49		324				
			4	SS	44		323				
			5	SS	59						
			6	SS	46		322				
			7	SS	33		321				
320.38											
5.94	FILL, sandy silt, trace to some clay, trace gravel Compact to dense Brown		8	SS	24		320				
			9	SS	31		319				
318.49											
7.83	FILL, sand and gravel, with wood Compact		10	SS	27	▽					
318.09							318				
8.23	FILL, sand, fine to medium, trace silt, trace gravel Compact Brown		11	SS	23						
316.82			12	SS	16		317				
9.50	FILL, clayey silt, trace sand, some topsoil Very stiff Brown and black										
9.75			13	SS	14		316				0 2 70 28
	CLAYEY SILT, trace sand, with silt layers Stiff Brown		14	SS	13						
314.74							315				
11.58	SILT, trace clay, trace sand Dense Grey		15	SS	33		314				0 1 98 1
313.21											
13.11	CLAYEY SILT, trace sand, with silt layers Very stiff Grey		16	SS	22		313				0 2 75 23
							312				

Continued Next Page

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

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

Golder Associates
London, Ontario

RECORD OF BOREHOLE No 506

2 OF 3 **METRIC**

PROJECT 08-1132-084-1 | W.P. 131-98-00 | DIST _____ HWY 7/8 | DATUM GEODETIC

LOCATION N 4810455.9 ;E 225966.2 | BOREHOLE TYPE POWER AUGER / TRICONE | DATE November 24, 2008, May 31 and June 1, 2009.

ORIGINATED BY MA | COMPILED BY DMB | CHECKED BY _____

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	CLAYEY SILT, trace sand, with silt layers Very stiff Grey		17	SS	29		311				
			18	SS	15		310				
308.64							309				
17.68	SILT, some clay, some sand Very dense Grey		19	SS	50	▽	308		○		0 20 68 12
			20	SS	70		307				
			21	SS	67		306				
304.07							305				
22.25	CLAYEY SILT, trace sand, with silt layers Very stiff Grey		22	SS	15		304				
			23	SS	21		303				
301.02							302				
25.30	SILT, some clay Dense Grey		24	SS	31		301				
299.50							300				
26.82	SILTY SAND, some gravel, trace clay Dense Grey		25	SS	44		299		○		10 64 23 3
297.97							298				
28.35	SAND AND GRAVEL, trace silt Very dense Grey		26	SS	75		297				
296.45											

Continued Next Page

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

Golder Associates
London, Ontario

PROJECT 08-1132-084-1

RECORD OF BOREHOLE No 506

3 OF 3

METRIC

W.P. 131-98-00 LOCATION N 4810455.9 ;E 225966.2 ORIGINATED BY MA

DIST HWY 7/8 BOREHOLE TYPE POWER AUGER / TRICONE COMPILED BY DMB

DATUM GEODETIC DATE November 24, 2008, May 31 and June 1, 2009. CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
29.87	SILTY CLAY, trace sand, with silt layers Very stiff to hard Grey						296				
			27	SS	81						
							295				
			28	SS	56/ 125mm		294		43		0 2 45 53
							293				
			29	SS	48						
							292				
			30	SS	27		291				
							290				
			31	SS	36				45		0 2 38 60
288.83							289				
37.49	SANDY SILT, trace gravel, trace clay Very dense Grey										
			32	SS	111/ 250mm		288				1 46 50 3
287.31											
39.01	SANDY SILT TILL, trace clay, trace gravel Very dense Grey						287				
			33	SS	75/ 50mm						
							286				
284.93			34	SS	102/ 250mm		285				
41.39	END OF BOREHOLE Groundwater encountered at about elev. 318.1m and elev. 308.6m during drilling on November 24, 2008, and May 31, 2009, respectively.										

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

LDN_MTO_06 08-1132-084-1.GPJ LDN_MTO.GDT 12/01/11

Golder Associates
London, Ontario

RECORD OF BOREHOLE No 507

1 OF 2

METRIC

PROJECT 08-1132-084-1
W.P. 131-98-00
DIST _____ HWY 7/8
DATUM GEODETIC

LOCATION N 4810466.3 ;E 226013.0
BOREHOLE TYPE POWER AUGER / HOLLOW STEM
DATE December 2, 2008

ORIGINATED BY MA
COMPILED BY LMK
CHECKED BY _____

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 × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
325.80	ROAD SURFACE										
0.00	ASPHALT										
0.15											
325.34	FILL, sand and gravel, trace silt, crushed										
0.46	Brown										
	FILL, sandy silt, trace clay, trace gravel Compact Brown		1	SS	18		325				
			2	SS	24		324				
			3	SS	23		323		○		0 48 43 9
			4	SS	17						
322.14							322				
3.66	FILL, sand, fine, trace to some silt, trace gravel Compact to dense Brown		5	SS	22						
			6	SS	31		321				
			7	SS	33				○		
319.86							320				
5.94	FILL, silty sand, trace to some clay, trace gravel Compact to dense Grey		8	SS	21						
			9	SS	64		319				
			10	SS	94		318		○		
			11	SS	16	▽			○		3 49 40 8
316.81							317				
8.99	FILL, sandy silt, trace clay, trace topsoil, trace gravel Compact to dense Brown and grey		12	SS	30						
			13	SS	26		316				
315.07						▽					
10.73	SILT, trace sand, trace clay Dense Brown to grey at about elev. 314.2m		14	SS	30		315				
			15	SS	34		314		○		0 2 89 9
312.69							313				
13.11	CLAYEY SILT, trace sand, with silt layers Stiff Grey		16	SS	14		312				
							311				

Continued Next Page

+ ³, × ³: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

LDN_MTO_06 08-1132-084-1.GPJ LDN_MTO.GDT 12/01/11

Golder Associates
London, Ontario

RECORD OF BOREHOLE No 507

2 OF 2

METRIC

PROJECT 08-1132-084-1
W.P. 131-98-00
DIST _____ HWY 7/8
DATUM GEODETIC

LOCATION N 4810466.3 ;E 226013.0
BOREHOLE TYPE POWER AUGER / HOLLOW STEM
DATE December 2, 2008

ORIGINATED BY MA
COMPILED BY LMK
CHECKED BY _____

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	CLAYEY SILT, trace sand, with silt layers Stiff Grey		17	SS	12		310				
			18	SS	14		309				0 1 63 36
308.12											
17.68	SILT, trace clay, trace sand Compact Grey		19	SS	17		308				
306.60						▽	307				
19.20	SILTY FINE SAND Loose to compact Grey		20	SS	8		306				
							305				
304.16			21	SS	12						
21.64	CLAYEY SILT, with silt layers Stiff Grey										
21.79	END OF BOREHOLE Groundwater encountered at about elev. 317.3m, elev. 315.1m, and elev. 306.6m during drilling on December 2, 2008.										

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

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

Golder Associates
London, Ontario

RECORD OF BOREHOLE No 511

1 OF 1

METRIC

PROJECT 08-1132-084-1
W.P. 131-98-00
DIST _____ HWY 7/8
DATUM GEODETIC

LOCATION N 4810419.0 ;E 225835.3
BOREHOLE TYPE POWER AUGER / HOLLOW STEM
DATE December 1, 2008

ORIGINATED BY MA
COMPILED BY LMK
CHECKED BY _____

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
327.62	ROAD SURFACE										
0.10	ASPHALT										
0.40	FILL, sand and gravel, trace silt, crushed, Brown						327				
	FILL, silty fine sand, trace gravel, Compact, Brown		1	SS	29				○		
326.25							326				
1.37	FILL, sand, fine to medium, trace silt, with silty sand layers, Very dense, Brown		2	SS	67/150mm				○		
325.49							325				
2.13	FILL, sandy silt, trace to some clay, trace gravel, with clayey silt layers, Dense, Brown		3	SS	37						
			4	SS	39				○		
			5	SS	36		324		○		
			6	SS	33		323		○		2 45 36 17
322.44											
5.18	CLAYEY SILT, trace sand, trace gravel, Very stiff, Brown		7	SS	22		322				
322.07											
5.55	SILTY SAND, some clay, trace gravel, with clayey silt layers, Compact, Brown		8	SS	25				○		9 46 34 11
320.61							321				
7.01	SAND, some silt, trace gravel, trace clay, Compact, Brown		9	SS	12	▽	320				
							319				
318.02			10	SS	12				○		9 72 16 3
9.60	END OF BOREHOLE Groundwater encountered at about elev. 320.3m during drilling on December 1, 2008.										

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

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

LDN_MTO_06 08-1132-084-1.GPJ LDN_MTO.GDT 12/01/11

Golder Associates
London, Ontario

RECORD OF BOREHOLE No 512

1 OF 1

METRIC

PROJECT 08-1132-084-1
W.P. 131-98-00
DIST _____ HWY 7/8
DATUM GEODETIC

LOCATION N 4810442.0 ;E 225916.0
BOREHOLE TYPE POWER AUGER / HOLLOW STEM
DATE December 1, 2008

ORIGINATED BY MA
COMPILED BY LMK
CHECKED BY _____

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 × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
326.92	ROAD SURFACE										
0.10	ASPHALT										
0.33	FILL, sand and gravel, crushed, trace silt, Brown										
	FILL, silty fine sand, trace gravel, with clayey silt pockets, Compact, Brown		1	SS	21		326		○		
			2	SS	19		325		○		
324.79											
2.13	FILL, sandy silt, trace gravel, with silty sand layers, Compact to dense, Brown		3	SS	23				○		
			4	SS	30		324		○		
323.26											
3.66	FILL, silty fine sand, trace topsoil, trace gravel, trace clay, Compact to dense, Brown		5	SS	27		323		○		2 62 28 8
			6	SS	31		322		○		
			7	SS	47				○		
			8	SS	34		321		○		
320.21											
6.71	FILL, sand and gravel, some silt, trace clay, Compact, Brown		9	SS	27		320		○ ⊢⊣		
7.01 319.60											
7.32	FILL, clayey silt, some sand, trace gravel, trace topsoil, Very stiff, Grey		10	SS	30		319		○ ⊢⊣		1 17 55 27
318.54	CLAYEY SILT TILL, some sand, trace gravel, Hard, Grey					▽					
8.38	SAND, fine, trace gravel, some silt, Dense, Brown		11	SS	38		318				
316.86							317				
10.06	SILT, trace sand, trace gravel, Very dense, Brown										
315.98			12	SS	63		316				
10.94	SAND, fine, some gravel, trace silt, Very dense, Brown										
11.13	END OF BOREHOLE Groundwater encountered at about elev. 318.5m during drilling on December 1, 2008.										

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

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

Golder Associates
London, Ontario

RECORD OF BOREHOLE No 513

1 OF 1

METRIC

PROJECT 08-1132-084-1
W.P. 131-98-00
DIST HWY 7/8
DATUM GEODETIC
LOCATION N 4810405.7 ;E 225793.2
BOREHOLE TYPE POWER AUGER / HOLLOW STEM
DATE May 11, 2010
ORIGINATED BY MA
COMPILED BY WDF
CHECKED BY

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 × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
328.00	ROAD SURFACE						328				
0.10	ASPHALT										
327.51	FILL, sand and gravel, crushed Brown										
0.49	FILL, silty fine sand, trace to some clay, trace gravel Compact to dense Brown		1	SS	20		327				
			2	SS	16		326				1 59 32 8
			3	SS	28						
324.52			4	SS	41		325				4 59 26 11
3.48	SAND AND GRAVEL, Compact Brown		5	SS	18		324				
323.82											
4.18	SILTY FINE SAND, trace gravel, trace clay Compact Brown		6	SS	18		323				
			7	SS	12						
			8	SS	10	▽	322				2 72 22 4
321.29											
6.71	SAND, fine to medium, trace silt Compact to dense Brown		9	SS	11		321				
			10	SS	33		320				
			11	SS	14						
			12	SS	11		319				
318.40											
9.60	END OF BOREHOLE Groundwater encountered at about elev. 321.3m during drilling on May 11, 2010.										

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

○ 3% STRAIN AT FAILURE

LDN_MTO_06 08-1132-084-1.GPJ LDN_MTO.GDT 12/01/11

Golder Associates
London, Ontario

RECORD OF BOREHOLE No 901

1 OF 1

METRIC

PROJECT 08-1132-084-1
W.P. 131-98-00
DIST HWY 7/8
DATUM GEODETIC

LOCATION N 4809787.4 ;E 223688.1
BOREHOLE TYPE POWER AUGER / HOLLOW STEM
DATE May 27, 2010

ORIGINATED BY MR
COMPILED BY WDF
CHECKED BY

ELEV / DEPTH	SOIL PROFILE: *Elevation has been interpolated from existing AGM survey data.* 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 × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
337.83	ROAD SURFACE										
0.09	ASPHALT										
0.30	FILL, sand and gravel, crushed Brown										
0.55	FILL, sand and gravel Brown										
	FILL, clayey silt, some sand, trace gravel, trace topsoil Stiff Brown		1	SS	8		337				
			2	SS	13		336				
			3	SS	9						3 33 40 24
334.93							335				
2.90	FILL, sandy silt, some clay, trace gravel, trace topsoil Loose to compact Brown		4	SS	11						
			5	SS	15		334				
			6	SS	7		333				0 26 54 20
			7	SS	15						
331.89							332				
5.94 331.58	FILL, topsoil, silty, some sand, some gravel										
6.25	Compact FILL, sand, fine to medium, trace to some gravel, some silt, trace clay Compact to dense		8	SS	25						
330.67			9	SS	36		331				2 81 12 5
7.16 330.36	FILL, topsoil, silty, some sand, some gravel										
7.47	Dense Black										
7.77	FILL, sandy silt, trace gravel, trace clay		10	SS	26		330				
329.60	Compact Grey										
8.23	TOPSOIL, silty Compact Black		11	SS	57		329				
328.84											
8.99	SAND AND GRAVEL, trace silt, trace topsoil Very dense		12	SS	25						
328.23											
9.60	CLAYEY SILT TILL, trace sand, trace gravel Very stiff Brown to grey at about 328.3m										
	END OF BOREHOLE Borehole dry during drilling on May 27, 2010.										

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

LDN_MTO_06 08-1132-084-1.GPJ LDN_MTO.GDT 12/01/11

Golder Associates
London, Ontario

RECORD OF BOREHOLE No 902

1 OF 1

METRIC

PROJECT 08-1132-084-1
W.P. 131-98-00
LOCATION N 4809802.0 ;E 223736.0
ORIGINATED BY MR
DIST HWY 7/8
BOREHOLE TYPE POWER AUGER / HOLLOW STEM
COMPILED BY WDF
DATUM GEODETIC
DATE May 26, 2010
CHECKED BY

ELEV / DEPTH	SOIL PROFILE: *Elevation has been interpolated from existing AGM survey data.* 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 × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
337.27	ROAD SURFACE						337				
0.09	ASPHALT										
0.27	FILL, sand and gravel, crushed Brown										
0.55	FILL, sand and gravel Brown										
	FILL, clayey silt, trace sand, trace gravel Firm to very stiff Brown		1	SS	7		336				
			2	SS	13						
			3	SS	16		335				
334.37											
2.90	FILL, sandy silt, some clay, trace gravel Loose to compact Brown		4	SS	12		334				5 33 48 14
			5	SS	9						
332.85							333				
4.42	FILL, clayey silt, trace to some sand, trace gravel, trace topsoil Firm to very stiff Brown and grey		6	SS	9						
			7	SS	5		332				5 38 41 16
			8	SS	9		331				
			9	SS	18						
329.65							330				
7.62	TOPSOIL, silty Loose Black		10	SS	9						
329.19											
8.08	CLAYEY SILT, trace sand, with silt layers Stiff Grey		11	SS	14		329				0 9 48 43
			12	SS	14		328				
327.67											
9.60	END OF BOREHOLE Borehole dry during drilling on May 26, 2010.										

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

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

Golder Associates
London, Ontario

RECORD OF BOREHOLE No 903

METRIC

PROJECT 08-1132-084-1			
W.P. 131-98-00	LOCATION N 4809755.1 ;E 223682.3		ORIGINATED BY MA
DIST	HWY 7/8	BOREHOLE TYPE POWER AUGER / HOLLOW STEM	COMPILED BY WDF
DATUM GEODETIC	DATE May 13, 2010		CHECKED BY

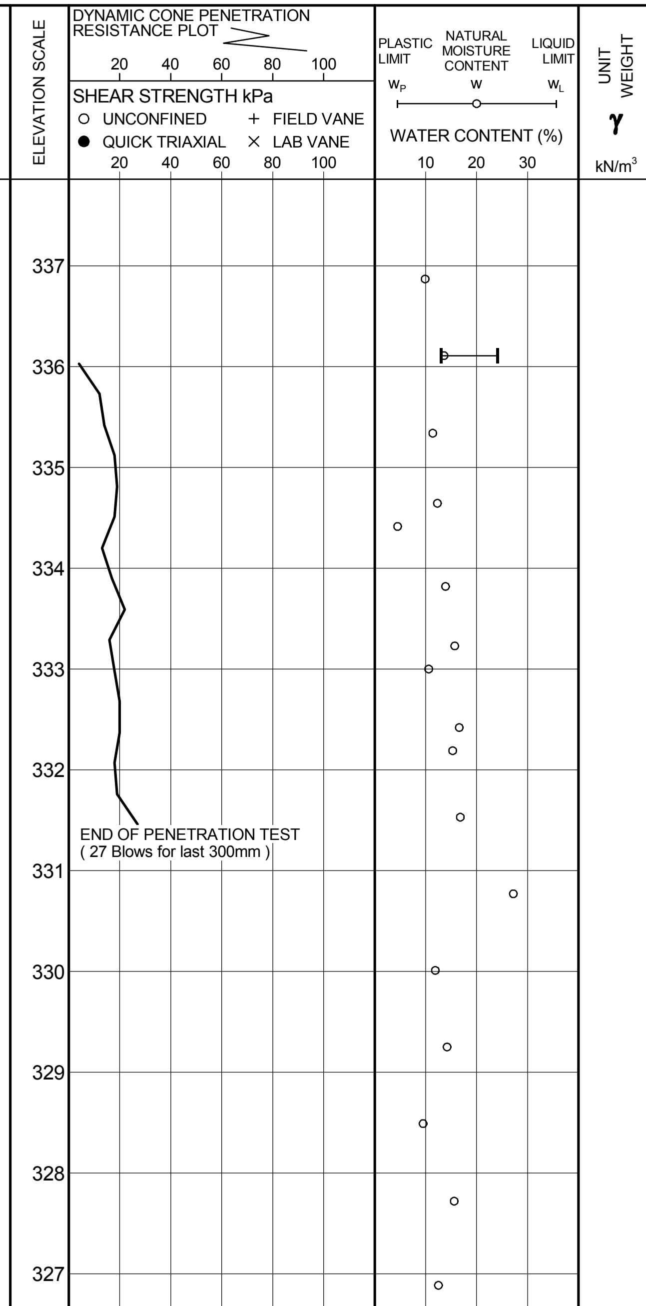
SOIL PROFILE

ELEV / DEPTH	DESCRIPTION
337.86	ROAD SURFACE
0.00	ASPHALT
0.12	FILL, sand and gravel, trace silt, crushed Brown
0.40	FILL, sand and gravel, trace silt, with cobbles Brown
0.67	FILL, clayey silt, trace gravel, with sand seams, trace topsoil Stiff to very stiff Brown to grey
334.96 2.90	FILL, silty sand, with clayey silt seams Loose Brown
334.48 3.38	FILL, sand, fine to medium, some gravel Loose Brown
3.66	FILL, clayey silt, trace gravel, trace silty sand layers Firm Brown
333.17 4.69	FILL, silty sand, trace gravel, trace sandy silt seams Very loose to loose Brown
332.31 5.55	FILL, clayey silt, trace gravel, trace topsoil Soft Brown
331.92 5.94	FILL, sandy silt, some clay, trace gravel, trace topsoil Very loose Grey
331.15 6.71	FILL, topsoil, silty sand, trace gravel Loose Black
330.39 7.47	FILL, silty sand, trace gravel Compact Brown
329.48 8.38	FILL, sand, fine to medium, trace to some silt, trace gravel, trace topsoil, clay tile fragments Loose to compact Brown
328.11 9.75	SAND, fine to medium, trace to some silt, trace gravel Loose Brown
326.58 11.28	END OF BOREHOLE Groundwater encountered at about elev. 329.5m during drilling on May 13, 2010.

SAMPLES

NUMBER	TYPE	"N" VALUES	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
1	SS	14	
2	SS	12	6 28 44 22
3	SS	22	
4	SS	8	
5	SS	6	
6	SS	8	
7	SS	3	
8	SS	3	0 31 49 20
9	SS	7	
10	SS	29	
11	SS	9	
12	SS	15	
13	SS	9	
14	SS	6	

GROUND WATER CONDITIONS: ∇ at approx. elev. 329.5



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

Golder Associates
London, Ontario

RECORD OF BOREHOLE No 903A

1 OF 1

METRIC

PROJECT 08-1132-084-1
W.P. 131-98-00
LOCATION N 4809755.4 ;E 223683.3
ORIGINATED BY MA
DIST HWY 7/8
BOREHOLE TYPE POWER AUGER / HOLLOW STEM
COMPILED BY WDF
DATUM GEODETIC
DATE May 13, 2010
CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
337.86	ROAD SURFACE										
0.00	Augered to 8.38m depth. For stratigraphy see record of borehole 903.										
329.48											
8.38	FILL, sand, fine to medium, trace to some silt, trace gravel, trace topsoil Loose to dense Brown		11	SS	14						
			12	SS	39						
328.11											
9.75	SILTY FINE SAND, trace to some gravel, trace clay Loose to compact Brown		13	SS	13						8 62 24 6
			14	SS	6	▽					
326.43											
11.43	SAND AND GRAVEL, trace silt Loose to compact Grey		15	SS	24						
			16	SS	6			END OF PENETRATION TEST (45 Blows for last 300mm)			
325.36											
12.50	CLAYEY SILT, trace to some sand, trace gravel Firm to very stiff Grey		17	SS	19						0 19 52 29
			18	SS	27						
323.69											
14.17	END OF BOREHOLE Groundwater encountered at about elev. 326.6m during drilling on May 13, 2010.										

ELEVATION SCALE: 337, 336, 335, 334, 333, 332, 331, 330, 329, 328, 327, 326, 325, 324

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

LDN_MTO_06 08-1132-084-1.GPJ LDN_MTO.GDT 12/01/11

Golder Associates
London, Ontario

RECORD OF BOREHOLE No 904

1 OF 1

METRIC

PROJECT 08-1132-084-1
W.P. 131-98-00
DIST HWY 7/8
DATUM GEODETIC

LOCATION N 4809772.0 ;E 223736.8
BOREHOLE TYPE POWER AUGER / HOLLOW STEM
DATE May 17, 2010

ORIGINATED BY MA
COMPILED BY WDF
CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
337.34	ROAD SURFACE										
0.00	ASPHALT						337				
0.12	FILL, sand and gravel, trace silt, crushed, Brown										
0.34	FILL, sand and gravel, trace silt, with cobbles, Brown		1	SS	14				○		
0.61	FILL, clayey silt, with sandy silt seams, trace sand, trace gravel, Stiff, Brown		2	SS	10		336		○ ○		
335.97	FILL, silty sand, fine to medium, Compact, Brown		3	SS	13		335		○ ○		
1.37	FILL, clayey silt, trace sand, trace topsoil, trace gravel, Stiff, Brown		4	SS	9		334		○ non-plastic		3 20 58 19
335.51	FILL, sandy silt, with clayey silt seams, trace gravel, Loose to compact, Brown		5	SS	7				○		
1.83	FILL, clayey silt, with sandy silt seams, trace gravel, trace topsoil, Firm to very stiff, Brown		6	SS	11		333		○		
334.78			7	SS	7		332		⊢		0 22 58 20
2.56			8	SS	12		331		○		
333.53			9	SS	16				○		
3.81			10	SS	9		330		○		
330.24			11	SS	11		329		⊢		1 30 49 20
7.10	FILL, sand, fine to medium, some silt, trace gravel, trace topsoil, Compact, Brown		12	SS	20		328				
329.72	TOPSOIL, sandy silt, Loose, Black		13	SS	19	▽	327				
7.62	CLAYEY SILT TILL, some sand, trace gravel, Stiff to very stiff, Grey										
329.11											
8.23											
327.59											
9.75	SAND, medium to coarse, trace gravel, Compact, Grey										
326.98											
10.36	END OF BOREHOLE										

Groundwater encountered at about elev. 327.5m during drilling on May 17, 2010.

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

Golder Associates
London, Ontario

RECORD OF BOREHOLE No 905

1 OF 1

METRIC

PROJECT 08-1132-084-1
W.P. 131-98-00
DIST _____ HWY 7/8
DATUM GEODETIC

LOCATION N 4810356.5 ;E 225449.8
BOREHOLE TYPE POWER AUGER / HOLLOW STEM
DATE May 21, 2010

ORIGINATED BY MR
COMPILED BY WDF
CHECKED BY _____

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
330.61	GROUND SURFACE										
0.09 / 330.15	TOPSOIL, silty, Dark brown										
0.46	FILL, sand and gravel, trace silt, Brown						330				
	FILL, silty sand, with silt layers, Compact, Brown		1	SS	16						
329.24											
1.37	FILL, sand, fine to medium, some silt, Loose, Brown		2	SS	6		329				
328.32											
2.29	SAND, fine to medium, trace silt, trace clay, Compact to dense, Brown		3	SS	26		328				0 93 3 4
			4	SS	29						
			5	SS	36		327				
			6	SS	27		326				
325.12											
5.49	CLAYEY SILT, some sand, trace gravel, trace sandy silt layers, Very stiff to hard, Brown		7	SS	17		325				
			8	SS	22						0 11 45 44
			9	SS	35		324				
323.14											
7.47	SAND, fine to coarse, some gravel, Very dense, Brown		10	SS	69		323				
322.38											
8.23	SILT, some sand, Dense, Brown		11	SS	37		322				
321.62											
8.99	SILTY FINE SAND, Dense, Brown		12	SS	40						
321.01											
9.60	END OF BOREHOLE Borehole dry during drilling on May 21, 2010.										

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

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

Golder Associates
London, Ontario

RECORD OF BOREHOLE No 906

1 OF 1

METRIC

PROJECT 08-1132-084-1
W.P. 131-98-00
DIST _____ HWY 7/8
DATUM GEODETIC

LOCATION N 4810372.4 ;E 225511.5
BOREHOLE TYPE POWER AUGER / HOLLOW STEM
DATE May 21, 2010

ORIGINATED BY MR
COMPILED BY WDF
CHECKED BY _____

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
330.22	GROUND SURFACE										
0.00	TOPSOIL, silty										
0.21	Dark brown										
329.46	FILL, sand and gravel, trace silt Brown										
0.76	FILL, sand, fine to medium Very loose to compact Brown		1	SS	15		330		○		
			2	SS	4		329		○		
			3	SS	2		328		○		
327.32											
2.90	SAND, fine to medium, trace to some silt, trace clay Compact to dense Brown		4	SS	21		327				
			5	SS	35		326		○		0 87 10 3
325.50											
4.72	CLAYEY SILT TILL, trace sand, trace gravel Hard Brown		6	SS	37		325				
			7	SS	40				○		
324.28							324				
5.94	SAND, fine to medium, trace silt, trace gravel Very dense Brown		8	SS	65						
323.51							323				
6.71	CLAYEY SILT, some sand, with sand layers Hard Brown		9	SS	45						
			10	SS	44				○ ⊢ ⊣		0 25 32 43
321.69							322				
8.53	SAND, fine to medium, trace gravel Dense Brown		11	SS	40						
320.62			12	SS	31		321				
9.60	END OF BOREHOLE Borehole dry during drilling on May 21, 2010.										

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

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

LDN_MTO_06 08-1132-084-1.GPJ LDN_MTO.GDT 12/01/11

Golder Associates
London, Ontario

RECORD OF BOREHOLE No 907

1 OF 1

METRIC

PROJECT 08-1132-084-1
W.P. 131-98-00
DIST HWY 7/8
DATUM GEODETIC

LOCATION N 4810390.0 ;E 225585.0
BOREHOLE TYPE POWER AUGER / HOLLOW STEM
DATE May 25, 2010

ORIGINATED BY MR
COMPILED BY WDF
CHECKED BY

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 × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
329.61	GROUND SURFACE										
0.00	TOPSOIL, silty Dark brown						Bentonite				
0.24											
0.46	FILL, sand and gravel Brown						329				
	FILL, silty sand, trace topsoil, trace clay, trace gravel Loose to compact Brown		1	SS	15				○		
			2	SS	8		328		○		
							Backfill				
			3	SS	7		327		○		0 59 33 8
326.56											
3.05	SILTY CLAY, trace to some sand, with sandy silt layers Very stiff to hard Brown		4	SS	23						
							326				
			5	SS	26		Bentonite		○ —		0 12 50 38
			6	SS	35		325				
324.43											
5.18	SAND, fine to medium, trace silt, trace clay Compact to dense Brown		7	SS	43		324				
							Backfill				
			8	SS	34						
							323				
			9	SS	40						
			10	SS	25		322		○		0 95 2 3
							Standpipe				
			11	SS	23		321				
320.47											
9.14	END OF BOREHOLE Augers advanced to 9.14m but sampler impeded by blowback below elev. 320.8m Groundwater encountered at about elev. 323.5m during drilling on May 25, 2010. Water level measured in standpipe at elev. 322.42m following installation on May 25, 2010. Water level measured in standpipe at elev. 323.69m on June 2, 2010. Water level measured in standpipe at elev. 323.54m on June 30, 2010. Water level measured in standpipe at elev. 323.01m on Nov. 25, 2010.										

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

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

LDN_MTO_06 08-1132-084-1.GPJ LDN_MTO.GDT 12/01/11

Golder Associates
London, Ontario

RECORD OF BOREHOLE No 908

1 OF 1

METRIC

PROJECT 08-1132-084-1
W.P. 131-98-00
DIST _____ HWY 7/8
DATUM GEODETIC

LOCATION N 4810408.3 ;E 225658.5
BOREHOLE TYPE POWER AUGER / HOLLOW STEM
DATE May 25, 2010

ORIGINATED BY MR
COMPILED BY WDF
CHECKED BY _____

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
328.96	GROUND SURFACE										
0.09 / 328.44	TOPSOIL, silty, Dark brown										
0.52	FILL, sand and gravel, Brown										
	FILL, sandy silt, trace clay, with clayey silt pockets, Loose to compact, Brown		1	SS	25		328				
			2	SS	6		327				
326.83											
2.13	FILL, sand, fine, some silt, trace gravel, trace clay, Very loose to compact, Brown		3	SS	19						
			4	SS	5		326				3 77 15 5
			5	SS	2		325				
324.54											
4.42	SAND, fine, some silt, trace clay, Compact to dense, Brown		6	SS	20		324				
			7	SS	34						0 85 11 4
323.02							323				
5.94	SAND, trace gravel, Very dense, Brown		8	SS	80						
322.25											
6.71	SAND AND GRAVEL, trace silt, trace clay, Compact, Brown		9	SS	23	▽	322				43 51 4 2
			10	SS	24		321				
320.73											
8.23	SAND, fine to medium, trace silt, trace gravel, Compact, Brown		11	SS	28						
			12	SS	24		320				
319.36											
9.60	END OF BOREHOLE Groundwater encountered at about elev. 322.1m during drilling on May 25, 2010.										

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

LDN_MTO_06 08-1132-084-1.GPJ LDN_MTO.GDT 12/01/11

Golder Associates
London, Ontario

RECORD OF BOREHOLE No 909

1 OF 1

METRIC

PROJECT 08-1132-084-1
W.P. 131-98-00
DIST _____ HWY 7/8
DATUM GEODETIC

LOCATION N 4810422.8 ;E 225729.9
BOREHOLE TYPE POWER AUGER / HOLLOW STEM
DATE May 11, 2010

ORIGINATED BY MA
COMPILED BY WDF
CHECKED BY _____

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
328.39	ROAD SURFACE										
0.09	ASPHALT										
327.99	FILL, sand and gravel, crushed, trace silt, Brown										
0.40	FILL, silty fine sand, trace clay, trace gravel, with sandy silt layers, Loose to dense, Brown		1	SS	7		328		○		
			2	SS	32		327		○		
			3	SS	31		326		○		0 68 26 6
325.34											
3.05	FILL, sand, fine to medium, trace to some sandy silt layers, trace topsoil, Dense, Brown		4	SS	49		325		○		
324.73											
3.66	FILL, sand, fine to medium, Compact, Brown		5	SS	20		324		○		
323.70											
4.69	FILL, clayey silt, some gravel, some sand, Very stiff, Brown		6	SS	16		323		○		
323.36									○		
5.03	FILL, sand and gravel, trace silt, trace topsoil, Dense, Brown		7	SS	39	▽	322		○		
322.45											
5.94	SAND, fine to medium, trace clay, with silty sand layers, Compact to dense, Brown		8	SS	24				○		0 86 12 2
			9	SS	32		321				
			10	SS	34						
320.16											
8.23	SAND, fine to medium, trace to some silt, Dense to very dense, Brown to grey at about elev. 319.4m		11	SS	31		320				
			12	SS	50		319				
318.79											
9.60	END OF BOREHOLE Groundwater encountered at about elev. 322.3m during drilling on May 11, 2010.										

+ 3, × 3: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

Golder Associates
London, Ontario

RECORD OF BOREHOLE No 910

1 OF 1

METRIC

PROJECT 08-1132-084-1
W.P. 131-98-00
DIST _____ HWY 7/8
DATUM GEODETIC
LOCATION N 4810442.0 ;E 225802.4
BOREHOLE TYPE POWER AUGER / HOLLOW STEM
DATE May 11, 2010
ORIGINATED BY MA
COMPILED BY WDF
CHECKED BY _____

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
327.80	ROAD SURFACE										
0.00	ASPHALT										
0.15	FILL, sand and gravel, crushed, trace silt, Brown										
0.37	FILL, silty fine sand, trace clay, trace gravel, with clayey silt pockets, Very loose to very dense, Brown		1	SS	15		327				
			2	SS	30		326				1 54 37 8
			3	SS	31		325				
			4	SS	60		324				
			5	SS	34						4 47 44 5
			6	SS	10		323				
			7	SS	6		322				
			8	SS	2						
321.09											
6.71	SILTY CLAY, trace sand, trace gravel, Very stiff, Grey and brown		9	SS	18		321		41		0 4 48 48
			10	SS	21	▽	320				
319.78											
8.02	SANDY SILT, trace clay, Compact, Brown										
8.23											
319.20			11	SS	15		319				
8.60	CLAYEY SILT, some sand, trace gravel, Very stiff, Brown										
			12	SS	17						
318.20	SILTY FINE SAND, trace gravel, Compact, Brown										
9.60	END OF BOREHOLE										

Groundwater encountered at about elev. 319.8m during drilling on May 11, 2010.

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

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

Golder Associates
London, Ontario

RECORD OF BOREHOLE No 911

1 OF 1

METRIC

PROJECT 08-1132-084-1
W.P. 131-98-00
DIST HWY 7/8
DATUM GEODETIC

LOCATION N 4810390.5 ;E 225745.5
BOREHOLE TYPE POWER AUGER / HOLLOW STEM
DATE May 11, 2010 - May 12, 2010

ORIGINATED BY MA
COMPILED BY WDF
CHECKED BY

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 × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
328.36	GROUND SURFACE										
0.08 / 327.87	TOPSOIL, clayey silt, Brown						328				
0.49	FILL, sand and gravel, crushed, Brown										
	FILL, silty sand, trace gravel, with clayey silt pockets, Compact to dense, Brown		1	SS	15						
							327				
			2	SS	10		*Backfill*				
							326				
			3	SS	37						
			4	SS	16		325				0 56 36 9
			5	SS	10						
323.94							324				
4.42	SANDY SILT, trace clay, Loose to compact, Brown		6	SS	13		*Bentonite*				
			7	SS	9		323				0 41 54 5
			8	SS	10		322				
321.65							*Backfill*				
6.71	SAND, fine to medium, trace silt, trace gravel, Compact, Brown		9	SS	11		321				
320.44			10	SS	26		*Standpipe*				
7.92 / 320.13	CLAYEY SILT, trace sand, trace gravel, Very stiff, Grey						320				
8.23	SILTY CLAY, trace sand, with silt layers, Very stiff, Grey		11	SS	28						
318.76			12	SS	23		319				
9.60	END OF BOREHOLE Groundwater encountered at about elev. 323.2m during drilling on May 11, 2010. Water level measured in standpipe at elev. 320.44m following installation on May 12, 2010. Water level measured in standpipe at elev. 322.21m on June 2, 2010. Water level measured in standpipe at elev. 322.16m on June 30, 2010. Water level measured in standpipe at elev. 321.98m on Nov. 25, 2010.										

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

LDN_MTO_06 08-1132-084-1.GPJ LDN_MTO.GDT 12/01/11

Golder Associates
London, Ontario

RECORD OF BOREHOLE No 912

1 OF 1

METRIC

PROJECT 08-1132-084-1
W.P. 131-98-00
DIST _____ HWY 7/8
DATUM GEODETIC

LOCATION N 4810506.2 ;E 226047.8
BOREHOLE TYPE POWER AUGER / HOLLOW STEM
DATE May 10, 2010

ORIGINATED BY MA
COMPILED BY WDF
CHECKED BY _____

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
325.28	ROAD SURFACE						325				
0.09	ASPHALT										
0.37	FILL, sand and gravel, crushed, trace silt Brown										
	FILL, sandy silt, trace to some clay, trace gravel, trace topsoil, with sand layers Compact Brown		1	SS	22				○		
			2	SS	22		324		○ ○		
			3	SS	11		323		○		
			4	SS	16		322		○		2 39 47 12
321.62											
3.66	FILL, sand, fine to medium, trace to some silt, trace clay, trace gravel Compact to dense Brown		5	SS	28				○		1 78 16 5
			6	SS	38		321		○		
			7	SS	30		320		○		
319.34											
5.94	FILL, sandy silt, trace clay, trace gravel Dense Brown		8	SS	45		319		○		
318.88											
6.40	FILL, sand, fine to medium, trace silt, trace gravel Dense Brown		9	SS	33		318		○		
317.81											
7.47	SAND, fine to medium, trace silt, trace gravel Dense to very dense Brown		10	SS	68						
			11	SS	46		317				
			12	SS	89		316				
315.68											
9.60	END OF BOREHOLE Borehole dry during drilling on May 10, 2010.										

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

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

Golder Associates
London, Ontario

RECORD OF BOREHOLE No 913

1 OF 1

METRIC

PROJECT 08-1132-084-1
W.P. 131-98-00
DIST _____ HWY 7/8
DATUM GEODETIC

LOCATION N 4810519.3 ;E 226109.9
BOREHOLE TYPE POWER AUGER / HOLLOW STEM
DATE May 10, 2010

ORIGINATED BY MA
COMPILED BY WDF
CHECKED BY _____

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
324.15	ROAD SURFACE						324				
0.09	ASPHALT										
0.34	FILL, sand and gravel, crushed, trace silt, Brown										
	FILL, silty fine sand, Compact, Brown		1	SS	17		323		○		
322.93											
1.22	FILL, sandy silt, some clay, trace gravel, trace topsoil, Dense, Brown		2	SS	33				○		
322.02							322				
2.13	FILL, silty fine sand, trace clay, Compact, Brown		3	SS	12				○		
			4	SS	14		321		○		0 73 22 5
320.00			5	SS	14				○		
4.15	FILL, clayey silt, trace sand, with topsoil layers, Stiff, Brown						320		○		
319.58			6	SS	7				○		
4.57	TOPSOIL, sandy silt, some clay, trace gravel, Loose, Black						319				
318.82			7	SS	16				○		
5.33	SILTY FINE SAND, trace clay, trace gravel, Compact to very dense, Brown						318				
			8	SS	28				○		
			9	SS	32		317		○		1 61 33 5
			10	SS	68		316				
			11	SS	70						
			12	SS	42	▽	315				
314.55											
9.60	END OF BOREHOLE Groundwater encountered at about elev. 314.9m during drilling on May 10, 2010.										

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

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

Golder Associates
London, Ontario

RECORD OF BOREHOLE No 914

1 OF 1

METRIC

PROJECT 08-1132-084-1
W.P. 131-98-00
DIST _____ HWY 7/8
DATUM GEODETIC

LOCATION N 4810479.7 ;E 226083.0
BOREHOLE TYPE POWER AUGER / HOLLOW STEM
DATE May 12, 2010

ORIGINATED BY MA
COMPILED BY WDF
CHECKED BY _____

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
324.33	ROAD SURFACE										
0.09	ASPHALT										
323.87	FILL, sand and gravel, crushed Brown						324				
0.46	FILL, silty fine sand, trace gravel Compact Brown		1	SS	19						
323.23							323				
1.10	FILL, sandy silt, some clay, trace gravel Compact Brown		2	SS	29						
322.41							322				
1.92	FILL, sand, fine to medium, trace silt Compact Brown		3	SS	24						9 40 33 18
2.13	FILL, sandy silt Compact Brown		4	SS	12		321				
320.52	FILL, sandy silt, some clay, trace gravel Compact Brown										
3.81	FILL, silty sand, with sandy silt pockets, trace gravel, trace clay, with cobbles Compact to very dense Brown and grey		5	SS	27		320				
			6	SS	44						
			7	SS	62		319				2 58 32 8
			8	SS	91		318				
			9	SS	98						
			10	SS	100/150mm		317				
316.25											
8.08	FILL, sandy silt, some topsoil Compact Brown and black		11	SS	15		316				
315.95											
8.38	TOPSOIL, silty Compact Black		12	SS	11		315				
314.82											
9.60	SILTY CLAY, trace sand Stiff Brown										
	END OF BOREHOLE Borehole dry during drilling on May 12, 2010.										

+ ³, × ³: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

Golder Associates
London, Ontario

RECORD OF BOREHOLE No 915

1 OF 1

METRIC

PROJECT 08-1132-084-1
W.P. 131-98-00
DIST _____ HWY 7/8
DATUM GEODETIC

LOCATION N 4810489.4 ;E 226141.8
BOREHOLE TYPE POWER AUGER / HOLLOW STEM
DATE May 13, 2010

ORIGINATED BY MR
COMPILED BY WDF
CHECKED BY _____

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
323.20	ROAD SURFACE										
0.11	ASPHALT										
322.59	FILL, sand and gravel, crushed Brown						323				
0.61	FILL, silty fine sand Loose to compact Brown		1	SS	15				○		
321.43			2	SS	9		322		○		
1.77	FILL, clayey silt, trace to some sand, trace gravel, with silt layers Firm to stiff Brown		3	SS	7		321		○		2 10 64 24
320.30											
2.90	FILL, silty fine sand, trace gravel Dense Grey		4	SS	32		320		○		
319.54											
3.66	FILL, silty fine sand, trace to some clay, trace gravel Compact to dense Brown		5	SS	36		319		○		2 65 22 11
			6	SS	48				○		
			7	SS	30		318		○		
			8	SS	38		317		○		
			9	SS	30		316		○		
			10	SS	20				○		3 57 31 9
314.97							315				
8.23	FILL, sandy silt, trace clay, trace topsoil Compact Brown		11	SS	12				○		
314.21											
8.99	SILTY CLAY, trace sand, trace topsoil Stiff Brown		12	SS	10		314				
313.60											
9.60	END OF BOREHOLE Borehole dry during drilling on May 13, 2010.										

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

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

LDN_MTO_06 08-1132-084-1.GPJ LDN_MTO.GDT 12/01/11

Golder Associates
London, Ontario

RECORD OF BOREHOLE No 925

1 OF 1

METRIC

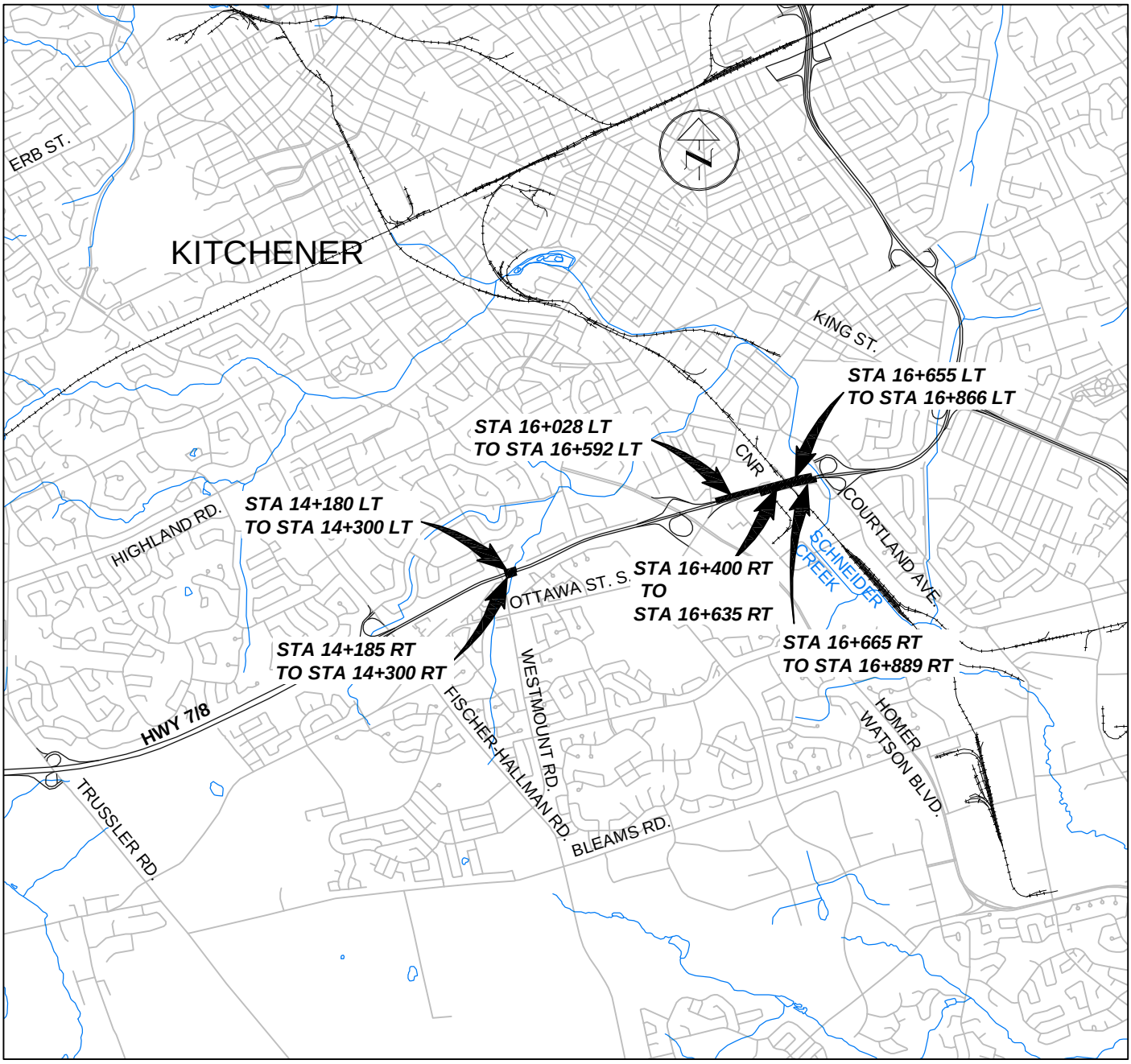
PROJECT 08-1132-084-1
W.P. 131-98-00
DIST HWY 7/8
DATUM GEODETIC
LOCATION N 4810460.0 ;E 225872.1
BOREHOLE TYPE POWER AUGER / HOLLOW STEM
DATE May 10, 2010
ORIGINATED BY MA
COMPILED BY WDF
CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
327.21	ROAD SURFACE						327				
0.08	ASPHALT										
326.81	FILL, sand and gravel, crushed, trace silt, Brown										
0.40	FILL, silty fine sand, trace gravel, Compact, Brown		1	SS	27						
			2	SS	24		326				
			3	SS	22		325				
324.31											
2.90	FILL, topsoil, silty, Compact, Brown		4	SS	27		324				
3.17	FILL, silty sand, fine to medium, trace gravel, trace clay, Compact to dense, Brown		5	SS	31						2 69 21 8
			6	SS	12		323				
322.03											
5.18	FILL, sandy silt, some clay, trace topsoil, trace gravel, Dense, Brown		7	SS	31		322				1 41 48 10
320.99											
6.22	TOPSOIL, silty, Compact, Black		8	SS	28		321				
320.50											
6.71	SILTY CLAY, trace to some sand, trace gravel, Hard, Brown		9	SS	30		320			41	6 18 39 37
319.74											
7.47	SAND, fine to medium, trace silt, trace gravel, Dense to very dense, Grey		10	SS	62						
			11	SS	35	▽	319				
318.07											
9.14	CLAYEY SILT, trace sand, trace gravel, Hard, Brown		12	SS	70		318				
317.61											
9.60	END OF BOREHOLE										

Groundwater encountered at about elev. 318.8m during drilling on May 10, 2010.

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

LDN_MTO_06 08-1132-084-1.GPJ LDN_MTO.GDT 12/01/11



SCALE IN METRES

0 1000 2000

1:50000

REFERENCE

DRAWING BASED ON CANMAP STREETFILES V2005.4.

NOTE

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

PROJECT

RETAINED SOIL SYSTEM WALLS
WIDENING OF HIGHWAY 7/8
GWP 131-98-00

TITLE

KEY PLAN

Golder Associates
LONDON, ONTARIO

PROJECT No.	08-1132-084-1		FILE No.	0811320841-F10001
			SCALE	AS SHOWN
CADD	WDF	July 02/10	REV.	
CHECK				

FIGURE 1

Drawing file: 0811320841-F10001.DWG Jan 12, 2011 - 10:44am

MINISTRY OF TRANSPORTATION, ONTARIO

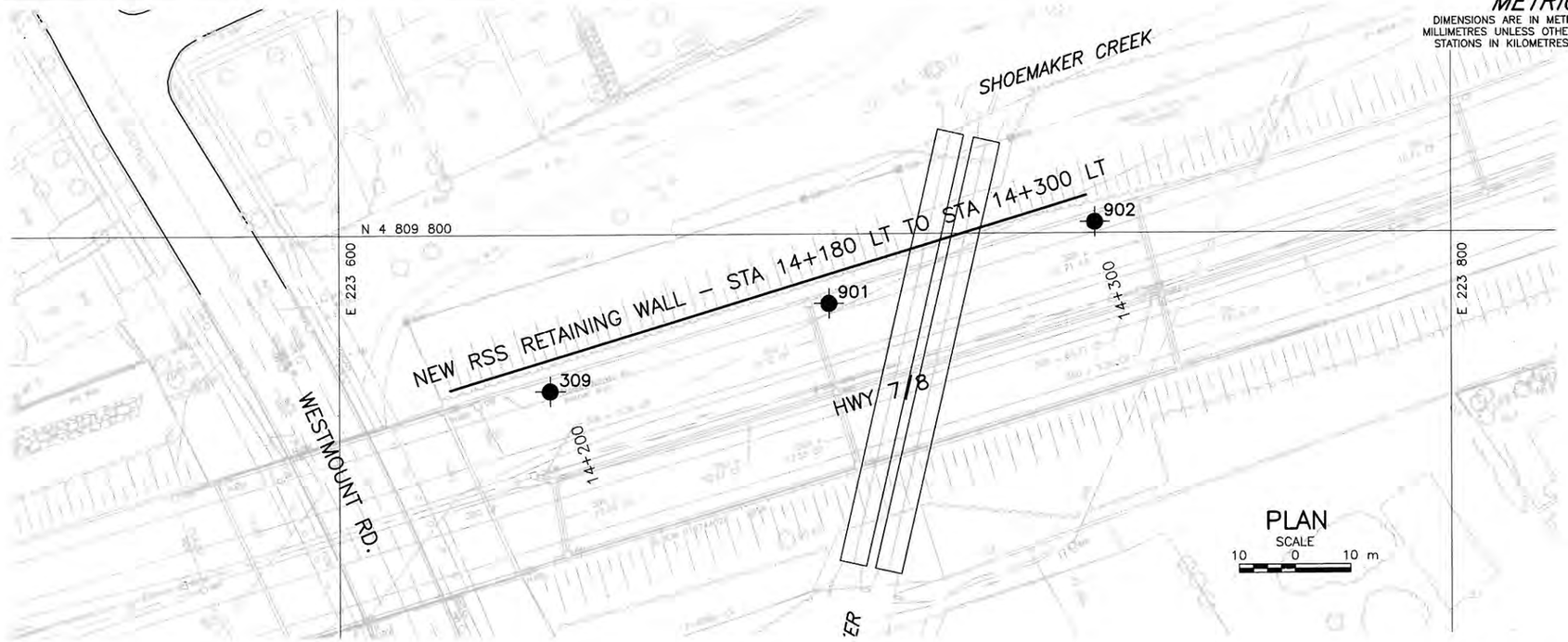
METRIC
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN.
STATIONS IN KILOMETRES + METRES.

CONT No.
WP No. 131-98-00

SHEET

RETAINED SOIL SYSTEM WALLS
STA 14+180 LT TO STA 14+300 LT
WIDENING OF HIGHWAY 7/8
BOREHOLE LOCATIONS & SOIL STRATA

Golder Associates
Golder Associates Ltd.
LONDON, ONTARIO, CANADA

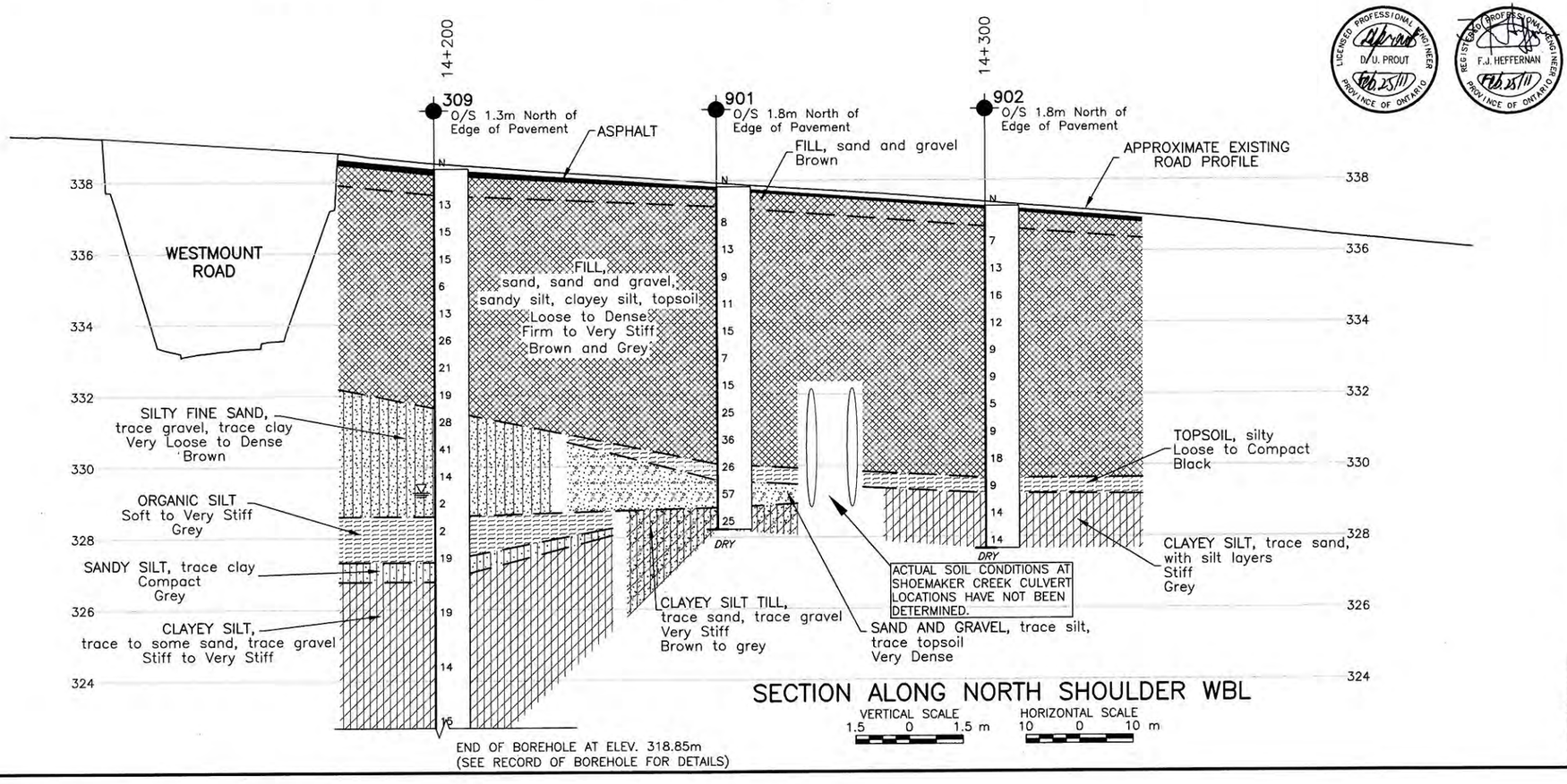


PLAN
SCALE
10 0 10 m

KEY PLAN

LEGEND

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



END OF BOREHOLE AT ELEV. 318.85m
(SEE RECORD OF BOREHOLE FOR DETAILS)

SECTION ALONG NORTH SHOULDER WBL
VERTICAL SCALE 1.5 0 1.5 m
HORIZONTAL SCALE 10 0 10 m

No.	ELEVATION	CO-ORDINATES (MTM ZONE 10) NORTHING	EASTING
309	338.36	4 809 771.7	223 638.0
901	337.83	4 809 787.4	223 688.1
902	337.27	4 809 802.0	223 736.0

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

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

Stratigraphy has been simplified for clarity. Please refer to Record of Boreholes and Sections for further detail.

REFERENCE
Base plans provided in digital format by Dillon Consulting.

D.U. PROUT — LICENSED PROFESSIONAL ENGINEER — PROVINCE OF ONTARIO — Feb. 25/11

F.J. HEFFERNAN — REGISTERED PROFESSIONAL ENGINEER — PROVINCE OF ONTARIO — Feb. 25/11

NO.	DATE	BY	REVISION

Geocres No. 40P8-191

HWY. 7/8		PROJECT NO. 08-1132-084-1	DIST.
SUBM'D. ML	CHKD.	DATE: Feb. 23/11	SITE:
DRAWN: WF/AG	CHKD.	APPD.	DWG. 1

PLOT DATE: February 25, 2011
FILENAME: N:\active\2008\1132 - Geotechnical\1132-000-00_08-1132-084-1 DILLON - GWP 131-98-00 FENG - HWY 7-8\Drafting\AutoCAD files\08113200841-D1C001.DWG

MINISTRY OF TRANSPORTATION, ONTARIO

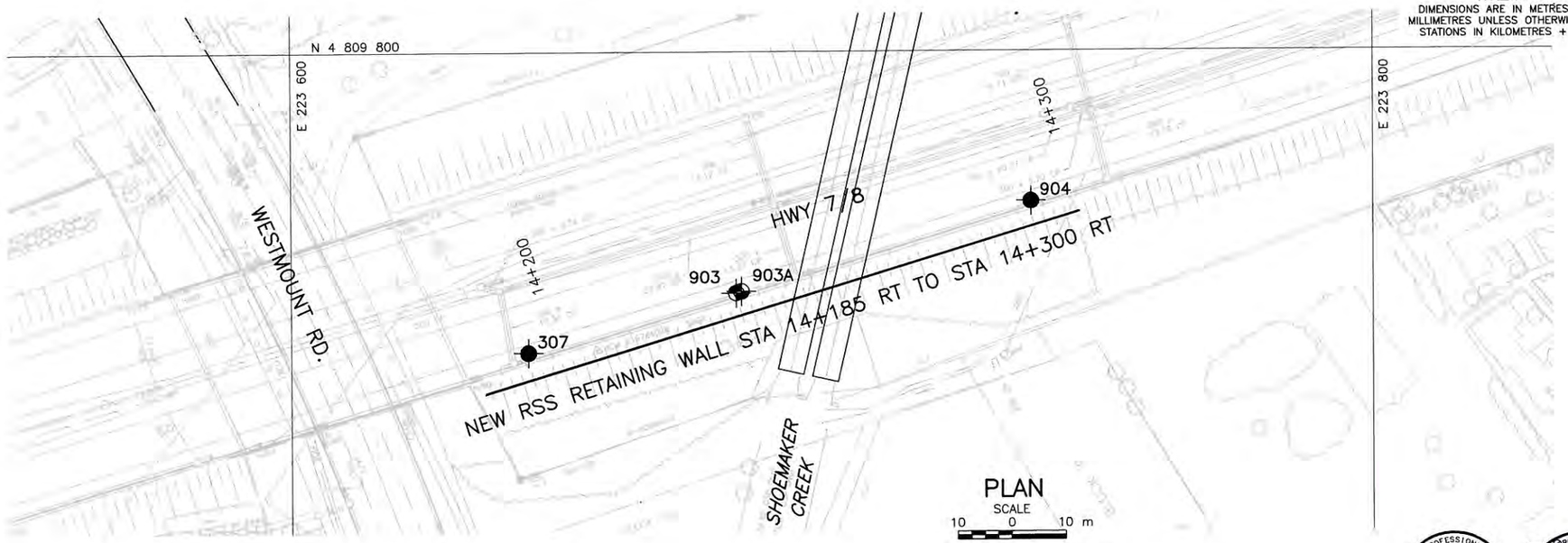
METRIC
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN.
STATIONS IN KILOMETRES + METRES.

CONT No.
WP No. 131-98-00

SHEET

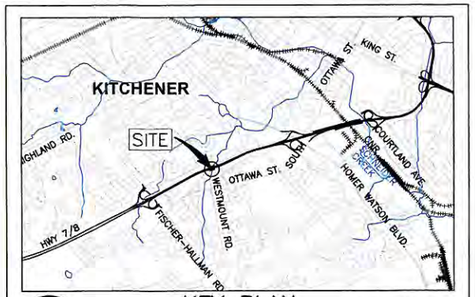
RETAINED SOIL SYSTEM WALLS
STA 14+185 RT TO STA 14+300 RT
WIDENING OF HIGHWAY 7/8
BOREHOLE LOCATIONS & SOIL STRATA

Golder Associates Ltd.
LONDON, ONTARIO, CANADA



PLAN
SCALE
10 0 10 m

SECTION ALONG SOUTH SHOULDER EBL
VERTICAL SCALE 1.5 0 1.5 m
HORIZONTAL SCALE 10 0 10 m



KEY PLAN
SCALE IN KILOMETRES

LEGEND

- Borehole – Current Investigation
- Borehole and Cone – Current Investigation
- N Standard Penetration Test Value
- 16 Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)
- *DRY* Borehole dry during drilling
- WL encountered during drilling

No.	ELEVATION	CO-ORDINATES (MTM ZONE 10) NORTHING	EASTING
307	338.45	4 809 744.1	223 643.8
903	337.86	4 809 755.1	223 682.3
903A	337.86	4 809 755.4	223 683.3
904	337.34	4 809 772.0	223 736.8

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

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

Stratigraphy has been simplified for clarity. Please refer to Record of Boreholes and Sections for further detail.

REFERENCE
Base plans provided in digital format by Dillon Consulting.

NO.	DATE	BY	REVISION

Geocres No. 40P8-191

HWY. 7/8		PROJECT NO. 08-1132-084-1		DIST.
SUBM'D. ML	CHKD.		DATE: Feb. 23/11	SITE:
DRAWN: WF/AG	CHKD.		APPD.	DWG. 2

PLOT DATE: February 25, 2011
FILENAME: N:\active\2008\1132 - Geotechnical\1132-000-01\08-1132-084-1 DILLON - GWP 131-98-00 FDNS - HWY 7-8\Drafting\AutoCAD files\081132084-1-01001.DWG

MINISTRY OF TRANSPORTATION, ONTARIO

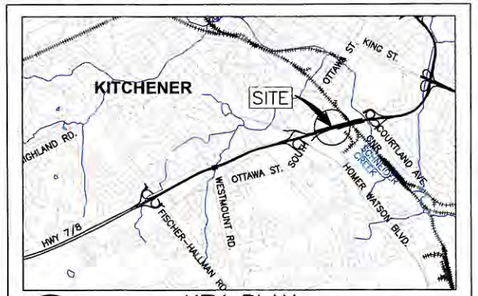
METRIC
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN.
STATIONS IN KILOMETRES + METRES.

CONT No.
WP No. 131-98-00

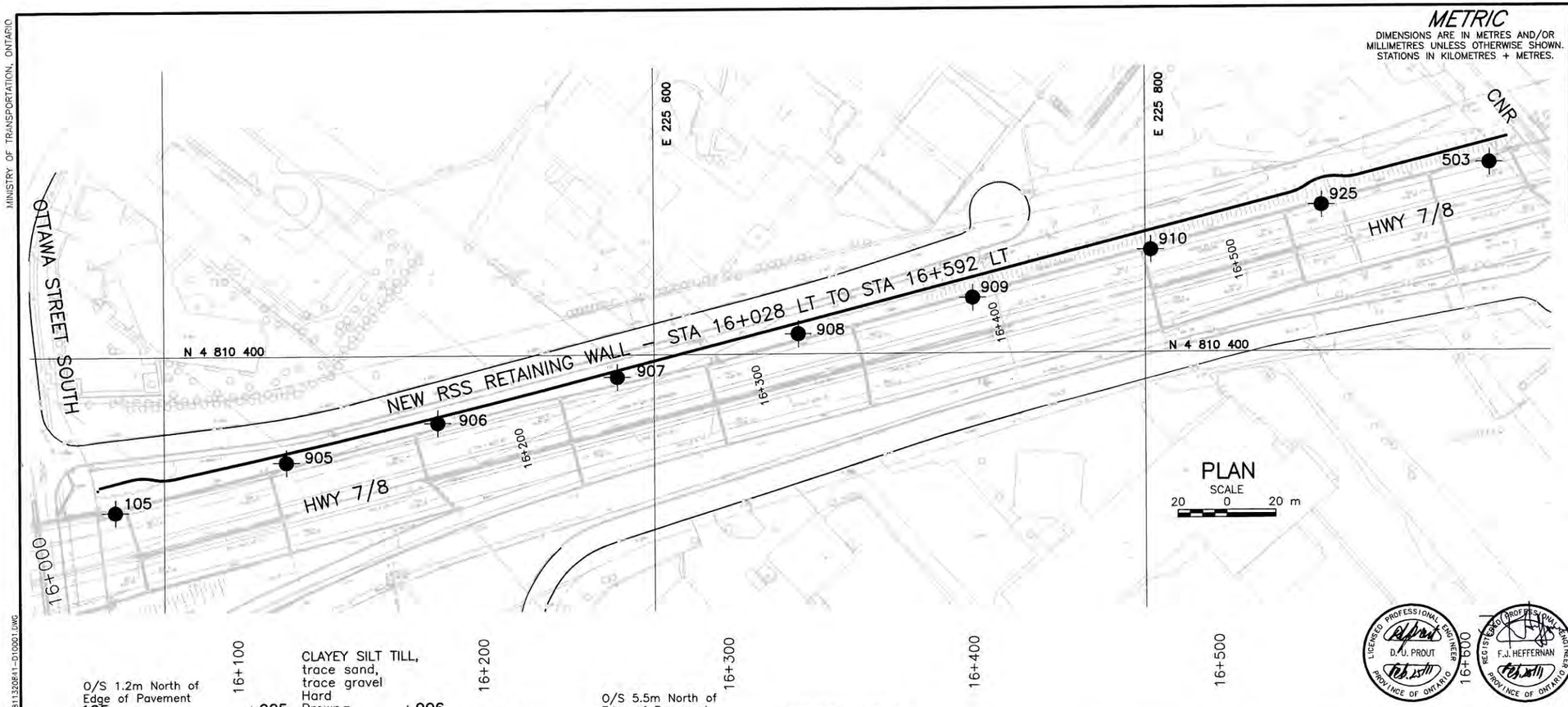
SHEET

RETAINED SOIL SYSTEM WALLS
STA 16+028 LT TO STA 16+592 LT
WIDENING OF HIGHWAY 7/8
BOREHOLE LOCATIONS & SOIL STRATA

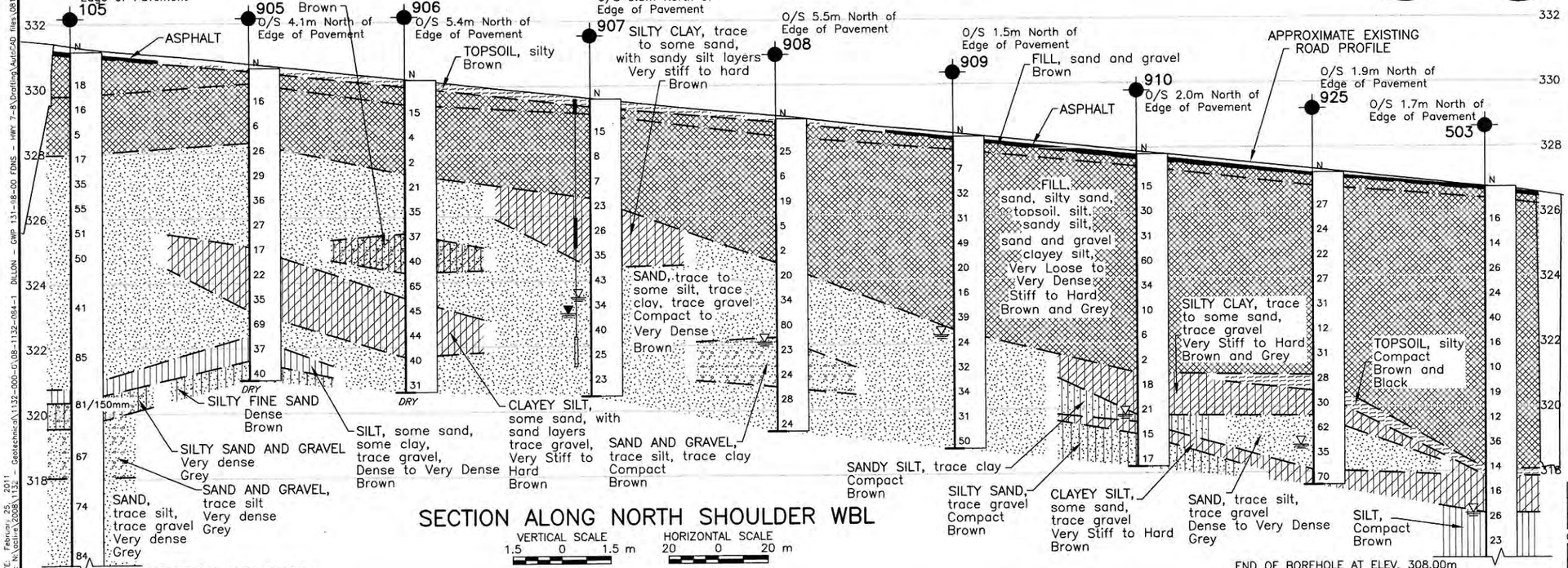
Golder Associates
Golder Associates Ltd.
LONDON, ONTARIO, CANADA



KEY PLAN



PLAN
SCALE
20 0 20 m



SECTION ALONG NORTH SHOULDER WBL
VERTICAL SCALE 1.5 0 1.5 m
HORIZONTAL SCALE 20 0 20 m

LEGEND

- Borehole – Current Investigation
- Seal
- Piezometer
- N Standard Penetration Test Value
- 16 Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)
- *DRY* Borehole dry during drilling
- WL encountered during drilling
- WL in standpipe (Nov. 25, 2010)

No.	ELEVATION	CO-ORDINATES (MTM ZONE 10) NORTHING	EASTING
105	331.14	4 810 336.3	225 380.0
503	326.75	4 810 477.1	225 940.5
905	330.61	4 810 356.5	225 449.8
906	330.22	4 810 372.4	225 511.5
907	329.61	4 810 390.9	225 585.0
908	328.96	4 810 408.3	225 658.5
909	328.39	4 810 422.8	225 729.9
910	327.80	4 810 442.0	225 802.4
925	327.21	4 810 460.0	225 872.1

NOTES

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Stratigraphy has been simplified for clarity. Please refer to Record of Boreholes and Sections for further detail.

REFERENCE

Base plans provided in digital format by Dillon Consulting.

NO.	DATE	BY	REVISION

Geocres No. 40P8-191

HWY. 7/8		PROJECT NO. 08-1132-084-1	DIST.
SUBM'D. ML	CHKD.	DATE: SEPT. 27/10	SITE:
DRAWN: WF/AG	CHKD.	APPD.	DWG. 3

PLOT DATE: February 25, 2011
FILENAME: N:\active\2008\1132 - Geotechnical\1132-000-08-1132-084-1 DILLON - GWP 131-98-00 FDNS - HWY 7-8\Drafting\AutoCAD files\08113208I1-D10001.DWG

MINISTRY OF TRANSPORTATION, ONTARIO

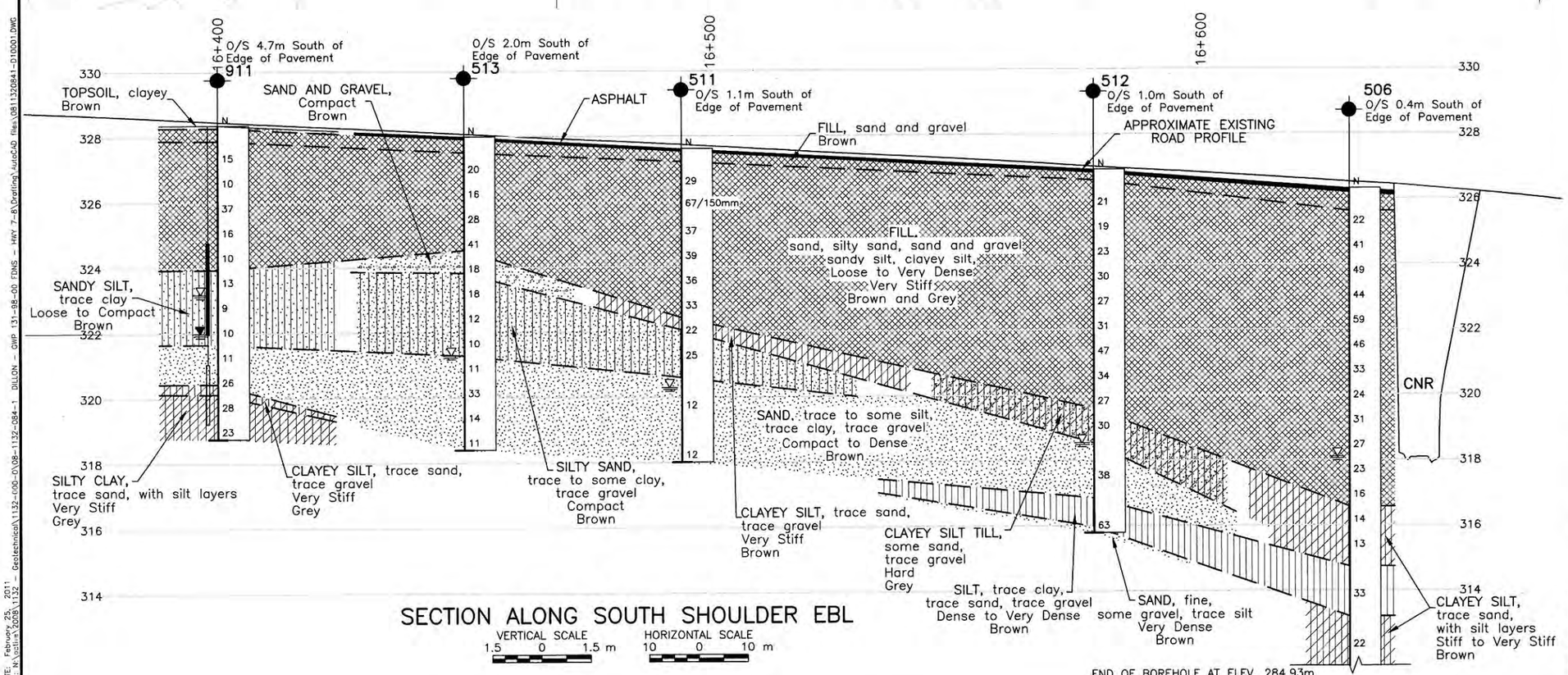
METRIC
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN.
STATIONS IN KILOMETRES + METRES.

CONT No.
WP No. 131-98-00

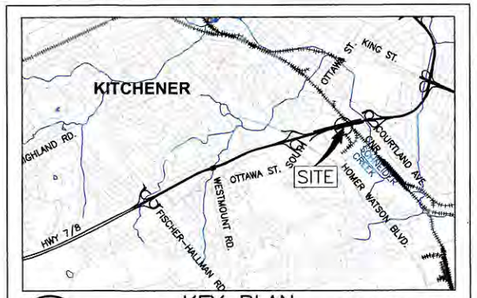
SHEET

RETAINED SOIL SYSTEM WALLS
STA 16+350 RT TO STA 16+635 RT
WIDENING OF HIGHWAY 7/8
BOREHOLE LOCATIONS & SOIL STRATA

PLAN
SCALE
10 0 10 m



SECTION ALONG SOUTH SHOULDER EBL
VERTICAL SCALE 1.5 0 1.5 m
HORIZONTAL SCALE 10 0 10 m



KEY PLAN

LEGEND

- Borehole – Current Investigation
- Seal
- Piezometer
- N Standard Penetration Test Value
- 16 Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)
- *DRY* Borehole dry during drilling
- WL encountered during drilling
- WL in standpipe (Nov. 25, 2010)

No.	ELEVATION	CO-ORDINATES (MTM ZONE 10) NORTHING	EASTING
506	326.32	4 810 455.9	225 966.2
511	327.62	4 810 419.0	225 835.3
512	326.92	4 810 442.0	225 916.0
513	328.00	4 810 405.7	225 793.2
911	328.36	4 810 390.5	225 745.5

LICENSED PROFESSIONAL ENGINEER D. U. PROUT PROVINCE OF ONTARIO Feb. 25/11

REGISTERED PROFESSIONAL ENGINEER F.J. HEFFERNAN PROVINCE OF ONTARIO Feb. 25/11

NOTES

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

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REFERENCE

Base plans provided in digital format by Dillon Consulting.

NO.	DATE	BY	REVISION

Geocres No. 40P8-191

HWY. 7/8		PROJECT NO. 08-1132-084-1	DIST.
SUBM'D. ML	CHKD.	DATE: Feb. 23/11	SITE:
DRAWN: WF/AG	CHKD.	APPD.	DWG. 4

Golder Associates
Golder Associates Ltd.
LONDON, ONTARIO, CANADA

PLOT DATE: February 25, 2011
FILENAME: N:\active\2008\1132 - Geotechnical\1132-100-01\08-1132-084-1 DILLON - GWP 131-98-00 FINS - HWY 7-8\Drafting\ AutoCAD files\0811320841-010001.DWG

MINISTRY OF TRANSPORTATION, ONTARIO

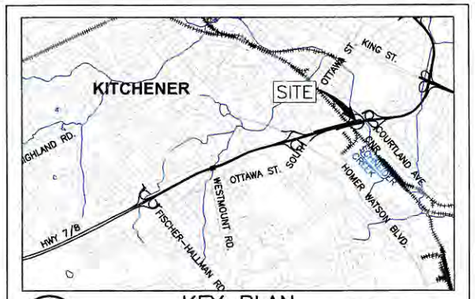
METRIC
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN.
STATIONS IN KILOMETRES + METRES.

CONT No.
WP No. 131-98-00

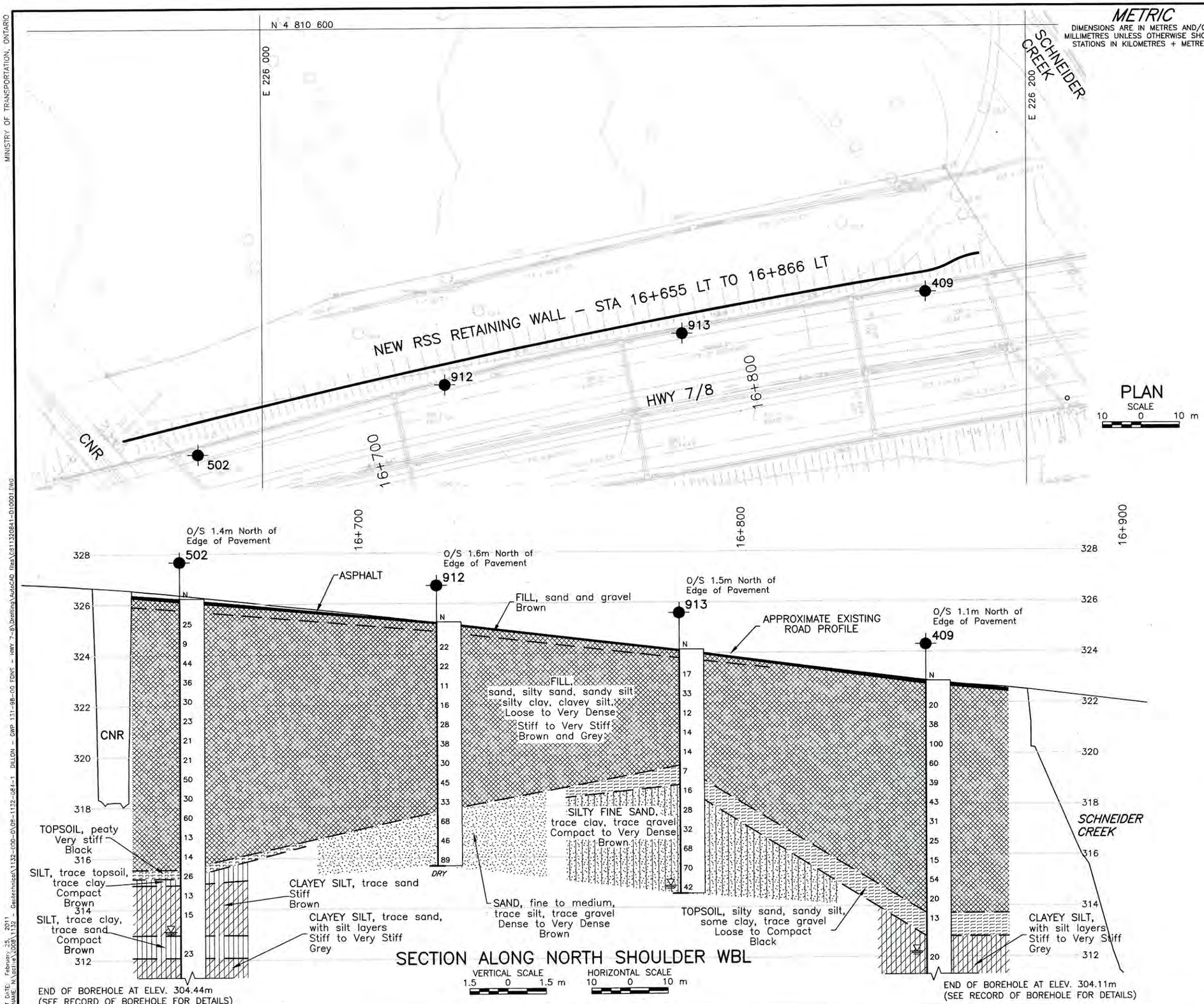
RETAINED SOIL SYSTEM WALLS
STA 16+655 LT TO 16+866 LT
WIDENING OF HIGHWAY 7/8
BOREHOLE LOCATIONS & SOIL STRATA

SHEET

Golder Associates Ltd.
LONDON, ONTARIO, CANADA



KEY PLAN
SCALE IN KILOMETRES 0 1 2



SECTION ALONG NORTH SHOULDER WBL

VERTICAL SCALE 1.5 0 1.5 m
HORIZONTAL SCALE 10 0 10 m

LEGEND

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

No.	ELEVATION	CO-ORDINATES (MTM ZONE 10) NORTHING	EASTING
409	322.86	4 810 530.0	226 173.6
502	326.23	4 810 488.1	225 983.2
912	325.28	4 810 506.2	226 047.8
913	324.15	4 810 519.3	226 109.9

D. U. PROUT — LICENSED PROFESSIONAL ENGINEER — PROVINCE OF ONTARIO — Feb 23/11
F.J. HEFFERNAN — REGISTERED PROFESSIONAL ENGINEER — PROVINCE OF ONTARIO — Feb 23/11

NOTES

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REFERENCE

Base plans provided in digital format by Dillon Consulting.

NO.	DATE	BY	REVISION

Geocres No. 40P8-191

HWY. 7/8		PROJECT NO. 08-1132-084-1	DIST.
SUBM'D. ML	CHKD.	DATE: Feb. 23/11	SITE:
DRAWN: WF/AG	CHKD.	APPD.	DWG. 5

PLOT DATE: February 25, 2011
FILENAME: N:\active\2008\1132 - Geotechnical\132-090-DWG-1172-084-1 DILLON - dwg 111-98-00 FDWG - HWY 7-8\Drafting\AutoCAD files\C8113208A1-D10001.DWG

MINISTRY OF TRANSPORTATION, ONTARIO

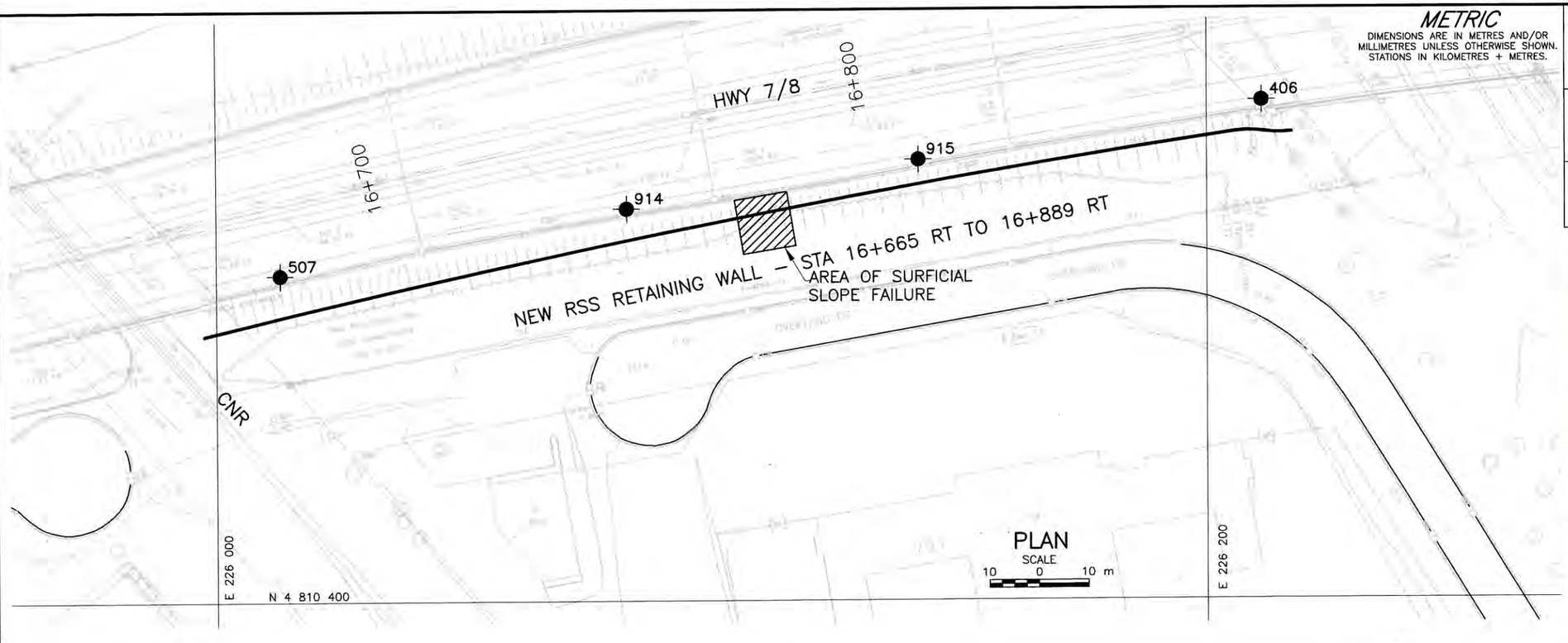
METRIC
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN.
STATIONS IN KILOMETRES + METRES.

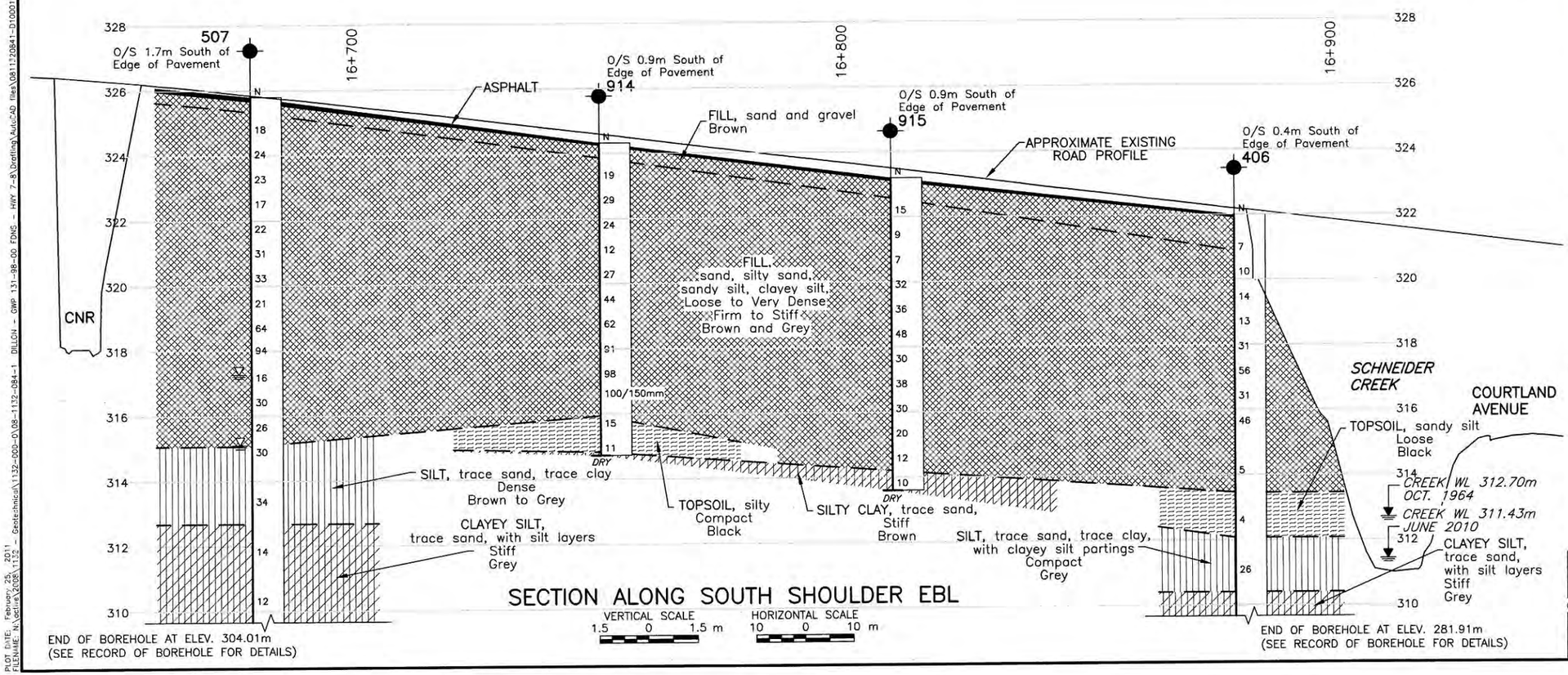
CONT No.
WP No. 131-98-00

SHEET

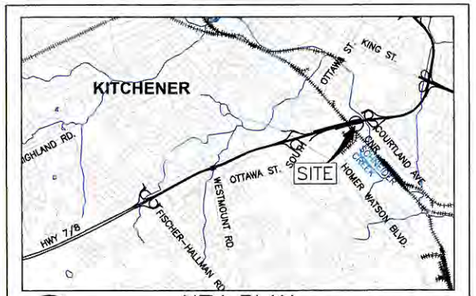
RETAINED SOIL SYSTEM WALLS
STA 16+665 RT TO 16+889 RT
WIDENING OF HIGHWAY 7/8
BOREHOLE LOCATIONS & SOIL STRATA

Golder Associates Ltd.
LONDON, ONTARIO, CANADA





SECTION ALONG SOUTH SHOULDER EBL
VERTICAL SCALE 1.5 0 1.5 m
HORIZONTAL SCALE 10 0 10 m



KEY PLAN

LEGEND

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

No.	ELEVATION	CO-ORDINATES (MTM ZONE 10) NORTHING	EASTING
406	321.99	4 810 501.2	226 211.1
507	325.80	4 810 466.3	226 013.0
914	324.33	4 810 479.7	226 083.0
915	323.20	4 810 489.4	226 141.8

D.U. PROUT
LICENSED PROFESSIONAL ENGINEER
PROVINCE OF ONTARIO
Feb 25/11

F.J. HEFFERNAN
REGISTERED PROFESSIONAL ENGINEER
PROVINCE OF ONTARIO
Feb. 25/11

NOTES
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REFERENCE
Base plans provided in digital format by Dillon Consulting.

NO.	DATE	BY	REVISION

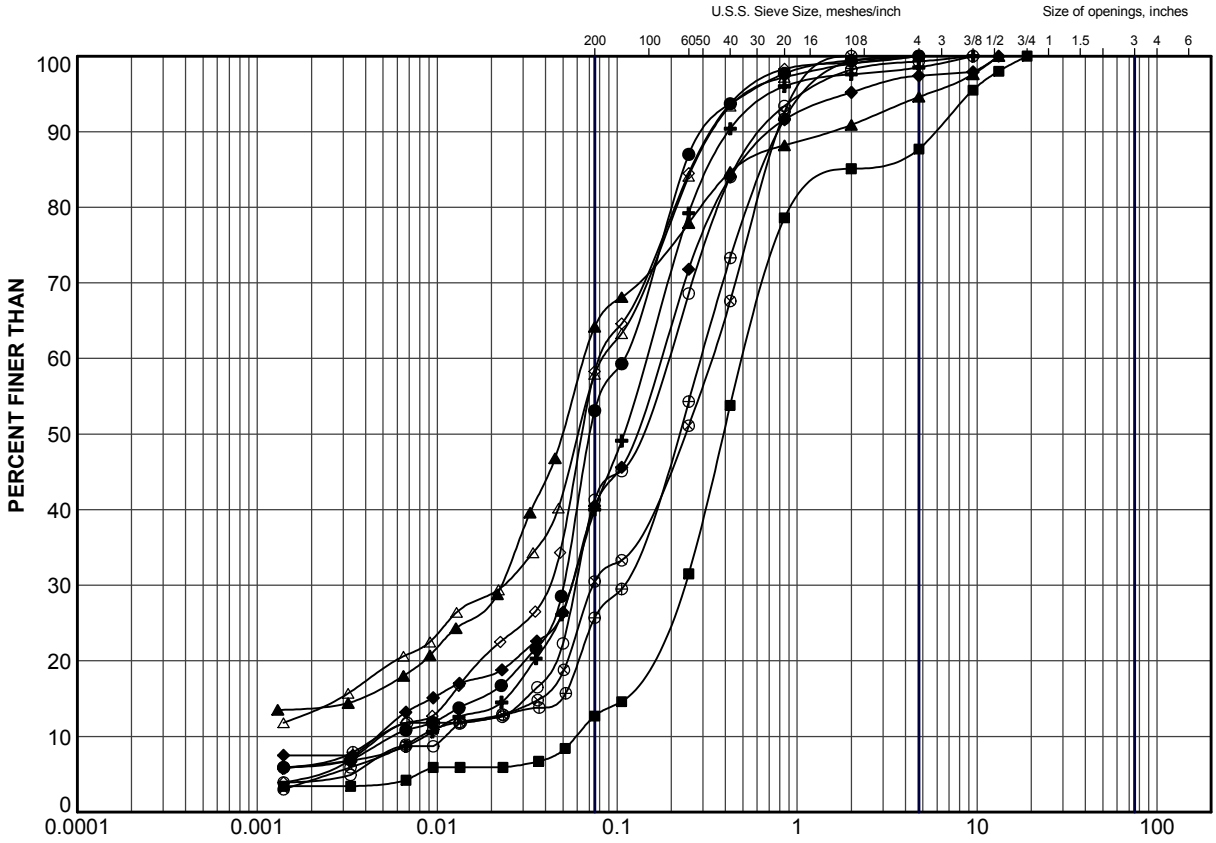
Geocres No. 40P8-191

HWY. 7/8	PROJECT NO. 08-1132-084-1		DIST.
SUBM'D. ML	CHKD.	DATE: Feb. 23/11	SITE:
DRAWN: WF/AG	CHKD.	APPD.	DWG. 6

PLOT DATE: February 25, 2011
FILENAME: N:\active\2008\1132 - Geotechnical\1132-003-00.08-1132-084-1 DILLON - GWP 131-98-00 PDNS - HWY 7-8\Drafting\AutoCAD files\08112084-D10001.DWG

APPENDIX A

Laboratory Test Data



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	105	2	329.4
■	406	4	318.7
▲	406	9	314.1
✚	409	2	321.1
◆	502	3	323.7
◇	502	4	323.0
○	502	9	319.1
△	503	3	324.2
⊗	503	8	320.4
⊕	503	9	319.7

PROJECT

RETAINED SOIL SYSTEM WALLS
WIDENING OF HIGHWAY 7/8
GWP 131-98-00

TITLE

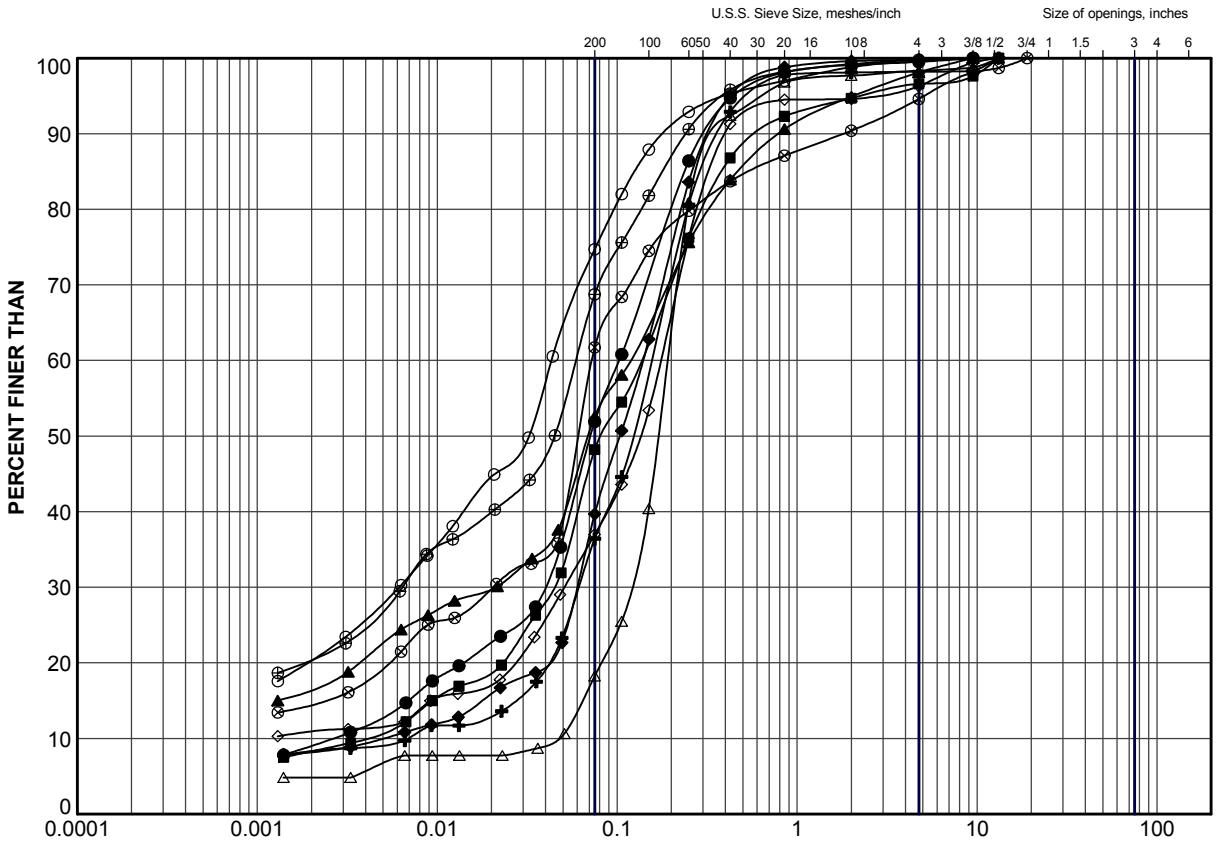
GRAIN SIZE DISTRIBUTION

FILL (non-cohesive)

Golder Associates
LONDON, ONTARIO

PROJECT No.		08-1132-084-1	FILE No.	0811320841-R100A1	
			SCALE	N/A	REV.
DRAWN	WDF	Jun 28/10			
CHECK			**FIGURE A-1**		

LDN_MTO_NEW GLDR_LDN.GDT



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	507	3	323.3
■	507	11	317.2
▲	511	6	322.8
✚	512	5	322.9
◆	513	2	326.3
◇	513	4	324.7
○	901	6	333.0
△	901	9	330.8
⊗	902	4	334.0
⊕	903	8	331.5

PROJECT

RETAINED SOIL SYSTEM WALLS
WIDENING OF HIGHWAY 7/8
GWP 131-98-00

TITLE

GRAIN SIZE DISTRIBUTION

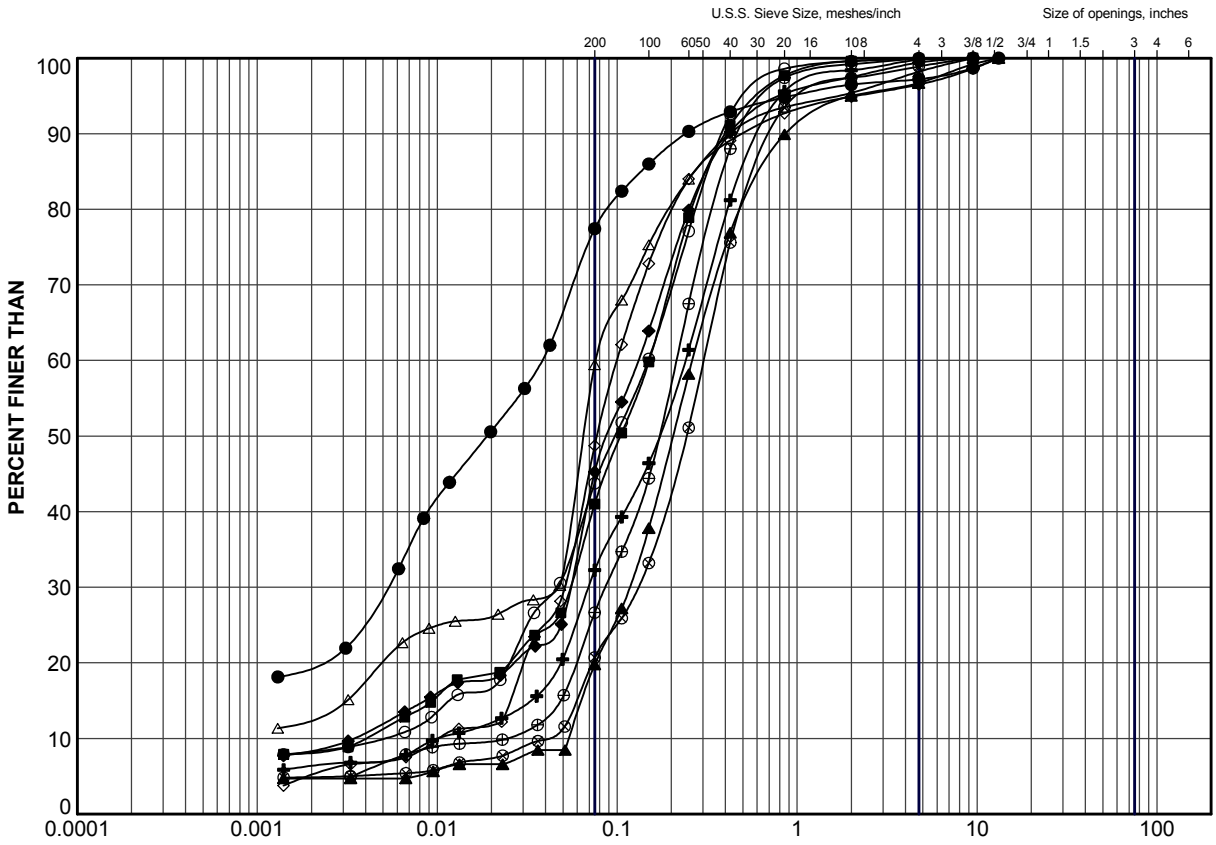
FILL (non-cohesive)

Golder Associates
LONDON, ONTARIO

PROJECT No.		08-1132-084-1		FILE No.	0811320841-R100A2
				SCALE	N/A
DRAWN	WDF	Jun 28/10		REV.	
CHECK					

FIGURE A-2

LDN_MTO_NEW GLDR_LDN.GDT



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	904	4	334.1
■	907	3	327.1
▲	908	4	325.7
✚	909	3	325.9
◆	910	2	326.1
◇	910	5	323.8
○	911	4	325.1
△	912	4	322.0
⊗	912	5	321.2
⊕	913	4	320.9

PROJECT

RETAINED SOIL SYSTEM WALLS
WIDENING OF HIGHWAY 7/8
GWP 131-98-00

TITLE

GRAIN SIZE DISTRIBUTION

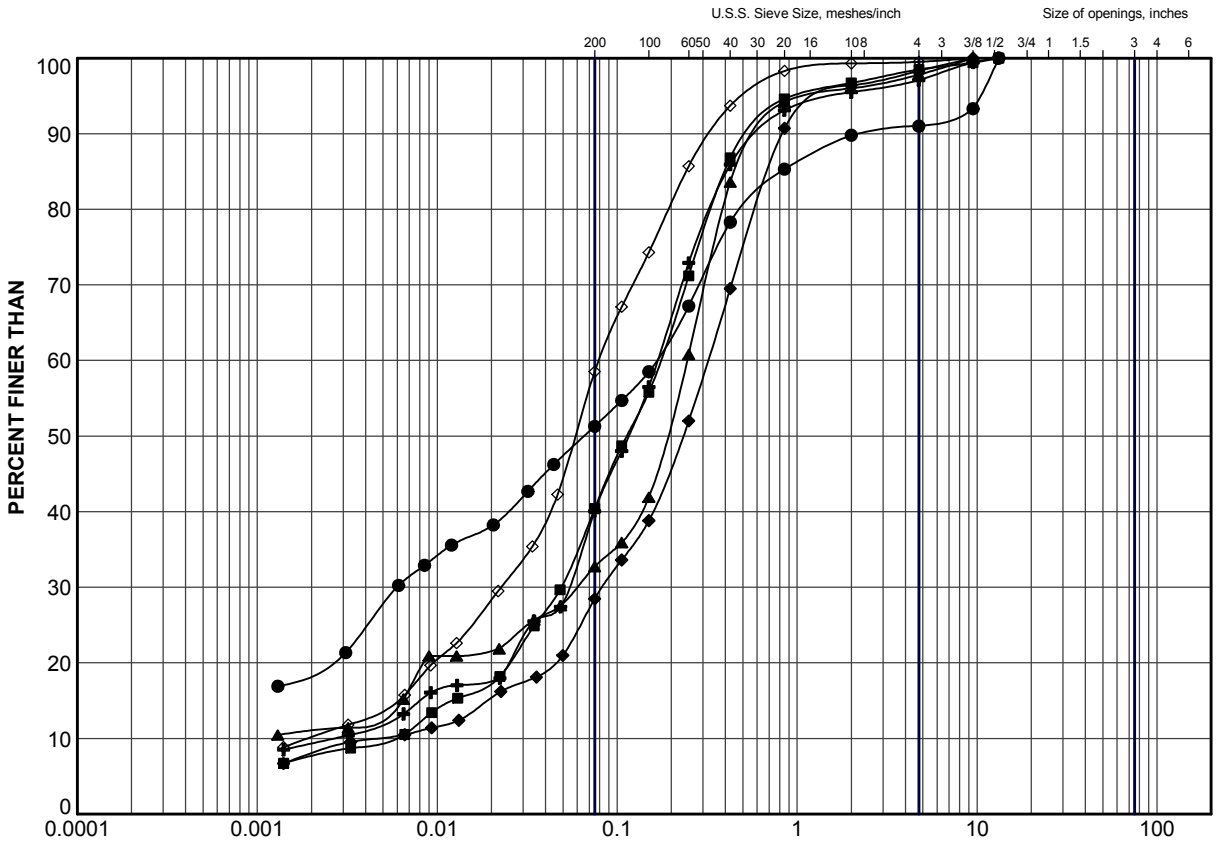
FILL (non-cohesive)

Golder Associates
LONDON, ONTARIO

PROJECT No.		08-1132-084-1		FILE No.	0811320841-R100A3
				SCALE	N/A
DRAWN	WDF	Jun 28/10		REV.	
CHECK					

FIGURE A-3

LDN_MTO_NEW GLDR_LDN.GDT



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	914	3	321.8
■	914	7	318.8
▲	915	5	319.2
✚	915	10	315.4
◆	925	5	323.2
◇	925	7	321.6

PROJECT

RETAINED SOIL SYSTEM WALLS
WIDENING OF HIGHWAY 7/8
GWP 131-98-00

TITLE

GRAIN SIZE DISTRIBUTION

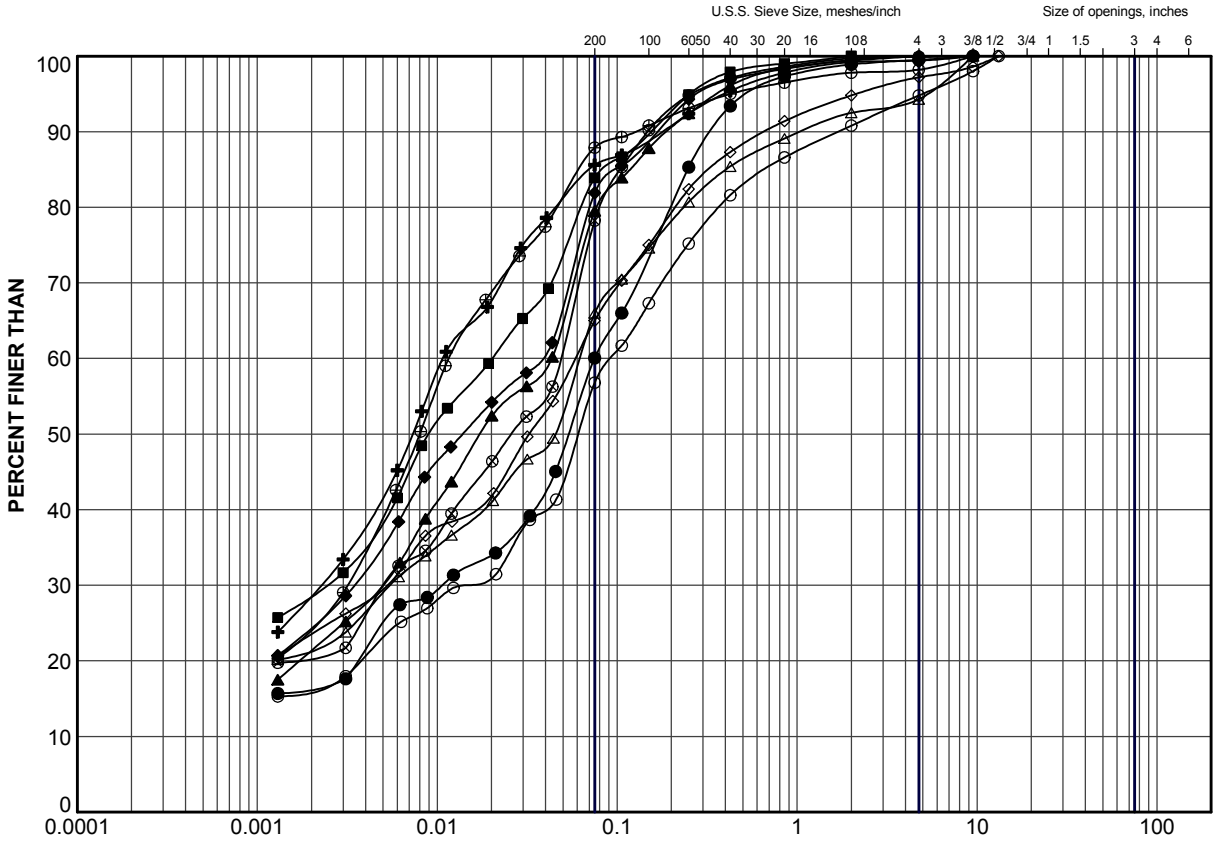
FILL (non-cohesive)

Golder Associates
LONDON, ONTARIO

PROJECT No.		08-1132-084-1		FILE No.	0811320841-R100A4
				SCALE	N/A
DRAWN	WDF	Jun 28/10		REV.	
CHECK					

FIGURE A-4

LDN_MTO_NEW GLDR_LDN.GDT



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	307	4	335.2
■	307	9	331.4
▲	309	5	334.3
✚	409	8	316.5
◆	502	13	316.1
◇	901	3	335.3
○	902	7	331.7
△	903	2	336.1
⊗	904	7	331.8
⊕	915	3	320.7

PROJECT

RETAINED SOIL SYSTEM WALLS
WIDENING OF HIGHWAY 7/8
GWP 131-98-00

TITLE

GRAIN SIZE DISTRIBUTION

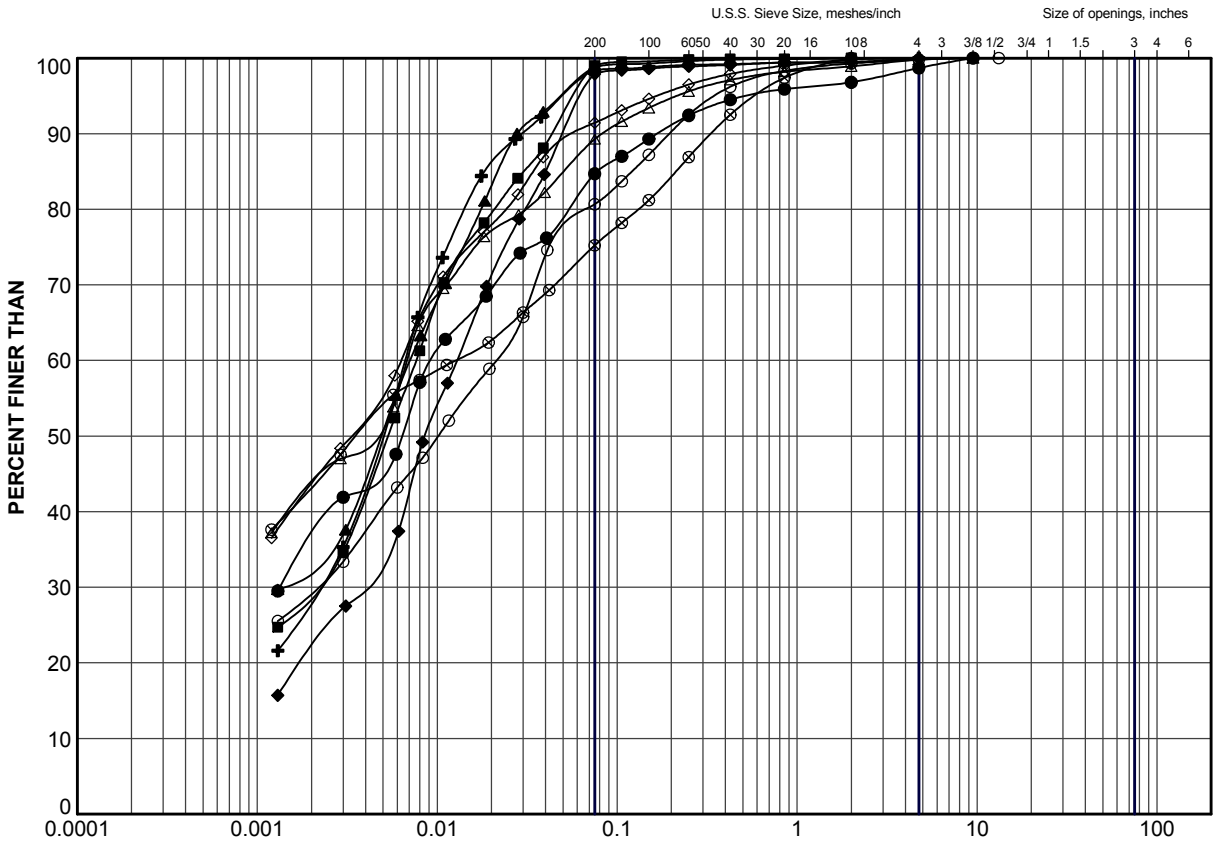
FILL (cohesive)

Golder Associates
LONDON, ONTARIO

PROJECT No.		08-1132-084-1	FILE No.	0811320841-R100A5
			SCALE	N/A
DRAWN	WDF	Jun 28/10	REV.	
CHECK				

FIGURE A-5

LDN_MTO_GSD-15 GLDR_LDN.GDT



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	309	15	325.9
■	502	15	314.6
▲	502	16	313.8
✚	506	13	316.2
◆	506	16	312.4
◇	902	11	328.7
○	903 A	17	324.7
△	905	8	324.3
⊗	906	10	322.4

PROJECT

RETAINED SOIL SYSTEM WALLS
WIDENING OF HIGHWAY 7/8
GWP 131-98-00

TITLE

GRAIN SIZE DISTRIBUTION

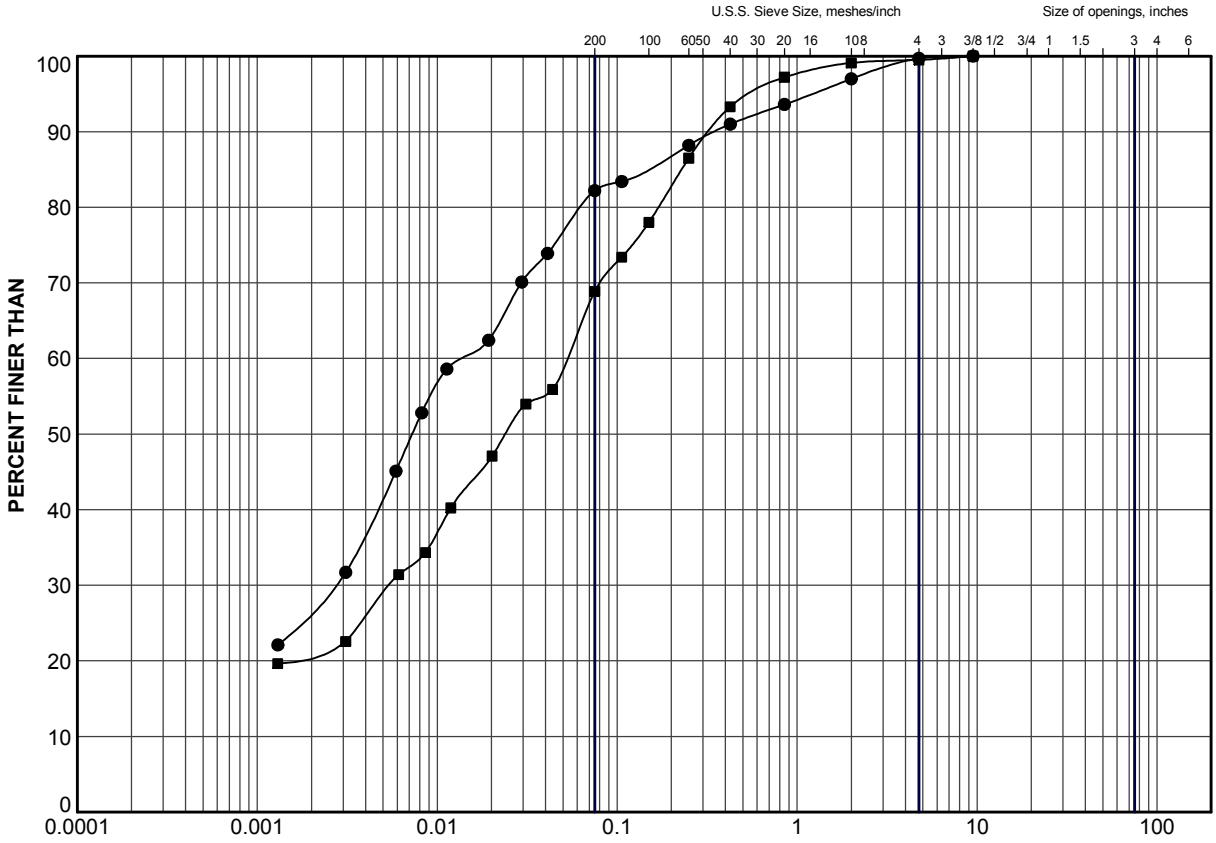
CLAYEY SILT

Golder Associates
LONDON, ONTARIO

PROJECT No.		08-1132-084-1		FILE No.	0811320841-R100A6
				SCALE	N/A
DRAWN	WDF	Jun 28/10		REV.	
CHECK					

FIGURE A-6

LDN_MTO_NEW GLDR_LDN.GDT



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	512	10	319.1
■	904	11	328.7

PROJECT

RETAINED SOIL SYSTEM WALLS
WIDENING OF HIGHWAY 7/8
GWP 131-98-00

TITLE

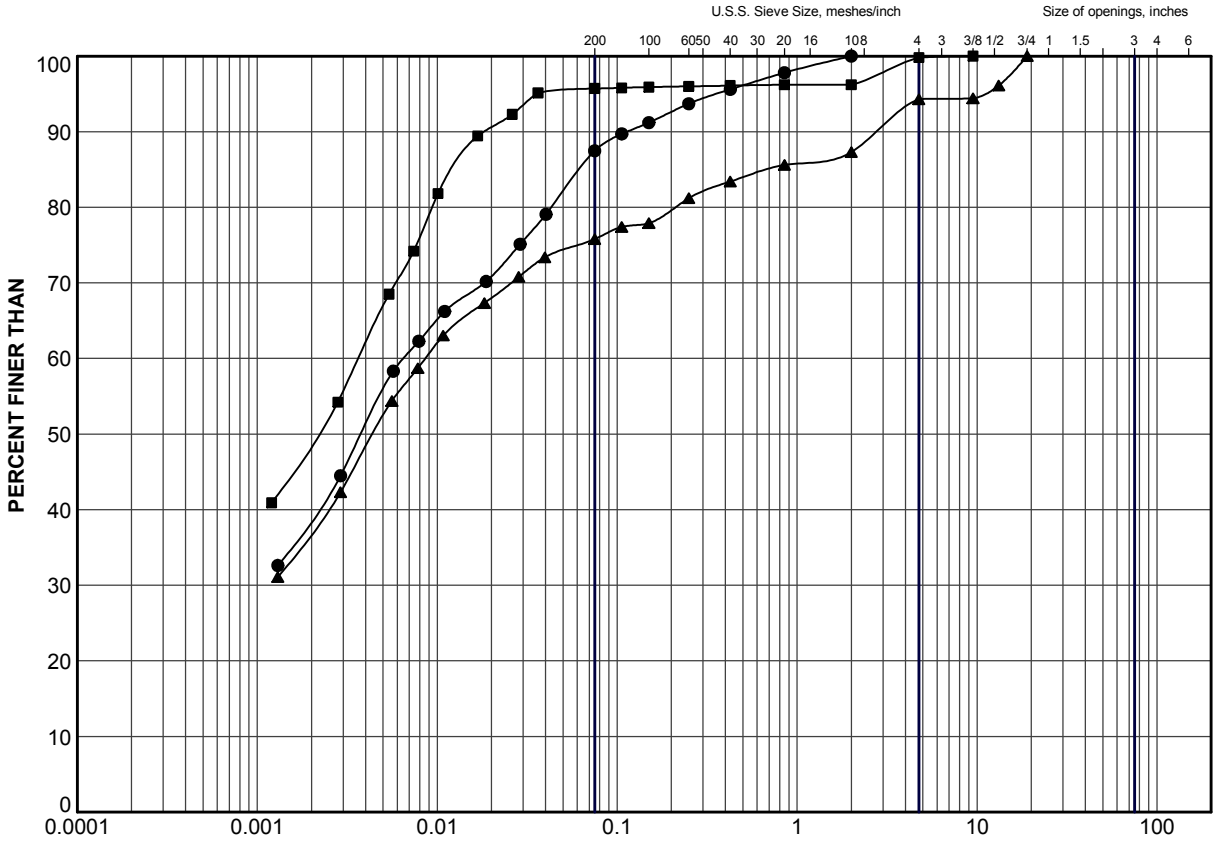
GRAIN SIZE DISTRIBUTION

CLAYEY SILT TILL

Golder Associates
LONDON, ONTARIO

PROJECT No.		08-1132-084-1	FILE No.	0811320841-R100A7
			SCALE	N/A REV.
DRAWN	WDF	Jun 28/10		
CHECK				FIGURE A-7

LDN_MTO_NEW GLDR_LDN.GDT



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	907	5	325.6
■	910	9	320.7
▲	925	9	320.1

PROJECT

RETAINED SOIL SYSTEM WALLS
WIDENING OF HIGHWAY 7/8
GWP 131-98-00

TITLE

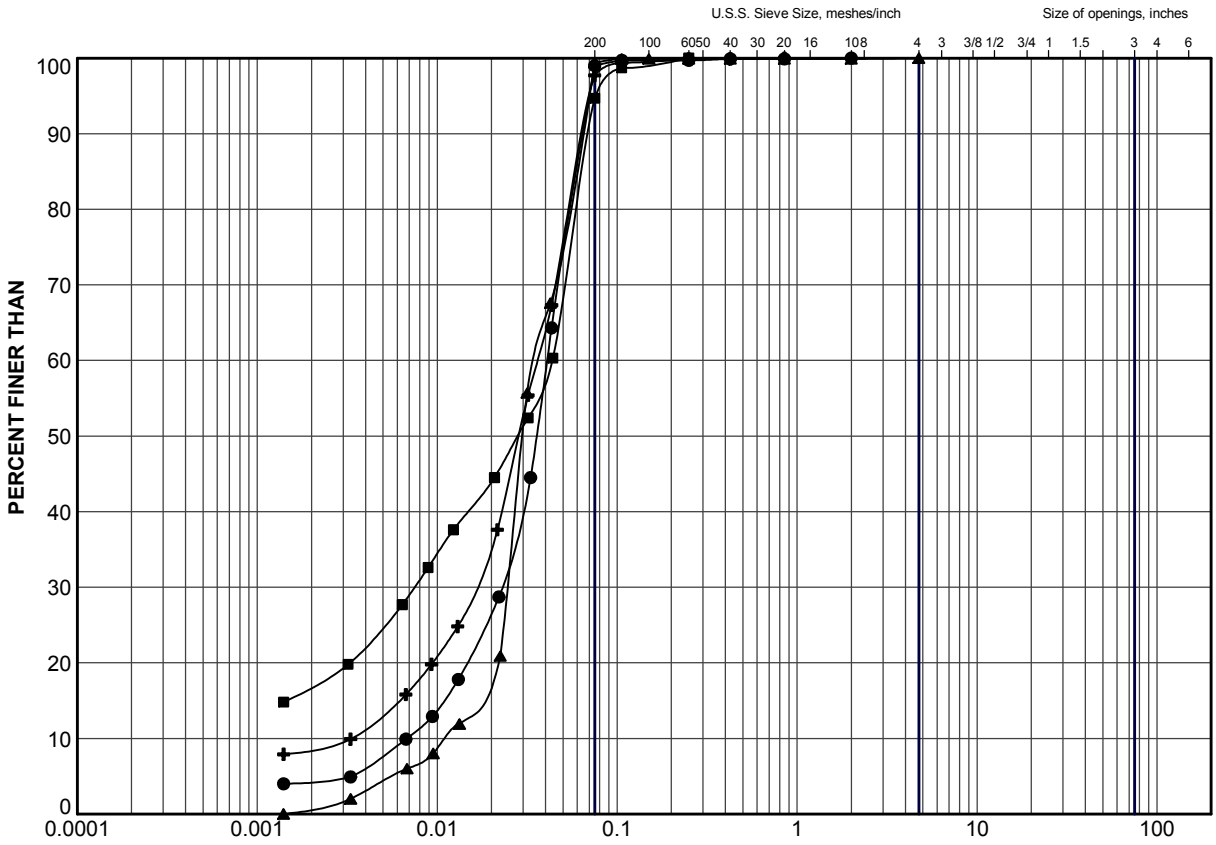
GRAIN SIZE DISTRIBUTION

SILTY CLAY

Golder Associates
LONDON, ONTARIO

PROJECT No.		08-1132-084-1	FILE No.	0811320841-R100A8
			SCALE	N/A REV.
DRAWN	WDF	Jun 28/10		
CHECK			**FIGURE**	**A-8**

LDN_MTO_NEW GLDR_LDN.GDT



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	502	17	312.3
■	503	14	315.9
▲	506	15	313.9
✚	507	15	313.4

PROJECT

RETAINED SOIL SYSTEM WALLS
WIDENING OF HIGHWAY 7/8
GWP 131-98-00

TITLE

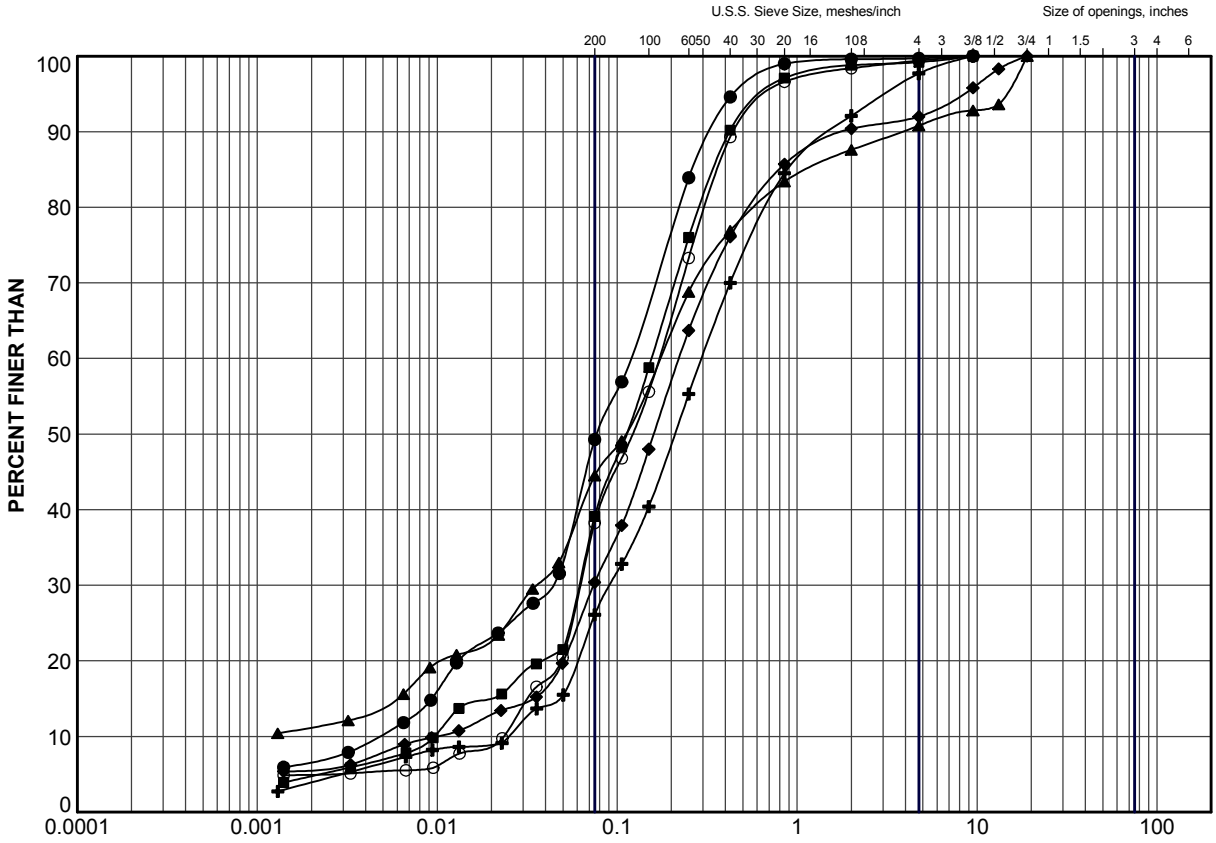
GRAIN SIZE DISTRIBUTION

SILT

Golder Associates
LONDON, ONTARIO

PROJECT No.		08-1132-084-1	FILE No.	0811320841-R100A9
			SCALE	N/A REV.
DRAWN	WDF	Jun 28/10		
CHECK			**FIGURE A-9**	

LDN_MTO_NEW GLDR_LDN.GDT



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	307	14	326.0
■	309	11	329.8
▲	511	8	321.3
✚	513	8	321.7
◆	903 A	13	327.7
○	913	9	317.1

PROJECT

RETAINED SOIL SYSTEM WALLS
WIDENING OF HIGHWAY 7/8
GWP 131-98-00

TITLE

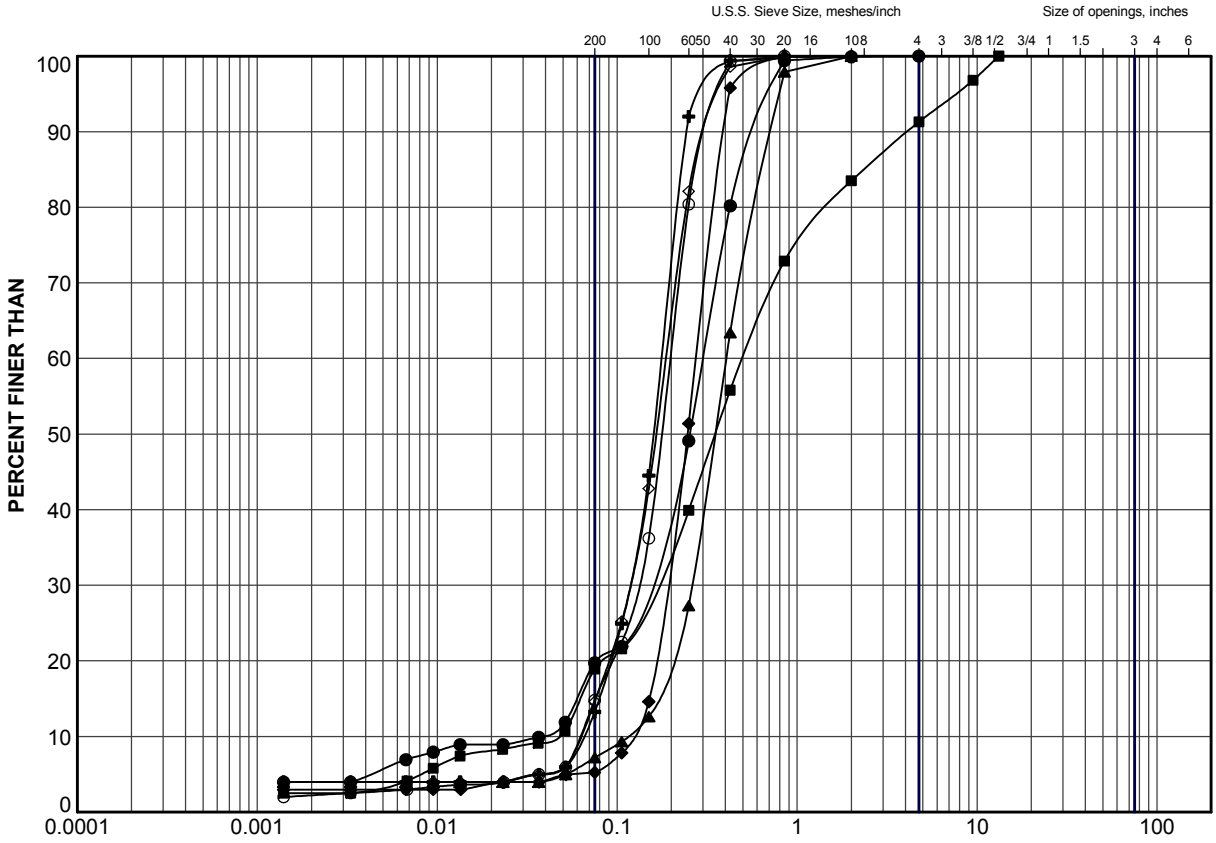
GRAIN SIZE DISTRIBUTION

SILTY SAND

Golder Associates
LONDON, ONTARIO

PROJECT No.		08-1132-084-1	FILE No.	0811320841-R100A10
			SCALE	N/A REV.
DRAWN	WDF	Jun 28/10		
CHECK			**FIGURE A-10**	

LDN_MTO_NEW GLDR_LDN.GDT



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	105	8	324.8
■	511	10	318.3
▲	905	3	328.1
✚	906	5	326.2
◆	907	10	321.8
◇	908	7	323.4
○	909	8	322.1

PROJECT

RETAINED SOIL SYSTEM WALLS
WIDENING OF HIGHWAY 7/8
GWP 131-98-00

TITLE

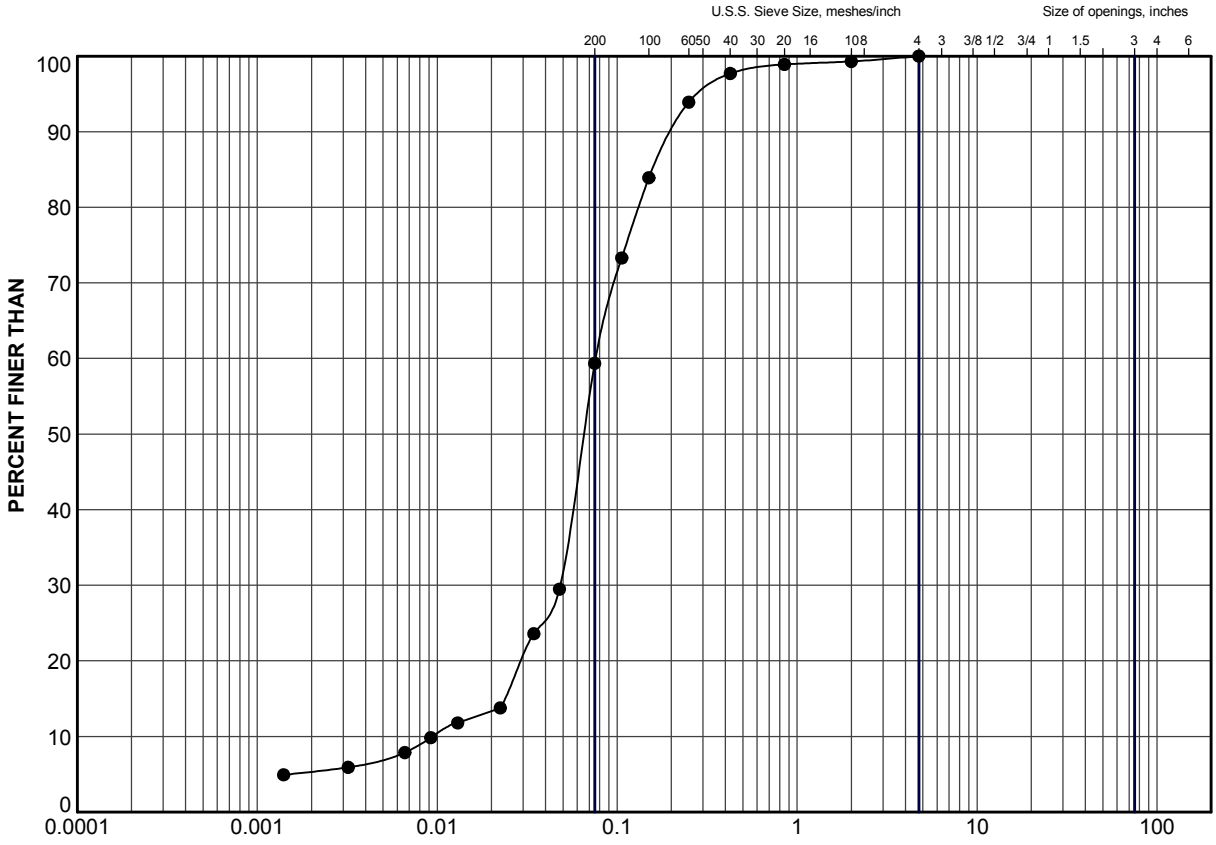
GRAIN SIZE DISTRIBUTION

SAND

Golder Associates
LONDON, ONTARIO

PROJECT No.		08-1132-084-1	FILE No.	0811320841-R100A11
			SCALE	N/A REV.
DRAWN	WDF	Jun 28/10		
CHECK			**FIGURE A-11**	

LDN_MTO_NEW GLDR_LDN.GDT



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	911	7	322.8

PROJECT

RETAINED SOIL SYSTEM WALLS
WIDENING OF HIGHWAY 7/8
GWP 131-98-00

TITLE

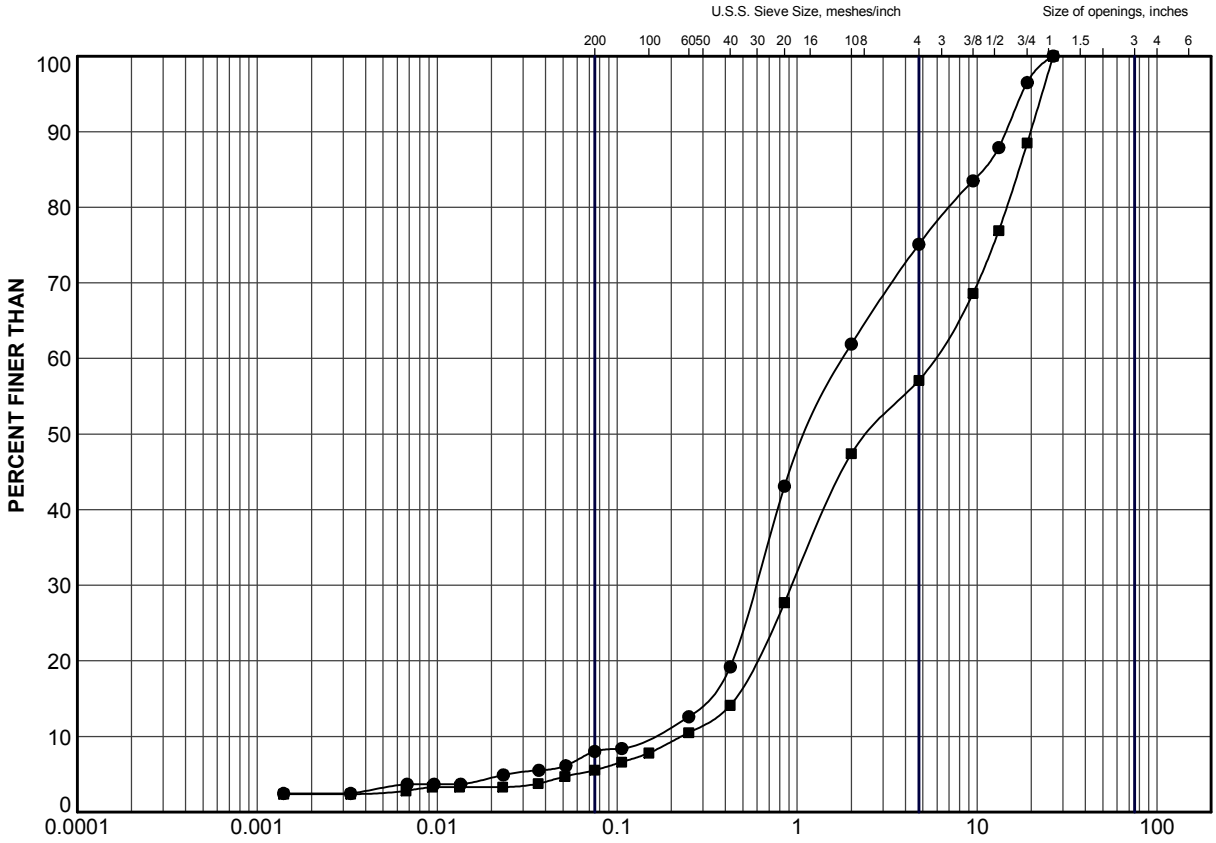
GRAIN SIZE DISTRIBUTION

SANDY SILT

Golder Associates
LONDON, ONTARIO

PROJECT No.		08-1132-084-1	FILE No.	0811320841-R100A12
			SCALE	N/A REV.
DRAWN	WDF	Jun 28/10		
CHECK			**FIGURE A-12**	

LDN_MTO_NEW GLDR_LDN.GDT



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	105	12	318.7
■	908	9	321.9

PROJECT

RETAINED SOIL SYSTEM WALLS
WIDENING OF HIGHWAY 7/8
GWP 131-98-00

TITLE

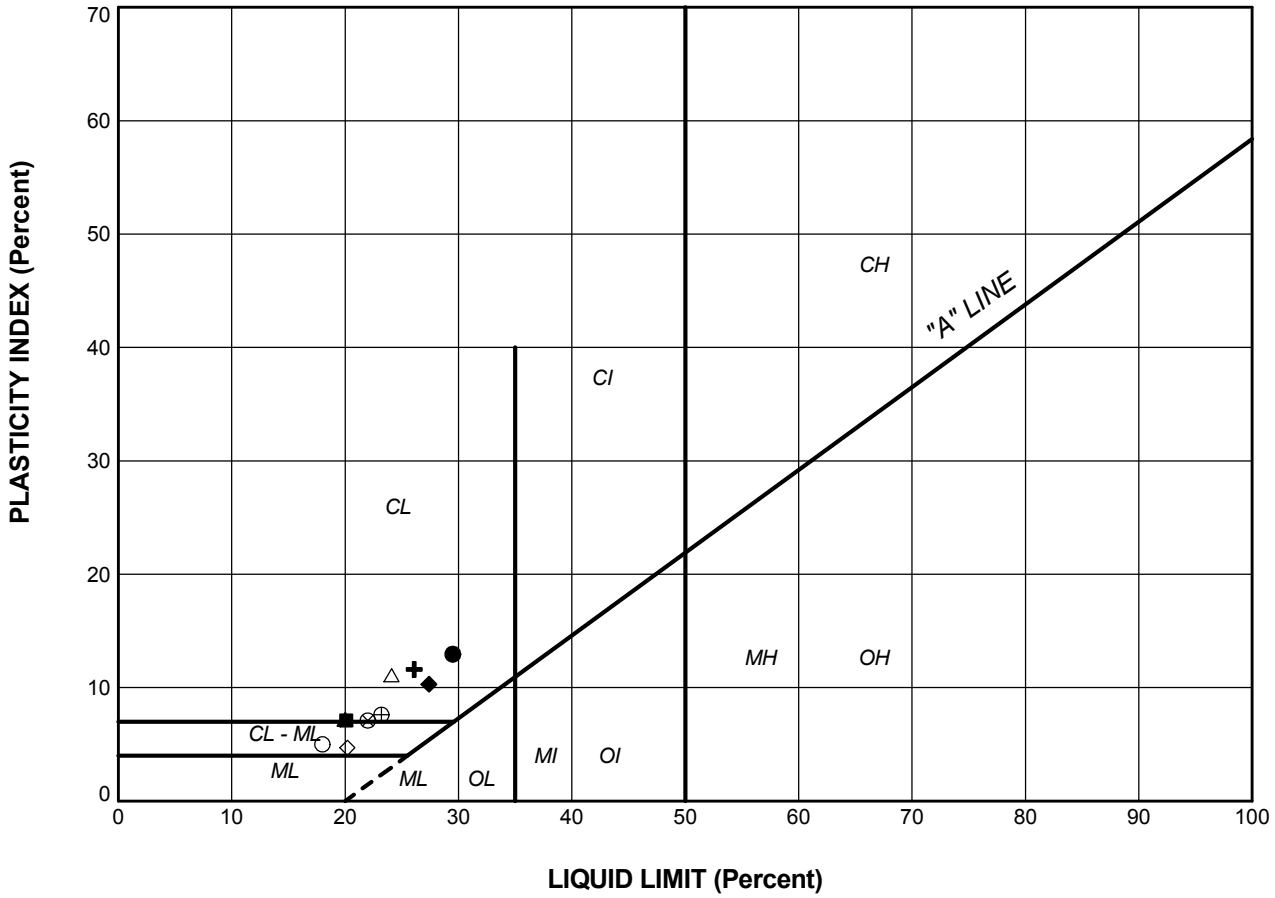
GRAIN SIZE DISTRIBUTION

SAND AND GRAVEL

Golder Associates
LONDON, ONTARIO

PROJECT No.	08-1132-084-1		FILE No.	0811320841-R100A13
			SCALE	N/A REV.
DRAWN	WDF	Jun 28/10		
CHECK				FIGURE A-13

LDN_MTO_NEW GLDR_LDN.GDT



SOIL TYPE
C = Clay
M = Silt
O = Organic

PLASTICITY
L = Low
I = Intermediate
H = High

LEGEND

SYMBOL	BOREHOLE	SAMPLE	LL(%)	PL(%)	PI
FILL (cohesive)					
●	307	9	29.5	16.6	13.0
■	309	5	20.1	13.0	7.1
▲	409	8	20.0	12.8	7.2
✚	502	13	26.1	14.5	11.6
◆	512	9	27.4	17.1	10.3
◇	901	3	20.2	15.5	4.7
○	902	7	18.0	13.0	5.0
△	903	2	24.1	13.0	11.1
⊗	904	7	22.0	14.9	7.1
⊕	915	3	23.2	15.6	7.6

PROJECT
RETAINED SOIL SYSTEM WALLS
WIDENING OF HIGHWAY 7/8
GWP 131-98-00

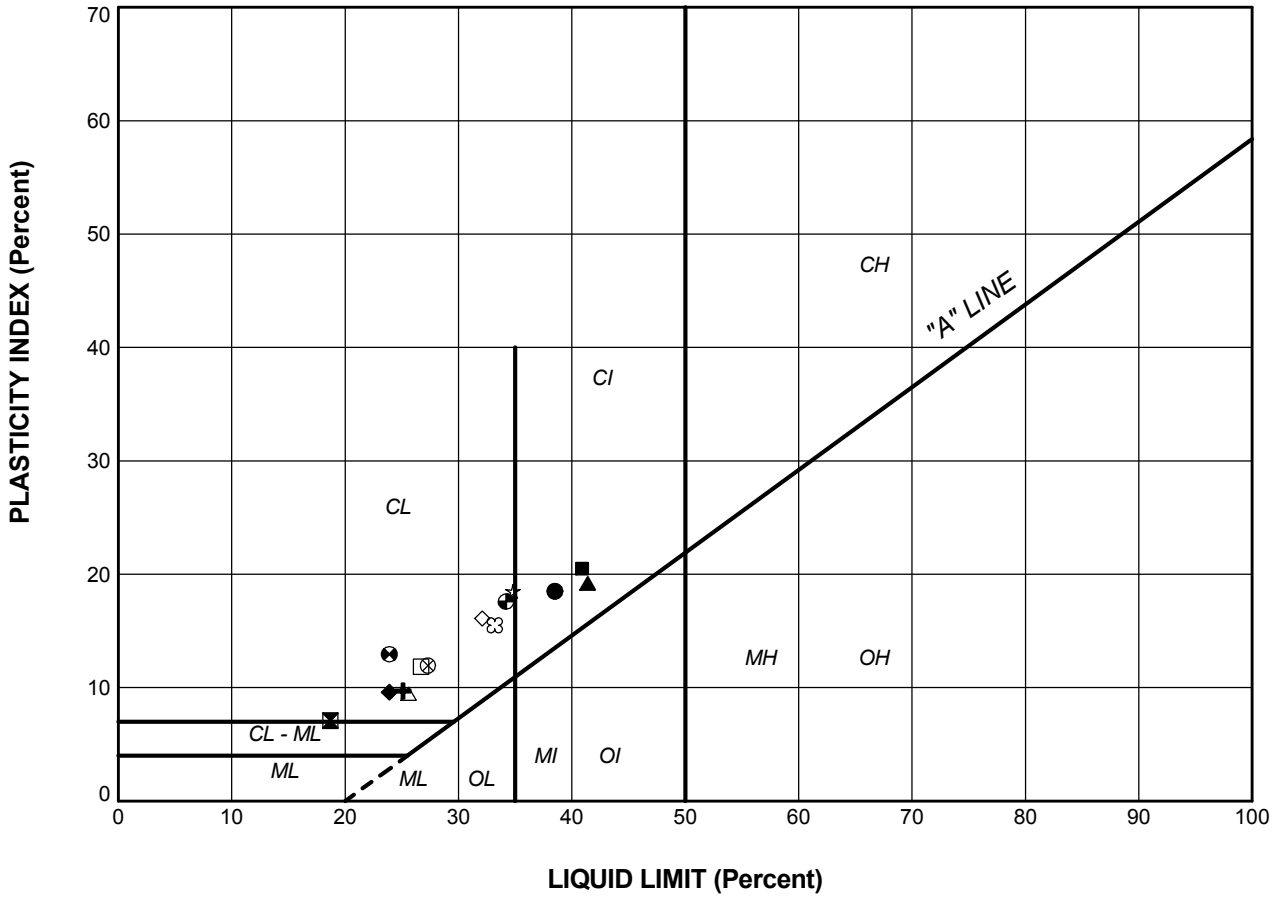
TITLE
PLASTICITY CHART
COHESIVE FILL

Golder Associates
LONDON, ONTARIO

PROJECT No.	08-1132-084-1			FILE No.	0811320841-R100A14
				SCALE	N/A
DRAWN	WDF	Jun 28/10		REV.	
CHECK					

FIGURE A-14

MTO_PI_25 GLDR_LDN.GDT



SOIL TYPE
C = Clay
M = Silt
O = Organic

PLASTICITY
L = Low
I = Intermediate
H = High

LEGEND

SYMBOL	BOREHOLE	SAMPLE	LL(%)	PL(%)	PI
SILTY CLAY					
●	907	5	38.5	20.0	18.5
■	910	9	40.9	20.4	20.5
▲	925	9	41.4	22.2	19.2
CLAYEY SILT TILL					
✚	512	10	25.1	15.4	9.7
◆	904	11	23.9	14.3	9.6
CLAYEY SILT					
◇	309	15	32.1	16.0	16.1
△	502	15	25.6	16.2	9.5
⊗	502	16	27.3	15.4	12.0
□	506	13	26.7	14.9	11.9
◓	506	16	23.9	11.0	13.0
◕	902	11	34.2	16.6	17.6
☆	905	8	34.8	16.3	18.5
⊠	906	10	33.2	17.7	15.5
⊠	903A	17	18.7	11.6	7.1

PROJECT
RETAINED SOIL SYSTEM WALLS
WIDENING OF HIGHWAY 7/8
GWP 131-98-00

TITLE
PLASTICITY CHART
SILTY CLAY, CLAYEY SILT, CLAYEY SILT TILL

Golder Associates
LONDON, ONTARIO

PROJECT No.	08-1132-084-1		FILE No.	0811320841-R100A15	
			SCALE	N/A	REV.
DRAWN	WDF	Jun 28/10			
CHECK			**FIGURE A-15**		

MTO_PI_25 GLDR_LDN.GDT

APPENDIX B

Technical Memorandum, Project No. 08-1132-084-6-M01 January 21, 2011

TECHNICAL MEMORANDUM

DATE January 21, 2011 **PROJECT No.** 08-1132-084-6-M01

TO Mr. Jeff Matthews, P.Eng., Partner
Dillon Consulting Limited

FROM Mr. Philip R. Bedell, P.Eng.
Mr. Fintan J. Heffernan, P.Eng.

EMAIL phil_bedell@golder.com
fheffernan@golder.com

PRELIMINARY FOUNDATIONS ENGINEERING REVIEW
EMBANKMENT MODIFICATIONS
WIDENING OF HIGHWAY 7/8
FROM 1.9 KM WEST OF FISCHER-HALLMAN ROAD INTERCHANGE
EASTERLY TO 0.8 KM EAST OF COURTLAND AVENUE INTERCHANGE
KITCHENER
GWP 131-98-00
MINISTRY OF TRANSPORTATION - WEST REGION

Jeff:

This technical memorandum summarizes the results of our preliminary foundations engineering review of the embankment modifications required for the above-noted project.

Background

Revisions to the originally proposed preliminary design have been required to accommodate widening of the four overpass structures and the Canadian National Rail (CNR) overhead. As a result, additional grade raises and widenings of the existing high fill embankments are required. However, in most locations, the toes of the existing embankments are in close proximity to the limit of the right-of-way (ROW) and the acquisition of additional property may be very difficult and costly due to the proximity of the adjacent developments. As a result, the use of retaining walls has been proposed to accommodate the high fill embankment modifications required.

Foundation Investigation and Design Reports have been completed and submitted to MTO for many of the components of the project.

In summary, the above-noted data indicates that the existing high fills generally consist primarily of compact granular materials ranging from sandy silt to sand and gravel with clayey layers. The underlying native soils are variable but typically consist of stiff, low plasticity clayey materials interbedded with compact silt layers.

Groundwater levels are typically 1 to 2 metres below the original ground surface.

Retaining Wall Options

To characterize the site, representative embankment heights of 5 and 9 metres have been selected, and the face of wall/toe slope has been set 0.5 metres behind the right-of-way (ROW) limit. Finished slope inclinations will be 2 horizontal to 1 vertical and a 2 metre wide bench will be provided at mid length in slopes equal to or higher than 8 metres. The embankment modifications result in additional fill depths of about one metre at a point 0.5 metres behind the ROW limit and representative grade raise and embankment widening of 0.5 and 1.5 to 5 metres, respectively, at the crest of the existing embankment. The existing and proposed cross-sections are shown on Figure 1 for the typical existing 5 metre high and 9 metre high embankments, respectively. In addition, consideration has been given to the potential for future widening of the roadway platform to accommodate an eight lane cross-section.

Based on the results of our preliminary analyses and the relevant Foundation Engineering considerations, the following retaining wall options have been considered:

i) Reinforced Soil System (RSS) Wall at the toe of slope - Figure 2

ii) Conventional Concrete Cantilever Wall at the toe of slope - Figure 3

iii) Driven Cantilever Steel Sheet Pile wall at toe of slope - Figure 4

iv) RSS Wall at the top of slope - Figure 5

v) Concrete Cantilever Wall at the top of slope - Figure 6

vi) Retaining Wall / Noise Attenuation Wall combination at the top of slope - Figure 7

vii) Geo-reinforced Slope - Figure 8

The various options are discussed briefly below and a comparison of the options is provided in Table I, attached.

i) RSS Wall at the Toe - This option requires a relatively massive wall which will require extensive excavation into the toe of the existing slope. If future eight laning is considered, the wall would need to be removed and replaced or a more robust base section of the future wall constructed at this time.

ii) Cantilever Wall at Toe - Construction of a concrete cantilever wall at the toe of the slope would also require relatively larger excavations into the existing slope and would be subject to the comments provided for i). Higher costs are expected for this option.

iii) Driven Cantilever Steel Sheet Pile Wall - Although not aesthetically pleasing, the use of a driven cantilever steel sheet pile wall could be considered at the toe of the slope. Very long piles would be required for the high fills.

iv) RSS Wall at Top - Construction of an RSS wall at the top of the slope requires a normal wall cross-section. The existing borehole data indicates adequate founding conditions. This option allows for future eight laning with the construction of a new wall outside of the currently proposed wall. The RSS wall for the future potential eight lane widening is shown on Figure 5.

v) Concrete Cantilever Wall at Top - The issues associated with this option are very similar to ii), but higher costs are expected. The use of a driven cantilever steel sheet pile wall at the top of the slope is not considered feasible.

vi) Retaining Wall / Noise Attenuation Wall at Top of Slope - Where the new / relocated noise attenuation wall is to be located at the top of the slope, there is the potential to incorporate a low (typically less than one metre high) retaining wall into the lower portion of the noise wall. However, due to the traffic surcharge loading and the sloping surface behind the wall, very deep / wide caisson foundations are required which results in very high costs and this option is therefore not considered feasible.

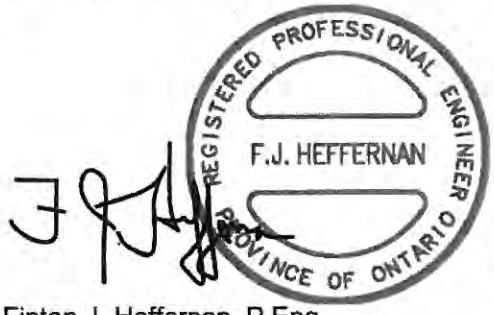
vii) Geo-Reinforced Slope - The use of slope inclinations significantly steeper than 2 horizontal to 1 vertical is possible with this option. However, to accommodate the currently proposed embankment modifications within the existing ROW, the required slopes are only somewhat steeper than 2 horizontal to 1 vertical and typically 1.5 horizontal to 1 vertical. Construction of the steep a geo-reinforced slope at inclinations of as steep as 1.5 horizontal to 1 vertical utilizing the existing fill material is possible; however, substantial excavation to place the required width of the reinforcement is required thus making this option non-feasible and very costly. Further, the slope would need to be removed and reconstructed for a future eight lane widening unless the platform is widened sufficiently at this time.

In summary, option iv) the RSS Wall at the top of the slope, is the preferred foundations engineering option. The RSS wall is to have a width to height ratio in the range of 0.6 to 0.8 unless surcharge loads dictate a wider wall. The global (external) stability RSS walls up to 6 metres in height and constructed at the top of the existing embankment slopes is expected to be adequate with a factor of safety greater than 1.3. The design of the RSS retaining walls must consider the impacts of installing the proposed highway infrastructure such as culverts, overhead signs, high mast lights and noise barrier walls, in order to protect the reinforcing elements from damage.

We trust that this technical memorandum provides an adequate summary of all of the preliminary foundation engineering issues related to our assessment of the potential retaining wall options for the proposed embankment modifications. If further, detail or input is required, please contact our office.

GOLDER ASSOCIATES LTD.

Philip R. Bedell, P.Eng.
Senior Consultant



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

PRB/FJH/ly

Attachments: Table I
Figures 1 to 8

n:\active\2008\1132 - geotechnical\1132-000-0\08-1132-084-6 dillon - prelim fdns eng - hwy 7-8\tech memos\0811320846-m01\0811320846-m01 jan 21 11 - (final) prelim fdns - embankment modification hwy 7-8.docx

TABLE I

COMPARISON OF RETAINING WALL OPTIONS

High Fill Embankment Modifications
Widening of Highway 7/8
GWP 131-98-00

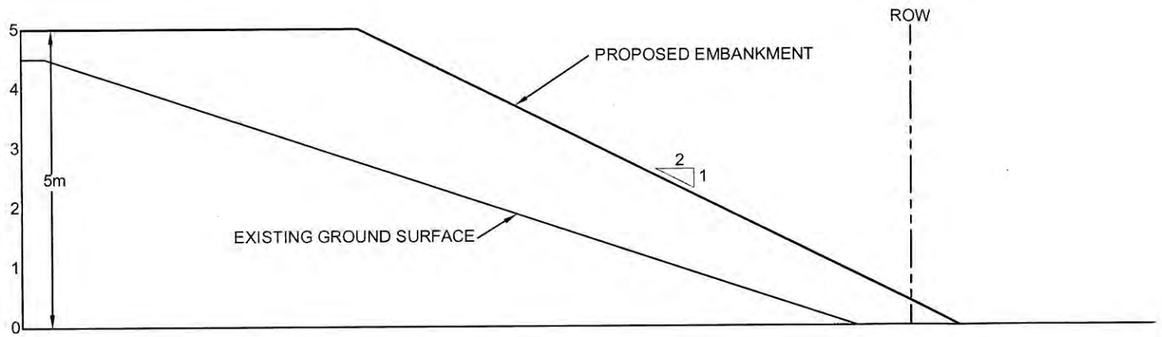
WALL OPTION	FEASIBILITY	ADVANTAGES	DISADVANTAGES	RELATIVE COSTS	RISKS/ CONSEQUENCES
i) RSS wall at toe of slope	Feasible	- Minimize impacts on roadway.	- Substantial excavation of existing slope required. - Construction access required at toe of slope. - Inclination of surface behind wall includes high lateral loads. Full slope regrading/reshaping required.	Moderate	Temporary excavation may adversely impact existing slope.
ii) Cantilever wall at toe of slope	Feasible	- Minimize impacts on roadway.	- Substantial excavation of existing slope required. - Construction access required at toe of slope. - Inclination of surface behind wall includes high lateral loads. Full slope regrading/reshaping required.	Higher than RSS Wall (i)	Temporary excavation may adversely impact existing slope.
iii) Driven Cantilever Steel Sheet Pile Wall at the toe of slope	Generally Not Feasible	- No excavation required.	- Larger risk area at toe of slope required.	Very High	Potential for vibration damage to adjacent structure.

COMPARISON OF RETAINING WALL OPTIONS

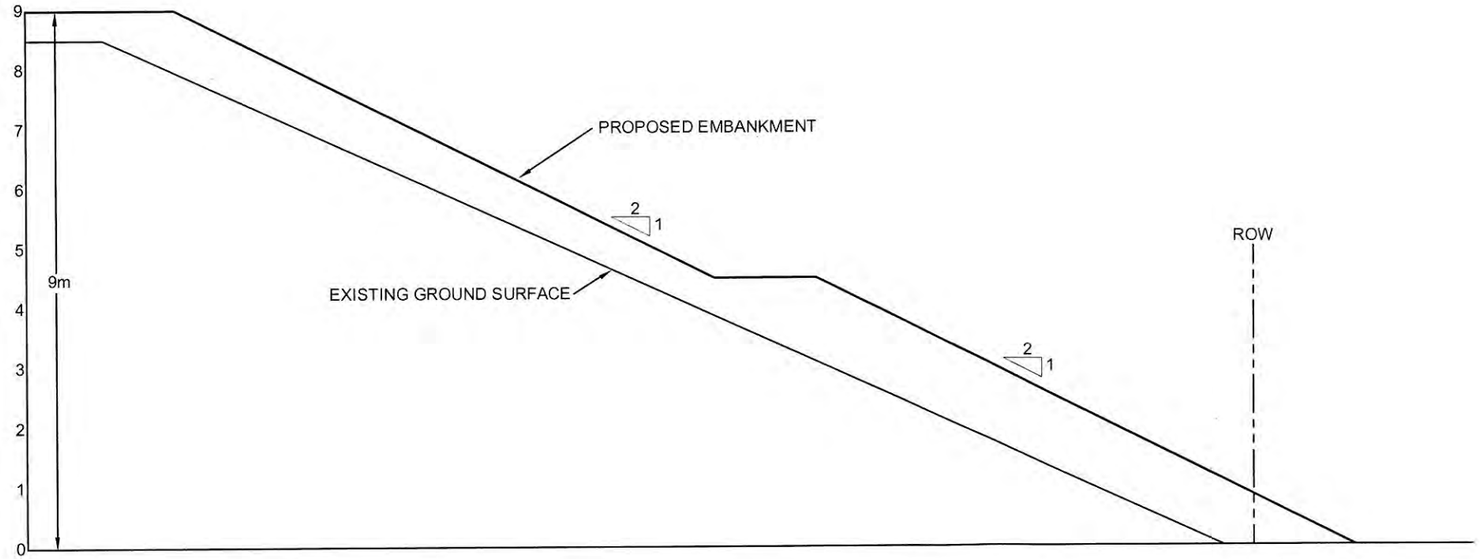
WALL OPTION	FEASIBILITY	ADVANTAGES	DISADVANTAGES	RELATIVE COSTS	RISKS/ CONSEQUENCES
iv) RSS wall at top of slope	Feasible	- Good construction access. - Reduced excavation required. - Least impact on existing slopes. - Adjacent wall can be added for future widening.	- Some impacts on roadway; temporary roadway protection is not likely required for excavation for RSS block/backfill as it can be accommodated by staging.	Low	Trimming of high slopes required and bench required in slope higher than 8 metres.
v) Concrete Cantilever Wall at top	Feasible	- Good construction access. - Reduced excavation required. - Least impact on existing slopes.	- Some impacts on roadway.	Higher than iii)	Trimming of high slopes required and bench required in slope higher than 8 metres.
vi) Retaining Wall / Noise Wall	Not Feasible due to excess caisson depth	- Good construction access. - Minimal excavation. - Least impact on existing slope.	- Very deep / wide caisson required.	High	Only limited area suitable for this option.
vii) Geo-Reinforced Slope	Not Feasible	- No wall required.	- Massive excavation and slope reconstruction required.	Very High	Does not accommodate future widening.

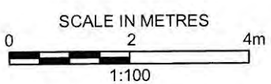
NOTES: 1. Table to be read in conjunction with accompanying technical memorandum.

Prepared By: PRB
Checked By: FJH



5m HIGH FILL





9m HIGH FILL

NOTES

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

ALL LOCATIONS ARE APPROXIMATE.

PROJECT

EMBANKMENT MODIFICATIONS
HWY 7/8 RECONSTRUCTION
GWP 131-98-00

TITLE

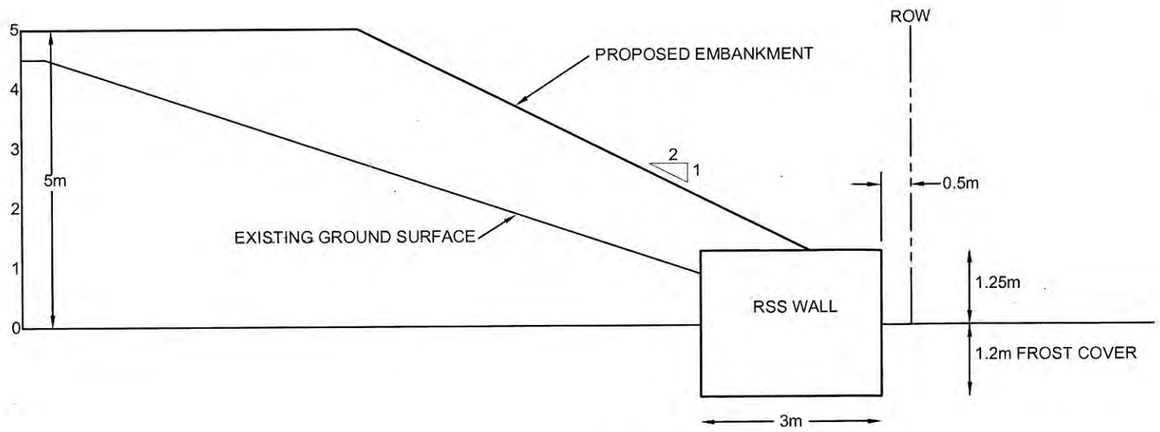
TYPICAL SECTIONS

Golder Associates
LONDON, ONTARIO

PROJECT No. 08-1132-084-6			FILE No.	0811320846-M01001
			SCALE AS SHOWN	REV.
CADD	DCH	Mar. 23/10		
CHECK				

FIGURE 1

Drawing file: 0811320846-M01001.dwg Jan 13, 2011 - 11:48am



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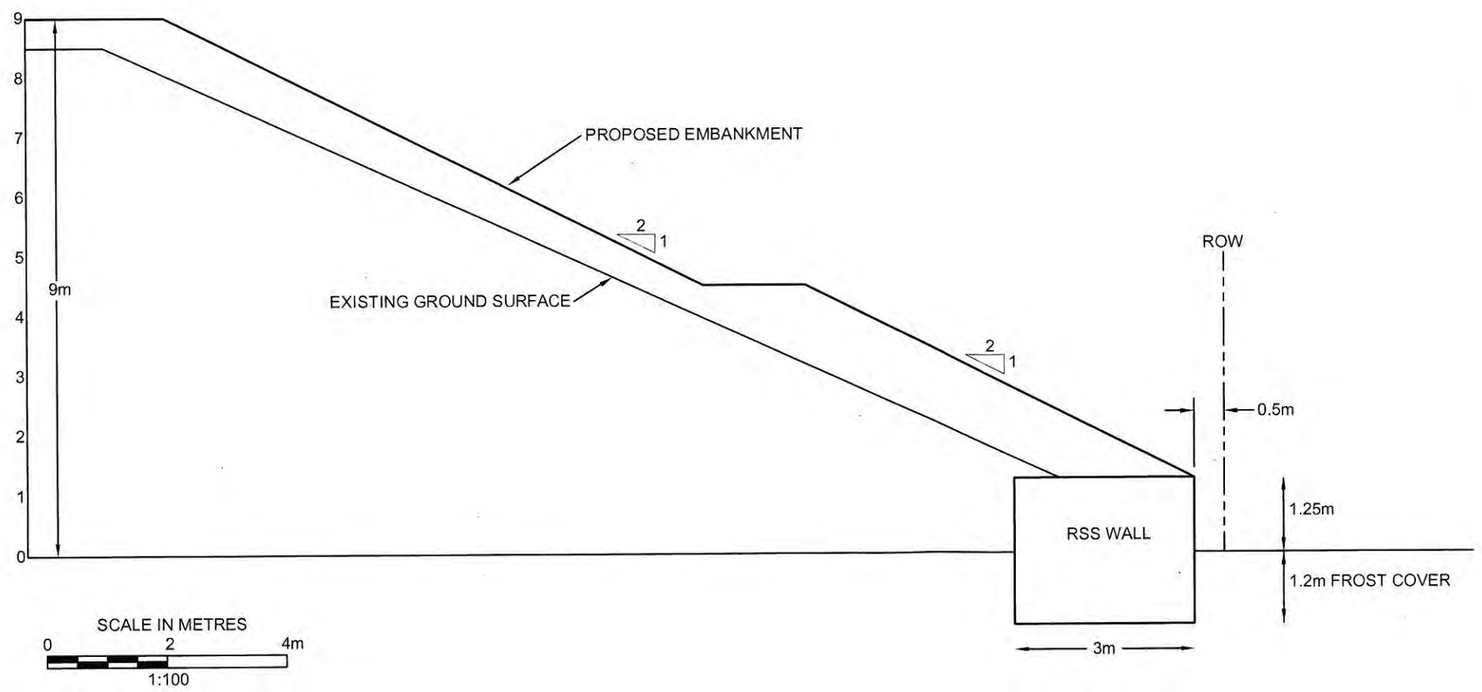


9m HIGH FILL

NOTES

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

ALL LOCATIONS ARE APPROXIMATE.

PROJECT

EMBANKMENT MODIFICATIONS
HWY 7/8 RECONSTRUCTION
GWP 131-98-00

TITLE

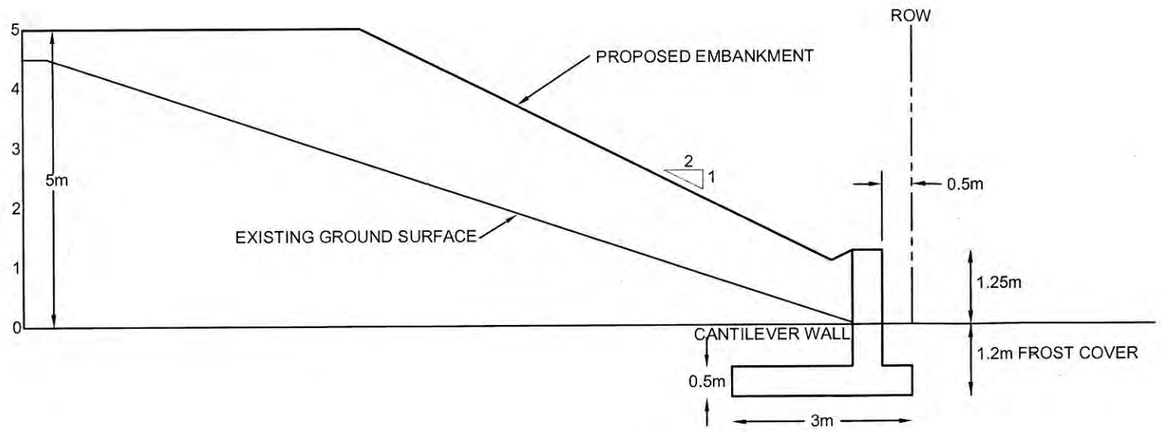
RSS WALL AT TOE OF SLOPE

Golder Associates
LONDON, ONTARIO

PROJECT No. 08-1132-0844			FILE No.	0811320846-M01001
			SCALE AS SHOWN	REV.
CADD	DGH	Mar. 23/10		
CHECK				

FIGURE 2

Drawing file: 0811320845-M01001.dwg Jan 13, 2011 - 11:48am



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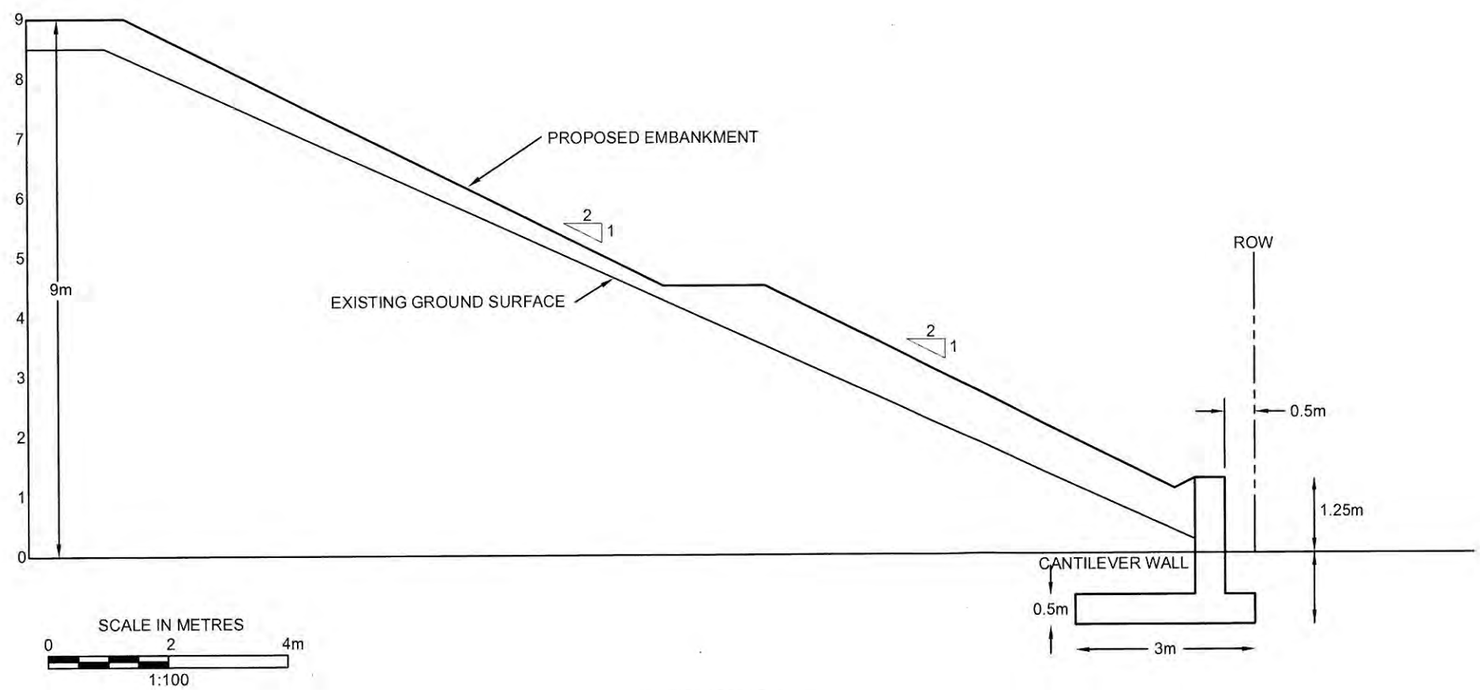


9m HIGH FILL

NOTES

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

ALL LOCATIONS ARE APPROXIMATE.

PROJECT

EMBANKMENT MODIFICATIONS
HWY 7/8 RECONSTRUCTION
GWP 131-98-00

TITLE

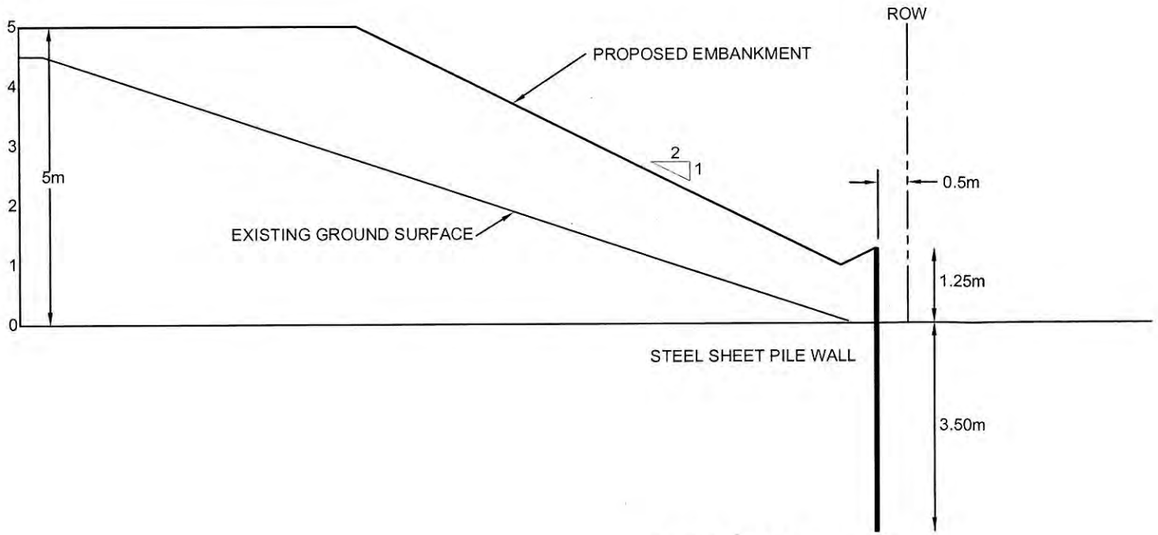
CANTILEVER WALL AT TOE OF SLOPE

Golder Associates
LONDON, ONTARIO

PROJECT No. 08-1132-0846			FILE No.	0811320846-M01001
			SCALE AS SHOWN	REV.
CADD	DSH	Mar. 23'10		
CHECK				

FIGURE 3

Drawing file: 0811320846-M01001.dwg Jan 13, 2011 - 11:49am



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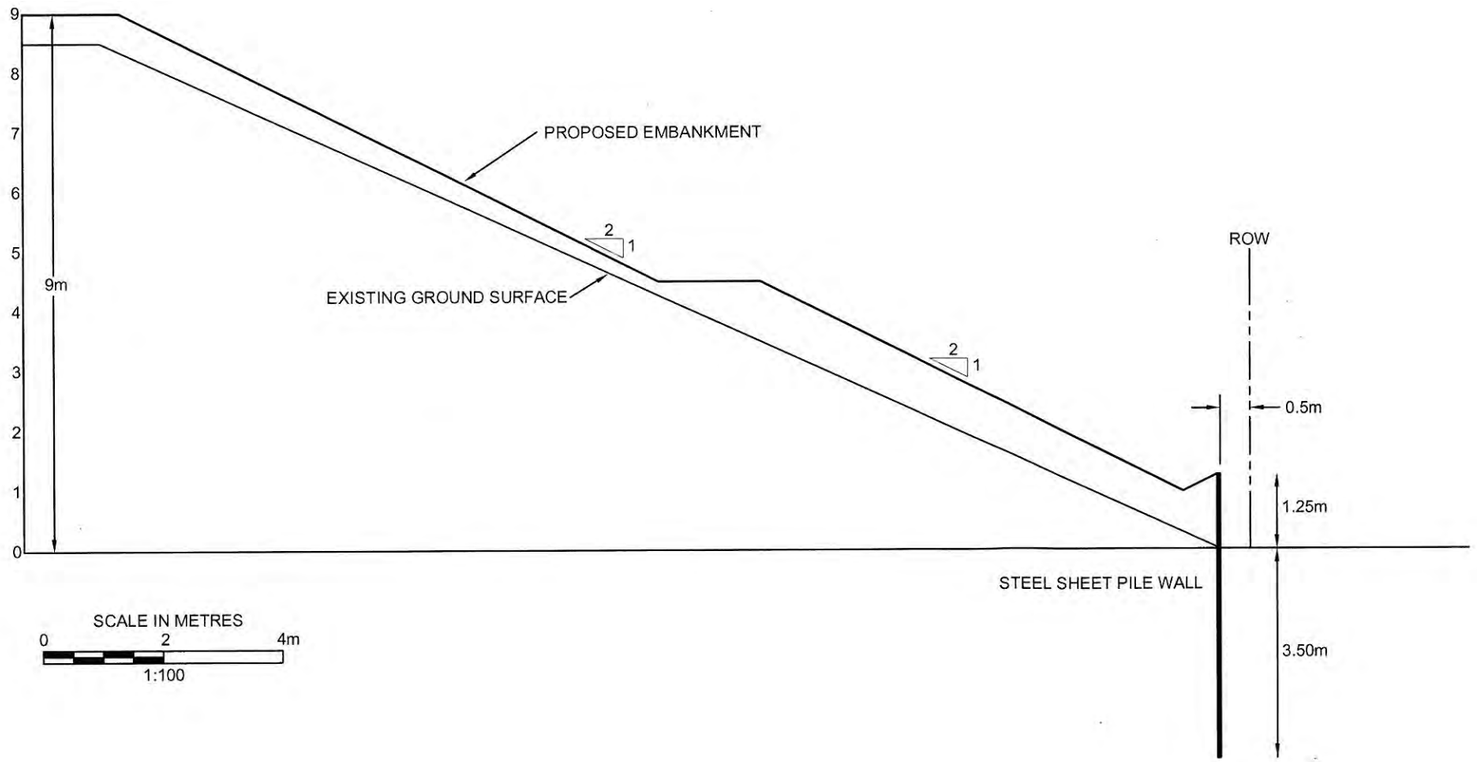


9m HIGH FILL

NOTES

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

ALL LOCATIONS ARE APPROXIMATE.

PROJECT

EMBANKMENT MODIFICATIONS
HWY 7/8 RECONSTRUCTION
GWP 131-98-00

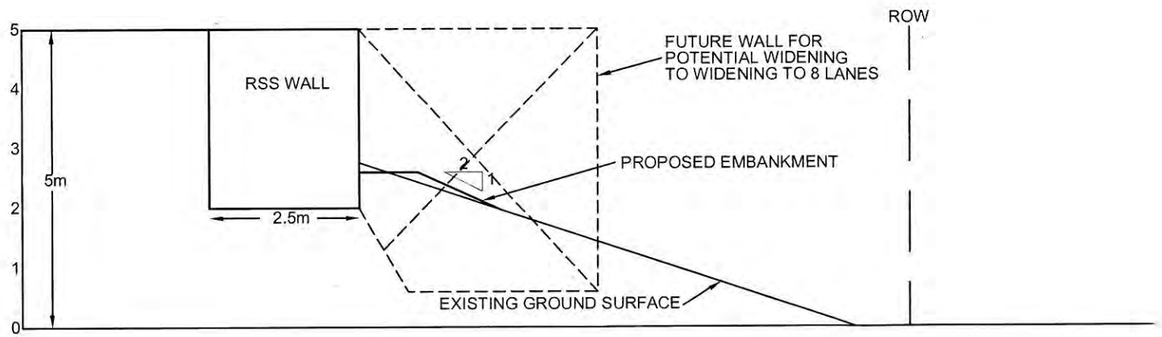
TITLE

STEEL SHEET PILE WALL AT TOE OF SLOPE

Golder Associates
LONDON, ONTARIO

PROJECT No. 08-1132-084-6			FILE No. 0811320846-M01001
			SCALE AS SHOWN REV.
CADD	DCN	Mar. 23/10	FIGURE 4
CHECK			

Drawing file: 0811320846-M01001.dwg Jan 13, 2011 - 11:49am



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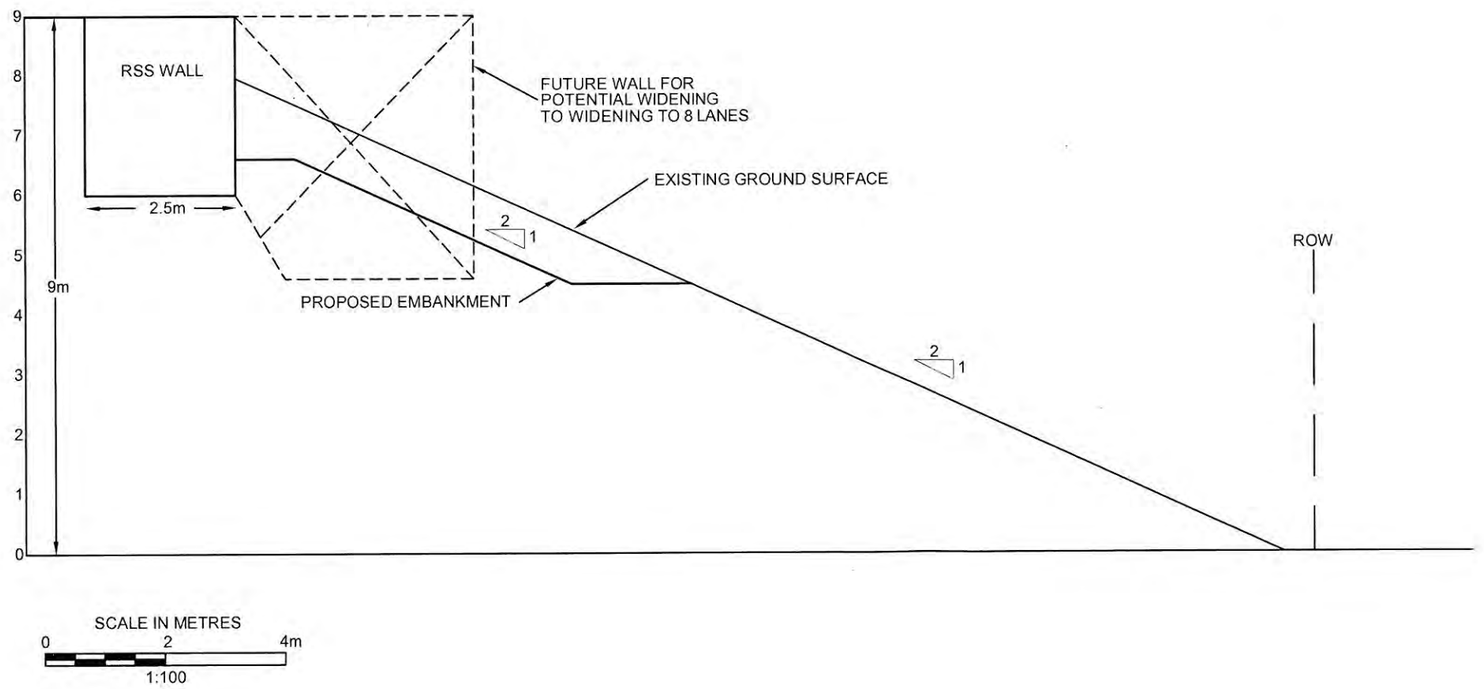

9m HIGH FILL

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ALL LOCATIONS ARE APPROXIMATE.

PROJECT

EMBANKMENT MODIFICATIONS
HWY 7/8 RECONSTRUCTION
GWP 131-98-00

TITLE

RSS WALL AT TOP OF SLOPE

Golder Associates
LONDON, ONTARIO

PROJECT No. 08-1132-084-6			FILE No. 0811320846-M01001
			SCALE AS SHOWN / REV.
CADD	DCH	Mar. 23/10	
CHECK			**FIGURE 5**

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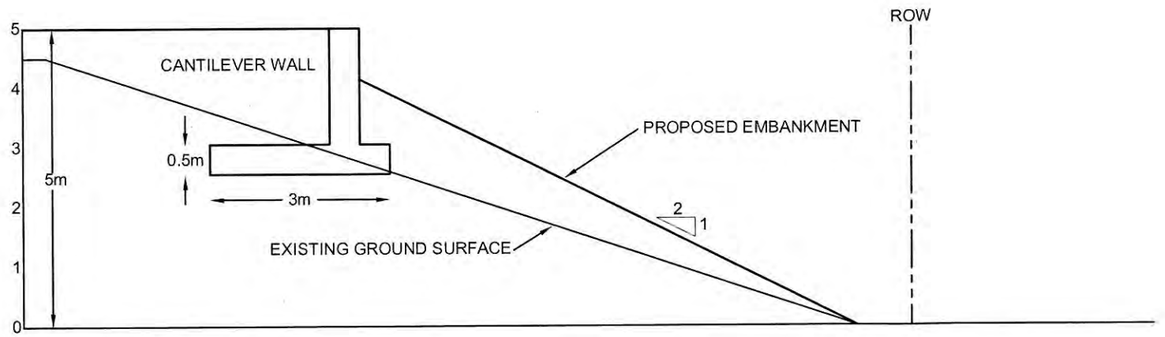

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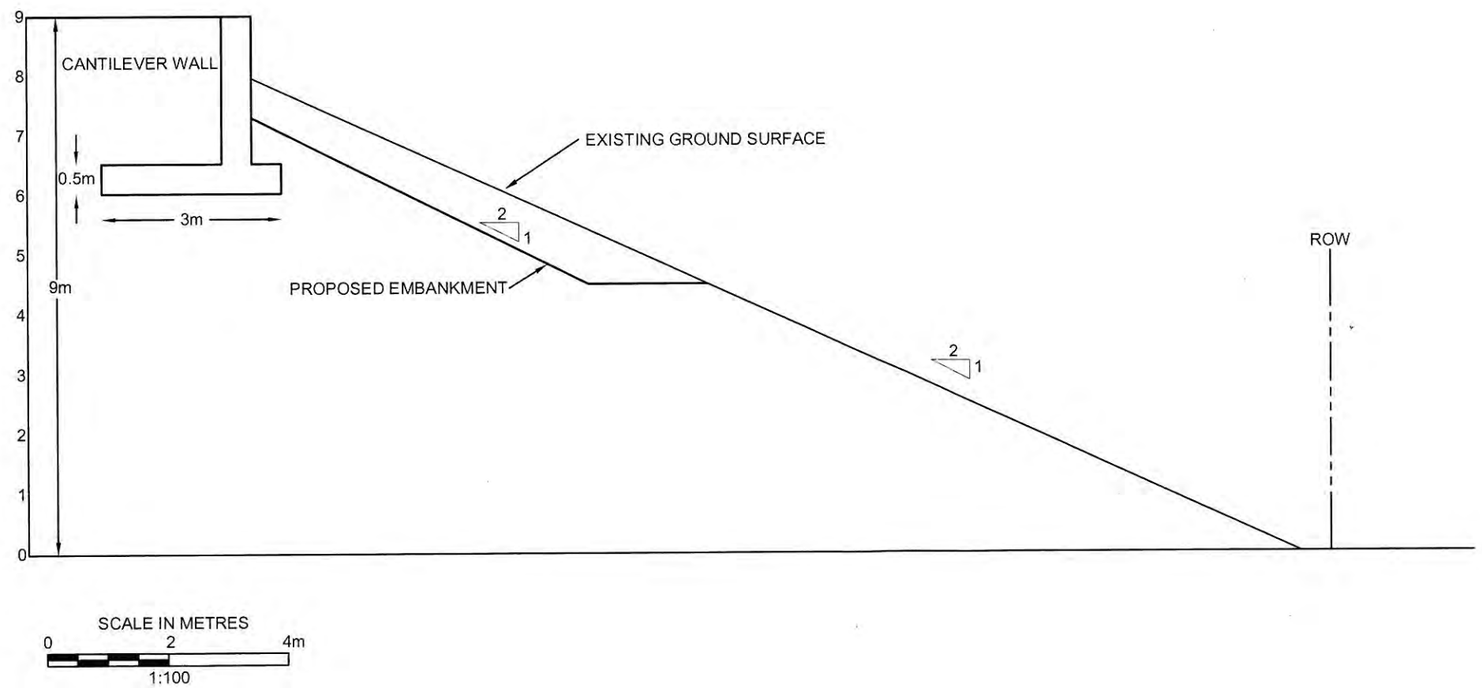

9m HIGH FILL

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PROJECT

EMBANKMENT MODIFICATIONS
HWY 7/8 RECONSTRUCTION
GWP 131-98-00

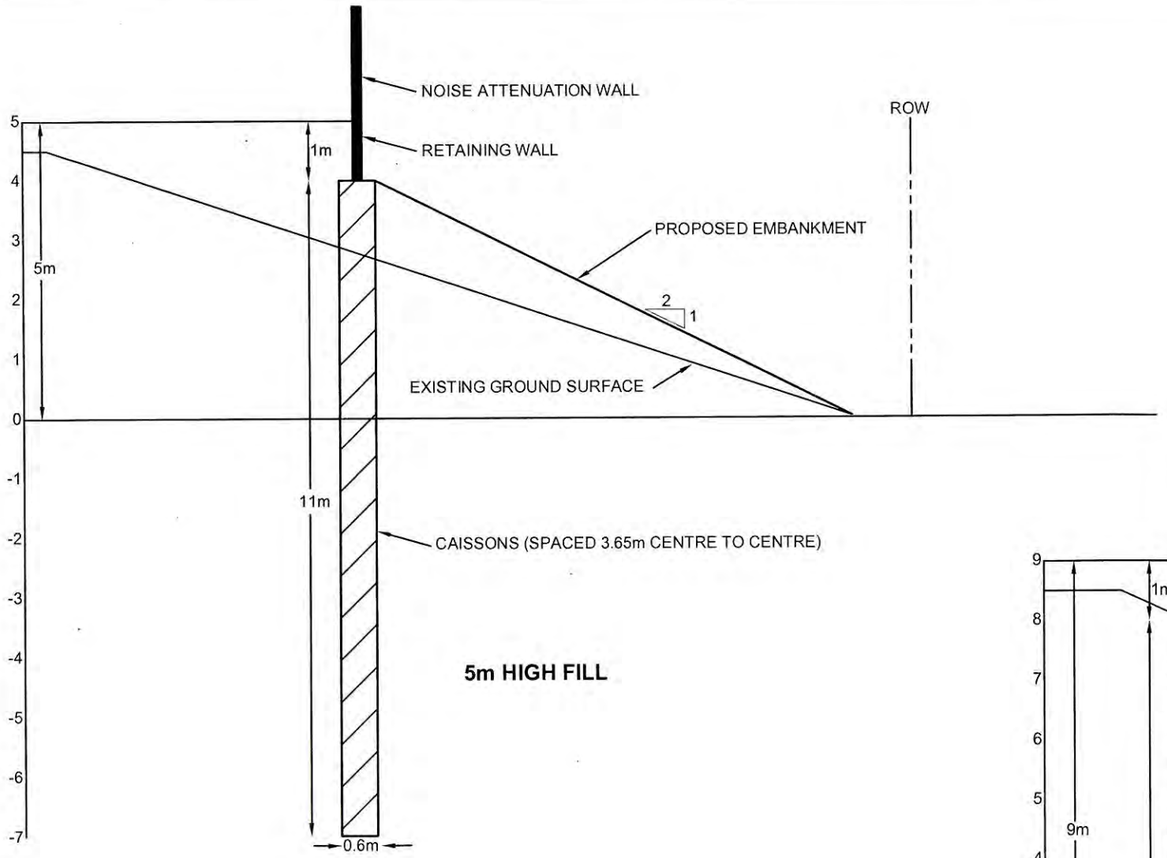
TITLE

CANTILEVER WALL AT TOP OF SLOPE

Golder Associates
LONDON, ONTARIO

PROJECT No. 08-1132-084-6			FILE No. 0811320846-M01001	
			SCALE AS SHOWN	REV.
CADD	DCH	Mar. 23/10	FIGURE 6	
CHECK				

Drawing file: 0811320846-M01001.dwg Jan 13, 2011 - 11:49am



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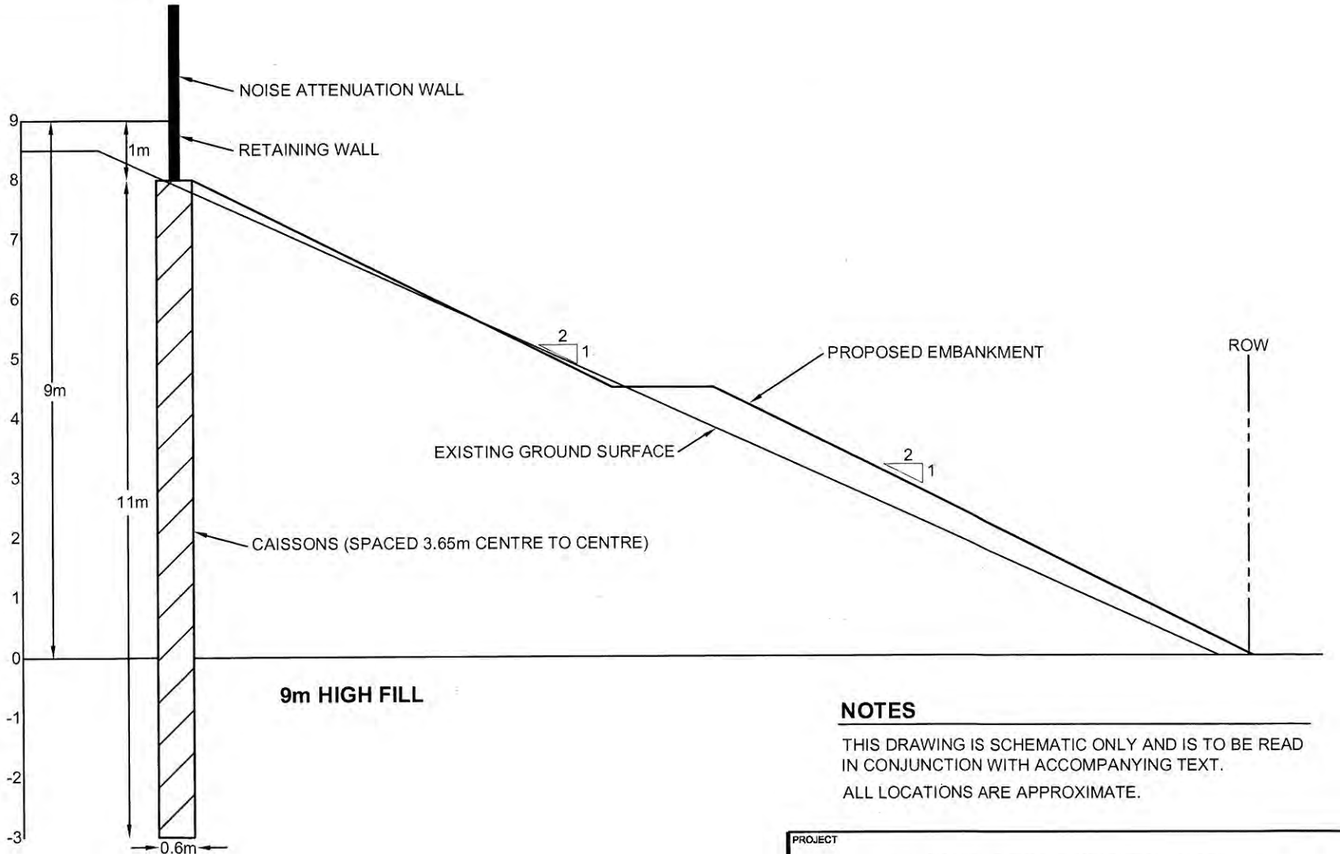

9m HIGH FILL

SCALE IN METRES
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PROJECT

EMBANKMENT MODIFICATIONS
HWY 7/8 RECONSTRUCTION
GWP 131-98-00

TITLE

NOISE ATTENUATION WALL/ RETAINING WALL ON CAISSONS

Golder Associates
LONDON, ONTARIO

PROJECT No. 08-1132-084-6			FILE No. 0811320846-M01001
			SCALE AS SHOWN / REV.
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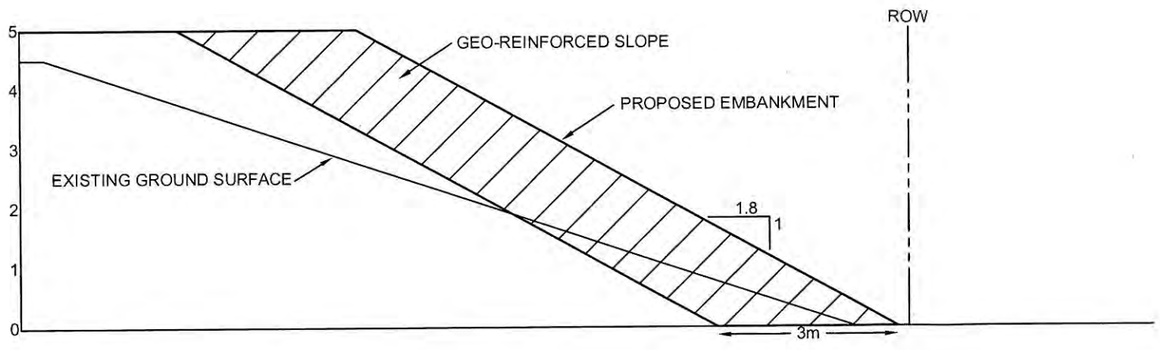
CHECK			

FIGURE 7

Drawing file: 0811320846-M01001.dwg Jan 13, 2011 - 11:49am



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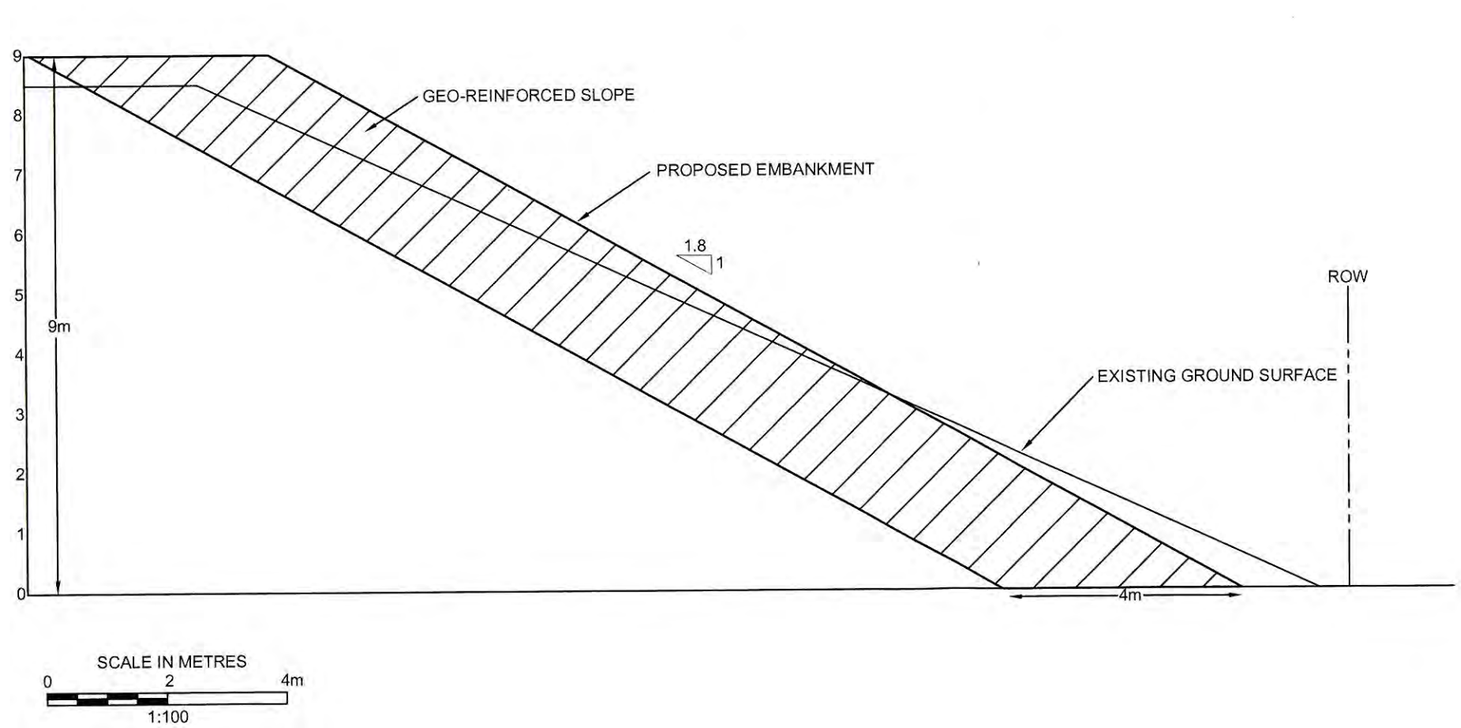

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PROJECT

EMBANKMENT MODIFICATIONS
HWY 7/8 RECONSTRUCTION
GWP 131-98-00

TITLE

GEO-REINFORCED SLOPE

Golder Associates
LONDON, ONTARIO

PROJECT No. 08-1132-084-6			FILE No.	0811320846-M01001
			SCALE AS SHOWN	REV.
CADD	DCH	Mar. 23/10		
CHECK				

FIGURE 8

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APPENDIX C

Site Photograph

Photograph 1: Slope failure between Stations 16+770 and 16+780 RT, looking north from Overland Drive (June 23, 2009).

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