



June 17, 2013

## FOUNDATION DESIGN REPORT

# NOISE BARRIER WALL REPLACEMENT HIGHWAY 401 FROM WEST OF WILSON ROAD TO HARMONY ROAD OSHAWA, ONTARIO ASSIGNMENT NO.: 2011-E-0018

**Submitted to:**

Ministry of Transportation, Ontario  
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REPORT

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# **PART A - FOUNDATION INVESTIGATION REPORT**

**NOISE BARRIER WALL**

**HIGHWAY 401 FROM WEST OF WILSON ROAD TO HARMONY ROAD**

**OSHAWA, ONTARIO**

**ASSIGNMENT NO.: 2011 - E - 0018**



### 1.0 INTRODUCTION

Golder Associates Ltd. (Golder) has been retained by the Ministry of Transportation, Ontario (MTO) to provide foundation engineering services for noise barrier walls to be constructed on the north and south sides of Highway 401, from west of Wilson Road South to Harmony Road South in Oshawa, Ontario (refer to Key Plan on Drawing 1, attached).

The factual data, interpretations and recommendations contained in this report pertain to a specific project as described in the report and are not applicable to any other project or site location. If the project is modified in concept, location or elevation, or if the project is not initiated within eighteen (18) months of the date of the report, Golder should be given an opportunity to confirm that the recommendations are still valid.

This report addresses only the geotechnical (physical) aspects of the subsurface conditions at this site. The geo-environmental (chemical) aspects of the subsurface conditions, including the consequences of possible surface and/or subsurface contamination resulting from previous activities or uses of the site and/or resulting from the introduction onto the site of materials from off-site sources, are outside the terms of reference for this investigation.

The terms of reference and scope of work for the foundation engineering services are outlined in MTO's Assignment Order Form for Agreement No. 2011-E-0018, issued in March 27, 2013.

### 2.0 SITE AND PROJECT DESCRIPTION

The site is located along the north and south sides of the Highway 401 from west of Wilson Road South to Harmony Road South in Oshawa, Ontario, a distance of approximately 1 km. The scope of work for this foundation investigation is describe in Work Order #8 issued by MTO. The terrain along the proposed noise barrier wall alignment is rolling, with ground surface varying between about Elevation 84 m and Elevation 99 m, referenced to geodetic datum.

### 3.0 INVESTIGATION PROCEDURES

The field work for this investigation was carried out from April 30 to May 8, 2013, at which time thirty-three (33) boreholes (BH1 to BH33) were advanced at the locations shown on the Borehole Location Plan, Drawing 1.

Twelve (12) boreholes were located along the south side of Highway 401 and advanced to depths ranging from about 4.8 m to 8.1 m below the existing ground surface. Twenty-one (21) boreholes were drilled along the north side of Highway 401 and advanced to depths ranging from about 4.9 m to 6.6 m. Twenty-four (24) boreholes were drilled through existing pavement structure and the measured thicknesses of asphalt, granular base and granular subbase are shown on the attached Record of Borehole sheets. Six (6) pavement cores were taken from the boreholes drilled through existing pavement structure.

The borehole investigation was carried out using CME 75 truck-mounted and CME 55 track-mounted drill rigs supplied and operated by Strong Soil Search Inc., a specialist drilling contractor subcontracted to Golder. The boreholes were advanced through the overburden using 121 mm outer diameter (O.D.) continuous flight solid-stem augers. Soil samples were obtained at intervals of depth of about 0.75 m and 1.5 m, using a 50 mm outer diameter split-spoon sampler driven by an automatic hammer in accordance with Standard Penetration Test (SPT) procedures (ASTM D1586 – Standard Test Method for Standard Penetration Test).

The shallow groundwater conditions were noted in open boreholes during and upon completion of drilling. All boreholes were backfilled to the ground surface upon completion of the drilling operation using bentonite pellets,



## GEOTECHNICAL INVESTIGATION, PROPOSED NOISE BARRIER WALL, OSHAWA, ONTARIO

in accordance with Ontario Regulation 903, Wells (as amended). The upper 1.3 m portion of each borehole above the bentonite backfill was capped using soil cuttings from the borehole, the boreholes located within paved areas on Highway 401 were patched at the surface with cold mix asphalt.

The field work for this investigation was observed by members of our engineering staff who arranged underground service locates, observed the drilling and sampling operations, logged the boreholes and cared for the soil samples. The soil samples were identified in the field, placed in appropriate containers, labelled and transported to our Whitby geotechnical laboratory for further examination, natural water content testing and selected classification testing (i.e. water content, sieve and hydrometer and Atterberg limits).

The borehole locations were staked in the field by Golder as close as possible to the proposed noise barrier walls. The corresponding ground surface elevations and coordinates of the boreholes were obtained from the Global Positioning System (GPS). Since the elevations and coordinates were not surveyed by a professional surveyor, they should be considered to be approximate. The borehole locations in MTM NAD83 northing and easting coordinates and the ground surface elevations (referenced to geodetic datum) are summarized in Table 1. The MTM NAD83 coordinates and ground surface elevations are also presented on Record of Borehole sheets and on Drawings 1, 2A, 2B and 2C.

**Table 1 – Borehole Coordinates and Elevation**

<b>Borehole Location</b>	<b>Borehole Number</b>	<b>Northing (m)</b>	<b>Easting (m)</b>	<b>Ground Surface Elevation (m)</b>
<b>South of Highway 401</b>	BH1	4,860,782.2	357,899.1	99.0
	BH2	4,860,803.9	357,929.3	95.7
	BH3	4,860,818.3	357,974.7	96.0
	BH4	4,860,833.1	358,024.4	94.7
	BH5	4,860,846.4	358,078.5	93.6
	BH6	4,860,869.4	358,127.6	94.4
	BH7	4,860,882.6	358,170.5	93.2
	BH8	4,860,895.0	358,213.2	92.8
	BH9	4,860,906.7	358,256.2	92.0
	BH10	4,860,917.7	358,317.8	92.8
	BH11	4,860,923.1	358,370.6	89.1
<b>North of Highway 401</b>	BH12	4,860,923.2	358,425.3	88.6
	BH13	4,860,835.0	357,916.1	96.1
	BH14	4,860,851.2	357,963.7	94.4
	BH15	4,860,866.9	358,010.9	95.1
	BH16	4,860,881.4	358,058.7	94.9
	BH17	4,860,900.3	358,114.4	94.6
	BH18	4,860,922.3	358,183.1	93.2
	BH19	4,860,931.4	358,213.0	94.0
	BH20	4,860,945.7	358,263.0	91.9
	BH21	4,860,957.6	358,310.9	89.8
	BH22	4,860,970.5	358,364.5	89.9
	BH23	4,860,980.1	358,408.8	89.0
	BH24	4,860,989.1	358,454.4	88.4
	BH25	4,860,997.2	358,498.2	88.2
	BH26	4,861,007.2	358,555.8	85.9
	BH27	4,861,014.6	358,611.2	85.1



Borehole Location	Borehole Number	Northing (m)	Easting (m)	Ground Surface Elevation (m)
	BH28	4,861,019.9	358,652.2	84.2
	BH29	4,861,044.2	358,696.6	90.3
	BH30	4,861,074.5	358,718.6	89.6
	BH31	4,861,103.4	358,746.4	88.7
	BH32	4,861,120.1	358,768.5	88.9
	BH33	4,861,155.5	358,827.1	86.5

## 4.0 GENERAL SITE GEOLOGY AND STRATIGRAPHY

### 4.1 Regional Geological Conditions

The study area for this assignment lies within the physiographic region of Southern Ontario known as the Iroquois Plain. Physiographic mapping in the immediate vicinity indicates that the site lies near the border of clay and till plains (Map 2226, Chapman and Putnam, 1984). This is generally consistent with the results of this investigation which indicate variable lacustrine surficial soil deposits underlain by strata of glacial till and till-like materials.

### 4.2 Site Stratigraphy

The borehole locations, ground surface elevations and interpreted stratigraphic conditions at the site are shown on Drawings 1, 2A, 2B and 2C. The detailed subsurface soil and groundwater conditions encountered in the boreholes, together with the results of geotechnical laboratory tests carried out on selected soil samples, are given on the Record of Borehole sheets included in Appendix A and on Figures B1 to B4 included in Appendix B. Also contained in Appendix A, are Lists of Abbreviation and Symbols to assist in the interpretation of the Record of Borehole sheets. The results of the in situ field tests (i.e. SPT 'N'-values and undrained shear strengths from field vanes) as presented on the Record of Borehole sheets and in Section 4 are uncorrected. The stratigraphic boundaries shown on the Record of Borehole sheets are inferred from non-continuous sampling, observations of drilling progress and the results of geotechnical in situ and laboratory tests. These boundaries, therefore, represent transitions between soil types rather than exact planes of geological change. Subsoil conditions will vary between and beyond the borehole locations.

#### 4.2.1 Overview

In summary, underlying topsoil or pavement structure, fill materials were encountered in all boreholes and extended to depths ranging from 1.4 m to 5.2 m below the ground surface. The native subsoils encountered below the fill materials or topsoil generally consisted of clayey silt to silty clay and glacial tills ranging in gradation from sandy silt till to silty sand till to clayey silt till.

A more detailed description of the subsurface conditions encountered in the boreholes is provided in the following sections.

#### 4.2.2 Topsoil

Approximately 0.1 m to 0.2 m of topsoil was encountered at the ground surface in Boreholes BH1 to BH5, BH10 to BH12 and BH33.



### 4.2.3 Pavement Structure

The existing pavement structure was encountered in the boreholes located within the paved asphalt shoulder along Highway 401, as summarized in Table 2.

In addition to the pavement structure measurements at the borehole locations, six pavement cores were recovered, three on each side of the Highway 401. The thickness of the asphalt in the cores ranges between 105 mm and 145 mm.

**Table 2 – Thickness of Pavement Structure**

<b>Borehole No.</b>	<b>Approximate Ground Surface Elevation (m)</b>	<b>Asphalt (mm)</b>	<b>Granular Base/Subbase (mm)</b>
BH6	94.4	140	190/590
BH7	93.2	140	230/700
BH8	92.8	130	200/740
BH9	92.0	120	260/690
BH13	96.1	150	340/500
BH14	94.4	120	370/530
BH15	95.1	135	385/390
BH16	94.9	145	255/590
BH17	94.6	120	180/840
BH18	93.2	180	380/510
BH19	94.0	150	360/560
BH20	91.9	115	395/610
BH21	89.8	110	330/550
BH22	89.9	115	355/600
BH23	89.0	120	410/610
BH24	88.4	100	370/670
BH25	88.2	100	350/650
BH26	85.9	175	345/550
BH27	85.1	140	320/610
BH28	84.2	160	370/480
BH29	90.3	150	290/630
BH30	89.6	100	320/340
BH31	88.7	130	310/320
BH32	88.9	120	380/670

### 4.2.4 Cohesionless Fill

A deposit of cohesionless fill comprised of black to brown to grey sandy silt, silt and sand and silty sand was encountered in all boreholes except Boreholes BH5, BH10, BH32 and BH33. The cohesionless fill deposit generally contains trace to some gravel, trace to some clay, trace organics with cobbles and boulders. The surface of the cohesionless fill deposit was encountered between about Elevation 98.8 m to Elevation 78.4 m at the borehole locations and the thickness of the cohesionless fill ranges from about 0.3 m to 4.1 m.

The SPT 'N'-values measured within the cohesionless fill deposit range from 3 blows to 57 blows per 0.3 m of penetration, but are generally greater than 10 blows per 0.3 m penetration, indicating a very loose to very dense





but generally compact to very dense relative density. SPT 'N'-values as high as 85 blows per 0.1 m of penetration were recorded at the boundary of the granular subbase and the cohesionless fill.

The natural water content measured on six (6) samples of the cohesionless fill ranged from about 7 per cent to 16 per cent.

The results of grain size distribution tests completed on three (3) samples of the cohesionless fill are shown on Figure B1, in Appendix B.

### 4.2.5 Cohesive Fill

A deposit of cohesive fill comprised of black to grey to brown clayey silt to silty clay was encountered in Boreholes BH2, BH4, BH5, BH7 to BH10, BH15 to BH17, BH19, BH20, BH24 and BH27 to BH33. The cohesive fill deposit generally contains trace to some gravel, trace to some sand and trace organics. The surface of the cohesive fill was encountered between about Elevation 94.3 m to Elevation 80.8 m at the borehole locations and the thickness of the deposit ranges from about 0.3 m to 2.0 m.

The SPT 'N'-values measured within the cohesive fill range from 4 blows to 26 blows per 0.3 m of penetration, but are generally below 18 blows per 0.3 m of penetration, suggesting a soft to very stiff consistency. SPT 'N'-values as high as 25 blows per 0.3 m of penetration were recorded at the boundary of the granular subbase and the cohesive fill deposit.

The natural water content measured on one (1) sample of the cohesive fill is about 37 per cent.

### 4.2.6 Clayey Silt to Silty Clay

A deposit of native clayey silt to silty clay was encountered in Boreholes BH4, BH6 to BH10, BH14 to BH16, BH18 to BH21, BH24 to BH30 and BH33 underlying the fill deposits and in Borehole BH3 within the cohesive till deposit. The surface of the deposit was encountered between about Elevation 92.6 m to Elevation 79.6 m at the borehole locations and the thickness of the deposit ranges from about 0.4 m to 4.5 m.

The SPT 'N'-values measured within this deposit range from 2 blows to 36 blows per 0.3 m of penetration. Four in situ field vane tests carried out within this deposit measured undrained shear strength ranging from about 19 kPa to 46 kPa and the sensitivity ranged from about 3 to 5. The overall data indicate that the consistency of the clayey silt to silty clay deposit varies from soft to hard, but is predominantly firm to very stiff.

The natural water content measured on nine (9) samples of the clayey silt to silty clay ranges from about 19 per cent to 36 percent.

The results of grain size distribution tests completed on five (5) samples of this deposit are shown on Figure B2, in Appendix B.

Atterberg limits tests were carried out on eight (8) samples of silty clay to clayey silt and measured liquid limits ranging from about 32 per cent to 42 per cent, plastic limits ranging from about 17 per cent to 19 per cent and plasticity indices ranging from about 15 per cent to 23 per cent. The results of the Atterberg limits tests are shown on the plasticity chart on Figure B3 in Appendix B, and indicate that the material is classified as clayey silt of low plasticity to silty clay of intermediate plasticity.

### 4.2.7 Sandy Silt to Silty Sand Till

Sandy silt to silt and sand to silty sand till containing trace to some clay, trace to some gravel was encountered in Boreholes BH3, BH6, BH11, BH12, BH17, BH22 to BH24 and BH31 to BH33. Cobbles and boulders were



encountered within this till deposit, as evidenced by auger grinding during drilling. The surface of the sandy silt to silty sand till was encountered between Elevation 90.6 m and Elevation 77.2 m at the borehole locations and the thickness of the sandy silt to silty sand till ranges from about 0.9 m to 3.9 m.

The SPT 'N'-values measured within the sandy silt to silt sand till range from 18 blows to 80 blows per 0.3 m of penetration, indicating a compact to very dense relative density.

The natural water content measured on a sample of the deposit is about 8 per cent.

The result of grain size distribution test completed on a sample of this deposit is shown on Figure B4, in Appendix B.

### 4.2.8 Clayey Silt Till

A deposit of brown to grey clayey silt till containing trace to some sand, trace to some gravel was encountered in Boreholes BH1, BH2, BH4, BH5, BH10, BH13 and BH33 underlying various deposits as described above. In Borehole BH3, an approximately 2.5 m thick layer of clayey silt till was encountered overlying the silty clay deposit. The surface of the cohesive till deposit was encountered between about Elevation 96.9 m to Elevation 76.1 m at the borehole locations. All the boreholes except Borehole BH3 were terminated within this layer, penetrating it to depths ranging from about 0.1 m to 2.9 m. Although, cobbles and boulders were not encountered in these boreholes, till deposits are known to contain cobbles and boulders.

The SPT 'N'-values measured within the clayey silt till ranged from 10 blows to 62 blows per 0.3 m of penetration, suggesting a firm to hard consistency. The SPT 'N'-values of 50 blows per 0.08 m to 0.15 m of penetration measured in Borehole BH1 may indicate the presence of cobbles and boulders within the clayey silt till.

### 4.3 Shallow Groundwater

In general, the soil samples taken in the boreholes were moist to wet. Boreholes BH1, BH5 to BH11, BH17 to BH20, BH22, BH24, BH25, BH27, BH29 to BH33 were dry upon completion of drilling. The ground water levels measured in open Boreholes BH2 to BH4, BH12 to BH16, BH21, BH23 and BH28 upon completion of drilling ranged from about Elevation 92.3 m to Elevation 80.5 m, corresponding to depths between about 3.0 m to 4.7 m below ground surface. The ground water level measured in Borehole BH26 during drilling was at about Elevation 81.3 m, corresponding to about 4.6 m below ground surface.



## **5.0 CLOSURE**

This Foundation Investigation Report was prepared by Al Varshoi, M.E.Sc., reviewed by Darrin Sellick, C. Tech. and Ty Garde, P.Eng., a Principal and Designated MTO Contact for Foundations, conducted an independent quality review of the report.

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# **PART B - FOUNDATION DESIGN REPORT**

**NOISE BARRIER WALL**

**HIGHWAY 401 FROM WEST OF WILSON ROAD TO HARMONY ROAD  
OSHAWA, ONTARIO**

**ASSIGNMENT NO.: 2011 - E – 0018**



## **6.0 ENGINEERING RECOMMENDATIONS**

### **6.1 General**

This section of the report provides geotechnical parameters and recommendations for the design of the proposed noise barrier wall approximately 1 km long, to be located along the north and south sides of Highway 401, from west of Wilson Road to Harmony Road. The design parameters and recommendations have been developed based on interpretation of the factual data obtained during subsurface investigations at the site and are intended to provide the designers with geotechnical information to design the proposed noise barrier wall foundations.

Where comments are made on construction, they are provided in order to highlight those aspects that could affect the design of the project, or for which special provisions or operational constraints may be required in the Contract Documents. Those requiring information on aspects of construction should make their own interpretation of the factual information provided as it may affect the equipment selection, proposed construction methods, scheduling and the like.

### **6.2 Noise Barrier Wall Foundation Design**

The noise barrier wall foundations should be designed and constructed in accordance with MTO's Special Provision SP799F01. It is recommended that the noise barrier walls be supported using augered caissons with a diameter ranging from 0.6 m to 0.9 m. Geotechnical parameters for design of the caisson foundations are provided in Table 3, based on the soil conditions encountered in the boreholes advanced along the proposed noise barrier walls. The stratigraphy presented in the following tables has been simplified for the purposes of the noise barrier wall foundation design. The selection of the design parameters has considered the irregularity and non-uniformity of the various soil strata. The stations included in Table 3 are referenced to the noise barrier walls stations provided to Golder by MTO and are approximate.



## GEOTECHNICAL INVESTIGATION, PROPOSED NOISE BARRIER WALL, OSHAWA, ONTARIO

**Table 3: GEOTECHNICAL DESIGN PARAMETERS FOR NOISE BARRIER WALL FOUNDATIONS  
WORK ORDER NO. 9, SOUTH SIDE OF HIGHWAY 401, From West of Wilson Road to Harmony Road**

Location	Approximate Noise Barrier Wall Stations	Borehole No.	Soil Stratum	Elevation (m)	Design Parameters				
					Ground Water Elevation (m)	$c_u$ kPa	$\phi^{**}$	$\gamma$ kN/m	$K_p^{**}$
South of Highway 401	13+000 to 13+025	BH1	Fill (Loose to compact silty sand to sandy silt) Hard clayey silt till	B.W. to 96.9 96.6 – 94.2	Dry	- 50	28° 32°	18 20	2.8 3.2
	13+025 to 13+075	BH2	Fill (Compact silty sand) Fill (Firm clayey silt) Very stiff to hard clayey silt till	B.W. to 94.3 94.3 – 93.6 below 93.6	92	- 25 50	28° 28° 32°	18 18 20	2.8 2.8 3.2
	13+075 to 13+115	BH3	Fill (Compact silty sand) Stiff to very stiff clayey silt till Soft to firm silty clay Compact silt and sand till	B.W. to 93.9 93.9 to 91.4 91.4 to 88.9 Below 88.9	92	- 50 20 -	28° 32° 27° 33°	18 20 18 21	2.8 3.2 2.7 3.4
	13+115 to 13+175	BH4	Fill (Compact silty sand) Fill (Soft clayey silt) Stiff clayey silt Stiff clayey silt till	B.W. to 93.3 93.3 to 92.6 92.6 to 90.7 below 90.7	92	- - 40 50	28° 27° 29° 32°	18 18 19 20	2.8 2.7 2.9 3.2
	13+175 to 13+220	BH5	Fill (Firm clayey silt) Very stiff clayey silt till	B.W. to 91.5 below 91.5	Dry	25 50	28° 32°	18 20	2.8 3.2
	14+000 to 14+025	BH6	Fill (compact to dense silty sand) Very stiff clayey silt Very dense Sandy silt till	B.W. to 91.5 91.5 to 90.4 Below 90.4	Dry	- 40 -	28° 29° 34°	18 19 21	2.8 2.9 3.5
	14+025 to 14+075	BH7	Fill (Stiff clayey silt) Fill (Compact silt and sand) Very stiff clayey silt	B.W. to 91.8 91.8 to 90.3 below 90.3	Dry	25 - 40	28° 28° 29°	18 18 19	2.8 2.8 2.9
	14+075 to 14+120	BH8	Fill (Stiff clayey silt) Fill (Compact to dense silty sand) Stiff clayey silt	B.W. to 91.3 91.3 to 89.9 below 89.9	Dry	25 - 40	28° 28° 29°	18 18 19	2.8 2.8 2.9
	14+120 to 14+170	BH9	Fill (Very stiff clayey silt) Fill (Compact silty sand) Stiff clayey silt	B.W. to 90.6 90.6 to 89.1 Below 89.1	89	30 - 40	28° 28° 29°	18 18 19	2.8 2.8 2.9
	14+170 to 14+230	BH10	Fill (Stiff silty clay) Stiff to very stiff clayey silt Stiff clayey silt till	B.W. to 91.4 91.4 to 87.9 Below 87.9	Dry	25 40 40	28° 29° 32°	18 19 20	2.8 2.9 3.2
	14+230 to 14+275	BH11	Fill (Compact sandy silt) Compact to very dense silty sand till	B.W. to 87.7 Below 87.7	Dry	- -	28° 33°	18 21	2.8 3.4
	14+275 to 14+310	BH12	Fill (Loose to compact sandy silt) Compact to dense silty sand till	B.W. to 86.5 Below 86.5	84	- -	28° 33°	18 21	2.8 3.4
North of Highway 401	11+000 to 11+075	BH13	Fill (Loose silty sand) Stiff to hard clayey silt till	B.W. to 94.0 Below 94.0	92	- 50	28° 32°	18 20	2.8 3.2
	11+075 to 11+130	BH14	Fill (Compact to very dense silty sand) Firm to very stiff silty clay	B.W. to 91.7 Below 91.7	90	- 40	28° 29°	18 19	2.8 2.9
	11+130 to 11+175	BH15	Fill (Compact to dense silty sand) Fill (Firm clayey silt) Stiff silty clay	B.W. to 93.0 93.0 to 92.2 Below 92.2	91	- 25 40	28° 28° 29°	18 18 19	2.8 2.8 2.9
	11+175 to 11+225	BH16	Fill (Dense silty sand) Fill (Very stiff clayey silt) Very stiff to hard silty clay	B.W. to 92.8 92.8 to 92.0 Below 92.0	90	- 30 40	28° 28° 29°	18 18 19	2.8 2.8 2.9



## GEOTECHNICAL INVESTIGATION, PROPOSED NOISE BARRIER WALL, OSHAWA, ONTARIO

North of Highway 401	12+000 to 12+040	BH17	Fill (Compact to very dense silty sand) Fill (Stiff clayey silt) Very dense silty sand till	B.W. to 91.7 91.7 to 90.6 Below 90.6	Dry	- 30 -	28° 28° 34°	18 18 21	2.8 2.8 3.5
	12+040 to 12+085	BH18	Fill (Compact to very dense silty sand) Very stiff silty clay	B.W. to 89.2 Below 89.2	Dry	- 50	28° 29°	18 19	2.8 2.9
	12+085 to 12+130	BH19	Fill (Compact to dense silty sand) Fill (Stiff clayey silt) Stiff silty clay	B.W. to 91.1 91.1 to 90.0 Below 90.0	Dry	- 25 40	28° 28° 29°	18 18 19	2.8 2.8 2.9
	12+130 to 12+175	BH20	Fill (Compact silty sand) Fill (Stiff silty clay) Firm clayey silt	B.W. to 89.0 89.0 to 87.3 Below 87.3	Dry	- 25 30	28° 28° 29°	18 18 19	2.8 2.8 2.9
	12+175 to 12+230	BH21	Fill (Compact to dense silty sand) Stiff to very stiff clayey silt	B.W. to 87.7 Below 87.7	86	- 40	28° 29°	18 19	2.8 2.9
	12+230 to 12+280	BH22	Fill (Compact silty sand) Compact to dense silt and sand till	B.W. 87.0 Below 87.0	Dry	- -	28° 33°	18 21	2.8 3.4
	12+280 to 12+330	BH23	Fill (Dense silty sand) Very dense silt and sand till	B.W. 86.9 Below 86.9	85	- -	28° 34°	19 21	2.8 3.5
	12+330 to 12+375	BH24	Fill (Compact silty sand) Fill (Stiff clayey silt) Very stiff clayey silt Dense sandy silt till	B.W. to 86.1 86.1 to 85.4 85.4 to 84.3 Below 84.3	Dry	- 25 40 -	28° 28° 29° 34°	18 18 19 21	2.8 2.8 2.9 3.5
	12+375 to 12+425	BH25	Fill (Compact to dense silty sand) Firm to hard clayey silt	B.W. to 85.3 Below 85.3	Dry	- 40	28° 29°	18 19	2.8 2.9
	12+425 to 12+480	BH26	Fill (very loose to compact silty sand) Very stiff clayey silt	B.W. to 80.7 Below 80.7	81	- 40	27° 29°	18 19	2.7 2.9
	12+480 to 12+530	BH27	Fill (Compact silty sand) Fill (Stiff clayey silt) Firm to very stiff clayey silt	B.W. to 83.7 83.7 to 83.0 Below 83.0	Dry	- 25 40	28° 28° 29°	18 18 19	2.8 2.8 2.9
	12+530 to 12+580	BH28	Fill (Dense silty sand) Fill (Stiff clayey silt) Firm to stiff clayey silt to silty clay	B.W. to 82.8 82.8 to 82.1 Below 82.1	81	- 25 30	28° 28° 29°	19 18 19	2.8 2.8 2.9
	15+000 to 15+035	BH29	Fill (Compact silty sand) Fill (Firm clayey silt) Very stiff clayey silt	B.W. to 88.1 88.1 to 87.4 Below 87.4	Dry	- 25 40	28° 28° 29°	18 18 19	2.8 2.8 2.9
	15+035 to 15+070	BH30	Fill (Compact sandy silt) Fill (Stiff clayey silt) Very stiff silty clay	B.W. to 88.2 88.2 to 86.7 Below 86.7	Dry	- 25 40	28° 28° 29°	18 18 19	2.8 2.8 2.9
	15+070 to 15+110	BH31	Fill (Compact silty sand) Fill (Stiff to very stiff clayey silt) Dense to very dense silty sand till	B.W. to 87.3 87.3 to 85.8 Below 85.8	Dry	- 30 -	28° 28° 34°	18 18 21	2.8 2.8 3.5
	15+110 to 15+160	BH32	Fill (Very stiff clayey silt) Dense sandy silt till	B.W. to 86.0 Below 86.0	Dry	30 -	28° 34°	18 21	2.8 3.5
	15+160 to 15+220	BH33	Fill (Soft silty clay) Very stiff silty clay Dense sandy silt till Hard clayey silt till	B.W. to 85.1 85.1 to 83.6 83.6 to 82.4 Below 82.4	Dry	10 40 - 50	28° 29° 34° 32°	18 19 21 21	2.8 2.9 3.5 3.2

\* - Consideration has been given to the irregularity and non uniform conditions of the fills;

\*\* -  $K_p$  was determined based on effective internal friction angle  $\phi'$ .



### NOTES:

B.W. = Base of Wall;

$c_u$  = Undrained shear strength of soil (kPa);

$\phi'$  = Effective angle of friction of soil (degrees);

$K_p$  = Passive earth pressure coefficient;

$\gamma$  = Bulk unit weight of soil ( $\text{kN/m}^3$ ); and

$\gamma'$  = Effective unit weight of soil below the groundwater level ( $\text{kN/m}^3$ )

In the design of the foundations, the passive resistance within the upper 1.2 m below ground surface should be neglected to account for frost action. The unfactored lateral resistance should be calculated assuming an equivalent width equal to three times the caisson diameter. A resistance factor of 0.5 should be applied to the unfactored lateral resistance to obtain the factored lateral geotechnical resistance at Ultimate Limit States (ULS).

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

The factored unit weight of soil ( $\gamma'$ ) should be used below the groundwater level, where applicable.

For foundation design, full passive resistance will be mobilized only where the width of soil in front and behind the caissons is equal to or greater than eight caisson diameters. If there is lesser width of soil for development of passive resistance (i.e. if there is sloping ground adjacent to the noise barrier wall), the magnitude of the passive resistance may be determined by interpolating between zero passive resistance at ground surface and full passive resistance at the depth where the slope face is greater than eight caisson diameters away from the face of the caisson.

### 6.3 Construction Considerations

The majority of the boreholes remained open during and upon completion of drilling, however, caving did occur in some of the boreholes as noted on the Record of Borehole sheets.

The caisson excavations for the noise barrier wall foundations will be extended through topsoil as well as cohesive and cohesionless fills into native deposits. Portions of the cohesionless sandy silt to silty sand fills as well as the cohesionless native soils will be water-bearing and these soils may run or flow into the caisson holes during or after drilling for the caisson foundation installation. Therefore, the contractor should utilize appropriate equipment and procedures to minimize ground loss during drilling and concrete placement within the caisson holes.

In addition, the soils at the site are glacially derived and should be expected to contain cobbles and boulders, as inferred from observations during the borehole drilling. Appropriate equipment and procedures will be required to penetrate obstructions (cobbles and boulders) that are encountered during excavation for noise barrier wall foundations.





## GEOTECHNICAL INVESTIGATION, PROPOSED NOISE BARRIER WALL, OSHAWA, ONTARIO

It is recommended that Non-Standard Special Provisions (NSSPs) be included in the Contract Documents to warn the Contractor of these conditions; sample NSSPs are provided in Appendix C.

Prior to pouring concrete for the foundations, the bases should be inspected to confirm that they are located in native, undisturbed and competent bearing stratum, which has been cleaned of any ponded water and loosened materials. Dewatering of the caisson holes may be necessary to permit the placement of the concrete under dry conditions. It is expected that bailer could be used to remove groundwater where temporary liners are installed. Placement of tremie concrete may be considered as an alternative to dewatering.

Concrete for the caisson should be poured as soon as practicable after augering. The bearing soils and fresh concrete must be kept from freezing during cold weather construction.

### 7.0 CLOSURE

This Foundation Investigation Report was prepared by Al Varshoi, M.E.Sc., reviewed by Darrin Sellick, C. Tech. and Ty Garde, P.Eng., a Principal and Designated MTO Contact for Foundations, conducted an independent quality review of the report.

#### GOLDER ASSOCIATES LTD.

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Geotechnical Engineering Group

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Senior Geotechnical Technologist

Ty Garde, P.Eng.  
Designated MTO contact, Principal



AV/DS/TJG/kv

n:\active\\_2011\1184 pavement materials\11-1184-0109 mto 2011-e-0018 central region retainer\assignment #8 - noise barrier wall wilson to harmony\9-report\final\11-1184-0109 ph 8 drt foundation design report.docx

**METRIC**  
DIMENSIONS ARE IN METRES AND/OR  
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STATIONS IN KILOMETRES + METRES.

CONT No. 2011-E-0018  
WP No. 8



BOREHOLE LOCATION PLAN

SHEET



**Golder Associates Ltd.**  
WHITBY, ONTARIO, CANADA



KEY PLAN

SCALE  
500 0 500 1000 m

LEGEND

● Borehole – Current Investigation

BOREHOLE CO-ORDINATES			
No.	ELEVATION	NORTHING	EASTING
BH1	99.0	4860782.2	357899.1
BH2	95.7	4860803.9	357929.3
BH3	96.0	4860818.3	357974.7
BH4	94.7	4860833.1	358024.4
BH5	93.6	4860846.4	358078.5
BH6	94.4	4860869.4	358127.6
BH7	93.2	4860882.6	358170.5
BH8	92.8	4860895.0	358213.2
BH9	92.0	4860906.7	358256.2
BH10	92.8	4860917.7	358317.8
BH11	89.1	4860923.1	358370.6
BH12	88.6	4860923.2	358425.3
BH13	96.1	4860835.0	357916.1
BH14	94.4	4860851.2	357963.7
BH15	95.1	4860866.9	358010.9
BH16	94.9	4860881.4	358058.7
BH17	94.6	4860900.3	358114.4
BH18	93.2	4860922.3	358183.1
BH19	94.0	4860931.4	358213.0
BH20	91.9	4860945.7	358263.0
BH21	89.8	4860957.6	358310.9
BH22	89.9	4860970.5	358364.5
BH23	89.0	4860980.1	358408.8
BH24	88.4	4860989.1	358454.4
BH25	88.2	4860997.2	358498.2
BH26	85.9	4861007.2	358555.8
BH27	85.1	4861014.6	358611.2
BH28	84.2	4861019.9	358652.2
BH29	90.3	4861044.2	358696.6
BH30	89.6	4861074.5	358718.6
BH31	88.7	4861103.4	358746.4
BH32	88.9	4861120.1	358768.5
BH33	86.5	4861155.5	358827.1

NOTES

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REFERENCES

Base plan provided in digital format by MTO, drawing file names: NoiseBarrierI-NCon.dwg, B-4-401-124203m.dwg, B-4-401-124204mc.dwg, received April 15, 2013.



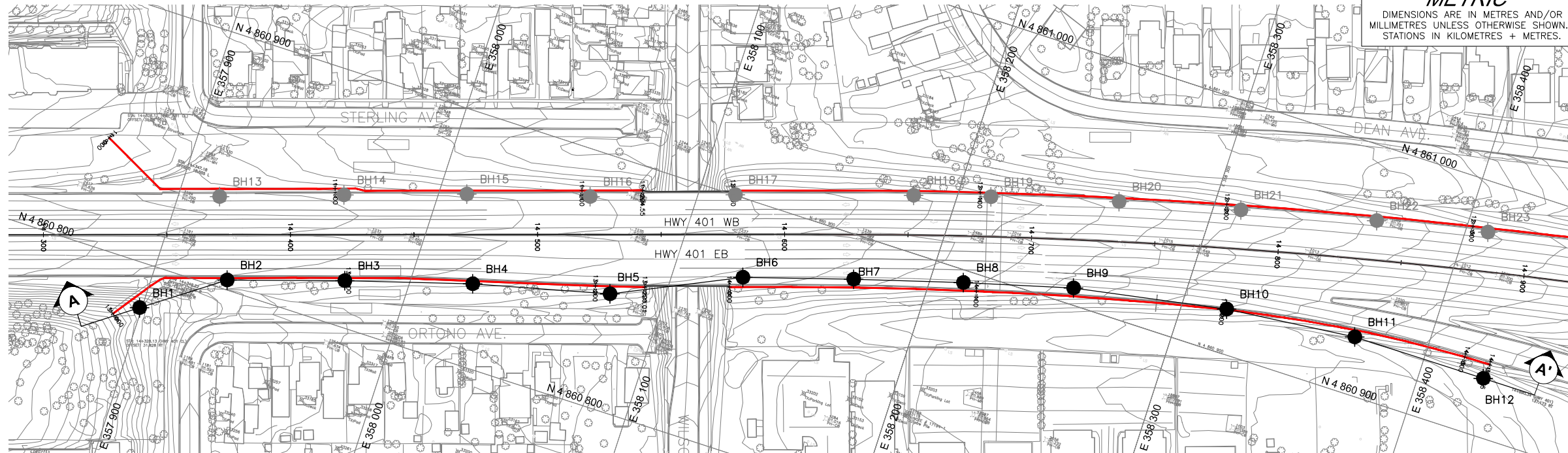
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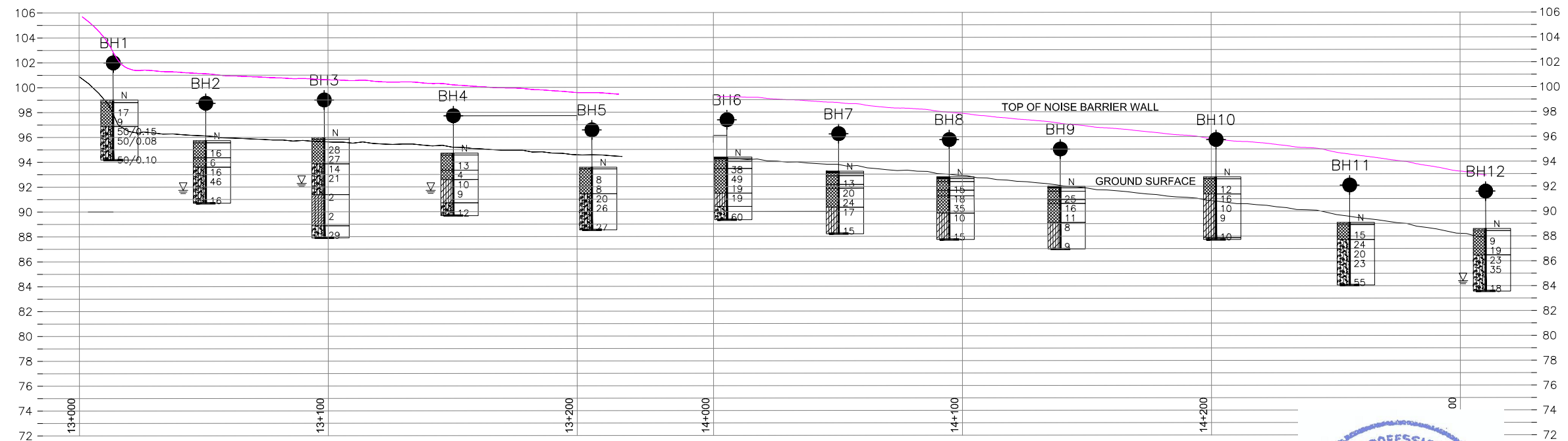
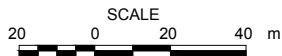
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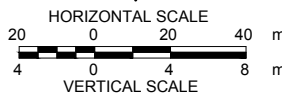




PLAN



SECTION/PROFILE



## METRIC

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

CONT No. 2011-E-0018

WP No. 8

BOREHOLE LOCATIONS AND SOIL STRATA

SHEET



**Golder Associates Ltd.**  
WHITBY, ONTARIO, CANADA



KEY PLAN

SCALE  
500 0 500 1000 m

## LEGEND

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

## BOREHOLE CO-ORDINATES

No.	ELEVATION	NORTHING	EASTING
BH1	99.0	4860782.2	357899.1
BH2	95.7	4860803.9	357929.3
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BH7	93.2	4860882.6	358170.5
BH8	92.8	4860895.0	358213.2
BH9	92.0	4860906.7	358256.2
BH10	92.8	4860917.7	358317.8
BH11	89.1	4860923.1	358370.6
BH12	88.6	4860923.2	358425.3

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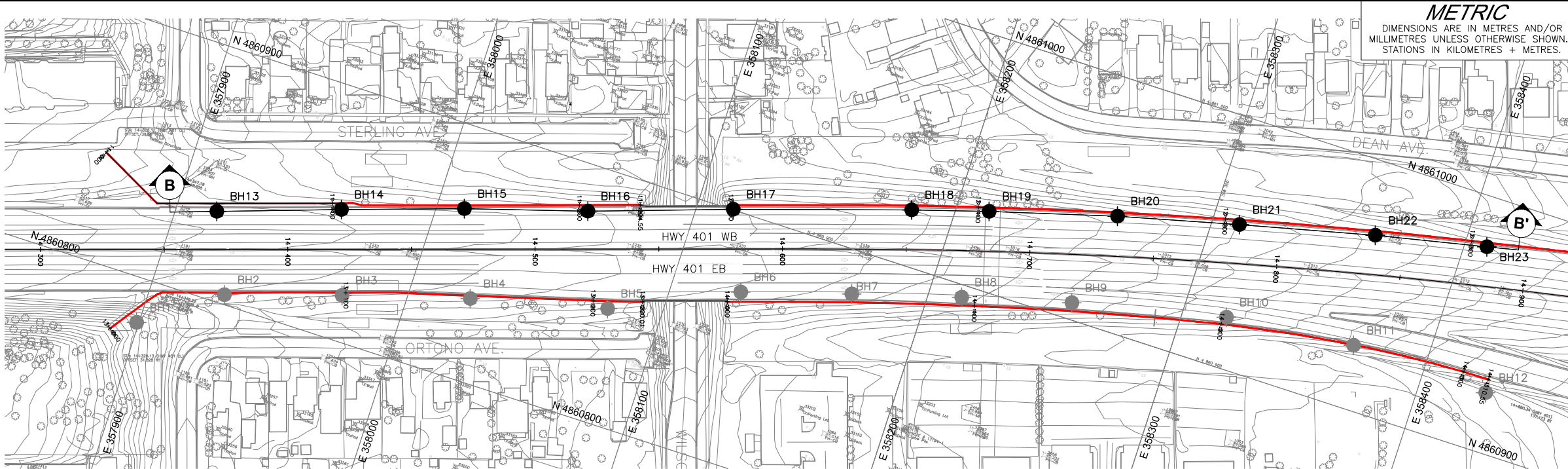
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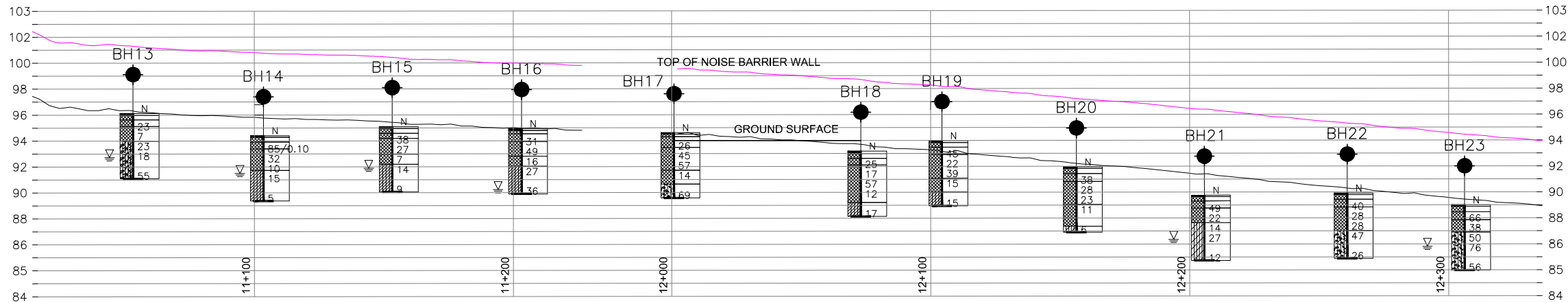
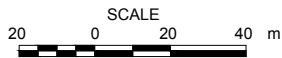


NO.	DATE	BY	REVISION	
Geocres No. 30M15-132				
HWY. 401		PROJECT NO. 11-1184-0109		DIST.
SUBM'D. AV		CHKD. AV	DATE: 6/17/2013	SITE:
DRAWN: GPC		CHKD. AV	APPD. TJG	DWG. 2A

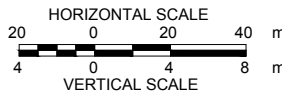




PLAN



SECTION/PROFILE



**METRIC**  
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STATIONS IN KILOMETRES + METRES.

CONT No. 2011-E-0018  
WP No. 8

BOREHOLE LOCATIONS AND SOIL  
STRATA



SHEET



**Golder Associates Ltd.**  
WHITBY, ONTARIO, CANADA



LEGEND

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

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BH13	96.1	4860835.0	357916.1
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BH15	95.1	4860866.9	358010.9
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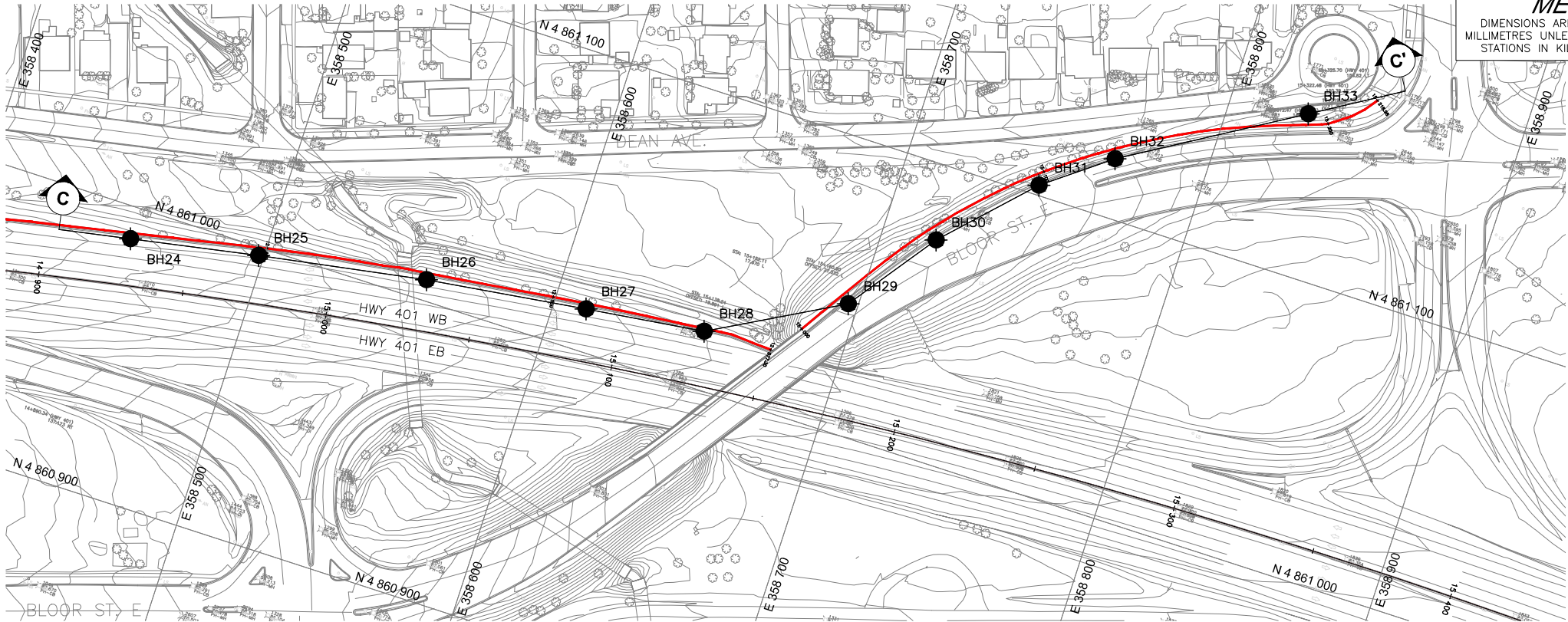
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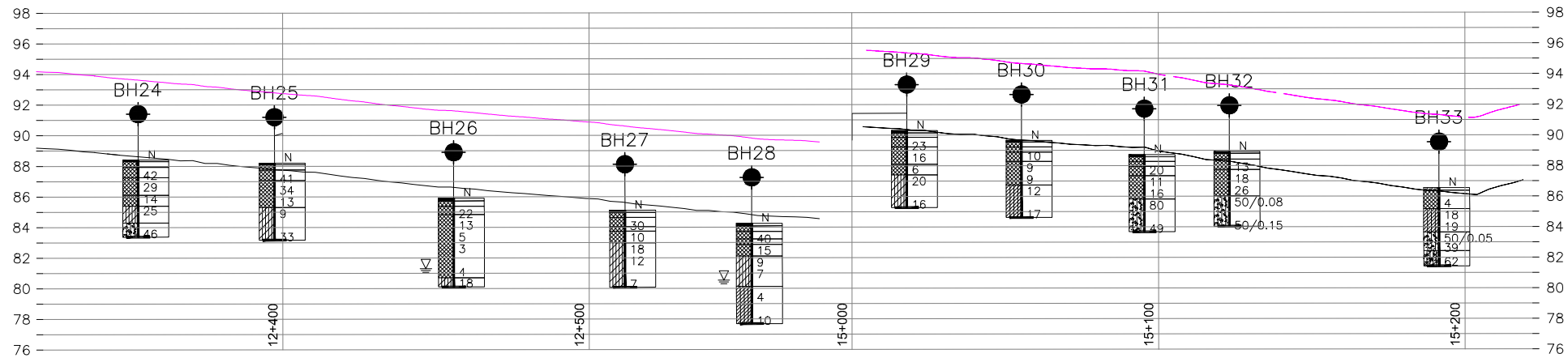
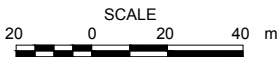


NO.	DATE	BY	REVISION
Geocres No. 30M15-132			
HWY. 401		PROJECT NO. 11-1184-0109	
SUBM'D. AV	CHKD. AV	DATE: 6/17/2013	SITE:
DRAWN: GPC	CHKD. AV	APPD. TJG	DWG. 2B

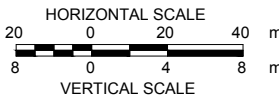




PLAN



SECTION/PROFILE



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CONT No. 2011-E-0018  
WP No. 8



BOREHOLE LOCATIONS AND SOIL  
STRATA

SHEET



**Golder Associates Ltd.**  
WHITBY, ONTARIO, CANADA



KEY PLAN

SCALE  
500 0 500 1000 m

LEGEND

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

BOREHOLE CO-ORDINATES

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BH25	88.2	4860997.2	358498.2
BH26	85.9	4861007.2	358555.8
BH27	85.1	4861014.6	358611.2
BH28	84.2	4861019.9	358652.2
BH29	90.3	4861044.2	358696.6
BH30	89.6	4861074.5	358718.6
BH31	88.7	4861103.4	358746.4
BH32	88.9	4861120.1	358768.5
BH33	86.5	4861155.5	358827.1

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NO.	DATE	BY	REVISION
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HWY. 401		PROJECT NO.	11-1184-0109
SUBM'D. AV	CHKD. AV	DATE: 6/17/2013	SITE:
DRAWN: GPC	CHKD. AV	APPD. TJG	DWG. 2C



# **APPENDIX A**

## **List of Abbreviations and Symbols Record of Borehole Sheets**

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

### III SOIL DESCRIPTION

#### (a) Cohesionless Soils

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

#### (b) Cohesive Soils

Consistency	$c_u, s_u$ kPa	psf
Very soft	0 to 12	0 to 250
Soft	12 to 25	250 to 500
Firm	25 to 50	500 to 1,000
Stiff	50 to 100	1,000 to 2,000
Very stiff	100 to 200	2,000 to 4,000
Hard	over 200	over 4,000

### II PENETRATION RESISTANCE

#### Standard Penetration Resistance (SPT), N:

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

#### Dynamic Penetration Resistance; $N_d$ :

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

**PH:** Sampler advanced by hydraulic pressure

**PM:** Sampler advanced by manual pressure

**WH:** Sampler advanced by static weight of hammer

**WR:** Sampler advanced by weight of sampler and rod

#### Piezo-Cone Penetration Test (CPT):

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

### IV. SOIL TESTS

w	water content
$w_p$	plastic limit
$w_l$	liquid limit
C	consolidation (oedometer) test
CHEM	chemical analysis (refer to text)
CID	consolidated isotropically drained triaxial test <sup>1</sup>
CIU	consolidated isotropically undrained triaxial test with porewater pressure measurement <sup>1</sup>
$D_R$	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 <sub>4</sub>	concentration of water-soluble sulphates
UC	unconfined compression test
UU	unconsolidated undrained triaxial test
V	field vane test (LV-laboratory vane test)
$\gamma$	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

$\pi$	= 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

$\gamma$	shear strain
$\Delta$	change in, e.g. in stress: $\Delta \sigma$
$\varepsilon$	linear strain
$\varepsilon_v$	volumetric strain
$\eta$	coefficient of viscosity
$\nu$	Poisson's ratio
$\sigma$	total stress
$\sigma'$	effective stress ( $\sigma' = \sigma - u$ )
$\sigma'_{vo}$	initial effective overburden stress
$\sigma_1, \sigma_2, \sigma_3$	principal stresses (major, intermediate, minor)
$\sigma_{oct}$	mean stress or octahedral stress $= (\sigma_1 + \sigma_2 + \sigma_3)/3$
$\tau$	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
$\gamma'$	unit weight of submerged soil ( $\gamma' = \gamma - \gamma_w$ )
$D_R$	relative density (specific gravity) of solid particles ( $D_R = \rho_s / \rho_w$ ) (formerly $G_s$ )
$e$	void ratio
$n$	porosity
$S$	degree of saturation
*	Density symbol is $\rho$ . Unit weight symbol is $\gamma$ where $\gamma = \rho g$ (i.e. mass density $\times$ acceleration due to gravity)

### (a) Index Properties (con't.)

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

### (c) 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

### (d) Consolidation (one-dimensional)

$C_c$	compression index (normally consolidated range)
$C_r$	recompression index (overconsolidated 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
$\sigma'_p$	pre-consolidation pressure
OCR	Overconsolidation ratio $= \sigma'_p / \sigma'_{vo}$

### (e) Shear Strength

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

Notes: 1.  $\tau = c' + \sigma' \tan \phi'$

2. Shear strength = (Compressive strength)/2



PROJECT		11-1184-0109(8)		RECORD OF BOREHOLE No BH1		SHEET 1 OF 1		METRIC										
LOCATION		N 4860782.2 ; E 357899.1		ORIGINATED BY		JL												
DIST		Central HWY 401		BOREHOLE TYPE		121 mm O.D. Continuous Flight Solid Stem Augers Auto Hammer		COMPILED BY										
AV		DATE		April 30, 2013		CHECKED BY		TJG										
DATUM		Geodetic																
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT			REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV	DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	SHEAR STRENGTH kPa					WATER CONTENT (%)			γ	GR SA SI CL
								20 40 60 80 100	○ UNCONFINED + FIELD VANE	● QUICK TRIAXIAL × REMOULDED	W <sub>p</sub>	W	W <sub>L</sub>	15 30 45				
99.0		GROUND SURFACE																
0.0		TOPSOIL (200 mm)																
0.2		Silty sand to sandy silt, trace to some clay, trace gravel, trace organics (FILL) Loose to compact Brown Moist		1	SS	17		98										
				2	SS	9		97										
96.9		CLAYEY SILT, some sand, trace to some gravel (TILL) Hard Grey Moist		3	SS	50/0.15		96										
				4	SS	50/0.08		95										
94.2		END OF BOREHOLE		5	SS	50/0.10												
4.8		NOTE: 1. Open borehole dry upon completion of drilling.																

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

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PROJECT		11-1184-0109(8)		RECORD OF BOREHOLE No BH3		SHEET 1 OF 1		METRIC							
LOCATION		N 4860818.3 ; E 357974.7		ORIGINATED BY		JL									
DIST		Central HWY 401		BOREHOLE TYPE		121 mm O.D. Continuous Flight Solid Stem Augers Auto Hammer		COMPILED BY							
AV		DATE		April 30, 2013		CHECKED BY		TJG							
SOIL PROFILE		SAMPLES		GROUND WATER CONDITIONS		ELEVATION SCALE		DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT		UNIT WEIGHT		REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES										
96.0	GROUND SURFACE														
0.0	TOPSOIL (150 mm)														
0.2	Silty sand, some gravel, trace organics (FILL) Compact Brown Moist		1	SS	28										
			2	SS	27										
93.9															
2.1	CLAYEY SILT, some sand, trace to some gravel (TILL) Stiff to very stiff Brown Moist		3	SS	14										
			4	SS	21										
91.4															
4.6	SILTY CLAY, trace to some sand Soft to firm Grey Wet		5	SS	2										
			6	SS	2										
88.9															
7.1	SILT and SAND, some clay, some gravel (TILL) Compact Grey Wet														
			7	SS	29										
87.9															
8.1	END OF BOREHOLE														
NOTES: 1. Water level in open borehole at a depth of 3.7 m below ground surface (Elev. 92.3 m) upon completion of drilling. 2. Borehole caved at a depth of 6.1 m below ground surface (Elev. 89.9 m) upon completion of drilling. 3. An additional borehole was drilled 1.5 m east of Borehole BH3 to carry out in situ field vane at a depth of 6.9 m (Elev. 89.1 m).															

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PROJECT		11-1184-0109(8)		RECORD OF BOREHOLE No BH4		SHEET 1 OF 1		METRIC							
LOCATION		N 4860833.1 ; E 358024.4		ORIGINATED BY		JL									
DIST		Central HWY 401		BOREHOLE TYPE		121 mm O.D. Continuous Flight Solid Stem Augers Auto Hammer		COMPILED BY							
AV		DATE		April 30, 2013		CHECKED BY		TJG							
SOIL PROFILE		SAMPLES		GROUND WATER CONDITIONS		ELEVATION SCALE		DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT		UNIT WEIGHT		REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES										
94.7	GROUND SURFACE														
0.0	TOPSOIL (150 mm)														
0.2	Silty sand, trace gravel, trace organics (FILL) Compact Brown to grey Moist		1	SS	13										
93.3															
1.4	Clayey silt, some sand, trace organics (FILL) Soft Black Moist		2	SS	4										
92.6															
2.1	CLAYEY SILT, trace to some sand Stiff Brown Wet		3	SS	10										
			4	SS	9										
90.7															
4.0	CLAYEY SILT, some sand, trace gravel (TILL) Stiff Brown to grey Wet		5	SS	12										
89.7															
5.0	END OF BOREHOLE														
NOTE: 1. Water level in open borehole at a depth of 3.0 m below ground surface (Elev. 91.7 m) upon completion of drilling.															

PROJECT		11-1184-0109(8)		RECORD OF BOREHOLE No BH5		SHEET 1 OF 1		METRIC							
LOCATION		N 4860846.4 ; E 358078.5		ORIGINATED BY		JL									
DIST		Central HWY 401		BOREHOLE TYPE		121 mm O.D. Continuous Flight Solid Stem Augers Auto Hammer		COMPILED BY							
AV		DATE		April 30, 2013		CHECKED BY		TJG							
SOIL PROFILE		SAMPLES		GROUND WATER CONDITIONS		ELEVATION SCALE		DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT		UNIT WEIGHT		REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES										
93.6	GROUND SURFACE														
0.0	TOPSOIL (140 mm)														
0.1	Clayey silt, some sand, trace gravel, trace organics (FILL) Firm Brown Moist		1	SS	8										
			2	SS	8										
91.5															
2.1	CLAYEY SILT, some sand, trace to some gravel (TILL) Very stiff Brown Moist		3	SS	20										
			4	SS	26										
88.6			5	SS	27										
5.0	END OF BOREHOLE														
	NOTE: 1. Open borehole dry upon completion of drilling.														

PROJECT		11-1184-0109(8)		RECORD OF BOREHOLE No BH6		SHEET 1 OF 1		METRIC							
LOCATION		N 4860869.4 ; E 358127.6		ORIGINATED BY		JL									
DIST		Central HWY 401		BOREHOLE TYPE		121 mm O.D. Continuous Flight Solid Stem Augers Auto Hammer		COMPILED BY							
AV		DATE		May 5, 2013		CHECKED BY		TJG							
SOIL PROFILE		SAMPLES		GROUND WATER CONDITIONS		ELEVATION SCALE		DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT		UNIT WEIGHT		REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES										
94.4	GROUND SURFACE														
0.0	ASPHALT (140 mm)														
0.3	GRANULAR BASE (190 mm)														
0.3	GRANULAR SUBBASE (590 mm)														
93.5			1A												
0.9	Silty sand, trace to some gravel, trace clay, trace organics (FILL) Compact to dense Brown Moist		1B	SS	38										
			2	SS	49										
			3	SS	19										
91.5															
2.9	CLAYEY SILT, some sand, trace organics, containing rootlets Very stiff Brown Moist		4	SS	19										
90.4															
4.0	Sandy SILT, trace clay, trace gravel, trace organics (TILL) Very dense Brown Moist														
			5	SS	60										
89.4															
5.0	END OF BOREHOLE														
	NOTE: 1. Open borehole dry upon completion of drilling.														



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

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PROJECT		RECORD OF BOREHOLE No BH8				SHEET 1 OF 1		METRIC									
11-1184-0109(8)		LOCATION N 4860895.0 ; E 358213.2				ORIGINATED BY JL											
DIST Central HWY 401		BOREHOLE TYPE 121 mm O.D. Continuous Flight Solid Stem Augers Auto Hammer				COMPILED BY AV											
DATUM Geodetic		DATE May 5, 2013				CHECKED BY TJG											
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
92.8	GROUND SURFACE																
0.0	ASPHALT (130 mm)																
	GRANULAR BASE (200 mm)																
0.4	GRANULAR SUBBASE (740 mm)																
91.7			1A	SS	15		92										
1.1	Clayey silt, some sand, trace gravel, trace organics (FILL)		1B														
91.3	Stiff Brown Moist																
1.5	Silty sand to sandy silt, trace clay, trace to some gravel, trace organics (FILL)		2	SS	18		91										
	Compact to dense Brown Moist																
89.9			3	SS	35		90										
2.9	CLAYEY SILT, trace sand, trace gravel		4	SS	10		89										
	Stiff Brown to grey Moist																
87.8			5	SS	15		88										
5.0	END OF BOREHOLE																
NOTE: 1. Open borehole dry upon completion of drilling.																	



PROJECT		11-1184-0109(8)		RECORD OF BOREHOLE No BH9		SHEET 1 OF 1		METRIC							
LOCATION		N 4860906.7 ; E 358256.2		ORIGINATED BY		JL									
DIST		Central HWY 401		BOREHOLE TYPE		121 mm O.D. Continuous Flight Solid Stem Augers Auto Hammer		COMPILED BY							
AV		DATE		May 6, 2013		CHECKED BY		TJG							
SOIL PROFILE		SAMPLES		GROUND WATER CONDITIONS		ELEVATION SCALE		DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT		UNIT WEIGHT		REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV	DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES									
92.0		GROUND SURFACE													
0.0		ASPHALT (120 mm)													
		GRANULAR BASE (260 mm)													
0.4		GRANULAR SUBBASE (690 mm)													
90.9		Clayey silt, some sand, trace gravel, trace organics (FILL) Very stiff Brown Moist  Silty sand, trace clay, trace to some gravel (FILL) Compact Brown Moist to wet		1A	SS	25									
90.6			1B												
1.4			2	SS	16										
			3	SS	11										
89.1			4	SS	8										
2.9		CLAYEY SILT, trace sand, trace gravel Stiff Brown Moist		5	SS	9									
87.0		END OF BOREHOLE													
5.0		NOTE: 1. Open borehole dry upon completion of drilling.													

PROJECT		11-1184-0109(8)		RECORD OF BOREHOLE No BH10		SHEET 1 OF 1		METRIC					
LOCATION		N 4860917.7 ; E 358317.8		ORIGINATED BY		JL							
DIST		Central HWY 401		BOREHOLE TYPE		121 mm O.D. Continuous Flight Solid Stem Augers Auto Hammer		COMPILED BY					
AV		DATE		May 1, 2013		CHECKED BY		TJG					
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC NATURAL LIQUID UNIT REMARKS				
ELEV	DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	20 40 60 80 100	W <sub>p</sub> W W <sub>L</sub>	WATER CONTENT (%)	γ	GR SA SI CL
92.8	0.0	GROUND SURFACE											
0.2		TOPSOIL (150 mm)											
		Silty clay, some sand, trace gravel (FILL)											
		Stiff											
		Brown											
		Moist											
91.4	1.4	CLAYEY SILT, trace sand											
		Stiff to very stiff											
		Brown											
		Moist											
				1	SS	12		92					
				2	SS	16		91					
				3	SS	10		90					
				4	SS	9		89					
				5A	SS	10		88					
				5B									
87.9	5.0	CLAYEY SILT, some sand, trace gravel (TILL)											
		Stiff											
		Grey											
		Moist											
		END OF BOREHOLE											
		NOTE:											
		1. Open borehole dry upon completion of drilling.											

PROJECT		11-1184-0109(8)		RECORD OF BOREHOLE No BH11		SHEET 1 OF 1		METRIC							
LOCATION		N 4860923.1 ; E 358370.6		ORIGINATED BY		JL									
DIST		Central HWY 401		BOREHOLE TYPE		121 mm O.D. Continuous Flight Solid Stem Augers Auto Hammer		COMPILED BY							
AV		DATE		May 1, 2013		CHECKED BY		TJG							
SOIL PROFILE		SAMPLES		GROUND WATER CONDITIONS		ELEVATION SCALE		DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT		UNIT WEIGHT		REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa		W <sub>p</sub> W W <sub>L</sub>		γ		GR SA SI CL	
89.1	GROUND SURFACE							20 40 60 80 100		15 30 45					
0.0	TOPSOIL (170 mm)							20 40 60 80 100		15 30 45					
0.2	Sandy silt, some gravel, trace clay (FILL) Compact Brown Moist		1	SS	15										
87.7															
1.4	Silty SAND, some gravel, trace to some clay (TILL) Compact to very dense Brown Moist		2	SS	24										
			3	SS	20										
			4	SS	23										
	Auger grinding indicating probable cobbles/boulders at a depth of 3.7 m														
84.1			5	SS	55										
5.0	END OF BOREHOLE														
	NOTE: 1. Open borehole dry upon completion of drilling.														

PROJECT		11-1184-0109(8)		RECORD OF BOREHOLE No BH12		SHEET 1 OF 1		METRIC										
LOCATION		N 4860923.2 ; E 358425.3		ORIGINATED BY		JL												
DIST		Central HWY 401		BOREHOLE TYPE		121 mm O.D. Continuous Flight Solid Stem Augers Auto Hammer		COMPILED BY										
AV		DATE		May 1, 2013		CHECKED BY		TJG										
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT			REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV	DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	SHEAR STRENGTH kPa					WATER CONTENT (%)			γ	GR SA SI CL
								20 40 60 80 100	20 40 60 80 100	W <sub>p</sub>	W	W <sub>L</sub>	15 30 45	kN/m <sup>3</sup>				
88.6	0.0	GROUND SURFACE																
	0.2	TOPSOIL (180 mm)																
		Sandy silt, trace gravel, trace organics (FILL)																
		Loose to compact																
		Dark brown to black																
		Moist		1	SS	9		88										
				2	SS	19		87										
86.5	2.1	Silty SAND, trace to some gravel, trace to some clay (TILL)																
		Compact to dense																
		Brown becoming grey below a depth of 4.6 m																
		Moist to wet		3	SS	23		86										
				4	SS	35		85										
				5	SS	18		84										
83.6	5.0	END OF BOREHOLE																
		NOTE:																
		1. Water level in open borehole at a depth of 4.2 m below ground surface (Elev. 84.4 m) upon completion of drilling.																

PROJECT		11-1184-0109(8)		RECORD OF BOREHOLE No BH13		SHEET 1 OF 1		METRIC							
LOCATION		N 4860835.0 ; E 357916.1		ORIGINATED BY		JL									
DIST		Central HWY 401		BOREHOLE TYPE		121 mm O.D. Continuous Flight Solid Stem Augers Auto Hammer		COMPILED BY							
AV		DATE		May 8, 2013		CHECKED BY		TJG							
SOIL PROFILE		SAMPLES		GROUND WATER CONDITIONS		ELEVATION SCALE		DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT		UNIT WEIGHT		REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES										
96.1	GROUND SURFACE														
0.0	ASPHALT (150 mm)														
95.6	GRANULAR BASE (340 mm)														
0.5	GRANULAR SUBBASE (500 mm)														
95.1			1A	SS	23										
1.0	Silty sand, trace to some gravel, trace to some clay (FILL) Loose Brown Moist		1B												
94.0			2	SS	7										
2.1	CLAYEY SILT, some sand, trace to some gravel (TILL) Stiff to hard Brown becoming grey below a depth of 3.0 m Moist to wet		3	SS	23										
			4	SS	18										
			5	SS	55										
91.1	END OF BOREHOLE														
5.0	NOTE: 1. Water level in open borehole at a depth of 4.4 m below ground surface (Elev. 91.7 m) upon completion of drilling.														

PROJECT 11-1184-0109(8)		<b>RECORD OF BOREHOLE No BH14</b>		SHEET 1 OF 1		<b>METRIC</b>															
		LOCATION N 4860851.2 ; E 357963.7				ORIGINATED BY JL															
DIST Central HWY 401		BOREHOLE TYPE 121 mm O.D. Continuous Flight Solid Stem Augers Auto Hammer				COMPILED BY AV															
DATUM Geodetic		DATE May 8, 2013				CHECKED BY TJG															
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT			REMARKS & GRAIN SIZE DISTRIBUTION (%)						
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	SHEAR STRENGTH kPa					WATER CONTENT (%)			γ					
94.4	GROUND SURFACE							20 40 60 80 100	20 40 60 80 100	15 30 45											
0.0	ASPHALT (120 mm)																				
93.9	GRANULAR BASE (370 mm)																				
0.5	GRANULAR SUBBASE (530 mm)																				
93.4			1A	SS	85/0.10																
1.0	Silty sand, some gravel, trace clay, containing cobbles and boulders (FILL) Compact to very dense Brown becoming grey below a depth of 1.5 m Moist		1B																		
			2	SS	32																
91.7			3A	SS	10																
2.7	SILTY CLAY, trace to some sand, trace gravel Firm to very stiff Brown Moist to wet		3B																		
			4	SS	15																
89.4			5	SS	5																
5.0	END OF BOREHOLE																				
	NOTE: 1. Water level in open borehole at a depth of 4.0 m below ground surface (Elev. 90.4 m) upon completion of drilling.																				

PROJECT		11-1184-0109(8)		RECORD OF BOREHOLE No BH15		SHEET 1 OF 1		METRIC							
LOCATION		N 4860866.9 ; E 358010.9		ORIGINATED BY		JL									
DIST		Central HWY 401		BOREHOLE TYPE		121 mm O.D. Continuous Flight Solid Stem Augers Auto Hammer		COMPILED BY							
AV		DATE		May 8, 2013		CHECKED BY		TJG							
SOIL PROFILE		SAMPLES		GROUND WATER CONDITIONS		ELEVATION SCALE		DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT		UNIT WEIGHT		REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES										
95.1	GROUND SURFACE														
0.0	ASPHALT (135 mm)														
94.6	GRANULAR BASE (385 mm)														
94.2	GRANULAR SUBBASE (390 mm)														
0.9	Silty sand, some gravel, trace clay (FILL) Compact to dense Brown Moist		1A 1B	SS	38										
93.0															
2.1	Clayey silt, some sand, trace gravel, trace organics (FILL) Firm Brown to black Moist		2	SS	27										
92.2															
2.9	SILTY CLAY, trace sand, trace gravel Stiff Brown to grey Moist to wet		3	SS	7										
			4	SS	14										
90.1															
5.0	END OF BOREHOLE		5	SS	9										
NOTE: 1. Water level in open borehole at a depth of 4.3 m below ground surface (Elev. 90.8 m) upon completion of drilling.															

PROJECT <u>11-1184-0109(8)</u>	<b>RECORD OF BOREHOLE No BH16</b>	SHEET 1 OF 1	<b>METRIC</b>
LOCATION <u>N 4860881.4 ; E 358058.7</u>		ORIGINATED BY <u>JL</u>	
DIST <u>Central</u> HWY <u>401</u>	BOREHOLE TYPE <u>121 mm O.D. Continuous Flight Solid Stem Augers Auto Hammer</u>	COMPILED BY <u>AV</u>	
DATUM <u>Geodetic</u>	DATE <u>May 7, 2013</u>	CHECKED BY <u>TJG</u>	

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					WATER CONTENT (%)				
94.9	GROUND SURFACE																
0.0	ASPHALT (145 mm)																
0.4	GRANULAR BASE (255 mm)																
	GRANULAR SUBBASE (590 mm)																
93.9			1A	SS	31		94										
1.0	Silty sand, some gravel, containing cobbles and boulders (FILL) Dense Brown Moist		1B														
			2	SS	49		93										
92.8																	
2.1	Clayey silt, trace sand, trace gravel, trace organics (FILL) Very stiff Dark brown Moist		3	SS	16		92										
92.0																	
2.9	SILTY CLAY, trace sand Very stiff to hard Brown Moist to wet		4	SS	27		91										
89.9			5	SS	36		90										
5.0	END OF BOREHOLE																
	NOTE:  1. Water level in open borehole at a depth of 4.7 m below ground surface (Elev. 90.2 m) upon completion of drilling.																

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PROJECT		11-1184-0109(8)		RECORD OF BOREHOLE No BH17		SHEET 1 OF 1		METRIC								
LOCATION		N 4860900.3 ; E 358114.4		ORIGINATED BY		JL										
DIST		Central HWY 401		BOREHOLE TYPE		121 mm O.D. Continuous Flight Solid Stem Augers Auto Hammer		COMPILED BY								
AV		DATE		May 7, 2013		CHECKED BY		TJG								
SOIL PROFILE		SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER			TYPE	"N" VALUES	SHEAR STRENGTH kPa								WATER CONTENT (%)
94.6	GROUND SURFACE															
0.0	ASPHALT (120 mm)															
0.3	GRANULAR BASE (180 mm)															
	GRANULAR SUBBASE (840 mm)															
93.5			1A	SS	26											
1.1	Silty sand, some gravel, trace clay (FILL) Compact to very dense Brown Moist		2	SS	45											
			3	SS	57											
91.7																
2.9	Clayey silt, some sand, trace gravel, trace organics (FILL) Stiff Black Moist		4	SS	14											
90.6																
4.0	Silty SAND, some gravel, trace clay (TILL) Very dense Brown Moist		5	SS	69											
89.6																
5.0	END OF BOREHOLE															
	NOTE: 1. Open borehole dry upon completion of drilling.															

PROJECT		11-1184-0109(8)		RECORD OF BOREHOLE No BH18		SHEET 1 OF 1		METRIC							
LOCATION		N 4860922.3 ; E 358183.1		ORIGINATED BY		JL									
DIST		Central HWY 401		BOREHOLE TYPE		121 mm O.D. Continuous Flight Solid Stem Augers Auto Hammer		COMPILED BY							
AV		DATE		May 7, 2013		CHECKED BY		TJG							
SOIL PROFILE		SAMPLES		GROUND WATER CONDITIONS		ELEVATION SCALE		DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT		UNIT WEIGHT		REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100 SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED 20 40 60 80 100		W <sub>p</sub> — W — W <sub>L</sub> WATER CONTENT (%)		15 30 45 γ kN/m <sup>3</sup>		GR SA SI CL	
93.2	GROUND SURFACE														
0.0	ASPHALT (180 mm)														
92.6	GRANULAR BASE (380 mm)														
0.6	GRANULAR SUBBASE (510 mm)														
92.1	Silty sand, some gravel, trace clay (FILL) Compact to very dense Brown becoming grey below a depth of 2.6 m Moist		1A	SS	25										
1.1			1B												
			2	SS	17										
			3	SS	57										
			4	SS	12										
89.2	SILTY CLAY, trace sand, trace gravel Very stiff Brown Moist														
4.0			5	SS	17										
88.2	END OF BOREHOLE														
5.0	NOTE: 1. Open borehole dry upon completion of drilling.														

PROJECT 11-1184-0109(8)		<b>RECORD OF BOREHOLE No BH19</b>		SHEET 1 OF 1		<b>METRIC</b>														
		LOCATION N 4860931.4 ; E 358213.0		ORIGINATED BY JL																
DIST Central HWY 401		BOREHOLE TYPE 121 mm O.D. Continuous Flight Solid Stem Augers Auto Hammer		COMPILED BY AV																
DATUM Geodetic		DATE May 7, 2013		CHECKED BY TJG																
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT			REMARKS & GRAIN SIZE DISTRIBUTION (%)					
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	SHEAR STRENGTH kPa					WATER CONTENT (%)			γ kN/m³	GR SA SI CL			
								20 40 60 80 100 ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED					W <sub>p</sub> W W <sub>L</sub> 15 30 45							
94.0	GROUND SURFACE																			
0.0	ASPHALT (150 mm)																			
93.5	GRANULAR BASE (360 mm)																			
0.5	GRANULAR SUBBASE (560 mm)																			
92.9			1A	SS	45		93													
1.1	Silty sand, some gravel, trace clay (FILL) Compact to dense Brown Moist		2	SS	22		92													
			3	SS	39		91													
91.1			4	SS	15		90													
2.9	Clayey silt, some sand, trace organics (FILL) Stiff Black to grey Moist		5	SS	15		89													
90.0																				
4.0	SILTY CLAY, trace sand Stiff Brown Moist																			
89.0																				
5.0	END OF BOREHOLE																			
	NOTE: 1. Open borehole dry upon completion of drilling.																			

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PROJECT <u>11-1184-0109(8)</u>	<b>RECORD OF BOREHOLE No BH20</b>	SHEET 1 OF 1	<b>METRIC</b>
LOCATION <u>N 4860945.7 ; E 358263.0</u>		ORIGINATED BY <u>JL</u>	
DIST <u>Central</u> HWY <u>401</u>	BOREHOLE TYPE <u>121 mm O.D. Continuous Flight Solid Stem Augers Auto Hammer</u>	COMPILED BY <u>AV</u>	
DATUM <u>Geodetic</u>	DATE <u>May 7, 2013</u>	CHECKED BY <u>TJG</u>	

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT   NATURAL MOISTURE CONTENT   LIQUID LIMIT			UNIT WEIGHT  γ  kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)  GR   SA   SI   CL			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					w <sub>p</sub>	w	w <sub>L</sub>					
								○ UNCONFINED   + FIELD VANE ● QUICK TRIAXIAL   × REMOULDED												
							20	40	60	80	100									
91.9	GROUND SURFACE																			
0.0	ASPHALT (115 mm)																			
91.4	GRANULAR BASE (395 mm)																			
0.5	GRANULAR SUBBASE (610 mm)																			
90.8			1A 1B	SS	38		91													
1.1	Silty sand, some gravel, trace organics, trace clay (FILL) Compact Brown to grey Moist		2	SS	28		90						○							
	Cobbles encountered at a depth of 1.5 m		3	SS	23															
89.0							89													
2.9	Silty clay, some sand, trace gravel, trace organics (FILL) Stiff Grey Moist		4	SS	11		88													
87.3																				
4.6	CLAYEY SILT, trace sand, trace gravel Firm Brown Moist		5	SS	6		87													
86.9																				
5.0	END OF BOREHOLE																			
	NOTE:  1. Open borehole dry upon completion of drilling.																			

PROJECT		11-1184-0109(8)		RECORD OF BOREHOLE No BH21		SHEET 1 OF 1		METRIC																
LOCATION		N 4860957.6 ; E 358310.9		ORIGINATED BY		JL																		
DIST		Central HWY 401		BOREHOLE TYPE		121 mm O.D. Continuous Flight Solid Stem Augers Auto Hammer		COMPILED BY																
AV		DATE		May 7, 2013		CHECKED BY		TJG																
DATUM		Geodetic																						
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS			ELEVATION SCALE			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT			REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV	DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES																		
89.8		GROUND SURFACE																						
9.0		ASPHALT (110 mm)																						
89.4		GRANULAR BASE (330 mm)																						
0.4		GRANULAR SUBBASE (550 mm)																						
88.8				1A	SS	49																		
1.0		Silty sand, some gravel, trace to some clay (FILL) Compact to dense Brown Moist		1B																				
				2	SS	22																		
87.7																								
2.1		CLAYEY SILT, some sand, trace gravel Stiff to very stiff Brown Moist to wet		3	SS	14																		
				4	SS	27																		
				5	SS	12																		
84.8		END OF BOREHOLE																						
5.0		NOTE:  1. Water level in open borehole at a depth of 4.1 m below ground surface (Elev. 85.7 m) upon completion of drilling.																						

PROJECT		11-1184-0109(8)		RECORD OF BOREHOLE No BH22		SHEET 1 OF 1		METRIC							
LOCATION		N 4860970.5 ; E 358364.5		ORIGINATED BY		JL									
DIST		Central HWY 401		BOREHOLE TYPE		121 mm O.D. Continuous Flight Solid Stem Augers Auto Hammer		COMPILED BY							
AV		DATE		May 7, 2013		CHECKED BY		TJG							
SOIL PROFILE		SAMPLES		GROUND WATER CONDITIONS		ELEVATION SCALE		DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT		UNIT WEIGHT		REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES										
89.9	GROUND SURFACE														
0.0	ASPHALT (115 mm)														
89.4	GRANULAR BASE (355 mm)														
0.5	GRANULAR SUBBASE (600 mm)														
88.8			1A	SS	40										
1.1	Silty sand, some gravel, trace clay (FILL) Compact Brown Moist		1B												
			2	SS	28										
			3	SS	28										
87.0															
2.9	SILT and SAND, some gravel, trace clay, containing cobbles (TILL) Compact to dense Brown Moist		4	SS	47										
84.9			5	SS	26										
5.0	END OF BOREHOLE														
NOTE: 1. Open borehole dry upon completion of drilling.															

PROJECT		11-1184-0109(8)		RECORD OF BOREHOLE No BH23		SHEET 1 OF 1		METRIC																
LOCATION		N 4860980.1 ; E 358408.8		ORIGINATED BY		JL																		
DIST		Central HWY 401		BOREHOLE TYPE		121 mm O.D. Continuous Flight Solid Stem Augers Auto Hammer		COMPILED BY																
AV		DATUM		Geodetic		DATE		May 6, 2013																
CHECKED BY		TJG																						
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS			ELEVATION SCALE			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT			REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV	DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES																		
89.0		GROUND SURFACE																						
0.0		ASPHALT (120 mm)																						
0.1		GRANULAR BASE (410 mm)																						
88.5		GRANULAR SUBBASE (610 mm)																						
0.5																								
87.9				1A	SS	66																		
1.1		Sandy silt, trace to some gravel (FILL) Dense Brown Moist		2	SS	38																		
86.9																								
2.1		SILT and SAND, trace to some clay, trace to some gravel (TILL) Very dense Brown becoming grey below a depth of 4.6 m Moist to wet		3	SS	50																		
				4	SS	76																		
				5	SS	56																		
84.0		END OF BOREHOLE																						
5.0		NOTE:  1. Water level in open borehole at a depth of 4.3 m below ground surface (Elev. 84.7 m) upon completion of drilling.																						

PROJECT		11-1184-0109(8)		RECORD OF BOREHOLE No BH24		SHEET 1 OF 1		METRIC							
LOCATION		N 4860989.1 ; E 358454.4		ORIGINATED BY		JL									
DIST		Central HWY 401		BOREHOLE TYPE		121 mm O.D. Continuous Flight Solid Stem Augers Auto Hammer		COMPILED BY							
AV		DATE		May 6, 2013		CHECKED BY		TJG							
SOIL PROFILE		SAMPLES		GROUND WATER CONDITIONS		ELEVATION SCALE		DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT		UNIT WEIGHT		REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES										
88.4	GROUND SURFACE														
87.9	ASPHALT (100 mm)														
87.9	GRANULAR BASE (370 mm)														
87.3	GRANULAR SUBBASE (670 mm)														
86.1	Silty sand, some gravel (FILL) Compact Brown Moist		1A 1B	SS	42										
85.4	Clayey silt, trace to some sand, trace gravel, trace organics (FILL) Stiff Brown to dark brown Moist		2	SS	29										
84.3	CLAYEY SILT, trace sand, trace gravel Very stiff Brown Moist		3	SS	14										
83.4	SANDY SILT, trace clay, some gravel (TILL) Dense Grey Moist		4	SS	25										
83.4			5	SS	46										
5.0	END OF BOREHOLE  NOTE: 1. Open borehole dry upon completion of drilling.														



PROJECT		11-1184-0109(8)		RECORD OF BOREHOLE No BH25		SHEET 1 OF 1		METRIC							
LOCATION		N 4860997.2 ; E 358498.2		ORIGINATED BY		JL									
DIST		Central HWY 401		BOREHOLE TYPE		121 mm O.D. Continuous Flight Solid Stem Augers Auto Hammer		COMPILED BY							
AV		DATE		May 6, 2013		CHECKED BY		TJG							
SOIL PROFILE		SAMPLES		GROUND WATER CONDITIONS		ELEVATION SCALE		DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT		UNIT WEIGHT		REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES										
88.2	GROUND SURFACE														
0.0	ASPHALT (100 mm)														
87.8	GRANULAR BASE (350 mm)														
0.5	GRANULAR SUBBASE (650 mm)														
87.1			1A	SS	41										
1.1	Silty sand, trace to some gravel, trace to some clay, trace organics (FILL) Compact to dense Brown Moist		2	SS	34										
			3	SS	13										
85.3			4	SS	9										
2.9	CLAYEY SILT, trace to some sand, trace gravel Firm to hard Brown and grey Moist		5	SS	33										
83.2	END OF BOREHOLE														
5.0	NOTE: 1. Open borehole dry upon completion of drilling.														

PROJECT		11-1184-0109(8)		RECORD OF BOREHOLE No BH26		SHEET 1 OF 1		METRIC							
LOCATION		N 4861007.2 ; E 358555.8		ORIGINATED BY		JL									
DIST		Central HWY 401		BOREHOLE TYPE		121 mm O.D. Continuous Flight Solid Stem Augers Auto Hammer		COMPILED BY							
AV		DATE		May 7, 2013		CHECKED BY		TJG							
SOIL PROFILE		SAMPLES		GROUND WATER CONDITIONS		ELEVATION SCALE		DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT		UNIT WEIGHT		REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES										
85.9	GROUND SURFACE														
0.0	ASPHALT (175 mm)														
85.4	GRANULAR BASE (345 mm)														
0.5	GRANULAR SUBBASE (550 mm)														
84.8			1A	SS	22										
1.1	Silt and sand, trace to some clay, trace gravel, some organics (FILL) Very loose to compact Brown to dark brown Moist to wet		1B												
			2	SS	13										
			3	SS	5										
			4	SS	3										
			5	SS	4										
80.7			6	SS	18										
5.2	CLAYEY SILT, trace sand, trace gravel Very stiff Grey Wet														
80.1															
5.8	END OF BOREHOLE														
NOTES: 1. Water level in open borehole at a depth of 4.6 m below ground surface (Elev. 81.3 m) during drilling. 2. Borehole caved at a depth of 3.7 m below ground surface (Elev. 82.2 m) upon completion of drilling.															

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity      ○<sup>3%</sup> STRAIN AT FAILURE

PROJECT		11-1184-0109(8)		RECORD OF BOREHOLE No BH28		SHEET 1 OF 1		METRIC							
LOCATION		N 4861019.9 ; E 358652.2		ORIGINATED BY		JL									
DIST		Central HWY 401		BOREHOLE TYPE		121 mm O.D. Continuous Flight Solid Stem Augers Auto Hammer		COMPILED BY							
AV		DATE		May 7, 2013		CHECKED BY		TJG							
SOIL PROFILE		SAMPLES		GROUND WATER CONDITIONS		ELEVATION SCALE		DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT		UNIT WEIGHT		REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES										
84.2	GROUND SURFACE														
0.0	ASPHALT (160 mm)														
83.7	GRANULAR BASE (370 mm)														
0.5	GRANULAR SUBBASE (480 mm)														
83.2	Silty sand, some gravel (FILL)		1A	SS	40										
82.8	Dense Brown Moist		1B												
1.4	Clayey silt, some sand, trace gravel (FILL)		2	SS	15										
82.1	Stiff Brown Moist														
2.1	CLAYEY SILT, trace to some sand, trace gravel Firm to stiff Brown Moist		3	SS	9										
			4	SS	7										
80.1	SILTY CLAY, some sand, trace gravel Firm Grey Moist to wet		5	SS	4										
4.1															
77.7	END OF BOREHOLE		6	SS	10										
6.6	NOTE: 1. Water level in open borehole at a depth of 3.7 m below ground surface (Elev. 80.5 m) upon completion of drilling.														

PROJECT		11-1184-0109(8)		RECORD OF BOREHOLE No BH29		SHEET 1 OF 1		METRIC			
LOCATION		N 4861044.2 ; E 358696.6		ORIGINATED BY		JL					
DIST		Central HWY 401		BOREHOLE TYPE		121 mm O.D. Continuous Flight Solid Stem Augers Auto Hammer		COMPILED BY			
AV		DATE		May 8, 2013		CHECKED BY		TJG			
SOIL PROFILE		SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT		UNIT WEIGHT $\gamma$	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER			TYPE	"N" VALUES	20 40 60 80 100	20 40 60 80 100		
90.3	GROUND SURFACE										
0.0	ASPHALT (150 mm)										
89.9	GRANULAR BASE (290 mm)										
0.4	GRANULAR SUBBASE (630 mm)										
89.2			1A	SS	23						
1.1	Silty sand, some clay, trace gravel (FILL) Compact Brown Moist		1B								
88.1			2	SS	16						
2.2	Clayey silt, some sand, trace gravel, trace organics (FILL) Firm Black Moist		3	SS	6						
87.4			4	SS	20						
2.9	CLAYEY SILT, some sand, trace to some gravel Very stiff Brown Moist										
85.3			5	SS	16						
5.0	END OF BOREHOLE										
NOTE: 1. Open borehole dry upon completion of drilling.											

PROJECT <u>11-1184-0109(8)</u>		<b>RECORD OF BOREHOLE No BH30</b>		SHEET 1 OF 1		<b>METRIC</b>															
		LOCATION <u>N 4861074.5 ; E 358718.6</u>				ORIGINATED BY <u>JL</u>															
DIST <u>Central</u> HWY <u>401</u>		BOREHOLE TYPE <u>121 mm O.D. Continuous Flight Solid Stem Augers Auto Hammer</u>				COMPILED BY <u>AV</u>															
DATUM <u>Geodetic</u>		DATE <u>May 8, 2013</u>				CHECKED BY <u>TJG</u>															
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT			REMARKS & GRAIN SIZE DISTRIBUTION (%)						
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	SHEAR STRENGTH kPa					WATER CONTENT (%)			γ					
								20 40 60 80 100	20 40 60 80 100	W <sub>p</sub>	W	W <sub>L</sub>	15 30 45								
89.6	GROUND SURFACE																				
0.0	ASPHALT (100 mm)																				
89.2	GRANULAR BASE (320 mm)																				
88.8	GRANULAR SUBBASE (340 mm)																				
0.8	Sandy silt, some gravel, some clay (FILL) Compact Brown Moist		1	SS	10		89														
88.2	Clayey silt, some sand, trace to some gravel (FILL) Stiff Dark brown Moist		2	SS	9		88														
1.4			3	SS	9		87														
86.7																					
2.9	SILTY CLAY, trace sand Very stiff Brown Moist		4	SS	12		86														
84.6			5	SS	17		85														
5.0	END OF BOREHOLE																				
	NOTE: 1. Open borehole dry upon completion of drilling.																				

PROJECT		11-1184-0109(8)		RECORD OF BOREHOLE No BH31		SHEET 1 OF 1		METRIC								
LOCATION		N 4861103.4 ; E 358746.4		ORIGINATED BY		JL										
DIST		Central HWY 401		BOREHOLE TYPE		121 mm O.D. Continuous Flight Solid Stem Augers Auto Hammer		COMPILED BY								
AV		DATE		May 8, 2013		CHECKED BY		TJG								
SOIL PROFILE		SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER			TYPE	"N" VALUES	SHEAR STRENGTH kPa								WATER CONTENT (%)
88.7	GROUND SURFACE															
0.0	ASPHALT (130 mm)															
88.3	GRANULAR BASE (310 mm)															
87.9	GRANULAR SUBBASE (320 mm)															
0.8	Sandy silt, some gravel, trace clay (FILL) Compact Dark brown Moist		1	SS	20											
87.3	Clayey silt, some sand, trace gravel, trace organics (FILL) Stiff to very stiff Brown to black Moist		2	SS	11											
1.4			3	SS	16											
85.8	Silty SAND, some gravel, trace to some clay (TILL) Dense to very dense Brown Moist		4	SS	80											
2.9	Auger grinding indicating cobbles/boulders encountered below a depth of 3.5 m		5	SS	49											
83.7	END OF BOREHOLE															
5.0	NOTE: 1. Open borehole dry upon completion of drilling.															

PROJECT		11-1184-0109(8)		RECORD OF BOREHOLE No BH32		SHEET 1 OF 1		METRIC																					
LOCATION		N 4861120.1 ; E 358768.5		ORIGINATED BY		JL																							
DIST		Central HWY 401		BOREHOLE TYPE		121 mm O.D. Continuous Flight Solid Stem Augers Auto Hammer		COMPILED BY																					
AV		DATE		May 8, 2013		CHECKED BY		TJG																					
DATUM		Geodetic																											
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS			ELEVATION SCALE			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			SHEAR STRENGTH kPa			WATER CONTENT (%)			UNIT WEIGHT			REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV	DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES																							
88.9		GROUND SURFACE																											
0.0		ASPHALT (120 mm)																											
88.4		GRANULAR BASE (380 mm)																											
0.5		GRANULAR SUBBASE (670 mm)																											
87.7				1A	SS	13																							
1.2		Clayey silt, some sand, some gravel (FILL) Very stiff Brown Moist		2	SS	18																							
				3	SS	26																							
86.0																													
2.9		Sandy SILT, some gravel, trace to some clay (TILL) Dense Dark brown Moist		4	SS	50/0.08																							
		Auger grinding indicating cobbles encountered below a depth of 3.2 m																											
84.0				5	SS	50/0.15																							
4.9		END OF BOREHOLE																											
		NOTE: 1. Open borehole dry upon completion of drilling.																											



PROJECT		11-1184-0109(8)		RECORD OF BOREHOLE No BH33		SHEET 1 OF 1		METRIC										
LOCATION		N 4861155.5 ; E 358827.1		ORIGINATED BY		JL												
DIST		Central HWY 401		BOREHOLE TYPE		121 mm O.D. Continuous Flight Solid Stem Augers Auto Hammer		COMPILED BY										
AV		DATE		May 1, 2013		CHECKED BY		TJG										
DATUM		Geodetic																
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT			REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV	DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	SHEAR STRENGTH kPa					WATER CONTENT (%)			γ	GR SA SI CL
								20 40 60 80 100	○ UNCONFINED + FIELD VANE	● QUICK TRIAXIAL × REMOULDED	W <sub>p</sub>	W	W <sub>L</sub>	15 30 45				
86.5	0.0	GROUND SURFACE																
	0.2	TOPSOIL (170 mm)																
		Silty clay, some sand, trace gravel (FILL)																
		Soft																
		Brown																
		Moist																
85.1	1.4	SILTY CLAY, some sand, trace gravel																
		Very stiff																
		Brown																
		Moist																
				2	SS	18												
				3	SS	19												
83.6	2.9	SANDY SILT, some clay, some gravel (TILL)																
		Dense																
		Brown																
		Moist																
		Cobbles encountered below a depth of 3.4 m																
				4	SS	50/0.05												
82.4	4.1	CLAYEY SILT, some sand, some gravel (TILL)																
		Hard																
		Brown																
		Moist																
				5	SS	39												
81.4	5.1	AUGER REFUSAL ON INFERRED BOULDER END OF BOREHOLE																
		NOTE:																
		1. Open borehole dry upon completion of drilling.																



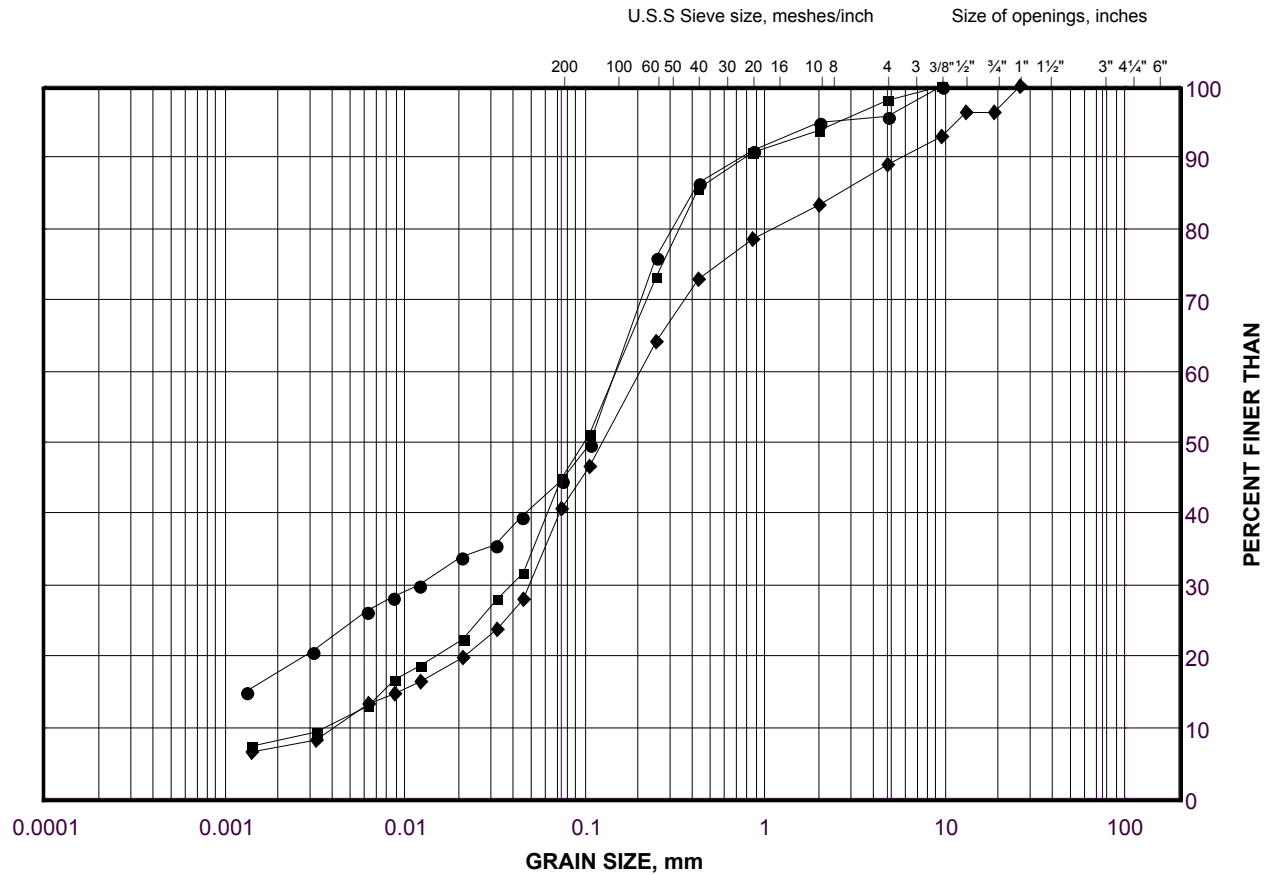
# **APPENDIX B**

## **Geotechnical Laboratory Test Results**

# GRAIN SIZE DISTRIBUTION

Silt and Sand to Silty Sand (FILL)

FIGURE B1



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

## LEGEND

SYMBOL	BOREHOLE	SAMPLE	DEPTH(m)
●	29	1b	1.1 - 1.2
■	26	2	1.5 - 2.0
◆	7	2	1.5 - 2.0

Project Number: 11-1184-0109 (8)

Checked By: AV

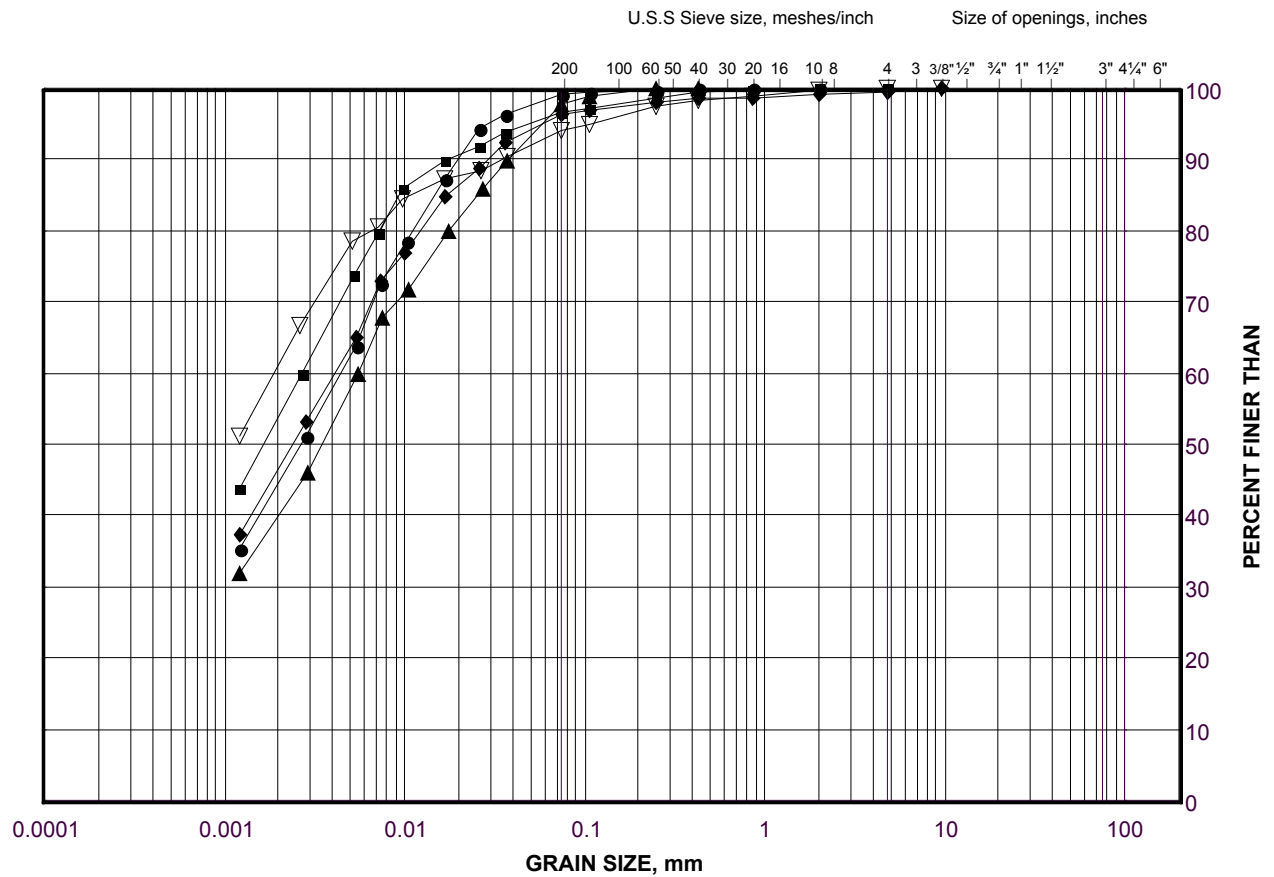
**Golder Associates**

Date: 22-May-13

# GRAIN SIZE DISTRIBUTION

## CLAYEY SILT to SILTY CLAY

FIGURE B2



### LEGEND

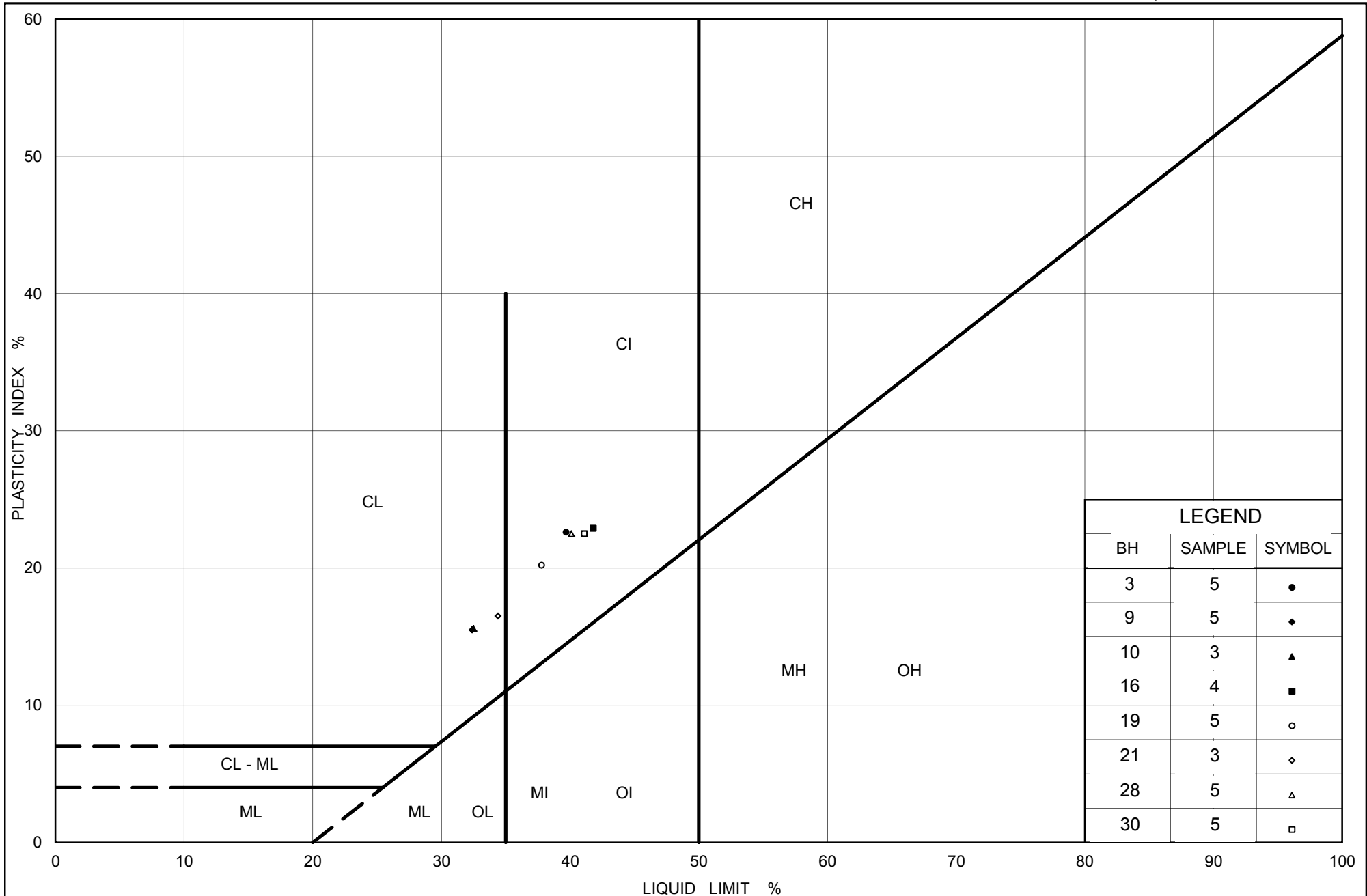
SYMBOL	BOREHOLE	SAMPLE	DEPTH(m)
●	10	3	2.3 - 2.7
■	16	4	3.0 - 3.5
◆	30	5	4.6 - 5.0
▲	19	5	4.6 - 5.0
▽	3	5	4.6 - 5.0

Project Number: 11-1184-0109 (8)

Checked By: AV

**Golder Associates**

Date: 22-May-13



Ministry of Transportation

Ontario

# PLASTICITY CHART CLAYEY SILT to SILTY CLAY

Figure No. B3

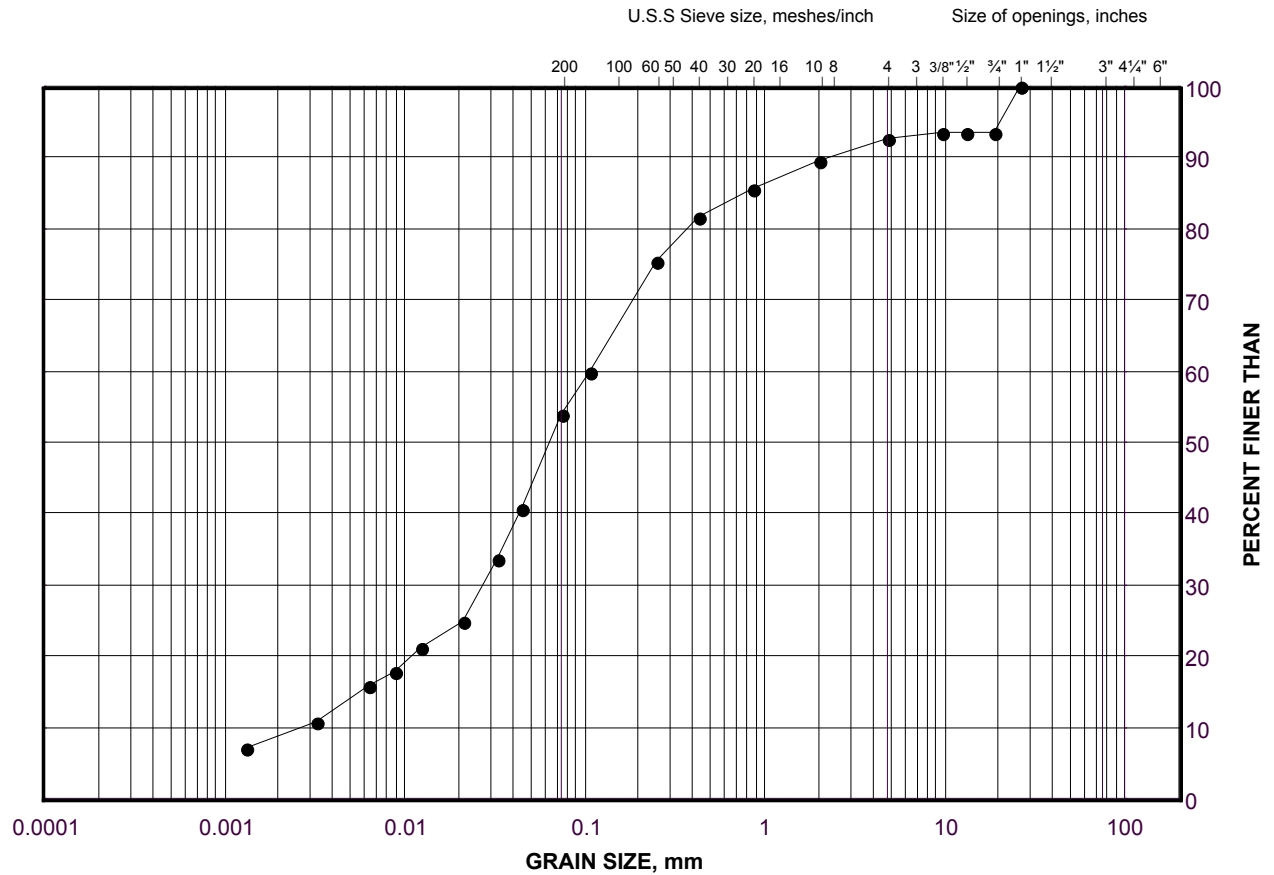
Project No. 11-1184-0109 (8)

Checked By: AV

# GRAIN SIZE DISTRIBUTION

SILT and SAND (TILL)

FIGURE B4



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

## LEGEND

SYMBOL	BOREHOLE	SAMPLE	DEPTH(m)
•	23	4	3.0 - 3.5

Project Number: 11-1184-0109 (8)

Checked By: AV

**Golder Associates**

Date: 22-May-13



# **APPENDIX C**

## **Non-Standard Special Provisions**



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## GEOTECHNICAL INVESTIGATION, PROPOSED NOISE BARRIER WALL, OSHAWA, ONTARIO

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### **CONTROL OF OVERBURDEN SOILS DURING NOISE BARRIER WALL FOUNDATION INSTALLATION - Item No. 799S01**

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#### **Special Provision**

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Excavations for the noise barrier wall foundations will be advanced through cohesionless fill materials (where present), into clayey silt till containing lenses or layers of potentially saturated cohesionless soils. These cohesionless soils could slough (if dry) or flow (if water-bearing) into unsupported auger holes during caissons installation. Appropriate construction procedures and equipment will be required to minimize ground loss during drilling, caisson installation and concrete placement.

#### **Basis of Payment**

Payment at the lump sum contract price for this tender item shall be full compensation for all labour, equipment and materials for completion of the work.

**END OF SECTION**





**BOULDERS/OBSTRUCTIONS DURING EXCAVATION FOR NOISE BARRIER WALL FOUNDATIONS –  
ITEM NO. 799S01**

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Special Provision

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The soils at the site are glacially-derived and should be expected to contain cobbles and boulders. Appropriate equipment and procedures will be required to penetrate obstructions (cobbles and boulders) that are encountered during excavation for noise barrier wall foundations.

**Basis of Payment**

Payment at the contract price for the above tender item shall include full compensation for all labour and materials to complete the work.

**END OF SECTION**

At Golder Associates we strive to be the most respected global company providing consulting, design, and construction services in earth, environment, and related areas of energy. Employee owned since our formation in 1960, our focus, unique culture and operating environment offer opportunities and the freedom to excel, which attracts the leading specialists in our fields. Golder professionals take the time to build an understanding of client needs and of the specific environments in which they operate. We continue to expand our technical capabilities and have experienced steady growth with employees who operate from offices located throughout Africa, Asia, Australasia, Europe, North America, and South America.

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