



February 2011

FOUNDATION INVESTIGATION AND DESIGN REPORT

Proposed Noise Barrier Wall 5

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

Submitted to:

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REPORT



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PART A

FOUNDATION INVESTIGATION REPORT

PROPOSED NOISE BARRIER WALL 5

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



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 noise barrier wall 5 to be located west of the Fischer-Hallman Road Interchange from Station 12+235 to 12+560 Lt along Highway 7/8.

The purpose of the foundation investigation is to determine the subsurface conditions at the locations of the proposed works 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, 2010, 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 Foundations Engineering dated July 4, 2008.

Dillon provided Golder Associates with locations and extent of the noise barrier walls in plan for this project in digital format.



2.0 SITE DESCRIPTION

2.1 General

The project area of Highway 7/8 is located in the south-central area of Kitchener, Ontario. The project 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 and the proposed noise barrier wall is shown on the Noise Barrier Wall Location Plan, Figure 2.

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

Proposed noise barrier wall 5 is to be located west of the Fischer-Hallman Road Interchange from Station 12+235 to 12+560 Lt along Highway 7/8. Residential developments and recreational spaces are located within the immediate vicinity of the site. An Ontario Hydro easement is adjacent to the west end of the proposed noise barrier wall. The topography of the site area is generally level around the Ontario Hydro easement at elevation 365 metres, sloping southwards to elevation 357 metres towards Highway 7/8. The ground surface elevations along the proposed wall alignment will vary from elevation 360 metres around Station 12+235 Lt to elevation 351 metres at about Station 12+560 Lt.

2.2 Site Geology

This project lies within the physiographic region of southwestern Ontario known as the Waterloo Hills¹. The soils generally consist of sandy hills; some are ridges 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 Northern Development and Mines Map 2559 entitled "Quaternary Geology, Stratford Area", the site lies on the edge of an area of ice-contact gravel surrounded by Maryhill Till (clay till) deposits. The ice-contact gravel deposits are described as "poorly to well sorted, fine gravel and/or sand to coarse gravel and/or sand textured". Areas of ice-contact sand are present to the east of the site.

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



FOUNDATION INVESTIGATION AND DESIGN REPORT PROPOSED NOISE BARRIER WALL 5

The Geologic Survey of Canada Map 1263A entitled "Geology, Toronto-Windsor Area, Ontario" indicates that the subcropping bedrock in the area of the site is dolomite and mudstone of the Salina formation of Upper Silurian age. Based on the Ministry of Natural Resources Map P.168 entitled "Bedrock Topography Series, Stratford Area, Southern Ontario", the bedrock surface at the site is at an elevation ranging between 275 and 270 metres with the bedrock sloping downwards towards the east end of the site



3.0 INVESTIGATION PROCEDURES

The field work for the foundation investigation for the design of the proposed noise barrier wall 5 was carried out on May 5 and 6, 2010 during which time eight boreholes were drilled along Highway 7/8 along the alignment of the proposed noise barrier wall. The borehole locations are shown on the Borehole Location Plan, Drawing 1. It should be noted that, following the fieldwork, the wall design was amended such that all boreholes with the exception of boreholes 9, 10 and 11 remain at the location of the proposed development. Boreholes 9, 10 and 11 are approximately 100 to 260 metres to the west of the currently proposed noise barrier wall.

Eight boreholes (numbered 9 to 16) were advanced to a depth of about 5.0 metres. 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)
9	4 808 825	221 612	357.35	5.03
10	4 808 861	221 688	357.61	5.03
11	4 808 894	221 756	363.24	5.03
12	4 808 943	221 867	359.25	5.03
13	4 808 961	221 894	359.75	5.03
14	4 808 996	221 962	356.87	5.03
15	4 809 025	222 029	356.04	5.03
16	4 809 057	222 096	351.37	5.03

The drilling 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 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.

The groundwater conditions were observed throughout the drilling operations and upon completion of drilling. During the foundation investigation fieldwork, one 12.5 millimetre diameter slotted standpipe was installed in borehole 10 to monitor the groundwater conditions within the native soils. The boreholes were backfilled in accordance with current Ontario Ministry of Transportation (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



FOUNDATION INVESTIGATION AND DESIGN REPORT PROPOSED NOISE BARRIER WALL 5

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 in Appendix A.

The locations of the boreholes are shown on the Record of Borehole sheets and on Drawing 1, attached.



4.0 SUBSURFACE CONDITIONS

4.1 Site Stratigraphy

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 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 variable ground conditions, consisting of surficial topsoil and/or variable layers of fill underlain by sandy silt, clayey silt till, silt, sand and gravel, sand and silty sand.

The borehole locations are shown on Drawing 1. A detailed description of the subsurface conditions encountered in the boreholes is provided on the Record of Borehole sheets and is summarized below.

4.1.1 Topsoil

All boreholes were drilled adjacent to the top of a cut slope on the north side of Highway 7/8. Topsoil was encountered at the ground surface in all boreholes. The thickness of the topsoil ranged from 100 to 360 millimetres. It should be noted that traces to some topsoil were also encountered within fill layers at elevations 363.1, 359.5 and 356.6 metres in boreholes 11, 13 and 14, respectively. 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.

4.1.2 Fill

Fill was encountered underlying the topsoil in boreholes 10, 11, 13 and 14 at elevations 357.3, 363.1, 359.5 and 356.6 metres, respectively. The fill is granular in nature and comprised of silty fine sands, silt and sandy silt in boreholes 10, 11 and 14. The fill in borehole 13 consisted of clayey silt. The fill layers were 1.0 to 2.7 metres thick.

The very loose to loose granular fill had standard penetration test N values of 2 to 6 blows per 0.3 metres and water contents of 14 to 20 per cent. The marginally higher water content of 20 per cent is likely to be influenced by the presence of traces of topsoil, which were observed within the fill layers. The soft cohesive fill had an N value of 3 blows per 0.3 metres.



The results of the grain size testing conducted on a granular fill sample obtained during standard penetration testing are presented on Figure A-1, in Appendix A.

4.1.3 Silt

A loose to compact silt layer was encountered in borehole 9 from elevation 357.1 metres underlying topsoil. The thickness of the silt layer was 1.9 metres.

The silt had N values of 9 and 10 blows per 0.3 metres with a water content of 17 per cent.

The grain size distribution curve for the silt sample recovered during standard penetration testing is shown on Figure A-2.

4.1.4 Sandy Silt

Layers of sandy silt were found in boreholes 9, 11 and 15 at elevations below 355.2, 361.9 and 355.9 metres, respectively. The sandy silt was encountered underlying silt in borehole 9, fill in borehole 11 and the topsoil in borehole 15. The sandy silt layers were 1.4 to 2.3 metres thick.

The N values for the sandy silt ranged from 9 to 28 blows per 0.3 metres indicating a loose to compact relative density. The water contents ranged from 10 to 18 per cent. An Atterberg limits test was carried out for a sandy silt sample with some clay which was confirmed to be non-plastic.

The results of grain size analyses conducted on four samples of the sandy silt obtained during the standard penetration testing are presented on Figure A-3.

4.1.5 Clayey Silt Till

Clayey silt till was encountered in boreholes 9 through 14 from elevation 353.7 to 359.6 metres. The clayey silt till was found underlying sandy silt in borehole 9, sandy silt till in borehole 10, fill in boreholes 13 and 14, sandy silt in borehole 11 and topsoil in borehole 12. The thickness of the clayey silt till was 1.5 metres in borehole 14. All remaining boreholes were terminated in the clayey silt till after exploring the stratum for 1.4 to 4.7 metres. Although not specifically encountered in the boreholes, cobbles and boulders should be anticipated in the clayey silt till due to the depositional history of this material.

The stiff to very stiff clayey silt till had N values of 10 to 26 blows per 0.3 metres. The water contents ranged from 9 to 18 per cent. The Atterberg limit tests indicate that the clayey silt till is of low plasticity. The plastic limit, liquid limit and plasticity index ranges for the clayey silt till were 12 to 16, 20 to 29 and 7 to 13 per cent, respectively. The Atterberg limits results for the test performed on the clayey silt till are shown on Figure A-8.



The results of the grain size testing conducted on clayey silt till samples obtained during the standard penetration testing are presented on Figure A-4.

4.1.6 Sandy Silt Till

The fill in borehole 10 was underlain by a 0.8 metre thick layer of sandy silt till. The sandy silt till was dense with an N value of 35 blows per 0.3 metres and a water content of 12 per cent. The results of a grain size analysis conducted on a sample of sandy silt till are presented on Figure A-5.

Even though cobbles and boulders were not specifically encountered during drilling in the sandy silt till, the presence of cobbles and boulders should be expected in this deposit based on its depositional history.

4.1.7 Sand and Gravel

Layers of compact to very dense sand and gravel were encountered in boreholes 14, 15 and 16 at elevations 352.5, 354.5 and 351.1 metres, respectively. The sand and gravel was found underlying clayey silt till in borehole 14, underlying sandy silt in borehole 15 and underlying topsoil in borehole 16. Evidence of cobbles and boulders were observed when drilling through the sand and gravel in boreholes 15 and 16. The thickness of the sand and gravel layers was 2.9 and 2.4 metres in boreholes 15 and 16, respectively. Borehole 14 was terminated in the sand and gravel after exploring the stratum for 0.6 metres.

The N values for the sand and gravel ranged from 14 to 55 blows per 0.3 metres. The water contents were 3 and 6 per cent.

The grain size distribution curves for two samples of sand and gravel recovered during the standard penetration testing are shown on Figure A-6.

4.1.8 Sand

Compact sand was encountered at the base of borehole 15 at elevation 351.6 metres. The sand was found beneath sand and gravel. Borehole 15 was terminated after exploring the stratum for 0.6 metres. An N value 23 blows per 0.3 metres was measured during the standard penetration testing.



4.1.9 Silty Sand

A layer of compact to dense silty sand was encountered in borehole 16 at elevation 348.8 metres below the sand and gravel. Borehole 16 was terminated in the silty sand after exploring the layer for 2.4 metres.

The silty sand had N values of 27 to 34 blows per 0.3 metres with a water content of 5 per cent.

The results of grain size testing conducted on a silty sand sample obtained during the standard penetration testing are presented on Figure A-7.

4.2 Groundwater Conditions

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

Borehole	Ground Surface Elevation (m)	Encountered Groundwater Level	
		Depth (m)	Elevation (m)
9	357.35	1.4	356.0
10	357.61	1.2	356.4
11	363.24	1.3	361.9
12	359.25	Dry	-
13	359.75	Dry	-
14	356.87	Dry	Below 352
15	356.04	Dry	Below 351
16	351.37	Dry	Below 347

During the fieldwork period, the groundwater was encountered between elevation 356.0 and 361.9 metres in boreholes 9 to 11. The remaining boreholes were dry upon completion. Considering the boreholes that were dry, grey soils were only encountered in boreholes 12 and 13.

One 12.5 millimetre diameter, slotted section, groundwater monitoring standpipe was installed in borehole 10.



FOUNDATION INVESTIGATION AND DESIGN REPORT PROPOSED NOISE BARRIER WALL 5

The post fieldwork groundwater monitoring results for borehole 10 are summarized in the following table.

Borehole	Ground Surface Elevation (m)	Installation	Measured Groundwater Elevation (m)			
			Upon Installation	May 10, 2010	May 31, 2010	Oct. 13, 2010
10	357.61	Standpipe	354.51	357.33	356.57	354.56

It should be noted that the above groundwater levels are not necessarily considered to be representative of the long-term, stabilized groundwater conditions as the readings were taken for a short duration only. The long-term inferred groundwater level is expected to vary from elevation 356 metres at about Station 11+960 Lt, elevation 357 metres at Station 12+050 Lt, elevation 362 metres around Station 12+120 and below elevation 347 metres around Station 12+560 Lt. 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. Matthew Rhody 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

PROPOSED NOISE BARRIER WALL 5

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



6.0 ENGINEERING RECOMMENDATIONS

6.1 General

This section of the report provides geotechnical parameters and recommendations for the geotechnical aspects of the design for the proposed noise barrier wall 5 along the north side of Highway 7/8 between Stations 12+235 and 12+560 Lt. The proposed noise barrier wall is to be mounted along the edge of the right-of-way.

The design parameters and recommendations have been developed based on interpretation of the factual data obtained from the boreholes advanced at the site. The interpretation and recommendations provided are intended to provide the designers with sufficient 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 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 foundation should be designed and constructed in accordance with MTO's SP599F01. It is recommended that the noise barrier wall should be supported using conventional augered caissons with a diameter of 0.6 to 0.9 metres. Foundation design parameters for design of the caisson foundations are provided in Table I following the text of this report based on the soil conditions encountered along the proposed noise barrier wall alignments. The stratigraphy presented in Table I has been simplified for the purposes of the noise barrier wall foundation design.

Where both an undrained shear strength, c_u and an effective friction angle, ϕ' , have been given for a specific stratum, the caisson design should be checked for both the drained and undrained condition and the larger of the two calculated caisson depths shall govern.

The passive resistance in the upper 1.4 metres below the ground should be neglected to account for frost action. In addition, for foundation design, full passive resistance will be mobilized only where the ground surface in front of and behind the caisson is level. Where sloping ground is present adjacent to the noise barrier wall, the K_p values used in the calculation should be adjusted to account for the presence of the sloping ground. Between Stations 12+235 and 12+240 Lt and Stations 12+390 and 12+490 Lt, the approximately 2 horizontal to 1 vertical cut slope in front of the wall will be within the passive wedge. Adjusted K_p values are provided in Table I for these areas. The adjusted K_p value is to be applied to that portion of the caisson that is above the elevation of the ground surface at the toe of the slope; below this elevation, the full K_p is to be applied.

It may be necessary to use deeper and/or larger diameter caissons in the vicinity of Station 12+350 where borehole 14 indicates that very loose to loose granular fill is present to a depth of 2.9 metres.



6.3 Construction Considerations

Excavations for the construction of the caisson noise barrier wall foundations will penetrate the surficial fill and will extend through deposits of clayey silt till, sandy silt, sand and gravel, sand and silty sand. The sands are predominantly fine to medium coarse grained and uniform in composition. The sands, silts and clayey silt tills at this site are susceptible to disturbance during caisson excavation and construction. Cobbles and boulders have been confirmed in the sand and gravel deposits and should be expected in the clayey silt till and sandy silt till.

A temporary liner will be required to support the sides of the excavation and permit cleaning and inspection of the base. Careful cleaning of the base of the caisson should be carried out prior to placement of concrete to remove all loosened or disturbed materials. Surface water run off should be directed away from the excavation. It is recommended that a Non-Standard Special Provision (NSSP) be included in the Contract Documents to alert the Contractor about the requirements for the support of the augered excavations and measures to deal with cobbles and boulders. The NSSP should include a note to the designer that near Station 12+350 Lt, use of deeper caissons may be warranted due to the presence of deep loose fills.

The caissons should be constructed and inspected in accordance with Ontario Provisional Standard Specifications 903 and SP599F01. Following construction, the Quality Verification Engineer shall submit a Certificate of Conformance confirming that the noise barrier wall foundations have been constructed in general conformance with the Contract Documents.



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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TABLE I

**FOUNDATION DESIGN PARAMETERS
PROPOSED NOISE BARRIER WALL 5**

Widening of Highway 7/8
GWP 131-98-00

Station and Borehole	Soil Type	Elevation Interval (m)	Design Groundwater Elevation (m)	Undrained Shear Strength, c_u^1 (kPa)	Effective Angle of Friction, ϕ^1 (°)	Coefficient of Passive Pressure, $K_p^{2,3}$ Level Ground/ 2H:1V Slope	Coefficient of Active Pressure, K_a Level Ground	Unit Weight ⁴ (kNm ⁻³)	
								Bulk, γ	Effective, γ'
12+235 to 12+265 Borehole 12	Stiff to very stiff clayey silt till	Below 358	355	100	30	3.0/1.1	0.33	21.0	11.0
12+265 to 12+320 Borehole 13	Stiff to very stiff clayey silt till	Below 358	356	100	30	3.0/N/A	0.33	21.0	11.0
12+320 to 12+390 Borehole 14	Very loose to loose granular fill	355 to 354	Below 352	150	-	-	-	18.0	8.0
	Very stiff clayey silt till	354 to 352			30	3.0/N/A	0.33	21.0	11.0
	Very dense sand and gravel	Below 352			35	3.7/N/A	0.27	21.0	11.0
12+390 to 12+465 Borehole 15	Compact to very dense sand and gravel	354 to 352	Below 351	-	34	3.5/1.3	0.28	20.5	10.5
	Compact sand	Below 352		-	32	3.3/1.2	0.31	19.5	9.5
12+465 to 12+560 Borehole 16	Compact sand and gravel	350 to 349	Below 347	-	34	3.5/1.3	0.28	20.0	10.0
	Compact to dense silty sand	Below 349		-	32	3.3/1.2	0.31	19.0	9.0

**FOUNDATION DESIGN PARAMETERS
PROPOSED NOISE BARRIER WALL 5**

NOTES:

1. Where both c_u and ϕ' have been given for a specific stratum, the foundation design should be checked for both the drained and undrained conditions and the larger of the two calculated foundation depths shall govern.
2. The passive resistance offered by the very loose to loose granular fill is negligible and should be neglected.
3. Passive earth pressure coefficient (K_p) values are provided for level ground. Where sloping ground is present adjacent to the noise barrier wall, adjusted K_p values must be used in the foundation design. Between Stations 12+235 and 12+240 Lt and 12+390 and 12+490 Lt, the ground in front of the proposed noise barrier wall and within the passive wedge area will slope downwards at 2 horizontal to 1 vertical.
4. Below the groundwater level, the effective unit weight of the soil (γ') should be used.
5. This table is to be read in conjunction with the accompanying report.

Prepared By: MSWL

Checked By: DUP

LIST OF ABBREVIATIONS

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

I. SAMPLE TYPE

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

III. SOIL DESCRIPTION

(a) Cohesionless Soils

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

II. PENETRATION RESISTANCE

Standard Penetration Resistance (SPT), N:

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

Consistency

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

(b) Cohesive Soils

Dynamic Cone Penetration Resistance; N_d :

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

PH: Sampler advanced by hydraulic pressure

PM: Sampler advanced by manual pressure

WH: Sampler advanced by static weight of hammer

WR: Sampler advanced by weight of sampler and rod

Piezo-Cone Penetration Test (CPT)

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

IV. SOIL TESTS

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

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

LIST OF SYMBOLS

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

I. General

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

II. STRESS AND STRAIN

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

III. SOIL PROPERTIES

(a) Index Properties

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

(a) Index Properties (continued)

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

(b) Hydraulic Properties

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

(c) Consolidation (one-dimensional)

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

(d) Shear Strength

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

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

RECORD OF BOREHOLE No 9

1 OF 1

METRIC

PROJECT 08-1132-084-1

W.P. 131-98-00

LOCATION N 4808825.2 ; E 221611.9

ORIGINATED BY MR

DIST HWY 7/8

BOREHOLE TYPE POWER AUGER / HOLLOW STEM

COMPILED BY WDF

DATUM GEODETIC

DATE May 6, 2010

CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa				W _P	W	W _L			WATER CONTENT (%)	
357.35	GROUND SURFACE					▽		20	40	60	80	100						
0.00	TOPSOIL, silty Dark brown																	
0.24	SILT, some clay, some sand, trace gravel Loose to compact Brown		1	SS	10													
			2	SS	9													
355.22																		
2.13	SANDY SILT, some clay, trace gravel Compact Brown		3	SS	23													
			4	SS	28													
353.69																		
3.66	CLAYEY SILT TILL, trace sand, trace gravel Very stiff Grey		5	SS	18													
			6	SS	26													
352.32																		
5.03	END OF BOREHOLE																	
	Groundwater encountered at about elev. 356.0m during drilling on May 6, 2010.																	

RECORD OF BOREHOLE No 10

1 OF 1

METRIC

PROJECT 08-1132-084-1
W.P. 131-98-00 LOCATION N 4808861.3 ; E 221687.9 ORIGINATED BY MR
DIST HWY 7/8 BOREHOLE TYPE POWER AUGER / HOLLOW STEM COMPILED BY WDF
DATUM GEODETIC DATE May 6, 2010 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
								○ UNCONFINED	+ FIELD VANE	● QUICK TRIAXIAL	× LAB VANE	WATER CONTENT (%)					
357.61	GROUND SURFACE						20	40	60	80	100						
0.00	TOPSOIL, silty Dark brown																
357.25																	
0.36	FILL, silty fine sand Very loose Brown		1	SS	3												
356.24																	
1.37	SANDY SILT TILL, some clay, some gravel Dense Brown		2	SS	35								o			16 23 43 18	
355.48																	
2.13	CLAYEY SILT TILL, trace to some sand, trace to some gravel Stiff to very stiff Brown to grey at about elev. 354.0m		3	SS	23								le	—		2 7 56 35	
			4	SS	20												
			5	SS	15								le	—		0 9 57 34	
			6	SS	13												
352.58	END OF BOREHOLE																
5.03	Groundwater encountered at about elev. 356.4m during drilling on May 6, 2010. Water level measured at elev. 354.51m following standpipe installation on May 6, 2010. Water level measured at elev. 357.33m on May 10, 2010.																

RECORD OF BOREHOLE No 11

1 OF 1

METRIC

PROJECT 08-1132-084-1

W.P. 131-98-00

LOCATION N 4808893.8 ; E 221755.5

ORIGINATED BY MR

DIST HWY 7/8





BOREHOLE TYPE POWER AUGER / HOLLOW STEM

COMPILED BY WDF

DATUM GEODETIC

DATE May 6, 2010

CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)						
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									WATER CONTENT (%)					
								○ UNCONFINED	+	FIELD VANE	×						LAB VANE					
363.24	GROUND SURFACE					▽		20	40	60	80	100					GR	SA	SI	CL		
0.00	TOPSOIL, silty																					
0.13	Dark brown																					
	FILL, silt, some clay, trace sand, trace topsoil		1	SS	2																	
	Very loose																					
	Brown																					
361.87																						
1.37	SANDY SILT, trace to some clay, trace gravel		2	SS	10										○			1	29	67	3	
	Compact																					
	Brown																					
			3	SS	14										○				0	26	58	16
			4	SS	14																	
359.58															○							
3.66	CLAYEY SILT TILL, trace sand, trace gravel		5	SS	14																	
	Stiff to very stiff																					
	Grey																					
			6	SS	15																	
358.21																						
5.03	END OF BOREHOLE																					
	Groundwater encountered at about elev. 361.9m during drilling on May 6, 2010.																					

RECORD OF BOREHOLE No 12

1 OF 1

METRIC

PROJECT 08-1132-084-1
W.P. 131-98-00 LOCATION N 4808943.0 ; E 221867.3 ORIGINATED BY MR
DIST HWY 7/8 BOREHOLE TYPE POWER AUGER / HOLLOW STEM COMPILED BY WDF
DATUM GEODETIC DATE May 5, 2010 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa										WATER CONTENT (%)		
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE												
359.25	GROUND SURFACE						20	40	60	80	100									
0.00	TOPSOIL, clayey																			
358.92	Dark brown																			
0.33	CLAYEY SILT TILL, trace to some sand, trace gravel Stiff to very stiff Brown to grey at about elev. 354.8m																			
			1	SS	10															
			2	SS	14															
			3	SS	18															
			4	SS	16															
			5	SS	15															
			6	SS	13															
354.22	END OF BOREHOLE																			
5.03	Borehole dry during drilling on May 5, 2010.																			

RECORD OF BOREHOLE No 13

1 OF 1

METRIC

PROJECT 08-1132-084-1
W.P. 131-98-00 LOCATION N 4808961.0 ; E 221894.4 ORIGINATED BY MR
DIST HWY 7/8 BOREHOLE TYPE POWER AUGER / HOLLOW STEM COMPILED BY WDF
DATUM GEODETIC DATE May 5, 2010 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									WATER CONTENT (%)		
								○ UNCONFINED	+ FIELD VANE	● QUICK TRIAXIAL	× LAB VANE								
359.75	GROUND SURFACE							20	40	60	80	100							
0.00	TOPSOIL, silty Dark brown																		
0.28	FILL, clayey silt, trace sand, some topsoil Soft Brown		1	SS	3		359												
358.38																			
1.37	CLAYEY SILT TILL, trace to some sand, trace gravel Stiff to very stiff Brown to grey at about elev. 356.1m		2	SS	20		358									1 19 55 25			
			3	SS	15		357												
			4	SS	14														
			5	SS	10		356												
			6	SS	26		355												
354.72	END OF BOREHOLE																		
5.03	Borehole dry during drilling on May 5, 2010.																		

RECORD OF BOREHOLE No 14

1 OF 1

METRIC

PROJECT 08-1132-084-1
W.P. 131-98-00 LOCATION N 4808996.3 ; E 221961.8 ORIGINATED BY MR
DIST HWY 7/8 BOREHOLE TYPE POWER AUGER / HOLLOW STEM COMPILED BY WDF
DATUM GEODETIC DATE May 5, 2010 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
								○ UNCONFINED	+ FIELD VANE	● QUICK TRIAXIAL	× LAB VANE	WATER CONTENT (%)					
356.87	GROUND SURFACE						20	40	60	80	100						
0.00	TOPSOIL, silty Dark brown																
0.23	FILL, sandy silt, some clay, trace gravel, trace topsoil Very loose to loose Brown		1	SS	6								○				
			2	SS	2								○			1 25 60 14	
			3	SS	4								○				
353.97	CLAYEY SILT TILL, some sand, trace gravel Very stiff Brown		4	SS	25								○	11		1 30 52 17	
			5	SS	21												
352.45	SAND AND GRAVEL, trace silt Very dense Brown		6	SS	55												
351.84	END OF BOREHOLE																
5.03	Borehole dry during drilling on May 5, 2010.																

RECORD OF BOREHOLE No 15

1 OF 1

METRIC

PROJECT 08-1132-084-1
W.P. 131-98-00 LOCATION N 4809024.7 ; E 222029.2 ORIGINATED BY MR
DIST HWY 7/8 BOREHOLE TYPE POWER AUGER / HOLLOW STEM COMPILED BY WDF
DATUM GEODETIC DATE May 5, 2010 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									WATER CONTENT (%)			
								20	40	60	80						100	○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE		
356.04	GROUND SURFACE																			
0.10	TOPSOIL, silty Dark brown SANDY SILT, some clay, trace gravel Loose Brown		1	SS	9															
354.52																				
1.52	SAND AND GRAVEL, trace to some silt, trace clay, with cobbles Compact to very dense Brown		2	SS	14															
			3	SS	42							o				43 45 10 2				
			4	SS	28															
			5	SS	51															
351.62																				
4.42	SAND, some gravel Compact Brown		6	SS	23															
351.01																				
5.03	END OF BOREHOLE Borehole dry during drilling on May 5, 2010.																			

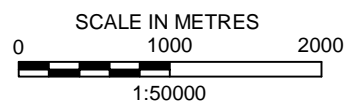
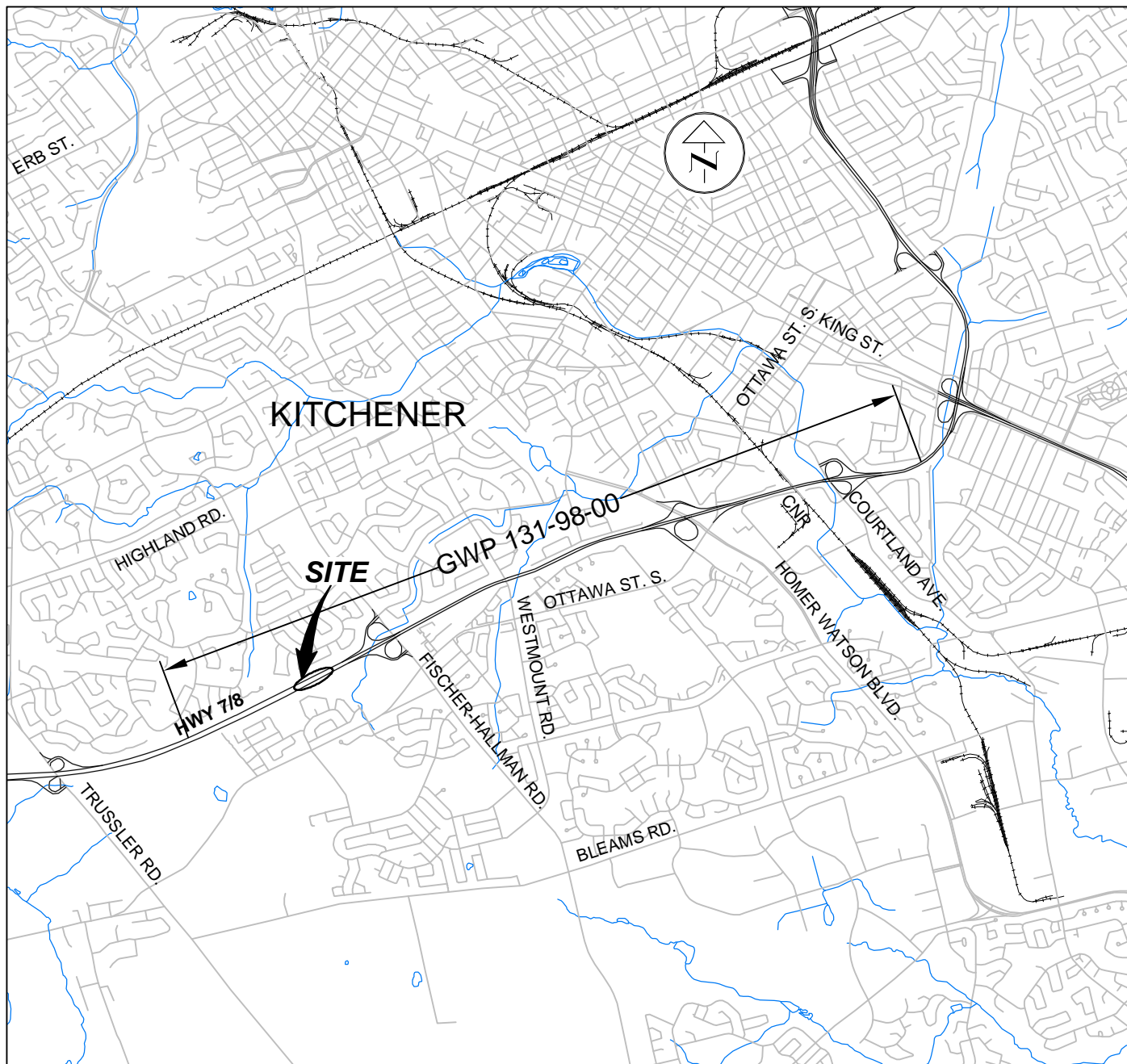
RECORD OF BOREHOLE No 16

1 OF 1

METRIC

PROJECT 08-1132-084-1
W.P. 131-98-00 LOCATION N 4809057.0 ; E 222095.9 ORIGINATED BY MR
DIST HWY 7/8 BOREHOLE TYPE POWER AUGER / HOLLOW STEM COMPILED BY WDF
DATUM GEODETIC DATE May 5, 2010 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa										WATER CONTENT (%)		
								20	40	60	80	100						○ UNCONFINED	+ FIELD VANE	● QUICK TRIAXIAL
351.37	GROUND SURFACE																			
0.00	TOPSOIL, silty Dark brown																			
0.23	SAND AND GRAVEL, trace silt, trace clay, with cobbles and boulders Compact Brown		1	SS	29															
			2	SS	17															
348.78			3	SS	27															
2.59	SILTY SAND, fine to medium, trace clay, layered Compact to dense Brown		4	SS	31															
			5	SS	32															
			6	SS	34															
346.34	END OF BOREHOLE																			
5.03	Borehole dry during drilling on May 5, 2010.																			



REFERENCE

DRAWING BASED ON CANMAP STREETFILES V2005.4.

NOTE

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

PROJECT

**PROPOSED NOISE BARRIER WALL 5
WIDENING OF HIGHWAY 7/8
GWP 131-98-00**

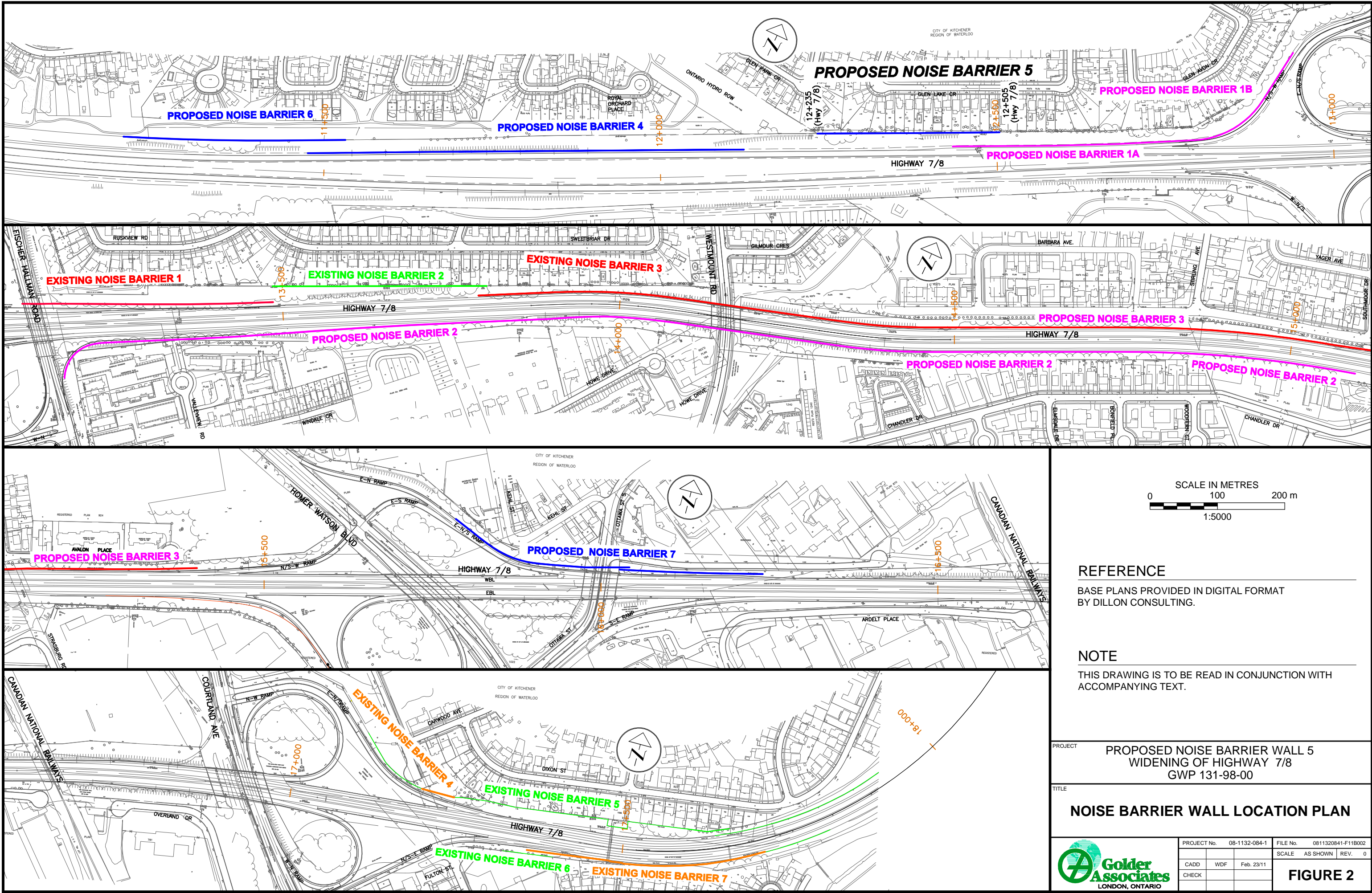
TITLE

KEY PLAN



PROJECT No.		08-1132-084-1	FILE No.		0811320841-F11B001
CADD	WDF	June 29/10	SCALE	AS SHOWN	REV.
CHECK			FIGURE 1		

Drawing file: 0811320841-F11B002.dwg Feb 24, 2011 - 10:27am



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

CONT No.
 WP No. 131-98-00



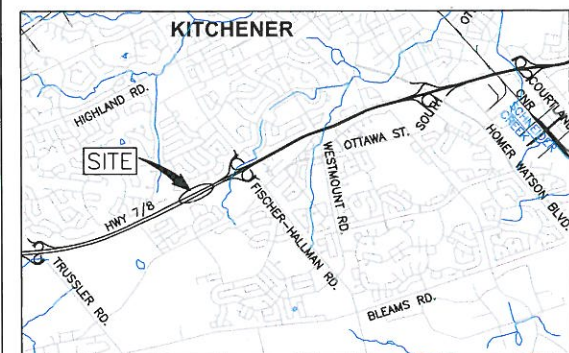
PROPOSED NOISE BARRIER WALL 5

SHEET

WIDENING OF HIGHWAY 7/8
 BOREHOLE LOCATIONS



Golder Associates Ltd.
 LONDON, ONTARIO, CANADA



KEY PLAN

SCALE IN KILOMETRES
 0 1 2

LEGEND

● Borehole - Current Investigation

No.	ELEVATION	CO-ORDINATES (MTM ZONE 10)	
		NORTHING	EASTING
9	357.35	4 808 825.2	221 611.9
10	357.61	4 808 861.3	221 687.9
11	363.24	4 808 893.8	221 755.5
12	359.25	4 808 943.0	221 867.3
13	359.75	4 808 961.0	221 894.4
14	356.87	4 808 996.3	221 961.8
15	356.04	4 809 024.7	222 029.2
16	351.37	4 809 057.0	222 095.9

NOTES

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

REFERENCE

Base plans provided in digital format by Dillon Consulting.



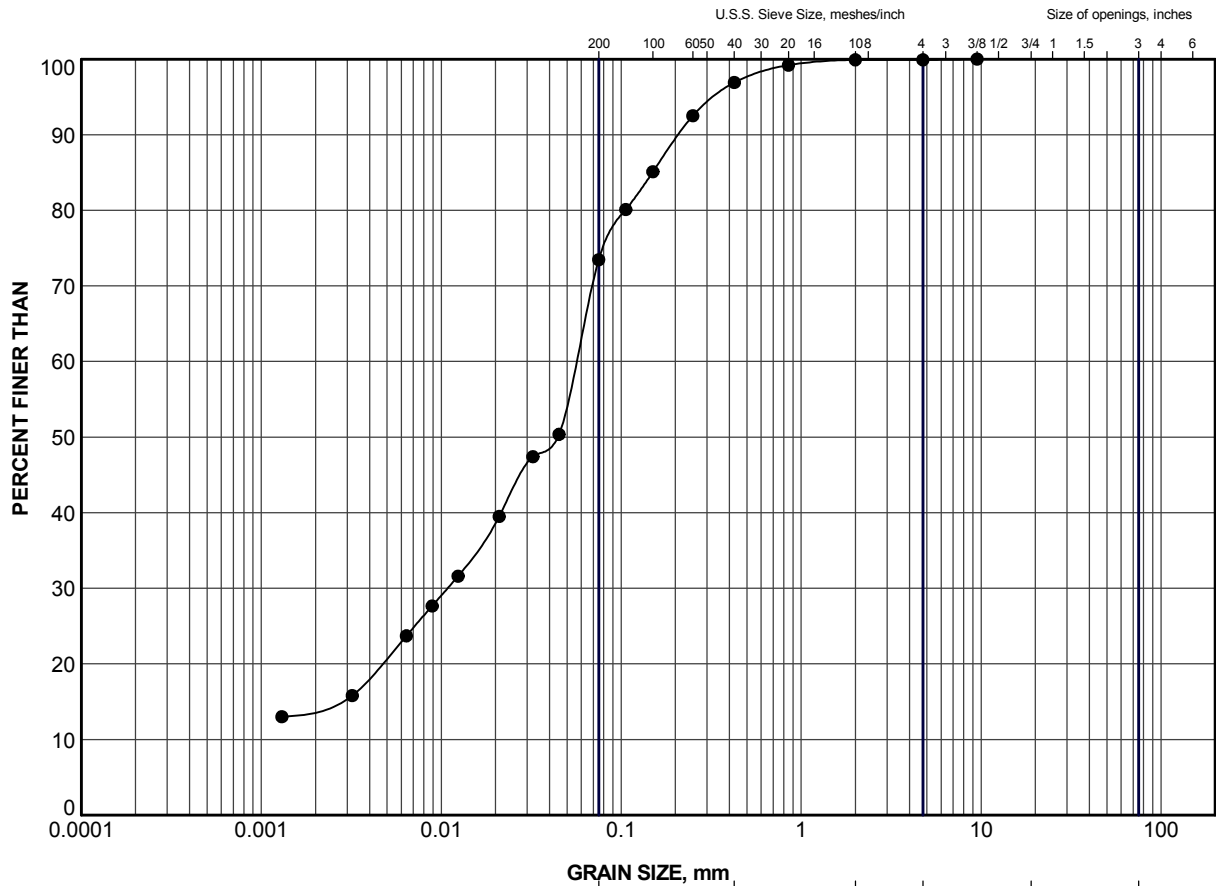
PLAN
 SCALE
 40 0 40 m

NO.	DATE	BY	REVISION
Geocres No. 40P7-60			
HWY.	7/8	PROJECT NO.	08-1132-084-1 DIST.
SUBM'D.	ML	CHKD.	DATE: June 16/10 SITE:
DRAWN:	WDF	CHKD.	APPD. DWG. 1



APPENDIX A

Laboratory Test Data

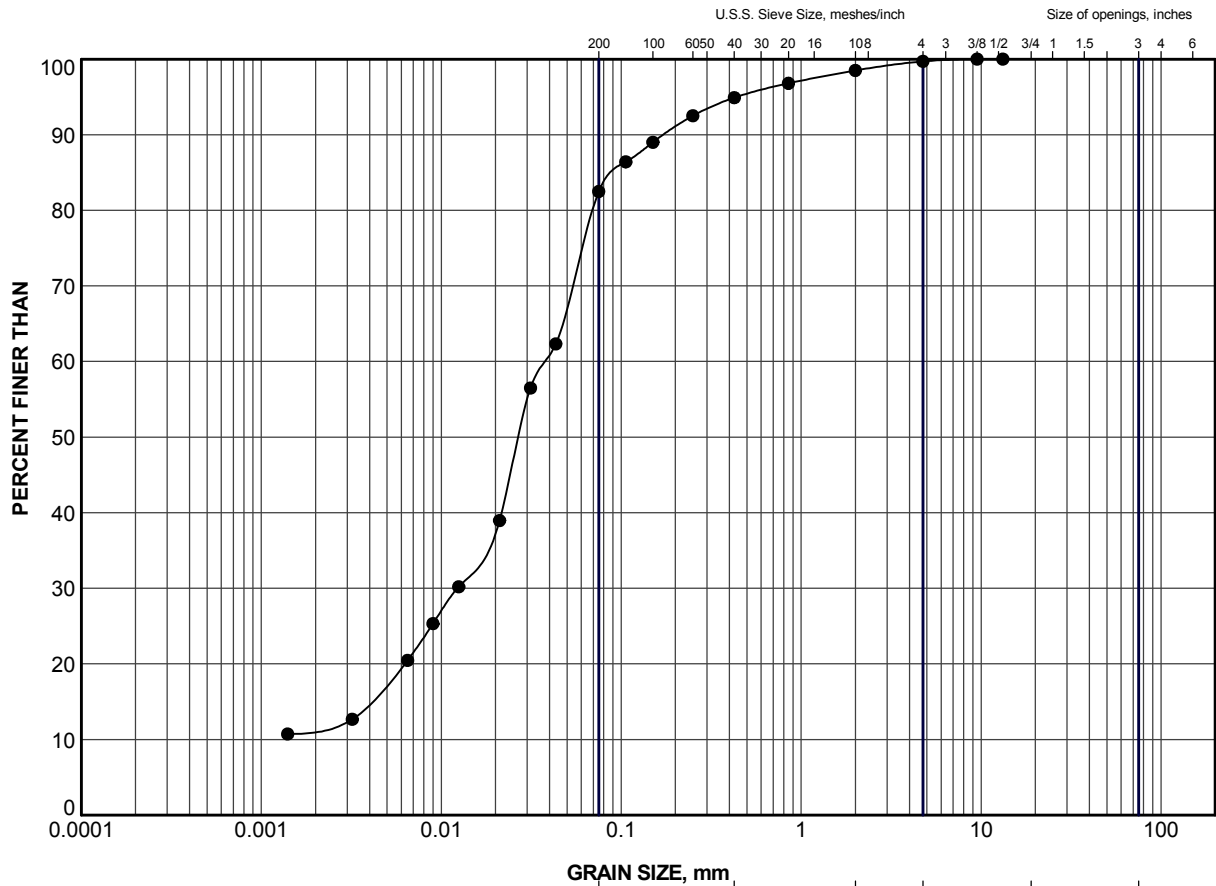


LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	14	2	355.1

PROJECT				PROPOSED NOISE BARRIER WALL 5 WIDENING OF HIGHWAY 7/8 GWP 131-98-00			
TITLE				GRAIN SIZE DISTRIBUTION FILL			
PROJECT No.		08-1132-084-1		FILE No.		0811320841-R11B0A1	
DRAWN		LMK		SCALE		N/A	
CHECK				REV.			
		Jul 27/10		FIGURE A-1			





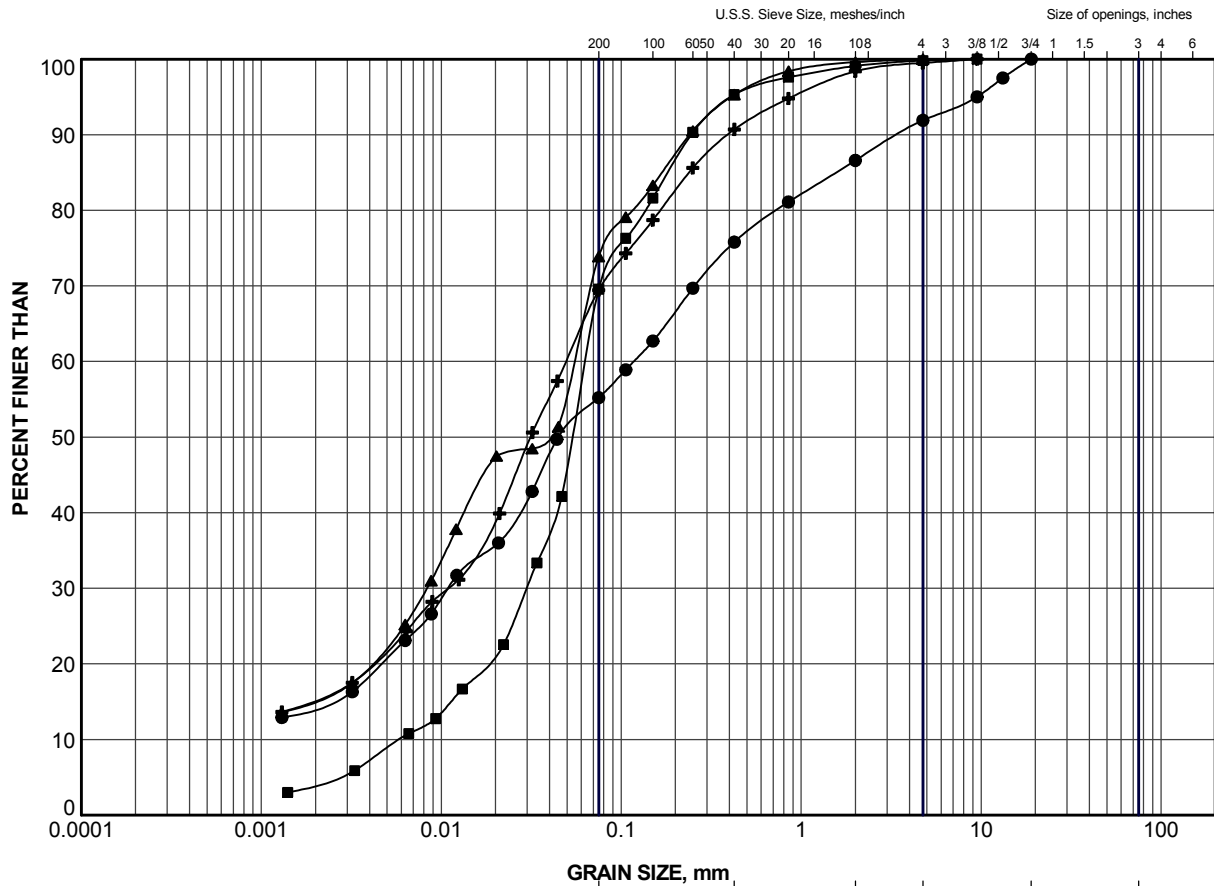
CLAY AND SILT	fine	medium	coarse	fine	coarse	Cobble Size
	SAND SIZE			GRAVEL SIZE		

LEGEND			
SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	9	2	355.6

PROJECT				PROPOSED NOISE BARRIER WALL 5 WIDENING OF HIGHWAY 7/8 GWP 131-98-00			
TITLE				GRAIN SIZE DISTRIBUTION SILT			
PROJECT No.		08-1132-084-1		FILE No.		0811320841-R11B0A2	
DRAWN		LMK		Aug. 10/10		SCALE N/A REV.	
CHECK						FIGURE A-2	



LDN_MTO_NEW_GLDR_LDN.GDT



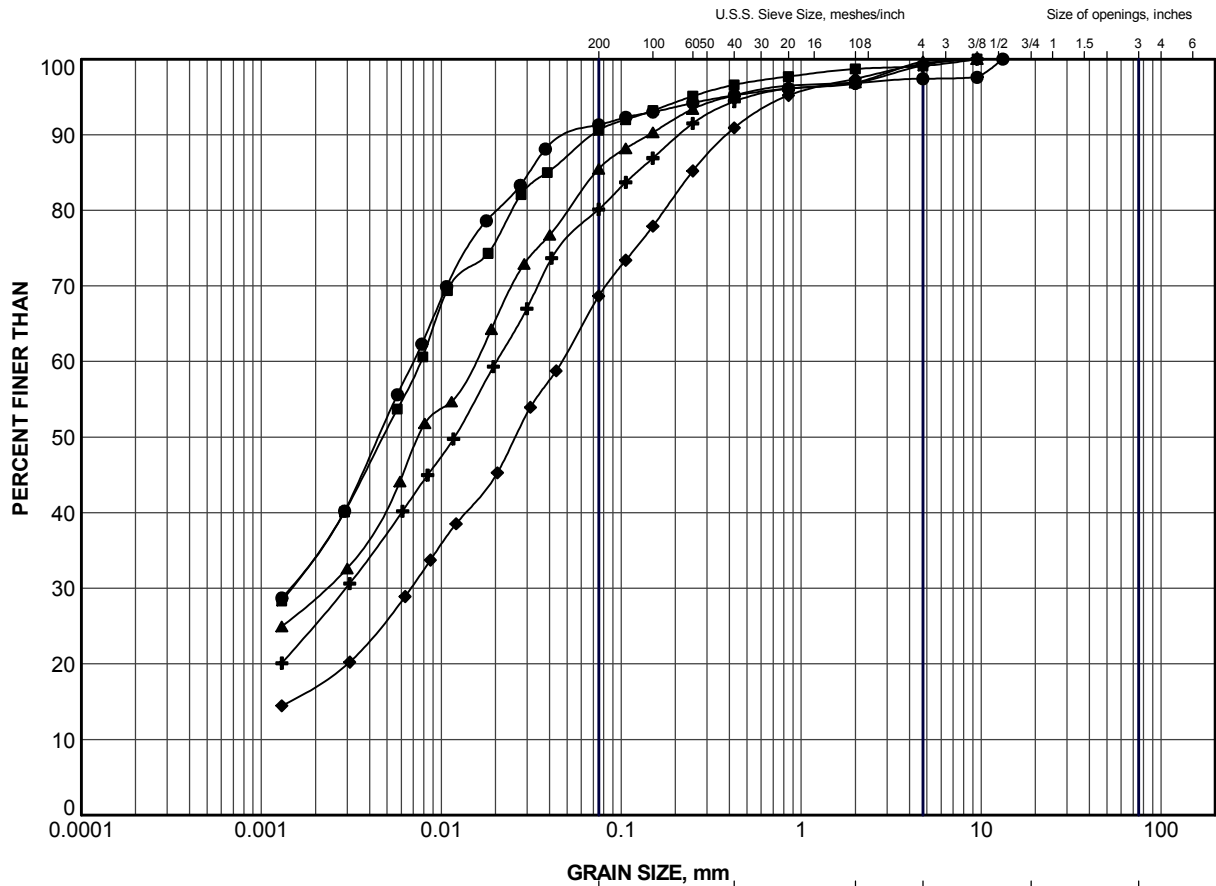
GRAIN SIZE, mm						
CLAY AND SILT	fine	medium	coarse	fine	coarse	Cobble Size
	SAND SIZE			GRAVEL SIZE		

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	9	3	354.8
■	11	2	361.5
▲	11	3	360.7
+	11	4	360.0

PROJECT				PROPOSED NOISE BARRIER WALL 5 WIDENING OF HIGHWAY 7/8 GWP 131-98-00			
TITLE				GRAIN SIZE DISTRIBUTION SANDY SILT			
PROJECT No.		08-1132-084-1		FILE No.		0811320841-R11B0A3	
DRAWN		LMK		Aug. 10/10		SCALE N/A REV.	
CHECK						FIGURE A-3	





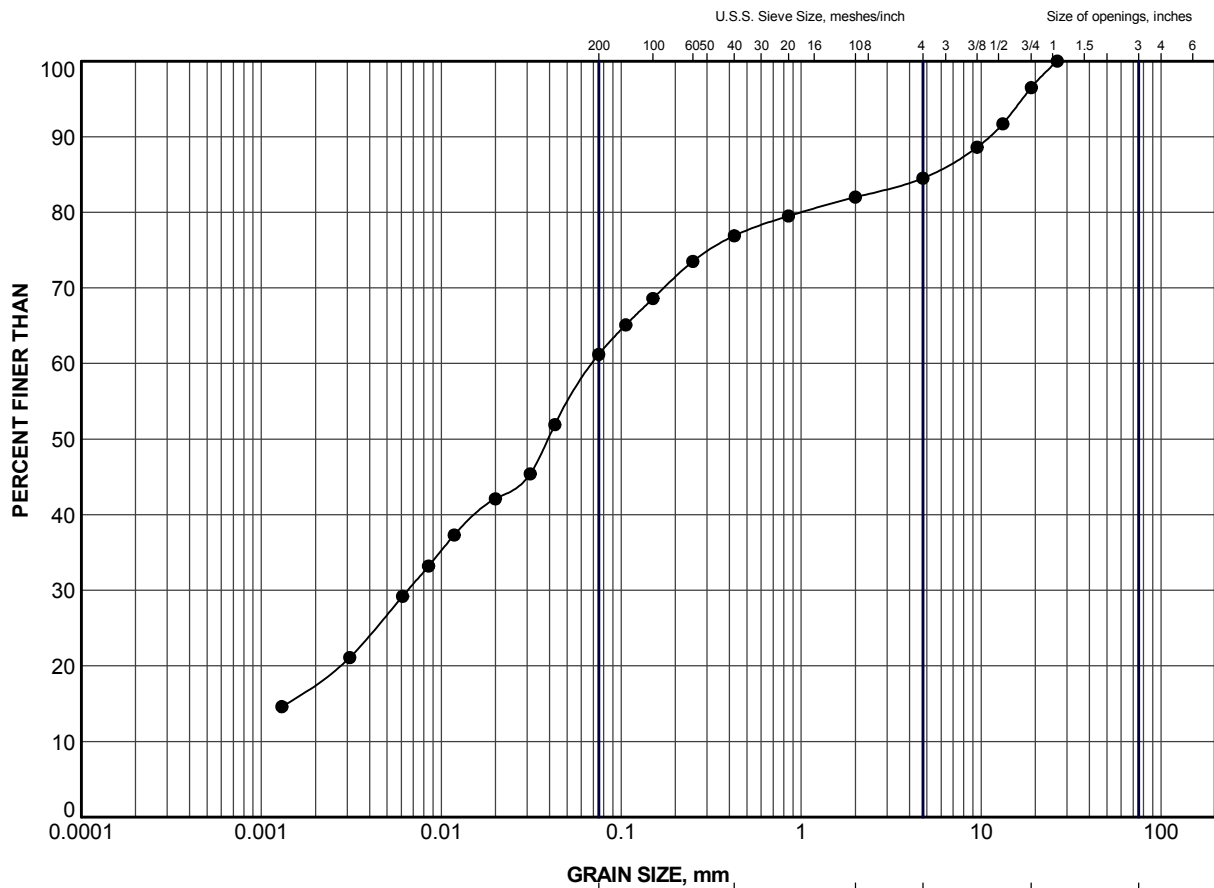
CLAY AND SILT	GRAVEL SIZE, mm					Cobble Size
	fine	medium	coarse	fine	coarse	
	SAND SIZE			GRAVEL SIZE		

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	10	3	355.1
■	10	5	353.6
▲	12	3	356.7
+	13	2	358.0
◆	14	4	353.6


PROJECT				PROPOSED NOISE BARRIER WALL 5 WIDENING OF HIGHWAY 7/8 GWP 131-98-00			
TITLE				GRAIN SIZE DISTRIBUTION CLAYEY SILT TILL			
PROJECT No.		08-1132-084-1		FILE No.		0811320841-R11B0A4	
DRAWN		LMK		Aug. 10/10		SCALE N/A REV.	
CHECK						FIGURE A-4	

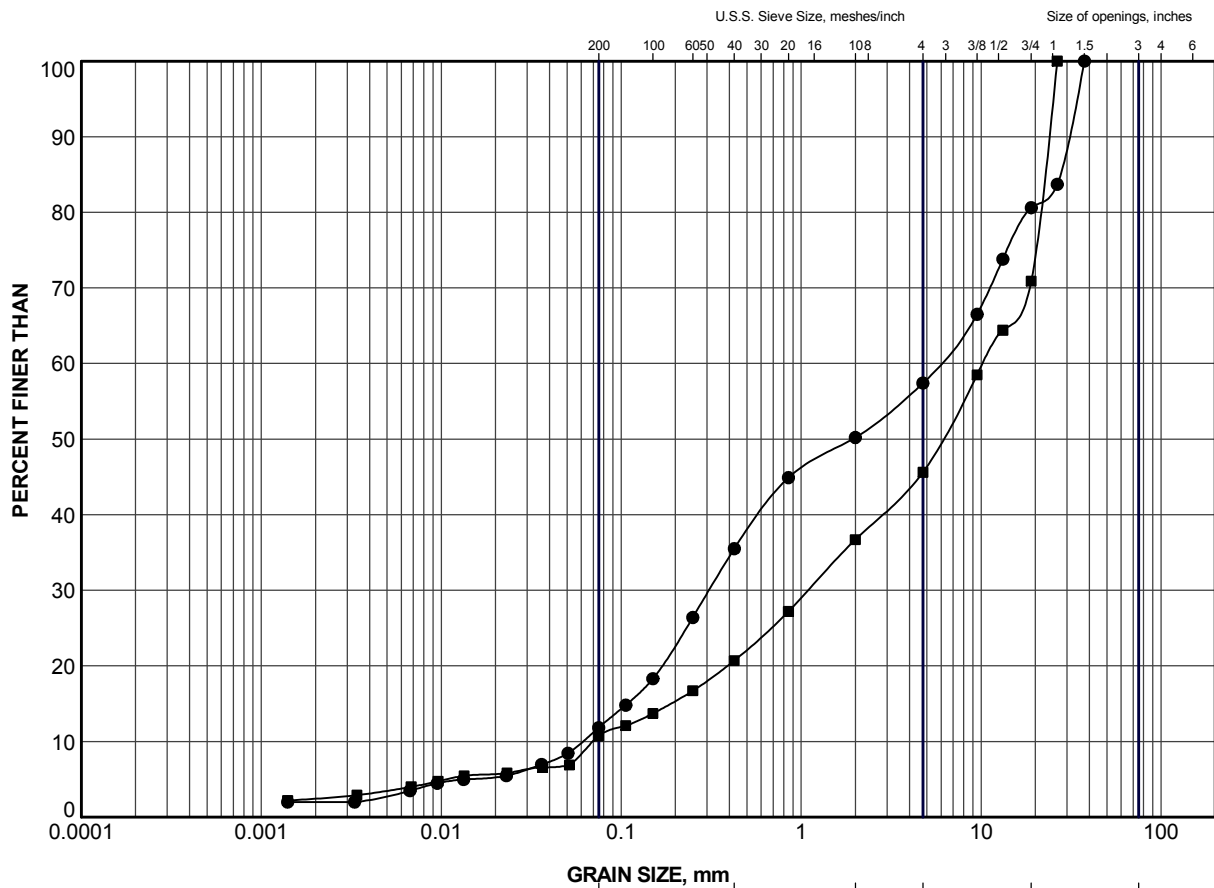




CLAY AND SILT	fine	medium	coarse	fine	coarse	Cobble Size
	SAND SIZE			GRAVEL SIZE		

LEGEND			
SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	10	2	355.9


PROJECT		PROPOSED NOISE BARRIER WALL 5 WIDENING OF HIGHWAY 7/8 GWP 131-98-00									
TITLE		GRAIN SIZE DISTRIBUTION SANDY SILT TILL									
 Golder Associates LONDON, ONTARIO		PROJECT No.		08-1132-084-1		FILE No.		0811320841-R11B0A5			
		DRAWN		LMK		Jul 27/10		SCALE N/A		REV.	
		CHECK						FIGURE A-5			

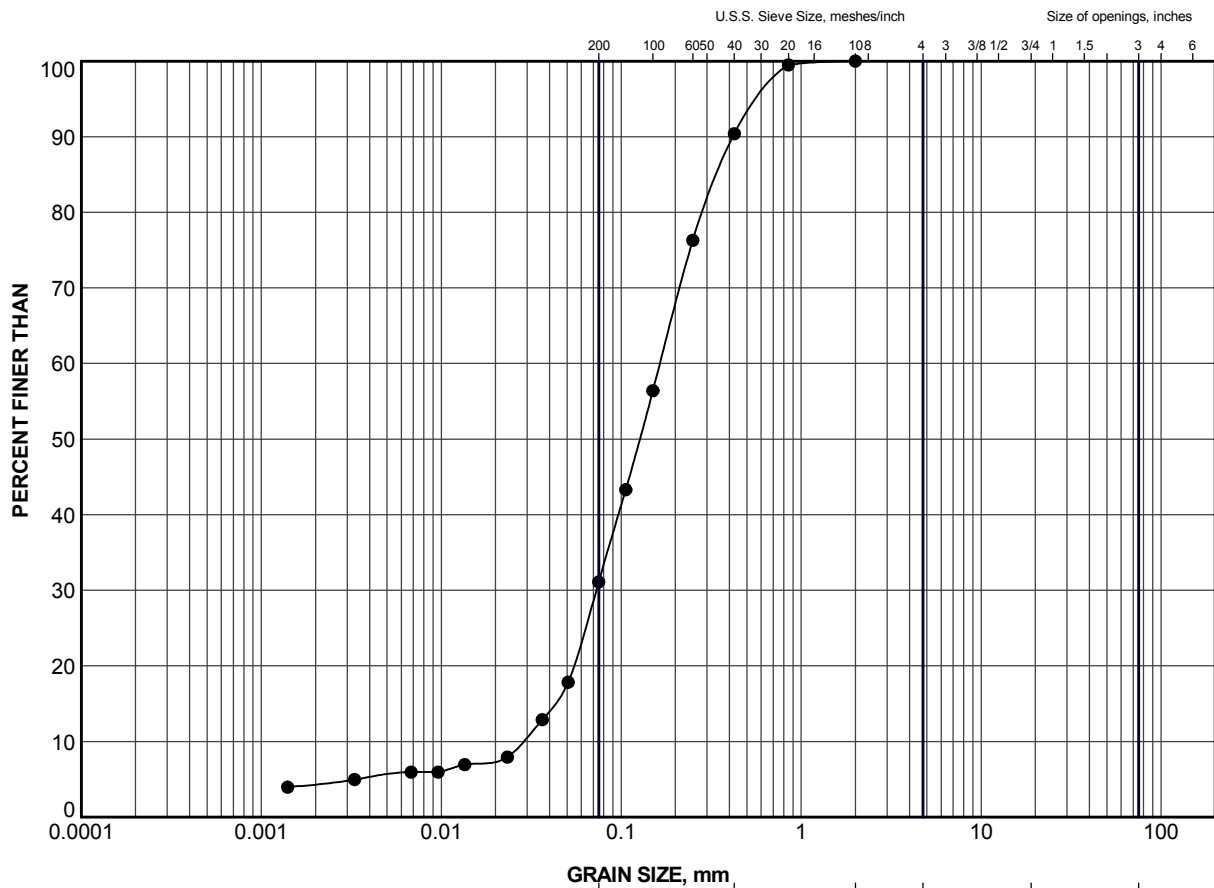


GRAIN SIZE, mm						
CLAY AND SILT	fine	medium	coarse	fine	coarse	Cobble Size
	SAND SIZE			GRAVEL SIZE		

LEGEND


SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	15	3	353.5
■	16	3	349.0

PROJECT				PROPOSED NOISE WALL BARRIER 5 WIDENING OF HIGHWAY 7/8 GWP 131-98-00			
TITLE				GRAIN SIZE DISTRIBUTION SAND AND GRAVEL			
PROJECT No.		08-1132-084-1		FILE No.		0811320841-R11B0A6	
DRAWN		LMK		SCALE		N/A	
CHECK				REV.			
		Jul 02/10					
 Golder Associates LONDON, ONTARIO				FIGURE A-6			

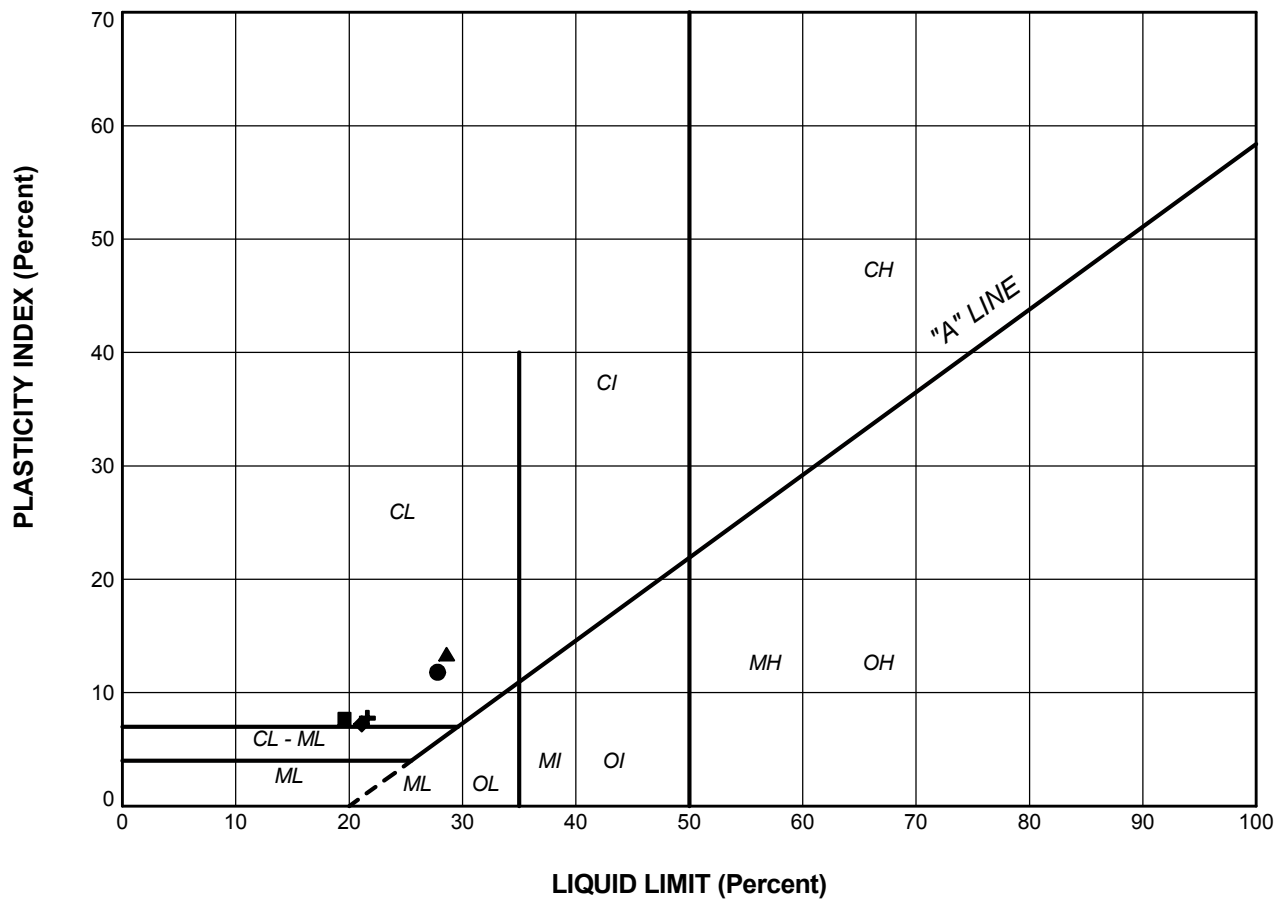


CLAY AND SILT	fine	medium	coarse	fine	coarse	Cobble Size
	SAND SIZE			GRAVEL SIZE		

LEGEND			
SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	16	5	347.3

PROJECT				PROPOSED NOISE BARRIER WALL 5 WIDENING OF HIGHWAY 7/8 GWP 131-98-00			
TITLE				GRAIN SIZE DISTRIBUTION SILTY SAND			
PROJECT No.		08-1132-084-1		FILE No.		0811320841-R11B0A7	
DRAWN		LMK		SCALE		N/A	
CHECK				REV.			
		Jun 21/10					
 Golder Associates LONDON, ONTARIO				FIGURE A-7			

LDN_MTO_NEW_GLDR_LDN.GDT



LEGEND

SYMBOL	BOREHOLE	SAMPLE	LL(%)	PL(%)	PI
●	10	3	27.8	16.0	11.8
■	10	5	19.6	11.9	7.7
▲	12	3	28.6	15.2	13.4
✚	13	2	21.6	13.9	7.8
◆	14	4	21.1	13.9	7.3

PROJECT				PROPOSED NOISE BARRIER WALL 5 WIDENING OF HIGHWAY 7/8 GWP 131-98-00			
TITLE				PLASTICITY CHART			
PROJECT No.		08-1132-084-1		FILE No.		0811320841-R11B0A8	
DRAWN	LMK	Jul 02/10		SCALE	N/A	REV.	
CHECK				FIGURE A-8			



At Golder Associates we strive to be the most respected global group of companies specializing in ground engineering and environmental services. Employee owned since our formation in 1960, we have created a unique culture with pride in ownership, resulting in long-term organizational stability. Golder professionals take the time to build an understanding of client needs and of the specific environments in which they operate. We continue to expand our technical capabilities and have experienced steady growth with employees now operating from offices located throughout Africa, Asia, Australasia, Europe, North America and South America.

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