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**FOUNDATION INVESTIGATION
AND DESIGN REPORT
NOISE BARRIER WALL REPLACEMENT
HIGHWAY 401 FROM AVENUE ROAD
TO BAYVIEW AVENUE
TORONTO, ONTARIO
G.W.P. 5-98-00**

Submitted to:

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PART A

**FOUNDATION INVESTIGATION REPORT
NOISE BARRIER WALL
HIGHWAY 401 FROM AVENUE ROAD TO BAYVIEW AVENUE
TORONTO, ONTARIO
G.W.P. 5-98-00**

1.0 INTRODUCTION

Golder Associates Ltd. (Golder) has been retained by Morrison Hershfield (MH) on behalf of the Ministry of Transportation, Ontario (MTO) to provide foundation engineering services associated with the rehabilitation/widening of Highway 401 eastbound and westbound core lanes between Avenue Road and Bayview Avenue, in the City of Toronto. Foundation engineering services are required for the widening of Hogg's Hollow bridge, replacement of the retaining walls associated with Hogg's Hollow bridge, new high mast light poles, new trichord overhead signs, and replacement of a noise barrier wall.

This report addresses the foundation investigation carried out for the proposed new noise barrier wall, extending along the north side of Highway 401 from Avenue Road eastward for a length of approximately 800 m.

The terms of reference and scope of work for the foundation investigation are outlined in MTO's Request for Proposal for Agreement No. 2005-E-0035, and in Section 6.8 of MH's *Technical Proposal* for G.W.P. 5-98-00.

2.0 SITE DESCRIPTION

The section of Highway 401 between Avenue Road and Bayview Avenue crosses the West Don River valley immediately to the west of Yonge Street. The ground surface adjacent to the West Don River banks is at about Elevation 134 m; the valley slopes rise approximately 33 m to 40 m, to about Elevation 167 m at the western crest of the valley, and about Elevation 174 m at the eastern crest of the valley. To the west and east of the West Don River valley, the “tableland” is relatively flat; at about Elevation 167 m to 171 m to the west of the river valley, and about Elevation 174 m to 178 m to the east of the river valley.

The proposed noise barrier wall replacement is located along the north side of Highway 401 and the E-N/S Avenue Road Ramp, south of Bombay Avenue, extending east from Avenue Road for a length of approximately 800 m. The ground surface in this area declines from west to east, from approximately Elevation 181.5 m on the east side of Avenue Road to approximately Elevation 171 m on Highway 401 near the east limit of the proposed noise barrier wall.

3.0 INVESTIGATION PROCEDURES

A subsurface investigation was carried out for the proposed noise barrier wall replacement in June and August 2007, at which time twelve boreholes (Boreholes NW-1 to NW-12) were advanced at the locations shown on Drawing 1. The borehole spacing along the proposed noise barrier wall alignment varies from approximately 50 m to 100 m depending on access conditions, and is on average approximately 75 m.

The boreholes were drilled with a truck-mounted D-25 drill rig, supplied and operated by Walker Drilling Ltd. of Utopia, Ontario. The boreholes were advanced to depths ranging from 6.2 m to 6.7 m, using solid stem augers. Soil samples were obtained at 0.75 m and 1.5 m intervals of depth, using 50 mm outside diameter split-spoon samplers driven by a manual hammer in accordance with the Standard Penetration Test (SPT) procedure.

The water level in the open boreholes was observed throughout the drilling operations. Upon completion, the boreholes were abandoned by backfilling to the ground surface using bentonite, in accordance with the requirements of Ontario Regulation 903 (amendment to Ontario Regulation 128).

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

The northings, eastings and elevations of the as-drilled borehole locations were measured in the field by a member of Golder's technical staff, relative to site features. The borehole locations (including MTM NAD83 northing and easting coordinates) and ground surface elevations (referenced to geodetic datum) are summarized below and are shown on Drawing 1.

<i>Borehole Number</i>	<i>MTM NAD83 Northing (m)</i>	<i>MTM NAD83 Easting (m)</i>	<i>Ground Surface Elevation (m)</i>
NW-1	4,844,862.0	310,913.0	181.5
NW-2	4,844,880.2	310,995.7	180.3
NW-3	4,844,892.8	311,047.9	179.5
NW-4	4,844,910.2	311,101.9	179.3
NW-5	4,844,951.4	311,153.2	178.9
NW-6	4,845,003.4	311,211.3	178.0
NW-7	4,845,053.4	311,266.0	176.8
NW-8	4,845,051.1	311,299.8	174.3
NW-9	4,845,168.3	311,392.6	172.5
NW-10	4,845,188.5	311,424.5	171.3
NW-11	4,845,255.6	311,467.6	171.4
NW-12	4,845,347.1	311,517.6	171.1

4.0 SITE GEOLOGY AND STRATIGRAPHY

4.1 Regional Geological Conditions

The Avenue Road to Bayview Avenue area of Highway 401 is located within the Peel Plain physiographic region, as delineated in *The Physiography of Southern Ontario*¹. A surficial till sheet, which generally follows the surface topography, is present throughout much of this area. The till is typically comprised of clayey silt to silty clay, with occasional sand to silt zones; it is mapped in this area as the Halton Till. Shallow, localized deposits of loose sand and silt and/or soft clay can overlie this uppermost till sheet, and these represent relatively recent deposits, formed in small glacial meltwater ponds scattered throughout the Peel Plain and concentrated near river valleys, such as the West Don River valley. The recent sand, silt and clay and uppermost till deposits in this area overlie and are interbedded with stratified deposits of sand, silt and clay.

4.2 Site Stratigraphy

Twelve boreholes (Boreholes NW-1 to NW-12) were advanced at this site along the proposed noise barrier wall alignment, at the locations shown on Drawing 1. The detailed subsurface soil and groundwater conditions encountered in the boreholes and the results of in situ and laboratory testing are shown on the borehole records following the text of this report; the laboratory testing results are also presented on Figures 1 through 5C. The stratigraphic boundaries shown on the borehole records are inferred from non-continuous sampling and, therefore, represent transitions between soil types rather than exact planes of geological change. The subsoil conditions will vary between and beyond the borehole location.

In general, Boreholes NW-1 to NW-12 encountered topsoil or asphalt and fill, overlying a deposit of stiff to hard clayey silt till; the till deposit grades to a non-plastic sand and silt till in some of the boreholes. The till deposit is underlain by a deposit of dense to very dense sand to sand and silt.

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

4.2.1 Topsoil

A layer of topsoil, between 200 mm and 450 mm thick, was encountered immediately below the ground surface in Boreholes NW-1 to NW-7, which were drilled in the grassed area to the south of Bombay Avenue.

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

4.2.2 Asphalt / Fill

Boreholes NW-8 and NW-10 to NW-12 were drilled along the shoulder of Highway 401, and Borehole NW-9 was drilled on Sandringham Drive to the north of the highway. These boreholes encountered 100 mm to 125 mm of asphalt overlying up to 200 mm of concrete, in turn underlain by approximately 150 mm to 500 mm of sand and gravel fill.

In Boreholes NW-11 and NW-12, the sand and gravel road base fill is underlain by a 2.2 m to 2.3 m thick layer of clayey silt fill. The surface of the clayey silt fill was encountered at Elevations 170.6 m and 170.3 m.

The fill consists of mottled brown and grey clayey silt with sand to some sand, trace gravel; trace quantities of organic matter was observed in the recovered samples from Borehole NW-11. The result of a grain size distribution test on one selected sample of the clayey silt fill is shown on Figure 1. An Atterberg limits test was completed on one selected sample of the fill; the result, which is plotted on a plasticity chart on Figure 2, confirms that this fill consists of low plasticity clayey silt.

The measured Standard Penetration Test (SPT) “N” values within the clayey silt fill were between 13 and 35 blows per 0.3 m of penetration, indicating that the encountered fill has a stiff to hard consistency.

4.2.3 Clayey Silt Till to Sand and Silt Till

A glacial till deposit was encountered below the topsoil in Boreholes NW-1 to NW-7, and below the pavement structure and fill in Boreholes NW-8 to NW-12. The surface of this till deposit was encountered between Elevation 181.2 m and 168.1 m, declining from west to east with the ground surface. The base of the till deposit also declines from west to east, from Elevation 178.5 m to below Elevation 165.3 m; Borehole NW-12, near the east limit of the noise barrier wall, was terminated within the till deposit at Elevation 164.4 m. The till deposit ranges in thickness from 1.5 m to 4.3 m in the boreholes in which it was fully penetrated; in Boreholes NW-10 and NW-12, where the deposit was not fully penetrated, the till is at least 5.4 m and 3.6 m thick, respectively.

The till deposit generally consists of clayey silt with sand to some sand, trace gravel; however, in Boreholes NW-6 and NW-8, the till grades to a non-plastic sand and silt containing trace gravel and trace to some clay. The results of grain size distribution tests completed on two selected samples of the clayey silt till and two selected samples of the sand and silt till are shown on Figure 3.

Cobbles were noted within the upper clayey silt till deposit in Borehole NW-9, as noted on the borehole record; although boulders were not encountered in any of the boreholes advanced along

the noise barrier wall alignment, this till deposit is glacially derived, and cobbles and boulders should be expected within the deposit.

Atterberg limits testing was carried out on fourteen selected samples of the till deposit. On twelve of the samples of clayey silt till, the testing measured plastic limits of 10 to 14 per cent, liquid limits of 16 to 25 per cent, and plasticity indices of 5 to 11 per cent. On two samples of sand and silt till, the testing determined one sample to be non-plastic while the second sample had a plastic limit of 11 per cent, a liquid limit of 15 per cent and a plasticity index of 4 per cent. These results, which are plotted on a plasticity chart on Figure 4, confirm that the cohesive portion of the till deposit consists of clayey silt of low plasticity, and that the till deposit grades to a non-plastic sand and silt.

The measured SPT “N” values within the clayey silt till range from 9 blows per 0.3 m of penetration to 50 blows per 0.08 m of penetration, but are typically between 15 and about 50 blows per 0.3 m of penetration. The SPT “N” values indicate that the clayey silt has a stiff to hard (but typically very stiff to hard) consistency. The measured SPT “N” values in the sand and silt till range from 32 blows per 0.3 m of penetration to 50 blows per 0.10 of penetration, indicating that this portion of the till has a dense to very dense relative density.

4.2.4 Sand to Sand and Silt

A cohesionless soil deposit was encountered below the clayey silt to sand and silt till deposit in all of the boreholes except Boreholes NW-10 and NW-12 (which were terminated within the till). The surface of this deposit was encountered at depths of between 2.3 m and 6.1 m, declining from Elevation 178.5 m in Borehole NW-1 at the west limit of the noise barrier wall to Elevation 165.3 m near the east end of the noise barrier wall. This soil deposit was fully penetrated only in Borehole NW-8, where it was found to be 3.8 m in thickness. This soil deposit was not fully penetrated in any of the other boreholes, though it is up to at least 4.3 m in thickness as encountered in some of the boreholes.

The cohesionless soil deposit varies in composition from sand containing trace silt, to sand and silt containing trace gravel and clay. The results of grain size distribution tests completed on sixteen selected samples of this sand to sand and silt deposit are shown on Figures 5A to 5C. Atterberg limits testing was carried out on one sample of this deposit (Borehole NW-8, Sample 3) and confirmed that it is non-plastic.

Although cobbles and boulders were not encountered within the sand to sand and silt in the boreholes advanced along the noise barrier wall alignment, this deposit is glacially (glaciofluvially) derived, and cobbles and boulders should be expected within the deposit.

The measured SPT “N” values within the sand to sand and silt deposit range from 40 blows per 0.3 m of penetration to 50 blows per 0.08 m of penetration, indicating that this deposit has a dense to very dense relative density.

4.2.5 Lower Clayey Silt Till

A lower deposit of clayey silt till was encountered below the sand and silt in Borehole NW-8. The surface of this clayey silt till was encountered at a depth of 6.1 m, at Elevation 168.2 m; the deposit was not fully penetrated in this borehole.

Although cobbles and boulders were not encountered within the lower clayey silt till deposit (where encountered in the boreholes along the noise barrier wall alignment), the lower till is glacially derived, and cobbles and boulders should be expected within the deposit.

One SPT “N” value of 50 blows per 0.1 m of penetration was measured in the lower clayey silt till, indicating that it has a hard consistency.

4.2.6 Groundwater Conditions

The boreholes drilled for the noise barrier wall were found to be dry upon completion of drilling, except Borehole NW-8 in which the water level in the open borehole was measured at a depth of 5.5 m (Elevation 168.8 m) on completion of drilling.


The groundwater level across the site follows the topography of the West Don River valley. Based on water level monitoring completed in previous boreholes advanced at the site, the groundwater level in the “tableland” to the west of the river valley is typically at a depth of approximately 3 m to 5 m below the ground surface.


The groundwater level is expected to fluctuate seasonally and is expected to rise during periods of high precipitation.

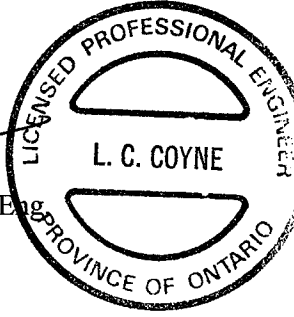
5.0 CLOSURE

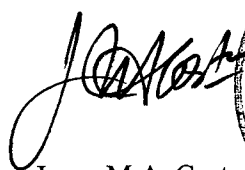
This Foundation Investigation Report was prepared by Mr. Matthew Kelly and reviewed by Ms. Lisa Coyne, P.Eng., an Associate and geotechnical engineer with Golder. Mr. Jorge Costa, P.Eng., a Principal and Designated MTO Contact for Golder, conducted an independent quality review of the report.

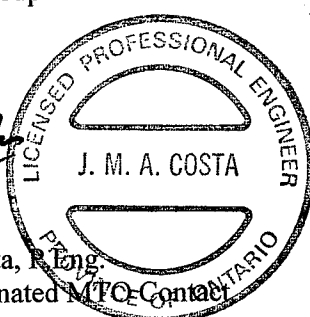
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PART B

**FOUNDATION DESIGN REPORT
NOISE BARRIER WALL
HIGHWAY 401 FROM AVENUE ROAD TO BAYVIEW AVENUE
TORONTO, ONTARIO
G.W.P. 5-98-00**

6.0 ENGINEERING RECOMMENDATIONS

6.1 General

This section of the report provides geotechnical parameters and recommendations for the geotechnical aspects of design of the proposed noise barrier wall replacement along the north side of Highway 401, extending easterly from Avenue Road for a length of approximately 800 m. 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 foundations should be designed and constructed in accordance with MTO's Special Provision SP599F01. It is recommended that the noise barrier wall be supported using conventional augered caissons, with a diameter of 0.6 m to 0.9 m. Geotechnical design parameters for design of the caisson foundations are provided in Table 1 following the text of this report, based on the soil conditions encountered along the proposed noise barrier wall alignments. The stratigraphy presented in Table 1 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 the undrained condition, and the larger of the two calculated caisson depths shall govern.

The passive resistance within the upper 1.2 m below ground surface 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 caissons is level. Where sloping ground is present adjacent to the noise barrier wall (i.e., east of approximately Station 0+700, where the proposed noise barrier wall will be installed at the crest of the Highway 401 embankment), the K_p values used in the calculation of the passive resistance should be adjusted to account for the presence of the sloping ground; adjusted K_p values are provided in Table 1 for the area east of Station 0+700, based on conventional embankment side slope orientations of 2 horizontal to 1 vertical (NAVFAC, 1982²). The adjusted K_p value is to be applied to that portion

² Department of the Navy, Naval Facilities Engineering Command (NAVFAC). 1982. *Foundations and Earth Structures, Design Manual 7.2*.

of the caisson that is above the elevation of the ground surface at the embankment toe; below this elevation, the full K_p value is applied.

Available utility plans indicate that a sanitary sewer is present parallel to and in close proximity to the proposed noise barrier wall alignment between approximately Stations 0+655 and 0+705. However, information regarding the existing pipe diameter and composition, invert elevation and age of this sanitary sewer has not been available to date from the City of Toronto. In the design of the noise barrier wall foundations, the lateral loading from the caisson foundations should be determined at the sewer level. If the existing sanitary sewer cannot accommodate the assessed lateral loading, then provision should be made for deepening of the caisson foundations, protection of the sewer, and/or realignment of the noise barrier wall or sewer.

6.3 Construction Considerations


Caisson construction for the noise barrier wall foundations will generally require excavation through the clayey silt to sand and silt till deposit, into the sand to sand and silt deposit, which could be susceptible to disturbance during caisson excavation and construction. The use of a temporary liner to advance the auger holes is recommended, in order to minimise disturbance and ground loss during drilling and concrete placement. It is recommended that a Non-Standard Special Provision (NSSP) be included in the Contract Documents to warn the Contractor of this condition since it may affect the installation of the noise barrier wall foundations. A sample NSSP is provided in Appendix A.


In accordance with MTO's SP 599F01, 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.

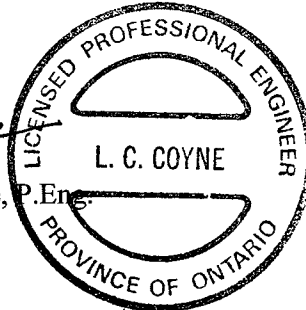
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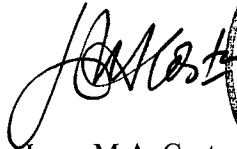
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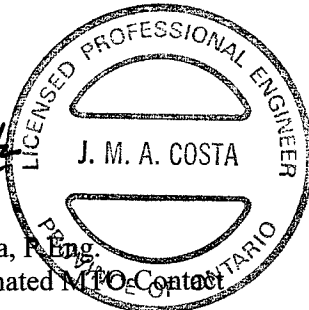
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TABLE 1
GEOTECHNICAL DESIGN PARAMETERS FOR
PROPOSED NOISE BARRIER WALL REPLACEMENT
HIGHWAY 401 EAST OF AVENUE ROAD, TORONTO, ONTARIO
G.W.P. 5-98-00

Noise Barrier Wall Station	Design Groundwater Elevation	Soil	Elevation Interval	c_u	ϕ'	K_p Level Ground	K_p 2H:1V	γ	γ'
0+000 to 0+075	177 m	Very stiff clayey silt till Hard clayey silt till / Very dense sand and silt	Above Elevation 180 m Below Elevation 180 m	150 -	32 35	3.3 3.7	- -	21 21	11 11
0+075 to 0+175	176 m	Stiff/very stiff clayey silt till Hard clayey silt till / Dense to very dense sand and silt	Above Elevation 178 m Below Elevation 178 m	100 -	32 35	3.3 3.7	- -	21 21	11 11
0+175 to 0+300	175 m	Very stiff clayey silt till Hard clayey silt till / Very dense sand to sand and silt	Above Elevation 177.5 m Below Elevation 177.5 m	150 -	32 35	3.3 3.7	- -	21 21	11 11
0+300 to 0+400	173.5 m	Stiff clayey silt till Dense to very dense sand and silt till / Very dense sand and silt	Above Elevation 176 m Below Elevation 176 m	100 -	32 35	3.3 3.7	- -	21 21	11 11
0+400 to 0+450	172.5	Stiff clayey silt till Hard clayey silt till / Very dense sand and silt	Above Elevation 175 m Below Elevation 175 m	75 -	28 35	2.8 3.7	- -	20 21	10 11
0+450 to 0+550	170 m	Fill / Dense sand and silt till Very dense sand and silt till / Very dense sand and silt	Above Elevation 172 m Below Elevation 172 m	- -	32 35	3.3 3.7	- -	20 21	10 11
0+550 to 0+675	168 m	Fill / Very stiff to hard clayey silt till Hard clayey silt till / Very Dense sand and silt	Above Elevation 170 m Below Elevation 170 m	- -	32 35	3.3 3.7	- -	21 21	11 11
0+675 to 0+700	165 m	Stiff to hard clayey silt fill Stiff to hard clayey silt till / Very dense sand and silt	Above Elevation 168 m Below Elevation 168 m	100 -	28 32	2.8 3.3	- -	20 21	10 11
0+700 to 0+819	165 m	Stiff to hard clayey silt fill Stiff to hard clayey silt till / Very dense sand and silt	Above Elevation 168 m Below Elevation 168 m	100 -	28 32	2.8 3.3	1.0 1.2	20 21	10 11

NOTES:

- c_u = Undrained shear strength of soil (kPa)
 ϕ' = Effective angle of friction in soil (degrees)
 K_p = Coefficient of passive pressure
 γ = Bulk unit weight of soil (kN/m³)
 γ' = Effective unit weight of soil below the groundwater level (kN/m³)
- Where both c_u and ϕ' have been given for a specific stratum, the foundation design should be checked for both the drained and the undrained conditions, and the larger of the two calculated foundation depths shall govern.
 - 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. In the above table, the adjusted K_p values are provided for a typical embankment side slope configuration of 2H:1V.
 - Below the groundwater level, the effective unit weight of the soil (γ') should be used.

LIST OF ABBREVIATIONS

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

I. SAMPLE TYPE

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

III. SOIL DESCRIPTION

(a) Cohesionless Soils

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

II. PENETRATION RESISTANCE

Standard Penetration Resistance (SPT), N:

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

Consistency

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

Dynamic Cone Penetration Resistance; N_d :

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

PH: Sampler advanced by hydraulic pressure

PM: Sampler advanced by manual pressure

WH: Sampler advanced by static weight of hammer

WR: Sampler advanced by weight of sampler and rod

Piezo-Cone Penetration Test (CPT)

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

IV. SOIL TESTS

w	water content
w_p	plastic limit
w_l	liquid limit
C	consolidation (oedometer) test
CHEM	chemical analysis (refer to text)
CID	consolidated isotropically drained triaxial 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 NW-1

1 OF 1 **METRIC**

PROJECT 06-1111-060

W.P. 5-98-00

LOCATION N 4844862.0 ; E 310913.0

ORIGINATED BY SB

DIST Central HWY 401

BOREHOLE TYPE Truck-Mount D-25, 108 mm Diameter Solid Stem Augers, Manual Hammer

COMPILED BY MWK

DATUM Geodetic

DATE June 22, 2007

CHECKED BY LCC

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
181.5	GROUND SURFACE							20 40 60 80 100						GR SA SI CL
0.0	TOPSOIL							20 40 60 80 100						
181.2														
0.3	CLAYEY SILT with sand to some sand, trace gravel (TILL) Very stiff to hard Brown Moist		1	SS	15		181							
							180							
			2	SS	56									
							179							
			3	SS	61									
178.5														
3.0	SAND and SILT, trace gravel Very dense Brown Moist		4	SS	48/0.15		178							7 43 43 7
							177							
			5	SS	86									
							176							
			6	SS	67									0 62 37 1
							175							
174.8			7	SS	58									
6.7	END OF BOREHOLE													
	NOTES: 1. Open borehole dry upon completion of drilling.													

IS-MTO 001_061111060.GPJ GAL-MISS.GDT 11/9/07 DD/RJ

RECORD OF BOREHOLE No NW-2

1 OF 1 **METRIC**

PROJECT 06-1111-060
 W.P. 5-98-00 LOCATION N 4844880.2 ; E 310995.7 ORIGINATED BY SB
 DIST Central HWY 401 BOREHOLE TYPE Truck-Mount D-25, 108 mm Diameter Solid Stem Augers, Manual Hammer COMPILED BY MWK
 DATUM Geodetic DATE June 22, 2007 CHECKED BY LCC

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 (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa			w _p	w	w _L		
								○ UNCONFINED	+ FIELD VANE	● QUICK TRIAXIAL × REMOULDED					
180.3	GROUND SURFACE						20	40	60	80	100				
0.0 180.0	TOPSOIL						20	40	60	80	100				
0.3	CLAYEY SILT with sand to some sand, trace gravel (TILL) Stiff to very stiff Brown Moist		1	SS	11								○ — —		
			2	SS	25										
178.0	Silty SAND to SAND, trace to some silt Dense to very dense Brown Moist		3	SS	40								○		0 70 28 2
2.3			4	SS	58										
			5	SS	75										
			6	SS	52								○		1 95 3 1
173.7			7	SS	93										
6.6	END OF BOREHOLE														
	NOTES: 1. Open borehole dry upon completion of drilling.														

+³, X³: Numbers refer to Sensitivity
 O³% STRAIN AT FAILURE

RECORD OF BOREHOLE No NW-3

1 OF 1 **METRIC**

PROJECT 06-1111-060

W.P. 5-98-00

LOCATION N 4844892.8 ; E 311047.9

ORIGINATED BY SB

DIST Central HWY 401

BOREHOLE TYPE Truck-Mount D-25, 108 mm Diameter Solid Stem Augers, Manual Hammer

COMPILED BY MWK

DATUM Geodetic

DATE June 21, 2007

CHECKED BY LCC

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT W _p W W _L			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED		WATER CONTENT (%)				
179.5	GROUND SURFACE													
0.0	TOPSOIL													
179.1														
0.4	CLAYEY SILT with sand to some sand, trace gravel (TILL) Very stiff to hard Brown Moist		1	SS	15		179							
			2	SS	38		178							
177.2														
2.3	SAND and SILT, trace gravel and clay Very dense Brown Moist		3	SS	55		177							9 39 44 8
			4	SS	76									
			5	SS	75		176							
			6	SS	105		175							
							174							
			7	SS	80									0 47 50 3
172.9	END OF BOREHOLE						173							
6.6	NOTES: 1. Open borehole dry upon completion of drilling.													

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RECORD OF BOREHOLE No NW-4

1 OF 1 **METRIC**

PROJECT 06-1111-060

W.P. 5-98-00

LOCATION N 4844910.2; E 311101.9

ORIGINATED BY SB

DIST Central HWY 401

BOREHOLE TYPE Truck-Mount D-25, 108 mm Diameter Solid Stem Augers, Manual Hammer

COMPILED BY MWK

DATUM Geodetic

DATE June 22, 2007

CHECKED BY LCC

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
179.3	GROUND SURFACE							20 40 60 80 100						
0.0	TOPSOIL							20 40 60 80 100						
0.2	CLAYEY SILT with sand to some sand, trace gravel (TILL) Hard Brown Moist		1	SS	35		179							
			2	SS	48		178							
177.0	SAND, trace silt to silty SAND Very dense Brown Moist		3	SS	89/0.25		177							0 91 8 1
2.3			4	SS	80		176							
			5	SS	52		175							0 62 24 4
			6	SS	58		174							



RECORD OF BOREHOLE No NW-5

1 OF 1 METRIC

PROJECT 06-1111-060

W.P. 5-98-00

LOCATION N 4844951.4; E 311153.2

ORIGINATED BY SB

DIST Central HWY 401

BOREHOLE TYPE Truck-Mount D-25, 108 mm Diameter Solid Stem Augers, Manual Hammer

COMPILED BY MWK

DATUM Geodetic

DATE June 21, 2007

CHECKED BY LCC

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x REMOULDED	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								
178.9	GROUND SURFACE												
0.0	TOPSOIL												
178.8													
0.3	CLAYEY SILT with sand to some sand, trace gravel (TILL) Very stiff to hard Brown Moist		1	SS	24		178						
			2	SS	42		177						
176.6			3	SS	57		176						
2.3	SAND and SILT, trace gravel, trace clay Very dense Brown Moist		4	SS	50/0.15								0 48 47 5
			5	SS	51/0.15		175						
			6	SS	55/0.15		174						
							173						
172.7			7	SS	70/0.15								2 46 47 5
6.2	END OF BOREHOLE												
	NOTES: 1. Open borehole dry upon completion of drilling.												

PROJECT 06-1111-060			RECORD OF BOREHOLE No NW-6			1 OF 1 METRIC					
W.P. 5-98-00			LOCATION N 4845003.4 ; E 311211.3			ORIGINATED BY SB					
DIST Central HWY 401			BOREHOLE TYPE Truck-Mount D-25, 108 mm Diameter Solid Stem Augers, Manual Hammer			COMPILED BY MWK					
DATUM Geodetic			DATE June 21, 2007			CHECKED BY LCC					
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x REMOULDED 20 40 60 80 100	PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT W _p — W — W _L WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
178.0	GROUND SURFACE										
0.0	TOPSOIL										
177.7											
0.3	CLAYEY SILT with sand to some sand, trace gravel (TILL) Stiff Brown Moist		1	SS	13		177				
176.5											
1.5	SAND and SILT, trace gravel, trace to some clay (TILL) Dense to very dense Brown Moist		2	SS	46		176				6 35 48 11
			3	SS	85/0.25						
			4	SS	88		175				
174.2											
3.8	SAND and SILT, trace gravel and clay Very dense Brown Moist		5	SS	55/0.15		174				
			6	SS	50/0.10		173				4 40 52 4
							172				
171.8			7	SS	67/0.15						
6.2	END OF BOREHOLE										
NOTES: 1. Open borehole dry upon completion of drilling.											

PROJECT 06-1111-060			RECORD OF BOREHOLE No NW-7			1 OF 1 METRIC	
W.P. 5-98-00			LOCATION N 4845053.4 ; E 311266.0			ORIGINATED BY SB	
DIST Central HWY 401			BOREHOLE TYPE Truck-Mount D-25, 108 mm Diameter Solid Stem Augers, Manual Hammer			COMPILED BY MWK	
DATUM Geodetic			DATE June 21, 2007			CHECKED BY LCC	
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE
176.8	GROUND SURFACE						
0.0	TOPSOIL						
176.3							
0.5	CLAYEY SILT with sand to some sand, trace gravel (TILL) Stiff to hard Brown Moist		1	SS	9		176
			2	SS	52		175
174.5							
2.3	SAND and SILT, trace clay and gravel Very dense Brown Moist		3	SS	67		174
			4	SS	50/0.08		
			5	SS	50/0.08		173
			6	SS	70/0.14		172
							171
170.6			7	SS	75/0.15		
6.2	END OF BOREHOLE						
NOTES: 1. Open borehole dry upon completion of drilling.							

RECORD OF BOREHOLE No NW-8

1 OF 1 **METRIC**

PROJECT 06-1111-060 LOCATION N 4845051.1 : E 311299.8 ORIGINATED BY SB
 W.P. 5-98-00 BOREHOLE TYPE Truck-Mount D-25, 108 mm Diameter Solid Stem Augers, Manual Hammer COMPILED BY PKS
 DIST Central HWY 401 DATE August 27, 2007 CHECKED BY LCC
 DATUM Geodetic

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							
174.3	GROUND SURFACE							20 40 60 80 100							
0.0	ASPHALT						174								
0.3	CONCRETE						173								
173.5	Sand and gravel (FILL)														
0.8	Compact Brown														
	SAND and SILT, trace to some gravel, trace clay (TILL) Dense to very dense Brown Moist		1	SS	32										
			2	SS	50/0.10										
172.0							172								
2.3	SAND and SILT, trace clay, trace gravel Very dense Brown Moist		3	SS	50/0.08										
			4	SS	50/0.15										
							171								
							170								
			5	SS	50/0.15										
							169								
168.2															
6.2	CLAYEY SILT, some sand, trace gravel (TILL) Hard Brown Moist END OF BOREHOLE		6	SS	50/0.10										
NOTES: 1. Water level in open borehole at a depth of 5.5 m (Elevation 168.8 m) upon completion of drilling.															

RECORD OF BOREHOLE No NW-9

1 OF 1 **METRIC**

PROJECT 06-1111-060

W.P. 5-98-00

LOCATION N 4845168.3 ; E 311392.6

ORIGINATED BY SB

DIST Central HWY 401

BOREHOLE TYPE Truck-Mount D-25, 108 mm Diameter Solid Stem Augers, Manual Hammer

COMPILED BY MWK

DATUM Geodetic

DATE June 21, 2007

CHECKED BY LCC

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa								
172.5	GROUND SURFACE							20	40	60	80	100				
0.0	ASPHALT							20	40	60	80	100				
0.3	Sand and gravel (FILL)															
	CLAYEY SILT with sand, trace gravel, containing cobbles (TILL) Very stiff to hard Brown Moist		1	SS	21		172									
			2	SS	34		171									3 35 45 17
			3	SS	34		170									
			4	SS	39		169									
	Becoming grey at a depth of 3.8 m		5	SS	50/0.08											
167.9			6	SS	50/0.15		168									5 50 40 5
4.6	SAND and SILT, trace gravel and clay Very dense Brown Moist						167									
166.3			7	SS	50/0.08											
6.2	END OF BOREHOLE															
	NOTES: 1. Open borehole dry upon completion of drilling.															

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

RECORD OF BOREHOLE No NW-10										1 OF 1 METRIC				
PROJECT 06-1111-060			LOCATION N 4845188.5 ; E 311424.5				ORIGINATED BY SB							
W.P. 5-98-00			BOREHOLE TYPE Truck-Mount D-25, 108 mm Diameter Solid Stem Augers, Manual Hammer				COMPILED BY PKS							
DIST Central HWY 401			DATE August 27, 2007				CHECKED BY LCC							
DATUM Geodetic														
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
171.3	GROUND SURFACE													
0.0	ASPHALT													
0.3	CONCRETE													
170.5	Sand and gravel (FILL) Compact													
0.9	Brown Moist Organic CLAYEY SILT		1	SS	22									
	CLAYEY SILT with sand, trace gravel (TILL) Very stiff to hard		2	SS	32									
	Brown to grey Moist		3	SS	43									
			4	SS	54									
			5	SS	55									
165.1	END OF BOREHOLE		6	SS	60/0.15									
6.3	NOTES: 1. Open borehole dry upon completion of drilling.													

RECORD OF BOREHOLE No NW-11

1 OF 1 **METRIC**

PROJECT 06-1111-060

W.P. 5-98-00

LOCATION N 4845255.6 ; E 311467.6

ORIGINATED BY SB

DIST Central HWY 401

BOREHOLE TYPE Truck-Mount D-25, 108 mm Diameter Solid Stem Augers, Manual Hammer

COMPILED BY PKS

DATUM Geodetic

DATE August 26, 2007

CHECKED BY LCC

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
								○ UNCONFINED + FIELD VANE									
								● QUICK TRIAXIAL × REMOULDED									
							WATER CONTENT (%)										
171.4	GROUND SURFACE						20	40	60	80	100	10	20	30			
0.0	ASPHALT																
0.3	CONCRETE																
170.6	Sand and gravel (FILL)																
0.8	Compact Brown Moist		1	SS	31												
	Clayey silt , some sand, trace gravel, containing organics (FILL) Very stiff to hard		2	SS	26												
	Brown Moist		3	SS	35												
168.4	CLAYEY SILT, some sand, trace gravel (TILL) Stiff to very stiff		4	SS	16												
3.0	Brown Moist		5	SS	14												
165.3	SAND and SILT, some clay, trace gravel		6	SS	55/0.15										3 46 40 12		
165.0	Very dense Brown Moist																
6.4	END OF BOREHOLE																
NOTES: 1. Open borehole dry upon completion of drilling.																	

RECORD OF BOREHOLE No NW-12

1 OF 1 **METRIC**

PROJECT 06-1111-060

W.P. 5-98-00

LOCATION N 4845347.1 ; E 311517.6

ORIGINATED BY SB

DIST Central HWY 401

BOREHOLE TYPE Truck-Mount D-25, 108 mm Diameter Solid Stem Augers, Manual Hammer

COMPILED BY PKS

DATUM Geodetic

DATE August 26, 2007

CHECKED BY LCC

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa		WATER CONTENT (%)				
171.1	GROUND SURFACE						20 40 60 80 100	20 40 60 80 100	10 20 30					
0.0	ASPHALT													
0.3	CONCRETE													
170.3	Sand and gravel (FILL)													
0.8	Compact Brown Moist													
	Clayey silt with sand, trace gravel (FILL)		1	SS	18									
	Stiff to very stiff													
	Mottled brown and grey		2	SS	24									
	Moist													
			3	SS	13									
168.1	CLAYEY SILT with sand, trace gravel (TILL)													
3.1	Hard Brown to grey Moist		4	SS	33									
			5	SS	37									
			6	SS	67									
164.4	END OF BOREHOLE													
6.7	NOTES: 1. Open borehole dry upon completion of drilling.													

+³, X³: Numbers refer to Sensitivity

○³% STRAIN AT FAILURE

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

CONT No.
WP No. 5-98-00

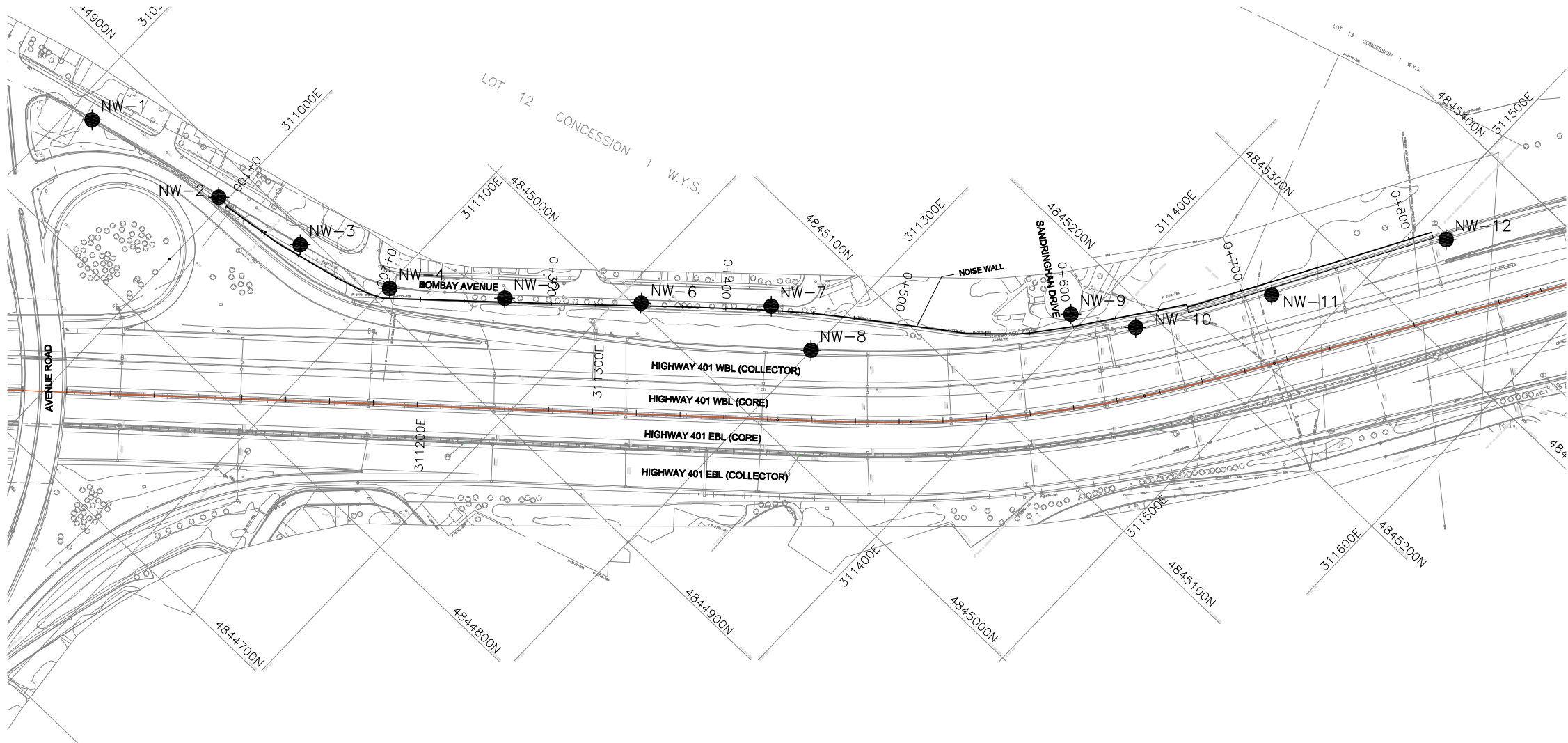
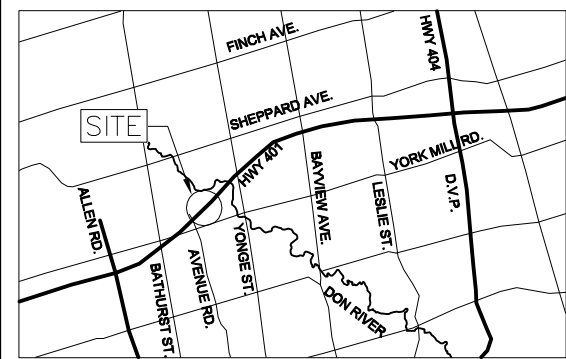


HIGHWAY 401
NOISE BARRIER WALL
BOREHOLE LOCATIONS

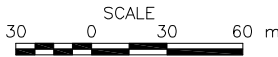
SHEET



Golder Associates Ltd.
MISSISSAUGA, ONTARIO, CANADA



PLAN



LEGEND

Borehole - Current Investigation

No.	ELEVATION	CO-ORDINATES	
		NORTHING	EASTING
NW-1	181.5	4844862.0	310913.0
NW-2	180.3	4844880.2	310995.7
NW-3	179.5	4844892.8	311047.9
NW-4	179.3	4844910.2	311101.9
NW-5	178.9	4844951.4	311153.2
NW-6	178.0	4845003.4	311211.3
NW-7	176.8	4845053.4	311266.0
NW-8	174.3	4845051.1	311299.8
NW-9	172.5	4845168.3	311392.6
NW-10	171.3	4845188.5	311424.5
NW-11	171.4	4845255.6	311467.6
NW-12	171.1	4845347.1	311517.6

NOTES

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

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

REFERENCE

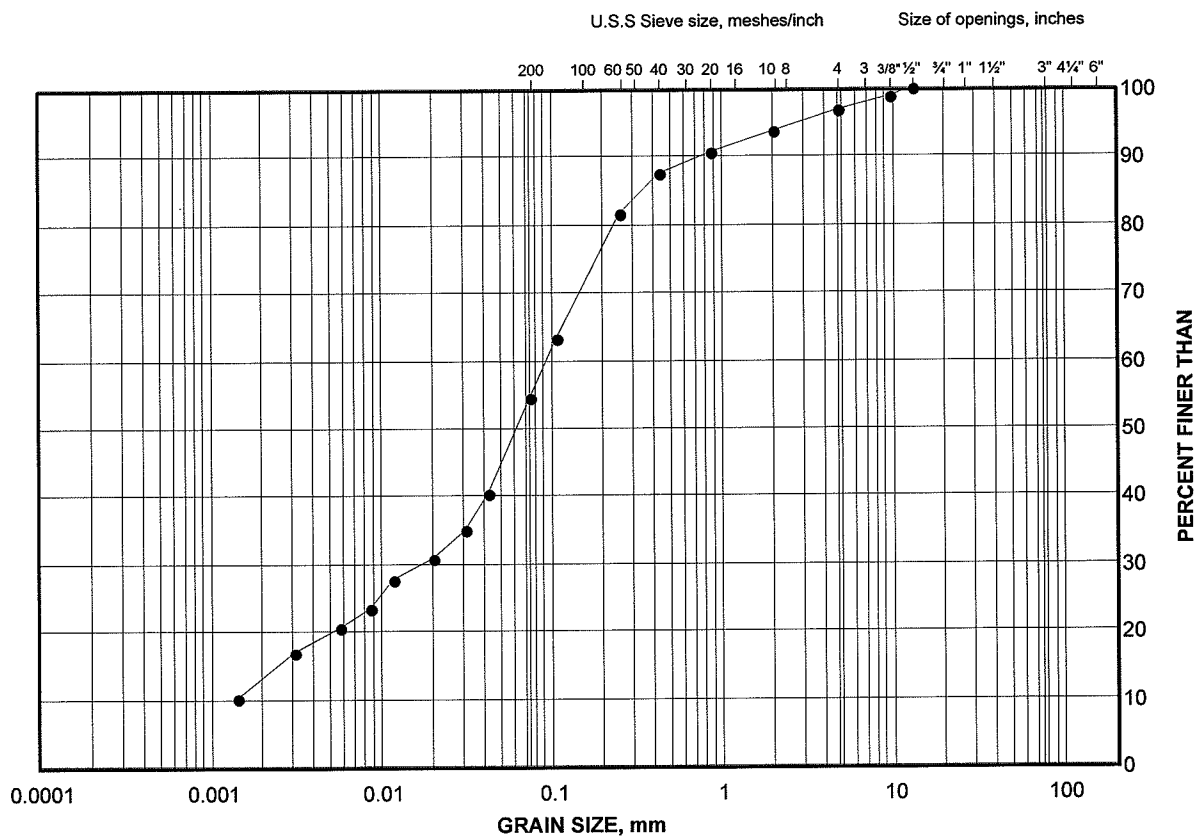
Base plans provided in digital format by Morrison Hershfield Limited, received Aug. 09, 2007.

NO.	DATE	BY	REVISION
Geocres No. 30M11-225			
HWY. 401		PROJECT NO. 06-1111-060-1	
SUBM'D. PKS	CHKD. LCC	DATE: 15/02/2008	SITE:
DRAWN: RJ/DD	CHKD. PKS	APPD. LCC	DWG. 1

GRAIN SIZE DISTRIBUTION TEST RESULT

Clayey Silt Fill

FIGURE 1



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

LEGEND

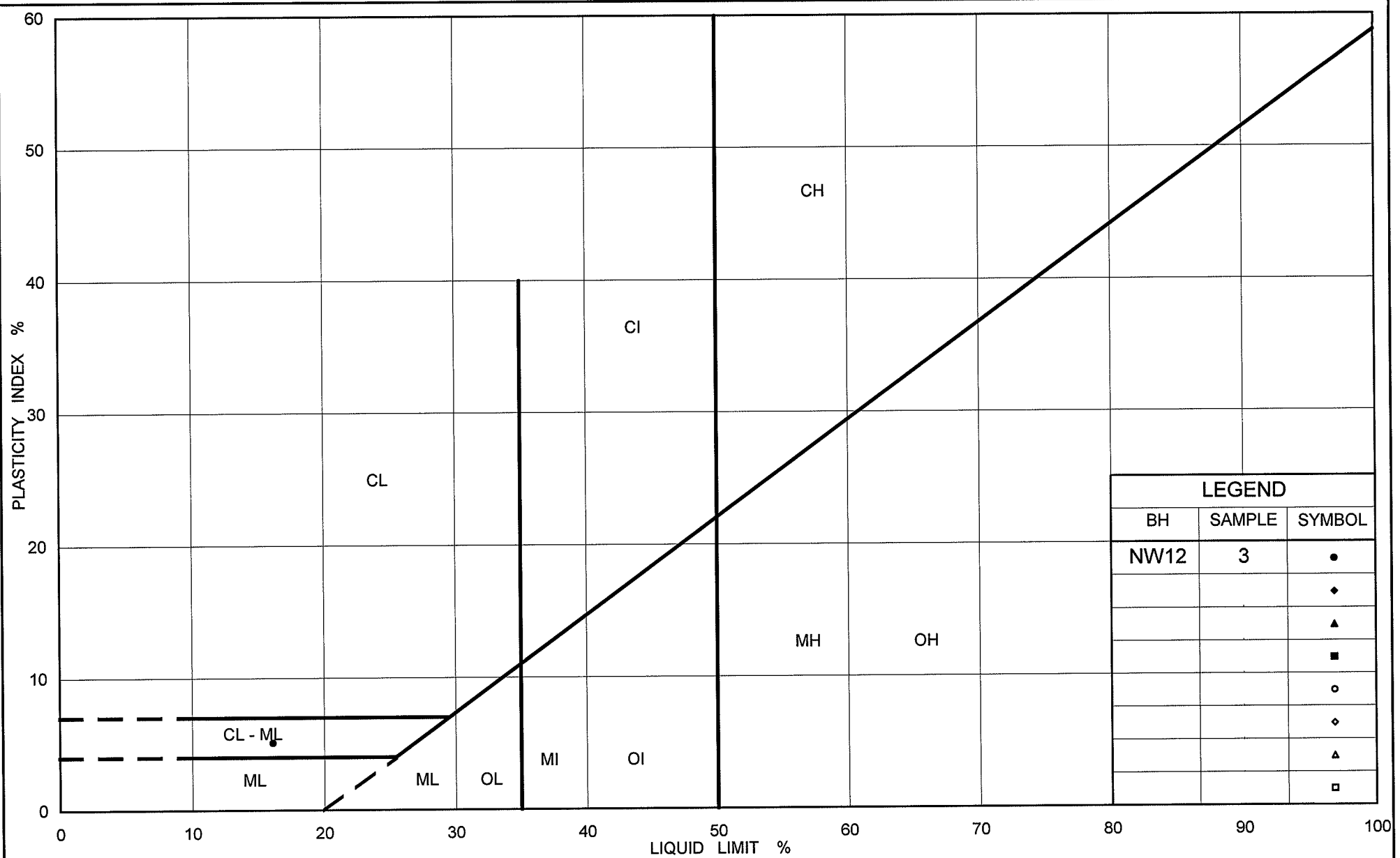
SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
•	NW12	3	168.5

Project Number: 06-1111-060-4

Checked By: *[Signature]*

Golder Associates

Date: 13-Nov-07



Ministry of Transportation

Ontario

PLASTICITY CHART Clayey Silt Fill

Figure No. 2

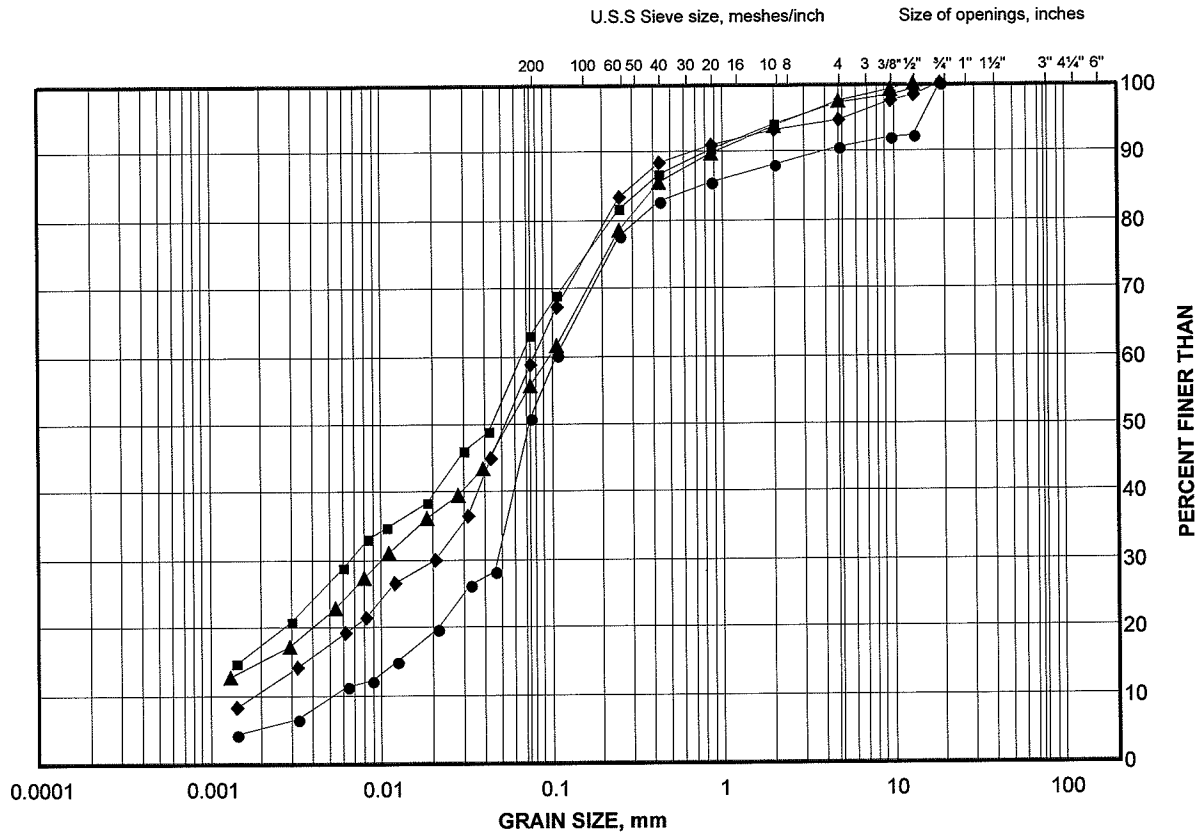
Project No. 06-1111-060-4

Checked By: *Ulysses*

GRAIN SIZE DISTRIBUTION TEST RESULTS

Clayey Silt Till to Sand and Silt Till

FIGURE 3



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

LEGEND

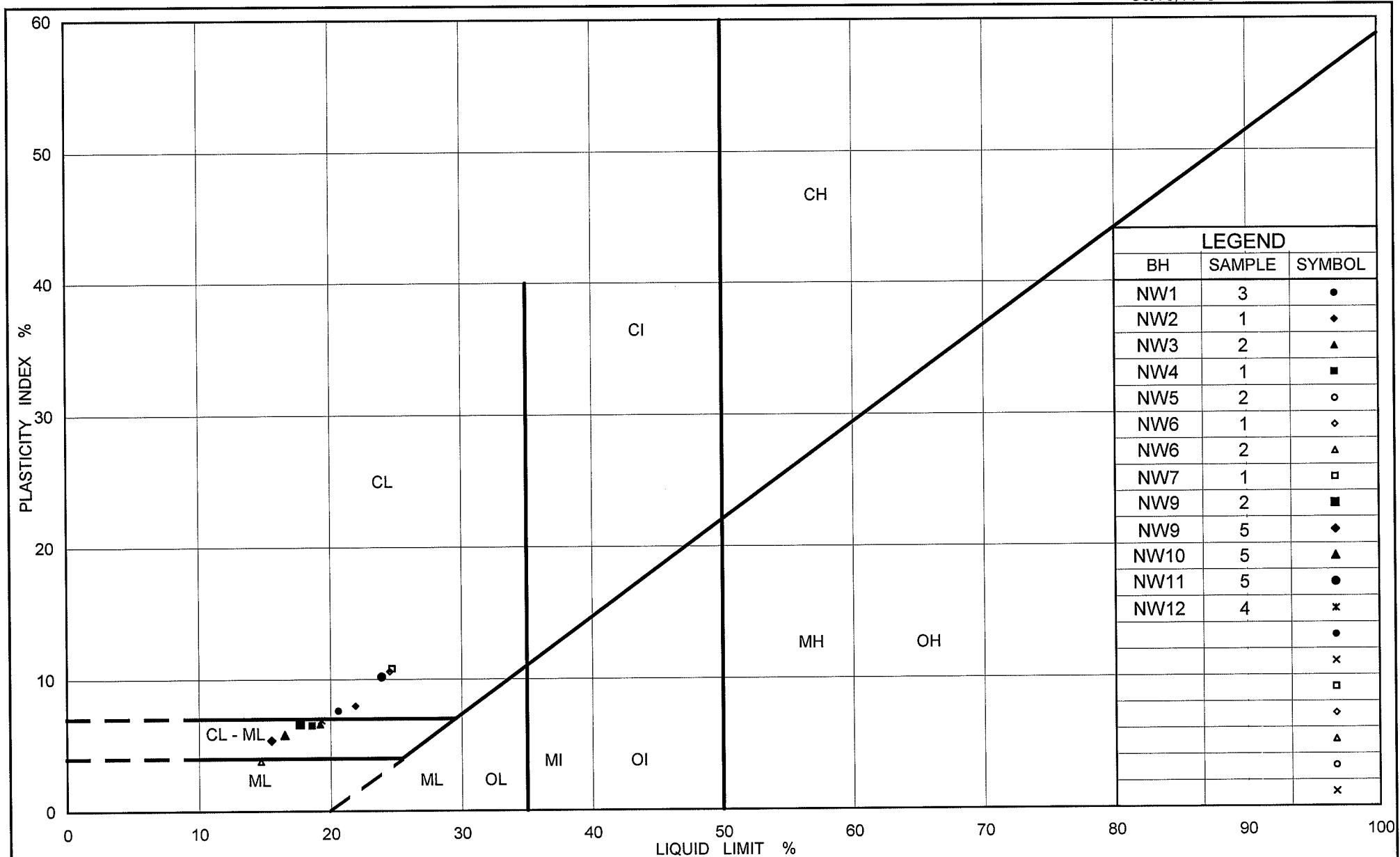
SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	NW8	2	172.7
■	NW9	2	170.7
◆	NW6	2	176.2
▲	NW10	5	166.4

Project Number: 06-1111-060-4

Checked By: *[Signature]*

Golder Associates

Date: 08-Nov-07



Ministry of Transportation

Ontario

PLASTICITY CHART Clayey Silt Till to Sand and Silt Till

Figure No. 4

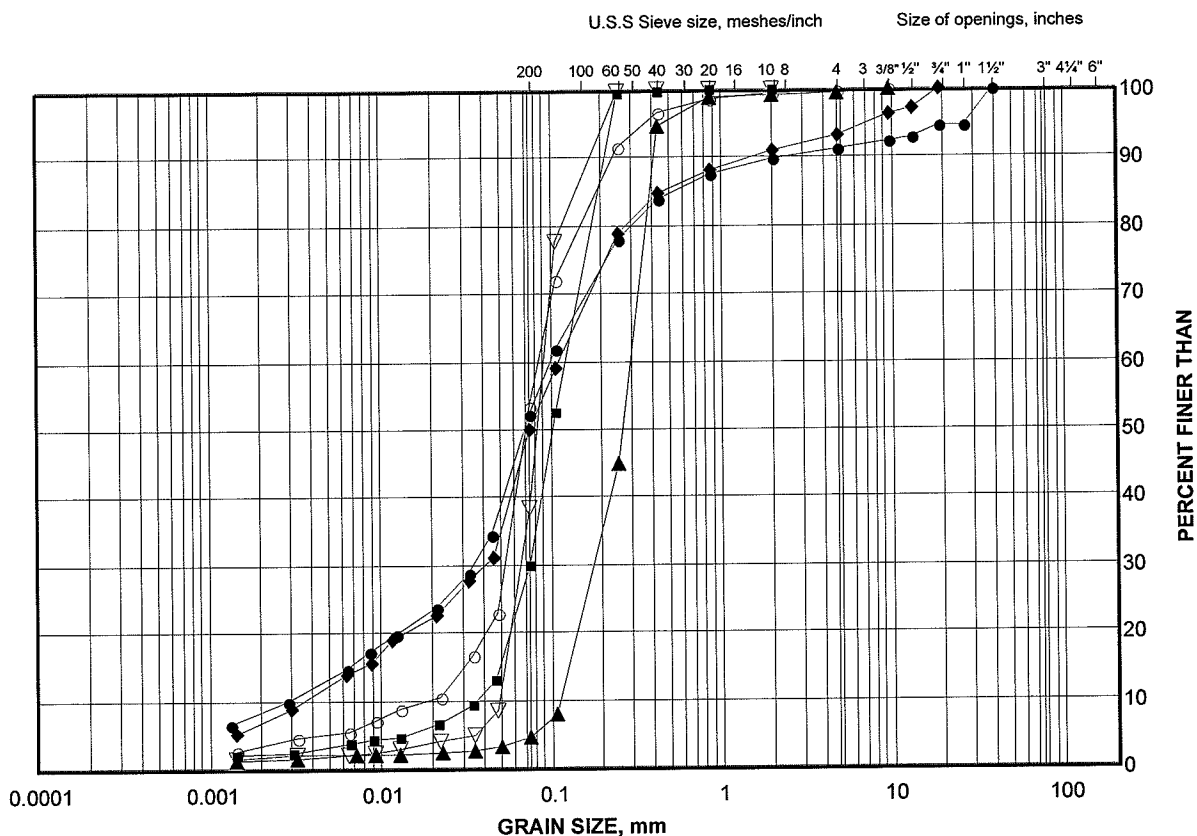
Project No. 06-1111-060-4

Checked By: *W. H. H. H.*

GRAIN SIZE DISTRIBUTION TEST RESULTS

Sand to Sand and Silt

FIGURE 5A



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

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	NW3	3	176.9
■	NW2	3	177.7
◆	NW1	4	178.3
▲	NW2	6	175.5
▽	NW1	6	176.7
○	NW3	7	173.2

Project Number: 06-1111-060-4

Checked By: *Ulozie*

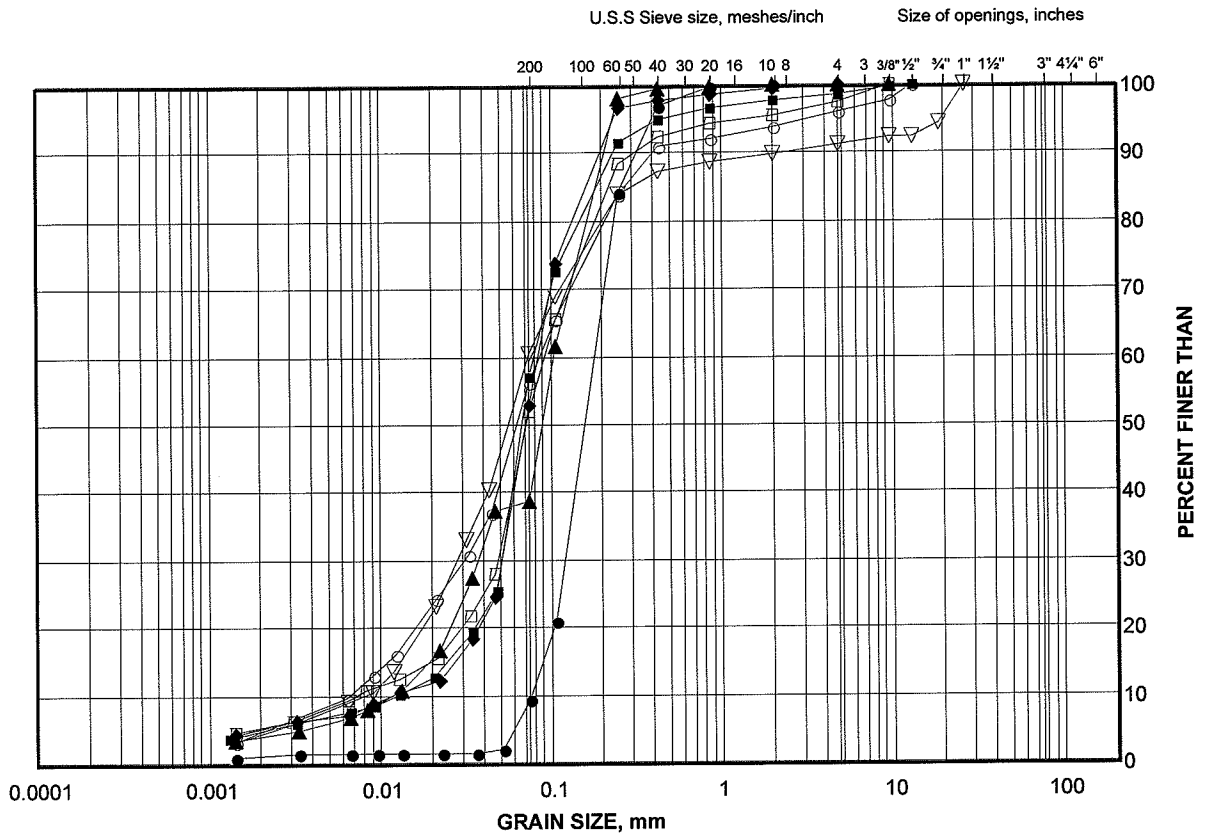
Golder Associates

Date: 13-Nov-07

GRAIN SIZE DISTRIBUTION TEST RESULTS

Sand to Sand and Silt

FIGURE 5B



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

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	NW4	3	176.8
■	NW7	4	173.7
◆	NW5	4	175.7
▲	NW4	5	175.3
▽	NW7	6	172.2
○	NW6	6	173.4
□	NW5	7	172.7

Project Number: 06-1111-060-4

Checked By: *[Signature]*

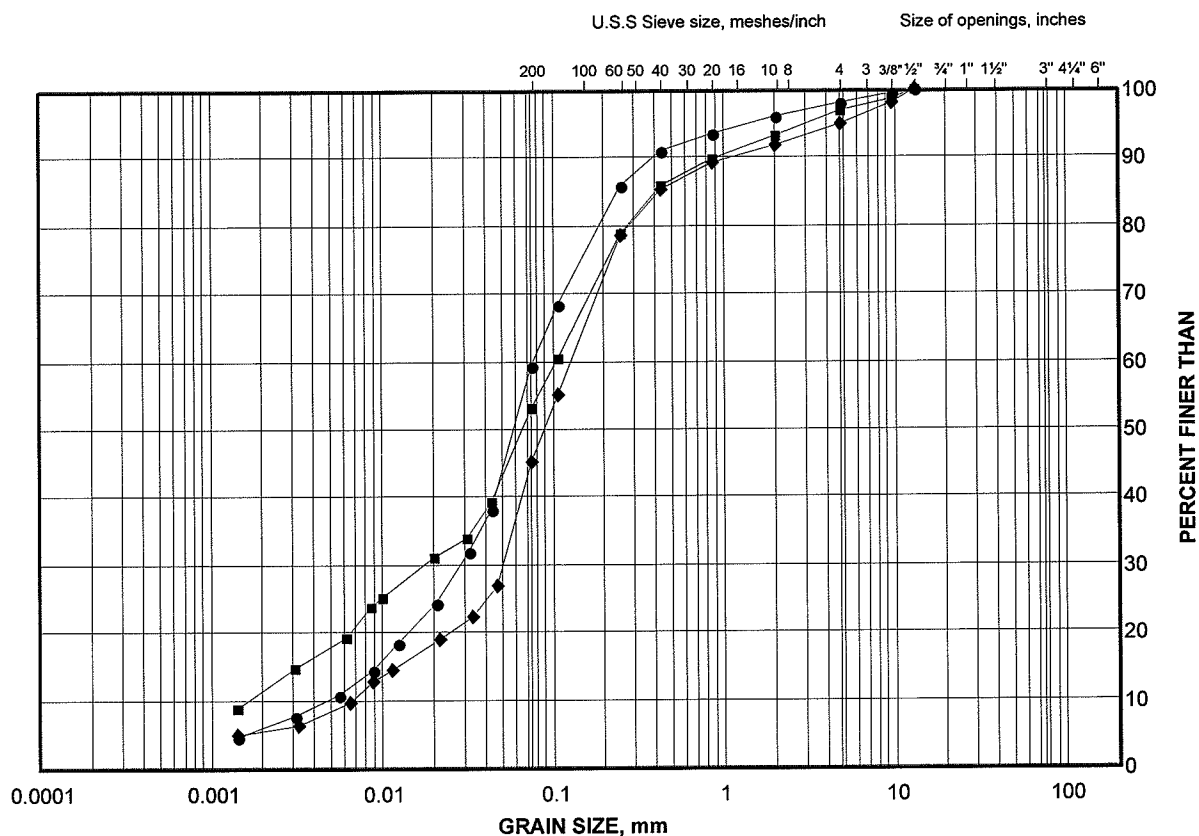
Golder Associates

Date: 13-Nov-07

GRAIN SIZE DISTRIBUTION TEST RESULTS

Sand to Sand and Silt

FIGURE 5C



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

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
•	NW8	3	171.9
■	NW11	6	165.2
◆	NW9	6	167.8

Project Number: 06-1111-060-4

Checked By: *Woyne*

Golder Associates

Date: 13-Nov-07

APPENDIX A
NON-STANDARD SPECIAL PROVISIONS

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

Special Provision

Excavations for the noise barrier wall foundations will be advanced through fill materials (where present), into clayey silt till to sand and silt till, and cohesionless sand to sand and silt soils; lenses or layers of cohesionless soils should also be expected to be present within the till. These cohesionless soils could slough (if dry) or flow (if water-bearing) into unsupported auger holes during caisson 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