



GEO-CANADA

GEORECS No:
30M14-301

**GEOTECHNICAL INVESTIGATION
PROPOSED WATERMAIN
ELGIN MILLS RD. (Y.R. 49)
LESLIE ST. TO WOODBINE AVE.
THE REGIONAL MUNICIPALITY OF YORK
WO: 98-23031**

Ref. No. G-03.0401
May 2003

Prepared for:

R.V. Anderson Associates Limited
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Distribution

6 Copies - R.V. Anderson Associates Limited
2 Copies - Geo-Canada Ltd.



CONTENTS

	<u>Page No.</u>
1.0 INTRODUCTION	1
2.0 PROJECT DESCRIPTION	2
3.0 METHOD OF INVESTIGATION	2
4.0 SUBSURFACE CONDITIONS	4
4.1 Fill (Soil Type A)	5
4.2 Native Fine Grained, Cohesive Soils (Soil Type B)	5
4.3 Native Fine Grained, Non-Cohesive Soils (Soil Type C)	5
4.4 Native Fine Grained, Non-Cohesive, Dilatant Soils (Soil Type D)	6
4.5 Native Coarse Grained, Granular Soils (Soil Type E)	6
4.6 Groundwater Conditions	7
5.0 DISCUSSION OF RESULTS	8
5.1 Engineering Evaluation of Subsurface Conditions	8
5.1.1 Fill (Soil Type A)	8
5.1.2 Native Fine Grained, Cohesive Soils (Soil Type B)	9
5.1.3 Native Fine Grained, Non-Cohesive Soils (Type C)	10
5.1.4 Fine Grained, Non-Cohesive, Dilatant Soils (Type D)	11
5.1.5 Native Coarse Grained, Granular Soils (Soil Type E)	12
5.2 Crossing under Hwy 404	13
5.2.1 Anticipated Construction Conditions	13
5.2.2 Anticipated Ground Movements	14
5.3 Watermain Support	14
5.4 Use of Trench Boxes	15
6.0 RECOMMENDATIONS	16
6.1 Pipe Bedding	16
6.2 Reuse of Excavated Materials	17
6.3 Primary Tunnel Support	17
6.4 Miscellaneous Items for Specification	18
6.5 Earth Pressures on Shoring	19
7.0 STATEMENT OF LIMITATION	19
BOREHOLE LOCATION PLAN	Drawings 1 to 4

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To: Betty Bennet

ATT: Tyler Neil

Fax: (905) 426-⁶⁰²⁰~~4292~~

From: Tim Machuletz
York Region

Re: Elgin Mills Rd. &
Hwy 404 Interchange



DUFFERIN CONSTRUCTION COMPANY

690 Darval Drive Suite 200, Oakville, Ontario L6K 3W7, Tel (905) 842-2741 Fax (905) 842-9278

Saturday, September 06, 2003

Regional Municipality of York

17250 Yonge Street
Newmarket, Ontario
L3Y 6Z1

Contract: Contract # 03 - 101 The Reconstruction and Widening of Elgin Mills Road (Y.R. # 49)

Re: Settlement Monitoring final report

Attention: Tim Machuletz (Contract Administrator)

File letter # 72 - DUFFERIN To Region of York

Dear Tim,

Please be advised that Dufferin Construction completed the tunneling underneath highway # 404 on September 3, 2003.
Please find attached the final settlement monitoring report from July 29, 2003 to September, 5, 2003.

Respectfully,
Dufferin Construction

Jeff Pollman
Project Engineer

MONITORING WATERMAIN AT HWY. 404

<u>DATE:</u>	<u>NAIL 1</u>	<u>NAIL 2</u>	<u>NAIL 3</u>	<u>NAIL 4</u>
July 29, 2003	231.018	231.140	231.056	230.883
July 30, 2003	231.018	231.141	231.058	230.885
July 31, 2003	231.018	231.141	231.058	230.885
August 1, 2003	231.018	231.141	231.058	230.885
August 6, 2003	231.017	231.140	231.055	230.885
August 6, 2003	231.017	231.140	231.055	230.885
August 7, 2003	231.018	231.140	231.058	230.885
August 7, 2003	231.017	231.140	231.058	230.886
August 8, 2003	231.015	231.140	231.054	230.886
August 8, 2003	231.017	231.140	231.055	230.886
August 11, 2003	231.018	231.140	231.058	230.886
August 11, 2003	231.017	231.140	231.058	230.886
August 12, 2003	231.018	231.141	231.055	230.886
August 12, 2003	231.018	231.140	231.058	230.885
August 13, 2003	231.017	231.140	231.058	230.886
August 13, 2003	231.017	231.141	231.055	230.886
August 14, 2003	231.017	231.140	231.056	230.886
August 15, 2003	231.017	231.139	231.056	230.886
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August 19, 2003	231.018	231.139	231.056	230.886
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August 20, 2003	231.018	231.140	231.056	230.887
August 20, 2003	231.018	231.139	231.056	230.887
August 21, 2003	231.018	231.139	231.056	230.886
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August 22, 2003	231.017	231.139	231.056	230.886
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August 25, 2003	231.018	231.140	231.058	230.886
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August 26, 2003	231.018	231.140	231.056	230.886
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August 27, 2003	231.018	231.140	231.055	230.885
August 28, 2003	231.018	231.140	231.058	230.886
August 28, 2003	231.017	231.140	231.056	230.886
August 29, 2003	231.018	231.140	231.056	230.886
August 29, 2003	231.018	231.140	231.056	230.886
September 1, 2003	231.018	231.140	231.056	230.886
September 1, 2003	231.018	231.140	231.054	230.885
September 2, 2003	231.018	231.140	231.056	230.886
September 2, 2003	231.018	231.139	231.058	230.886
September 3, 2003	231.018	231.139	231.058	230.886
September 3, 2003	231.018	231.140	231.058	230.885
September 4, 2003	231.018	231.139	231.058	230.886
September 4, 2003	231.018	231.139	231.056	230.886
September 5, 2003	231.018	231.140	231.056	230.886
September 5, 2003	231.018	231.140	231.056	230.887



CONTENTS (CONT'D)

APPENDICES

LOGS OF BOREHOLES 301 TO 312 - ENCLOSURES 1 TO 12	Appendix 'A'
PREVIOUS BOREHOLES	Appendix 'B'
GRAIN SIZE DISTRIBUTION CURVES (FIGURES 1 TO 5) EARTH PRESSURE DISTRIBUTION ON BRACED SHEETING IN NON-COHESIVE SOILS (FIGURE 6) EARTH PRESSURE DISTRIBUTION ON BRACED SHEETING IN COHESIVE SOILS (FIGURE 7)	Appendix 'C'
STATEMENT OF LIMITATION	Appendix 'D'



REPORT
ON
GEOTECHNICAL INVESTIGATION
PROPOSED WATERMAIN
ELGIN MILLS RD. (Y.R. 49)
LESLIE ST. TO WOODBINE AVE.
THE REGIONAL MUNICIPALITY OF YORK

1.0 INTRODUCTION

The investigation described in this report was conducted at the request of R.V. Anderson Associates Ltd., to obtain geotechnical input for the design and construction of a proposed watermain along Elgin Mills Road, between Leslie Street and Woodbine Avenue in the Region of York. In 1998, 2000 and 2001, Geo-Canada Ltd. carried out a total of three (3) geotechnical investigations for: a proposed storm sewer and widening of this section of Elgin Mills Road; a proposed 300mm dia. watermain to be located at the north side of Elgin Mills Road; and for the Hwy 404/Elgin Mills Road interchange. The boreholes which were drilled for those investigations and are sufficiently deep, were also utilized for this investigation and are incorporated in this report. The objectives of the study are to determine the subsurface conditions along the alignment and to provide geotechnical input for the design and construction of the proposed watermain.



2.0 PROJECT DESCRIPTION

We understand that the total length of the concrete pressure pipe watermain is about 2.0 km. The proposed pipe diameter is 600mm. The pipe will be installed in open cut, with the exception of a tunnelled section crossing under Hwy 404, where the jacking of a 1050mm diameter steel liner is proposed, in which the watermain pipe will be installed. The invert elevation of the proposed steel jacking liner is 223.2±m. The depth to the invert of the watermain in the open cut sections is generally between 2m and 4.5m below existing grade. Where the watermain is to be constructed under the proposed ramps of the Hwy 404/Elgin Mills interchange, the pipes will be installed within a 1050mm dia. CSP sleeve. The proposed approximate invert elevations of the sleeves at the Hwy 404/Elgin Mills Road ramp crossings are as follows:

Ramp	Approximate Station	Proposed Approximate Invert El. (m)
W-S	4+720	223.2
	4+765	223.2
W-N	4+958	231.8
	4+970	232.1
S-E	5+010	232.3
	5+040	232.5

3.0 METHOD OF INVESTIGATION

The scope of the investigation, in agreement with R.V. Anderson Associates Limited, consisted of drilling twelve (12) boreholes at selected locations to supplement the previously drilled boreholes. These boreholes were put down between April 14 and 16, 2003, using



both truck and track mounted power auger drill rigs. The boreholes were drilled with solid stem continuous flight augers at the following approximate locations:

Borehole No.	Approximate Location	
	Station	Offset
301	3+782	17m Rt.
302	4+113	16m Rt.
303	4+463	22m Rt.
304	4+564	12m Rt.
305	4+855	41m Rt.
306	4+952	21m Rt.
307	5+037	10m Rt.
308	5+156	6m Rt.
309	5+445	6m Rt.
310	5+585	5m Rt.
311	5+678	11m Rt.
312	5+805	7m Rt.

The locations of the new and the previously drilled boreholes are shown on the attached Borehole Location Plans (Drawings 1 to 4). The log sheets for boreholes put down during the present investigation are numbered 301 to 312 inclusive and are presented in Appendix A. The relevant previous borehole log sheets are attached in Appendix B.

A senior field technician from our office supervised the drilling of the boreholes and logged the soil samples. In the boreholes, soil samples were taken at 0.75m and 1.5m intervals. The samples were transported to our laboratory, where they were re-examined by a senior



engineer. Representative samples were selected for analyses, which included natural moisture contents and particle size distribution tests. The results of the laboratory tests are summarized on the individual borehole log sheets and the grading curves are plotted on Figures 1 to 5 of Appendix C of this report.

The elevations of the boreholes were estimated from the topographic plan provided to us via e-mail by R.V. Anderson Associates. The elevations of the boreholes are, therefore, approximate.

4.0 **SUBSURFACE CONDITIONS**

The 300-series boreholes encountered fill overlying a variety of native soil types such as silt, sandy silt, sand and silt, clayey silt, sand, sand and gravel and glacial tills composed of sandy silt and sand and silt. The fill materials are loose to compact or soft to very stiff, while the native soils are compact to very dense or stiff to hard.

Similar soil conditions were found also in the previous boreholes.

Details of the subsurface conditions encountered in the boreholes put down during the present and previous investigations are presented in Appendix A and B respectively. In the following paragraphs, generalized properties of the various soil strata are briefly discussed.



4.1 **Fill (Soil Type A)**

Fill was encountered in each borehole (Boreholes 301 to 312) with thicknesses ranging from 0.8 to 3.0m. Below some granular shoulder material in places, the fill is mostly composed of clayey silt, sandy silt and silty sand with organic matter, topsoil inclusions and rootlets. The natural moisture content of the fill samples was in the range of 2 to 37%. The fill is loose to compact or soft to very stiff.

4.2 **Native Fine Grained, Cohesive Soils (Soil Type B)**

Clayey silt was encountered in Boreholes 304, 309, 105 and 312 at depths of between 1.5 and 2.1m below the ground surface with thicknesses between 0.6 and 1.7m. These are low to medium plasticity soils of stiff to hard consistency ($N = 11$ to greater than 100 blows/0.3 m). Figure 2 shows a particle size distribution for one (1) selected sample of the clayey silt. The tested sample contains 1% gravel, 20% sand, 57% silt and 22% clay. The natural moisture content of the samples tested ranged from 14 to 17%.

4.3 **Native Fine Grained, Non-Cohesive Soils (Soil Type C)**

These deposits which include silt, sand and silt, sandy silt, sandy silt till and sand and silt till were encountered at random depths in all boreholes, except Boreholes 307 and 309. In this latter borehole, dilatant sandy silt was found, which is described in Section 4.4 of this report. These are broadly graded deposits of probably common geological origin, but with minor variations in the relative proportions of sand and silt. Figures 1 and 5 show the test results of twelve (12) grain size analyses on these materials. These samples contain 0 to 14%



gravel, 10 to 46% sand and 40 to 90% silt and clay size particles.

A wide range of standard penetration blow counts (SPT 'N' values) were recorded in these materials, from 9 to over 100 blows/0.3 m. However, these materials are generally compact to very dense. The natural moisture content of selected samples ranged from 7 to 26%, but was mostly between 8 and 14%.

4.4 Native Fine Grained, Non-Cohesive, Dilatant Soils (Type D)

A stratum of dilatant sandy silt was encountered in Borehole 309 between depths of 3.8 and 7.6m below the ground surface (i.e. between El. 230.1m and 226.3m). Based on the results of a particle size analysis performed on a selected sample obtained from this deposit (Figure 5), this is a narrowly graded soil, composed of 30% sand, 65% silt and 5% clay.

The natural moisture content in the deposit was found to be ranging from 12 to 14%.

Recorded SPT 'N' values of 24 to 44 blows per 0.3m indicate compact to dense state of compactness.

4.5 Native Coarse Grained, Granular Soils (Soil Type E)

Included in this soil group are the sand, silty sand and sand and gravel found in Boreholes 305 to 312. The results of grain size analyses on six (6) samples of sand and silty sand (Figure 3) show a range of particle sizes from 0 to 6% gravel, 62 to 94% sand, and 6 to 33%



silt and clay size particles. Grain size distribution curves for the coarser sand and gravel are shown on Figure 4. The test results on the coarser samples revealed 46 to 60% gravel, 38 to 40% sand and 2 to 14% soil fines (i.e. particles smaller than 75 microns). These deposits are generally compact to very dense ($28 \leq N \leq 100$), but generally dense to very dense. The natural moisture content of the tested samples ranged from 7 to 17%, but were typically 10 to 13%.

4.6 Groundwater Conditions

Boreholes 310, 311 and 312 were found to be dry upon completion of drilling. In Boreholes 302, 303, 306 and 308, groundwater was found at 1.5 to 4.6m depth shortly after the boreholes were drilled. These relatively short-term observations in the open uncased boreholes may, however, not be representative of the 'stabilized' groundwater conditions.

In order to monitor the longer-term groundwater levels, piezometers were installed in Boreholes 301, 304, 305, 307, 309 and 312, in which the groundwater was found at 0.8 to 4.0m below the ground surface (i.e. El. 228.9 to 231.5m) six to eight days after the piezometers were installed, except Borehole 312, which was dry to El. 232.5m. In addition, the groundwater was monitored on April 14, 2003 in the piezometer installed in Borehole 111 located at approximately Sta 4+458 and was found at El. 222.8m (i.e. 0.6m below the ground surface).

The observed water levels are shown on the borehole log sheets.



5.0 DISCUSSION OF RESULTS

In the following paragraphs, our interpretation of the data and the anticipated ground behaviour in response to the proposed construction methods are discussed. The anticipated construction conditions are described for the benefit of the design engineers to allow them to incorporate measures in their design to accommodate the anticipated problems. The opinions expressed regarding the proposed construction methods should not be considered as recommendations or as the only method that could be considered for the proposed project. It is suggested that the contractors bidding on the project should select their methods using the factual data presented in the previous sections of this report and their experience in similar soil conditions.

5.1 Engineering Evaluation of Subsurface Conditions

5.1.1 Fill (Soil Type A)

Based on the available borehole information, the proposed watermain will be supported on compact, heterogeneous fill at the west end of the project (in the vicinity of Borehole 301), mostly on granular fill at the existing culvert structure located at Sta 4+450± (Borehole 28) and on very stiff clayey silt fill at approximately Sta 5+156 (Borehole 308).

The fill at these locations should be able to support a 600mm diameter rigid pipe, however, its suitability for pipe support should be determined during construction based on an inspection by the geotechnical engineer. Notwithstanding this, the thickness of the granular bedding at these and any other areas where the pipes will be supported on fill, should be at



least 300mm.

Where the existing granular fill materials are above the water table, they should be temporarily stable at 35 to 45° cuts above the horizontal. Cohesive (i.e. clayey silt) fills can be excavated to steeper angles, however, OHSA safety regulations require that any excavation deeper than 1.2m be excavated with braced sheeting or be cut back at 1H:1V. Most of the fill soils would be considered to be Type 3 Soils under the OHSA.

Below the water table, seepage pressure in granular fills will cause caving conditions. This may occur at the west end of the project (i.e. vicinity of Borehole 301). Where the groundwater is encountered in the trenches, either the water table will have to be lowered or the granular fill will have to be fully supported with tight sheeting.

Vertical cuts in the granular fill must be supported by braced tight sheeting or a trench box. The limitations of trench boxes are described later in this report.

5.1.2 Native Fine Grained, Cohesive Soils (Soil Type B)

This soil type was encountered at the pipe invert level in the vicinity of Borehole 309. This soil will require nominal support in an open excavation, however, when unsupported, they should be cut back to 45° to comply with the Ministry of Labour OHSA safety regulations.



The watermain on this soil type can be supported on granular bedding in accordance with OPSS Class B.

The groundwater table in Borehole 309 was encountered below the proposed pipe invert. Groundwater seepage through the native clayey silt should be low and is expected to be handled by pumping from local sumps.

5.1.3 Native Fine Grained, Non-Cohesive Soils (Type C)

These soil types are broadly graded mixture of gravel to clay size particles, in which sand and silt are the dominant fractions. These soils often contain sufficient amount of soil fines (materials passing No. 200 sieve) to impart a slight apparent cohesion to the soil. These soils, therefore, can be excavated with slope sides of 35° to 40° above the horizontal, at which angle they should remain temporarily stable during construction. Below the water table, due to seepage forces, sloughing and ravelling is expected. However, the groundwater seepage rate is expected to be moderate and the groundwater flow in most cases is expected to be handled by gravity drainage and pumping from filtered sumps.

Reference to Boreholes 31, 101, 103, 105 and 305 indicates that the proposed tunnel invert below Hwy 404 will be within glacial tills. These tills are very dense as characterized by SPT 'N' values of greater than 100 blows per 0.3 m. The zone of tunnelling being below the water table, it is expected to behave as "slow" to "fast ravelling" ground, requiring support within a very short period of time. This condition will have to be taken into account for the



successful completion of the jack and bore operation. Although boulders were not encountered in the boreholes, their presence in the glacial tills should be expected.

Based on the grain size analyses performed, the hydraulic conductivity of the soil in which the tunnel will be driven is estimated to be in the order of 10^{-6} cm/sec. At this range, the soil is considered to have a low permeability through which the rate of groundwater seepage is expected to be slow. Glacial tills are, however, heterogeneous soils and given their unsorted mode of deposition, often contain lenses or layers of coarser grained soils. The dense overconsolidated tills are also frequently fissured and thus blocky in structure. These layers and fissures may have permeabilities several order of magnitude higher and are often the main source of infiltration into open cuts and tunnels.

5.1.4 Native, Fine Grained, Non-Cohesive, Dilatant Soils (Type D)

Dilatant sandy silt was encountered in Borehole 309, below the proposed watermain invert elevation. Similar deposits could be encountered in-between the boreholes and at random depths. If encountered in the trenches together with free water above the bottom of the trench, the silt will exhibit dilatancy, i.e. will expand.

If the pipes are laid on the dilated soil, which can be recognized from the liverish, jelly-like appearance of the soil, then large post construction settlements of the pipe can be expected.

In order to maintain excavation stability and to prevent dilatancy, the water level should be temporarily lowered to at least 0.5m below the excavation level by pumping from closely



spaced vacuum well points. The well point risers should be surrounded by sand wicks which are sealed at ground surface with a clay seal to increase the effectiveness of the vacuum pumps. The well points should be surrounded with a graded granular filter to prevent the removal of fine soil particles during pumping. With the water level lowered, the sandy silt can be excavated with side slopes to about 40° to the horizontal. The coefficient of permeability of the sandy silt is estimated to range from 10^{-4} to 10^{-3} cm/sec.

5.1.5 Native Coarse Grained, Granular Soils (Soil Type E)

The deposits belonging to this group are non-cohesive and at the pipe invert level are dense to very dense. They should provide good support for the watermain, and conventional granular bedding conforming to OPSS Type B will be sufficient.

Their behaviour in an excavation will depend on the position of the groundwater level in these strata at the time of construction. Above the water table, these soils should be possible to excavate to about 40° above the horizontal without support, at which angle the soils should remain temporarily stable. Below the water table, seepage pressure will rapidly cause caving and unstable ground conditions. A groundwater table above the pipe invert level in the soils belonging to this group was found in the vicinity of Borehole 26 (Sta 4+315±). At this area, the water table will have to be lowered ahead of the excavation to 0.5m below the base of the excavation. Based on the grain size analyses carried out on a selected sample from Borehole 26, the coefficient of permeability of the silty sand is estimated to be of the order of 10^{-4} cm/sec. Higher coefficients of permeability (i.e. 10^{-2} cm/sec) are estimated for



the sand encountered in Boreholes 307 and 310. Dewatering of the silty sand will likely require the use of closely spaced well points and filtered sumps.

5.2 Crossing under Hwy 404

5.2.1 Anticipated Construction Conditions

As presently proposed, the 600mm diameter watermain between Sta 4+725± and 4+870± will be placed within a 1050mm steel liner installed by the jack and bore method.

Boreholes 31, 101, 103, 105 and 305 found similar soil conditions at the proposed tunnel invert (223.2±m), consisting of dense to very dense sand and silt/sandy silt glacial till.

Although cobbles and boulders were not encountered in the boreholes, their presence in the glacial tills should be expected. However, a 1050mm diameter steel liner is large enough to allow the entry of personnel to facilitate the manual break-up and removal of the boulders.

The rate of groundwater seepage into the tunnel opening is expected to be moderate. In order to remove the accumulated water by gravity, the jack and bore operation should preferably proceed upslope.

In the event that coarser zones/lenses of silty sand or sand are encountered at the tunnel face, “rapidly ravelling” conditions and high rates of infiltration will be experienced, resulting in ground losses greatly exceeding the 1% mentioned in Section 5.2.2. Jack and boring



operations are traditionally poorly suited to deal with these types of conditions. The contractor should, therefore, be requested to present his contingency plans for dealing with such ground.

5.2.2 Anticipated Ground Movements

Due to the generally competent nature of the ground through which the tunnel will be advanced, it should be possible to keep ground losses to a minimum with good workmanship and assuming uniform dense sandy silt conditions at the face. Assuming a ground loss equal to 1% of the volume of the tunnel, the theoretical ground settlement at road level will be less than 6mm and the width of the settlement trough is estimated to be 15m.

Ground losses of 1% or less are considered achievable in these soils, using good construction practices and careful sequencing of operations. The length of unlined tunnel between the drillhead and the cutting edge of the steel liner should not exceed 0.5m at any given time. It is recommended that the ground movements during tunnelling be closely monitored.

5.3 Watermain Support

Most of the materials encountered in the boreholes should give adequate support to the watermain placed on granular bedding. Exception to this generalization is the existing fill materials, which will be supporting the watermain in the vicinity of Borehole 28, 301 and 308 and, possibly the dilatant sandy silt, if encountered at the bottom of the trench.



The fill materials at pipe level should be visually inspected to determine their suitability for pipe support. Loose, soft, organic or otherwise unsuitable fill should be removed and replaced by select subgrade material (OPSS SSM) compacted to 95% of SPMDD. If its replacement is not required, the thickness of the granular bedding material under the watermain should be increased to at least 300mm. The sandy silt, if encountered, must be prevented from dilating as discussed in Section 5.1.4 of this report.

The bedding materials should be broadly graded such as an OPSS Granular 'A'. Contractors often prefer to use clear stone bedding in areas where groundwater seepage is high. If clear stone bedding is used, it must be completely wrapped with a suitable filter cloth to prevent soil fines in the surrounding native soil from being washed into the voids of the clear stone and subsequent settlement.

5.4 Use of Trench Boxes

Where permissible under the OHSA and where the use of tight sheeting has not otherwise been recommended in this report, contractors may elect to utilize trench boxes for temporary trench support.

While in many situations, the use of trench boxes can result in a high rate of productivity in trenching, it is not without some technical drawbacks. These include:

- (i) increased loss of ground relative to many other shoring methods; and
- (ii) reduced ability to compact backfill between the trench wall and the trench box.



Ground loss, ravelling and/or loosening of soils will occur when using a trench box prior to its installation and while moving the box, particularly in cohesionless soils or in pre-existing fill.

Granular courses below existing pavements are particularly susceptible and significant undermining can occur. It is important that the trench not be over-excavated to ensure a tight fit between the box and trench walls. Trench boxes need to be installed expediently. When moving the box, the void space between its outer walls and the trench must be backfilled and compacted. This may require raising the box sequentially prior to sliding it laterally. If this is not done, post-construction settlements will occur along the trench walls.

Where trench boxes are used in existing roadways, it is prudent to expect pavement structure settlement along both sides of the trench. In such cases, following backfilling of the trench, road reconstruction should include a provision for saw cutting of the asphalt at least 600mm back from the trench walls, recompaction of the upper trench backfill and then repaving.

6.0 RECOMMENDATIONS

6.1 Pipe Bedding

The watermain in open cut sections should be founded on granular bedding in accordance with OPSD 1102.01. The bedding material should be broadly graded (i.e. Granular 'A'). If clear stone is used, it should be completely wrapped with a filter fabric which has a filtration opening size of 120 microns or smaller.



The thickness of bedding material should be a minimum of 300mm under pipes where the founding material is fill.

6.2 Reuse of Excavated Materials

The trenches may be backfilled with excavated inorganic materials, which have a moisture content within $\pm 2\%$ of optimum and where approved by qualified geotechnical personnel.

Under roadways, driveway, sidewalks or other areas where long term settlement is to be avoided, the backfill materials should be placed in not more than 300mm lifts and compacted to a minimum 96% standard Proctor maximum dry density (SPMDD). Within the upper metre below design subgrade, the degree of compaction should be increased to 98% of SPMDD. The recompaction of the excavated saturated soils may not be possible, therefore, their use in areas where settlements cannot be tolerated should be avoided.

6.3 Primary Tunnel Support

Primary support to the tunnel opening will be provided by the steel liner advanced by jacking following immediately behind the drillhead.

The design of the steel liner, its size and wall thickness should be the responsibility of the contractor.

The loading on the flexible steel liner can be taken as being uniformly distributed around its perimeter and to be equal to the vertical overburden pressure calculated at the springline of



the tunnel. The unit weight of the soil overlying the springline can be taken as 21.5 kN/m^3 .

Hydrostatic water pressure equal to the water table at El. 231m will have to be added. In addition to the earth and hydrostatic pressures, the liner should be designed to carry the liveload from Hwy 404 and the loads generated by the pipe jacking.

The jacking force applied by the thrust pit jacks shall not exceed the design allowable stress in the steel liner. The thrust loads shall be transferred to the liner through a thrust ring, which shall be sufficiently rigid to ensure even distribution of the load.

6.4 Miscellaneous Items for Specification

The contractor should be required to submit method statements for the tunnelling operation for the review of the Engineer before commencement of the work.

The jacking and reception pits (shafts) shall be designed and constructed to allow the safe operation of the plant, equipment and handling of materials, and to withstand all loading imposed by ground pressure, groundwater pressures, superimposed loads from surface loads, and the maximum anticipated thrust forces. Design of all shoring systems should follow the 3rd Edition of the Canadian Foundation Engineering Manual.

The jacking force available at the thrust pit should not be less than 133% of the theoretical maximum force required to complete the pipe jacking.



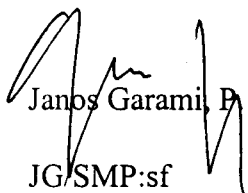
6.5 Earth Pressures on Shoring

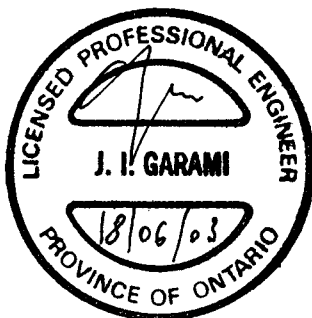
Recommended apparent earth pressure distributions acting on the temporary braced shoring system of the trenches and jacking pits are given on Figures 6 and 7.

7.0 STATEMENT OF LIMITATION

The Statement of Limitation, as quoted in Appendix 'D', is an integral part of this report.


GEO-CANADA LTD.


Janos Garami, P. Eng.
JG/SMP:sf

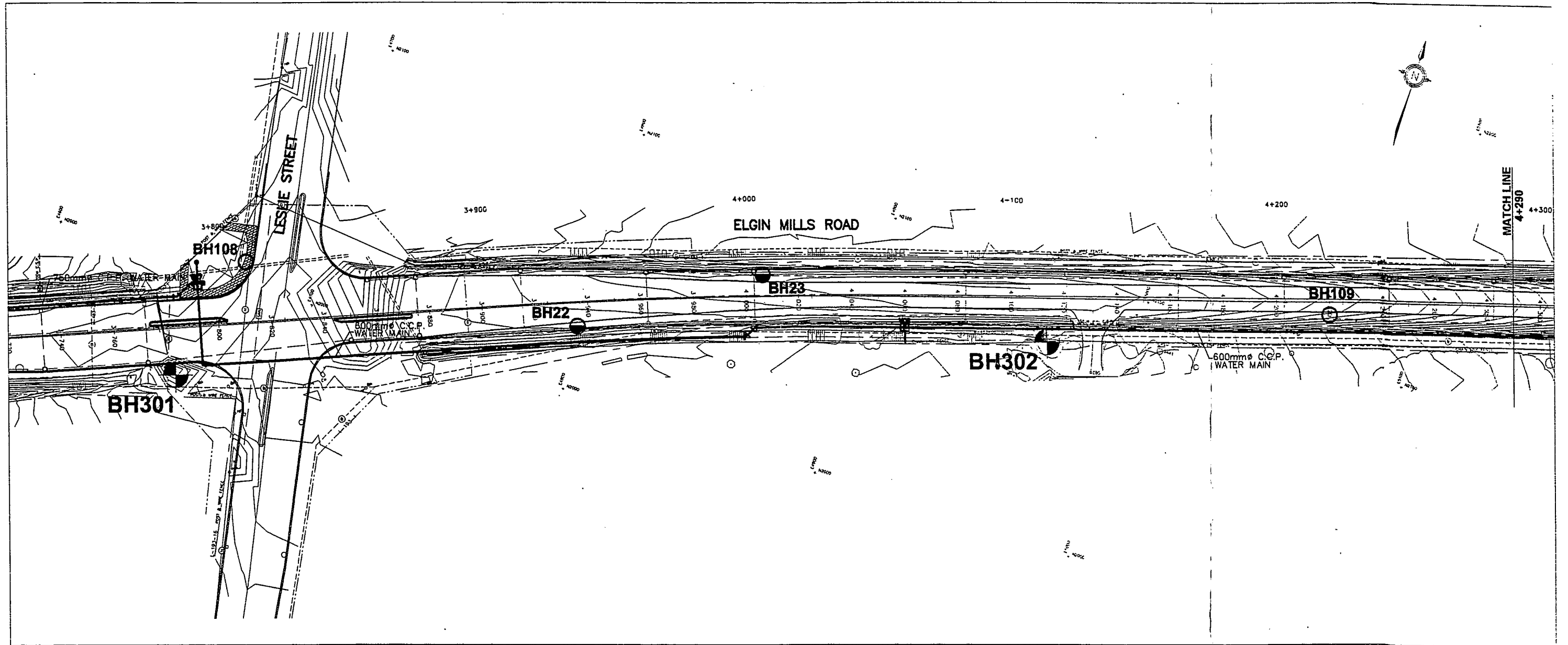


Encl.


DR27/G-03 0401 RVA


Scott M. Peaker, P.Eng.





LEGEND

 BH305 BOREHOLE

BOREHOLES - PREVIOUS INVESTIGATIONS

 BH108 GEO-CANADA 2001

 BH103 GEO-CANADA 2000

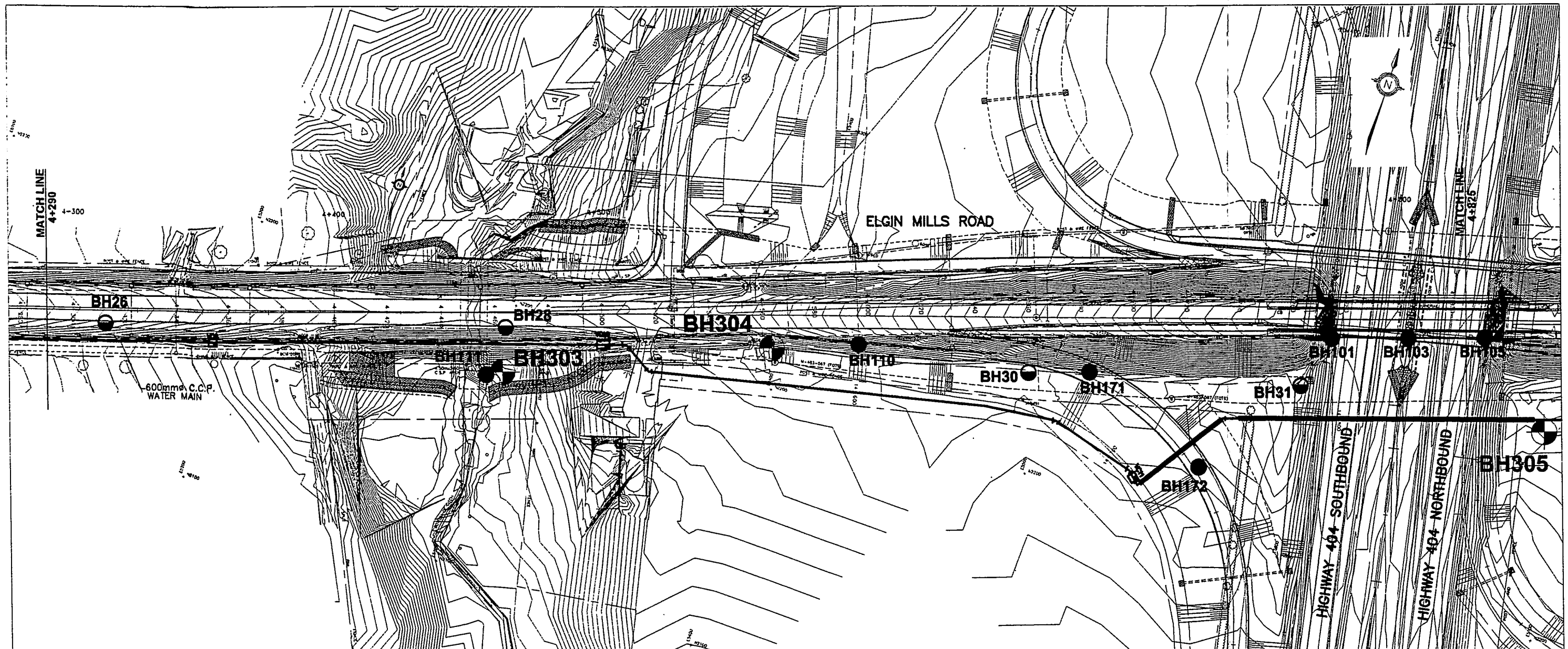
 BH26 GEO-CANADA 1998

SCALE 1:1500


ELGIN MILLS ROAD WATERMAIN BOREHOLE LOCATION PLAN

Project No.: G-03.0401
Date: APRIL, 2003
Drawing No.: 1




GEO-CANADA LTD.



LEGEND

 BH305 BOREHOLE

BOREHOLES - PREVIOUS INVESTIGATIONS

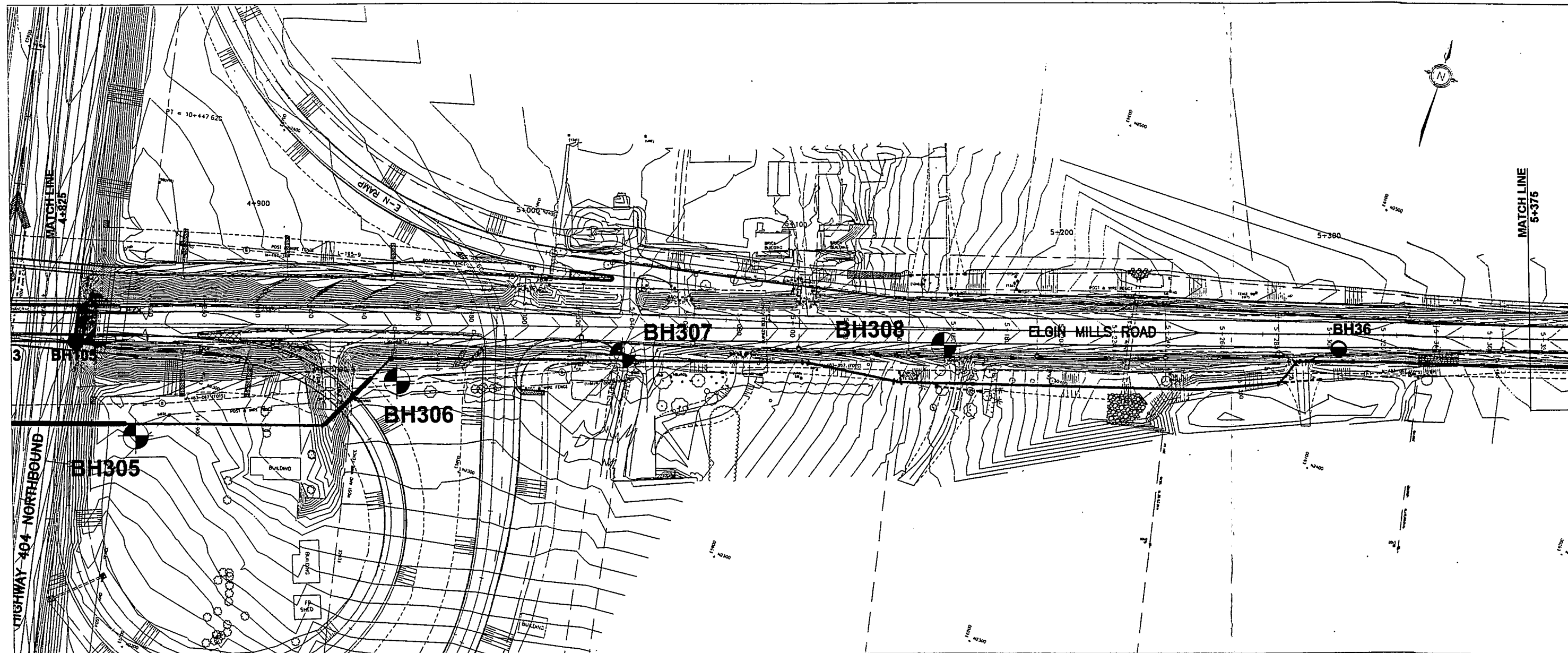
-  BH108 GEO-CANADA 2001
-  BH103 GEO-CANADA 2000
-  BH26 GEO-CANADA 1998

SCALE 1:1500


ELGIN MILLS ROAD WATERMAIN BOREHOLE LOCATION PLAN

Project No.: G-03.0401
Date: APRIL, 2003
Drawing No.: 2

GEO-CANADA LTD.



LEGEND

 BH305 BOREHOLE

BOREHOLES - PREVIOUS INVESTIGATIONS

 BH108 GEO-CANADA 2001

 BH103 GEO-CANADA 2000

 BH26 GEO-CANADA 1998

SCALE 1:1500

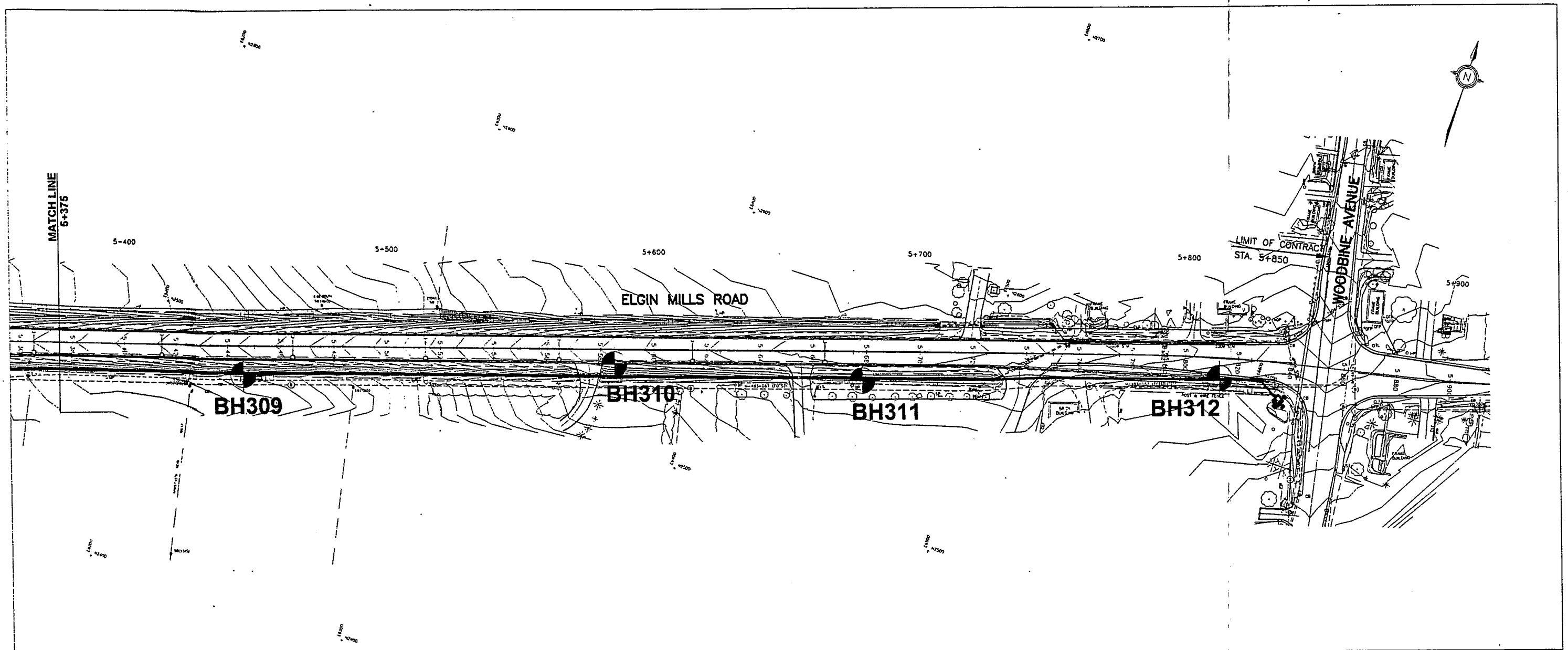
ELGIN MILLS ROAD WATERMAIN BOREHOLE LOCATION PLAN

Project No.: G-03.0401


Date: APRIL, 2003

Drawing No.: 3




GEO-CANADA LTD.



LEGEND

 BH305 BOREHOLE

BOREHOLES - PREVIOUS INVESTIGATIONS

-  BH108 GEO-CANADA 2001
-  BH103 GEO-CANADA 2000
-  BH26 GEO-CANADA 1998

SCALE 1:1500

ELGIN MILLS ROAD WATERMAIN BOREHOLE LOCATION PLAN

Project No.: G-03.0401
Date: APRIL, 2003
Drawing No.: 4

GEO-CANADA LTD.



APPENDIX A
LOGS OF BOREHOLES 301 TO 312
ENCLOSURES 1 TO 12



CLIENT: R.V. Anderson Associates Limited

DRILLING DATA

PROJECT: Elgin Mills Road Watermain

Method: Continuous flight solid-stem augers

REF. NO.: G-03.0401

PROJECT LOCATION: Elgin Mills Road

Diameter: 110mm

ENCL NO.: 1

BOREHOLE LOCATION: Refer to Drawing No. 1

Date: 15 April 2003

DATUM ELEVATION: Geodetic

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT LIMIT		UNIT WEIGHT γ (kN/m ³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%)
(m) ELEV DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" BLOWS 0.3 m			20 40 60 80 100	20 40 60 80 100	W _p W W _L	WATER CONTENT (%)		
231.7	Ground Surface												
0.0	FILL		1	SS	29								
	mixture of sandy silt and silty clay, trace of gravel, rootlets and topsoil seams, brown, compact		2	SS	24		231						
			3	SS	28		230						
229.4													
2.3	SAND and SILT (Glacial Till)		4	SS	60		229						
	some clay, trace of gravel, brown, very dense		5	SS	67		229						
			6	SS	50/ 25mm		228						
			7	SS	50/ 100mm		227						
226.7													
5.0	END OF BOREHOLE												
	Date W.L. Elevation April 22/03 228.9m												



CLIENT: R.V. Anderson Associates Limited

DRILLING DATA

PROJECT: Elgin Mills Road Watermain

Method: Continuous flight solid-stem augers

REF. NO.: G-03.0401

PROJECT LOCATION: Elgin Mills Road

Diameter: 110mm

ENCL NO.: 2

BOREHOLE LOCATION: Refer to Drawing No. 1

Date: 15 April 2003

DATUM ELEVATION: Geodetic

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT γ (kN/m ³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%)
(m) ELEV DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" BLOWS 0.3 m			20 40 60 80 100	20 40 60 80 100	W _p	W	W _L		
233.8	Ground Surface													
0.0	TOPSOIL													
	FILL		1	SS	17		233							
	mixture of sandy silt and silty clay, trace of gravel, brown, compact		2	SS	20									
232.3														
1.5	SAND and SILT (Glacial Till)		3	SS	27		232							Split spoon wet
	some clay, trace of gravel compact to very dense		4	SS	32									
			5	SS	65		231							
							230							3 34 45 18
229.1			6	SS	50/									
4.7	END OF BOREHOLE													



CLIENT: R.V. Anderson Associates Limited

DRILLING DATA

PROJECT: Elgin Mills Road Watermain

Method: Continuous flight solid-stem augers

REF. NO.: G-03.0401

PROJECT LOCATION: Elgin Mills Road

Diameter: 110mm

ENCL NO.: 3

BOREHOLE LOCATION: Refer to Drawing No. 2

Date: 14 April 2003

DATUM ELEVATION: Geodetic

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC NATURAL LIQUID LIMIT MOISTURE LIMIT CONTENT		UNIT WEIGHT γ (kN/m ³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%)
(m) ELEV DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" BLOWS 0.3 m			20 40 60 80 100		W _p	W	W _L	
224.3	Ground Surface							SHEAR STRENGTH (kPa)		WATER CONTENT (%)			
								○ UNCONFINED + FIELD VANE					
								● QUICK TRIAXIAL x LAB VANE					
								20 40 60 80 100		10 20 30			
0.0	FILL		1	SS	5		224						
	clayey silt, topsoil inclusions and rootlets, trace of sand, brown, soft to firm		2	SS	3		223						
222.8							W. L. 222.8 m Upon completion						Split spoon wet
1.5	SAND and SILT (Glacial Till)		3	SS	52								
	some clay, trace of gravel, grey-brown to grey, very dense		4	SS	90		222						
			5	SS	50/ 50mm		221						1 33 48 18
			6	SS	50/ 50mm		220						
			7	SS	50/ 50mm		219						
			8	SS	74		218						
217.0							217						
7.3	END OF BOREHOLE												

CLIENT: R.V. Anderson Associates Limited

PROJECT: Elgin Mills Road Watermain

PROJECT LOCATION: Elgin Mills Road

BOREHOLE LOCATION: Refer to Drawing No. 2

DATUM ELEVATION: Geodetic

DRILLING DATA

Method: Continuous flight solid-stem augers

Diameter: 110mm

Date: 15 April 2003

REF. NO.: G-03.0401

ENCL NO.: 4

[illegible]

GEO-CANADA SOIL LOG BOREHOLE LOGS GPJ GEO-CANADA TEMPLATE GDT 28/4/03

GRAPH
CUBES

- 3 x 3 Numbers refer to Sensitivity

 $\epsilon = \epsilon_f$ Strain at Failure



CLIENT: R.V. Anderson Associates Limited

PROJECT: Elgin Mills Road Watermain

PROJECT LOCATION: Elgin Mills Road

BOREHOLE LOCATION: Refer to Drawing No. 2

DATUM ELEVATION: Geodetic

DRILLING DATA

Method: Continuous flight solid-stem augers

Diameter: 110mm

Date: 14 April 2003

REF. NO.: G-03.0401

ENCL NO.: 5

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ (kN/m ³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%)
(m) ELEV DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" BLOWS 0.3 m			20 40 60 80 100	20 40 60 80 100					
233.1	Ground Surface													
0.0	FILL		1	SS	6		233							
	topsoil mixed with clayey silt, rootlets, black, firm													
231.6							232							
1.5	SAND and SILT		2	SS	29		231							
	trace of fine gravel and clay, wet, yellow brown, compact													
230.1							230							
3.0	SILTY SAND		3	SS	72									
	trace of clay and gravel, frequent cemented layers, wet at depth of 4.0m, brown, very dense													
			4	SS	50/ 25mm		229							
			5	SS	50/ 100mm		228							
227.8							228							
5.3	SANDY SILT (Glacial Till)		6	SS	50/ 100mm									
	clayey, trace of gravel, grey, very dense													
			7	SS	50/ 25mm		227							
							226							
225.5							225							
7.6	SAND and SILT (Glacial Till)		8	SS	50/ 25mm									
	some clay, trace of gravel, grey, very dense													
							224							
			9	SS	50/ 50mm									
223.1			10	SS	50/ 25mm									
10.1	END OF BOREHOLE													
	Date April 22/03 W.L. Elevation 231.2m													

GRAPH
NOTES+ 3 × 3 Numbers refer
to Sensitivity

○ e = 3% Strain at Failure



CLIENT: R.V. Anderson Associates Limited

PROJECT: Elgin Mills Road Watermain

PROJECT LOCATION: Elgin Mills Road

BOREHOLE LOCATION: Refer to Drawing No. 3

DATUM ELEVATION: Geodetic

DRILLING DATA

Method: Continuous flight solid-stem augers

Diameter: 110mm

Date: 14 April 2003

REF. NO.: G-03.0401

ENCL. NO.: 6

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION	DYNAMIC CONE PENETRATION RESISTANCE PLOT	PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT γ (kN/m ³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%)
(m) ELEV DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" BLOWS 0.3 m			20 40 60 80 100	W _p	W	W _L		
234.8	Ground Surface							SHEAR STRENGTH (kPa) ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE	WATER CONTENT (%) 10 20 30				
0.0	FILL sandy silt, some clay, rootlets, topsoil, brown, compact		1	SS	13		234						
233.3													
1.5	SAND and SILT trace of gravel and clay, compact		2	SS	25		233						
232.3													
2.4	SILT trace of sand and clay, sand seams, brown, very dense		3	SS	74		232						
			4	SS	50/ 150mm		231						
230.2													
4.6	SAND and SILT some gravel, trace of clay, grey to brown, wet at 6.0m, very dense		5	SS	50/ 25mm		230						
			6	SS	50/ 25mm		229						
228.7													
6.1	SILTY SAND trace of gravel and clay, brown, very dense		7	SS	64		228						
			8	SS	50/ 25mm		227						
226.7			9	SS	50/ 25mm								
8.1	END OF BOREHOLE												

GRAPH
NOTES+ 3 x 3 Numbers refer
to Sensitivity

○ 8 = 1% Strain at Failure



CLIENT: R.V. Anderson Associates Limited

PROJECT: Elgin Mills Road Watermain

PROJECT LOCATION: Elgin Mills Road

BOREHOLE LOCATION: Refer to Drawing No. 3

DATUM ELEVATION: Geodetic

DRILLING DATA

Method: Continuous flight solid-stem augers

Diameter: 110mm

Date: 15 April 2003

REF. NO.: G-03 0401

ENCL NO.: 7

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH (kPa) ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE 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 AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
(m) ELEV DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" BLOWS 0.3 m						
235.9	Ground Surface										
0.0	FILL		1	SS	24						
	silty sand, trace of clay and gravel, brown, loose to compact										
			2	SS	5		235				
							234				
							233				
232.9			3	SS	50/ 25mm						
	SILTY SAND										
	brown, very dense		4	SS	50/ 150mm		232				
231.3											
	SAND and GRAVEL		5	SS	50/ 100mm		231				
	trace of silt and clay, very dense										
							230				
229.8			6	SS	50/ 100mm						
	SAND										
	trace of silt and clay, wet at 6.9m, very dense		7	SS	50/ 75mm		229				
228.0			8	SS	50/ 50mm						
							228				
7.9	END OF BOREHOLE										
	Date April 22/03 W.L. Elevation 231.5m										

GRAPH
NOTES+ 3 x 3 Numbers refer
to Sensitivity

○ e=3 Strain at Failure

CLIENT: R.V. Anderson Associates Limited

PROJECT: Elgin Mills Road Watermain

PROJECT LOCATION: Elgin Mills Road

BOREHOLE LOCATION: Refer to Drawing No. 3

DATUM ELEVATION: Geodetic

DRILLING DATA

Method: Continuous flight solid-stem augers

Diameter: 110mm

Date: 16 April 2003

REF. NO.: G-03,0401

ENCL NO.: 8

SOIL PROFILE				SAMPLES			GROUND WATER CONDITIONS	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ (kN/m ³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
(m) ELEV DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" BLOWS 0.3 m	SHEAR STRENGTH (kPa)									
						20		40	60	80					
233.8	Ground Surface						○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE			WATER CONTENT (%) 10 20 30					
0.0	FILL														
	sand and gravel, brown														
232.7															
1.1	FILL														
	clayey silt, with seams of topsoil, trace of sand, grey to brown, very stiff		1	SS	18										
231.5															
2.3	SILTY SAND		2	SS	39										
	trace of gravel, wet, dense														
230.8															
3.0	SAND and GRAVEL														
230.5	trace of silt, wet, dense		3	SS	47									60 38 (2)	
3.4	SANDY SILT (Glacial Till)														
	some clay, occasional coarse gravel, very dense		4	SS	50/ 50mm									0 32 52 16	
	<div><div></div><div>brown</div><div>-----</div><div>grey</div></div>														
228.8			5	SS	50/ 50mm										
5.0	END OF BOREHOLE														

GEO-CANADA SOIL LOG BOREHOLE LOGS GPJ GEO-CANADA TEMPLATE GDT 1/5/03

GRAPH
NOTES

+3 x3 Numbers refer to Sensitivity

Strain at Failure



CLIENT: R.V. Anderson Associates Limited
 PROJECT: Elgin Mills Road Watermain
 PROJECT LOCATION: Elgin Mills Road
 BOREHOLE LOCATION: Refer to Drawing No. 4
 DATUM ELEVATION: Geodetic

DRILLING DATA
 Method: Continuous flight solid-stem augers
 Diameter: 110mm
 Date: 16 April 2003

REF. NO.: G-03.0401
 ENCL NO.: 9

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ (kN/m ³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%)
(m) ELEV DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" BLOWS 0.3 m			20 40 60 80 100	20 40 60 80 100					
233.9	Ground Surface													
0.0	150mm Gravel FILL													
	sand, trace of gravel													
233.1	0.8 FILL						233							
	clayey silt, trace of fine gravel, sand and rootlets, brown, very stiff		1	SS	18		232							
231.8	2.1 CLAYEY SILT						231							
	trace of fine gravel and sand, brown, hard		2	SS	38									
			3	SS	50/ 150mm									
230.1	3.8 SANDY SILT						230							
	occasional fine gravel, trace of clay, wet, dilatant, brown, compact to dense		4	SS	44		W. L. 229.9 m Apr 22, 2003							
			5	SS	34		229							
			6	SS	38		228							
			7	SS	24		227							
226.3	7.6 SAND						226							
225.8	trace of silt, brown, compact		8	SS	28									
8.1	END OF BOREHOLE													
	Date April 22/03 Depth of W.L. 229.9m													

GRAPH
NOTES

± 3 × 3 Numbers refer
to Sensitivity

○ &=3% Strain at Failure



CLIENT: R.V. Anderson Associates Limited

PROJECT: Elgin Mills Road Watermain

PROJECT LOCATION: Elgin Mills Road

BOREHOLE LOCATION: Refer to Drawing No. 4

DATUM ELEVATION: Geodetic

DRILLING DATA

Method: Continuous flight solid-stem augers

Diameter: 110mm

Date: 16 April 2003

REF. NO.: G-03.0401

ENCL NO.: 10

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100	PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ (kN/m ³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%)
(m) ELEV DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" BLOWS 0.3 m								
237.1	Ground Surface												
0.0	FILL						237						
	sand, trace of gravel												
236.3													
0.8	FILL						236						
	clayey silt, brown												
235.4													
1.7	SANDY SILT		1	SS	28		235						
	trace of fine gravel, brown, compact												
234.8													
2.3	SAND		2	SS	36		234						
	occasional fine gravel, trace of silt and clay, brown, dense to very dense												
			3	SS	39		233						
			4	SS	50								
			5	SS	54		232						
			6	SS	84/ 280mm		231						
			7	SS	60								
230.6													
6.6	END OF BOREHOLE												
	Borehole dry upon completion.												

GEO-CANADA SOIL LOG BOREHOLE LOGS GPJ GEO-CANADA TEMPLATE GDT 28/4/03

GRAPH
NOTES

+ 3 X 3

Numbers refer
to Sensitivity○ $\epsilon = 3$

Strain at Failure



CLIENT: R.V. Anderson Associates Limited

PROJECT: Elgin Mills Road Watermain

PROJECT LOCATION: Elgin Mills Road

BOREHOLE LOCATION: Refer to Drawing No. 4

DATUM ELEVATION: Geodetic

DRILLING DATA

Method: Continuous flight solid-stem augers

Diameter: 110mm

Date: 16 April 2003

REF. NO.: G-03.0401

ENCL NO.: 11

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ (kN/m ³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%)
(m) ELEV DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" BLOWS 0.3 m			20 40 60 80 100	20 40 60 80 100					
237.0	Ground Surface													
0.0	FILL mixture of topsoil and clayey silt, trace of rootlets and fine gravel, brown, firm		1	SS	7									
236.3														
0.8	SILT trace to some clay, trace of gravel, brown, loose to compact		2	SS	9		236							
			3	SS	26		235							
234.7														
2.3	SAND and SILT brown, dense		4	SS	50		234							
			5	SS	37									
233.2														
3.8	SAND trace of silt, brown, dense to very dense		6	SS	47		233							0 94 (6)
			7	SS	53									
232.0							232							
5.0	END OF BOREHOLE Borehole dry upon completion.													



CLIENT: R.V. Anderson Associates Limited

PROJECT: Elgin Mills Road Watermain

PROJECT LOCATION: Elgin Mills Road

BOREHOLE LOCATION: Refer to Drawing No. 4

DATUM ELEVATION: Geodetic

DRILLING DATA

Method: Continuous flight solid-stem augers

Diameter: 110mm

Date: 16 April 2003

REF. NO.: G-03.0401

ENCL NO.: 12

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH (kPa) ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w _p NATURAL MOISTURE CONTENT w LIQUID LIMIT w _L WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ (kN/m ³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
(m) ELEV DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" BLOWS 0.3 m						
237.1	Ground Surface										
0.0	FILL						237				
	clayey silt, trace of sand and fine gravel, dark brown, firm		1	SS	6		236				
235.4											
1.7	CLAYEY SILT		2	SS	11		235				
234.8	trace of sand, brown, stiff										
2.3	SANDY SILT		3	SS	50/ 150mm		234				
	slightly cemented, trace of clay, sand seams with occasional fine gravel below 3.2m brown, dense to very dense		4	SS	46		233				
233.3											
3.8	SAND		5	SS	51		233				
	trace to some silt and clay, very dense		6	SS	70		232				
231.3			7	SS	50/ 150mm						
5.8	END OF BOREHOLE										
	Borehole dry upon completion. Date April 22/03 Depth of W.L. Dry at EL. 232.5m										

GRAPH
NOTES+ 3 × 3 Numbers refer
to Sensitivity

○ e=3% Strain at Failure



APPENDIX B

PREVIOUS BOREHOLES

LOG OF BOREHOLE 22

CLIENT : R. V. Anderson

PROJECT : Widening of Elgin Mills Rd.

LOCATION : Between Bayview Ave. and Woodbine Ave.

DATUM ELEVATION : Geodetic

DRILLING DATA

Method : Augering

Diameter : 100mm

Date : 10/08/99

REF. NO. : G-981203

ENCL NO. : 24

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT	REMARKS AND GRAIN SIZE DISTRIBUTION (%)
(m) ELEV DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE			20	40	60	80	100	W _p	W	W _L		
233.7	Ground Surface															
0.0	FILL gravelly sand trace of silt brown, damp to moist compact		1	SS	19											
232.9																
0.8	FILL silty clay some organic matter and asphalt fragments black, damp stiff		2	SS	11											
232.2																
1.5	SILTY CLAY brown to mottled grey damp, very stiff		3	SS	16	232										
231.4																
2.3	SANDY SILT (Glacial Till) some clay brown dense to v. dense		4	SS	37											
	damp															
	wet sand seams some clay		5	SS	30	W.L. 230.6 m 10/08/99										
	damp															
229.4			6	SS	72	230										
4.3	END OF BOREHOLE															

LOG OF BOREHOLE 23

CLIENT : R. V. Anderson

PROJECT : Widening of Elgin Mills Rd.

LOCATION : Between Bayview Ave. and Woodbine Ave.

DATUM ELEVATION : Geodetic

DRILLING DATA






Method : Augering

Diameter : 100mm

Date : 10/08/99

REF. NO. : G-981203

ENCL. NO. : 25


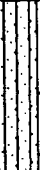

(m) ELEV DEPTH	SOIL PROFILE DESCRIPTION	STRATA PLOT	SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 					PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
			NUMBER	TYPE	BLOWS N 0.3 M			20	40	60	80	100	W _p	W	W _L		
234.0	Ground Surface																
0.0	FILL silty sand some gravel brown, damp compact		1	SS	20												
233.2																	
0.8	FILL clayey silt to silty clay mixed with topsoil, wood chips, some organic matter brown to grey, damp stiff		2	SS	13												
232.3																	
1.7	SILTY CLAY to CLAYEY SILT brown, damp stiff		3	SS	15		232										
231.7																	
2.3	SANDY SILT (Glacial Till) some clay oxidized at approx. 3 meters brown, damp to moist compact to v. dense		4	SS	20												
			5	SS	27		W.L. 230.9 m 10/08/99										
			6	SS	84		230										
229.7																	
4.3	END OF BOREHOLE																

LOG OF BOREHOLE 26

CLIENT : R. V. Anderson
PROJECT : Widening of Elgin Mills Rd.
LOCATION : Between Bayview Ave. and Woodbine Ave.
DATUM ELEVATION : Geodetic

DRILLING DATA
Method : Augering
Diameter : 100mm
Date : 10/08/99

REF. NO. : G-981203
ENCL. NO. : 28

(m) ELEV DEPTH	SOIL PROFILE DESCRIPTION	STRATA PLOT	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	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
			NUMBER	TYPE	BLOWS 0.3 M			20	40	60	80	100					
231.4	Ground Surface																
0.0	FILL gravelly sand some silt, clayey lumps brown, damp compact		1	SS	20												
230.6																	
0.8	SANDY SILT (Glacial Till) some clay wet sand seams between 1.5m to 2m brown, damp to moist compact		2	SS	18												
							230										
			3	SS	17												
229.1																	
2.3	SILTY SAND trace of gravel and clay brown, moist to wet very dense		4	SS	50												
			5	SS	50/150mm												
							228										
227.3																	
4.1	END OF BOREHOLE																

LOG OF BOREHOLE 28

CLIENT : R. V. Anderson

PROJECT : Widening of Elgin Mills Rd.

LOCATION : Between Bayview Ave. and Woodbine Ave.

DATUM ELEVATION : Geodetic

DRILLING DATA

Method : Augering

Diameter : 100mm

Date : 11/08/99

REF. NO. : G-981203

ENCL. NO. : 30

(m) ELEV DEPTH	SOIL PROFILE DESCRIPTION	STRATA PLOT	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	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
			NUMBER	TYPE	BLOWS 0.3 M			20	40	60	80	100					
229.0	Ground Surface																
0.0	70mm ASPHALT FILL gravelly sand some silt brown, damp, compact		1	SS	23												24 59 17
228.4																	
0.6	FILL sandy silt some clay compact		2	SS	12		228										
	black to brown damp																
	grey moist		3	SS	28												
226.7																	
2.3	FILL sandy clay some silt and gravel trace of cobbles brown, moist firm to stiff		4	SS	13		228										
			5	SS	7												
	some sand and topsoil rootlets		6	SS	6												
			7	SS	4		Seal										
223.7							224										
5.3	SANDY SILT trace of clay brown, damp compact to v. dense		8	SS	22		W.L. 223.5 m 11/08/99										
			9	SS	72		Piezometer										
222.4																	
6.6	END OF BOREHOLE Date W.L. 18/08/99 223.7m 23/08/99 223.6m																

LOG OF BOREHOLE 30

CLIENT : R. V. Anderson

PROJECT : Widening of Elgin Mills Rd.

LOCATION : Between Bayview Ave. and Woodbine Ave. Diameter : 100mm

DATUM ELEVATION : Geodetic

DRILLING DATA

Method : Augering

Date : 11/08/99

REF. NO. : G-981203

ENCL. NO. : 32

(m) ELEV DEPTH	SOIL PROFILE DESCRIPTION	STRATA PLOT	SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT	REMARKS AND GRAIN SIZE DISTRIBUTION (%)
			NUMBER	TYPE	BLOWS 0.3 M			20	40	60	80	100	W _p	W	W _L		
230.2	Ground Surface																
0.0	100mm TOPSOIL FILL clayey silt asphalt fragments rootlets brown, damp stiff		1	SS	14		230										
229.4																	
0.8	SANDY SILT (Glacial Till) brown, mottled grey damp compact		2	SS	19												
228.8																	
1.4	SILTY SAND trace of clay and gravel brown, damp dense		3	SS	45												
227.9																	
2.3	SANDY SILT (Glacial Till) wet sand seams cobbles and boulders brown, wet very dense		4	SS	54												
227.2																	
3.0	SANDY SILT trace of clay some gravel brown, moist to wet very dense		5	SS	78												
226.1																	
4.1	END OF BOREHOLE																

31

ENCL. NO. : 33

[illegible]

LOG OF BOREHOLE 36

CLIENT : R. V. Anderson

PROJECT : Widening of Elgin Mills Rd.

LOCATION : Between Bayview Ave. and Woodbine Ave.

DATUM ELEVATION : Geodetic

DRILLING DATA






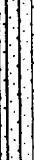

Method : Augering

Diameter : 100mm

Date : 10/08/99

REF. NO. : G-981203

ENCL. NO. : 38


SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 					PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT	REMARKS AND GRAIN SIZE DISTRIBUTION (%)
(m) ELEV DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	BLOWS 0.3 M		20	40	60	80	100	W _p	W	W _L		
232.5	Ground Surface															
0.0	FILL silty sand some gravel occasional clayey silt lumps brown, damp compact		1	SS	12	232										
231.7																
0.8	FILL silty clay some topsoil, rootlets, organic matter some sand and gravel brown to black damp to moist soft to firm		2	SS	5	230										
			3	SS	3											
229.5			4	SS	18											
3.0	SILTY CLAY (POSSIBLE FILL) brown, damp to moist very stiff															
229.5			5	SS	33											
3.0	SANDY SILT to SILTY SAND (Glacial Till) some cobbles below 3.8m brown, damp dense to very dense															
			6	SS	80											
228.2																
4.3	END OF BOREHOLE Borehole was dry upon completion															

LOG OF BOREHOLE 101

CLIENT : R.V. Anderson Associates Ltd.
PROJECT : Elgin Mills Road Reconstruction
LOCATION : West abutment, South side
DATUM ELEVATION : Geodetic

DRILLING DATA
Method : Solid Stem Augering
Diameter : 110 mm
Date : Jan. 5, 2001

REF. NO. : G-20.0702
ENCL. NO. : 4



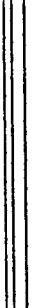
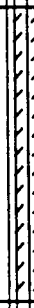
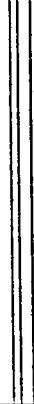
SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	RESISTANCE PLOT 					PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT	REMARKS AND GRAIN SIZE DISTRIBUTION (%)
(m)	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	BLOWS N' 0.3 m		20	40	60	80	100	W _p	W	W _L		
231.6	Ground Surface															
0.0	~150mm TOPSOIL CLAYEY SILT with organics and rootlets, brown very stiff		1	SS	16	Seal										
230.8																
0.8	SILTY SAND some gravel, trace of clay brown dense		2	SS	34											17 42 41
			3	SS	40											
229.3																
2.3	SANDY SILT (Glacial Till) some gravel, trace of clay brown very dense		4	SS	77/275mm											
			5	SS	89/250mm											
			6	SS	50/100mm											
			7	SS	50/100mm	Seal										
			8	SS	50/75mm											
			9	SS	50/50mm											
			10	SS	50/75mm											
			11	SS	50/100mm	Piezometer										
222.4																
9.2	END OF BOREHOLE															
	Date 05/01/01 16/01/01															
	W.L. 230.1m 230.1m															

LOG OF BOREHOLE 103

CLIENT : R.V. Anderson Associates Ltd.
 PROJECT : Elgin Mills Road Reconstruction
 LOCATION : South pier
 DATUM ELEVATION : Geodetic

DRILLING DATA
 Method : Solid Stem Augering
 Diameter : 110 mm
 Date : Jan. 5, 2001

REF. NO. : G-20.0702
 ENCL NO. : 6

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 					PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT	REMARKS AND GRAIN SIZE DISTRIBUTION (%)
(m) ELEV DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	BLOWS 0.3 m		20	40	60	80	100	W _p	W	W _L		
230.4	Ground Surface															GR SA SI CL
0.0	GRAVELLY SAND some silt and clay brown, wet dense to very dense		1	SS	37	230							○			35 49 16
229.0			2	SS	77/275mm								○			
1.4	SILTY SAND (Glacial Till) trace of gravel, trace to some clay brown to grey very dense		3	SS	50/100mm								○			
			4	SS	50/125mm	228							○			
			5	SS	50/50mm								○			
226.6																
3.8	CLAYEY SILT (Glacial Till) trace of gravel and sand grey hard		6	SS	50/125mm	226							○			1 6 71 22
			7	SS	50/150mm								○			
			8	SS	50/150mm								○			
224.3																
6.1	SANDY SILT (Glacial Till) trace to some clay, trace of gravel grey very dense		9	SS	50/125mm	224										
			10	SS	50/75mm								○			
						222										
221.1			11	SS	60/125mm								○			
9.3	END OF BOREHOLE Borehole was dry upon completion															

LOG OF BOREHOLE 105

CLIENT : R.V. Anderson Associates Ltd.
PROJECT : Elgin Mills Road Reconstruction
LOCATION : East abutment, South side
DATUM ELEVATION : Geodetic

DRILLING DATA
Method : Solid Stem Augering
Diameter : 110 mm
Date : Jan. 2, 2001

REF. NO. : G-20.0702
ENCL. NO. : 8















(m) ELEV DEPTH	SOIL PROFILE DESCRIPTION	STRATA PLOT	SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT	REMARKS AND GRAIN SIZE DISTRIBUTION (%)
			NUMBER	TYPE	BLOWS N 0.3 m			20	40	60	80	100	W _p	W	W _L		
232.1	Ground Surface																
0.0	~75mm TOPSOIL SILTY CLAY with organics and rootlets dark brown, firm		1	SS	8		232 Seal							○			
231.3																	
0.8	SANDY SILT trace of gravel brown, wet compact to v. dense		2	SS	25									○			
			3	SS	68									○			0 34 66
			4	SS	59									○			
229.3																	
2.8	SAND and GRAVEL trace of silt brown, wet very dense		5	SS	78/275mm									○			57 37 6
228.5																	
3.8	SAND fine to medium some gravel, trace of silt, brown, wet very dense		6	SS	76									○			
227.8							228										
4.3	SILTY SAND (Glacial Till) trace of clay, some gravel grey, wet very dense		7	SS	50/125mm									○			
			8	SS	50/125mm		Seal							○			
			9	SS	50/100mm									○			12 47 41
			10	SS	50/50mm									○			
							226										
							224										
222.9			11	SS	50/75mm		Piezometer							○			
9.2	END OF BOREHOLE Date W.L. 03/01/01 230.7m 16/01/01 230.0m																

LOG OF BOREHOLE 108

CLIENT : R. V. Anderson Associates Ltd.
 PROJECT : Proposed Watermain
 LOCATION : Elgin Mills Road, Region of York
 DATUM ELEVATION : Geodetic

DRILLING DATA
 Method : Solid Stem Augering
 Diameter : 100 mm
 Date : Oct. 03, 2001

REF. NO. : G-01.0904
 ENCL. NO. : 10


SOIL PROFILE		SAMPLES				GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC NATURAL LIQUID LIMIT MOISTURE LIMIT CONTENT			UNIT WEIGHT	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
(m) ELEV DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	BLOWS 'N' 0.3 M			20	40	60	80	100	W _p	W	W _L			
SHEAR STRENGTH													WATER CONTENT (%)					
						○ UNCONFINED + FIELD VANE												
						● QUICK TRIAXIAL × LAB VANE												
233.0	Ground Surface											10	20	30				
0.0	150mm TOPSOIL		1	A	SS	12		Seal										
	FILL		2	B	SS	13		232										
231.8	silty sand and clayey silt, trace of rootlets and organic matter brown, compact/stiff																	
1.4	SANDY SILT (POSSIBLE FILL) trace of gravel and clay, brown, compact		3		SS	16												
230.9																		
2.1	SILTY SAND trace of gravel clay lumps brown, very dense		4		SS	50/150mm		Seal										
230.0																		
3.0	SILTY SAND (Glacial Till) trace of gravel and clay very dense		5		SS	92		230										
	brown		6		SS	50/125mm		Seal										
	grey		7		SS	50/125mm		228										
			8		SS	50/100mm												
			9		SS	50/125mm		Piezometer										
226.4																		
6.6	END OF BOREHOLE																	
	Borehole was dry on completion																	
	DATE WL EL																	
	09/10/01 230.6m																	
	10/10/01 230.5m																	

LOG OF BOREHOLE 109

CLIENT : R. V. Anderson Associates Ltd.
 PROJECT : Proposed Watermain
 LOCATION : Elgin Mills Road, Region of York
 DATUM ELEVATION : Geodetic

DRILLING DATA
 Method : Solid Stem Augering
 Diameter : 100 mm
 Date : Oct. 03, 2001

REF. NO. : G-01.0904
 ENCL. NO. : 11





SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 					PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
(m) ELEV DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	BLOWS N 0.3 M		20	40	60	80	100	W _p	W	W _L		
233.3	Ground Surface															
0.0	FILL		1	AS												
232.7	gravelly sand, trace of sand, clay lumps, brown															
0.8	FILL		2	SS	15											
231.8	organic stained silty clay dark brown, stiff															
1.5	SANDY SILT (Glacial Till)		3	SS	19											
	trace to some clay trace of gravel brown compact		4	SS	20											
230.3																
3.0	SILTY SAND (Glacial Till)		5	SS	53											
	trace of gravel and clay very dense		6	SS	50/150mm											
	brown															
228.3	grey		7	SS	50/150mm											
5.0	END OF BOREHOLE															

LOG OF BOREHOLE 110

CLIENT : R.V. Anderson Associates Ltd.
 PROJECT : Elgin Mills Road Reconstruction
 LOCATION : W-S Ramp Sta. 9+980 approx. @ C.
 DATUM ELEVATION : Geodetic

DRILLING DATA
 Method : Solid Stem Augering
 Diameter : 110 mm
 Date : Jan. 5, 2001

REF. NO. : G-20.0702
 ENCL. NO. : 13




(m) ELEV DEPTH	SOIL PROFILE DESCRIPTION	STRATA PLOT	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	REMARKS AND GRAIN SIZE DISTRIBUTION (%)
			NUMBER	TYPE	BLOWS 0.3 m			20	40	60	80	100					
230.8	Ground Surface																GR SA SI CL
0.0	~150mm TOPSOIL over CLAYEY SILT trace of organics, some gravel, grey, stiff		1	SS	12									○			
230.0							230										
0.8	SAND and SILT (Glacial Till)		2	SS	49									○			5 40 55
	trace of clay, trace to some gravel brown to mottled grey, wet dense to v. dense		3	SS	80/275mm									○			
			4	SS	76									○			
			5	SS	50/125mm		228							○			
227.0			6	SS	63									○			
3.8	END OF BOREHOLE																

LOG OF BOREHOLE 111

CLIENT : R.V. Anderson Associates Ltd.
PROJECT : Elgin Mills Road Reconstruction
LOCATION : Sta. 4+450 South
DATUM ELEVATION : Geodetic

DRILLING DATA
Method : Solid Stem Augering
Diameter : 110 mm
Date : Dec. 18, 2000

REF. NO. : G-20.0702
ENCL. NO. : 14

(m) ELEV DEPTH	SOIL PROFILE DESCRIPTION	STRATA PLOT	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	REMARKS AND GRAIN SIZE DISTRIBUTION (%)
			NUMBER	TYPE	BLOWS 'N' 0.3 M			20	40	60	80	100					
223.4	Ground Surface																
0.0	~50mm TOPSOIL POSSIBLE FILL silty sand trace of gravel. rootlets and organics dark brown loose to compact		1	SS	6		Seal										
222.0			2	SS	15		W.L. 222.6 m 29/01/01										1 78 21
1.4	SILT and SAND (Glacial Till) some clay and gravel grey very dense		3	SS	78		222										
220.2			4	SS	50/125mm		Piezometer Caved 220.5 m 18/12/00										
3.2	END OF BOREHOLE Date W.L. 18/12/00 222.6m 16/01/01 222.7m 14/04/03 222.8m																

LOG OF BOREHOLE 171

CLIENT : R.V. Anderson Associates Ltd.
PROJECT : Elgin Mills Road Reconstruction
LOCATION : W-S Ramp Sta. 10+050 approx. @ C
DATUM ELEVATION : Geodetic

DRILLING DATA
Method : Solid Stem Augering
Diameter : 110 mm
Date : Dec.11, 2000

REF. NO. : G-20.0702
ENCL NO. : 31

(m) ELEV DEPTH	SOIL PROFILE DESCRIPTION	STRATA PLOT	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	REMARKS AND GRAIN SIZE DISTRIBUTION (%)
			NUMBER	TYPE	BLOWS 0.3 m			20	40	60	80	100					
230.4	Ground Surface																
0.0	~75mm TOPSOIL SILTY CLAY, some rootlets, trace gravel & sand, brown, firm		1	SS	6		230										
229.8																	
0.6	SAND and SILT (Glacial Till)		2	SS	48												3 37 46 9
	trace of gravel and clay brown to grey dense to v. dense		3	SS	78												
			4	SS	50/125mm												
			5	SS	50/150mm												
226.8																	
3.6	SILTY SAND		6	SS	50/125mm		226										
	trace of gravel brown, wet very dense		7	SS	63												
			8	SS	50/100mm												
224.8																	
5.6	END OF BOREHOLE																

LOG OF BOREHOLE 172

CLIENT : R.V. Anderson Associates Ltd.
PROJECT : Elgin Mills Road Reconstruction
LOCATION : W-S Ramp Sta. 10+100 approx. ● C
DATUM ELEVATION : Geodetic

DRILLING DATA
Method : Solid Stem Augering
Diameter : 110 mm
Date : Dec. 11, 2000

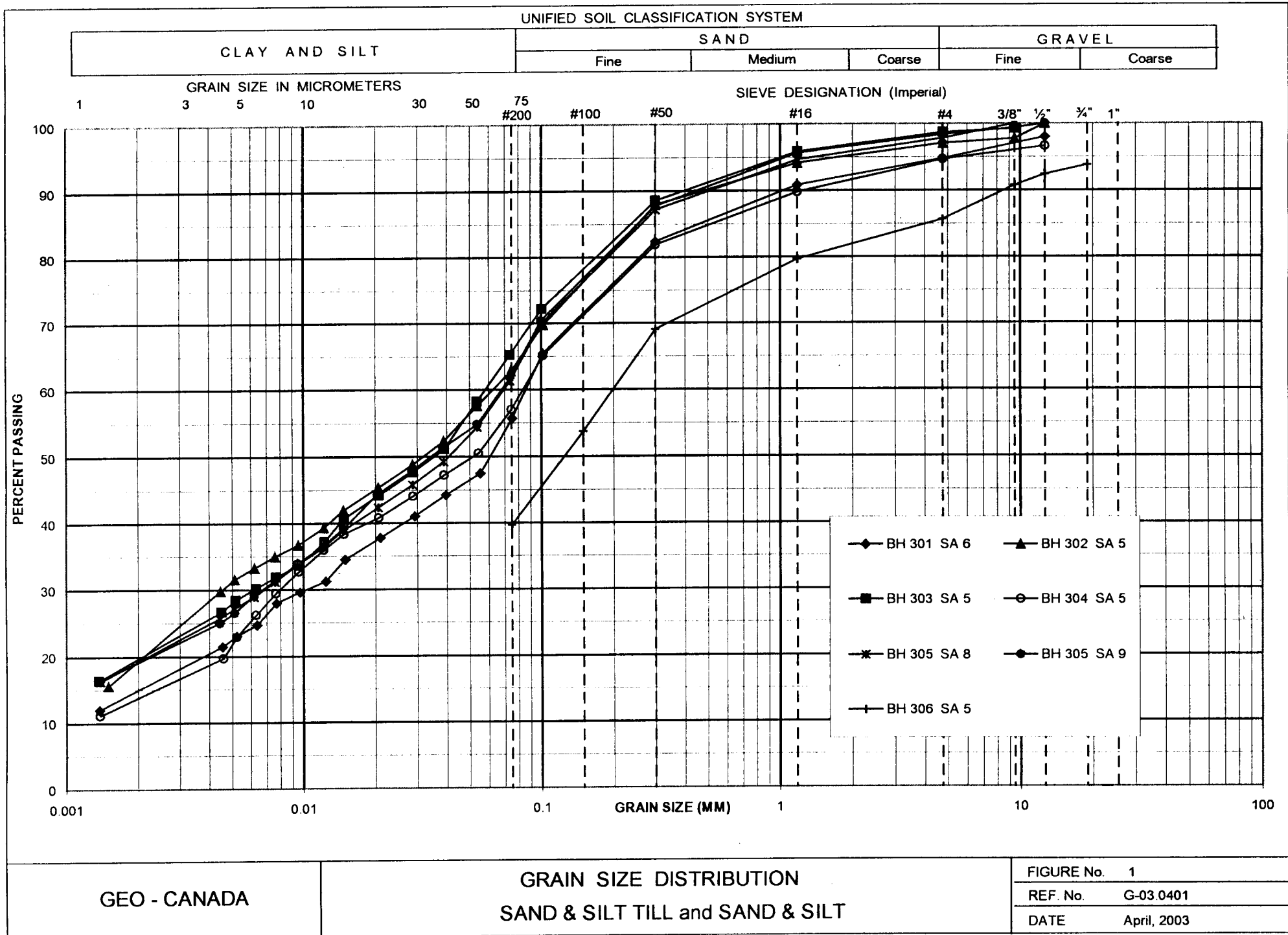
REF. NO. : G-20.0702
ENCL NO. : 32

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT	REMARKS AND GRAIN SIZE DISTRIBUTION (%)
(m) ELEV DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE			20	40	60	80	100	W _p	W	W _L		
230.6	Ground Surface															GR SA SI CL
0.0	~100mm TOPSOIL SILT		1	SS	9								○			
	clayey, trace of sand and gravel brown loose to compact		2	SS	17								○			
229.2																
1.4	SAND and SILT		3	SS	61								○			0 45 55
	some gravel, trace of clay brown, wet very dense		4	SS	64								○			
			5	SS	50/150mm								○			
			6	SS	50/150mm								○			
225.8			7	SS	49								○			
4.8	SANDY SILT (Glacial Till)		8	SS	52/150mm								○			
	some gravel, trace of clay brown dense to v. dense		9	SS	86/225mm								○			
			10	SS	50/100mm								○			
			11	SS	50/150mm								○			
221.3																
9.3	END OF BOREHOLE															

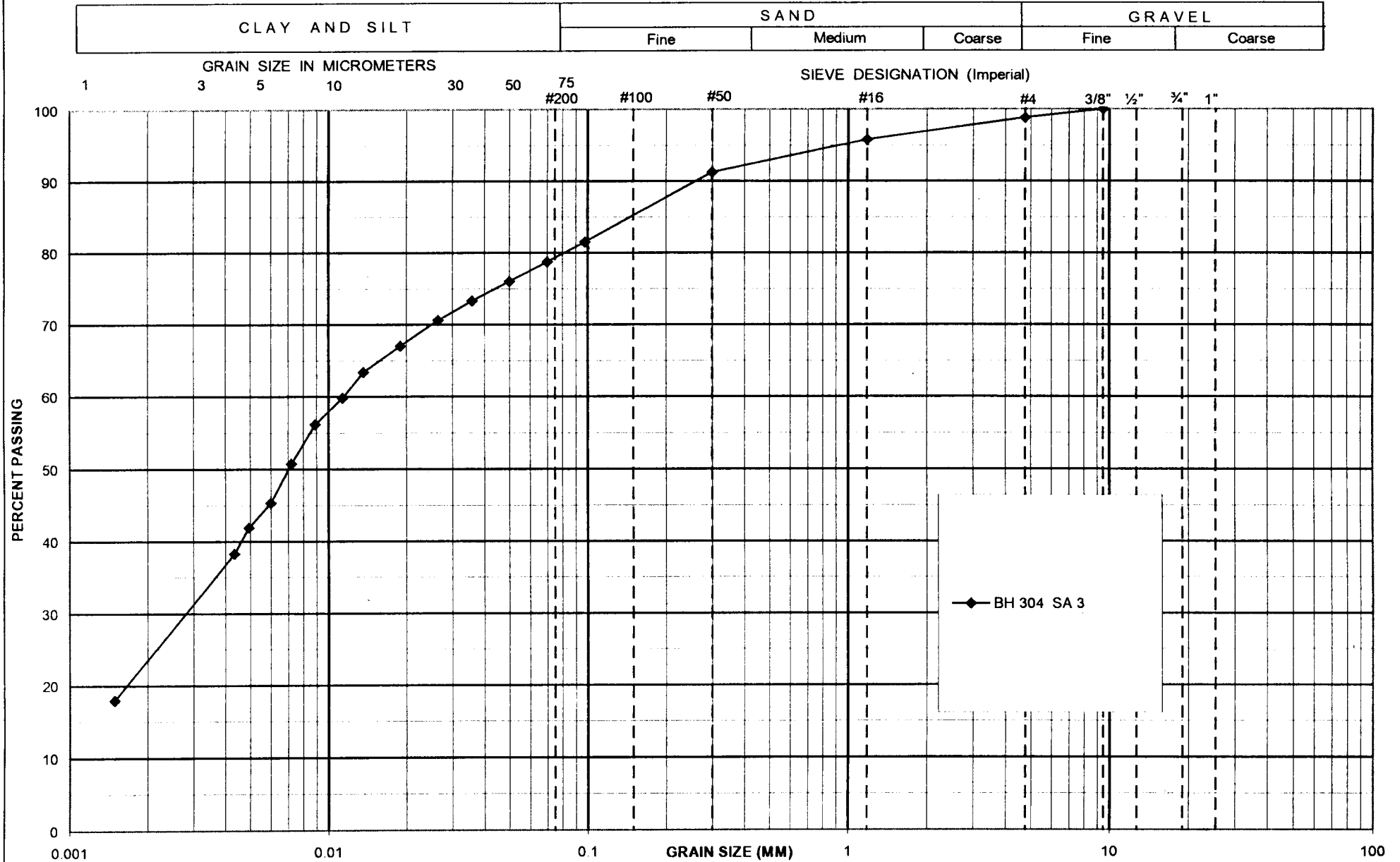


APPENDIX C

**GRAIN SIZE DISTRIBUTION CURVES (FIGURES 1 TO 5),
EARTH PRESSURE DISTRIBUTION ON BRACED SHEETING
IN NON-COHESIVE SOILS (FIGURE 6)
EARTH PRESSURE DISTRIBUTION ON BRACED SHEETING
IN COHESIVE SOILS (FIGURE 7)**



UNIFIED SOIL CLASSIFICATION SYSTEM



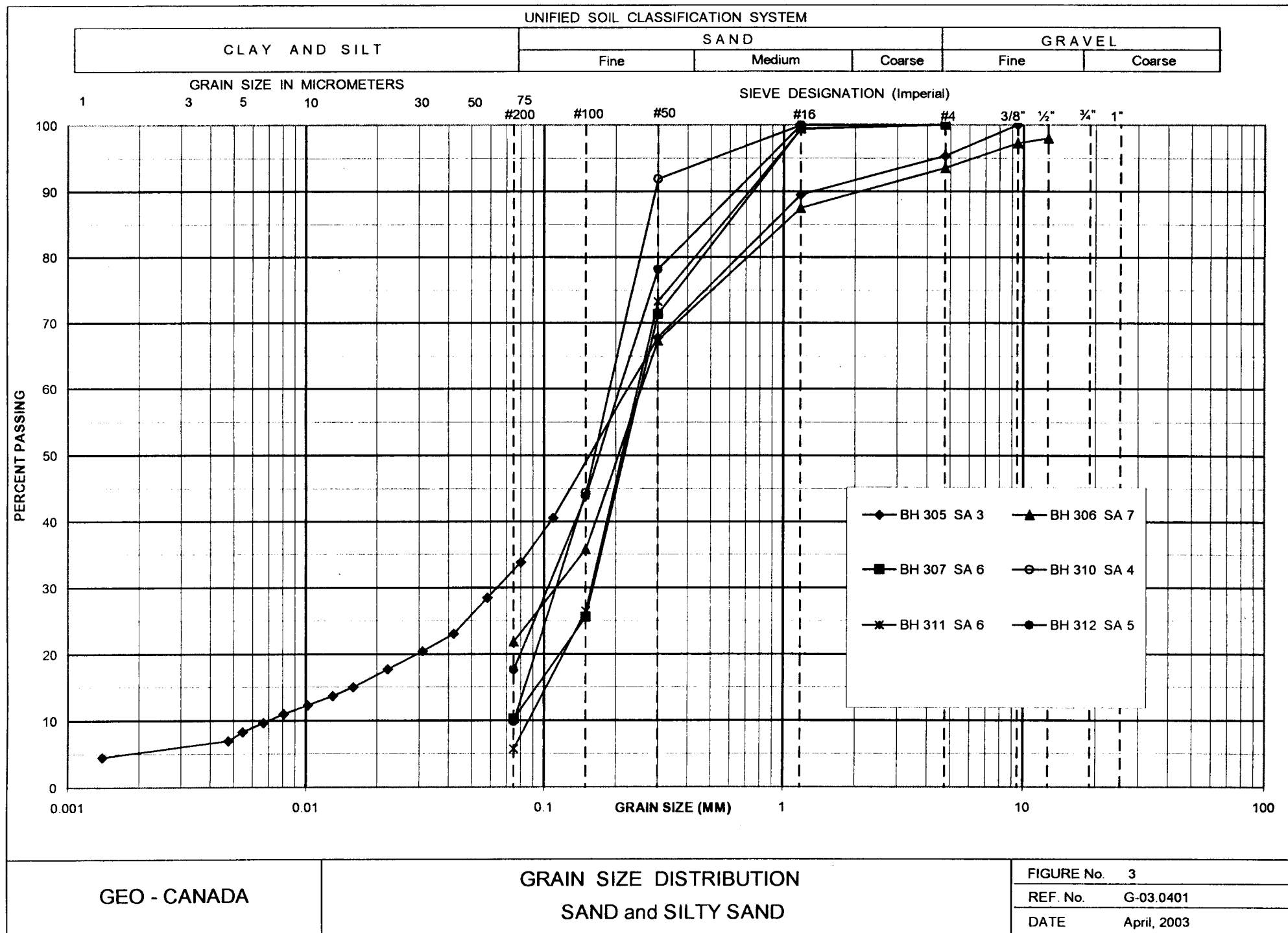
GEO - CANADA

GRAIN SIZE DISTRIBUTION
CLAYEY SILT

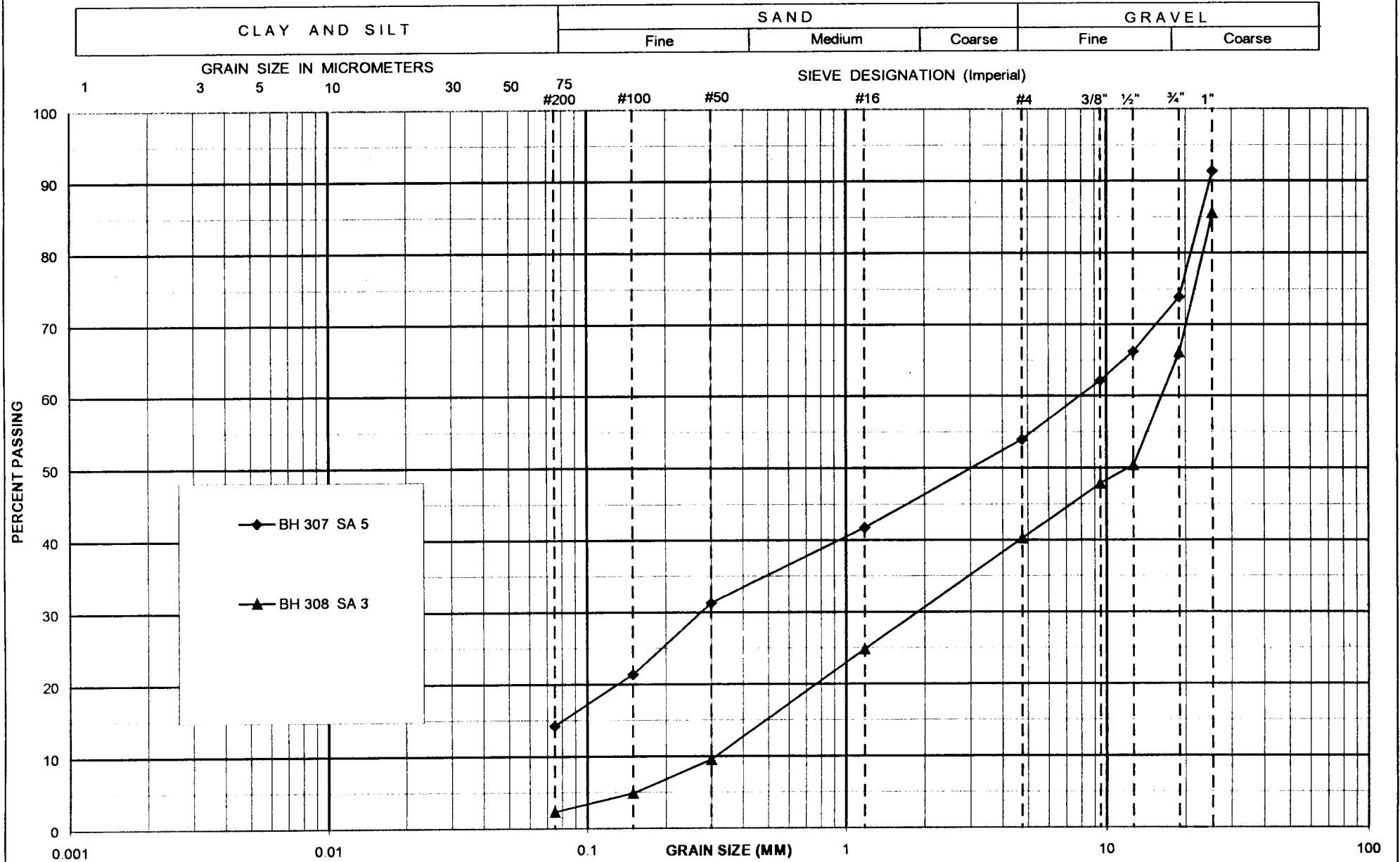
FIGURE No. 2

REF. No. G-03.0401

DATE April, 2003



UNIFIED SOIL CLASSIFICATION SYSTEM



GEO - CANADA

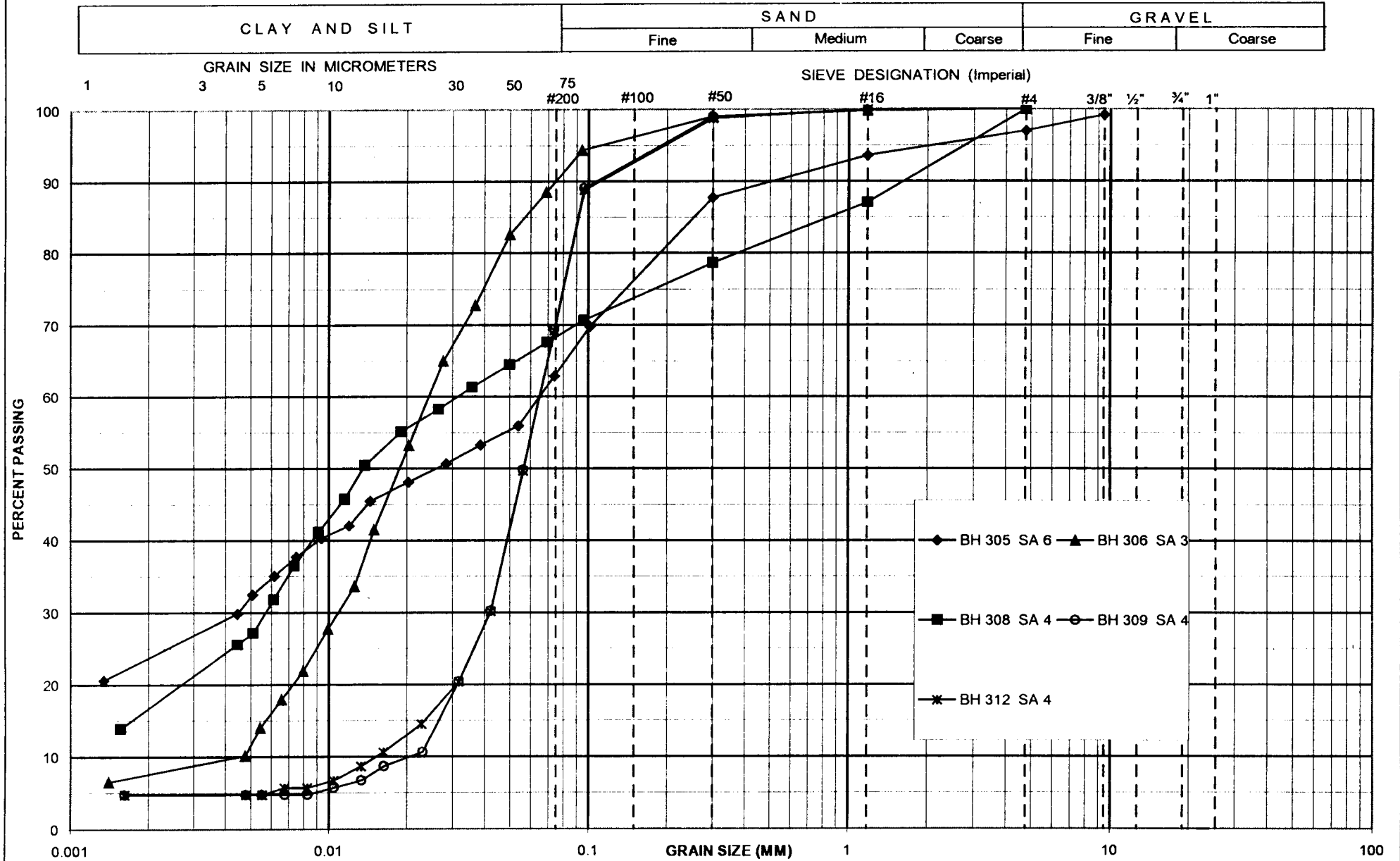
GRAIN SIZE DISTRIBUTION
SAND & GRAVEL

FIGURE No. 4

REF. No. G-03.0401

DATE April, 2003

UNIFIED SOIL CLASSIFICATION SYSTEM



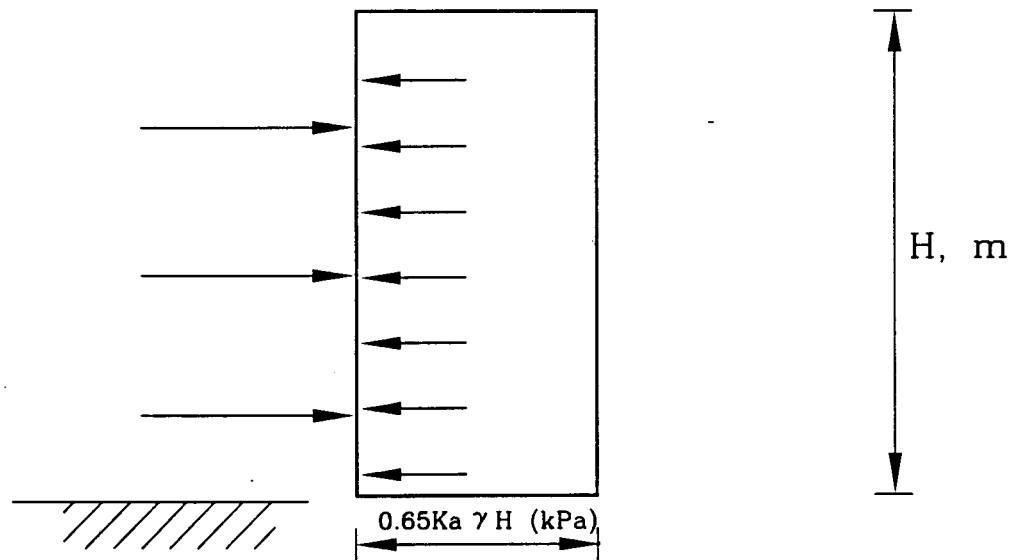
GEO - CANADA

GRAIN SIZE DISTRIBUTION
SILT, SANDY SILT and SANDY SILT TILL

FIGURE No. 5

REF. No. G-03.0401

DATE April, 2003

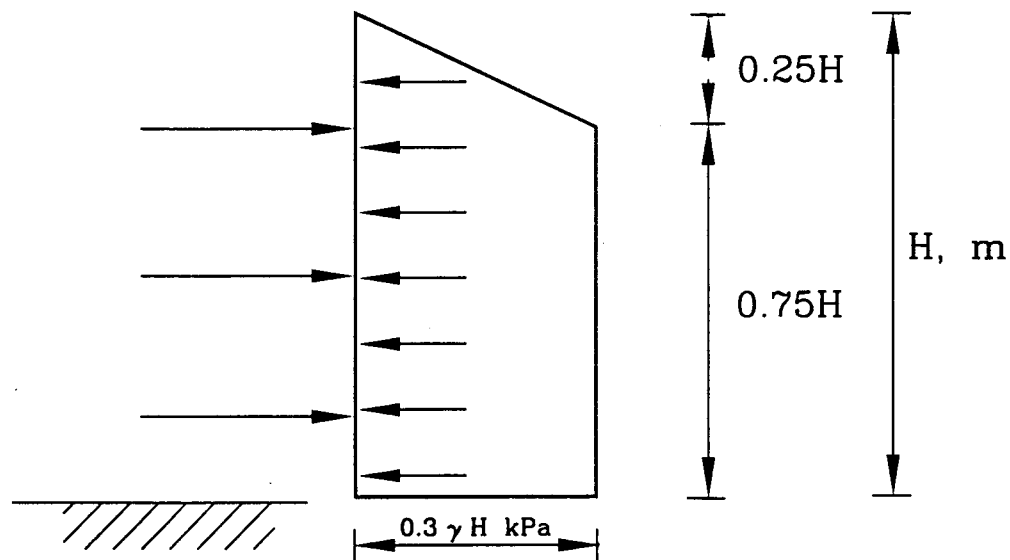


γ = unit weight of soil = 21.5 kN/m³

K_a = 0.3

Notes:

1. Check system for partial excavation condition
2. If the free water level is above the base of the excavation, the hydrostatic pressure must be added to the above pressure distribution
3. If surcharge loadings are present near the excavation, these must be included in the lateral pressure calculation



$\gamma = \text{unit weight of soil} = 22.0 \text{ kN/m}^3$

Notes:

1. Check system for partial excavation condition
2. If the free water level is above the base of the excavation, the hydrostatic pressure must be added to the above pressure distribution
3. If surcharge loadings are present near the excavation, these must be added to the lateral pressure calculation



APPENDIX D
STATEMENT OF LIMITATION



Statement of Limitation

The conclusions and recommendations in this report are based on information determined at the borehole locations. Soil and groundwater conditions between and beyond the boreholes may differ from those encountered at the borehole locations, and conditions may become apparent during construction which could not be detected or anticipated at the time of the soil investigation.

The design recommendations given in this report are applicable only to the project described in the text, and then only if constructed substantially in accordance with details of alignment and elevations stated in the report. Since all details of the design may not be known to us, in our analysis certain assumptions had to be made. The actual conditions may, however, vary from those assumed, in which case changes and modifications may be required to our recommendations.

We recommend, therefore, that we be retained during the final design stage to review the design drawings and to verify that they are consistent with our recommendations or the assumptions made in our analysis. We recommend also that we be retained during construction to confirm that the subsurface conditions throughout the site do not deviate materially from those encountered in the boreholes. In cases where these recommendations are not followed, the company's responsibility is limited to interpreting accurately the information encountered at the boreholes.

The comments given in this report on potential construction problems and possible methods are intended only for the guidance of the design engineer. The number of boreholes may not be sufficient to determine all the factors that may affect construction methods and costs. The contractors bidding on this project or undertaking the construction should, therefore, make their own interpretation of the factual information presented and draw their own conclusions as to how the subsurface conditions may affect their work.



GEO-CANADA

June 2, 2003

Ref. No. G-03.0401

R.V. Anderson Associates Limited
2001 Sheppard Avenue East
Suite 400
Willowdale, Ontario
M2J 4Z8

Att: John Does, P.Eng.

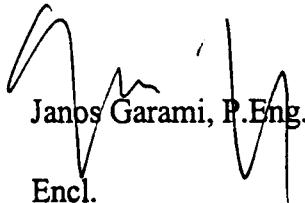
Re: **Addendum to Geotechnical Investigation
Proposed Watermain - Elgin Mills Rd.
Leslie St. to Woodbine Ave.
The Regional Municipality of York**

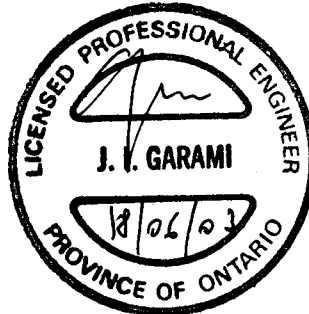
Dear Sir:

Please find attached an Addendum to our geotechnical investigation report which we carried out at your request for the above project.

Yours very truly,

GEO-CANADA LTD.


Janos Garami, P.Eng.
Encl.



JG:sf



ADDENDUM TO
GEOTECHNICAL INVESTIGATION
PROPOSED WATERMAIN - ELGIN MILLS RD.
LESLIE ST. TO WOODBINE AVE.
THE REGIONAL MUNICIPALITY OF YORK

Environmental Quality of Soils with Respect to Off-Site Disposal

To provide a general measure of the environmental soil quality of the excavated soils with respect to on-site reuse and off-site disposal, four (4) selected soil samples were subjected to the following analyses: general and inorganic parameters for the MOE "Guideline for Use at Contaminated Sites in Ontario" (GUCSO) and O. Reg. 558 leachate test for inorganic parameters.

The four (4) samples analyzed are:

- Borehole 301, Sample 2, from 0.75m to 1.2m depth
- Borehole 304, Sample 2, from 0.75m to 1.2m depth
- Borehole 308, Sample 1, from 1.5m to 1.95m depth
- Borehole 312, Sample 1, from 0.75m to 1.2m depth

The analytical data are enclosed herewith.

Based on the inorganic parameters assessed relative to the Leachate Quality Criteria, all of the tested soils would be considered as "Non-Hazardous Waste".



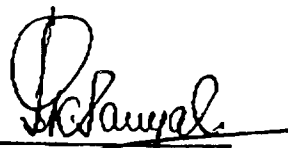
As far as the general and inorganic GUCSO criteria are concerned, all of the four (4) test samples have parameter concentrations below the MOE Table 'A' Residential Criteria (the most stringent criteria). Exceptions to this are the Electrical Conductivity (EC) and the Sodium Absorption Ratio (SAR) in Sample 1 of Borehole 308 and SAR in Sample 1 of Borehole 312, which are elevated above the remediation criteria. These exceedances may be related to road salt application.

Based on the available test results and absence of other aesthetic indicators of impact, such as staining or odours, the site soils with the above exceptions are generally considered suitable for either reuse on site (where geotechnically suitable) or for off-site disposal as 'clean' fill by an approved receiver of fill. However, Geo-Canada makes no warranty, express or implied, as to whether or not excavated soils will be accepted by receivers and contractors should qualify their bids to protect themselves in the event that environmental impact to soils increases disposal costs. Off-site receivers will likely require additional testing prior to acceptance of any soils. They may also reject soils based on other criteria, such as presence of organic material or elevated moisture content.

Notwithstanding the test results provided herein, vigilance must be kept on the excavated soils. Soils with any evidence of anomalous fill, staining or odours should be stockpiled separately, and this office immediately contacted so that additional testing may be performed to assess its environmental quality.

DR27/G-03 0401 RVA Addendum

Client: Geo-Canada
 Attention: Janos Garami
 Project: G-030401
 P.O.: 344
 Sample Type: Soil
 Date Received: May 23/03
 Date Analysed: May 23, 26 to May 28/03
 Date Reported: May 28/03


 Sam Sanyal, M.Sc. C. Chem.
 Manager, Inorganic Analysis.

ENTECH

A Division of Agri-Service Lab Inc.
 6820 Kitchin Rd., Unit #4
 Mississauga, ON L5N 5M3
 TEL: (905) 821-1112
 FAX: (905) 821-2095

CERTIFICATE OF ANALYSIS FOR ONTARIO REGULATION 558/00 TCLP - LEACHATE QUALITY CRITERIA (INORGANICS)

Data Pertain To Specific Sample(s) Tested

CONTAMINANT	SCHEDULE 4 Concentration (mg/L)	Method Detection Limit (mg/L)	CONTROL SAMPLE			SAMPLE DATA (mg/L)			
			Expected Conc. (mg/L)	Found Conc. (mg/L)	Recovery %	Blank	18738 BH304/SA2	18739 BH308/SA1	
Arsenic	2.5	0.001	0.258	0.243	94	<0.001	<0.001	<0.001	
Barium	100	0.01	1.12	1.13	101	<0.01	0.33	0.65	
Boron	500	0.01	0.626	0.659	105	<0.01	0.04	0.05	
Cadmium	0.5	0.005	0.175	0.186	106	<0.005	<0.005	<0.005	
Chromium	5.0	0.01	0.938	0.945	101	<0.01	<0.01	<0.01	
Cyanide Free	20.0	0.005	0.10	0.100	100	<0.005	<0.005	<0.005	
Fluoride	150	0.05	3.73	3.5	94	<0.05	0.29	0.21	
Lead	5.0	0.02	0.053	0.051	96	<0.02	<0.02	<0.02	
Mercury	0.1	0.0001	0.0262	0.0269	103	<0.0001	<0.0001	<0.0001	
(Nitrate+Nitrite)-N	1000	0.01	5.39	5.50	102	<0.01	0.03	0.19	
Selenium	1.0	0.002	0.019	0.0186	98	<0.002	<0.002	<0.002	
Silver	5.0	0.005	0.050	0.046	92	<0.005	<0.005	<0.005	
Initial pH (units)	-	-	-	-	-	2.9	9.0	9.2	
Fluid No.	-	-	-	-	-	2	2	2	
Fluid pH (units)	-	-	-	-	-	2.9	2.9	2.9	
Final pH (units)	-	-	-	-	-	2.9	5.8	5.6	

Sample Disposal: 30 Days from the Reporting Date.

All Results except pH are expressed in mg/L (parts per million).

Note: "+" means the result exceeds the Schedule 4 concentration.

Method:

As, Se: HG-FAAS (EPA 3005/7062/7742)

Hg: CV-AAS (EPA 245.1)

Metals: ICP-AES (EPA 3005/200.7)

pH: Electrometric/pH-Meter (EPA 150.1)

Cyanide Free: Auto-Color (EPA 365.1)

Fluoride: ISE (EPA 340.2)

(NO₃ + NO₂)-N: Auto-Color (EPA 353.2)

Analyst(s): MD, SS, JW, AI, AV, MR

Client: Geo-Canada
 Attention: Janos Garami
 Project: G-030401
 P.O.: 344
 Sample Type: Soil
 Date Received: May 23/03
 Date Analysed: May 23, 26 to May 28/03
 Date Reported: May 28/03

ENTECH

A Division of Agri-Service Lab Inc.
 6820 Kitchener Rd., Unit #4
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TEL: (905) 821-1112
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Sam Sanyal, M.Sc., C.Chem.
 Manager, Inorganic Analysis

CERTIFICATE OF CHEMICAL ANALYSIS - MOEE SOIL DECOMM. GUIDELINES FOR CONTAMINATED SITES IN ONTARIO (GENL. & INORGANIC)

Data Pertain To Specific Sample(s) Tested

PARAMETER	Soil Remediation Criteria (µg/g)		Method Detection Limit (µg/g)	CONTROL SAMPLE			SAMPLE DATA (µg/g)			
	Tables A & B Res./Ind. Comm	Tables C & D Res./Ind. Comm		Expected Concentration (µg/g)	Concentration Found (µg/g)	Recovery %	Blank	18737 BH301/SA2	18738 BH304/SA2	18739 BH308/SA1
Dry Matter (%)	-	-	-	-	-	-	-	84.25	91.41	88.96
pH (units)	5 to 9	5 to 11	-	7.41	7.42	100	-	8.5	8.4	8.9
E C (µmhos/cm)	700/1400	N.A./N.A.	-	147.3	145.8	99	-	239	127	729
SAR	5/12	N.A./N.A.	-	-	-	-	-	8.88	1.98	21.6
Arsenic	20/40	40/N.V.	1	75	72.6	97	<1	2.2	1.2	1.3
Cadmium	12/12	41/41	1	3.4	3.4	100	<1	<1	<1	<1
Chromium (VI) *	8/8	600/1100	1	0.72	0.70	97	<1	<1	<1	<1
Chromium (total)	750/750	2500/5000	1	34	31.3	92	<1	21.9	10.8	13.4
Cobalt	40/80	2500/3400	1	2.8	2.75	88	<1	1.3	<1	<1
Copper	225/225	2500/2500	1	69	75.2	109	<1	1.7	3.8	3.0
Lead *	200/1000	1000/N.V.	2	2	1.94	97	<2	<2	<2	<2
Mercury	10/10	57/57	0.05	0.28	0.30	107	<0.05	0.06	<0.05	<0.05
Molybdenum	40/40	550/550	2	5.35	4.66	87	<2	<2	<2	<2
Nickel	150/150	710/710	2	63.3	62.0	98	<2	8.0	3.2	3.5
Boron(HWE) *	1.5/2.0	2.0/N.V.	0.02	1	1.03	103	<0.02	0.06	0.03	0.10
Cyanide Free *	100/100	100/390	0.1	0.20	0.213	107	<0.1	<0.1	<0.1	<0.1
Selenium	10/10	2500/2500	1	0.8	0.759	95	<1	<1	<1	<1
Silver *	20/40	240/240	0.3	0.20	0.185	93	<0.3	<0.3	<0.3	<0.3
Zinc	600/600	2500/5000	1	46.7	49.1	105	<1	42	23	18
Antimony *	13/40	44/44	1	0.010	0.010	100	<1	<1	<1	<1
Barium	750/1500	2500/4100	1	102	97	95	<1	117	41.5	59.4
Beryllium	1.2/1.2	1.2/3.1	0.5	68.3	72.8	107	<0.5	<0.5	<0.5	<0.5
Vanadium	200/200	910/910	1	4.77	5.07	106	<1	7.1	4.7	4.6

- a) Table A: Surface soil criteria for a potable groundwater condition
 b) Table B: Surface soil criteria for a non-potable groundwater condition
 c) Table C: Sub-surface soil criteria for a potable groundwater condition
 d) Table D: Sub-surface soil criteria for a non-potable groundwater condition

Sample Disposal: 30 Days from the Reporting Date.

* Control Sample Unit is µg/mL for the specified parameter instead of µg/g unless otherwise specified.

Method:

pH: Extraction/Electrometric (EPA 9045)
 EC: Extraction/Electrometric (EPA 120.1)
 As, Se, Sb: Digestion/HGFAAS (EPA 3050A/7062/7742)
 Hg: Digestion/CV-AAS (EPA 7471A/245.5)
 SAR: Extraction/ICP-AES (EPA 200.7)

All guideline criteria are for coarse textured soil

HWE - Hot water extractable

Sample data and MDL units are in µg/g unless otherwise specified

Analyst(s): NL, SS, MR, JW, AV, AI, MD

Metals: Digestion/ICP-AES (EPA 3050A/200.7)
 Cyanide Free: Extraction/Auto-Color (EPA 335.4)
 B (HWE): Extraction/ICP-AES
 Cr(VI): Alkaline Digestion/Colorimetry (EPA 3060A/7186)

Client: Geo-Canada
 Attention: Janos Garami
 Project: G-030401
 P.O. : 344
 Sample Type: Soil
 Date Received: May 23/03
 Date Analysed: May 23, 26 to May 28/03
 Date Reported: May 28/03

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Sam Sanyal

Sam Sanyal, M.Sc., C.Chem.
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CERTIFICATE OF CHEMICAL ANALYSIS - MOEE SOIL DECOMM. GUIDELINES FOR CONTAMINATED SITES IN ONTARIO (GENL. & INORGANIC)

Data Pertain To Specific Sample(s) Tested

PARAMETER	Soil Remediation Criteria (µg/g)		Method Detection Limit (µg/g)	CONTROL SAMPLE			SAMPLE DATA (µg/g)			
	Tables A & B Res./Ind. Comm	Tables C & D Res./Ind. Comm		Expected	Concentration	Recovery	18740	18740		
				Concentration (µg/g)	Found (µg/g)	%	BH312/SA1	BH312/SA1 Duplicate		
Dry Matter (%)	-	-	-	-	-	-	85.14	85.14		
pH (units)	5 to 9	5 to 11	-	7.41	7.42	100	7.9	7.9		
E C (µmhos/cm)	700/1400	N.A./N.A.	-	147.3	145.8	99	294	300		
SAR	5/12	N.A./N.A.	-	-	-	-	15.0	15.8		
Arsenic	20/40	40/N.V.	1	75	72.6	97	2.5	2.5		
Cadmium	12/12	41/41	1	3.4	3.4	100	<1	<1		
Chromium (VI) *	8/8	600/1100	1	0.72	0.70	97	<1	<1		
Chromium (total)	750/750	2500/5000	1	34	31.3	92	20.3	21.6		
Cobalt	40/80	2500/3400	1	2.8	2.75	98	9.3	9.5		
Copper	225/225	2500/2500	1	69	75.2	109	15.2	15.2		
Lead *	200/1000	1000/N.V.	2	2	1.94	97	29.0	29.7		
Mercury	10/10	57/57	0.05	0.28	0.30	107	0.09	0.07		
Molybdenum	40/40	550/550	2	5.35	4.66	87	2.4	<2		
Nickel	150/150	710/710	2	63.3	62.0	98	17.4	17.8		
Boron(HWE) *	1.5/2.0	2.0/N.V.	0.02	1	1.03	103	0.13	0.15		
Cyanide Free *	100/100	100/390	0.1	0.20	0.213	107	<0.1	<0.1		
Selenium	10/10	2500/2500	1	0.8	0.759	95	<1	<1		
Silver *	20/40	240/240	0.3	0.20	0.185	93	<0.3	<0.3		
Zinc	600/600	2500/5000	1	48.7	49.1	105	52	53		
Antimony *	13/40	44/44	1	0.010	0.010	100	<1	<1		
Barium	750/1500	2500/4100	1	102	97	95	76.8	79.2		
Beryllium	1.2/1.2	1.2/3.1	0.5	68.3	72.8	107	<0.5	<0.5		
Vanadium	200/200	910/910	1	4.77	5.07	106	22.2	23.4		

- a) Table A: Surface soil criteria for a potable groundwater condition
 b) Table B: Surface soil criteria for a non-potable groundwater condition
 c) Table C: Sub-surface soil criteria for a potable groundwater condition
 d) Table D: Sub-surface soil criteria for a non-potable groundwater condition

Sample Disposal: 30 Days from the Reporting Date.

* Control Sample Unit is µg/mL for the specified parameter instead of µg/g unless otherwise specified.

Method:

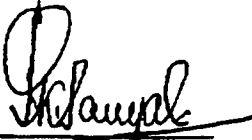
pH: Extraction/Electrometric (EPA 9045)
 EC: Extraction/Electrometric (EPA 120.1)
 As, Se, Sb: Digestion/HGFAAS (EPA 3050A/7062/7742)
 Hg: Digestion/NCV-AAS (EPA 7471A/245.5)
 SAR: Extraction/ICP-AES (EPA 200.7)

All guideline criteria are for coarse textured soil
 HWE - Hot water extractable
 Sample data and MDL units are in µg/g unless otherwise specified

Analyst(s): NL, SS, MR, JW, AV, AI, MD

Metals: Digestion/ICP-AES (EPA 3050A/200.7)
 Cyanide Free: Extraction/Auto-Color (EPA 335.4)
 B (HWE): Extraction/ICP-AES
 Cr(VI): Alkaline Digestion/Colorimetry (EPA 3060A/7196)

Client: Geo-Canada
 Attention: Janos Garami
 Project: G-030401
 P.O.: 344
 Sample Type: Soil
 Date Received: May 23/03
 Date Analysed: May 23, 26 to May 28/03
 Date Reported: May 28/03


 Sam Sanyal, M.Sc. C. Chem.
 Manager, Inorganic Analysis.

ENTECH
 A Division of Agri-Service Lab Inc.
 6820 Kitchener Rd., Unit #4
 Mississauga, ON L5N 5M3
 TEL: (905) 821-1112
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CERTIFICATE OF ANALYSIS FOR ONTARIO REGULATION 558/00 TCLP - LEACHATE QUALITY CRITERIA (INORGANICS)

Data Pertain To Specific Sample(s) Tested

CONTAMINANT	SCHEDULE 4 Concentration (mg/L)	Method Detection Limit (mg/L)	CONTROL SAMPLE			SAMPLE DATA (mg/L)			
			Expected Conc. (mg/L)	Found Conc. (mg/L)	Recovery %	Blank	18737 BH301/SA2	18740 BH312/SA1	18740 BH312/SA1 Duplicate
Arsenic	2.5	0.001	0.258	0.243	94	<0.001	<0.001	<0.001	<0.001
Barium	100	0.01	1.12	1.13	101	<0.01	0.53	0.26	0.26
Boron	500	0.01	0.626	0.659	105	<0.01	0.03	<0.01	<0.01
Cadmium	0.5	0.005	0.175	0.186	106	<0.005	<0.005	<0.005	<0.005
Chromium	5.0	0.01	0.938	0.945	101	<0.01	<0.01	<0.01	<0.01
Cyanide Free	20.0	0.005	0.10	0.100	100	<0.005	<0.005	<0.005	<0.005
Fluoride	150	0.05	3.73	3.5	94	<0.05	0.09	0.11	0.11
Lead	5.0	0.02	0.053	0.051	96	<0.02	<0.02	<0.02	<0.02
Mercury	0.1	0.0001	0.0262	0.0269	103	<0.0001	<0.0001	<0.0001	<0.0001
(Nitrate+Nitrite)-N	1000	0.01	5.39	5.50	102	<0.01	0.19	0.64	0.71
Selenium	1.0	0.002	0.019	0.0186	98	<0.002	<0.002	<0.002	<0.002
Silver	5.0	0.005	0.050	0.046	92	<0.005	<0.005	<0.005	<0.005
Initial pH (units)	-	-	-	-	-	5.0	9.0	8.5	8.5
Fluid No.	-	-	-	-	-	1	1	1	1
Fluid pH (units)	-	-	-	-	-	5.0	5.0	5.0	5.0
Final pH (units)	-	-	-	-	-	5.0	5.8	6.2	6.2

Sample Disposal: 30 Days from the Reporting Date.

All Results except pH are expressed in mg/L (parts per million).

Note: "+" means the result exceeds the Schedule 4 concentration.

Method:

As, Se: HG-FAAS (EPA 3005/7062/7742)

Hg: CV-AAS (EPA 245.1)

Metals: ICP-AES (EPA 3003/200.7)

pH: Electrometric/pH-Meter (EPA 150.1)

Cyanide Free: Auto-Color (EPA 365.1)

Fluoride: ISE (EPA 340.2)

(NO3 + NO2)-N: Auto-Color (EPA 353.2)

Analyst(s): MD, SS, JW, AI, AV, MR