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Golder Associates

REPORT
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FOUNDATION INVESTIGATION AND DESIGN SANITARY SEWER CROSSING BENEATH HIGHWAY 403 AND 407 RAMP AND STORMWATER POND MISSISSAUGA, ONTARIO

30M12-281

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1.0 INTRODUCTION

Golder Associates Ltd. (Golder) has been retained by The Erin Mills Development Corporation to provide geotechnical engineering services for the proposed installation of a new 300 mm diameter sanitary sewer to cross under Highway 403 and Highway 407 ramp, approximately one kilometer west of Winston Churchill Boulevard in the City of Mississauga, Ontario. The geotechnical investigation was carried out at this site in April and May 2008 to obtain subsurface data pertinent to the design of the access shafts and the tunnel crossing, and to facilitate approval of the crossing by the Ministry of Transportation, Ontario (MTO).

This report presents the results of the subsurface investigation carried out for: the proposed sanitary sewer crossing beneath the traveled lanes of Highway 403/407 ramp, as well as comment on conventional open cut excavations immediately beyond the highway crossing; and the proposed pond expansion area south of Highway 403. The purposes of the report are to:

- describe the subsurface conditions anticipated along the proposed sanitary sewer alignment at the Highway 403/407 ramp crossing, present recommendations and comments on the geotechnical aspects of design of the works and provide an interpretation of the ground behaviour in relation to anticipated tunnelling operations and open cut excavations; and,

- describe the nature of the fill materials forming the existing berm/stockpile located south of the highway in the general area of the proposed stormwater pond expansion and in the area of the existing high mast light standard, assess the potential for reuse of the stockpiled material and determine the potential effect of the construction of the proposed stormwater pond on the existing high mast light standard.

The terms of reference and scope of work for the geotechnical investigation are outlined in Golder's Proposal No. P81-1129 dated March 14, 2008.

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

The contents of this report have been based on information pertinent to the proposed sewer alignment and stormwater pond expansion provided to us by The Erin Mills Development Corporation and Earth Tech Canada Inc. (EarthTech) and have been prepared solely for use by The City of Mississauga, its consultant (Earth Tech) retained to design the sanitary sewer crossing and government agencies from whom permitting for the crossing are required. Golder Associates Ltd. (Golder) accepts no responsibility for any reliance upon, including any decisions made on the basis of, the contents of this report by any other third party. This report should be read in conjunction with the "Important Information and Limitations of this Report" following the text of the report. The reader's attention is specifically drawn to this information, as it is essential for the proper use and interpretation of this report.

2.0 PROJECT DESCRIPTION AND AVAILABLE INFORMATION

The site of the proposed sanitary sewer crossing of Highway 403/407 ramp is located between Winston Churchill Boulevard and Ninth Line, approximately one kilometre west of Winston Churchill Boulevard in Mississauga, Ontario. The proposed sanitary sewer crossing is to be constructed from the north side of Highway 403 at the end of Ridgeway Drive, extend beneath Highway 403 and Highway 407 ramp and connect into an existing sanitary sewer located south of the proposed stormwater pond. Directly south of Highway 403, the sanitary sewer alignment will be installed around the southwest perimeter of the proposed stormwater pond.

In the area of the Highway 403/407 ramp, the project consists of installing a 300 mm diameter sanitary sewer inside a 1,200 mm diameter steel liner by means of tunnelling/trenchless installation methods, with two access shafts; one on either side of Highway 403/407 ramp. Conventional open-cut excavations will be carried out beyond the proposed highway crossing. It is understood that the tunnel crossing will be approximately 77.0 m in length and the invert of the sanitary sewer pipe is to be at depths between approximately 7 m and 8 m below the Highway 403 road grade.

The terrain in the area of the sanitary sewer crossing is generally flat-lying with the exception of two drainage ditches that run along the north and south sides of Highway 403. An existing soil stockpile, approximately 7 m high relative to the surface of the highway is located directly south of the Highway 403 Eastbound lanes; southeast of the proposed sewer crossing. This existing stockpile is in the location of the proposed stormwater pond expansion, and is to be excavated/removed during pond construction. A natural water course cuts through the relatively flat-lying field about 100 m north of Highway 403/407 and flows to the south through a concrete box culvert, about 15 m east of the proposed sanitary sewer crossing. Fill materials have been locally placed along the north and south sides of Highway 403 and the grade across the site varies between approximately Elevation 176 m and Elevation 179 m (with exception of the existing berm/stockpile which rises to about Elevation 186.5 m), while the Highway 403/407ramp grades vary from about Elevation 178.8 m to Elevation 179 m at the proposed crossing, based on the topographic plan/profile provided by Earth Tech.

For the purpose of this investigation, the following drawings were provided to Golder by Earth Tech:

- Drawing No. 73452-P1 titled "Storm and Sanitary Sewers Sheet 1 of 2 from 0+000 to 0+220" dated June 2004.

- Drawing No. 73452-P2 titled "Storm and Sanitary Sewers Sheet 2 of 2 from 0+220 to 0+501.9" dated June 2004.

2.1 Previous Investigations

Borehole information from a previous subsurface investigation carried out further to the west of the site for a proposed overpass to connect Ridgeway Drive north and south of Highway 403 was reviewed in preparation of this report. The results of this previous investigation are provided and discussed in the following report and the relevant borehole information is included in Appendix B following the text of this report:

- Golder Associates Ltd. Report No. 06-1111-021 entitled "Foundation Investigation and Design Report, Municipal Class Environmental Assessment Study, Ridgeway Drive/Highway 403 Grade Separation, Mississauga, Ontario, Procurement No: FA.49.333-05", dated July 2007;

Based on the available information from the above referenced investigation, the subsurface conditions generally consist of fill materials underlain by a deposit of clayey silt till, which is underlain by a layer of clayey silt to silty clay and/or silty sand to sandy silt till, overlying shale bedrock at depths of 9 m to 12 m below ground surface (Elevation 170 m to Elevation 165 m).

3.0 INVESTIGATION PROCEDURES

A subsurface investigation was carried out between April 24, 2008 and May 5, 2008 at the site of the proposed sanitary sewer crossing beneath Highway 403/Highway 407 ramp and southeast of the crossing at the location of the proposed stormwater pond. At this time, six (6) boreholes (numbered BH1 to BH6) were advanced at the site using a track-mounted CME 55 drill rig supplied and operated by Geo-Environmental Drilling Ltd. of Milton, Ontario. Boreholes BH1 to BH3 were advanced for the proposed sanitary sewer crossing and Boreholes BH4 to BH6 were drilled in the area of the proposed stormwater pond through the existing stockpile of fill and near an existing high mast light pole.

The boreholes were advanced using 108 mm inside diameter (I.D.) continuous flight hollow stem augers to depths ranging from 10.7 m to 12.8 m below the existing ground surface. Soil samples were obtained at 0.75 m and 1.5 m intervals of depth, using 50 mm O.D. split-spoon samplers in accordance with the Standard Penetration Test (SPT) procedure.

The groundwater conditions in the open boreholes were observed during the drilling operations and two piezometers were installed; one in each of Boreholes BH1 and BH4 to permit monitoring of the groundwater levels at the site. The piezometers consist of 50 mm diameter PVC pipe with 1.5 m long screens surrounded by a sand pack, sealed with bentonite from the top of the sand pack to the ground surface. The installation details and water level readings are described on the Record of Borehole sheets that follow the text of this report. Upon completion of the drilling operations, the non-instrumented boreholes were backfilled to the ground surface using bentonite pellets, as per Ontario Regulation 372 (amendment to O.Reg. 903).

The field work was monitored on a full-time basis by a member of Golder's engineering staff who arranged for the clearance of underground utility services, directed the 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 content determinations, Atterberg limits and grain size distribution were carried out on selected soil samples.

The boreholes were located in the field by a member of our engineering staff relative to site features; with the three boreholes drilled for the tunnel crossing located approximately 2 m to 3 m from the proposed sewer alignment. The drilled borehole locations and elevations were surveyed by MMM Geomatics Ontario Limited and provided to Golder. The borehole locations (referenced to MTM NAD83, Zone 10 northing and easting coordinates) and ground surface elevations (referenced to Geodetic datum) are shown on Drawings 1 and 2 and summarized below.

Borehole Number	*Borehole Locations*	*MTM NAD83 Northing (m)*	*MTM NAD83 Easting (m)*	*Ground Surface Elevation (m)*
BH1	North of Highway 403	4821723.7	287082.8	177.0
BH2	North shoulder of Highway 403 westbound lane	4821723.5	287114.6	179.0
BH3	South of Highway 403	4821718.6	287172.8	176.7
BH4	South of Highway 403 – west corner of existing stockpile	4821795.0	287250.0	178.9
BH5	South of Highway 403 – Through existing stockpile	4821812.7	287287.5	186.8
BH6	South of Highway 403 – Through existing stockpile	4821850.2	287314.8	186.5

4.0 SITE GEOLOGY AND STRATIGRAPHY

4.1 Regional Geology

According to *The Physiography of Southern Ontario*[1], the site is located within the physiographic regions known as the Peel Plain and the Trafalgar Moraine portion of the South Slope. This area slopes gradually downward towards Lake Ontario. The overburden generally consists of silty clay till to clayey silt till with significant shale content. The till in turn overlies shale bedrock of the Queenston Formation, with interbedded grey limestone / siltstone layers.

4.2 Site Stratigraphy

Six boreholes were advanced at the site of the proposed sanitary sewer crossing and stormwater pond at the locations shown on Drawings 1 and 2. Three boreholes were drilled at the location of the sewer crossing and three boreholes were drilled through the existing stockpile in the area of the proposed stormwater management pond.

The detailed subsurface soil, bedrock, and groundwater conditions encountered in the boreholes and the results of in-situ and laboratory testing are given on the Record of Borehole sheets; and the results of the laboratory tests are also presented on Figures 1 to 10. The stratigraphic boundaries shown on the Record of Borehole sheets are inferred from non-continuous sampling, observations of drilling progress and the results of Standard Penetration Tests (SPTs). These boundaries, therefore, represent transitions between soil types rather than exact planes of geological change. The subsoil conditions will vary between and beyond the borehole locations. The inferred soil stratigraphies based on the results of the boreholes advanced at the sanitary sewer crossing site is shown on Drawings 1.

4.3 Proposed Sanitary Sewer Crossing

The following provides a summary of the subsurface conditions encountered in the three boreholes (Boreholes BH1 to BH3) drilled along the alignment of the proposed sanitary sewer crossing Highway 403. The simplified stratigraphy as encountered in these boreholes is presented on Drawing 1 relative to the proposed sewer alignment.

In general, the subsoils along the proposed sanitary sewer crossing consist of fill materials underlain by deposits of clayey silt till and silty sand till. The fill materials generally consist of pavement fills and/or a cohesive material containing varying amounts of topsoil and generally ranged in thickness from about 1.5 m to 3.8 m, with the greatest thickness of fill being generally

[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.

encountered near the north shoulder of the Highway 403 westbound lanes. Shale bedrock was encountered on the south side of Highway 403 at a depth of about 7.3 m below ground surface.

A detailed description of the subsurface conditions encountered in the boreholes along the proposed sewer crossing is provided in the following sections.

4.3.1 Fill Materials

Borehole BH2 was advanced through the north shoulder of the westbound lanes of Highway 403. At this location, a pavement structure consisting of about 100 mm of asphalt and 700 mm of sand and gravel fill materials was penetrated.

A clayey silt fill material was encountered in all three boreholes (BH1 to BH3) either beneath the existing pavement shoulder or at ground surface north and south of Highway 403. The clayey silt fill generally contained some sand, trace gravel and varying amounts of organic matter including pockets of topsoil, rootlets and wood fragments. At Boreholes BH1 and BH3, located north and south of Highway 403, respectively, the clayey fill material extended from ground surface to a depth of about 1.5 m; however, the fill thickness at Boreholes BH2 was much greater extending to a depth of about 3.8 m below ground surface. The bottom of the fill materials sloped varied from about Elevation 175.5 m to Elevation 175.2 m.

Standard Penetration Tests (SPT) 'N' values measured within the clayey fill materials in Boreholes BH1 to BH3, range from 7 to 17 blows per 0.3 m of penetration, suggesting generally a firm to very stiff consistency. Water contents measured on samples of these fill materials range from 13 percent to 16 percent.

4.3.2 Clayey Silt (Till)

A till deposit consisting of brown to grey clayey silt with sand was encountered below the fill materials in all the boreholes. The clayey silt till deposit varied in thickness from 4 to 4.8 and extended to between Elevation 171.5 m and Elevation 170.8 m. SPT 'N' values measured within the till deposit ranged from 16 to 73 blows per 0.3 m of penetration, indicating a very stiff to hard consistency, being generally hard in Boreholes BH1 and BH3 north and south of the highway.

The results of three grain size distribution tests carried out on selected samples of the till deposit are provided on Figure 1. The results of three Atterberg limit tests carried out on select samples measured liquid limits ranging from 23 percent to 26 percent, plastic limits between 13 percent and 15 percent and plasticity indices ranging from 10 to 12. The results of the Atterberg limits testing suggest that this material is a clayey silt of low plasticity, as shown on Figure 2.

The natural water content measured on selected samples of the clayey silt till deposit typically varies from about 9 percent to 15 percent.

4.3.3 Silty Sand to Silt and Sand (Till)

A deposit of grey silty sand to silt and sand till containing trace to some gravel and trace clay was encountered directly below the clayey silt till deposit in Boreholes BH1 and BH2. Auger difficulty during drilling was observed at the inferred surface of the silt and sand till in Borehole BH2 due to the presence of possible cobbles.

The surface of the silty sand to silt and sand till at the north and central portions of the proposed crossing was encountered at approximate Elevations of 170.8 m and 171.5 m. The thickness of this till deposit was about 4.3 m in Boreholes BH1 where fully penetrated and about 2.7 m at Borehole BH2 to the bottom of the borehole, corresponding to Elevation 167.3 m and Elevation 168.1 m, respectively.

SPT 'N' values measured within the silty sand to silt and sand till deposit varied from 37 blows per 0.3 m of penetration to 50 blows per 0.05 m of penetration, indicating a very dense relative density.

The results of two grain size distribution tests carried out on samples of the silty sand to silt and sand till are shown on Figure 3. Two natural water contents measured on selected samples of this till range were 5 percent and 10 percent.

4.3.4 Silty Sand

A deposit of silty sand was encountered at a depth of 9.8 m (Elevation 167.3) below the silt and sand till in Borehole BH1, and is at least 1.5 m thick extending to the bottom of the borehole. An SPT 'N' value measured within the silty sand layer was 32 blows per 0.3 m of penetration, indicating a dense relative density.

The results of a grain size distribution test is shown on Figure 4. The natural water content measured on a sample of the silty sand layer was 15 percent.

4.3.5 Clayey Silt (Residual Soil)

A 1.8 m thick deposit of reddish brown clayey silt containing trace to some sand and gravel with a "till-like" texture was encountered in Borehole BH3 at Elevation 171.2 m directly above the shale bedrock. This deposit is classified as residual soil (derived from weathering of the underlying shale bedrock) and contained varying amounts of siltstone/limestone and shale fragments.

An SPT 'N' value measured within the residual was 76 blows per 0.3 m of penetration, suggesting a hard consistency. The natural water content measured on a sample of the residual soil was 11 percent. The results of a grain size distribution analysis performed on a sample of this deposit are provided on Figure 5. An Atterberg limit test on a sample of the residual soil measured a liquid limit of 26 percent, a plastic limit of 15 percent and a plasticity index 11 percent, suggesting that this material is a clayey silt of low plasticity, as shown on Figure 6.

4.3.6 Bedrock

Shale bedrock of the Queenston Formation was encountered in Borehole BH3 at about Elevation 169.3 m and confirmed by split spoon sampling and augering to a depth of 10.7 m, corresponding to Elevation 166.0 m; coring was not carried out at this location. The shale bedrock samples were red-brown, and appeared to be highly weathered, thinly layered and very fine grained. Shale bedrock of the Queenston Formation is also generally very weak to weak, calcareous and contains layers of weathered, grey, siltstone and medium strong to strong grey.

Two SPT 'N' values obtained within the red shale bedrock measured 83 blows per 0.25 m of penetration and 50 blows per 0.03 m of penetration.

4.4 Existing Stockpile / Proposed Stormwater Pond Area

The following provides a summary of the subsurface conditions encountered in the three boreholes (Boreholes BH4 to BH6) drilled through/adjacent to the existing stockpile, south of Highway 403, for the proposed stormwater management pond expansion. The simplified stratigraphy as encountered in these boreholes is presented on Drawing 2 relative to the proposed pond.

In general, the subsoils in the area of the proposed stormwater pond expansion, south of Highway 403, consist of an existing stockpile with over 10 m of fill materials underlain by a deposit of clayey silt till. The fill materials were generally cohesive and contained variable amounts of organic matter. The fill materials encountered adjacent to the existing stockpile in the immediate vicinity of an existing high mast light pole was approximately 2 m in thickness.

A detailed description of the subsurface conditions encountered in the boreholes advanced near an existing high mast light and stockpile is provided in the following sections.

4.4.1 Fill

Clayey silt fill materials containing some sand, trace gravel and variable amounts of organic matter were encountered in all three boreholes (BH4 to BH6). In Borehole BH4, located near an existing high mast light northwest of the stockpile, the fill materials extended to a depth of about

2.1 m below ground surface; Boreholes BH5 and BH6, which were advanced from the top of the existing stockpile, encountered approximately 9.1 m to 10.4 m of clayey silt fill material. The base of the fill materials varied from Elevation 177.7 m to 176.2 m between the three boreholes.

SPT 'N' values measured within the fill materials in Boreholes BH4 to BH6 ranged from 5 to 19 blows per 0.3 m of penetration, suggesting a generally firm to very stiff consistency.

Water contents measured on the nine samples of the stockpiled fill ramped from about 11 percent and 26 percent. The results two grain size distribution analysis performed on select samples of this fill provided on Figure 7. The results of an Atterberg limit test carried out on a sample of fill indicate measured a liquid limit of 33 percent, a plastic limit of 18 percent and a plasticity index 15 percent, suggesting that this material is a clayey silt of low plasticity, as shown on Figure 8.

4.4.2 Topsoil

The stockpile material may have been placed directly on top of the original ground, including topsoil, as a 0.08 m thick layer of topsoil was noted in a split spoon sample obtained from Borehole BH5 at a depth of about 9.1 m, but was not noted in Boreholes BH4 and BH6; it should be noted that the observed thickness of topsoil may not be representative of the overall topsoil layer across the site.

4.4.3 Clayey Silt

A near- surface deposit of brown and grey clayey silt, containing some sand, trace gravel and organic matter including pieces of wood, was encountered beneath the layer of topsoil in Borehole BH5 advanced through the stockpile. This clayey deposit was noted at a depth of about 9.2 m and was approximately 2.3 m thick. The clayey silt fill.

Two SPT 'N' values measured within the clayey silt deposit were 10 and 14 blows per 0.3 m of penetration, indicating a stiff consistency.

The natural water content measured on a sample of the clayey silt deposit was 22 percent.

4.4.4 Clayey Silt (Till)

A deposit of brown to grey clayey silt till containing some sand and trace gravel was encountered below the fill materials in Boreholes BH4 and BH6 and below the clayey silt layer in Borehole BH5. The top of the clayey silt till deposit was encountered between Elevation 175.3 m and Elevation 176.7 m. Borehole BH4 fully penetrated this till deposit of a thickness of about 7 m, and Boreholes BH5 and BH6 penetrated into the till approximately 1.3 m to 2.4 m prior to

termination of drilling. SPT 'N' values measured within the till deposit ranged from 14 to 62 blows per 0.3 m of penetration, suggesting a stiff to hard consistency.

The results of the two grain size distribution tests carried out on selected samples of the till deposit are provided on Figure 9. The results of Atterberg limit tests carried out on two samples of the till measured liquid limits of 22 percent and 24 percent, plastic limits of 13 percent and 14 percent and a plasticity indices of 9 percent and 10 percent, suggesting that this material is a clayey silt of low plasticity, as shown on Figure 10.

The natural water content measured on selected samples of the clayey silt till deposit ranged from about 10 percent to 15 percent.

4.4.5 Bedrock

Shale bedrock of the Queenston Formation was encountered in Borehole BH3 at about Elevation 169.3 m and confirmed by split spoon sampling and augering to a depth of 10.7 m, corresponding to Elevation 166.0 m; coring was not carried out at this location. The shale bedrock samples were red-brown, and appeared to be highly weathered, thinly layered and very fine grained. Shale bedrock of the Queenston Formation is also generally very weak to weak, calcareous and contains layers of weathered, grey, siltstone and medium strong to strong grey.

Three SPT 'N' values obtained within the red shale bedrock measured 50 blows per 0.13 m of penetration to 50 blows per 0.05 m of penetration.

4.5 Groundwater Conditions

The water levels were observed in the open boreholes during and after the drilling operations and piezometers were installed in Boreholes BH1 and BH4; BH1 was sealed immediately above the interface of the silt and sand till and silty sand deposits and BH4 was sealed within the clayey silt till. Details of the piezometer installations as well as the groundwater observations during and after drilling are shown on the Record of Borehole Sheets following the text of this report. The water levels in the piezometers are summarized below:

Borehole No.	*Ground Surface Elevation (m)*	*Water Level - June 4, 2008*	
		Depth (m)	*Elevation (m)*
BH1	177.0	2.1	174.9
BH4	178.9	6.8	172.1

The relatively low groundwater level observed in the boreholes upon completion of drilling are not considered to be representative of the groundwater conditions at these locations, as there was insufficient time for the groundwater level to stabilize on the open borehole. It should be noted that groundwater levels at the site are anticipated to fluctuate with seasonal variations in precipitation and runoff and are expected to rise during wet periods of the year.

5.0 DISCUSSION AND ENGINEERING RECOMMENDATIONS

5.1 General

This section of the report provides geotechnical comments and recommendations for the proposed Highway 403/407 ramp sanitary sewer crossing east of Ridgeway Drive. The recommendations are based on interpretation of the factual data obtained from the boreholes advanced during the subsurface investigation at this site. The interpretation and recommendations provided are intended only to provide the designers with sufficient information to assess the feasible tunnelling alternatives and to design the proposed sewer crossing. As such, where comments are made on construction they are provided only in order to highlight those aspects which could affect the design of the project. Those requiring information on aspects of construction should make their own interpretation of the factual information provided as it may affect equipment selection, proposed construction methods, scheduling and the like.

Based on available drawings, it is understood that the proposed 300 mm diameter sanitary sewer is to be encased within a 1,200 mm diameter steel liner which will be installed by means of tunnelling/trenchless methods with two access shafts; one on either side of Highway 403/407. The actual location of the two access shafts are not known at this time. Conventional open-cut excavations will be carried out beyond the proposed highway tunnelled crossing. It is further understood that the crossing will be approximately 77.0 m in length and the invert of the steel liner will be at about Elevation 171.3 m which is at depths between approximately 7 m and 8 m below the Highway 403 road grade.

In addition, this section of the report also provides comments on potential re-use off-site of stockpiled material located southeast of the sanitary sewer crossing and on the potential impact of the construction/expansion of a stormwater pond on an existing high mast light pole located at the top of the proposed pond slope.

The following sections and recommendations relate to the geotechnical aspects of the sanitary sewer design for the Highway 403/407 crossing.

5.2 Temporary Works

This section provides a discussion of and parameters for conceptual design of temporary ground support systems that will be required for the access shafts to the sanitary sewer tunnel crossing. It is assumed that the contractor will be responsible for the detailed design of any temporary support systems, if required.

5.2.1 Excavation Support

It is not known at this time whether the entry and exit shafts will be constructed vertically or will be conventional open cuts with sloping banks.

Care should be taken to direct surface water away from the open excavations and all temporary excavations should be carried out in accordance with the Occupational Health and Safety Act and Regulations for Construction Projects. For excavations, the cohesive fill materials would be classified as a "Type 3" soil under the Act and the native clayey silt till and silt and sand till deposit would be classified as a "Type 2" soil. Temporary excavations may be made with side slopes no steeper than 1H: 1V, as measured from the bottom of the excavation.

Temporary excavation support/shoring will be required in areas where sufficient space is not available to carry out the excavation using these side slopes and in areas where settlement/deformation sensitive structures and/or existing utilities are present adjacent to the excavation.

Where shafts will be vertical and constructed by sheeted and braced excavations, the temporary support systems for the excavation, including the headwalls for the tunnel entry and exit shafts, should be designed to resist the earth pressure and surcharge load distribution presented on Figure 10, and the design parameters provided below may be used for conceptual design. The loading from existing adjacent structures and/or construction equipment should be included as a surcharge.

Material	γ	K_A	γ_w	h_w
Fill	19 kN/m^3	0.35	9.81 kN/m^3	From Elev. 177.8 m to Base
Very Stiff to Hard Clayey Silt Till and Residual Soil	20 kN/m^3	0.3		
Very Dense Silty Sand to Sandy Silt Till	22 kN/m^3	0.25		

* The subsurface conditions will vary in layer thickness and elevation at each shaft and should be reviewed separately for the design of the temporary shoring system.

The distribution shown on Figure 10 should be applied to the design of the vertical support members, as well as for the calculation of horizontal restraint loads. The design must also include water pressure assuming groundwater levels.

Although, the locations of the shafts are not known at this time, they are anticipated to remain inside of MTO property; therefore, if temporary excavation support is required at this site within the MTO road allowance, it should be designed and constructed in accordance with MTO's Special Provision 105S19, such that lateral movement of the temporary shoring system meet Performance Level 2, as specified.

5.2.2 Thrust Block Resistance

It is anticipated that the entry shaft for tunnelling beneath Highway 403/407 will be located such that tunnelling proceeds "up-gradient" allowing any seepage water to flow by gravity back to the entry shaft. It is also anticipated that thrust blocks constructed at the rear of the entry shaft will bear against the clayey silt till to silt and sand till.

The thrust block may be sized in accordance with the passive resistance pressure calculated from the following equation:

$$P_p = K_p \sigma_z'$$

where P_p is the passive earth pressure (kPa)
K_p Coefficient of passive earth pressure, which can be assumed to be 3.25
σ_z' Effective Stress at the depth of the thrust block (kPa)

The passive earth pressure derived using the above equation is an ultimate value and should be reduced by a Factor of Safety of 2 for calculation of allowable jacking stresses.

5.2.3 Shaft Preparation and Groundwater Control

The shaft to be located on the south side of Highway 403/407 is anticipated to be located below the groundwater table and will be extended through the hard clayey silt with sand till; the base of the shaft will potentially extend into the hard clayey silt residual soil. It is anticipated that groundwater seepage at this shaft location will be minor and may be handled by properly filtered sump pumps.

The shaft to be located on the north side of the highway is anticipated to be located below the groundwater table and will be generally within the hard clayey silt with sand till. Assuming a tunnel invert Elevation of 171.3 m, the base of the shaft will likely extend into the upper portion of the very dense silt and sand till. It is possible that the base of the north shaft may encounter saturated cohesionless soil (the silt and sand till deposit), which is generally anticipated to be moderately to highly susceptible to disturbance by construction activities. Therefore, base treatment measures will be required in the shaft to provide a stable working base for the tunnelling operations. A levelling and drainage mat of compacted granular material should be placed at the base and covered with a working mat of lean mix concrete. Pumping of groundwater from the shaft will be required to relieve pressure from under the working slab and to remove groundwater that seeps from cohesionless soil lenses. Removal of such groundwater can be carried out by pumps installed in properly filtered sumps that extend below the working slab and intersect the drainage layer below the slab.

If thick interlayers or lenses of cohesionless deposits are encountered at and below the base of the excavation, then supplementary groundwater lowering by dewatering wells or a temporary shoring system that would provide cut-off to groundwater flow will be necessary to maintain stability of the excavation base. The proximity of adjacent services or structures and their tolerance for settlement must be assessed and confirmed that they can tolerate some movement as a consequence of the excavation and potential dewatering.

Based on the subsurface information at the borehole locations and the alignment provided, the underlying cohesionless tills deposits are anticipated to be approximately 0.2 m to 0.5 m below the proposed tunnel invert. Depending on the final shaft invert level, this condition may result in basal uplift for the north shaft. Once the final design is completed, the stability of the shaft bases against basal uplift should be reviewed and if an adequate factor of safety does not exist, dewatering of the underlying water-bearing deposits will be required.

6.0 GROUND BEHAVIOUR IN RELATION TO TUNNELLING

It is understood that the tunnelling contractor will be responsible for choosing the method and equipment for tunnelling. The preferred alternative should be chosen to ensure that ground movements as monitored at the ground surface do not exceed 15 mm. The description of the anticipated ground behaviour provided in this section only applies to anticipated construction methods described herein and in the previous section. Ground behaviour will vary if methods different from those considered in the report are adopted. It should not be construed that the Contractor is restricted to the particular methods considered herein, although in the event of alternative methods, the Contractor must make his own interpretation of the anticipated ground behaviour, based on the factual information provided herein.

Descriptions of anticipated soil behaviour such as "firm" ground are based on Terzaghi's[2] classifications of soils for tunnelling as referenced below.

6.1 Highway 403/407 Ramp Tunnel Crossing

The proposed sanitary sewer invert is expected to be at approximate Elevation 171.3 m, which is approximately about 7 m to 8 m below the centreline of Highway 403, resulting in a minimum of about 6.3 m of cover material above the casing/liner obvert. The entry and exit shaft locations are not known at this time but are expected to be located on each side of Highway 403 in the general area of Boreholes BH1 and BH3. The subsurface soil conditions in these boreholes (at the approximate location of the shafts on the north and south sides of Highway 403), generally consist of surficial fill materials which are underlain by very stiff to hard clayey silt till underlain by very dense silt and sand till south of the highway and hard clayey residual soil north of the highway. Depending on the variation of the subsoil interfaces, there is a potential for the proposed tunnel alignment to extend through the clayey silt till into the silt and sand till, where an increase in groundwater seepage may occur due to the presence of cohesionless layers. The groundwater level within these deposits is above the proposed tunnel obvert, and therefore, these layers and seams would potentially flow into unsupported tunnel headings, causing localized ground loss at and above the tunnel heading. The following information is provided regarding the geotechnical aspects of the design of the tunnelling operations.

- Excavation progress and selection of excavation equipment must take due account of the very stiff to hard nature of the clayey silt till deposit.

- Cobbles and boulders were encountered in the boreholes within the glacial till and provisions must be made in the proposed tunnelling method for handling cobbles and boulders without loss of ground.

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[2] Terzaghi, K. "Geologic Aspects of Soft Ground Tunnelling", Chapter 2 of Applied Sedimentation, P.D. Trask ed; John Wiley & Sons, New York, 1950.

- An unsupported tunnel in the clayey silt till deposit is expected to behave as firm to bouldery ground if exposed as an open face. However, relatively thin water-bearing seams and interlayers of cohesionless silty sand may be present within the clayey silt till, particularly near the interface with the underlying silt and sand till. Such lenses are expected to be initially stable due to dilation in response to stress relief upon initial exposure. However, if left unsupported, the material will behave as slow ravelling ground. Therefore, while it is considered feasible to advance a tunnel with an unsupported face through these ground conditions anticipated along the alignment, contingency measures for controlling water-bearing seams and lenses must be incorporated into the tunnelling methodology.

- To maintain face stability and minimize ground movements it is recommended that mining operations continue non-stop once started. If it is necessary to stop tunnelling operations for any reason, the face should be completely supported by breasting boards. Such face support should be pre-cut and assembled prior to the start of tunnelling so that it can be readily installed, if required. Further, filter fabric, straw and other packing materials should be available on site for use in containing any localized occurrences of ravelling or flowing ground.

- If the tunnel alignment is to extend through the underlying silt and sand to sandy silt till deposit, greater amounts of water seepage may occur. Tunnelling methods that utilize a closed-face (pressurized face), such as micro-tunnelling slurry pressure balance shields or air-pressure shields, will control the surrounding groundwater pressures and therefore, minimize the risk of ground losses occurring.

- Whatever tunnelling method is selected, it is emphasized that the resulting performance of the completed tunnel crossing is largely dependant upon construction procedures and techniques. The work should be carried out by a qualified contractor experienced in this type of work. The contractor's proposed methodology should be reviewed by the geotechnical engineer prior to construction. During construction, the tunnelling operations should be monitored by the geotechnical engineer.

6.2 Tunnelling Options

It is understood that the proposed sanitary sewer is to be installed beneath Highway 403/407 ramp by trenchless technology. Trenchless technology covers a wide range of methods, such as "jack and mine", "jack and bore", "microtunnelling" and "pipe ramming" techniques. With any of these options, the equipment must be able to handle the presence of water-bearing sand layers and the removal and/or breaking of boulders, if encountered during tunnelling, such that the stability of the tunnel face is maintained and tunnelling advance can be assumed.

Based on drawings provided to us by Earth Tech, the tunnel is to be constructed with a 1.2 m diameter steel primary liner and the sanitary sewer will be subsequently installed in the liner and surrounded by grout. Therefore, it is anticipated that "pipe" jacking operations will be utilized to install the casing/liner behind soil mining operations at the tunnel face. It is anticipated that the casing/liner will be installed and advanced in sections with the segment connections designed to provide a smooth flush exterior to minimize resistance along the pipe exterior and facilitate jacking. Given the proposed length of the tunnel crossing and the nature of the site soils, the use of a bentonite slurry for lubrication may be considered during installation of the casing/liner.

While the use of a conventional steel ribs and lagging primary lining is feasible at the site, it would not provide satisfactory permanent protection to the sewer and a steel liner would therefore be required to be placed inside the ribs and lagging. This lining process would increase the required tunnel diameter and increase tunnelling costs, and for these reasons, it is not considered further in this report.

A discussion of the various tunnelling methods are outlined below and a summary comparison of the advantages, disadvantages and risks associated with these installation methods is presented in Table 1 following the text of this report. Methods that do not permit installation of a steel liner prior to installation of the pipe, such as Horizontal Directional Drilling, are not considered feasible and will not be discussed herein.

6.2.1 Jack and Mine

As noted, the clayey silt till and silt and sand till are anticipated to behave as firm to bouldery ground if exposed in an open tunnel face. Thus, it is considered feasible to advance the tunnel using an open face shield in which material at the face is excavated by "hand" or with a hydraulic excavator arm (digger shield). Such an open shield should have the capability of being jacked independently ahead of the steel liner to provide alignment control. The shield should be equipped with a suitable tail skin to support the ground above the jacks.

The principal risk associated with this method is from encountering thick cohesionless water-bearing interlayers and/or the interface of the underlying sandy till in areas between the locations where boreholes were advanced. To control this risk, consideration should be given to specifying a "hooded" shield for hand-mining (or "digger" shield) operation, as this would allow the tunnel face to be maintained at an angle for face stability as the tunnel heading is advanced. A pre-fabricated bulkhead that could be readily erected at the face of the shield should be specified to be on site throughout tunnel construction to allow the face to be rapidly secured, in the event that unstable cohesionless soils are encountered at the tunnel face. Hand-mining and "digger" shield mining may both be carried out ahead of a temporary lining that is jacked into place. Based on the proposed diameter of the steel liner, jack and mine operations may not be considered suitable for this crossing, as the tunnel diameter may need to be increased to allow man-entry for work.

6.2.2 Jack and Bore

For the proposed 1.2 m diameter liner pipe, the jack and bore tunnel is relatively large and therefore, some disadvantages associated with this methodology include:

- The consistency of the clayey silt till is generally very stiff to hard and it may be difficult to jack the pipe and advance the auger through the hard portions of the deposit;
- To control jacking forces, the use of a lubricating bentonite grout injected around the exterior of the casing/liner may be required;
- The clayey silt till deposit (particularly near the silty sand/sandy silt till) is expected to contain cobbles and boulders that will both obstruct progress of the auger and lining and tend to deflect the liner off alignment; and
- If the operation is deflected off alignment, it is difficult to detect the misdirection and it is not possible to correct the alignment.

If jacking and boring is used for the sewer crossing then it should be specified that the casing always be advanced as far ahead of the augers as possible, that the auger be maintained at least 150 mm behind the leading edge of the casing and that under no circumstances should the auger be advanced ahead of the casing. Furthermore, if jacking and boring were to be carried out, the specifications should require that a plug of spoil material remains in the casing at all times and that the jacking and boring operations continue without stoppage until completed. However, it must be noted that in the event that an obstruction such as a boulder or nest of cobbles is encountered, it will be necessary to remove the augers and the soil plug and if a cohesionless water-bearing interlayer is present at the same location, uncontrolled ground loss could occur during the removal operation.

6.2.3 Micro-Tunnel Boring Machine (MTBM)

It is considered that the risk of ground loss during tunnelling through potential cohesionless and/or wet layers and lenses would be reduced if tunnelling were carried out using a micro-tunnel boring machine (MTBM). These machines typically utilize pressurized bentonite slurry to counterbalance the earth and water pressures acting at the tunnel face. The slurry is circulated back through the tunnel to transport cuttings to a settling tank. Given the presence of cobbles and potentially boulders in the till soils along the proposed tunnel alignment, an MTBM capable of crushing boulders would be required for the work. Consistent with other tunnelling methods, if a micro tunnel boring machine were to be used for this project, consideration would have to be given to the use of an intermediate jacking station(s) to ensure that the casing/liner pipe could be advanced over the full length of the tunnel drive.

6.2.4 Pipe Ramming

Pipe ramming is a method for installing steel casings utilizing the energy from a percussion hammer attached to the end of the pipe. The casing is generally advanced open-ended and the soil within the casing is typically removed (with an auger) after the casing has been driven the entire length of the installation, thereby reducing the potential for ground loss into the casing. Pipe ramming methods are also better suited for penetrating through potential obstructions such as cobbles and boulders; however, deflection and/or refusal to penetration of the casing can still occur if large obstructions are encountered. Further, vibrations from the pipe ramming operations may result in settlement of loose materials in the immediate vicinity of the installation. Lubrication (i.e. bentonite) at the face may be required to aid in reducing side friction and advancing the steel pipe. Furthermore, a "plug" of soil may form at the head of the casing inducing surficial heave as the pipe is advanced. This could be controlled by stopping the operation and removing spoil from within the pipe before advancing further. Also, from the current borehole information, the proposed tunnel alignment would extend through the clayey silt till that generally increases in consistency from very stiff to hard with depth, and therefore, it may be difficult to advance the casing/liner through the harder portions of the till resulting in refusal or deviation. Given the concerns with handling boulders, the risk of significant alignment deviation, the inability to adjust the alignment and the significant tunnel length during ramming operations, pipe ramming is not recommended for this crossing.

6.3 Settlement and Settlement Control

The measures described in the preceding sections for the various tunnelling methods must be implemented to control settlement above the tunnel; however, the effects of stress relief at the tunnel face and partial closure of the over-cut between the shield and pipe will result in some settlement of the ground above the tunnel. It is anticipated that ground surface settlement can be restricted to 15 mm or less, if:

- measures to control face stability are implemented;
- the over-cut between the tunnelling shield and the liner casing is 12 mm or less;
- suitable lubricant is applied directly behind the shield to minimize friction between the casing and the ground; and
- the gap created between the soil and the pipe is grouted with cement grout at the completion of jacking.

To achieve appropriate grouting, it is recommended that grout ports around the circumference of the pipe be not further than 2 m apart.

To verify that tunnelling movements are maintained within specified levels, to verify the suitability of the Contractor's tunnelling methods and to provide an early warning that will allow tunnelling methods to be modified to meet the specified settlement limits, it is essential that a monitoring program as described in Section 7.0 be implemented during tunnelling.

6.4 Jacking Resistance

In addition to the subsurface conditions and pipe geometry, the jacking forces required to advance the casing are dependent upon a number of factors directly related to construction equipment and methodology, including:

- the size of the shield over-cut;
- the use of lubricants and the timing of lubricant injection;
- the alignment maintained during jacking;
- the rate of mining achieved; and
- the frequency and duration of stoppages in the work.

For these reasons and considering the natural variability of the ground, it is not possible to predict actual jacking forces prior to construction. In comparison to the unit jacking resistance on the surface area of the casing, higher face resistance will be met where boulders are encountered.

Given the uncertainties in predicting jacking forces and the limitations on jacking forces imposed by the pipe strength, it is recommended that an assessment is made to determine if intermediate jacking stations are required along the pipe length. Jacking forces should be monitored throughout the tunnelling operation to ensure that allowable pipe stresses are not exceeded and to determine if jacking from the intermediate jacking stations is necessary.

6.4.1 Obstructions

Boulders are commonly encountered in the overburden soils/tills of Southern Ontario and were noted at the boreholes at this site. The specific presence of boulders can significantly affect the selection of equipment and progress of construction works, especially in tunnelling. The soils at the site are glacially derived, and thus, are anticipated to contain boulders (rock of such a size that it is unable to pass through a 0.3 m square opening); sizes much larger than this should be anticipated at this site. Further, boulders within the till deposits can originate from the igneous and metamorphic rocks of the Canadian Shield and, these can have uniaxial compressive strengths of up to 250 MPa. Therefore, suitable equipment will be required to remove any

boulders encountered during tunnelling; either the tunnelling equipment itself or methodology to allow careful excavation at the face.

7.0 INSPECTION, INSTRUMENTATION AND MONITORING

Regardless of the tunnelling method selected, it is recommended that a monitoring program be implemented during the construction operation. An inspection, instrumentation and monitoring program is necessary on this project to:

- document the effects of tunnelling on the overlying Highway;
- obtain prior warning of ground movements that could occur due to the construction methods and equipment or unforeseen ground conditions;
- verify the contractor's compliance with the settlement limits imposed in the Contract; and,
- allow adjustments to be made to the tunnelling methods such that the settlement limits established are not exceeded.

Control of ground settlement on this project depends on the behaviour of the ground at the tunnel face and on the control exercised by the contractor during excavation work at the tunnel face. Therefore, if the method and tunnel size permit, it is recommended that inspection of the tunnel face by qualified geotechnical engineering personnel be carried out at least once per shift to verify that the ground conditions are consistent with those anticipated based on the borehole investigations and that the contractor is excavating the material at the face in a controlled manner.

It is recommended that the monitoring program include measures to track the quantity of material excavated from the tunnel and measure the amount of settlement resulting from the tunnelling operation. The amount of material excavated from the tunnelling operation should be recorded in terms of estimated volume of excavated material (for example number of muck cars/buckets) per convenient unit of advance (length of liner pipe or distance of each shield push). The volume of material per unit advance should be compared to the calculated volume of excavated tunnel length (i.e. establish a theoretical relationship between the spoil volume and insitu volume). A change in the excavated volume over a particular tunnel increment could indicate that uncontrolled ground losses are occurring into the tunnel.

Recommendations for the proposed monitoring program for the Highway 403/407 ramp tunnel crossing, consistent with the "MTO Guideline Foundation Engineering – Tunnelling Specialty for Corridor Encroachment Permit Application; Appendix: Settlement Monitoring Guidelines - Tunnelling", for the monitoring program are summarized below., for the monitoring program are summarized below.

- A series of "surface" monitoring points and "in ground" monitoring points (at depths of 1.5 m to 1.8 m below the surface grade) should be installed along the tunnel alignment.

- "Surface" monitoring points should be regularly spaced, on the asphalt pavement and along side slopes of the highway embankment, along the centre-line of the tunnel. The maximum spacing of such points should be 5 m.

- The monitoring program should include an "array" of "in ground" monitoring points installed roughly perpendicular to the tunnel alignment to measure the lateral extent of any settlement. The arrays of "in ground" monitoring points should extend on both sides of the tunnel alignment at a distance of one horizontal to one vertical from the centre of the tunnel invert. The "in ground" monitoring points should be installed at the outside edges of the Highway and in the median.

- Prior to the start of construction all monitoring points should be read a minimum of two times to provide a baseline.

- The monitoring points should be surveyed a minimum of 2 times per day during tunnelling operations, with allowance made for more frequent monitoring (up to every 4 hours) should observations dictate. For monitoring points that have stable readings and are located more than 10 m away from the active tunnel face, the monitoring frequency may be reduced to once per day.

Monitoring of settlement points on this project is constrained by the continuous and high traffic volume and the limited periods during which access to the Highway can be obtained. By necessity, settlement points on the road must be read remotely and the use of EDM equipment reading reflectors installed on the Highway is suggested. Positioning of the equipment to read the instruments at this site is constrained by the elevated pavement surface relative to the surrounding ground. If survey measurements cannot be adequately made from the sides of Highway 403/407 ramp, an elevated platform may need to be constructed to allow the reflective targets to be read. It is assumed that a specialist surveying firm will be retained to confirm the setup and to carry out the settlement monitoring during construction; their equipment and procedures must be capable of surveying the settlement point elevation to within ± 1 mm of the actual elevation.

The following procedure should be followed if settlement levels of 10 mm (Review Level) and 15 mm (Alert Level) are reached, as stated in MTO's "Guideline for Foundation Engineering – Tunnelling Specialty for Corridor Encroachment Permit Application; Appendix: Settlement Monitoring Guidelines - Tunnelling", for the monitoring program are summarized below.:

- If the Review Level (10 mm) is reached the contractor would be required to provide a formal plan that states what is going to be done to ensure that the Alert Level is not reached.

- If the Alert Level (15 mm) is reached, the contractor shall stop tunnel advance and the owner would have the authority to order that the contractor make the face secure and suspend all tunnelling activities.

8.0 TEMPORARY OPEN TRENCH EXCAVATION

Based on available drawings, the proposed sanitary sewer invert along the proposed open cut portions north of the proposed tunnel crossing between Highway 403 and the proposed industrial development would generally be founded at depths ranging from about 5 m to 6 m below existing ground surface, corresponding to about Elevations 172.5 m and 173 m. Therefore, excavations extending to depths of up to 6 m below ground surface in this area will be required to install the sewer. Based on the results of this investigation and information obtained from the previous investigation (see Appendix B, Borehole BH21), the founding soils for the sewer will consist predominately of a very stiff to hard clayey silt till near the highway and likely a dense to very dense silty sand to sandy silt till near the proposed development. These native till deposits are considered to be suitable for supporting the sanitary sewer, provided that the integrity of the base can be maintained during construction.

If any softened/loose materials are encountered during trench excavation at the proposed founding elevation they must be subexcavated and replaced. As boreholes were not drilled directly along the open cut portion of the alignment, an allowance should be made for increasing the bedding thickness and for subexcavation and replacement in the event that unsuitable conditions, softened/loose materials and/or deleterious fills, are encountered at the proposed subgrade/pipe founding level in this area. The extent of any potentially unsuitable soils would need to be confirmed during excavation.

Shallow open cut temporary excavations extending through the clayey till deposits at the site are not anticipated to have significant volumes of groundwater seepage. Some groundwater seepage into the excavation may occur as a result of perched water conditions within the site soils or from the sandier portions of the sandy silt till. It is anticipated that groundwater encountered within open cut excavations within these soils can be handled by pumping from properly constructed and filtered sumps located within the excavations.

It is anticipated that the trench excavations within the existing fields north of Highway 403 will consist of conventional temporary open cuts with side slopes not steeper than 1 horizontal to 1 vertical. However, depending upon the construction and groundwater control procedures adopted by the contractor and weather conditions at the time of construction, some local flattening of the slopes may be required. Possible cobbles and/or boulders were encountered at some of the borehole locations during drilling, particularly near the interface of the clayey and sandy tills, and therefore, the excavation equipment has to be capable of handling possible obstructions anticipated to be present till deposits at the site.

Care should be taken to direct surface water away from the open excavations and all temporary excavations should be carried out in accordance with the Occupational Health and Safety Act and Regulations for Construction Projects. As discussed in Section 5.2.1, the cohesive fill materials

would be classified as a "Type 3" soil under the Act and the native clayey silt till and silt and sand till deposit would be classified as a "Type 2" soil. Temporary excavations may be made with side slopes no steeper than 1H: 1V, as measured from the bottom of the excavation.

Temporary excavation support/shoring will be required in areas where sufficient space is not available to carry out the excavation using these side slopes and in areas where settlement/deformation sensitive structures and/or existing utilities are present adjacent to the excavation. Prefabricated support system should be certified as being designed in accordance with current Occupational Health and Safety Act regulations. A prefabricated support system should be designed, installed and removed in such a manner that it not only provides protection for the workmen, but also provides adequate support for the sides of the excavation. Further, excavated trench material should not be stockpiled adjacent to the trench. In addition, care must be taken during excavation to ensure that adequate support is provided for any existing structures or underground services located above a line projected upward from the base of the excavation at an inclination of 1.5 horizontal to 1 vertical. Where utilities are located above such a line, it may be necessary to utilize a braced excavation support system to minimize water/ground movement associated with the trench excavation.

8.1 Existing Utilities

Based on the available drawings, numerous existing services are understood to be present along the proposed alignment. The majority of these services were likely constructed using open cut methods and the service trenches are anticipated to be backfilled with variable fill materials. In areas where the excavations intersect the backfill materials, further flattening of the sideslopes of the excavations and protection of the services will likely be required. Alternatively, temporary shoring systems may be used to support the sidewalls of the excavations in these areas.

Further, where existing services are exposed during the excavation, suitable temporary and/or permanent support of these utilities should be provided during excavation and be designed to meet the tolerable deflection limits of the existing services; consistent with the requirements of the respective utility companies.

8.2 Pipe Cover and Trench Backfill

The bedding for the sanitary sewer should be compatible with the sizes, type and class of pipe and the surrounding subsoil and the requirements of the City of Mississauga. If granular bedding is deemed to be acceptable, then Ontario Provincial Standard Specifications (OPSS) 1010 Granular "A" material should be used from at least 150 mm below invert to springline of the pipe. Clear stone should not be used as bedding material unless a complete, stitched geotextile surround is provided. From springline to 300 mm above the obvert of the pipe, sand cover could be used.

All bedding and cover material should be placed in 150 mm loose lifts and uniformly compacted to at least 95 percent of Standard Proctor maximum dry density.

Based on the measured natural water contents, the very stiff to hard portions of the clayey silt till are estimated to be at or slightly below their estimated laboratory optimum water content for compaction. These soils would require addition and mixing of some water so that the material is at its optimum water for compaction. Soils that are significantly above their optimum water content for compaction are not considered suitable for re-use as trench backfill. Therefore, these soils, if encountered, would require drying or mixing with drier materials prior to re-use as trench backfill.

Care should be taken to minimize the potential for over-wetting of the soils during the construction operations. Difficulties with compaction and/or backfill performance should be anticipated for fine-grained soils where the water content is above the optimum moisture content for compaction purposes. Soils that contain significant quantities of organic matter are also not suitable for use as trench backfill within settlement sensitive areas. Any boulders or cobbles greater than 150 mm in size should be removed from the trench backfill.

If the water contents of the excavated materials are too high above the respective optimum water content at the time of construction, or if there is a shortage of suitable insitu material, an approved imported material such as OPSS1010 Select Subgrade Material should be used for trench backfill. Trench backfill should be placed in maximum 300 mm loose lift thickness and uniformly compacted to at least 95 percent of its Standard Proctor Maximum Dry Density (SPMDD) within the existing fields/open spaces and to at least 98 percent of their SPMDD beneath settlement-sensitive areas (e.g. beneath roadways and right of ways). To further limit post-construction settlements, consideration should be given to the use of granular material in accordance with Ontario Provincial Standard Specifications (OPSS) 1010 or unshrinkable fill materials to backfill service trenches beneath roadways, existing utilities/services and other settlement sensitive areas.

Backfilling operations during cold weather should be avoided. If cold weather fill placement is necessary, it should be carried out so that frozen lumps of material, snow and ice are not present in the fill and so that the placed material is not allowed to freeze after placement and compaction. Any such backfilling work should be carried out under the fulltime inspection of qualified geotechnical personnel with the understanding that work may have to be suspended if temperatures are too low and some material might have to be removed and replaced if it is allowed to freeze after placement.

Normal post-construction settlement of the compacted trench backfill should be anticipated with the majority of such settlement taking place within about six months following the completion of trench backfilling operations. This settlement will be reflected at the ground surface. In order to provide a more uniform transition of the subgrade soil from the undisturbed native material to the

trench backfill, it is recommended that the sides of the excavation be sloped at an inclination of 1 horizontal to 1 vertical, outwards and upwards from the base of the excavation.

9.0 STORMWATER POND EXPANSION

An existing concrete box culvert extends beneath Highway 403/407 approximately 15 m east of the proposed sanitary sewer crossing and flows into an existing stormwater pond located on the south side of Highway 403. It is proposed that reconstruction/expansion of the stormwater pond will be carried out to encompass and extend easterly beyond the existing pond. An existing stockpile, approximately 7 m high, relative to the surface of the highway, is located directly south of the Highway 403 Eastbound lanes and east of the existing stormwater pond. Removal/excavation of this existing stockpile will be required to permit construction of the proposed stormwater pond expansion.

It is understood that the proposed stormwater pond expansion will generally extend parallel to the highway and the pond will be approximately 250 m long and about 60 m wide. Based on available drawings, it is proposed that the pond be excavated to base Elevation 169.4 m and the side slopes are to be constructed at 2.5 horizontal to 1 vertical (2.5H:1V) to 3H:1V. It is further understood that the northerly edge of the crest of the pond is proposed to be constructed in close proximity to an existing high mast light

The purpose of this portion of the investigation is to provide comments on the nature of the fill materials forming the existing stockpile, for potential re-use of the material off-site and, to provide comments on the potential impact of the construction/expansion of the stormwater pond on the existing high mast light.

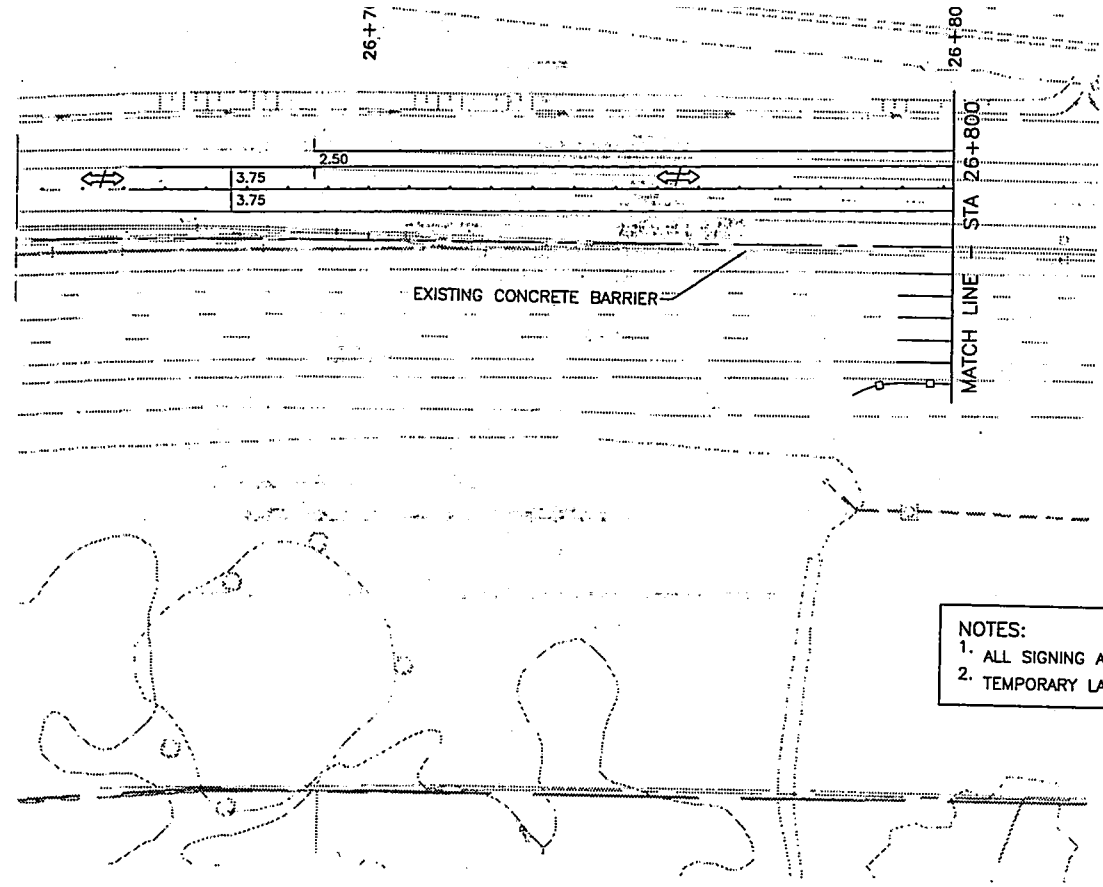
The following drawings were provided to Golder by Earth Tech and were utilized for this portion of the investigation:

- Drawing No. 73452-D1 titled "Highway 403 Corridor, Quality Stormwater PondCross-Sections"dated June 2005.

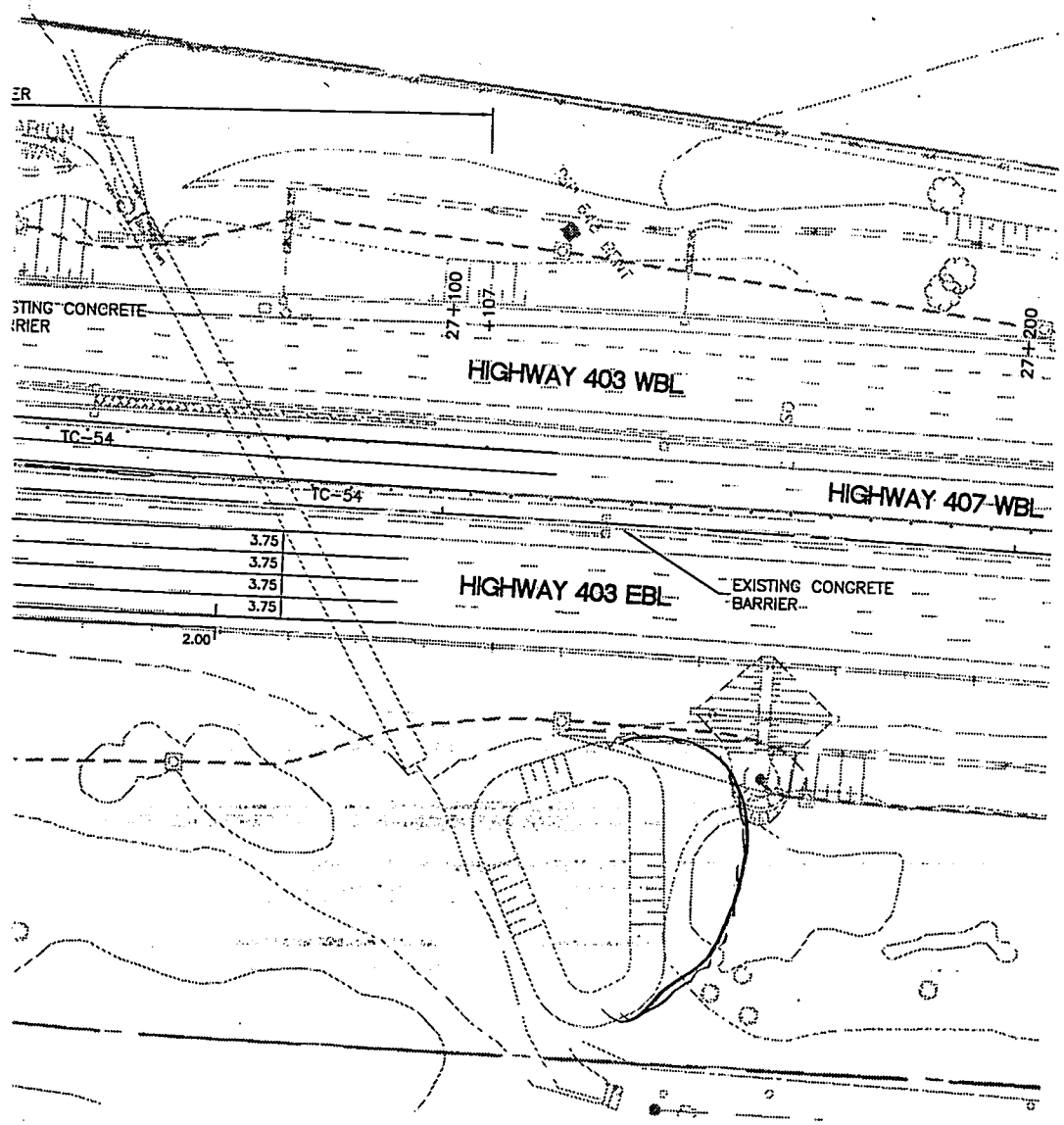
- Drawing No. 73452-S1 titled "Glen Erin Brook Stormwater Facility, Highway 403 Cross-Sections".

- Drawing No. 1 prepared by Delcan Engineers titled "Highway 403, Central Parkway East to Highway 401, High Mast Lighting Pole Footing, Frost depth < 1.8 m, Sheet 896, Cont. No. 2003-2012, W.P. No. 148-00-01", dated July 2003.

- Ministry of Transportation, Ontario (MTO) As-Built Drawings, Sheets nos. 31 to 35, Cont. No. 2000-0094, W.P. No. 147-00-00.



NOTES:
1. ALL SIGNING AND LANE SHIFTS AS PER OTM BOOK 7
2. TEMPORARY LANE CLOSURE SUBJECT TO DAILY TIMING CONSTRAINT



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The following discussion and recommendations relate to the geotechnical aspects of the expansion/construction of the proposed stormwater pond relative to an existing high mast light and the proposed re-use of material.

9.1 High Mast Light Considerations

Based on available drawings, it is understood that the northern limit of the proposed expansion/construction of the stormwater pond is to extend and partially wrap around an existing high mast light standard. Based on available information, the existing high mast light in question is identified by MTO as "P139". It is understood that this high mast light standard is approximately 40 m high, and is supported on a 1.5 m diameter, 9 m long steel reinforced caisson, corresponding to a founding level at about Elevation 168.3 m.

Borehole BH4 was advanced in the area of the existing high mast light and encountered about 2 m of firm to very stiff clayey silt fill underlain by very stiff to hard clayey silt till. Shale bedrock was encountered below the till deposit at Elevation 169.7 m; therefore, it is anticipated that the caisson supporting the high mast light has been extended at least 1 m into bedrock and that the proposed stormwater pond may extend into the upper portion of the weathered shale bedrock. (i.e. base at approximately Elevation 169.4 m)

Limit equilibrium slope stability analyses were performed using the commercially available program SLOPE/W (produced by Geo-Slope International Ltd.), employing the Morgenstern-Price method of analyses, to check that a minimum Factor of Safety of 1.3 is achieved against deep-seated, global type failures that would impact the stability of the proposed stormwater pond, and ultimately the existing high mast light. Static slope stability analyses to examine the global stability was carried out in the area of the high mast light. The configuration of the pond side slopes was based on available drawings in plan (3H:1V) and in cross-section (2.5H:1V) provided by Earth Tech, as noted above. The soil parameters used in the analysis were based on correlations with the available field data.

For the purpose of the analyses, it was assumed that the base and sideslopes of the stormwater pond are constructed as per the design recommendations and the clay liner backfill materials was placed in thin lifts and compacted to industry accepted engineered fill standards. Based on the available design drawings, the analysis was carried out for cases with sideslopes of both 2.5H:1V and 3H:1V. For the above assumptions, suitable Factors of Safety of 1.3 or greater were calculated against deep seated global slope instability for the proposed stormwater pond in close proximity to high mast light; Factors of Safety ranging from 0.8 to 1.1 were also calculated against surficial global slope instability. In addition, for the existing location of the high mast light, it is anticipated that the limited space between the light and the proposed pond location will not allow continuous sideslopes of 3H:1V. Confirmation of proposed sideslopes pond design in this area is required.

Further, it should be confirmed by a structural engineer that there is sufficient passive resistance in front of the high mast light foundation as a result of the sloping ground with the proposed stormwater pond slope configuration.

During construction of the stormwater pond in the vicinity of the high mast light standard (where there will be cutting into the existing stockpile), observations of the exposed materials present within the cut should be made by qualified geotechnical personnel. If the existing fill/site materials in these areas are found to consist of loose/soft/disturbed or other deleterious materials, additional support of the high mast light may be required Consideration should also be given to monitoring for vertical and lateral movement of the light standard during excavation for the pond in the vicinity of the high mast light.

9.2 Existing Stockpile Material for Potential Re-Use

9.2.1 Chemical Testing of Stockpile Material

This section of the report provides the results of analytical testing carried out on 5 samples of soils that were obtained from the existing stockpile to provide background information for the assessment of the off-site removal requirements for these excess soils generated during construction of the proposed stormwater pond. An environmental site assessment to determine the geo-environmental (chemical) aspects of the subsurface conditions is outside the terms of reference for this report and such conditions have not been investigated or addressed by Golder Associates. Therefore, the results of the chemical testing described in this section of the report should not be construed as a guarantee or warranty that the site soils are free from any and all contamination. Further, no statement made herein should be construed as relieving the Contractor of his duty to comply with all applicable regulations related to disposal of the excess soil.

Five soil samples of the clayey silt fill material from Boreholes BH5 and BH6 were submitted for chemical analysis in order to assess possible disposal or reuse options for the removal of the stockpiled materials south of Highway 403. It is understood that consideration is being given to the re-use of this material for construction of the proposed Ridgeway Drive Overpass embankment on the north side of Highway 403. The soil samples were submitted to Maxxam Analytics Inc. (independent CAEAL accredited laboratories) in Mississauga, Ontario for chemical analysis for pH and select metal parameters, and one sample was submitted for Toxicity Characteristic Leaching Procedure (TCLP) testing. The results of the analytical testing and Certificate of Analyses are presented in Appendix C of this report.

The analytical results for the five samples tested were compared to Table 1 standards of the Ontario Ministry of the Environment (MOE) "Soil, Ground Water and Sediment Standards for Use Under Part XV.I of the Environmental Protection Act", dated March 2004. The

concentrations of the parameters analysed on the above soil samples are lower than the Table 1 Standards (Full Depth Background Site Condition Standards for non-agricultural land uses), or were below the laboratory method detection limits. Further, the results of the TCLP analyses of the single sample from BH5 tested in accordance with Ontario Regulation 347 (as amended by Ontario Regulation 558/00) indicate that the concentrations of the parameter analyses are lower than the Schedule 4 (TCLP) standards.

We note that the current investigation was carried out for geotechnical investigation purposes and, as such, the samples were not collected in a manner that allowed for analytical testing of volatile organic compounds. Additional investigation and environmental assessment may be required depending on the intent/use and/or disposal of the existing fill materials.

9.2.2 Geotechnical Testing of Stockpile Material

As discussed in previous sections, the existing stockpile is approximately 9 m to 10 m high and, consists of clayey silt fill containing some sand, trace gravel and generally trace amounts of organic matter; however, an approximately 1.8 m thick layer of fill material noted below about Elevation 179.5 m in Borehole BH5 contained significant amounts of organic matter, which is not suitable for re-use. Further, it is anticipated that the existing stockpile was originally placed without removal of the topsoil.

Water contents measured on the ten samples of the stockpiled fill varied from about 11 percent to 26 percent. Further a standard Proctor test was carried out on a sample obtained from the stockpile during drilling, and measured a standard Proctor maximum dry density (SPMDD) of 1.812 Mg/m^3 and an optimum water content of 16 percent, as shown on Figure 12.

Materials proposed for re-use as engineered fill must be approved by geotechnical personnel prior to placement. In this regard, excavated soils from the site, free of significant amounts of organics and other deleterious materials, may be reused as engineered fill provided that they are at suitable water content(s) for compaction (i.e. within 2 percent above or below the optimum water content for compaction). Topsoil and other site materials containing significant amounts of organics are not considered suitable for re-use as engineered fill materials.

The natural water contents of the fill materials present were generally at or above the optimum water content; therefore, these materials may require to be dried or mixed with drier materials to bring the water content to appropriate levels for compaction prior to re-use as engineered fill. If cobble or boulders greater than 150 mm in size are encountered in the stockpiled material, they must be removed from the fill prior to its placement as engineered fill.

9.2.3 Suitability for Re-Use of Stockpile Material

Based on the above chemical and geotechnical test results, the existing stockpile fill material may be considered suitable for re-use off-site for engineer fill purposes. It is the Contractor's responsibility to locate a site requiring fill for an appropriate purpose, and to obtain written approval from receiving site authorities to transfer acceptable material to that property. The excavated stockpile materials should be visually monitored during construction by an environmental consultant to verify the materials are consistent with the tested soil samples. If materials are encountered that are different than the tested samples or there is visual and/or olfactory evidence of contamination, the Contractor should separate and stockpile the materials on site, and provide analytical testing of representative samples to determine appropriate handling options.

10.0 INSPECTION AND TESTING

Consideration should be given to carrying out a "public digging" during the tender stage to allow prospective bidders to assess their methods of construction and type of groundwater control, consistent with their equipment capabilities and the existing groundwater conditions at that time. The location of the test pits should be determined in consultation with the geotechnical engineer.

Prior to tendering, the geotechnical aspects of the final design drawings and specifications should be reviewed by the geotechnical engineer to confirm that the intent of this report has been met. During construction, sufficient tunnel monitoring and inspection at the face should be carried out to confirm that the conditions exposed are consistent with those encountered in the boreholes and to monitor conformance to the pertinent project specifications. Monitoring of the tunnel operation should, as a minimum, include measurement of the volume of tunnel muck as noted above, the jacking forces required to advance the pipe/lining and in the case of use of a MTBM, the slurry pressure at the face of the machine.

11.0 CLOSURE

This Geotechnical Investigation and Design Report was prepared by Ms. Shannon Palmer, P.Eng. and was reviewed by Ms. Anne Poschmann, P.Eng., a Principal and geotechnical engineer with Golder. Mr. Jorge Costa, P.Eng., a Designated MTO Foundations Contact for Golder, conducted a quality control review of this report.

GOLDER ASSOCIATES LTD.

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Principal, Designated MTO Contact

SLP/ASP/JMAC/slp/sm

N:\Active\2008\1111\08-1111-0010 EarthTech 403 Sewer\Report\08-1111-0010 RPT June08 SanSewer slp.doc

TABLE 1
EVALUATION OF ALTERNATIVE TUNNELLING METHODS
SANITARY CROSSING OF HIGHWAY 403/407
AT RIDGEWAY DRIVE EXTENSION/OVERPASS
MISSISSAUGA, ONTARIO

Installation Method	*Feasibility*	*Advantages*	*Disadvantages*	*Risk/Consequences*
Jack and Mine (Hydraulic excavator arm or hand-mining)	Not Feasible	• Ability to adjust alignment • Easy access to remove obstructions. • Provides access for break-up and handling boulders. • Hooded shield would allow inclined face to be maintained.	• Difficulty controlling cohesionless water-bearing interlayers (would require supplementary support measures) • Would require an increase in tunnel size to allow for man entry work.	• Localized ground loss if water-bearing cohesionless layers encountered.
Jack and Bore Installation	Feasible	• Does not require personnel at tunnel face.	• Large diameter steel liner will be difficult to install through till. • Obstructions (e.g. cobbles, boulders) may deflect and/or halt bore. Removal of augers and man entry would be required to remove boulders. • Misalignment cannot be detected or corrected during advance. • Water-bearing cohesionless interlayers can go undetected until ground loss and settlement has occurred. • Hard clayey silt till and/or dense to very dense sandy silt till will make augering difficult.	• Risk of encountering refusal on obstructions. • Obstructions can result in deflection of the casing resulting in misalignment of watermain. • Greatest risk of ground subsidence of highway because unstable cohesionless water-bearing interlayers could go undetected.

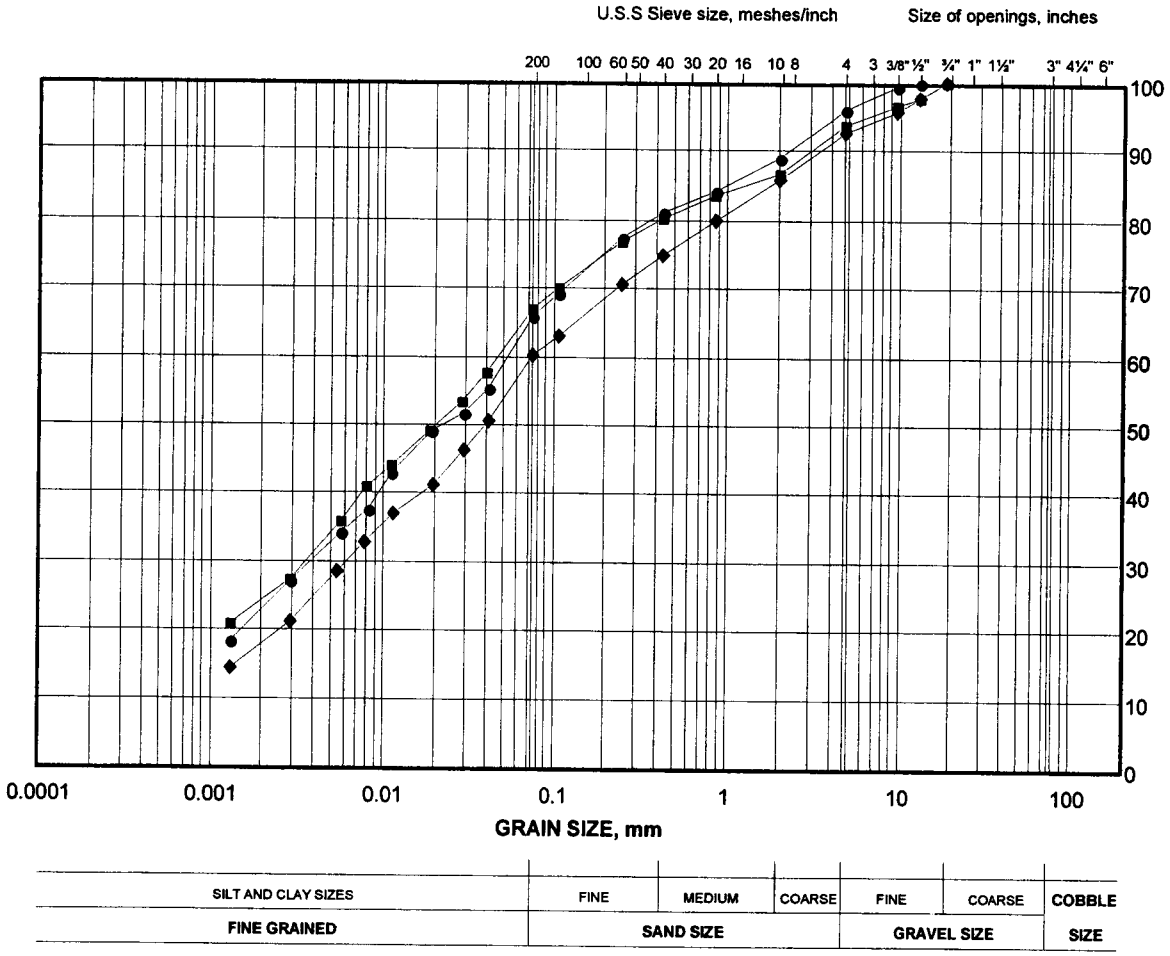
TABLE 1
EVALUATION OF ALTERNATIVE TUNNELLING METHODS
SANITARY CROSSING OF HIGHWAY 403/407
AT RIDGEWAY DRIVE EXTENSION/OVERPASS
MISSISSAUGA, ONTARIO

Installation Method	*Feasibility*	*Advantages*	*Disadvantages*	*Risk/Consequences*
Micro-tunnel Boring Machine	Feasible	• Counter-balance groundwater and earth pressures with tunnel muck or slurry providing face support when advancing through cohesionless water-bearing interlayers. • Does not require man entry.	• May require an intermediate jacking station to fully advance the steel casing. • Will require a machine capable of crushing boulders • Greater cost for muck handling and disposal. • Lack of local experience and/or equipment.	• Machine could be halted by boulders if appropriate crushers are not provided. • May not receive competitive tenders if this method is specified.
Pipe Ramming	Not Feasible	• Suitable to penetrate through obstructions (dependent on size and strength of obstruction). • Continuous casing installation. • Spoil is removed once the exit pit is reached, minimizing subsidence and overcut.	• Large obstructions/boulders can result in deflection or refusal • Potential for heave at ground surface. • Potential for settlement of near surface fills due to vibration. • Removal of spoil may be required after advancing the pipe partway due to drag on and weight of the pipe • Hard clayey silt till and/or dense to very dense sandy silt till will make ramming difficult and subsequent augering of spoil from inside the pipe.	• Misalignment of tunnel may occur if large obstructions are encountered and this cannot be corrected. • Nests of cobbles and/or boulders can stop penetration of casing requiring hand mining. • Vibration from pipe ramming may be experienced by the users of the highway. • Significant jacking/ramming forces would be required due to hard/dense nature of the overburden material and the proposed length of the pipe.
Horizontal Directional Drilling	N/A	• N/A	• Not capable of installing a steel liner to isolate the watermain below the highway • Pipe material would have to consist of HDPE.	• N/A

GRAIN SIZE DISTRIBUTION

Clayey Silt with Sand (Till)

FIGURE 1



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	BH3	4	174.0
■	BH1	5	173.8
◆	BH2	7	172.5

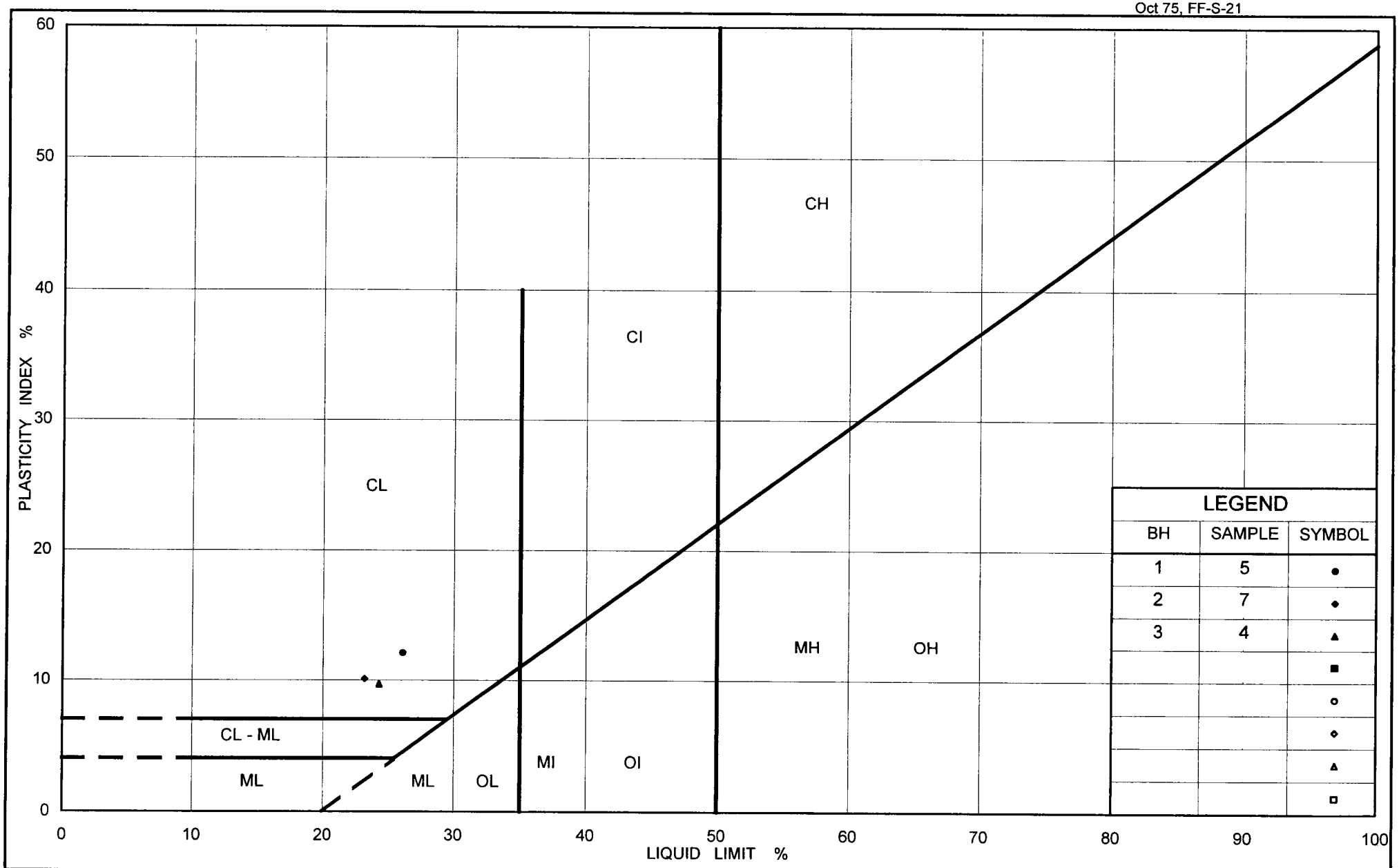
Project Number: 08-1111-0010

Checked By: _____

Golder Associates

Date: 08-Jul-08

Oct 75, FF-S-21



Ministry of Transportation

Ontario

PLASTICITY CHART
Clayey Silt (Till)

Figure No. 2

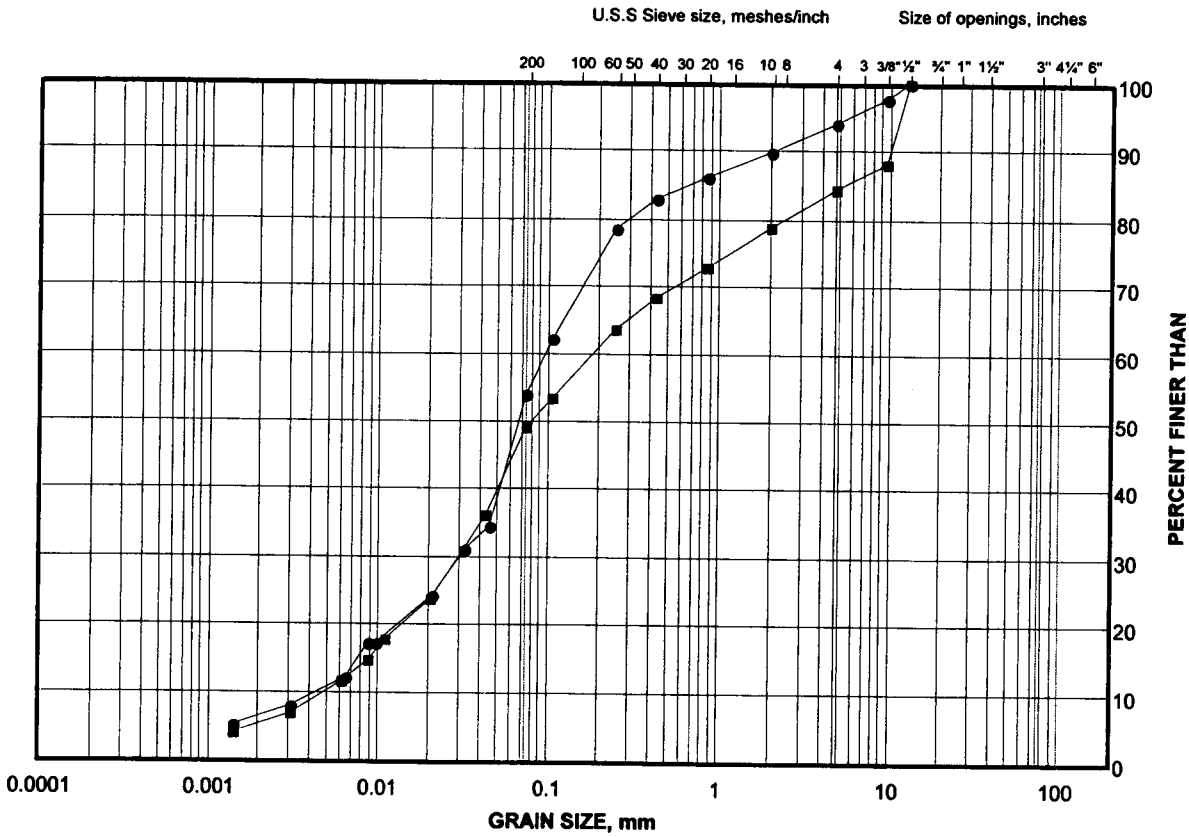
Project No. 08-1111-0010

Checked By:

GRAIN SIZE DISTRIBUTION

Silt and Sand (Till)

FIGURE 3



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	BH2	9	169.6
■	BH1	9	169.3

Project Number: 08-1111-0010

Checked By: _____

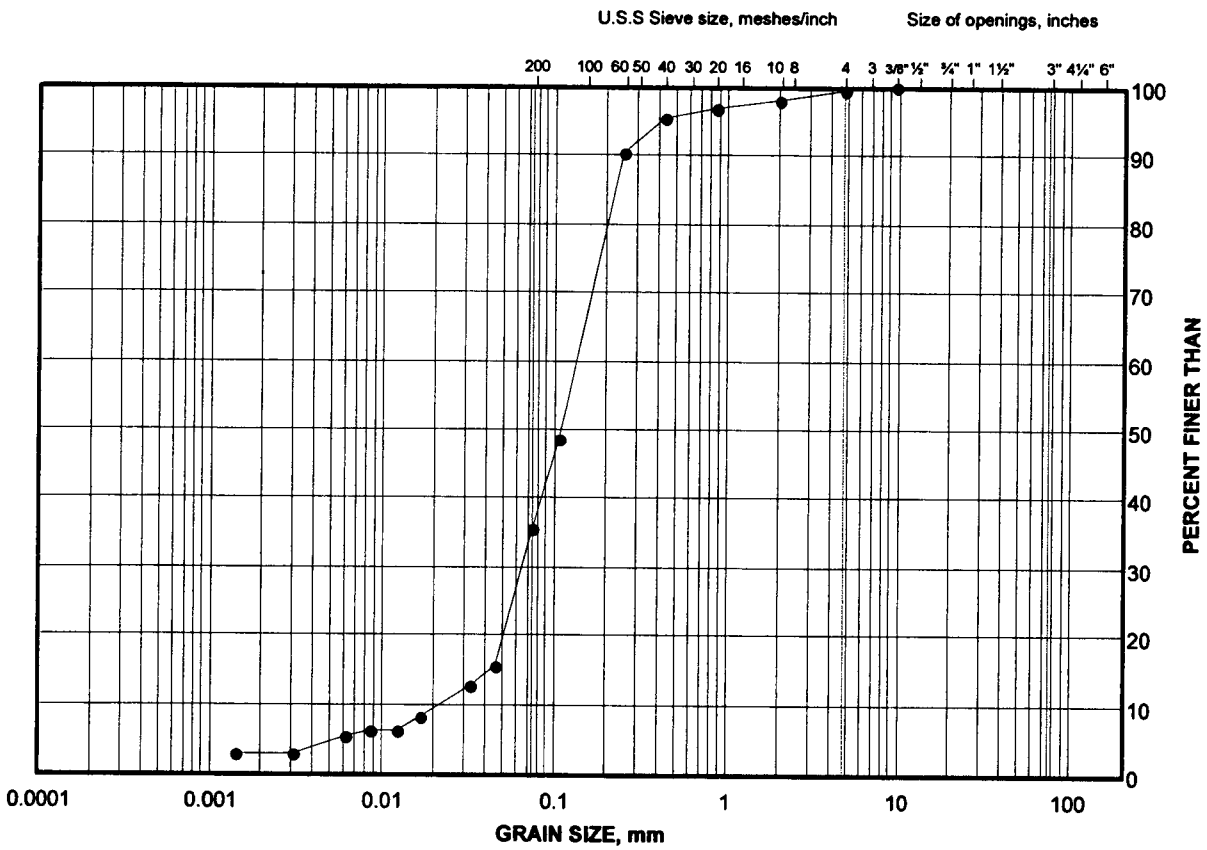
Golder Associates

Date: 11-Jul-08

GRAIN SIZE DISTRIBUTION

Silty Sand

FIGURE 4



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
•	BH1	11	166.0

Project Number: 08-1111-0010

Checked By: _____

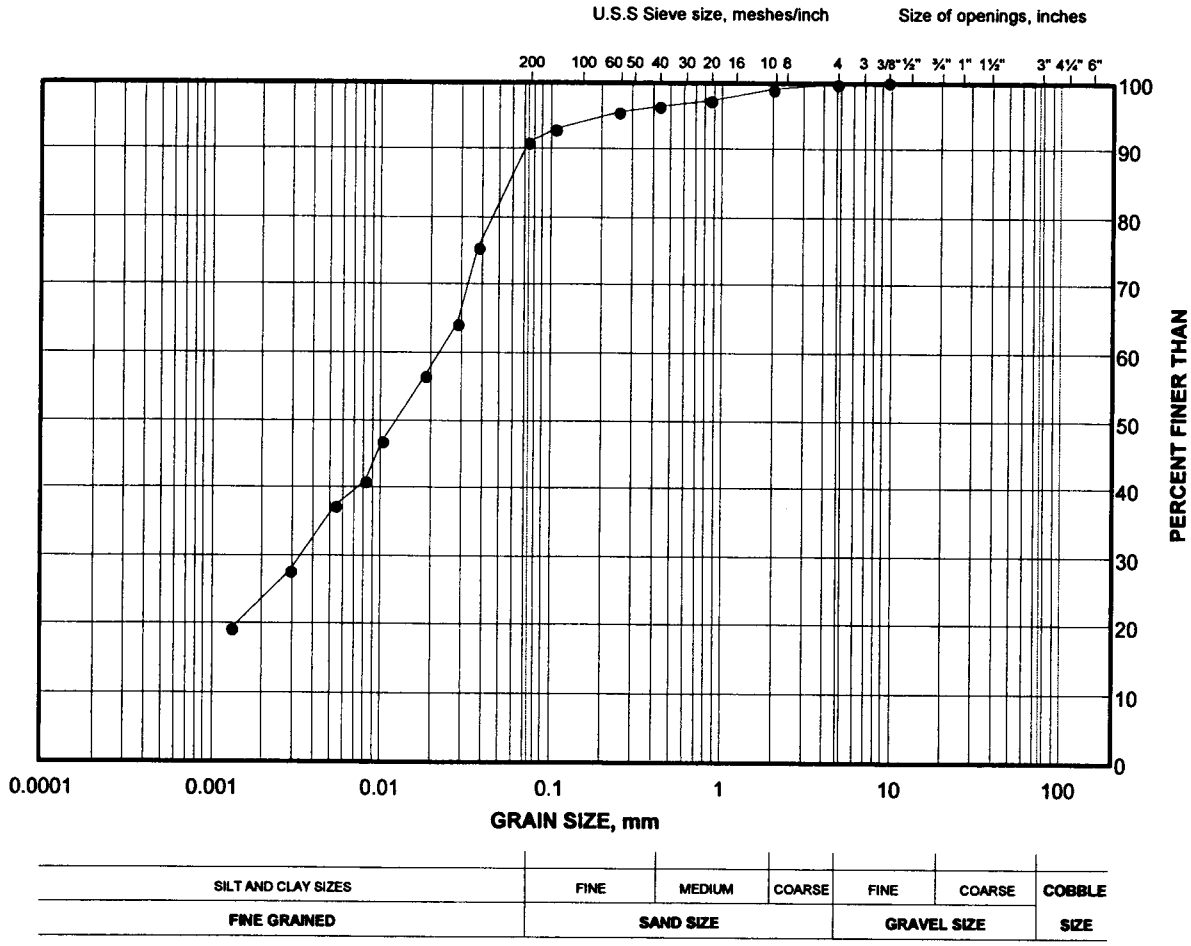
Golder Associates

Date: 11-Jul-08

GRAIN SIZE DISTRIBUTION

Clayey Silt (Residual Soil)

FIGURE 5



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
•	BH3	8	170.2

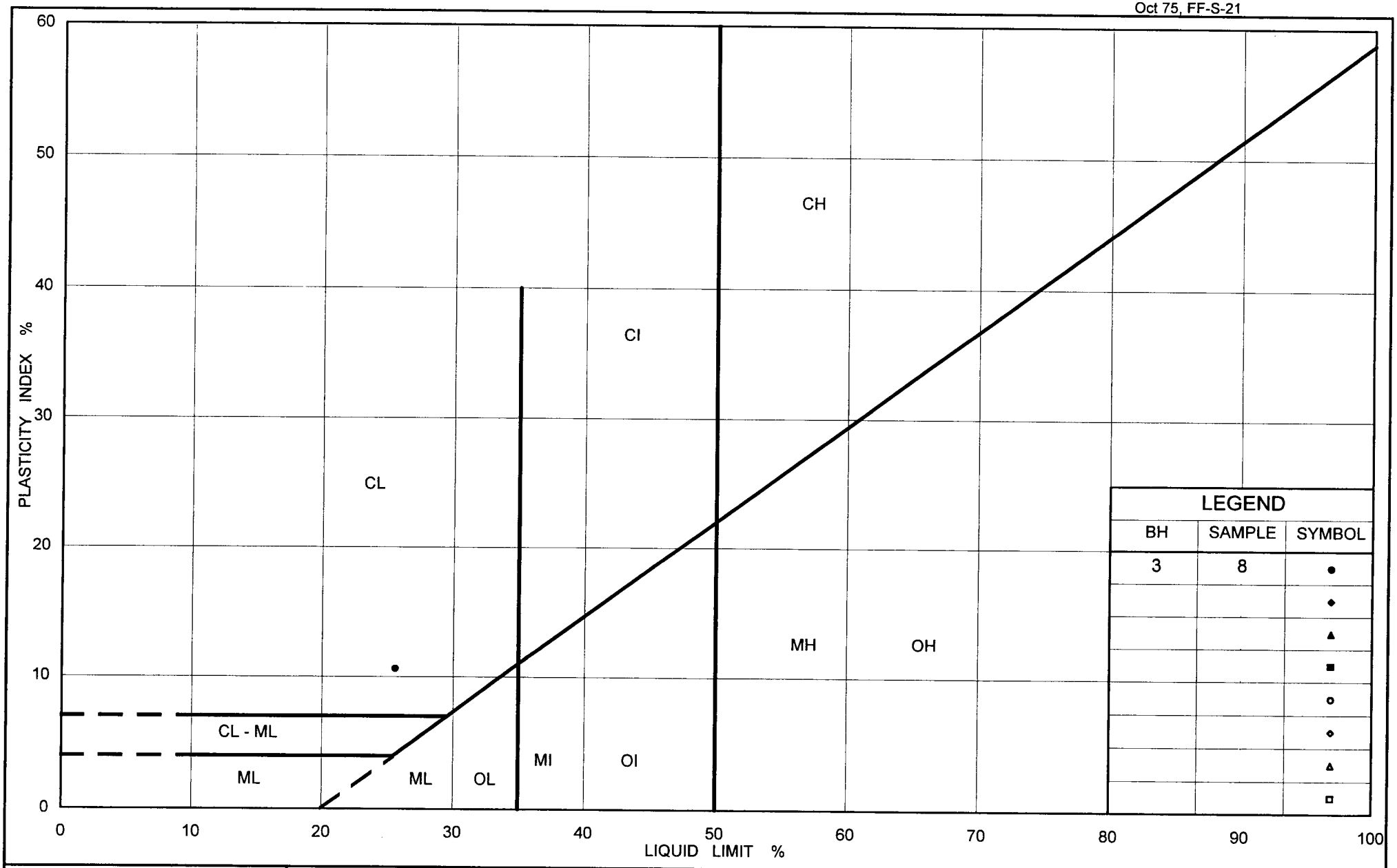
Project Number: 08-1111-0010

Checked By: _____

Golder Associates

Date: 11-Jul-08

Oct 75, FF-S-21



Ministry of Transportation

Ontario

PLASTICITY CHART
Clayey Silt Residual Soil

Figure No. 6

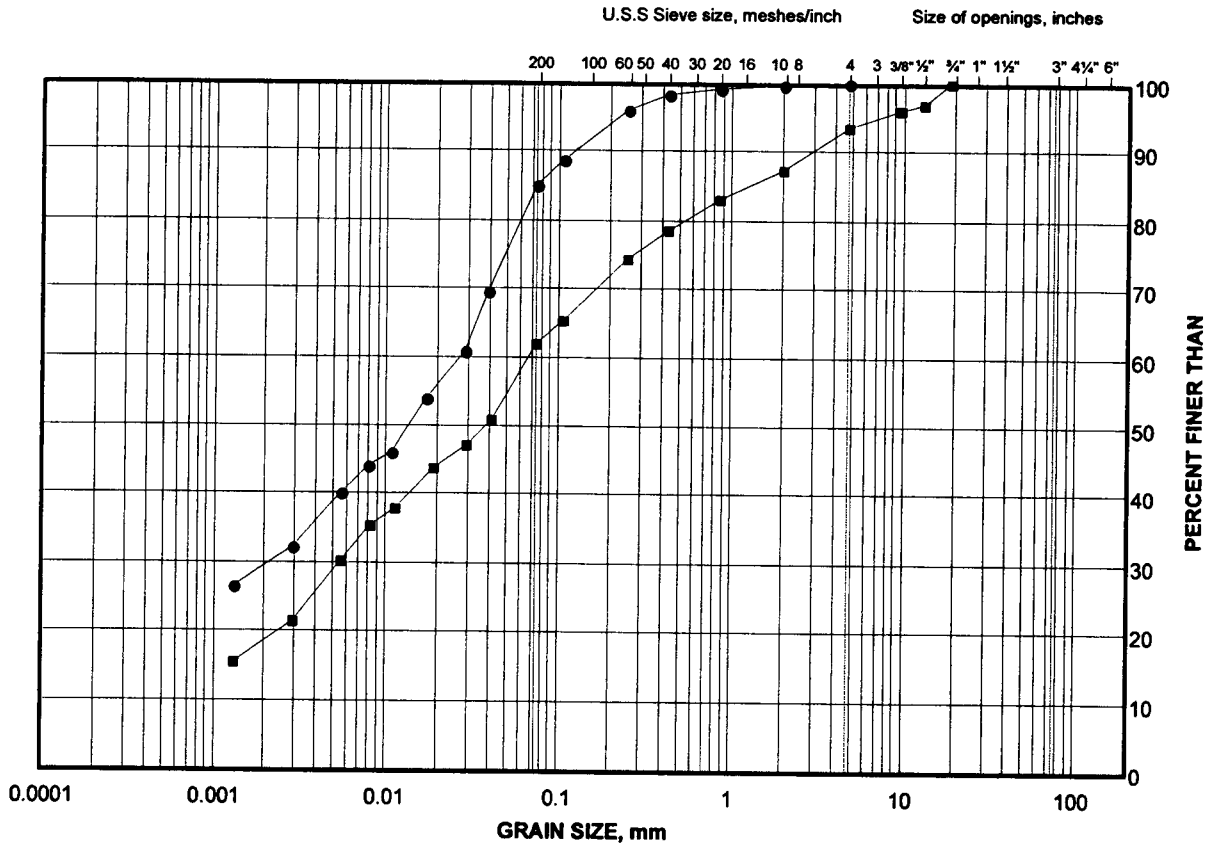
Project No. 08-1111-0010

Checked By:

GRAIN SIZE DISTRIBUTION

Clayey Silt (Fill)

FIGURE 7



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	BH5	11	175.7
■	BH6	3	184.7

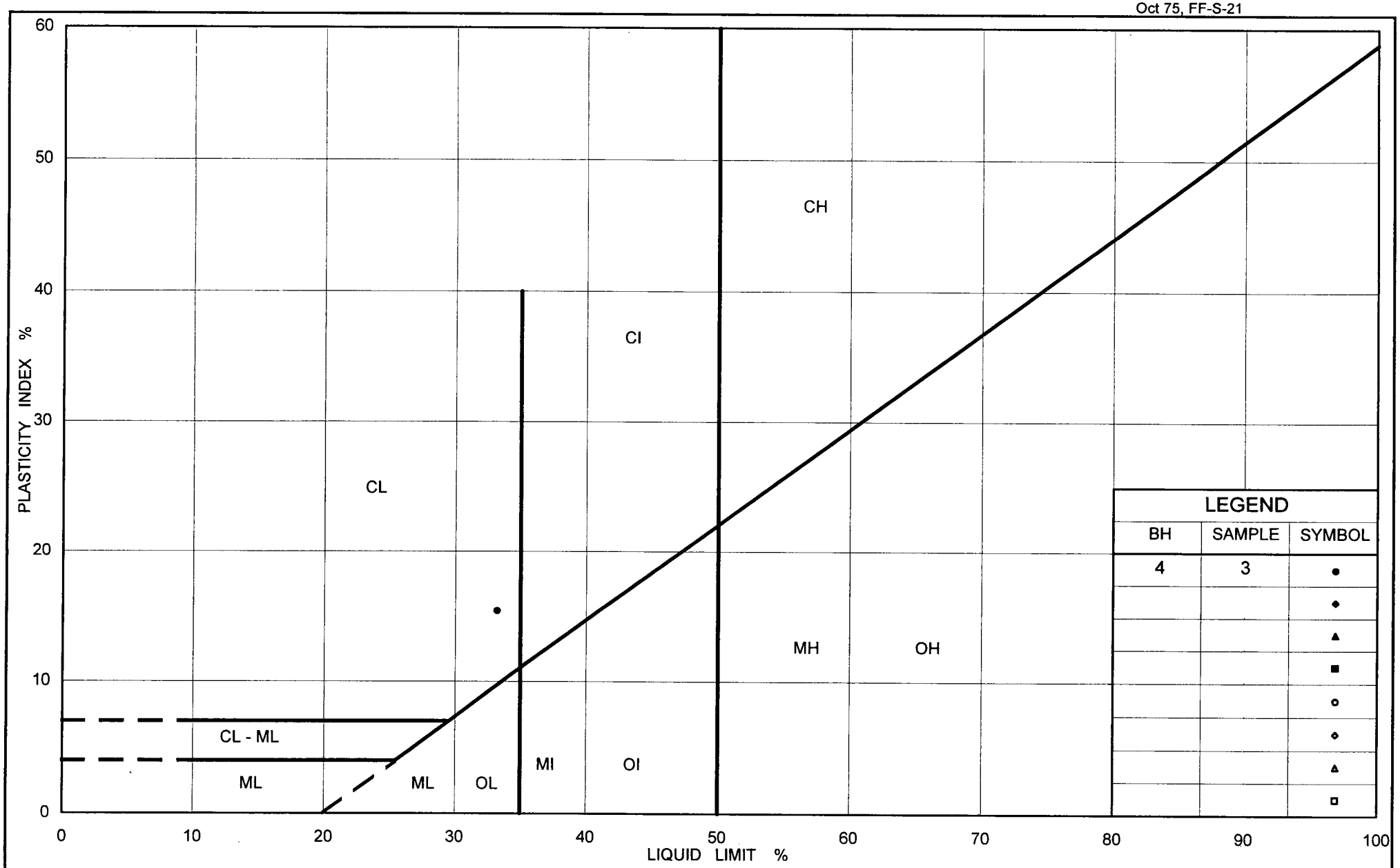
Project Number: 08-1111-0010

Checked By: _____

Golder Associates

Date: 11-Jul-08

Oct 75, FF-S-21



Ministry of Transportation

Ontario

PLASTICITY CHART
Clayey Silt (Fill)

Figure No. 8

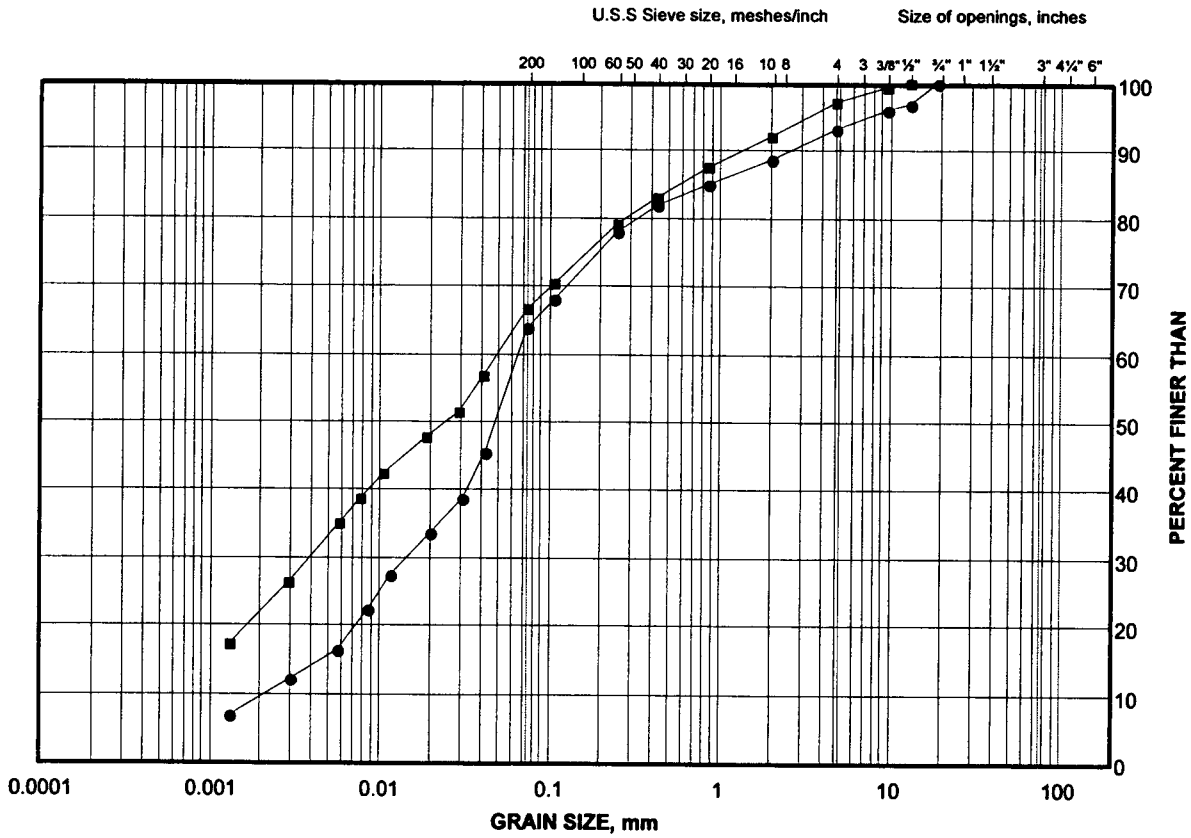
Project No. 08-1111-0010

Checked By:

GRAIN SIZE DISTRIBUTION

Clayey Silt with Sand (Till)

FIGURE 9



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	BH6	11	175.5
■	BH4	7	174.1

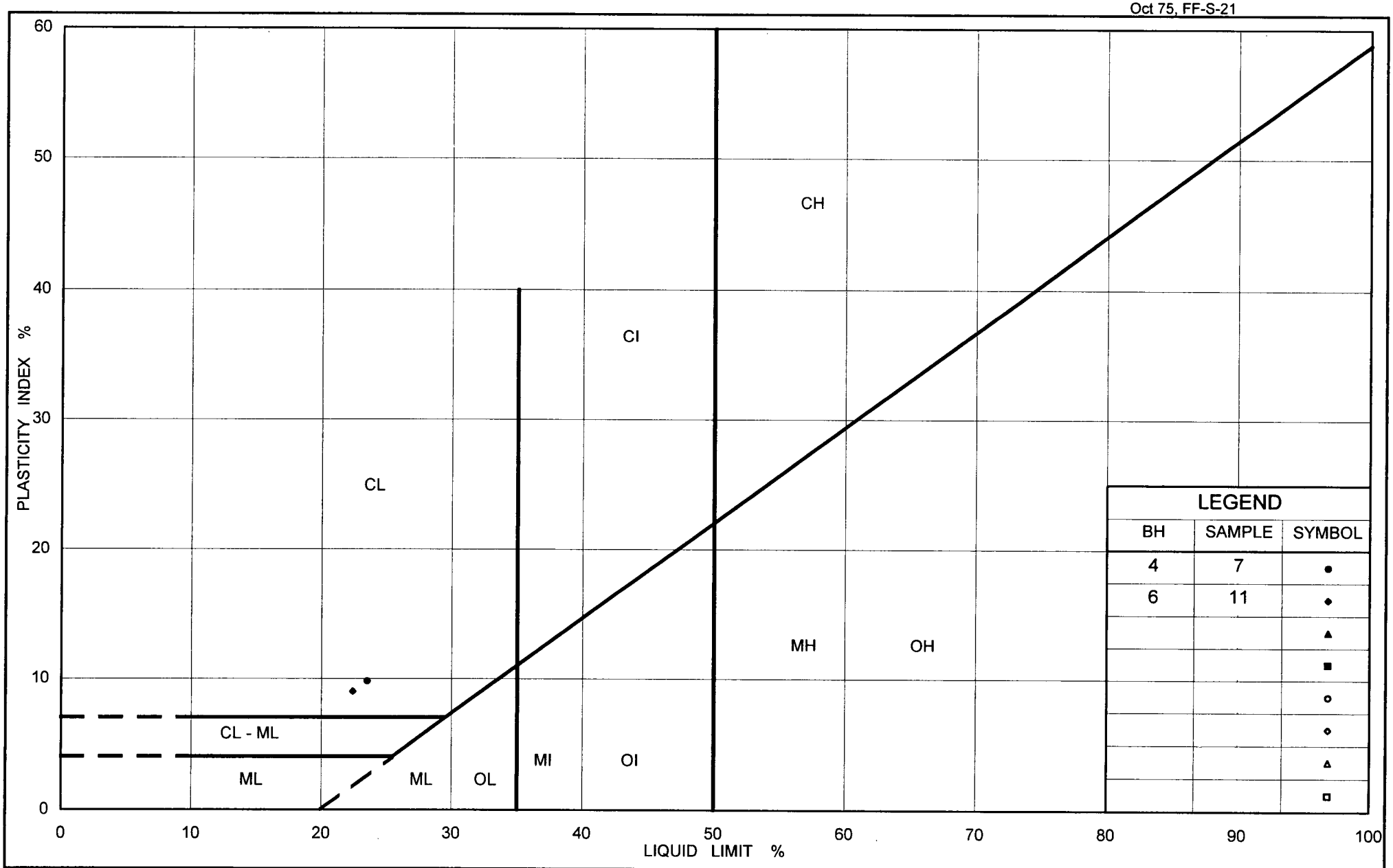
Project Number: 08-1111-0010

Checked By: _____

Golder Associates

Date: 11-Jul-08

Oct 75, FF-S-21



Ministry of Transportation

Ontario

PLASTICITY CHART
Clayey Silt (Till)

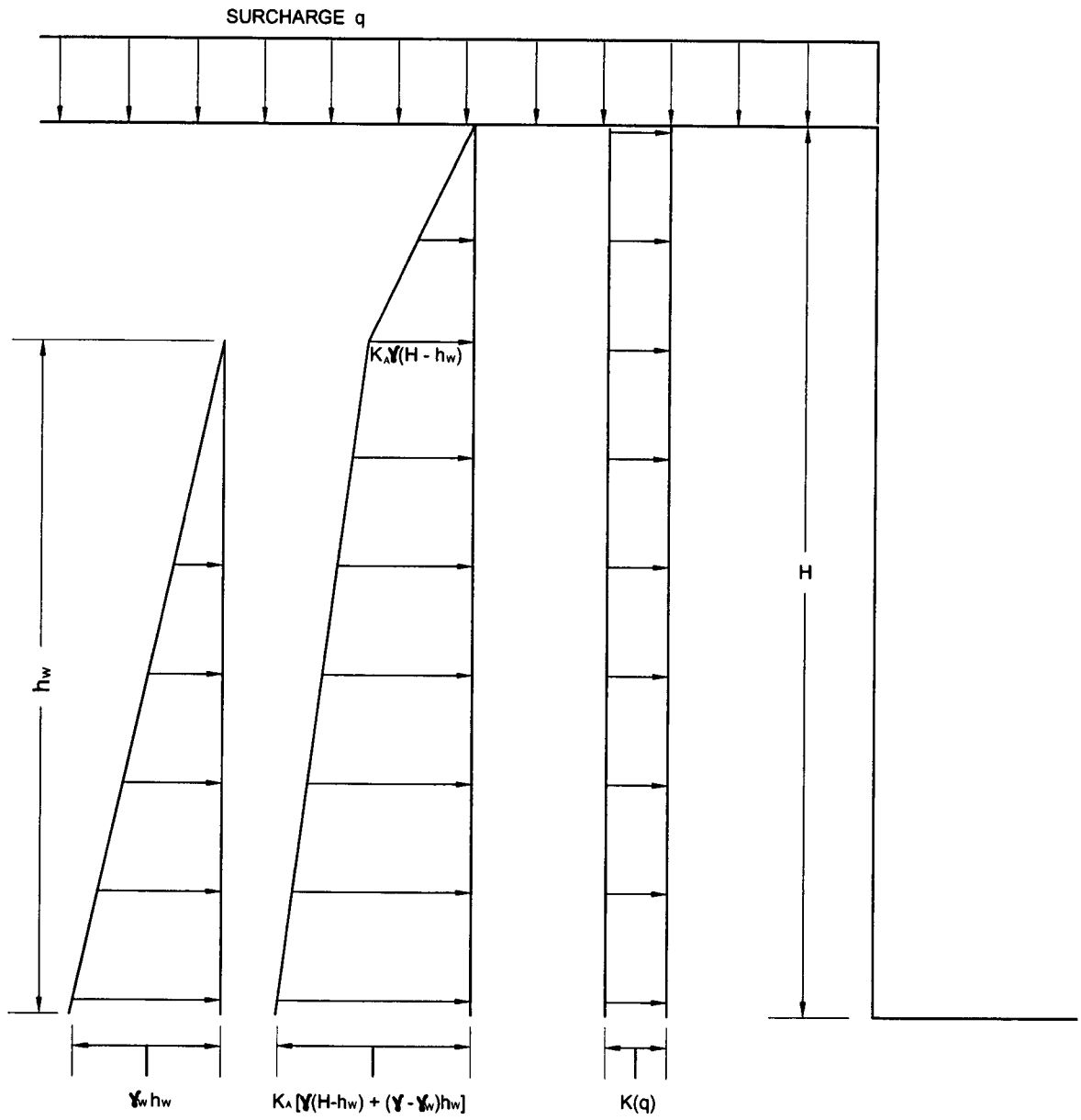
Figure No. 10

Project No. 08-1111-0010

Checked By:

DESIGN LATERAL EARTH PRESSURES FOR TEMPORARY SHORING SYSTEM AT SHAFT LOCATIONS

FIGURE 11



γ - UNIT WEIGHT OF SOIL

γ_w - UNIT WEIGHT OF WATER

K_A - EARTH PRESSURE COEFFICIENT

H - HEIGHT OF EXCAVATION

h_w - HEIGHT OF WATER

DATE: July 10, 2008

PROJECT: 08-1111-0010

Golder Associates

CAD: DD

CHK: SLP

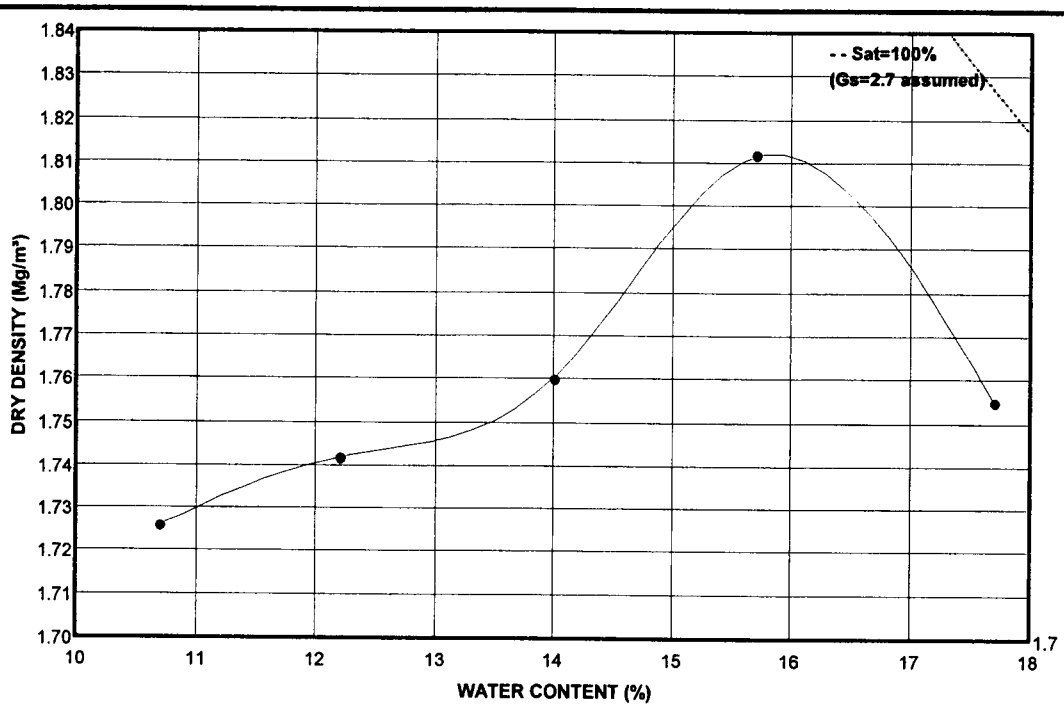
PLOT DATE: July 10, 2008
FILENAME: T:\Projects\2008\08-1111-0010 (THE ERIN MILLS, Mississauga)\-AB- Sanitary Sewer Crossing Under Hwy 403 & 407\081111010AB011.dwg

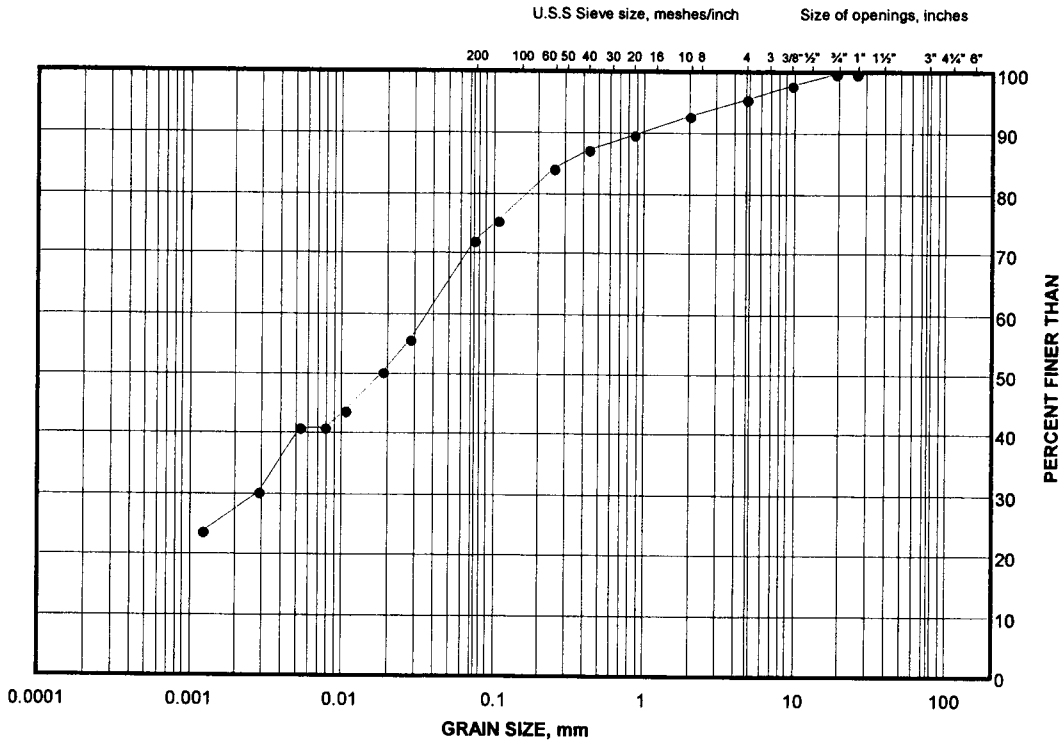
LABORATORY COMPACTION AND GRAIN SIZE DISTRIBUTION TEST RESULTS
CLAYEY SILT FILL

FIGURE 12

Test Results Summary

TEST: Standard
MAX. DRY DENSITY(Mg/m³): 1.812
NATURAL WATER CONTENT(%): 0.0
OPTIMUM WATER CONTENT(%): 15.9
BOREHOLE: 6
DEPTH: 0.0-12.2m





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

Project Number: 08-1111-0010
Checked By:

Golder Associates

LABID: '08-1251'
Date: 11-Jul-08

MINISTRY OF TRANSPORTATION, ONTARIO

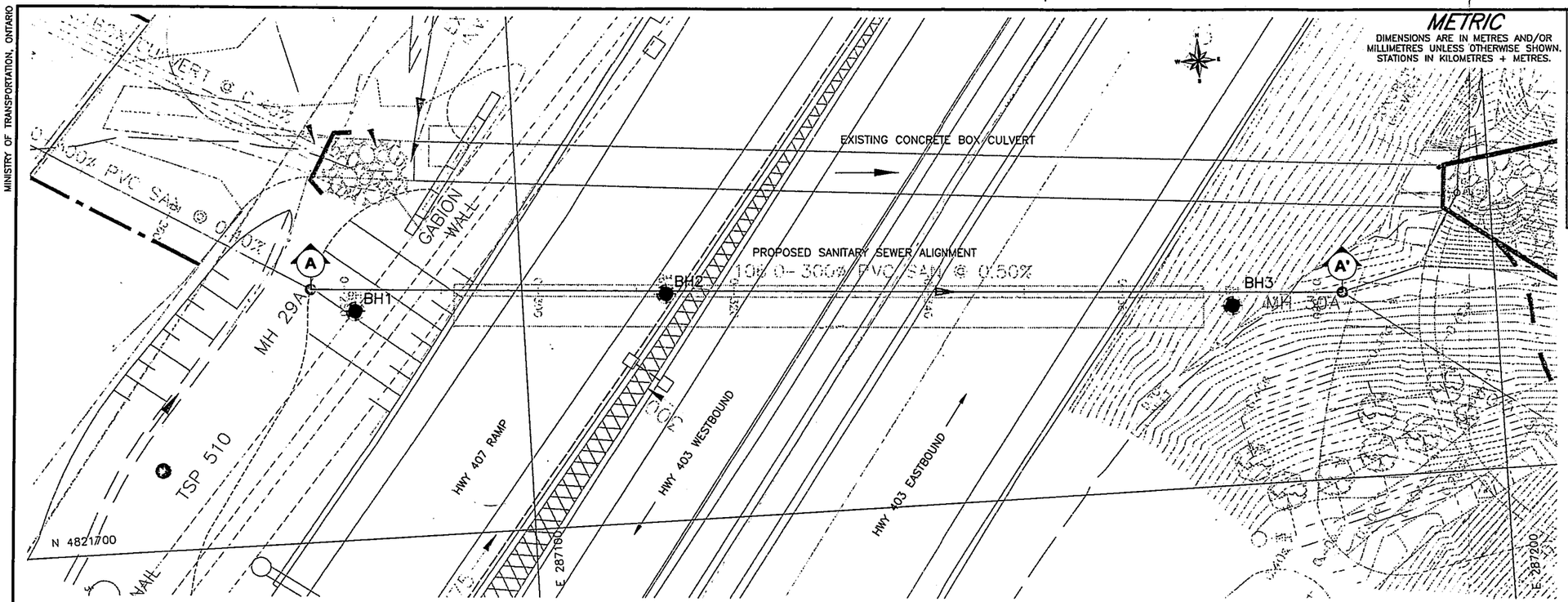
METRIC
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN.
STATIONS IN KILOMETRES + METRES.

CONT No.
WP No.

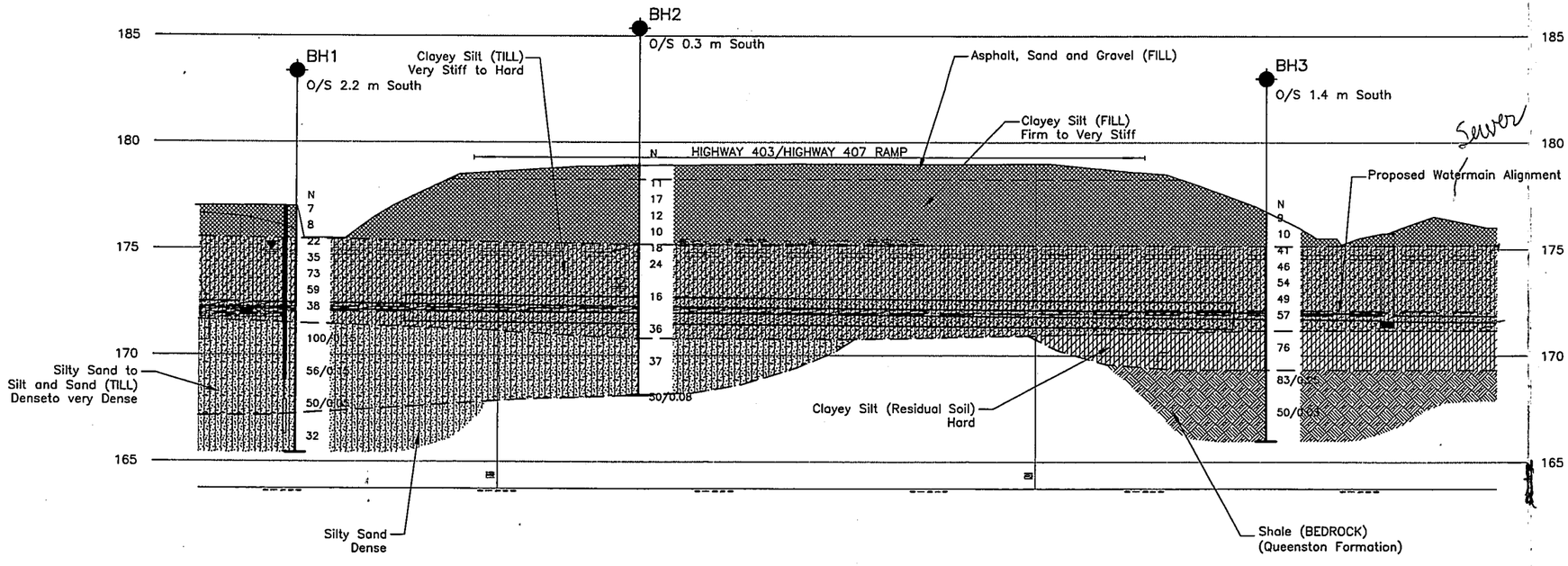
HIGHWAY 403/407
SANITARY SEWER CROSSING
BOREHOLE LOCATION
AND SOIL STRATA

SHEET

Golder Associates Ltd.
MISSISSAUGA, ONTARIO, CANADA



PLAN
SCALE
5 0 5 10 m



PROFILE A – A'
SCALE HORIZONTAL
5 0 5 10 m
2.5 0 2.5 5 m
SCALE VERTICAL

KEY PLAN
SCALE
400 0 400 800 m

LEGEND

- Borehole – Current Investigation
- Seal
- Piezometer
- N — Standard Penetration Test Value
- 16 — Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)
- WL in piezometer, measured on June 4, 2008
- WL upon completion of drilling

No.	ELEVATION	MTM CO-ORDINATES	
		NORTHING	EASTING
BH1	177.0	4821723.7	287082.8
BH2	179.0	4821723.5	287114.6
BH3	176.7	4821718.6	287172.8

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

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 Earthtech, drawing file no. 73452gen.dwg, received June 18, 2008.

NO.	DATE	BY	REVISION

Geocres No.

HWY. 403	PROJECT NO. 08-1111-0010		DIST.
SUBM'D.	CHKD. SLP	DATE: July 10, 2008	SITE:
DRAWN: DD	CHKD. ASP	APPD. JMAC	DWG. 1

PLOT DATE: August 7, 2008
FILNAME: T:\Projects\2008\08-1111-0010 (THE ORBIT MILLS, Mississauga)\<db> Sanitary Sewer Crossing Under Hwy 403 & 407\08111100100001.dwg

MINISTRY OF TRANSPORTATION, ONTARIO

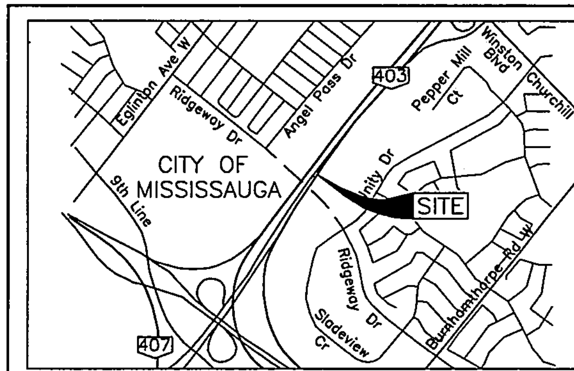
METRIC
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN. STATIONS IN KILOMETRES + METRES.

CONT No.
WP No.

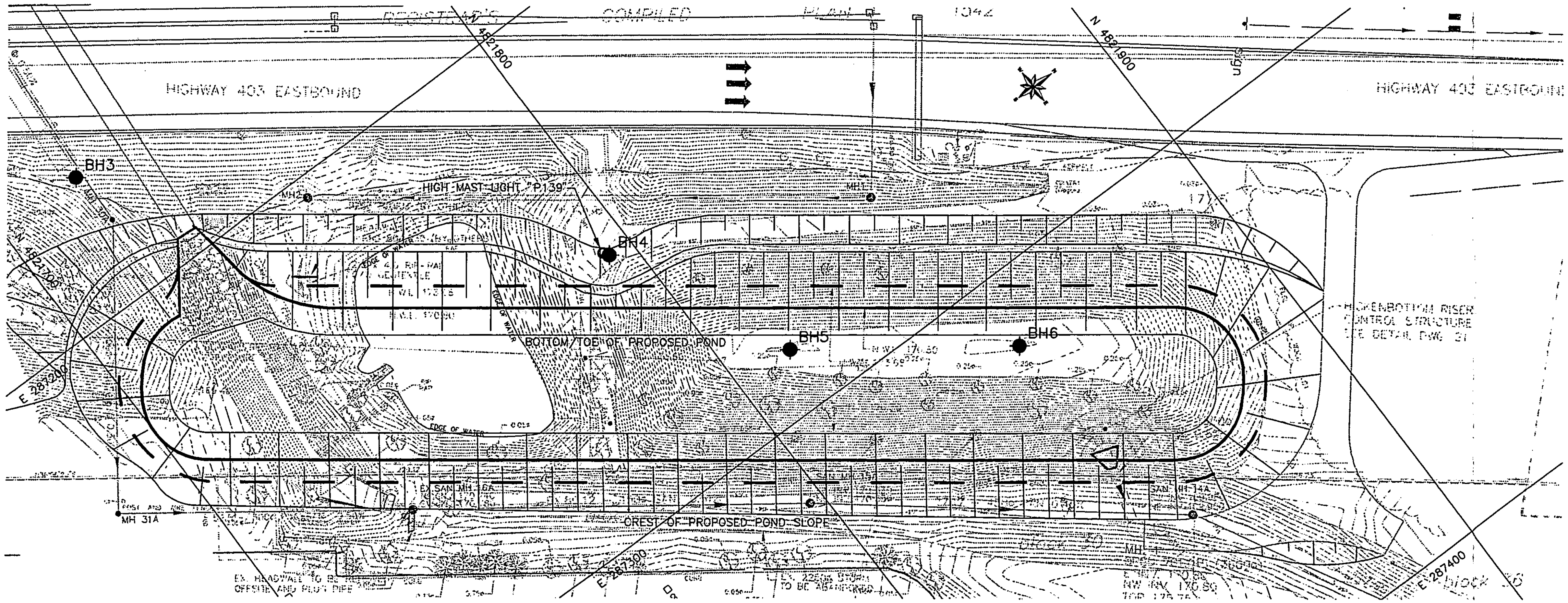
HIGHWAY 403
STOEMWATER POND EXPANSIONS
BOREHOLE LOCATION PLAN

SHEET

Golder Associates Ltd.
MISSISSAUGA, ONTARIO, CANADA



KEY PLAN
SCALE
400 0 400 800 m



PLAN
SCALE
10 0 10 20 m

LEGEND

● Borehole – Current Investigation

No.	ELEVATION	MTM CO-ORDINATES	
		NORTHING	EASTING
BH3	176.7	4821718.6	287172.8
BH4	178.9	4821795.0	287250.0
BH5	186.8	4821812.7	287287.5
BH6	186.5	4821850.2	287314.8

NOTES

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NO.	DATE	BY	REVISION

Geocres No.

HWY. 403		PROJECT NO. 08-1111-0010	DIST.
SUBM'D.	CHKD. SLP	DATE: July 10, 2008	SITE:
DRAWN: DD	CHKD. ASP	APPD.	DWG. 2

LIST OF ABBREVIATIONS

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

I. SAMPLE TYPE

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

II. PENETRATION RESISTANCE

Standard Penetration Resistance (SPT), N:

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

Dynamic Cone Penetration Resistance; N_d:

The number of blows by a 63.5 kg (140 lb.) hammer dropped 760 mm (30 in.) to drive uncased a 50 mm (2 in.) diameter, 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 cm^2 pushed through ground at a penetration rate of 2 cm/s. Measurements of tip resistance (Q_t), porewater pressure (PWP) and friction along a sleeve are recorded electronically at 25 mm penetration intervals.

III. SOIL DESCRIPTION

(a) Cohesionless Soils

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

(b) Cohesive Soils

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

IV. SOIL TESTS

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

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

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LIST OF SYMBOLS

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

I. General

π	3.1416
in 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
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 = σ'_p/σ'_{vo}

(d) Shear Strength

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

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

2 shear strength = (compressive strength)/2

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

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LITHOLOGICAL AND GEOTECHNICAL ROCK DESCRIPTION TERMINOLOGY

WEATHERING STATE

Fresh: no visible sign of weathering.

Faintly weathered: weathering limited to the surface of major discontinuities.

Slightly weathered: penetrative weathering developed on open discontinuity surfaces but only slight weathering of rock material.

Moderately weathered: weathering extends throughout the rock mass but the rock material is not friable.

Highly weathered: weathering extends throughout rock mass and the rock material is partly friable.

Completely weathered: rock is wholly decomposed and in a friable condition but the rock texture and structure are preserved.

BEDDING THICKNESS

Description	Bedding Plane Spacing
Very thickly bedded	> 2 m
Thickly bedded	0.6 m to 2m
Medium bedded	0.2 m to 0.6 m
Thinly bedded	60 mm to 0.2 m
Very thinly bedded	20 mm to 60 mm
Laminated	6 mm to 20 mm
Thinly laminated	< 6 mm

JOINT OR FOLIATION SPACING

Description	Spacing
Very wide	> 3 m
Wide	1 - 3 m
Moderately close	0.3 - 1 m
Close	50 - 300 mm
Very close	< 50 mm

GRAIN SIZE

Term	Size*
Very Coarse Grained	> 60 mm
Coarse Grained	2 - 60 mm
Medium Grained	60 microns - 2 mm
Fine Grained	2 - 60 microns
Very Fine Grained	< 2 microns

Note: * Grains >60 microns diameter are visible to the naked eye.

CORE CONDITION

Total Core Recovery

The percentage of solid drill core recovered regardless of quality or length, measured relative to the length of the total core run.

Solid Core Recovery (SCR)

The percentage of solid drill core, regardless of length, recovered at full diameter, measured relative to the length of the total core run.

Rock Quality Designation (RQD)

The percentage of solid drill core, greater than 100 mm length, recovered at full diameter, measured relative to the length of the total core run. RQD varies from 0% for completely broken core to 100% for core in solid sticks.

DISCONTINUITY DATA

Fracture Index

A count of the number of discontinuities (physical separations) in the rock core, including both naturally occurring fractures and mechanically induced breaks caused by drilling.

Dip with Respect to (W.R.T.) Core Axis

The angle of the discontinuity relative to the axis (length) of the core. In a vertical borehole a discontinuity with a 90° angle is horizontal.

Description and Notes

An abbreviated description of the discontinuities, whether naturally occurring separations such as fractures, bedding planes and foliation planes or mechanically induced features caused by drilling such as ground or shattered core and mechanically separated bedding or foliation surfaces. Additional information concerning the nature of fracture surfaces and infillings are also noted.

Abbreviations

B - Bedding	P - Polished
FO - Foliation/Schistosity	S - Slickensided
CL - Cleavage	SM - Smooth
SH - Shear Plane/Zone	R - Ridged/Rough
VN - Vein	ST - Stepped
F - Fault	PL - Planar
CO - Contact	FL - Flexured
J - Joint	UE - Uneven
FR - Fracture	W - Wavy
MF - Mechanical Fracture	C - Curved
∥ - Parallel To	
⊾ - Perpendicular To	

Form...G.A.-R-3

Golder Associates

RECORD OF BOREHOLE No BH1

1 OF 1 **METRIC**

PROJECT 08-1111-0010 | LOCATION N 4821723.7 ;E 287082.8 | ORIGINATED BY SB

W.O. | DIST | HWY 403 | BOREHOLE TYPE Power Auger, 108 mm I.D. Hollow Stem Augers | COMPILED BY DD

DATUM Geodetic | DATE May 1, 2008 | CHECKED BY SLP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
177.0	GROUND SURFACE								
0.0	Clayey silt, some sand, trace gravel. Contains topsoil pockets, organic matter, and rootlets (FILL) Firm to stiff Brown Moist		1	SS	7				
			2	SS	8		176		
175.5									
1.5	CLAYEY SILT, with sand, trace gravel (TILL) Very stiff to hard Brown to grey Moist		3	SS	22		175		
			4	SS	35		174		
			5	SS	73				6 27 43 24
			6	SS	59		173		
	Becoming grey at 4.5 m depth		7	SS	38		172		
171.5	Difficulty augering at a depth of 5.5 m - Possible cobbles and boulders								
5.5	SILT and SAND, some gravel, trace clay. Contains cobbles (TILL) Very dense Grey Moist		8	SS	100/0.1		171		
			9	SS	56/0.15		170		15 36 44 5
	Bouncing of hammer at 9.1 m depth		10	SS	50/0.05		169		
167.3							168		
9.8	Silty SAND, trace clay and gravel Dense Grey Wet						167		
			11	SS	32		166		1 64 32 3
165.7									
11.3	END OF BOREHOLE								

NOTES:

1. Water level measured after installation of monitoring well at a depth of 5.2 m below ground surface.

2. Water level in monitoring well measured at a depth of 2.1 m (Elevation 174.9 m) on June 4, 2008.

DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100

SHEAR STRENGTH kPa 20 40 60 80 100
o UNCONFINED + FIELD VANE
● QUICK TRIAXIAL × REMOULDED

PLASTIC LIMIT w_P | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w_L

WATER CONTENT (%) 10 20 30

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

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

Golder Associates

RECORD OF BOREHOLE No BH2

1 OF 1 **METRIC**

PROJECT 08-1111-0010 | W.O. | DIST | HWY 403 | DATUM Geodetic

LOCATION N 4821723.5 ;E 287114.6 | BOREHOLE TYPE Power Auger, 108 mm I.D. Hollow Stem Augers | DATE May 4 and 5, 2008

ORIGINATED BY SB | COMPILED BY DD | CHECKED BY SLP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (O UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
179.0	GROUND SURFACE										
0.0	ASPHALT										
0.1	Sand and gravel (FILL) Brown/grey										
178.3	Moist										
0.8	Clayey silt, some sand, trace gravel. Contains topsoil, organic matter and rootlets (FILL) Stiff to very stiff Brown Moist		1	SS	11		178		o		
			2	SS	17		177				
			3	SS	12				o		
			4	SS	10		176				
175.2											
3.8	CLAYEY SILT, with sand, trace gravel (TILL) Very stiff to hard Brown to grey Moist		5	SS	18		175		o		
			6	SS	24		174				
	Becoming grey at 6.0 m depth					▽	173				
			7	SS	16				o ⊢		8 32 42 18
							172				
170.8			8	SS	36		171				
8.2	Silty SAND to SILT and SAND, trace to some gravel, trace clay (TILL) Dense to very dense Grey Moist to wet										
			9	SS	37		170		o		6 41 47 6
							169				
168.1			10	SS	50/0.08						
10.9	END OF BOREHOLE										

NOTE:

1. Borehole open to a depth of 8.2 m and water level noted at depth of 5.8 m (Elevv. 173.2) upon completion of drilling.

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

Golder Associates

RECORD OF BOREHOLE No BH3

1 OF 1 **METRIC**

PROJECT 08-1111-0010 | W.O. | DIST | HWY 403 | DATUM Geodetic

LOCATION N 4821718.6 ;E 287172.8 | BOREHOLE TYPE Power Auger, 108 mm I.D. Hollow Stem Augers | DATE April 24, 2008

ORIGINATED BY SB | COMPILED BY DD | CHECKED BY SLP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (20 40 60 80 100): O UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × REMOULDED	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
176.7	GROUND SURFACE										
0.0	Clayey silt, trace sand and gravel. Contains organic matter including wood fragments (FILL). Stiff Brown and grey Moist		1	SS	9						
			2	SS	10		176				
175.1											
1.5	CLAYEY SILT, with sand, trace gravel (TILL) Hard Brown to grey Moist		3	SS	41		175				
			4	SS	46		174				4 30 43 23
			5	SS	54						
	Becoming grey below 3.7 m depth						173				
			6	SS	49						
			7	SS	57		172				
171.2											
5.5	CLAYEY SILT, trace sand and gravel. Contains shale fragments (Residual Soil) Hard Reddish brown Moist						171				
			8	SS	76						1 8 67 24
169.3							170				
7.3	Weathered SHALE Reddish brown Moist		9	SS	83/0.25		169				
							168				
			10	SS	50/0.03						
							167				
166.0											
10.7	END OF BOREHOLE						166				

NOTE:

1. Borehole open and dry to a depth of 9.8 m upon completion of drilling.

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

Golder Associates

RECORD OF BOREHOLE No BH4

1 OF 1 **METRIC**

PROJECT 08-1111-0010 | W.O. | DIST | HWY 403 | DATUM Geodetic

LOCATION N 4821795.0 ;E 287250.0 | BOREHOLE TYPE Power Auger, 108 mm I.D. Hollow Stem Augers | DATE April 28, 2008

ORIGINATED BY SB | COMPILED BY DD | CHECKED BY SLP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
178.9	GROUND SURFACE										
0.0	Clayey silt with silty sand layers, trace gravel. Contains organic matter (FILL) Firm to very stiff Reddish brown and grey Moist		1	SS	11		178				
			2	SS	7						
176.7			3	SS	19		177				
2.1	CLAYEY SILT, with sand, trace gravel (TILL) Very stiff to hard Brown to grey Moist		4	SS	24		176				
			5	SS	25						
			6	SS	26		175				
			7	SS	40		174				3 31 44 22
	Becoming grey below 6.0 m depth						173				
			8	SS	53		172				
169.7			9	SS	40		171				
9.1	Weathered SHALE Reddish brown Moist		10	SS	50/0.13		170				
			11	SS	50/0.13		169				
166.6							168				
12.2	END OF BOREHOLE		12	SS	50/0.05		167				

NOTES:

1. Monitoring well installed adjacent to sampled Borehole BH4.
2. Water level in monitoring well measured at a depth of 6.8 m (Elevation 172.1 m) on June 4, 2008.

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

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

MIS-MTO 001 08-1111-0010.GPJ GAL-MISS.GDT 8/7/08 DD

Golder Associates

RECORD OF BOREHOLE No BH5

1 OF 1 **METRIC**

PROJECT 08-1111-0010 | W.O. | DIST | HWY 403 | DATUM Geodetic

LOCATION N 4821812.7 ;E 287287.5 | BOREHOLE TYPE Power Auger, 108 mm I.D. Hollow Stem Augers | DATE April 28, 2008

ORIGINATED BY SB | COMPILED BY DD | CHECKED BY SLP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (O UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × REMOULDED; 20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
186.8	GROUND SURFACE										
0.0	Clayey silt, some sand, trace gravel, trace topsoil and rootlets noted between about 1.0 m depth and 1.5 m depth(FILL) Firm to stiff Brown to grey Moist		1	SS	7		186				
			2	SS	12				o		
			3	SS	7		185				
			4	SS	6		184		o		
			5	SS	10						
			6	SS	10		183		o		
			7	SS	8		182				
			8	SS	14		181				
179.5							180				
7.3	Clayey silt, some sand, trace gravel. Contains organic matter (FILL) Stiff Dark grey Moist		9	SS	10		179		o		0 15 54 29
177.7							178				
9.2	TOPSOIL Black										
	CLAYEY SILT, some sand, trace gravel. Contains organic matter including pieces of wood Stiff Brown and grey Moist		10	SS	14		177				
			11	SS	10		176		o		
175.3							175				
11.5	CLAYEY SILT, some sand, trace gravel (TILL) Hard Brown Moist		12	SS	62						
174.0							174				
12.8	END OF BOREHOLE NOTE: 1. Borehole open and dry to a depth of 12.8 m upon completion of drilling.										

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

Golder Associates

RECORD OF BOREHOLE No BH6

1 OF 1 **METRIC**

PROJECT 08-1111-0010 | LOCATION N 4821850.2 ;E 287314.8 | ORIGINATED BY SB

W.O. | DIST | HWY 403 | BOREHOLE TYPE Power Auger, 108 mm I.D. Hollow Stem Augers | COMPILED BY DD

DATUM Geodetic | DATE April 28, 2008 | CHECKED BY SLP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
186.5	GROUND SURFACE										
0.0	Clayey silt, trace to some sand and gravel, Contains organic matter including roots (FILL) Firm to very stiff Brown and grey Moist		1	SS	15		186				
			2	SS	8		185		○		6 32 44 18
			3	SS	9		184				
			4	SS	5		183		○		
			5	SS	8		182				
			6	SS	16		181		○		
			7	SS	9		180				
			8	SS	9		179		○		
			9	SS	5		178				
			10	SS	16		177				
176.2							176		○—		7 29 54 10
10.4	CLAYEY SILT, some sand, trace gravel (TILL) Stiff to hard Brown to grey Moist		11	SS	14		175				
173.7			12	SS	30		174				
12.8	END OF BOREHOLE NOTE: 1. Borehole open and dry to a depth of 12.8 m upon completion of drilling.										

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

APPENDIX A

IMPORTANT INFORMATION AND LIMITATIONS OF THIS REPORT

IMPORTANT INFORMATION AND LIMITATIONS OF THIS REPORT

Standard of Care: Golder Associates Ltd. (Golder) has prepared this report in a manner consistent with that level of care and skill ordinarily exercised by members of the engineering and science professions currently practising under similar conditions in the jurisdiction in which the services are provided, subject to the time limits and physical constraints applicable to this report. No other warranty, expressed or implied is made.

Basis and Use of the Report: This report has been prepared for the specific site, design objective, development and purpose described to Golder by the Client. The factual data, interpretations and recommendations pertain to a specific project as described in this report and are not applicable to any other project or site location. Any change of site conditions, purpose, development plans or if the project is not initiated within eighteen months of the date of the report may alter the validity of the report. Golder can not be responsible for use of this report, or portions thereof, unless Golder is requested to review and, if necessary, revise the report.

The information, recommendations and opinions expressed in this report are for the sole benefit of the Client. No other party may use or rely on this report or any portion thereof without Golder's express written consent. If the report was prepared to be included for a specific permit application process, then upon the reasonable request of the client, Golder may authorize in writing the use of this report by the regulatory agency as an Approved User for the specific and identified purpose of the applicable permit review process. Any other use of this report by others is prohibited and is without responsibility to Golder. The report, all plans, data, drawings and other documents as well as all electronic media prepared by Golder are considered its professional work product and shall remain the copyright property of Golder, who authorizes only the Client and Approved Users to make copies of the report, but only in such quantities as are reasonably necessary for the use of the report by those parties. The Client and Approved Users may not give, lend, sell, or otherwise make available the report or any portion thereof to any other party without the express written permission of Golder. The Client acknowledges that electronic media is susceptible to unauthorized modification, deterioration and incompatibility and therefore the Client can not rely upon the electronic media versions of Golder's report or other work products.

The report is of a summary nature and is not intended to stand alone without reference to the instructions given to Golder by the Client, communications between Golder and the Client, and to any other reports prepared by Golder for the Client relative to the specific site described in the report. In order to properly understand the suggestions, recommendations and opinions expressed in this report, reference must be made to the whole of the report. Golder can not be responsible for use of portions of the report without reference to the entire report.

Unless otherwise stated, the suggestions, recommendations and opinions given in this report are intended only for the guidance of the Client in the design of the specific project. The extent and detail of investigations, including the number of test holes, necessary to determine all of the relevant conditions which may affect construction costs would normally be greater than has been carried out for design purposes. Contractors bidding on, or undertaking the work, should rely on their own investigations, as well as their own interpretations of the factual data presented in the report, as to how subsurface conditions may affect their work, including but not limited to proposed construction techniques, schedule, safety and equipment capabilities.

Soil, Rock and Groundwater Conditions: Classification and identification of soils, rocks, and geologic units have been based on commonly accepted methods employed in the practice of geotechnical engineering and related disciplines. Classification and identification of the type and condition of these materials or units involves judgment, and boundaries between different soil, rock or geologic types or units may be transitional rather than abrupt. Accordingly, Golder does not warrant or guarantee the exactness of the descriptions.

IMPORTANT INFORMATION AND LIMITATIONS OF THIS REPORT (cont'd)

Special risks occur whenever engineering or related disciplines are applied to identify subsurface conditions and even a comprehensive investigation, sampling and testing program may fail to detect all or certain subsurface conditions. The environmental, geologic, geotechnical, geochemical and hydrogeologic conditions that Golder interprets to exist between and beyond sampling points may differ from those that actually exist. In addition to soil variability, fill of variable physical and chemical composition can be present over portions of the site or on adjacent properties. **The professional services retained for this project include only the geotechnical aspects of the subsurface conditions at the site, unless otherwise specifically stated and identified in the report.** The presence or implication(s) of possible surface and/or subsurface contamination resulting from previous activities or uses of the site and/or resulting from the introduction onto the site of materials from off-site sources are outside the terms of reference for this project and have not been investigated or addressed.

Soil and groundwater conditions shown in the factual data and described in the report are the observed conditions at the time of their determination or measurement. Unless otherwise noted, those conditions form the basis of the recommendations in the report. Groundwater conditions may vary between and beyond reported locations and can be affected by annual, seasonal and meteorological conditions. The condition of the soil, rock and groundwater may be significantly altered by construction activities (traffic, excavation, groundwater level lowering, pile driving, blasting, etc.) on the site or on adjacent sites. Excavation may expose the soils to changes due to wetting, drying or frost. Unless otherwise indicated the soil must be protected from these changes during construction.

Sample Disposal: Golder will dispose of all uncontaminated soil and/or rock samples 90 days following issue of this report or, upon written request of the Client, will store uncontaminated samples and materials at the Client's expense. In the event that actual contaminated soils, fills or groundwater are encountered or are inferred to be present, all contaminated samples shall remain the property and responsibility of the Client for proper disposal.

Follow-Up and Construction Services: All details of the design were not known at the time of submission of Golder's report. Golder should be retained to review the final design, project plans and documents prior to construction, to confirm that they are consistent with the intent of Golder's report.

During construction, Golder should be retained to perform sufficient and timely observations of encountered conditions to confirm and document that the subsurface conditions do not materially differ from those interpreted conditions considered in the preparation of Golder's report and to confirm and document that construction activities do not adversely affect the suggestions, recommendations and opinions contained in Golder's report. Adequate field review, observation and testing during construction are necessary for Golder to be able to provide letters of assurance, in accordance with the requirements of many regulatory authorities. In cases where this recommendation is not followed, Golder's responsibility is limited to interpreting accurately the information encountered at the borehole locations, at the time of their initial determination or measurement during the preparation of the Report.

Changed Conditions and Drainage: Where conditions encountered at the site differ significantly from those anticipated in this report, either due to natural variability of subsurface conditions or construction activities, it is a condition of this report that Golder be notified of any changes and be provided with an opportunity to review or revise the recommendations within this report. Recognition of changed soil and rock conditions requires experience and it is recommended that Golder be employed to visit the site with sufficient frequency to detect if conditions have changed significantly.

Drainage of subsurface water is commonly required either for temporary or permanent installations for the project. Improper design or construction of drainage or dewatering can have serious consequences. Golder takes no responsibility for the effects of drainage unless specifically involved in the detailed design and construction monitoring of the system.

APPENDIX B

PREVIOUS INVESTIGATION BY GOLDER

Golder Associates

RECORD OF BOREHOLE No BH1

1 OF 1 **METRIC**

PROJECT 06-1111-021 | LOCATION N 4820789.2 ;E 603605.4 | ORIGINATED BY BML

W.P. | DIST HWY Ridgeway Dr | BOREHOLE TYPE CME 75 Track Mount, 102 mm Solid Stem Augers | COMPILED BY BML

DATUM Geodetic | DATE January 24, 2007 | CHECKED BY HJ

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			o UNCONFINED + FIELD VANE; • QUICK TRIAXIAL × REMOULDED			GR SA SI CL
180.5	GROUND SURFACE										
0.0 / 180.1	Topsoil		1	SS	4		180				
179.6 / 0.9	Sandy Silt, some gravel, trace clay (FILL) Loose Brown Moist		2	SS	17		179		o		
	Clayey Silt with Sand (TILL) Very stiff to hard Brown Moist		3	SS	28		178		o		
			4	SS	22						
			5	SS	29		177				
			6	SS	31				o		
175.5			7	SS	21		176				
5.0	Sandy Silt, some clay Very dense Grey Moist to wet										
174.1			8	SS	50/0.03		175		o		
6.5	End of Borehole										

Notes:

1. Open borehole dry upon completion of drilling.
2. Borehole open to 6.5 m depth upon completion of drilling.

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

MIS-MTO 001 08-1111-021.GPJ GAL-MISS.GDT 7/20/07 DD

Golder Associates

RECORD OF BOREHOLE No BH2

1 OF 1 **METRIC**

PROJECT 06-1111-021 | LOCATION N 4820831.8 ;E 603579.3 | ORIGINATED BY BML

DIST _____ HWY Ridgeway Dr | BOREHOLE TYPE CME 75 Track Mount, 102 mm Solid Stem Augers | COMPILED BY BML

DATUM Geodetic | DATE January 24, 2007 | CHECKED BY HJ

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (20 40 60 80 100): O UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × REMOULDED	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
180.2	GROUND SURFACE						180				
0.0	Topsoil										
0.3	Clayey Silt, trace gravel (FILL), occasional boulders Stiff to hard Reddish brown Moist		1	SS	3						
			2	SS	14		179		o		
			3	SS	50/0.03				o		
177.6							178				
2.6	Clayey Silt with Sand (TILL) Very stiff to hard Brown Moist		4	SS	12						
			5	SS	20		177				
			6	SS	43		176		o		5 29 40 26
175.2			7	SS	46	▽					
5.0	Sandy Silt, some clay Very dense Grey Moist						175				
			8	SS	60		174				
							173				
172.0			9	SS	55		172		o		0 21 65 14
8.2	End of Borehole										

Notes:

1. Water level in open borehole at 5.1 m depth (Elev. 175.1 m) upon completion of drilling.

2. Borehole open to 7.0 m depth upon completion of drilling.

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

Golder Associates

RECORD OF BOREHOLE No BH3

1 OF 1 **METRIC**

PROJECT 06-1111-021 | LOCATION N 4820871.1 ;E 603548.2 | ORIGINATED BY BML

W.P. | DIST | HWY Ridgeway Dr | BOREHOLE TYPE CME 75 Track Mount, 102 mm Solid Stem Augers | COMPILED BY BML

DATUM Geodetic | DATE January 24, 2007 | CHECKED BY HJ

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (O UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
180.2	GROUND SURFACE										
0.0	Topsoil										
0.2	Clayey Silt, some sand and gravel, occasional boulders (FILL) Stiff to soft Reddish brown Moist		1	SS	15		180				
			2	SS	12		179		o		
			3	SS	4		178				
177.8											
2.4	Clayey Silt with Sand (TILL) Very stiff to hard Brown Moist to dry		4	SS	26				o		
			5	SS	24		177				
			6	SS	28		176		o		
			7	SS	60		175		o		
173.9											
173.5	Sandy Silt, some clay Very dense Grey Dry		8	SS	64		174		o		
6.7	End of Borehole										

Notes:

1. Open borehole dry upon completion of drilling.

2. Borehole open to 6.7 m depth upon completion of drilling.

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

MIS-MTO 001 06-1111-021.GPJ GAL-MISS.GDT 7/20/07 DD

Golder Associates

RECORD OF BOREHOLE No BH4

1 OF 1 **METRIC**

PROJECT 06-1111-021 | W.P. | DIST | HWY Ridgeway Dr | DATUM Geodetic

LOCATION N 4820905.2 ;E 603511.4 | BOREHOLE TYPE CME 75 Track Mount, 102 mm Solid Stem Augers | DATE January 24, 2007

ORIGINATED BY BML | COMPILED BY BML | CHECKED BY HJ

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
181.2	GROUND SURFACE						181				
0.0	Topsoil										
0.3	Clayey Silt, trace sand and gravel, frequent rootlets (FILL) Stiff to firm Brown to dark brown Moist		1	SS	14		180				
			2	SS	16		179				
			3	SS	8				○		
177.8							178				
3.4	Clayey Silt with Sand (TILL) Very stiff to hard Brown Moist		4	SS	14						
			5	SS	25		177		○		
			6	SS	35		176				
			7	SS	65		175		○		
174.0							174				
7.2	Clayey Silt to Silty Clay, trace sand Hard Grey Moist		8	SS	37				○		0 3 52 45
173.0							173				
8.2	End of Borehole Notes: 1. Open borehole dry upon completion of drilling. 2. Borehole open to 8.2 m depth upon completion of drilling.										

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

Golder Associates

RECORD OF BOREHOLE No BH5

1 OF 1 **METRIC**

PROJECT 06-1111-021 | LOCATION N 4820914.0 ;E 603487.7 | ORIGINATED BY BML

W.P. | DIST | HWY Ridgeway Dr | BOREHOLE TYPE CME 75 Track Mount, 102 mm Solid Stem Augers | COMPILED BY BML

DATUM Geodetic | DATE Started on Jan. 25, 2007; Completed on Feb. 1, 2007 | CHECKED BY HJ

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (o UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × REMOULDED; 20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
178.4	GROUND SURFACE						178				
0.0	Topsoil										
0.3	Clayey Silt with Sand (TILL) Very stiff to hard Brown Moist		1	SS	20		177	o	o		
			2	SS	33		176		o		
			3	SS	27						
	Becoming grey below 3.5 m depth (Elev. 174.9 m)		4	SS	35		175				
174.0			5	SS	28		174		o		
4.4	Clayey Silt to Silty Clay, trace sand Hard Grey Dry		6	SS	49				o		0 2 51 47
			7	SS	46		173				
171.1							172				
7.3	Sandy Silt, some clay (TILL) Very dense Reddish brown Dry		8	SS	80/0.15		171		o		5 33 49 13
169.4							170				
9.0	Highly to moderately weathered, red, calcareous SHALE BEDROCK (Queenston Formation) with occasional grey siltstone and limestone layers up to 100 mm thick NQ Coring from 10.3 m depth (Elev. 168.1 m) For coring details see Record of Drillhole BH5		9	SS	50/0.08		169				
			10	SS	50/0.10						
			1	NQ RC	REC 96%		168				RQD = 33%
			2	NQ RC	REC 100%						RQD = 36%
			3	NQ RC	REC 100%		167				RQD = 53%
165.4			4	NQ RC	REC 93%		166				RQD = 48%
13.0	End of Borehole Notes: 1. Water level in open borehole on Feb. 1, 2007 before resuming drilling at 1.5 m depth (Elev. 176.9 m). 2. Water level in piezometer on April 3, 2007 at 0.3 m depth (Elev. 178.1 m).										

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

MIS-MTO 001 06-1111-021.GPJ GAL-MISS.GDT 7/20/07 DD

PROJECT: 06-1111-021

RECORD OF DRILLHOLE: BH5

SHEET 1 OF 1

LOCATION: N 4820914.0 ;E 603487.7

DRILLING DATE: Started on Jan. 25, 2007; Completed on Feb. 1, 2007

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: —

DRILL RIG: CME 75

DRILLING CONTRACTOR: Geo-Environmental Ltd.

JN - Joint; FLT - Fault; SHR- Shear; VN - Vein; CJ - Conjugate
BD- Bedding; FO- Foliation; CO- Contact; OR- Orthogonal; CL - Cleavage
PL - Planar; CU- Curved; UN - Undulating; ST - Stepped; IR - Irregular
PO- Polished; K - Slickensided; SM- Smooth; Ro - Rough; MB- Mechanical Break
BR - Broken Rock
NOTE: For additional abbreviations refer to list of abbreviations & symbols.

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	PENETRATION RATE min/m	FLUSH	COLOUR % RETURN	RECOVERY TOTAL CORE %	RECOVERY SOLID CORE %	R.Q.D. %	FRACT. INDEX PER 0.3 m	DISCONTINUITY DATA: β Angle	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	Jr	Ja	Jn	HYDRAULIC CONDUCTIVITY K, cm/sec	Diametral Point Load Index (MPa)	RMC Ω AVG.	CAVITIES OBSERVED IN BOREHOLE VIDEO
		GROUND SURFACE		168.21																		
		Highly to moderately weathered, thinly layered, red, very fine grained, very weak to weak, calcareous SHALE BEDROCK (Queenston Formation)		10.16	1										,BC,,							
															,JN, BD,PL,Ro							
					2																	
		Occasional interbeds of weathered, grey siltstone and limestone													,BC,,							
12		Elevation (m) Thickness (mm)			3										,JN, BD,PL,Ro							Screen
		166.5 50													,JN, BD,PL,Ro							
		160.0 125													,JN, BD,PL,Ro							
		165.6 25			4										,JN, BD,PL,Ro							
		All fractures are rough bedding		165.34																		
14		End of Drillhole		13.03																		
16																						
18																						
20																						
22																						
24																						
26																						
28																						
30																						

MIS-RCK 004 08-1111-021.GPJ GAL-MISS.GDT 7/20/07 DD

DEPTH SCALE
1 : 100

Golder Associates

LOGGED: BML
CHECKED: HJ

Golder Associates

RECORD OF BOREHOLE No BH6

1 OF 1 METRIC

PROJECT 06-1111-021 | LOCATION N 4820927.5 ;E 603502.1 | ORIGINATED BY BML

W.P. | DIST HWY Ridgeway Dr | BOREHOLE TYPE CME 75 Track Mount, 102 mm Solid Stem Augers | COMPILED BY BML

DATUM Geodetic | DATE January 25, 2007 | CHECKED BY HJ

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
183.0	GROUND SURFACE							
0.0	Topsoil							
0.2	Clayey Silt, trace to some sand and gravel (FILL), occasional rootlets Firm to stiff Reddish brown Moist		1	SS	5		182	
			2	SS	8		181	
			3	SS	5		180	
			4	SS	5		179	
			5	SS	5		179	
177.8			6	SS	14		178	
5.2	Clayey Silt with Sand (TILL) Very stiff Brown Moist		7	SS	19		177	13 31 36 20
			8	SS	25		176	
173.5							175	
9.4	Sandy Silt to Silty Sand, trace to some clay (TILL), contains rock fragments Very dense Reddish brown Moist		9	SS	43		174	
			10	SS	50/0.25		173	
			11	SS	70/0.10		172	
169.6							171	
13.4	Clayey Silt to Silty Clay, trace sand Hard Grey Moist		12	SS	60		170	
168.0						▽	169	0 2 53 45
14.9	Silty Sand, some gravel and clay (Residual Soil) Very dense Reddish brown Moist		13	SS	50/0.05		168	
166.2							167	
165.7	Red SHALE BEDROCK (Queenston Formation) with interlayers of grey siltstone		14	SS	118		166	
17.2	End of Borehole							

Note:

1. Water level in open borehole at 14.9 m depth (Elev. 168.1 m) upon completion of drilling.

DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100

SHEAR STRENGTH kPa
○ UNCONFINED + FIELD VANE
● QUICK TRIAXIAL × REMOULDED
20 40 60 80 100

PLASTIC LIMIT w_P | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w_L
WATER CONTENT (%) 10 20 30

UNIT WEIGHT γ kN/m³

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

MIS-MTO 001 06-1111-021.GPJ GAL-MISS.GDT 7/20/07 DD

Golder Associates

RECORD OF BOREHOLE No BH7

1 OF 1 **METRIC**

PROJECT 06-1111-021 | LOCATION N 4820934.8 ;E 603457.6 | ORIGINATED BY BML

W.P. | HWY Ridgeway Dr | BOREHOLE TYPE CME 75 Track Mount, 102 mm Solid Stem Augers | COMPILED BY BML

DATUM Geodetic | DATE January 29, 2007 | CHECKED BY HJ

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa: o UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × REMOULDED (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
179.3	GROUND SURFACE						179				
0.0	Asphalt										
178.5	Sand and Gravel (FILL)										
0.8	Clayey Silt, some sand (Probable FILL) Stiff to firm Brown Moist Occasional dark brown organics/rootlets between 2.2 m and 3.1 m depth (Elev. 177.1 m to 176.2 m)		2	SS	14		178		o		
			3	SS	10						
			4	SS	6		177		o		6 18 50 26
176.0			5	SS	18		176				
3.4	Clayey Silt with Sand (TILL) Hard Brown Moist		6	SS	42				o		
			7	SS	50/0.15		175				
173.7							174				
5.6	Clayey Silt to Silty Clay, some sand Hard Grey Moist Reddish brown Clayey Silt, some sand from 6.1 m to 6.6 m depth		8	SS	44				o		
			9	SS	56		173		o		0 13 62 25
171.8			10	SS	52		172				
7.5	Sandy Silt to Silty Sand, trace to some clay (TILL) Very dense Reddish brown Moist		11	SS	50/0.15				o		
170.2							171				
9.1	Red SHALE BEDROCK (Queenston Formation) with interlayers of grey siltstone		12	SS	50/0.07		170				
			13	SS	50/0.01		169				
			14	SS	108		168				
			15	SS	100/0.10	▽	167				
164.0							166				
			16	SS	50/0.05		165				
15.3	End of Borehole										

Notes:

1. Water level in open borehole at 14.0 m depth (Elev. 153.2 m) upon completion of drilling.

2. Borehole open to 15.3 m depth upon completion of drilling.

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

MIS-MTO 001 06-1111-021.GPJ GAL-MISS.GDT 7/20/07 DD

Golder Associates

RECORD OF BOREHOLE No BH8

1 OF 1 METRIC

PROJECT 06-1111-021 | LOCATION N 4820952.8 ;E 603469.6 | ORIGINATED BY BML

W.P. | DIST | HWY Ridgeway Dr | BOREHOLE TYPE CME 75 Track Mount, 102 mm Solid Stem Augers | COMPILED BY BML

DATUM Geodetic | DATE January 30, 2007 | CHECKED BY HJ

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
179.3	GROUND SURFACE						179				
0.0	Asphalt										
0.2	Sand and Gravel (FILL) Compact Light brown Moist		1	SS	17		178				
178.1	Clayey Silt, some sand (Probable FILL) Stiff to very stiff Brown Moist		2	SS	10				○		
1.2			3	SS	20		177				
			4	SS	9		176		○		
174.9			5	SS	15		175		○		
4.3	Clayey Silt with Sand (TILL) Very stiff Brown Moist		6	SS	30		174				
173.0											
6.3	Silty Sand to Sandy Silt (TILL), trace to some gravel Very dense Grey to reddish brown Moist		7	SS	90		173		○		
			8	SS	50/0.10		172		○		
			9	SS	90/0.10		171				
			10	SS	00/0.10		170		○		
167.7							169				
11.6	Clayey Silt to Silty Clay, trace sand Hard Grey Moist		11	SS	100	▽	168				
166.1							167		○		
13.1	Silty Sand, some gravel and clay (Residual Soil) Very dense Reddish brown Moist		12	SS	00/0.10		166		○		17 44 25 14
165.4							165				
13.9	Red SHALE BEDROCK (Queenston Formation) with interlayers of grey siltstone		13	SS	00/0.10		164				
							163				
							162				
161.0							161				
18.3	End of Borehole										

Notes:

1. Water level in open borehole at 12.8 m depth (Elev. 166.5 m) upon completion of drilling.

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

Golder Associates

RECORD OF BOREHOLE No BH9

1 OF 1 METRIC

PROJECT 06-1111-021 | LOCATION N 4820951.1 ;E 603449.2 | ORIGINATED BY BML

W.P. | | COMPILED BY BML

DIST | HWY Ridgeway Dr | BOREHOLE TYPE CME 75 Track Mount, 102 mm Solid Stem Augers | CHECKED BY HJ

DATUM Geodetic | DATE January 31, 2007

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
179.0	GROUND SURFACE										
0.0 / 178.4	Sand and Gravel (FILL) Compact Brown Moist										
0.6	Clayey Silt, some sand (Probable FILL) Stiff Brown Moist		1	SS	9		178				
			2	SS	12		177		o		
			3	SS	11		176				
			4	SS	10		175		o		
174.6											
4.4	Clayey Silt with Sand, trace gravel (TILL) Very stiff to hard Brown Moist		5	SS	30		174				
	Becoming grey below 5.5 m depth (Elev. 173.5 m)		6	SS	50/0.03		173		o		4 25 56 15
172.0											
7.0	Clayey Silt to Silty Clay, trace sand Hard Grey Moist		7	SS	50/0.13		172		o		
			8	SS	79		171				
169.0							170				
10.1 / 168.2	Silty Sand, some gravel and clay (Residual Soil) Very dense Reddish brown Moist		9	SS	50/0.13		169		o		
10.8	Red SHALE BEDROCK (Queenston Formation) with interlayers of grey siltstone						168				
166.6			10	SS	50/0.07		167				
12.4	End of Borehole										

Notes:

1. Open borehole dry upon completion of drilling.
2. Borehole open to 12.4 m depth upon completion of drilling.

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

MIS-MTO 001 06-1111-021.GPJ GAL-MISS.GDT 7/20/07 DD

Golder Associates

RECORD OF BOREHOLE No BH10

1 OF 1 **METRIC**

PROJECT 06-1111-021 | LOCATION N 4820965.9 ;E 603459.5 | ORIGINATED BY BML

W.P. | BOREHOLE TYPE CME 75 Track Mount, 102 mm Solid Stem Augers | COMPILED BY BML

DIST | HWY Ridgeway Dr | DATE January 31, 2007 | CHECKED BY HJ

DATUM Geodetic

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa: ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
179.3	GROUND SURFACE						179				
0.0	Sand and Gravel, trace asphalt (FILL) Dense Light brown Moist		1	SS	31		178				
177.5			2	SS	26		177		○		
1.8	Clayey Silt, some sand (Probable FILL) Stiff to very stiff Brown Moist		3	SS	11		176		○		
174.7	Sand seam, compact, dark brown to grey, moist between 3.7 to 4.1 m depth		4	SS	15		175				
4.6	Clayey Silt with Sand (TILL) Very stiff Brown Moist		5	SS	24		174		○		5 32 43 20
173.4			6	SS	50/0.08		173		○		
5.9	Silty Sand to Sandy Silt, trace to some clay (TILL), trace to some gravel, occasional boulders Very dense Grey Moist		7	SS	50/0.15		172		○		
			8	SS	50/0.10		171		○		
			9	SS	50/0.13		170				
			10	SS	50/0.13	▽	169		○		5 36 50 9
166.4							168				
12.9	Silty Sand, some gravel and clay (Residual Soil) Very dense Reddish brown Moist		11	SS	50/0.13		167		○		
165.5							166				
13.9	Red SHALE BEDROCK (Queenston Formation) with interlayers of grey siltstone						165				
163.9			12	SS	50/0.08		164				
15.4	End of Borehole										

Notes:

1. Water level in open borehole at 12.2 m depth (Elev. 167.1 m) upon completion of drilling.

2. Borehole open to 15.4 m depth upon completion of drilling.

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

MIS-MTO 001 06-1111-021.GPJ GAL-MISS.GDT 7/20/07 DD

Golder Associates

RECORD OF BOREHOLE No BH11

1 OF 1 **METRIC**

PROJECT 06-1111-021 | LOCATION N 4820973.6 ;E 603423.8 | ORIGINATED BY BML

W.P. | DIST | HWY Ridgeway Dr | BOREHOLE TYPE CME 75 Track Mount, 102 mm Solid Stem Augers | COMPILED BY BML

DATUM Geodetic | DATE January 29, 2007 | CHECKED BY HJ

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (o UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
176.7	GROUND SURFACE										
0.0	Topsoil										
0.3	Clayey Silt with Sand (TILL) Very stiff to hard Brown Moist		1	SS	28		176				
			2	SS	37		175				
	Becoming grey below 2.1 m (Elev. 174.6 m)		3	SS	26		174				
173.0			4	SS	58						
3.7	Silty Sand to Sandy Silt, trace to some clay (TILL) Very dense Grey Moist		5	SS	56/0.13		173				
			6	SS	50/0.10		172				
			7	SS	34/0.07		171				
			8	SS	75/0.10		170				
167.8							169				
8.8	Clayey Silt to Silty Clay, trace sand Hard Grey Moist		9	SS	50/0.10		168				0 4 51 45
166.3							167				
	Silty Sand, some gravel and clay (Residual Soil) Very dense Reddish brown Moist		10	SS	50/0.03	▽	166				
10.7	Red SHALE BEDROCK (Queenston Formation) with interlayers of grey siltstone		11	SS	50/0.07		165				
							164				
162.8			12	SS	50/0.13		163				
13.9	End of Borehole										

Notes:

1. Water level in open borehole at 10.7 m depth (Elev. 166.0 m) upon completion of drilling.

2. Borehole open to 12.5 m depth upon completion of drilling.

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

MIS-MTO 001 06-1111-021.GPJ GAL-MISS.GDT 7/20/07 DD

Golder Associates

PROJECT 06-1111-021

RECORD OF BOREHOLE No BH12

1 OF 1 **METRIC**

W.P. _____ LOCATION N 4820987.6 ;E 603433.6 ORIGINATED BY BML

DIST _____ HWY Ridgeway Dr BOREHOLE TYPE CME 75 Track Mount, 110 mm I.D. Solid Stem Augers COMPILED BY BML

DATUM Geodetic DATE February 1, 2007 CHECKED BY HJ

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (O UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
176.6	GROUND SURFACE										
0.0 / 176.6	Topsoil										
0.4	Clayey Silt with Sand (TILL) Hard Brown Moist		1	SS	36		176				
			2	SS	72		175				
	Becoming grey below 2.3 m depth (Elev. 174.3 m)						174				
173.5											
3.1	Silty Sand to Sandy Silt, trace to some clay (TILL) Very dense Grey		3	SS	50/0.10		173				
			4	SS	50/0.07		172				
	Some gravel in auger cuttings, augers grinding on possible cobbles/boulders at 5.2 m depth		5	SS	50/0.13		171				
			6	SS	50/0.10		170				
			7	SS	50/0.03		169				
166.2							168				
10.4	Silty Sand, some gravel and clay (Residual Soil) Very dense Reddish brown Moist		8	SS	50/0.13		167				
164.7							166				
11.9	Red SHALE BEDROCK (Queenston Formation) with interlayers of grey siltstone and limestone NQ Coring from 12.0 m depth to 14.9 m depth (Elev. 164.2 m to 161.7 m) For coring details see Record of Drillhole BH12		9	SS	50/0.03		165				RQD = 0%
				NQ RC	0.33%						
			2	NQ RC	REC 90%		164				RQD = 63%
			3	NQ RC	REC 91%		163				RQD = 18%
161.6							162				
14.9	End of Borehole Note: 1. Water level in piezometer on April 3, 2007 at 0.0 m depth (Elev. 176.6 m).										

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

Golder Associates

RECORD OF BOREHOLE No BH13

1 OF 1 **METRIC**

PROJECT 06-1111-021 | LOCATION N 4820997.5 ;E 603410.1 | ORIGINATED BY BML

W.P. | HWY Ridgeway Dr | BOREHOLE TYPE CME 75 Track Mount, 102 mm Solid Stem Augers | COMPILED BY BML

DATUM Geodetic | DATE January 30, 2007 | CHECKED BY HJ

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (O UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × REMOULDED; 20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
179.1	GROUND SURFACE						179				
0.0	Topsoil										
0.3	Clayey Silt with Sand (TILL) Very stiff to hard Brown Moist		1	SS	23		178		O		
			2	SS	28						
			3	SS	33		177		O		
			4	SS	43		176				
	Becoming grey below 4.3 m depth (Elev. 174.8 m)						175				
			5	SS	28		174		O		
172.7											
6.4	Silty Sand to Sandy Silt, trace to some clay (TILL), contains rock fragments Very dense Moist		6	SS	65		173		O		
			7	SS	50/0.1		172		O		
171.1											
8.1	End of Borehole										

Notes:

1. Open borehole dry upon completion of drilling.

2. Borehole open to 8.1 m depth upon completion of drilling.

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

Golder Associates

RECORD OF BOREHOLE No BH18

1 OF 1 METRIC

PROJECT 06-1111-021 | LOCATION N 4821028.4 ;E 603386.5 | ORIGINATED BY BML

W.P. | DIST | HWY Ridgeway Dr | BOREHOLE TYPE CME 75 Track Mount, 110 mm I.D. Solid Stem Augers | COMPILED BY BML

DATUM Geodetic | DATE January 22, 2007 | CHECKED BY HJ

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (O UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × REMOULDED)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
178.6	GROUND SURFACE										
0.0	Topsoil										
0.3	Clayey Silt with Sand, trace gravel (TILL) Very stiff to hard Brown Moist		1	SS	19		178		o		
			2	SS	28	▼	177				
			3	SS	38		176				
			4	SS	23		175				
	Becoming grey below 4.0 m depth (Elev. 174.6 m)		5	SS	30				o		
			6	SS	25		174				
172.8							173				
5.8	Silty Sand to Sandy Silt, trace clay, trace gravel (TILL) Very dense Reddish brown to grey Dry		7	SS	50/0.10		172				
			8	SS	50/0.10		171				
			9	SS	50/0.13		170		o		8 43 41 8
			10	SS	50/0.13		169				
166.7							168		o		
	Clayey Silt to Silty Clay, containing shale fragments		11	SS	50/0.00		167		o		
166.2	Hard Grey Moist										
12.4	End of Borehole										

Note:

1. Water level in piezometer on April 3, 2007 at 1.4 m depth (Elev. 177.2 m).

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

Golder Associates

RECORD OF BOREHOLE No BH19

1 OF 1 **METRIC**

PROJECT 06-1111-021 | LOCATION N 4821046.6 ;E 603401.7 | ORIGINATED BY BML

DIST _____ HWY Ridgeway Dr | BOREHOLE TYPE CME 75 Track Mount, 102 mm Solid Stem Augers | COMPILED BY BML

DATUM Geodetic | DATE January 23, 2007 | CHECKED BY HJ

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (O UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
177.9	GROUND SURFACE										
0.0	Topsoil										
0.2	Silty Clay, some sand, trace gravel (TILL) Firm to stiff Brown Moist		1	SS	3						
			2	SS	10		177		O		
			3	SS	14		176				
175.6											
	Clayey Silt with sand, trace gravel (TILL) Hard Brown Moist		4	SS	40		175		O		
174.2			5	SS	44				O		
3.7	End of Borehole										

Notes:

1. Open borehole dry upon completion of drilling.

2. Borehole open to 3.7 m depth upon completion of drilling.

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

Golder Associates

RECORD OF BOREHOLE No BH20

1 OF 1 **METRIC**

PROJECT 06-1111-021 | LOCATION N 4821058.6 ;E 603342.9 | ORIGINATED BY BML

W.P. | DIST HWY Ridgeway Dr | BOREHOLE TYPE CME 75 Track Mount, 102 mm Solid Stem Augers | COMPILED BY BML

DATUM Geodetic | DATE January 22, 2007 | CHECKED BY HJ

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (O UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
176.9	GROUND SURFACE										
0.0	Topsoil										
0.3	Clayey Silt with Sand (TILL) Firm to hard Brown Moist		1	SS	6		176				
			2	SS	17		175				
			3	SS	45						
173.3			4	SS	32		174				
3.6	Silty Sand to Sandy Silt, trace to some clay (TILL), occasional cobbles Very dense Grey Moist Augers grinding from 3.6 m to 3.8 m depth		5	SS	92		173 172				10 31 42 17
170.2			6	SS	98		171				
6.7	End of Borehole Notes: 1. Open borehole dry upon completion of drilling. 2. Borehole open to 5.5 m depth upon completion of drilling.										

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

MIS-MTO 001 06-1111-021.GPJ GAL-MISS.GDT 7/20/07 DD

Golder Associates

RECORD OF BOREHOLE No BH21

1 OF 1 **METRIC**

PROJECT 06-1111-021 | LOCATION N 4821098.4 ;E 603299.1 | ORIGINATED BY BML

W.P. | DIST | HWY Ridgeway Dr | BOREHOLE TYPE CME 75 Track Mount, 102 mm Solid Stem Augers | COMPILED BY BML

DATUM Geodetic | DATE January 22, 2007 | CHECKED BY HJ

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (O UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × REMOULDED)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
179.9	GROUND SURFACE							20 40 60 80 100	10 20 30		
0.0	Clayey silt, trace to some sand, organics and rootlets (FILL) Very soft Dark brown Moist		1	SS	1		179				
			2	SS	1		178				
177.3											
2.5	Clayey Silt with Sand (TILL) Very stiff to hard Brown Moist		3	SS	8		177				
			4	SS	20						
			5	SS	33		176				
			6	SS	41		175				
173.7							174				
173.2	Silty Sand to Sandy Silt, trace to some clay (TILL), containing rock fragments Very dense Reddish brown Moist		7	SS	72						
6.7	End of Borehole										

Notes:

1. Open borehole dry upon completion of drilling.
2. Borehole open to 5.8 m depth upon completion of drilling.

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

MIS-MTO 001 06-1111-021.GPJ GAL-MISS.GDT 7/20/07 DD

MINISTRY OF TRANSPORTATION, ONTARIO

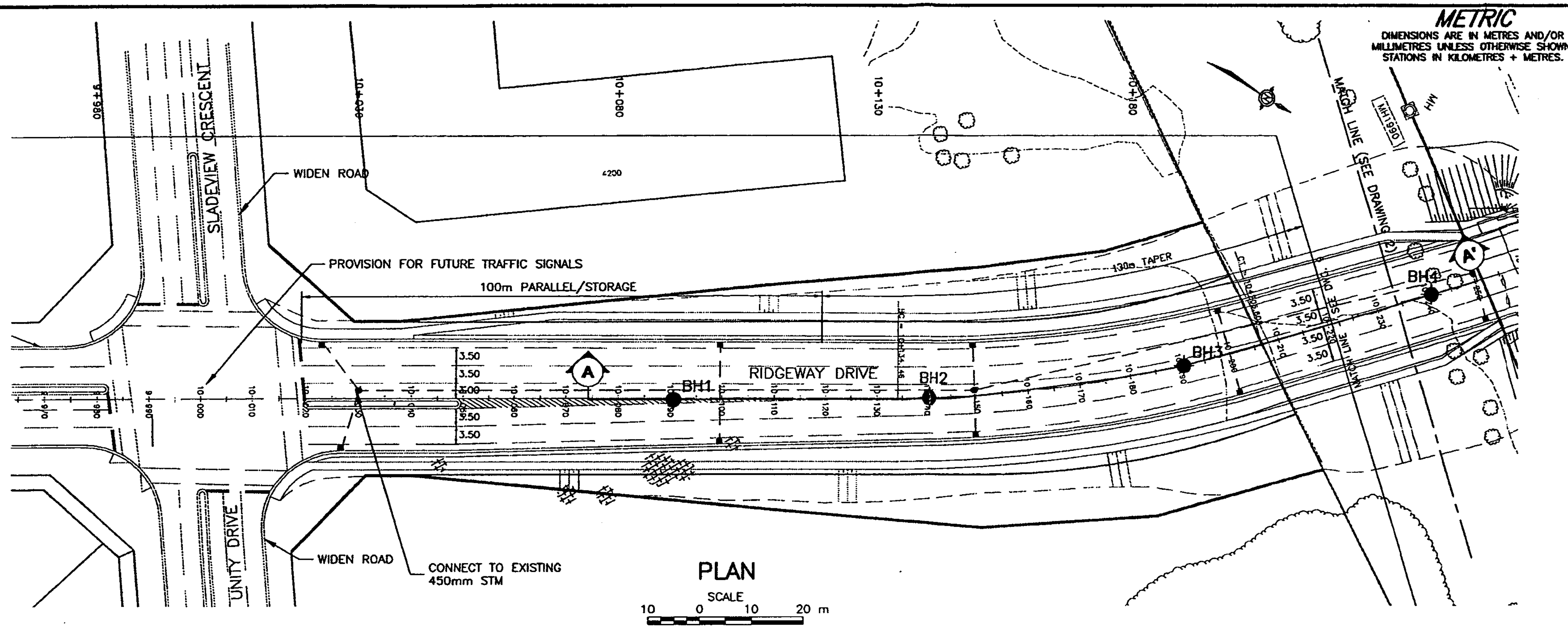
METRIC
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN. STATIONS IN KILOMETRES + METRES.

CONT No.
WP No.

SHEET

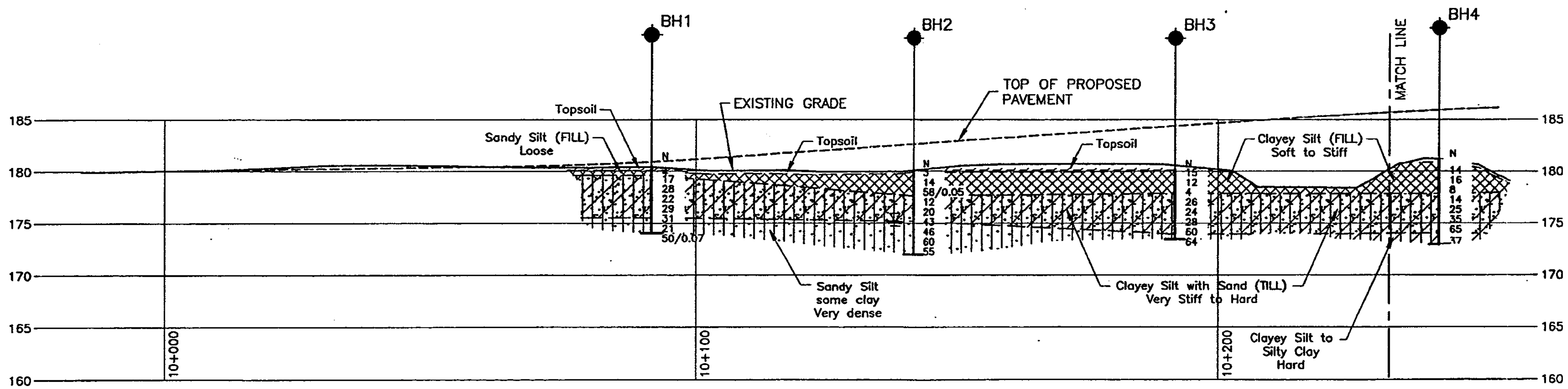
RIDGEWAY DR./HIGHWAY 403 GRADE SEPARATION BOREHOLE LOCATIONS AND SOIL STRATA SOUTH OF HIGHWAY 403/HIGHWAY 407 RAMPS

Golder Associates Ltd.
MISSISSAUGA, ONTARIO, CANADA



PLAN

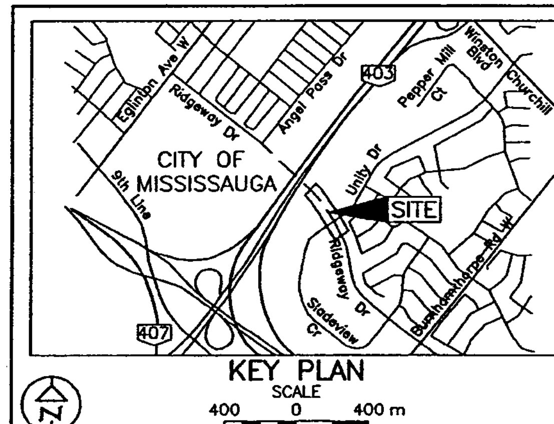
SCALE 10 0 10 20 m



PROFILE A–A' ALONG RIDGEWAY DRIVE STATION 10+075 TO STATION 10+232

SCALE HOR 10 0 10 20 m

SCALE VER 5 0 5 10 m 1:250



KEY PLAN
SCALE 400 0 400 m
1:20000

LEGEND

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

No.	ELEVATION	CO-ORDINATES NORTHING	CO-ORDINATES EASTING
BH1	180.5	4820789.2	603605.4
BH2	180.2	4820831.8	603579.3
BH3	180.2	4820871.1	603548.2
BH4	181.2	4820905.2	603511.4

NOTES

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

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.

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

REFERENCE

Base plans provided in digital format by Phillips Engineering Limited, drawing file nos. xdesign.dwg; xalign.dwg; 403xb1.dwg and xbase.dwg, received December 11, 2006. and drawing files nos. 06053–01.dwg, 06053–02.dwg and 06053–03.dwg, recieved December 14, 2006.

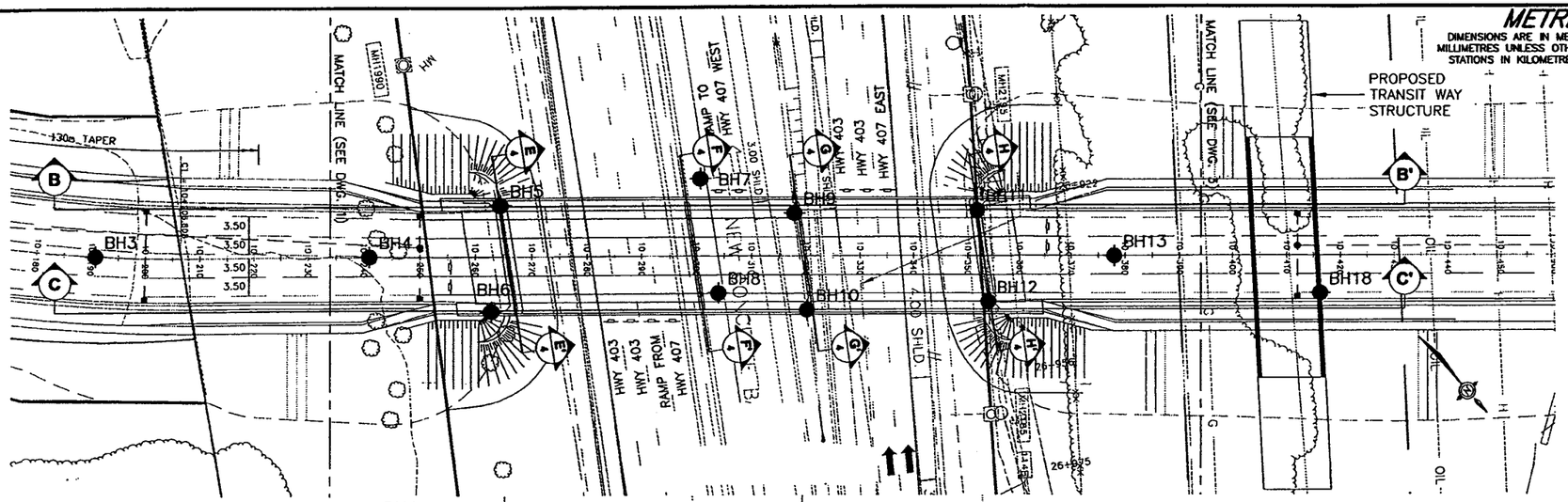
NO.	DATE	BY	REVISION

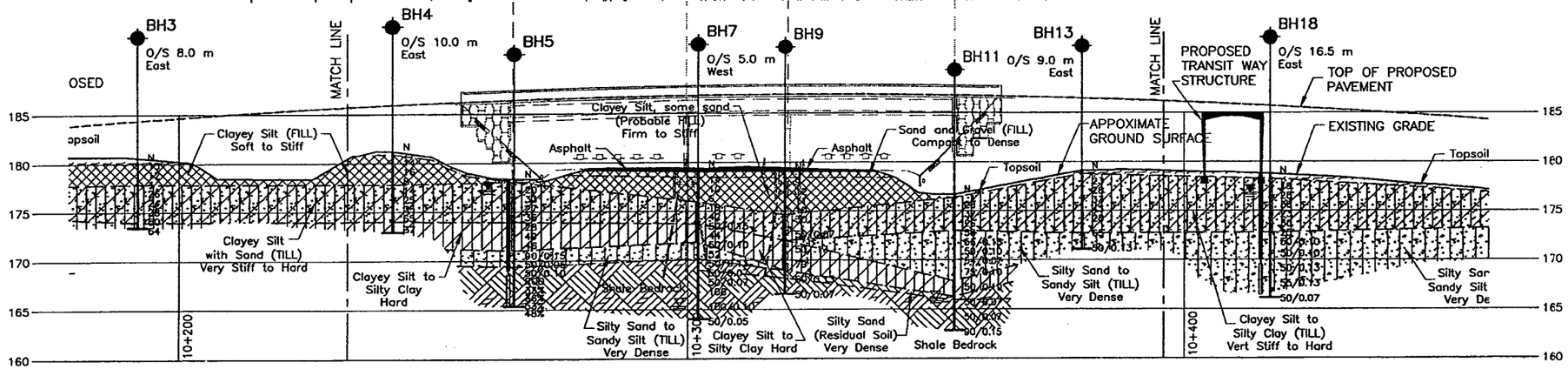
Geocres No.

HWY. RIDGEWAY DR		PROJECT NO. 06–1111–021	DIST.
SUBM'D. BML	CHKD. BML	DATE: JULY 2007	SITE:
DRAWN: JFC/MSM	CHKD. HJ	APPD. JMAC	DWG. 1

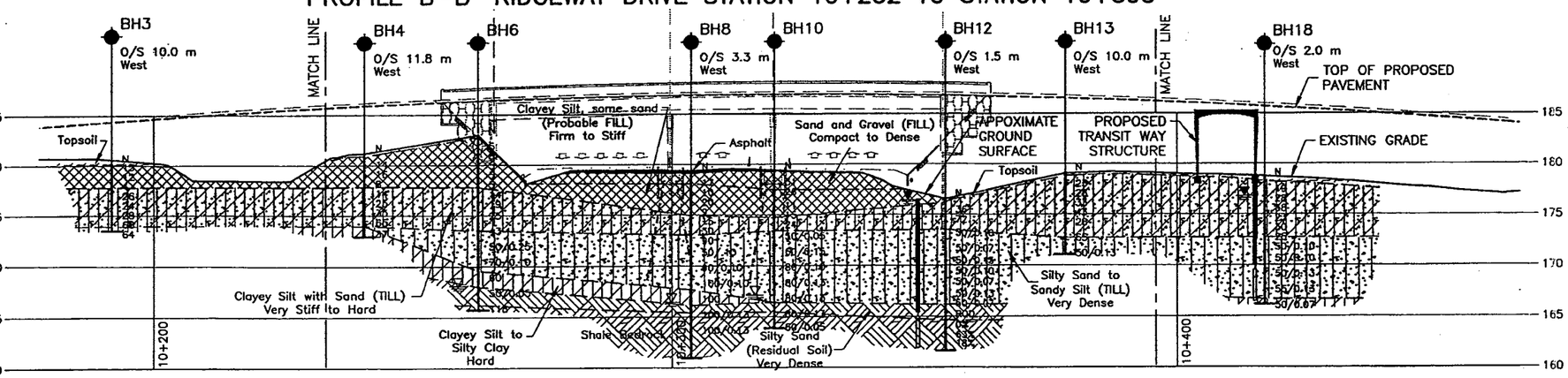
MINISTRY OF TRANSPORTATION, ONTARIO

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





PROFILE B–B' RIDGEWAY DRIVE STATION 10+232 TO STATION 10+395



PROFILE C–C' RIDGEWAY DRIVE STATION 10+232 TO STATION 10+395

SCALE
HOR 10 0 10 20 m
SCALE
VER 5 0 5 10 m
1:250

REFERENCE

Base plans provided in digital format by Philips Engineering Limited. drawing file nos. xdesign.dwg; xalign.dwg; 403xb1.dwg and xbase.dwg, received December 11, 2006. and drawing files nos. 06053–01.dwg, 06053–02.dwg and 06053–03.dwg, recieved July 10, 2007.

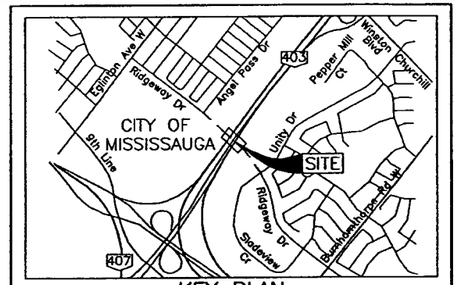
CONT No.
WP No.

SHEET

RIDGEWAY DR./HIGHWAY 403 GRADE SEPARATION
BOREHOLE LOCATIONS AND SOIL STRATA
HIGHWAY 403/HIGHWAY 407 RAMPS

Golder Associates

Golder Associates Ltd.
MISSISSAUGA, ONTARIO, CANADA



KEY PLAN
SCALE
400 0 400 m
1:20000

LEGEND

- Borehole
- Seal
- Piezometer
- N Standard Penetration Test Value
- 16 Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)
- 100% Rock Quality Designation (RQD)
- WL in piezometer on April 3, 2007
- WL upon completion of drilling

No.	ELEVATION	CO–ORDINATES	
		NORTHING	EASTING
BH3	180.2	4820871.1	603548.2
BH4	181.2	4820905.2	603511.4
BH5	178.4	4820914.0	603487.7
BH6	183.0	4820927.5	603502.1
BH7	179.3	4820934.8	603457.6
BH8	179.3	4820952.8	603469.6
BH9	179.0	4820951.1	603449.2
BH10	179.3	4820965.9	603459.5
BH11	176.7	4820973.6	603423.8
BH12	176.6	4820987.6	603433.6
BH13	179.1	4820997.5	603410.1
BH18	178.6	4821028.4	603386.5

NOTES

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

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NO.	DATE	BY	REVISION

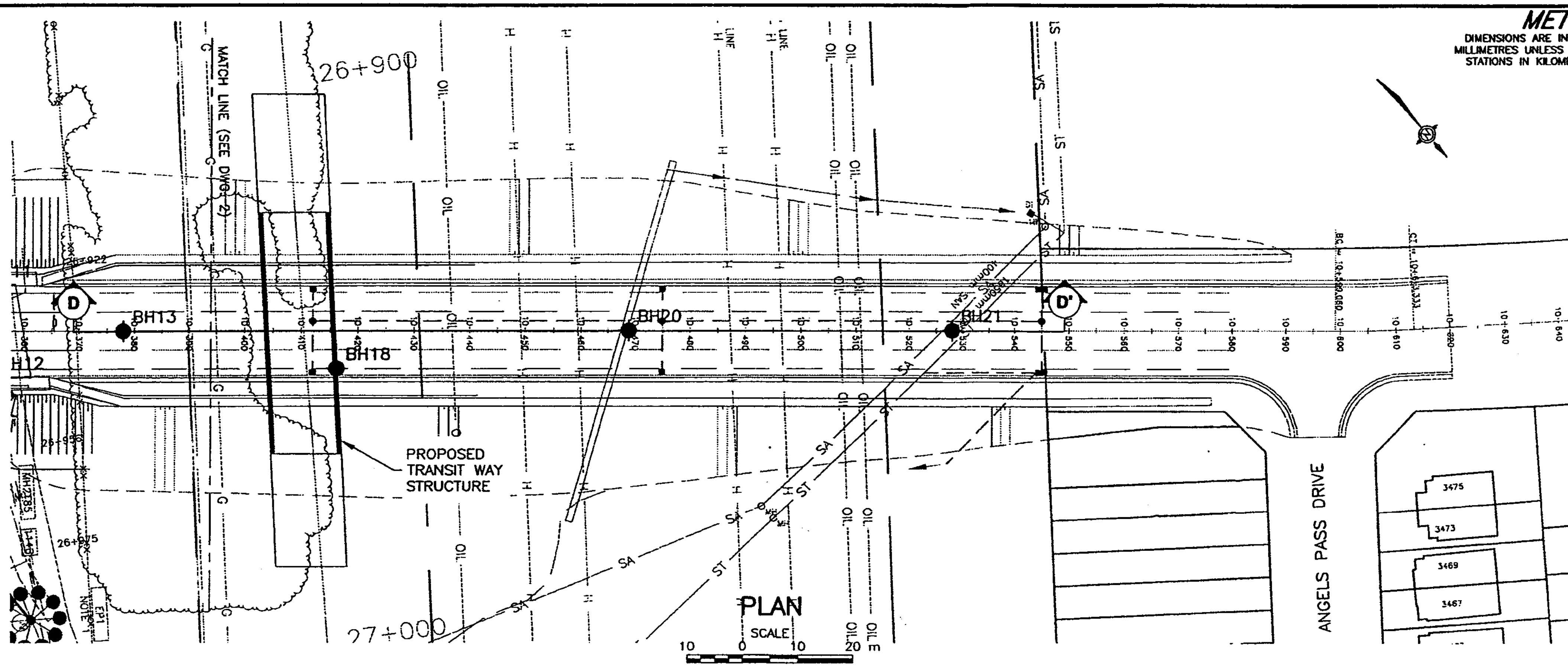
Geocres No.

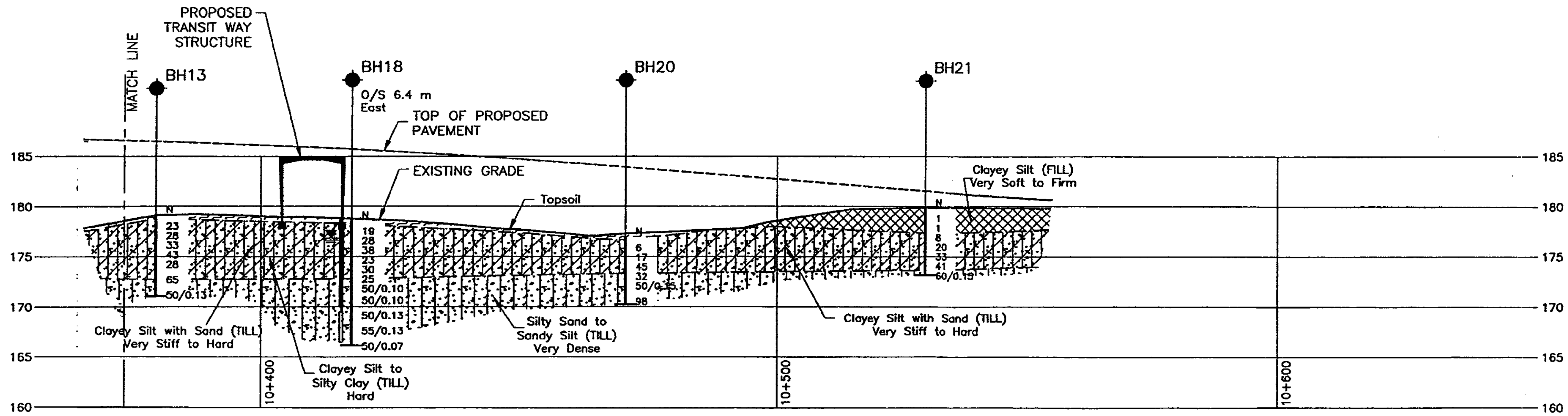
HWY. RIDGEWAY DR	PROJECT NO. 06–1111–021		DIST.
SUBM'D. BML	CHK'D. BML	DATE: JULY 2007	SITE:
DRAWN: JFC	CHK'D. HJ	APP'D. JMAC	DWG. 2

PLOT DATE: July 26, 2007
PLOTTED: T:\Projects\2006\06-1111-021 (Philips Eng, Hwy 403, Mississauga)\~JC-Ridgeway Dr Bridge\06111021A002.dwg

MINISTRY OF TRANSPORTATION, ONTARIO

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





PROFILE D–D' RIDGEWAY DRIVE STATION 10+395 TO STATION 10+555

SCALE
HOR 10 0 10 20 m

SCALE
VER 5 0 5 10 m
1:250

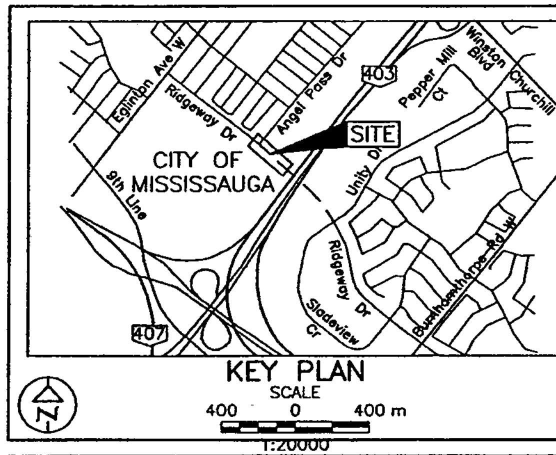
CONT No.
WP No.

SHEET

RIDGEWAY DR./HIGHWAY 403 GRADE SEPARATION
BOREHOLE LOCATIONS AND SOIL STRATA
NORTH OF HIGHWAY 403/HIGHWAY 407 RAMPS

Golder Associates

Golder Associates Ltd.
MISSISSAUGA, ONTARIO, CANADA



KEY PLAN
SCALE
400 0 400 m
1:20000

LEGEND

●	Borehole
	Seal
	Piezometer
N	Standard Penetration Test Value
16	Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)
100%	Rock Quality Designation (RQD)
▼	WL in piezometer on April 3, 2007

No.	ELEVATION	CO-ORDINATES	
		NORTHING	EASTING
BH13	179.1	4820997.5	603410.1
BH18	178.6	4821028.4	603386.5
BH20	176.9	4821058.6	603342.9
BH21	179.9	4821098.4	603299.1

NOTES

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

REFERENCE

Base plans provided in digital format by Phillips Engineering Limited, drawing file nos. xdesign.dwg; xalign.dwg; 403xb1.dwg and xbase.dwg, received December 11, 2006. and drawing files nos. 06053–01.dwg, 06053–02.dwg and 06053–03.dwg, recieved December 14, 2006.

NO.	DATE	BY	REVISION

Geocres No.

HWY. RIDGEWAY DR		PROJECT NO. 06–1111–021	DIST.
SUBM'D. BML	CHKD. BML	DATE: JULY 2007	SITE:
DRAWN: JFC	CHKD. HJ	APPD. JMAC	DWG. 3

APPENDIX C

CERTIFICATE OF ANALYSES

Your Project #: 08-1111-0010
Site#: MISSISSAUG
Site: SANITARY SEWER CROSSING
Your C.O.C. #: 80021-01

Attention: Houda Jadi
Golder Associates Ltd
Mississauga - Standing Offer
2390 Argentia Rd
Mississauga, ON
L5N 5Z7

Report Date: 2008/05/12

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: A844327
Received: 2008/05/02, 15:38

Sample Matrix: Soil
Samples Received: 5

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Method Reference
Hot Water Extractable Boron	4	2008/05/09	2008/05/12	CAM SOP-00408	EPA 3050B
Free Cyanide	4	N/A	2008/05/09	CAM SOP-00457	EPA 9012 modified
Cyanide (WAD) in Leachates	1	N/A	2008/05/08	CAM SOP-00457	SM 4500 CN-I
Conductivity	4	N/A	2008/05/08	CAM SOP-00414	APHA 2510
Chromium (VI) in Soil	4	2008/05/06	2008/05/06	CAM SOP-00420	EPA 3060A
Fluoride by ISE in Leachates	1	2008/05/08	2008/05/08	CAM SOP-00456	SM 4500FC
Mercury (TCLP Leachable) (mg/L)	1	N/A	2008/05/08	CAM SOP-00453	EPA 7470
Mercury in Soil by CVAA	3	2008/05/06	2008/05/06	CAM SOP-00453	EPA 7470
Mercury in Soil by CVAA	1	2008/05/07	2008/05/07	CAM SOP-00453	EPA 7470
Acid Extr. Metals (aqua regia) by ICPMS	3	2008/05/06	2008/05/06	CAM SOP-00447	EPA 6020
Acid Extr. Metals (aqua regia) by ICPMS	1	2008/05/07	2008/05/07	CAM SOP-00447	EPA 6020
Total Metals in TCLP Leachate by ICPMS	1	2008/05/08	2008/05/08	CAM SOP-00447	EPA 6020
Ignitability of a Sample (1)	1	2008/05/09	2008/05/09	Ont SOP-0932	EPA 1030
MOISTURE	4	N/A	2008/05/06	CAM SOP-00445	McKeague 2nd ed 1978
Nitrate(NO3) + Nitrite(NO2) in Leachate	1	N/A	2008/05/08	CAM SOP-00440	SM 4500 NO3 I
Polychlorinated Biphenyl in Leachate	1	2008/05/08	2008/05/09	CAM SOP-00307	EPA 8082
pH CaCl2 EXTRACT	4	N/A	2008/05/08	Ont SOP-0067	4500-H+B
Sodium Adsorption Ratio (SAR)	3	2008/05/03	2008/05/07	Ont SOP 0072	EPA 6010
Sodium Adsorption Ratio (SAR)	1	2008/05/03	2008/05/08	Ont SOP 0072	EPA 6010
TCLP - % Solids	1	2008/05/08	2008/05/08	CAM SOP-00401	EPA 1311 (TCLP)
TCLP - EXTRACTION FLUID	1	N/A	2008/05/08	CAM SOP-00401	EPA 1311
TCLP-INITIAL AND FINAL PH	1	N/A	2008/05/08	CAM SOP-00401	EPA 1311
TCLP Zero Headspace Extraction	1	2008/05/08	2008/05/08	CAM SOP-00430	EPA 1311
VOCs in ZHE Leachates	1	2008/05/08	2008/05/09	CAM SOP 00226	EPA 8260 modified

(1) Ignitability is not an SCC accredited test.

../2

Your Project #: 08-1111-0010
Site#: MISSISSAUG
Site: SANITARY SEWER CROSSING
Your C.O.C. #: 80021-01

Attention: Houda Jadi
Golder Associates Ltd
Mississauga - Standing Offer
2390 Argentia Rd
Mississauga, ON
L5N 5Z7

Report Date: 2008/05/12

CERTIFICATE OF ANALYSIS

Encryption Key

Please direct all questions regarding this Certificate of Analysis to your Project Manager.

KRISTEN BURMEISTER, Project Manager
Email: Kristen.Burmeister@maxxamanalytics.com
Phone# (905) 817-5700 Ext:5816

==========

Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. SCC and CAEAL have approved this reporting process and electronic report format.

For Service Group specific validation please refer to the Validation Signature Page

Total cover pages: 2

Maxxam Job #: A844327
Report Date: 2008/05/12

Golder Associates Ltd
Client Project #: 08-1111-0010
Project name: SANITARY SEWER CROSSING

O'REG 153 METALS & INORGANICS COMPLETE (SOIL)

Maxxam ID		Y42820		Y42821		
Sampling Date		2008/04/28		2008/04/28		
COC Number		80021-01		80021-01		
	Units	**BH-6/SA-5**	**QC Batch**	**BH-5/SA-7**	**RDL**	**QC Batch**
Calculated Parameters						
Sodium Adsorption Ratio	N/A	0.37	1506699	1.1	N/A	1506699
Inorganics						
Conductivity	mS/cm	0.32	1509926	0.29	0.002	1509926
Free Cyanide	ug/g	<0.01	1510493	<0.01	0.01	1510493
Moisture	%	15	1507974	18	0.2	1507974
Available (CaCl2) pH	pH	6.94	1509882	7.25		1509867
Metals						
Hot Water Ext. Boron (B)	ug/g	0.24	1510975	0.15	0.01	1510975
Chromium (VI)	ug/g	<0.2	1507736	<0.2	0.2	1507736
Acid Extractable Mercury (Hg)	ug/g	<0.05	1507999	<0.05	0.05	1507999
Acid Extractable Antimony (Sb)	ug/g	<0.2	1507995	<0.2	0.2	1507995
Acid Extractable Arsenic (As)	ug/g	4	1507995	4	1	1507995
Acid Extractable Barium (Ba)	ug/g	98	1507995	64	0.5	1507995
Acid Extractable Beryllium (Be)	ug/g	0.8	1507995	0.5	0.2	1507995
Acid Extractable Cadmium (Cd)	ug/g	0.2	1507995	0.2	0.1	1507995
Acid Extractable Chromium (Cr)	ug/g	20	1507995	18	1	1507995
Acid Extractable Cobalt (Co)	ug/g	10	1507995	11	0.1	1507995
Acid Extractable Copper (Cu)	ug/g	29	1507995	27	0.5	1507995
Acid Extractable Lead (Pb)	ug/g	13	1507995	12	1	1507995
Acid Extractable Molybdenum (Mo)	ug/g	0.5	1507995	<0.5	0.5	1507995
Acid Extractable Nickel (Ni)	ug/g	22	1507995	22	0.5	1507995
Acid Extractable Selenium (Se)	ug/g	<0.5	1507995	<0.5	0.5	1507995
Acid Extractable Silver (Ag)	ug/g	<0.2	1507995	<0.2	0.2	1507995
Acid Extractable Thallium (Tl)	ug/g	0.13	1507995	0.13	0.05	1507995
Acid Extractable Vanadium (V)	ug/g	27	1507995	27	5	1507995
Acid Extractable Zinc (Zn)	ug/g	64	1507995	59	5	1507995

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

6740 Campobello Road, Mississauga, Ontario Canada L5N 2L8 Tel: 905-817-5700 Toll free:800-563-6266 Fax: 905-817-5777

Maxxam Job #: A844327
Report Date: 2008/05/12

Golder Associates Ltd
Client Project #: 08-1111-0010
Project name: SANITARY SEWER CROSSING

O'REG 153 METALS & INORGANICS COMPLETE (SOIL)

Maxxam ID		Y42822		Y42823		
Sampling Date		2008/04/28		2008/04/28		
COC Number		80021-01		80021-01		
	Units	**BH-6/SA-8**	**QC Batch**	**BH-5/SA-3**	**RDL**	**QC Batch**
Calculated Parameters						
Sodium Adsorption Ratio	N/A	0.82	1506699	0.79	N/A	1506699
Inorganics						
Conductivity	mS/cm	0.22	1509926	0.27	0.002	1509926
Free Cyanide	ug/g	<0.01	1510493	<0.01	0.01	1510493
Moisture	%	15	1507974	11	0.2	1507974
Available (CaCl2) pH	pH	7.54	1509882	7.64		1509867
Metals						
Hot Water Ext. Boron (B)	ug/g	0.14	1510975	0.04	0.01	1510975
Chromium (VI)	ug/g	<0.2	1507736	<0.2	0.2	1507736
Acid Extractable Mercury (Hg)	ug/g	<0.05	1508726	<0.05	0.05	1507999
Acid Extractable Antimony (Sb)	ug/g	<0.2	1508723	<0.2	0.2	1507995
Acid Extractable Arsenic (As)	ug/g	4	1508723	4	1	1507995
Acid Extractable Barium (Ba)	ug/g	69	1508723	62	0.5	1507995
Acid Extractable Beryllium (Be)	ug/g	0.5	1508723	0.5	0.2	1507995
Acid Extractable Cadmium (Cd)	ug/g	<0.1	1508723	<0.1	0.1	1507995
Acid Extractable Chromium (Cr)	ug/g	17	1508723	16	1	1507995
Acid Extractable Cobalt (Co)	ug/g	9.3	1508723	12	0.1	1507995
Acid Extractable Copper (Cu)	ug/g	24	1508723	27	0.5	1507995
Acid Extractable Lead (Pb)	ug/g	9	1508723	8	1	1507995
Acid Extractable Molybdenum (Mo)	ug/g	<0.5	1508723	<0.5	0.5	1507995
Acid Extractable Nickel (Ni)	ug/g	20	1508723	23	0.5	1507995
Acid Extractable Selenium (Se)	ug/g	<0.5	1508723	<0.5	0.5	1507995
Acid Extractable Silver (Ag)	ug/g	<0.2	1508723	<0.2	0.2	1507995
Acid Extractable Thallium (Tl)	ug/g	0.11	1508723	0.10	0.05	1507995
Acid Extractable Vanadium (V)	ug/g	26	1508723	22	5	1507995
Acid Extractable Zinc (Zn)	ug/g	48	1508723	53	5	1507995

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

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Maxxam Job #: A844327
Report Date: 2008/05/12

Golder Associates Ltd
Client Project #: 08-1111-0010
Project name: SANITARY SEWER CROSSING

O'REG 558 TCLP VOLATILE ORGANICS (SOIL)

Maxxam ID		Y42819		
Sampling Date		2008/04/28		
COC Number		80021-01		
	Units	**BH-5/COMPOSITE**	**RDL**	**QC Batch**
Charge/Prep Analysis				
Amount Extracted (Wet Weight) (g)	N/A	25	N/A	1509973
Volatile Organics				
Benzene	mg/L	<0.01	0.01	1510492
Carbon Tetrachloride	mg/L	<0.01	0.01	1510492
Chlorobenzene	mg/L	<0.01	0.01	1510492
Chloroform	mg/L	<0.01	0.01	1510492
1,2-Dichlorobenzene	mg/L	<0.02	0.02	1510492
1,4-Dichlorobenzene	mg/L	<0.02	0.02	1510492
1,2-Dichloroethane	mg/L	<0.02	0.02	1510492
1,1-Dichloroethylene	mg/L	<0.01	0.01	1510492
Methylene Chloride(Dichloromethane)	mg/L	<0.05	0.05	1510492
Methyl Ethyl Ketone (2-Butanone)	mg/L	<0.5	0.5	1510492
Tetrachloroethylene	mg/L	<0.01	0.01	1510492
Trichloroethylene	mg/L	<0.01	0.01	1510492
Vinyl Chloride	mg/L	<0.02	0.02	1510492
Surrogate Recovery (%)				
4-Bromofluorobenzene	%	100		1510492
D4-1,2-Dichloroethane	%	100		1510492
D8-Toluene	%	99		1510492

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

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Maxxam Job #: A844327
Report Date: 2008/05/12

Golder Associates Ltd
Client Project #: 08-1111-0010
Project name: SANITARY SEWER CROSSING

O'REG 558 TCLP INORGANICS PACKAGE (SOIL)

Maxxam ID		Y42819		
Sampling Date		2008/04/28		
COC Number		80021-01		
	Units	**BH-5/COMPOSITE**	**RDL**	**QC Batch**
Inorganics				
Leachable Fluoride (F-)	mg/L	0.5	0.1	1509785
Leachable Free Cyanide	mg/L	<0.002	0.002	1509756
Leachable Nitrite (N)	mg/L	0.01	0.01	1509780
Leachable Nitrate (N)	mg/L	<0.1	0.1	1509780
Leachable Nitrate + Nitrite	mg/L	<0.1	0.1	1509780
Metals				
Leachable Mercury (Hg)	mg/L	<0.001	0.001	1509784
Leachable Arsenic (As)	mg/L	<0.2	0.2	1509815
Leachable Barium (Ba)	mg/L	0.6	0.2	1509815
Leachable Boron (B)	mg/L	0.2	0.1	1509815
Leachable Cadmium (Cd)	mg/L	<0.05	0.05	1509815
Leachable Chromium (Cr)	mg/L	<0.1	0.1	1509815
Leachable Lead (Pb)	mg/L	<0.1	0.1	1509815
Leachable Selenium (Se)	mg/L	<0.2	0.2	1509815
Leachable Silver (Ag)	mg/L	<0.01	0.01	1509815
Leachable Uranium (U)	mg/L	<0.01	0.01	1509815

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

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Maxxam Job #: A844327
Report Date: 2008/05/12

Golder Associates Ltd
Client Project #: 08-1111-0010
Project name: SANITARY SEWER CROSSING

O'REG 558 TCLP LEACHATE PREPARATION (SOIL)

Maxxam ID		Y42819		
Sampling Date		2008/04/28		
COC Number		80021-01		
	Units	**BH-5/COMPOSITE**	**RDL**	**QC Batch**
Inorganics				
Final pH	pH	5.52		1509744
Initial pH	pH	9.28		1509744
TCLP - % Solids	%	100	0.2	1509733
TCLP Extraction Fluid	N/A	FLUID2	N/A	1509740

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

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Maxxam Job #: A844327
Report Date: 2008/05/12

Golder Associates Ltd
Client Project #: 08-1111-0010
Project name: SANITARY SEWER CROSSING

POLYCHLORINATED BIPHENYLS BY GC-ECD (SOIL)

Maxxam ID		Y42819		
Sampling Date		2008/04/28		
COC Number		80021-01		
	Units	**BH-5/COMPOSITE**	**RDL**	**QC Batch**
PCBs				
Leachable Total PCB	ug/L	<3	3	1509971
Surrogate Recovery (%)				
Leachable 2,4,5,6-Tetrachloro-m-xylene	%	79		1509971
Leachable Decachlorobiphenyl	%	69		1509971

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

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Maxxam Job #: A844327
Report Date: 2008/05/12

Golder Associates Ltd
Client Project #: 08-1111-0010
Project name: SANITARY SEWER CROSSING

MISCELLANEOUS (SOIL)

Maxxam ID		Y42819		
Sampling Date		2008/04/28		
COC Number		80021-01		
	Units	**BH-5/COMPOSITE**	**RDL**	**QC Batch**
Inorganics				
Ignitability	mm/min.	NI		1510628

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

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Maxxam Job #: A844327
Report Date: 2008/05/12

Golder Associates Ltd
Client Project #: 08-1111-0010
Project name: SANITARY SEWER CROSSING

Package 1	9.7°C

Each temperature is the average of up to three cooler temperatures taken at receipt

GENERAL COMMENTS

Sample Y42819-01: NI = Not Ignitable

Results relate only to the items tested.

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Golder Associates Ltd
Attention: Houda Jadi
Client Project #: 08-1111-0010
P.O. #:
Project name: SANITARY SEWER CROSSING

Quality Assurance Report

Maxxam Job Number: MA844327

QA/QC Batch Num Init	QC Type	Parameter	Date Analyzed yyyy/mm/dd	Value	Recovery	Units	QC Limits
1507736 VRO	MATRIX SPIKE						
	[Y42821-01]	Chromium (VI)	2008/05/07		109	%	75 - 125
	QC STANDARD	Chromium (VI)	2008/05/07		96	%	85 - 115
	Spiked Blank	Chromium (VI)	2008/05/07		107	%	75 - 125
	Method Blank	Chromium (VI)	2008/05/07	<0.2		ug/g	
	RPD [Y42821-01]	Chromium (VI)	2008/05/07	NC		%	35
1507974 MYG	RPD	Moisture	2008/05/07	1.2		%	50
1507995 VIV	MATRIX SPIKE	Acid Extractable Antimony (Sb)	2008/05/07		97	%	75 - 125
		Acid Extractable Arsenic (As)	2008/05/07		105	%	75 - 125
		Acid Extractable Barium (Ba)	2008/05/07		NC	%	75 - 125
		Acid Extractable Beryllium (Be)	2008/05/07		99	%	75 - 125
		Acid Extractable Cadmium (Cd)	2008/05/07		102	%	75 - 125
		Acid Extractable Chromium (Cr)	2008/05/07		100	%	75 - 125
		Acid Extractable Cobalt (Co)	2008/05/07		99	%	75 - 125
		Acid Extractable Copper (Cu)	2008/05/07		99	%	75 - 125
		Acid Extractable Lead (Pb)	2008/05/07		NC (1)	%	75 - 125
		Acid Extractable Molybdenum (Mo)	2008/05/07		100	%	75 - 125
		Acid Extractable Nickel (Ni)	2008/05/07		101	%	75 - 125
		Acid Extractable Selenium (Se)	2008/05/07		104	%	75 - 125
		Acid Extractable Silver (Ag)	2008/05/07		100	%	75 - 125
		Acid Extractable Thallium (Tl)	2008/05/07		99	%	75 - 125
		Acid Extractable Vanadium (V)	2008/05/07		100	%	75 - 125
		Acid Extractable Zinc (Zn)	2008/05/07		NC	%	75 - 125
	QC STANDARD	Acid Extractable Antimony (Sb)	2008/05/07		84	%	75 - 125
		Acid Extractable Arsenic (As)	2008/05/07		112	%	75 - 125
		Acid Extractable Barium (Ba)	2008/05/07		105	%	75 - 125
		Acid Extractable Beryllium (Be)	2008/05/07		101	%	75 - 125
		Acid Extractable Cadmium (Cd)	2008/05/07		93	%	75 - 125
		Acid Extractable Chromium (Cr)	2008/05/07		101	%	75 - 125
		Acid Extractable Cobalt (Co)	2008/05/07		101	%	75 - 125
		Acid Extractable Copper (Cu)	2008/05/07		100	%	75 - 125
		Acid Extractable Lead (Pb)	2008/05/07		102	%	75 - 125
		Acid Extractable Molybdenum (Mo)	2008/05/07		93	%	75 - 125
		Acid Extractable Nickel (Ni)	2008/05/07		100	%	75 - 125
		Acid Extractable Selenium (Se)	2008/05/07		65	%	50 - 150
		Acid Extractable Silver (Ag)	2008/05/07		90	%	75 - 125
		Acid Extractable Thallium (Tl)	2008/05/07		93	%	75 - 125
		Acid Extractable Vanadium (V)	2008/05/07		109	%	75 - 125
		Acid Extractable Zinc (Zn)	2008/05/07		99	%	75 - 125
	Method Blank	Acid Extractable Antimony (Sb)	2008/05/07	<0.2		ug/g	
		Acid Extractable Arsenic (As)	2008/05/07	<1		ug/g	
		Acid Extractable Barium (Ba)	2008/05/07	<0.5		ug/g	
		Acid Extractable Beryllium (Be)	2008/05/07	<0.2		ug/g	
		Acid Extractable Cadmium (Cd)	2008/05/07	<0.1		ug/g	
		Acid Extractable Chromium (Cr)	2008/05/07	<1		ug/g	
		Acid Extractable Cobalt (Co)	2008/05/07	<0.1		ug/g	
		Acid Extractable Copper (Cu)	2008/05/07	<0.5		ug/g	
		Acid Extractable Lead (Pb)	2008/05/07	<1		ug/g	
		Acid Extractable Molybdenum (Mo)	2008/05/07	<0.5		ug/g	
		Acid Extractable Nickel (Ni)	2008/05/07	<0.5		ug/g	
		Acid Extractable Selenium (Se)	2008/05/07	<0.5		ug/g	
		Acid Extractable Silver (Ag)	2008/05/07	<0.2		ug/g	
		Acid Extractable Thallium (Tl)	2008/05/07	<0.05		ug/g	
		Acid Extractable Vanadium (V)	2008/05/07	<5		ug/g	
		Acid Extractable Zinc (Zn)	2008/05/07	<5		ug/g	

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Golder Associates Ltd
Attention: Houda Jadi
Client Project #: 08-1111-0010
P.O. #:
Project name: SANITARY SEWER CROSSING

Quality Assurance Report (Continued)

Maxxam Job Number: MA844327

QA/QC Batch Num Init	QC Type	Parameter	Date Analyzed yyyy/mm/dd	Value	Recovery	Units	QC Limits
1507995 VIV	RPD	Acid Extractable Antimony (Sb)	2008/05/07	NC		%	35
		Acid Extractable Arsenic (As)	2008/05/07	4.4		%	35
		Acid Extractable Barium (Ba)	2008/05/07	2.4		%	35
		Acid Extractable Beryllium (Be)	2008/05/07	NC		%	35
		Acid Extractable Cadmium (Cd)	2008/05/07	NC		%	35
		Acid Extractable Chromium (Cr)	2008/05/07	6.7		%	35
		Acid Extractable Cobalt (Co)	2008/05/07	6.0		%	35
		Acid Extractable Copper (Cu)	2008/05/07	6.1		%	35
		Acid Extractable Lead (Pb)	2008/05/07	4.7		%	35
		Acid Extractable Molybdenum (Mo)	2008/05/07	NC		%	35
		Acid Extractable Nickel (Ni)	2008/05/07	4.9		%	35
		Acid Extractable Selenium (Se)	2008/05/07	NC		%	35
		Acid Extractable Silver (Ag)	2008/05/07	NC		%	35
		Acid Extractable Thallium (Tl)	2008/05/07	NC		%	35
		Acid Extractable Vanadium (V)	2008/05/07	NC		%	35
		Acid Extractable Zinc (Zn)	2008/05/07	1.8		%	35
1507999 MC	MATRIX SPIKE	Acid Extractable Mercury (Hg)	2008/05/06		106	%	75 - 125
	QC STANDARD	Acid Extractable Mercury (Hg)	2008/05/06		87	%	75 - 125
	Method Blank	Acid Extractable Mercury (Hg)	2008/05/06	<0.05		ug/g	
	RPD	Acid Extractable Mercury (Hg)	2008/05/06	NC		%	35
1508723 VIV	MATRIX SPIKE [Y42822-01]						
		Acid Extractable Antimony (Sb)	2008/05/07		102	%	75 - 125
		Acid Extractable Arsenic (As)	2008/05/07		106	%	75 - 125
		Acid Extractable Barium (Ba)	2008/05/07		NC (1)	%	75 - 125
		Acid Extractable Beryllium (Be)	2008/05/07		101	%	75 - 125
		Acid Extractable Cadmium (Cd)	2008/05/07		107	%	75 - 125
		Acid Extractable Chromium (Cr)	2008/05/07		100	%	75 - 125
		Acid Extractable Cobalt (Co)	2008/05/07		96	%	75 - 125
		Acid Extractable Copper (Cu)	2008/05/07		96	%	75 - 125
		Acid Extractable Lead (Pb)	2008/05/07		98	%	75 - 125
		Acid Extractable Molybdenum (Mo)	2008/05/07		104	%	75 - 125
		Acid Extractable Nickel (Ni)	2008/05/07		97	%	75 - 125
		Acid Extractable Selenium (Se)	2008/05/07		103	%	75 - 125
		Acid Extractable Silver (Ag)	2008/05/07		104	%	75 - 125
		Acid Extractable Thallium (Tl)	2008/05/07		100	%	75 - 125
		Acid Extractable Vanadium (V)	2008/05/07		NC	%	75 - 125
		Acid Extractable Zinc (Zn)	2008/05/07		NC	%	75 - 125
	QC STANDARD	Acid Extractable Antimony (Sb)	2008/05/07		121	%	75 - 125
		Acid Extractable Arsenic (As)	2008/05/07		95	%	75 - 125
		Acid Extractable Barium (Ba)	2008/05/07		92	%	75 - 125
		Acid Extractable Beryllium (Be)	2008/05/07		90	%	75 - 125
		Acid Extractable Cadmium (Cd)	2008/05/07		97	%	75 - 125
		Acid Extractable Chromium (Cr)	2008/05/07		86	%	75 - 125
		Acid Extractable Cobalt (Co)	2008/05/07		91	%	75 - 125
		Acid Extractable Copper (Cu)	2008/05/07		95	%	75 - 125
		Acid Extractable Lead (Pb)	2008/05/07		98	%	75 - 125
		Acid Extractable Molybdenum (Mo)	2008/05/07		105	%	75 - 125
		Acid Extractable Nickel (Ni)	2008/05/07		86	%	75 - 125
		Acid Extractable Selenium (Se)	2008/05/07		73	%	50 - 150
		Acid Extractable Silver (Ag)	2008/05/07		98	%	75 - 125
		Acid Extractable Thallium (Tl)	2008/05/07		90	%	75 - 125
		Acid Extractable Vanadium (V)	2008/05/07		94	%	75 - 125
		Acid Extractable Zinc (Zn)	2008/05/07		89	%	75 - 125
	Method Blank	Acid Extractable Antimony (Sb)	2008/05/07	<0.2		ug/g	
		Acid Extractable Arsenic (As)	2008/05/07	<1		ug/g	

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QA/QC Batch Num Init	QC Type	Parameter	Date Analyzed yyyy/mm/dd	Value	Recovery	Units	QC Limits
1508723 VIV	Method Blank	Acid Extractable Barium (Ba)	2008/05/07	<0.5		ug/g	
		Acid Extractable Beryllium (Be)	2008/05/07	<0.2		ug/g	
		Acid Extractable Cadmium (Cd)	2008/05/07	<0.1		ug/g	
		Acid Extractable Chromium (Cr)	2008/05/07	<1		ug/g	
		Acid Extractable Cobalt (Co)	2008/05/07	<0.1		ug/g	
		Acid Extractable Copper (Cu)	2008/05/07	<0.5		ug/g	
		Acid Extractable Lead (Pb)	2008/05/07	<1		ug/g	
		Acid Extractable Molybdenum (Mo)	2008/05/07	<0.5		ug/g	
		Acid Extractable Nickel (Ni)	2008/05/07	<0.5		ug/g	
		Acid Extractable Selenium (Se)	2008/05/07	<0.5		ug/g	
		Acid Extractable Silver (Ag)	2008/05/07	<0.2		ug/g	
		Acid Extractable Thallium (Tl)	2008/05/07	<0.05		ug/g	
		Acid Extractable Vanadium (V)	2008/05/07	<5		ug/g	
		Acid Extractable Zinc (Zn)	2008/05/07	<5		ug/g	
	RPD [Y42822-01]	Acid Extractable Antimony (Sb)	2008/05/07	NC		%	35
		Acid Extractable Arsenic (As)	2008/05/07	NC		%	35
		Acid Extractable Barium (Ba)	2008/05/07	9.3		%	35
		Acid Extractable Beryllium (Be)	2008/05/07	NC		%	35
		Acid Extractable Cadmium (Cd)	2008/05/07	NC		%	35
		Acid Extractable Chromium (Cr)	2008/05/07	9.3		%	35
		Acid Extractable Cobalt (Co)	2008/05/07	8.4		%	35
		Acid Extractable Copper (Cu)	2008/05/07	7.9		%	35
		Acid Extractable Lead (Pb)	2008/05/07	10.1		%	35
		Acid Extractable Molybdenum (Mo)	2008/05/07	NC		%	35
		Acid Extractable Nickel (Ni)	2008/05/07	9.3		%	35
		Acid Extractable Selenium (Se)	2008/05/07	NC		%	35
		Acid Extractable Silver (Ag)	2008/05/07	NC		%	35
		Acid Extractable Thallium (Tl)	2008/05/07	NC		%	35
		Acid Extractable Vanadium (V)	2008/05/07	NC		%	35
		Acid Extractable Zinc (Zn)	2008/05/07	8.6		%	35
1508726 MC	MATRIX SPIKE [Y42822-01]	Acid Extractable Mercury (Hg)	2008/05/07		119	%	75 - 125
	QC STANDARD	Acid Extractable Mercury (Hg)	2008/05/07		112	%	75 - 125
	Method Blank	Acid Extractable Mercury (Hg)	2008/05/07	<0.05		ug/g	
	RPD [Y42822-01]	Acid Extractable Mercury (Hg)	2008/05/07	NC		%	35
1509733 LYA	RPD	TCLP - % Solids	2008/05/08	0		%	35
1509740 LYA	RPD	TCLP Extraction Fluid	2008/05/08	NC		%	35
1509756 CP	MATRIX SPIKE	Leachable Free Cyanide	2008/05/08		105	%	75 - 125
	LEACH. BLANK	Leachable Free Cyanide	2008/05/08	<0.002		mg/L	
	Spiked Blank	Leachable Free Cyanide	2008/05/08		106	%	75 - 125
	Method Blank	Leachable Free Cyanide	2008/05/08	<0.002		mg/L	
	RPD	Leachable Free Cyanide	2008/05/08	NC		%	20
1509780 CCI	MATRIX SPIKE	Leachable Nitrite (N)	2008/05/08		98	%	75 - 125
		Leachable Nitrate (N)	2008/05/08		103	%	75 - 125
	LEACH. BLANK	Leachable Nitrite (N)	2008/05/08	<0.01		mg/L	
		Leachable Nitrate (N)	2008/05/08	<0.1		mg/L	
		Leachable Nitrate + Nitrite	2008/05/08	<0.1		mg/L	
	Spiked Blank	Leachable Nitrite (N)	2008/05/08		102	%	80 - 120
		Leachable Nitrate (N)	2008/05/08		93	%	80 - 120
	Method Blank	Leachable Nitrite (N)	2008/05/08	<0.01		mg/L	
		Leachable Nitrate (N)	2008/05/08	<0.1		mg/L	
		Leachable Nitrate + Nitrite	2008/05/08	<0.1		mg/L	
	RPD	Leachable Nitrite (N)	2008/05/08	NC		%	25
		Leachable Nitrate (N)	2008/05/08	NC		%	25
		Leachable Nitrate + Nitrite	2008/05/08	NC		%	25

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QA/QC Batch Num Init	QC Type	Parameter	Date Analyzed yyyy/mm/dd	Value	Recovery	Units	QC Limits
1509784 SUK	MATRIX SPIKE	Leachable Mercury (Hg)	2008/05/08		93	%	75 - 125
	LEACH. BLANK	Leachable Mercury (Hg)	2008/05/08	<0.001		mg/L	
	Spiked Blank	Leachable Mercury (Hg)	2008/05/08		98	%	84 - 113
	Method Blank	Leachable Mercury (Hg)	2008/05/08	<0.001		mg/L	
	RPD	Leachable Mercury (Hg)	2008/05/08	NC		%	25
1509785 SAC	MATRIX SPIKE	Leachable Fluoride (F-)	2008/05/08		86	%	80 - 120
	LEACH. BLANK	Leachable Fluoride (F-)	2008/05/08	<0.1		mg/L	
	Spiked Blank	Leachable Fluoride (F-)	2008/05/08		95	%	80 - 120
	Method Blank	Leachable Fluoride (F-)	2008/05/08	<0.1		mg/L	
	RPD	Leachable Fluoride (F-)	2008/05/08	1.0		%	25
1509815 HRE	MATRIX SPIKE	Leachable Arsenic (As)	2008/05/08		98	%	75 - 125
		Leachable Barium (Ba)	2008/05/08		NC (1)	%	75 - 125
		Leachable Boron (B)	2008/05/08		88	%	75 - 125
		Leachable Cadmium (Cd)	2008/05/08		96	%	75 - 125
		Leachable Chromium (Cr)	2008/05/08		94	%	75 - 125
		Leachable Lead (Pb)	2008/05/08		94	%	75 - 125
		Leachable Selenium (Se)	2008/05/08		100	%	75 - 125
		Leachable Silver (Ag)	2008/05/08		102	%	75 - 125
		Leachable Uranium (U)	2008/05/08		97	%	75 - 125
	LEACH. BLANK	Leachable Arsenic (As)	2008/05/08	<0.2		mg/L	
		Leachable Barium (Ba)	2008/05/08	<0.2		mg/L	
		Leachable Boron (B)	2008/05/08	<0.1		mg/L	
		Leachable Cadmium (Cd)	2008/05/08	<0.05		mg/L	
		Leachable Chromium (Cr)	2008/05/08	<0.1		mg/L	
		Leachable Lead (Pb)	2008/05/08	<0.1		mg/L	
		Leachable Selenium (Se)	2008/05/08	<0.2		mg/L	
		Leachable Silver (Ag)	2008/05/08	<0.01		mg/L	
		Leachable Uranium (U)	2008/05/08	<0.01		mg/L	
	Spiked Blank	Leachable Arsenic (As)	2008/05/08		99	%	86 - 119
		Leachable Barium (Ba)	2008/05/08		95	%	83 - 115
		Leachable Boron (B)	2008/05/08		92	%	78 - 133
		Leachable Cadmium (Cd)	2008/05/08		96	%	85 - 116
		Leachable Chromium (Cr)	2008/05/08		94	%	76 - 120
		Leachable Lead (Pb)	2008/05/08		96	%	80 - 123
		Leachable Selenium (Se)	2008/05/08		96	%	82 - 118
		Leachable Silver (Ag)	2008/05/08		103	%	75 - 125
		Leachable Uranium (U)	2008/05/08		97	%	82 - 124
	Method Blank	Leachable Arsenic (As)	2008/05/08	<0.2		mg/L	
		Leachable Barium (Ba)	2008/05/08	<0.2		mg/L	
		Leachable Boron (B)	2008/05/08	<0.1		mg/L	
		Leachable Cadmium (Cd)	2008/05/08	<0.05		mg/L	
		Leachable Chromium (Cr)	2008/05/08	<0.1		mg/L	
		Leachable Lead (Pb)	2008/05/08	<0.1		mg/L	
		Leachable Selenium (Se)	2008/05/08	<0.2		mg/L	
		Leachable Silver (Ag)	2008/05/08	<0.01		mg/L	
		Leachable Uranium (U)	2008/05/08	<0.01		mg/L	
	RPD	Leachable Arsenic (As)	2008/05/08	NC		%	25
		Leachable Barium (Ba)	2008/05/08	NC		%	25
		Leachable Boron (B)	2008/05/08	NC		%	25
		Leachable Cadmium (Cd)	2008/05/08	NC		%	25
		Leachable Chromium (Cr)	2008/05/08	NC		%	25
		Leachable Lead (Pb)	2008/05/08	NC		%	25
		Leachable Selenium (Se)	2008/05/08	NC		%	25
		Leachable Silver (Ag)	2008/05/08	NC		%	25
		Leachable Uranium (U)	2008/05/08	NC		%	25

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QA/QC Batch Num Init	QC Type	Parameter	Date Analyzed yyyy/mm/dd	Value	Recovery	Units	QC Limits
1509926 PAL	QC STANDARD	Conductivity	2008/05/08		98	%	85 - 115
	Method Blank	Conductivity	2008/05/08	<0.002		mS/cm	
	RPD	Conductivity	2008/05/08	0.9		%	35
1509971 JZ	MATRIX SPIKE	Leachable 2,4,5,6-Tetrachloro-m-xylene	2008/05/09		82	%	30 - 130
		Leachable Decachlorobiphenyl	2008/05/09		78	%	30 - 130
		Leachable Total PCB	2008/05/09		86	%	40 - 130
	Spiked Blank	Leachable 2,4,5,6-Tetrachloro-m-xylene	2008/05/09		87	%	30 - 130
		Leachable Decachlorobiphenyl	2008/05/09		79	%	30 - 130
		Leachable Total PCB	2008/05/09		88	%	40 - 130
	Method Blank	Leachable 2,4,5,6-Tetrachloro-m-xylene	2008/05/09		80	%	30 - 130
		Leachable Decachlorobiphenyl	2008/05/09		70	%	30 - 130
		Leachable Total PCB	2008/05/09	<3		ug/L	
	RPD	Leachable Decachlorobiphenyl	2008/05/09	0		%	N/A
		Leachable Total PCB	2008/05/09	NC		%	40
1510492 AGE	MATRIX SPIKE	4-Bromofluorobenzene	2008/05/09		99	%	70 - 130
		D4-1,2-Dichloroethane	2008/05/09		93	%	70 - 130
		D8-Toluene	2008/05/09		102	%	70 - 130
		Benzene	2008/05/09		95	%	70 - 130
		Carbon Tetrachloride	2008/05/09		97	%	70 - 130
		Chlorobenzene	2008/05/09		96	%	70 - 130
		Chloroform	2008/05/09		95	%	70 - 130
		1,2-Dichlorobenzene	2008/05/09		99	%	70 - 130
		1,4-Dichlorobenzene	2008/05/09		103	%	70 - 130
		1,2-Dichloroethane	2008/05/09		92	%	70 - 130
		1,1-Dichloroethylene	2008/05/09		97	%	70 - 130
		Methylene Chloride(Dichloromethane)	2008/05/09		93	%	70 - 130
		Methyl Ethyl Ketone (2-Butanone)	2008/05/09		90	%	60 - 140
		Tetrachloroethylene	2008/05/09		98	%	70 - 130
		Trichloroethylene	2008/05/09		94	%	70 - 130
		Vinyl Chloride	2008/05/09		87	%	70 - 130
	Spiked Blank	4-Bromofluorobenzene	2008/05/09		98	%	70 - 130
		D4-1,2-Dichloroethane	2008/05/09		95	%	70 - 130
		D8-Toluene	2008/05/09		101	%	70 - 130
		Benzene	2008/05/09		93	%	70 - 130
		Carbon Tetrachloride	2008/05/09		95	%	70 - 130
		Chlorobenzene	2008/05/09		92	%	70 - 130
		Chloroform	2008/05/09		94	%	70 - 130
		1,2-Dichlorobenzene	2008/05/09		95	%	70 - 130
		1,4-Dichlorobenzene	2008/05/09		98	%	70 - 130
		1,2-Dichloroethane	2008/05/09		92	%	70 - 130
		1,1-Dichloroethylene	2008/05/09		95	%	70 - 130
		Methylene Chloride(Dichloromethane)	2008/05/09		93	%	70 - 130
		Methyl Ethyl Ketone (2-Butanone)	2008/05/09		89	%	60 - 140
		Tetrachloroethylene	2008/05/09		95	%	70 - 130
		Trichloroethylene	2008/05/09		92	%	70 - 130
		Vinyl Chloride	2008/05/09		86	%	70 - 130
	Method Blank	4-Bromofluorobenzene	2008/05/09		99	%	70 - 130
		D4-1,2-Dichloroethane	2008/05/09		98	%	70 - 130
		D8-Toluene	2008/05/09		98	%	70 - 130
		Benzene	2008/05/09	<0.01		mg/L	
		Carbon Tetrachloride	2008/05/09	<0.01		mg/L	
		Chlorobenzene	2008/05/09	<0.01		mg/L	
		Chloroform	2008/05/09	<0.01		mg/L	
		1,2-Dichlorobenzene	2008/05/09	<0.02		mg/L	
		1,4-Dichlorobenzene	2008/05/09	<0.02		mg/L	

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QA/QC Batch Num Init	QC Type	Parameter	Date Analyzed yyyy/mm/dd	Value	Recovery	Units	QC Limits
1510492 AGE	Method Blank	1,2-Dichloroethane	2008/05/09	<0.02		mg/L	
		1,1-Dichloroethylene	2008/05/09	<0.01		mg/L	
		Methylene Chloride(Dichloromethane)	2008/05/09	<0.05		mg/L	
		Methyl Ethyl Ketone (2-Butanone)	2008/05/09	<0.5		mg/L	
		Tetrachloroethylene	2008/05/09	<0.01		mg/L	
		Trichloroethylene	2008/05/09	<0.01		mg/L	
		Vinyl Chloride	2008/05/09	<0.02		mg/L	
	RPD	Benzene	2008/05/09	NC		%	40
		Carbon Tetrachloride	2008/05/09	NC		%	40
		Chlorobenzene	2008/05/09	NC		%	40
		Chloroform	2008/05/09	NC		%	40
		1,2-Dichlorobenzene	2008/05/09	NC		%	40
		1,4-Dichlorobenzene	2008/05/09	NC		%	40
		1,2-Dichloroethane	2008/05/09	NC		%	40
		1,1-Dichloroethylene	2008/05/09	NC		%	40
		Methylene Chloride(Dichloromethane)	2008/05/09	NC		%	40
		Methyl Ethyl Ketone (2-Butanone)	2008/05/09	NC		%	40
		Tetrachloroethylene	2008/05/09	NC		%	40
		Trichloroethylene	2008/05/09	NC		%	40
		Vinyl Chloride	2008/05/09	NC		%	40
1510493 CP	MATRIX SPIKE	Free Cyanide	2008/05/09		86	%	75 - 125
	Spiked Blank	Free Cyanide	2008/05/09		107	%	75 - 125
	Method Blank	Free Cyanide	2008/05/09	<0.01		ug/g	
	RPD	Free Cyanide	2008/05/09	NC		%	35
1510628 HVP	RPD [Y42819-01]	Ignitability	2008/05/09	NC		%	10
1510975 ADA	QC STANDARD	Hot Water Ext. Boron (B)	2008/05/12		99	%	77 - 121
	Method Blank	Hot Water Ext. Boron (B)	2008/05/12	<0.01		ug/g	

N/A = Not Applicable
NC = Non-calculable
RPD = Relative Percent Difference
QC Standard = Quality Control Standard
SPIKE = Fortified sample
(1) The recovery in the matrix spike was not calculated (NC). Because of the high concentration of this analyte in the parent sample, the relative difference between the spiked and unspiked concentrations is not sufficiently significant to permit a reliable recovery calculation.

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Validation Signature Page

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The analytical data and all QC contained in this report were reviewed and validated by the following individual(s).

CHARLES ANCKER, B.Sc., M.Sc., C.Chem, Senior Analyst

CHRISTINA NERVO, Scientific Services

Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. SCC and CAEAL have approved this reporting process and electronic report format.

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