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**FOUNDATION
INVESTIGATION AND DESIGN REPORT
APPLETON SIDEROAD (COUNTY ROAD 17)
UNDERPASS (STRUCTURE SITE 15-225)
HIGHWAY 7 TWINNING FROM 3 KM WEST OF
JINKINSON ROAD TO CARLETON PLACE
W.P. 252-99-00**

Submitted to:

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PART A

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Golder Associates

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Report No. CA9559-JUL03

1.0 INTRODUCTION

Golder Associates Ltd. (Golder Associates) has been retained by Marshall Macklin Monaghan (MMM) on behalf of the Ministry of Transportation, Ontario (MTO) to carry out foundation investigations associated with the twinning of Highway 7 from two to four lanes in West Carleton and Goulbourn Townships which are now part of the City of Ottawa, and in Beckwith Township in Lanark County. The sections of Highway 7 included in this assignment extend from Highway 417 westerly 7 km to 3 km west of Jinkinson Road (W.P. 256-99-00), and from 3 km west of Jinkinson Road westerly to Carleton Place (W.P. 251-99-00 and 252-99-00). Foundation investigation services are also required as part of this assignment for the widening of Highway 417 from the Highway 417-7 interchange easterly.

Foundation investigation services are required for the following components:

- **W.P. 256-99-00:** New structures at the Highway 417E-7W ramp and Hazeldean Road, including a high fill embankment along the Highway 417E-7W ramp, high mast light poles, and overhead signs.
- **W.P. 251-99-00 and 252-99-00:** Five new structures at Appleton Sideroad, Ashton Station Road, Dwyer Hill Road, the Trans-Canada Trail, and Lavallee Creek.
- **W.P. 458-98-00:** Widening of two existing structures (the Carp River bridge and CN Rail overpass) into the existing Highway 417 median area, a 900 m long section of high fill embankment within the Highway 417 median in the vicinity of the CN Rail overpass, and overhead signs.

This report addresses the new Appleton Sideroad (County Road 17) underpass structure.

The terms of reference for the original scope of work and Addenda 1 through 7 issued during the proposal period are outlined in the MTO's Request for Proposal (RFP) and in Golder Associates' Proposal No. P21-1301, dated July 2002. Scope changes (Scope Change No. 1) related to additional borehole investigation work at the abutments of several structures and the high fill embankment on the Highway 417E-7W ramp are outlined in Golder Associates' letters dated November 12, 2002 and November 18, 2002, respectively. Further scope changes (Scope Change No. 2) related to additional borehole investigation work associated with overhead signs, high mast light pole foundations, the high fill embankments at the Hazeldean Road site, and additional investigation work for the south abutment at the Hazeldean Road site, are outlined in Golder Associates' letter dated May 7, 2003.

2.0 SITE DESCRIPTION

The proposed Appleton Sideroad (County Road 17) underpass structure is located approximately 3.5 km east of Carleton Place in Beckwith Township, in Lanark County. It is noted that north of Highway 7, County Road 17 is called Appleton Sideroad, while south of Highway 7, County Road 17 is called Cemetery Road. The proposed underpass structure is designated as MTO's Structure Site 15-225.

The terrain in the vicinity of the site is relatively flat, with the natural ground surface varying from about Elevation 129 m to 130 m, generally declining slightly toward the north. The existing Highway 7 grade at the proposed structure location is at or slightly above Elevation 130 m, slightly above the surrounding natural grade. Ditches between 1.0 m and 1.5 m in depth are present along both sides of Highway 7.

The proposed site of the underpass structure is located about 30 m to 50 m east of the current intersection of County Road 17 and Highway 7. North of Highway 7, Appleton Sideroad will extend in-line with the alignment of the current intersection. South of Highway 7, Cemetery Road will be offset about 30 m to 50 m east of the existing alignment; removing the existing "S"-curve in the alignment of Cemetery Road, immediately south of Highway 7. An existing park-and-ride facility lies on the south side of Highway 7, in-line with Cemetery Road, and the "S" curve runs along the west side of that facility. As presently proposed, the underpass structure will be located along the northerly extension of the Cemetery Road alignment, some 30 m to 50 m east of the present intersection.

The existing lanes of Highway 7 will be maintained and will form the new westbound lanes. To the south of the existing lanes, the area of the proposed structure and the south approach is occupied by an existing park-and-ride facility and the entrance roadway to the parking lot. There is an existing retail fuel outlet in the north approach area which includes a small building, a canopy, and several fuel pumps, which will be demolished.

3.0 INVESTIGATION PROCEDURES

A subsurface investigation was carried out for the proposed Appleton Sideroad underpass structure in which a total of fourteen boreholes were drilled in two phases, first in May 2003 and then subsequently in July 2003. For the first phase, ten boreholes (Boreholes 02-801 to 02-810) were advanced at the proposed foundation elements and two boreholes (Boreholes 02-820 and 02-821) were advanced at the north and south approach embankments, respectively. For the second phase of the investigation, two additional boreholes (Boreholes 02-820A and 02-820B) were advanced at the north approach embankment, adjacent to Borehole 02-820, to carry out supplementary in situ testing and sampling in the silty clay deposit. All of the boreholes were advanced using hollow stem augers by a bombardier-mounted drill rig, supplied and operated by Marathon Drilling Ltd. of Ottawa, Ontario.

With the exception of Borehole 02-820 within the footprint of the north approach embankment, all of the boreholes for the first phase of the investigation were advanced to auger refusal which occurred at depths between 5.4 m and 6.1 m below the existing ground surface at the borehole locations; Borehole 02-820 was terminated at about 6.7 m depth without encountering auger refusal. Samples of the overburden were obtained at 0.75 m intervals of depth using 50 mm outside diameter split-spoon samplers in accordance with the Standard Penetration Test (SPT) procedure. In six of the ten boreholes advanced at the proposed foundation locations, the boreholes were advanced about 3 m into the bedrock by coring using NQ-size coring equipment. The water level in the open boreholes was observed throughout the drilling operations and a total of four piezometers were installed to monitor the groundwater level(s) at the site. For the second phase of the investigation, Borehole 02-820A included in situ vane testing in the silty clay (using a B-sized vane due to the very stiff consistency of the deposit) at approximately 0.3 m intervals to a depth of about 6.1 m. Borehole 02-820B was advanced directly (i.e., without sampling or in situ testing) to about 4.6 m depth, at which depth one relatively undisturbed 73 mm diameter Shelby tube sample of the silty clay was retrieved using a fixed-piston sampler.

The field work was supervised on a full-time basis by members of Golder Associates' staff who located the boreholes in the field, directed the drilling, sampling, and in-situ testing operations, and logged the boreholes. The soil and bedrock samples were identified in the field, placed in labelled containers and transported to Golder Associates' laboratory in Ottawa for further examination and laboratory testing. Index and classification tests consisting of water content determinations, Atterberg Limits testing and grain size distribution analyses were carried out on selected soil samples. Laboratory oedometer consolidation testing was carried out on one sample of the silty clay deposit, and also included a sustained load test to assess the secondary compression behaviour of the deposit. Three samples of the bedrock were also submitted to SGS Lakefield Research Limited of Lakefield, Ontario, for chemical ("whole rock") analysis.

The borehole locations and ground surface elevations were determined by Golder Associates relative to points staked by MMM. The borehole locations, including MTM NAD83 northing and easting coordinates, and ground surface elevations referenced to geodetic datum are summarized in the following table and are shown on Drawing 1.

<i>Borehole Number</i>	<i>Borehole Location</i>	<i>MTM NAD83 Northing (m)</i>	<i>MTM NAD83 Easting (m)</i>	<i>Ground Surface Elevation (m)</i>
02-801	North abutment	5001259.2	336943.7	129.5 m
02-802	North abutment	5001252.6	336946.0	129.3 m
02-803	Centre pier	5001225.8	336976.3	129.5 m
02-804	South abutment	5001200.5	337000.7	130.3 m
02-805	South abutment	5001196.7	337003.4	130.4 m
02-806	North abutment	5001242.9	336927.4	129.4 m
02-807	North abutment	5001238.9	336930.4	129.3 m
02-808	Centre pier	5001211.6	336959.1	129.5 m
02-809	South abutment	5001185.9	336984.5	129.8 m
02-810	South abutment	5001182.5	336987.4	129.8 m
02-820	North approach	5001260.2	336915.7	129.7 m
02-820A	North approach	5001259.5	336915.0	129.7 m
02-820B	North approach	5001258.8	336914.3	129.7 m
02-821	South approach	5001173.5	337008.2	130.1 m

4.0 SITE GEOLOGY AND STRATIGRAPHY

4.1 Regional Geological Conditions

The study area for this assignment lies within two minor physiographic regions, as delineated in *The Physiography of Southern Ontario*¹, that lie within the major physiographic region of the Ottawa-St. Lawrence Lowland. The Highway 7 area between the Highway 417-7 interchange and Carleton Place is part of the Smiths Falls Limestone Plain, while the area along Highway 417 east of the Highway 417-7 interchange is part of the Ottawa Valley Clay Plain. Most of both physiographic regions is underlain by a series of sedimentary rocks, consisting of sandstones, dolostones, limestones and shales that are, in turn, underlain by igneous and metamorphic bedrock of the Precambrian Shield. The Shield rock generally outcrops to the north of the Ottawa River, and it is also present immediately below the overburden in a localized area between the Hazeldean Fault (approximately the location of the Carp River) and the Ottawa River.

The Smiths Falls Limestone Plain is characterized by shallow overburden deposits overlying limestone bedrock of the Ottawa Formation; this formation consists of grey limestone with some shaly partings and seams.² The shallow overburden soils are typically between 1 m and 3 m in thickness and are commonly comprised of sandy to gravelly till derived from the Precambrian Shield to the north, overlain by glaciofluvial sediments that consist of layered sands and gravels. Large areas of the plain are covered with peat and muck, due to poor drainage as a consequence of the relatively flat topography and shallow depth to bedrock.¹

The Ottawa Valley Clay Plain region, present along Highway 417 from the Highway 417-7 interchange site eastward, is characterized by relatively thick deposits of sensitive marine clay, silt and silty clay that were deposited within the Champlain Sea basin. These deposits, known as the Champlain Sea clay or Leda clay, overlie relatively thin, commonly reworked glacial till and glaciofluvial deposits, that in turn overlie bedrock.¹ West of the Carp River valley along Highway 417, the upper bedrock consists of limestone of the Ottawa Formation, as described above. Within and immediately east of the Carp River valley, the upper bedrock consists of sandstones and dolostones that have been cut by igneous and metamorphic rocks, controlled by faulting in the vicinity of the Carp River.²

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.

² Belanger, J.R. "Urban Geology of Canada's National Capital Area", in *Urban Geology of Canadian Cities*, Geological Association of Canada Special Paper 42, Ed. P.F. Karrow and O.L. White, 1998.

4.2 Site Stratigraphy

As part of the subsurface investigation at this site, twelve boreholes were advanced within the limits of the foundation elements and immediate approach embankments for the proposed underpass structure. The borehole locations and ground surface elevations are shown on Drawing 1.

The detailed subsurface soil and groundwater conditions encountered in the boreholes and the results of in-situ and laboratory testing are given on the Record of Borehole sheets and Figures 1 to 8. The stratigraphic boundaries shown on the borehole records are inferred from non-continuous sampling and, therefore, represent transitions between soil types rather than exact planes of geological change. Subsoil conditions will vary between and beyond the borehole locations.

In summary, the soils encountered immediately below ground surface at this site generally consist of existing surficial fill materials associated with the existing Highway 7, park-and-ride lot and retail fuel outlet, and topsoil, overlying about 0.7 m to 1.0 m of layered clayey silt and silty clay, over an approximately 3.6 m to 4.6 m thick deposit of silty clay to clay. The upper 2 m to 3 m of this clay deposit have been weathered to a grey brown crustal zone while the underlying portions of the deposit are grey in colour. Below a depth of about 5.2 m to 6.3 m, the silty clay to clay is underlain by about 0.1 m to 0.8 m of sandy silt till. These soils are, in turn, underlain by interlayered limestone, dolomitic limestone, and sandstone bedrock that was encountered between about 5.4 m and 6.1 m depth (at about Elevation 123.2 m to 124.4 m).

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

4.2.1 Asphalt and Fill

Fill materials were encountered in all of the boreholes with the exception of Borehole 02-807. However, the variation in type and thickness of the fill materials reflects the different land uses across the site, associated with the retail fuel outlet, the existing lanes of Highway 7, and the park-and-ride lot.

In the area of the proposed north abutment, located in the landscaped area between the retail fuel outlet and the existing lanes of Highway 7, Boreholes 02-801, 02-802, and 02-806 encountered 150 mm to 300 mm of topsoil fill at ground surface. No fill material was encountered in Borehole 02-807 in that same area.

At the proposed pier, essentially within the ditch on the south side of the existing Highway 7 lanes, Boreholes 02-803 and 02-808 encountered about 0.5 m of fill material at ground surface, consisting of both topsoil fill as well as sand and gravel.

In the area of the proposed south abutment, Boreholes 02-804 and 02-805 penetrated the pavement surface in the park-and-ride lot and encountered approximately 90 mm of asphalt overlying crushed stone granular base to about 0.5 m depth, overlying about 0.7 m to 1.0 m of mixed crushed stone and silty clay fill material, with cobbles, and trace amounts of plastic and organic matter. The result of grain size distribution testing carried out on one sample of this material from Borehole 02-804 is provided on Figure 1. Two Standard Penetration Test (SPT) "N" values measured within this fill of 14 blows per 0.3 m of penetration, indicate that the fill is compact. Boreholes 02-809 and 02-810 were put down within the landscaped area to the west of the park-and-ride lot and encountered about 150 mm of topsoil fill overlying sand and gravel fill to about 0.6 m depth.

Borehole 02-821, put down within the footprint of the future south approach embankment and within the landscaped area to the south of the park-and-ride lot, encountered about 120 mm of topsoil fill overlying sand and gravel fill to about 0.9 m depth.

Borehole 02-820, put down within the footprint of the future north approach embankment and within the paved area around the pumps of the existing retail fuel outlet, encountered about 90 mm of asphalt overlying about 60 mm of crushed stone base, over about 0.7 m of sand and gravel subbase.

4.2.2 Topsoil

Topsoil was encountered in all of the boreholes put down at the proposed foundation elements (i.e., Boreholes 02-801 to 02-810). In Borehole 02-807, the topsoil layer exists at ground surface. In the remaining foundation boreholes, the topsoil layer is buried beneath the surficial fill material. Topsoil also exists beneath the fill material in Borehole 02-821 at the south approach embankment. Where present, the topsoil ranges in thickness from about 90 mm to 390 mm, averaging 220 mm.

4.2.3 Layered Clayey Silt and Silty Clay

The fill material and/or topsoil are underlain at all borehole locations by layered clayey silt and silty clay with sand seams. This deposit ranges from about 0.7 m to 1.0 m in thickness. The results of grain size distribution testing carried out on two samples of this material (from Boreholes 02-808 and 02-809) are provided on Figure 2.

Measured Standard Penetration Test (SPT) “N” values in this deposit range from 4 to 9 blows per 0.3 m of penetration. Based on past experience in this area, this range of “N” values indicates a generally very stiff consistency.

4.2.4 Silty Clay to Clay

The layered clayey silt and silty clay are underlain by a deposit of silty clay to clay which extends to depths ranging from 5.2 m to 6.3 m below ground surface (Elevation 123.5 m to 124.6 m).

The upper 2.0 m to 2.9 m of this deposit have been weathered to a grey brown crust. The results of grain size distribution testing carried out on one selected sample of this material are provided on Figure 3. Measured SPT “N” values in this portion of the deposit range from 6 to 15 blows per 0.3 m of penetration, generally decreasing with depth. The results of in situ vane testing carried out within the weathered crust in Borehole 02-820A indicate undrained shear strengths in excess of 130 kPa. These in situ test results indicate the weathered crust to have a very stiff consistency. The results of Atterberg limit testing on selected samples of the weathered crust indicate plasticity index values ranging from 28 to 33 per cent and liquid limit values ranging from 51 to 57 per cent. These results are summarized on the plasticity chart on Figure 4 and indicate this material to be a clay of high plasticity. The measured natural water content of samples of the weathered crust ranges from 33 to 42 per cent.

The silty clay to clay below the depth of weathering is grey in colour. The results of grain size distribution testing carried out on one selected sample of this material are provided on Figure 5. Measured SPT “N” values in this deposit range from 4 to 8 blows per 0.3 m of penetration. The results of in situ vane testing carried out in Borehole 02-820A indicate undrained shear strengths generally in excess of 130 kPa, with one measured value of about 115 kPa. These results indicate the grey silty clay to clay deposit to have a generally very stiff consistency. The results of Atterberg limit testing on selected samples indicate plasticity index values ranging from 23 to 31 per cent and liquid limit values ranging from 45 to 53 per cent. These results are summarized on the plasticity chart on Figure 6 and indicate this material to be of intermediate to high plasticity. The measured natural water contents of samples of the grey silty clay to clay range from 29 to 41 per cent.

Oedometer consolidation testing was carried out on one thin-walled Shelby tube sample of the deposit. The results of that testing are provided on Figure 7 and are summarized in the table below.

Borehole/ Sample Number	Sample Depth/Elev. (m)	Unit Weight (kN/m ³)	σ_p' (kPa)	σ_{vo}' (kPa)	Cc	Cr	e _o	OCR	Cv (cm ² /s)
02-820B / 1	5.0 / 124.7	19.4	700	40	0.37	0.012	0.79	18	0.01

NOTES:

- σ_p' - Apparent preconsolidation pressure
- σ_{vo}' - Computed existing vertical effective stress
- Cc - Compression index
- Cr - Recompression index
- e_o - Initial void ratio
- OCR - Overconsolidation ratio
- Cv - Coefficient of consolidation

Following completion of this test, another specimen was taken from the same Shelby tube sample and loaded to a stress of 280 kPa (the approximate estimated average final stress level for the deposit) in the oedometer consolidation test machine. That stress level was maintained for a period of approximately 20 days, well past the end of primary consolidation, to assess the secondary compression behaviour of the sample. The results of that testing are summarized on Figure 7c and indicate a secondary compression index value of 0.0038

4.2.5 Silty Sand Till to Sandy Silt Till

The silty clay deposit is underlain by glacial till, which ranges in thickness from 0.1 m to 0.8 m at those locations where the deposit was fully penetrated and/or before auger refusal was encountered. The results of grain size distribution carried out on one sample of the glacial till matrix recovered from Borehole 02-808 are provided on Figure 8. From these results as well as observations of the drilling resistance, the glacial till is considered to consist of a heterogeneous mixture of gravel, cobbles, and boulders in a matrix of silty sand to sandy silt with a trace of clay.

Due to the limited thickness of this deposit, only limited standard penetration testing could be carried out before sampler refusal was encountered on the bedrock surface. However three measured SPT "N" values of between 17 and 25 blows and one measurement of 58 blows per 0.3 m of penetration indicate the deposit to be compact to very dense, although the one higher SPT "N" value may reflect the presence of cobbles in the deposit, rather than the state of packing of the matrix.

The base of this till deposit was encountered between about Elevations 123.2 m and 124.5 m in the boreholes (at depths below ground surface ranging from 5.4 to 6.1 m), except in Borehole 02-820 which was terminated in the till at about 6.7 m depth.

4.2.6 Limestone and Dolomitic Limestone Bedrock

Interlayered limestone and dolomitic limestone bedrock, locally containing a bed of sandstone bedrock, underlies the till deposit at this site. In the boreholes put down at the proposed bridge foundations, the surface of the bedrock was encountered between Elevation 123.2 m and 124.2 m. The following table summarizes the bedrock surface depth and elevation as encountered at the borehole locations. It should be noted that bedrock was cored in six of the boreholes; the surface of the limestone bedrock was inferred in the six remaining boreholes by refusal to auger advance.

<i>Borehole Location</i>	<i>Borehole Number</i>	<i>Ground Surface Elevation</i>	<i>Depth to Bedrock</i>	<i>Bedrock Surface Elevation</i>
North approach	02-820	129.7 m	Bedrock surface not encountered	
North abutment	02-801	129.5 m	5.7 m	123.8 m (Cored)
	02-802	129.3 m	6.1 m	123.2 m
	02-806	129.4 m	5.6 m	123.8 m
	02-807	129.3 m	5.4 m	123.9 m (Cored)
Centre pier	02-803	129.5 m	6.1 m	123.4 m (Cored)
	02-808	129.5 m	6.0 m	123.5 m (Cored)
South abutment	02-804	130.3 m	6.1 m	124.2 m (Cored)
	02-805	130.4 m	6.1 m	124.3 m
	02-809	129.8 m	5.6 m	124.2 m
	02-810	129.8 m	5.6 m	124.2 m (Cored)
South approach	02-821	130.1 m	5.7 m	124.4 m

Overall, the natural bedrock sequence is inferred to consist of dolomitic limestone bedrock overlying a layer of sandstone (about 120 mm to 600 mm thick), overlying limestone and dolomitic limestone. Using the sandstone layer as a marker bed, (absent from the boreholes at the south abutment, present at the bedrock surface at the centre pier, and located beneath the upper limestone layer at the north abutment) the stratigraphic sequence is inferred to be dipping to the north.

Three samples of bedrock core from borehole 02-801 were submitted to SGS Lakefield Research Limited of Lakefield, Ontario, for chemical ("whole rock") analysis. The results of that testing are provided in Appendix A, with the sample designations, sample depths, and SiO₂ contents being as follows:

<i>Sample Identification</i>	<i>Depth Interval (m)</i>	<i>Description</i>	<i>SiO₂ Content</i>
02-801A	6.4 – 6.6	Upper dolomitic limestone	61.6 %
02-801B	7.5 – 7.7	Sandstone	75.9 %
02-801C	8.3 – 8.4	Lower domomitic limestone	3.1 %

The results indicate relatively high silica contents (from the measured SiO₂ contents) for both the upper dolomitic limestone as well as the sandstone layer.

The interlayered limestone and dolomitic limestone bedrock at the site is a member of the Rockcliffe Formation; it is generally medium strong and thinly- to medium-bedded. Rock Quality Designation (RQD) values measured on recovered bedrock core samples typically ranged from 32 to 92 per cent, although isolated intervals were observed to have RQD values of 0 per cent. The discontinuities observed in the rock core are typically horizontal to sub-horizontal, associated with the bedding planes, although some vertical to sub-vertical jointing was also observed. A description of some of the terms used in the description of the bedrock samples from this site is provided on the *Lithological and Geotechnical Rock Description Terminology* sheet which precedes the Record of Borehole sheets included with this report.

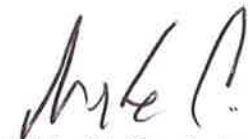
4.3 Groundwater Conditions

Four piezometers were installed within the overburden soil deposits at this site. The water levels measured in the piezometers ranged from about Elevation 129.2 m to 128.7 m, generally declining from north to south, as summarized in the following table:


Borehole No.	Borehole Location	June 6, 2003		Aug. 1, 2003	
		Depth	Elevation	Depth	Elev.
02-801	North abutment	0.3 m	129.2 m	0.3 m	129.2 m
02-803	Centre pier	0.4 m	129.1 m	0.5 m	129.0 m
02-809	South abutment	0.6 m	129.2 m	1.0 m	128.8 m
02-821	South approach	1.0 m	129.1 m	1.4 m	128.7 m

It should be noted that groundwater levels are expected to fluctuate seasonally and are expected to rise during wet periods of the year.

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LIST OF ABBREVIATIONS

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

I. SAMPLE TYPE

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

III. SOIL DESCRIPTION

(a) Cohesionless Soils

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

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.)

(b) Cohesive Soils

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

Dynamic Cone Penetration Resistance; N_d :

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

PH: Sampler advanced by hydraulic pressure

PM: Sampler advanced by manual pressure

WH: Sampler advanced by static weight of hammer

WR: Sampler advanced by weight of sampler and rod

Piezo-Cone Penetration Test (CPT)

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

IV. SOIL TESTS

w	water content
w _p	plastic limit
w _l	liquid limit
C	consolidation (oedometer) test
CHEM	chemical analysis (refer to text)
CID	consolidated isotropically drained triaxial test ¹
CIU	consolidated isotropically undrained triaxial test with porewater pressure measurement ¹
D _R	relative density (specific gravity, G _s)
DS	direct shear test
M	sieve analysis for particle size
MH	combined sieve and hydrometer (H) analysis
MPC	Modified Proctor compaction test
SPC	Standard Proctor compaction test
OC	organic content test
SO ₄	concentration of water-soluble sulphates
UC	unconfined compression test
UU	unconsolidated undrained triaxial test
V	field vane (LV-laboratory vane test)
γ	unit weight

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

LIST OF SYMBOLS

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

I. General

π	3.1416
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

(a) Index Properties (continued)

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

(b) Hydraulic Properties

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

(c) Consolidation (one-dimensional)

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

(d) Shear Strength

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

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

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	



PROJECT 021-1155-8		RECORD OF BOREHOLE No 02-801		1 OF 2		METRIC						
W.P. 252-99-00		LOCATION N 5001259.2, E 336943.7		ORIGINATED BY D.J.S.								
DIST _____ HWY 7		BOREHOLE TYPE CME 55 Bombardier, 108 mm I.D. Hollow Stem Augers		COMPILED BY S.L.								
DATUM Geodetic		DATE May 27, 2003		CHECKED BY M.I.C.								
SOIL PROFILE			SAMPLES		DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT		UNIT WEIGHT		REMARKS & GRAIN SIZE DISTRIBUTION	
ELEV	DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	20 40 60 80 100	25 50 75	γ	GR SA SI CL
129.5	0.0	Ground Surface										
129.2	0.3	Sandy topsoil, trace gravel (FILL)										
129.0	0.6	Grey brown Topsoil										
128.1	1.4	Layered Clayey Silt and Silty Clay, with sand seams Very stiff Grey brown Wet		1	SS	8		125				
126.0	3.5	Clay (Weathered Crust) Very stiff Grey brown Wet		2	SS	6		126				
				3	SS	9		127				
				4	SS	7		128				
				5	SS	4		129				
				6	SS	5		130				
123.9	5.7	Silty Clay to Clay Very Stiff Grey Wet		7	SS	8/0.23		131				
122.0	7.7	Sandy Silt, some gravel and clay (Till) Loose Grey Wet						132				
121.8		DOLOMITIC LIMESTONE (BEDROCK) Fresh Medium strong Thinly to medium bedded Grey						133				
120.5	9.0	SANDSTONE (BEDROCK) Fresh Medium strong Thinly bedded Grey green LIMESTONE AND DOLOMITIC LIMESTONE (BEDROCK) with sandy intervals Fresh Medium strong Thinly to medium bedded Grey						134				
		Bedrock cored between 5.7m and 9.0m depth For Bedrock coring details refer to Record of Drillhole 02-801						135				

Continued Next Page

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

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

PROJECT: 021-1155-5050

RECORD OF DRILLHOLE: 02-801

SHEET 1 OF 1

LOCATION: N 5001259.2 ; E 336943.7

DRILLING DATE: May 27, 2003



DATUM: Geodetic

INCLINATION: -90° AZIMUTH: --

DRILL RIG: CME 55 Bombardier

DRILLING CONTRACTOR: Marathon Drilling

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	CORRELATION CHART																		NOTES WATER LEVELS INSTRUMENTATION		
				ELEV. DEPTH (m)	RUN No.	PENETRATION RATE (mm/min)	FLUSH % RETURN	FR/FX-FRACTURE F-FAULT				SM-SMOOTH				FL-FLEXURED				BC-BROKEN CORE				
								CL-CLEAVAGE		J-JOINT		R-ROUGH		UE-UNEVEN		MB-MECH. BREAK		B-BEDDING						
								SH-SHEAR		P-POLISHED		ST-STEPPED		W-WAVY										
								VN-VEIN		S-SLICKENSIDED		PL-PLANAR		C-CURVED										
RECOVERY		R.O.D. %		FRACT INDEX PER 0.3		DISCONTINUITY DATA		HYDRAULIC CONDUCTIVITY		DIAMETRAL POINT LOAD INDEX (MPa)														
TOTAL CORE %		SOLID CORE %				TYPE AND SURFACE DESCRIPTION		K _f cm/sec																
3 3 3 3		3 3 3 3		3 3 3 3		5 2 2 2		10 ⁻⁶ 10 ⁻⁵ 10 ⁻⁴ 10 ⁻³		4 4 4 4														

6	Rotary Drill NQ Core	DOLOMITIC LIMESTONE (BEDROCK) Fresh Medium strong Thinly to medium bedded Grey		123.75 5.73	8	100														
7					9	100														
8		SANDSTONE (BEDROCK) Fresh Medium strong Thinly bedded Grey green LIMESTONE and DOLOMITIC LIMESTONE (BEDROCK) with sandy intervals Fresh Medium strong Thinly to medium bedded Grey		122.04 7.47 121.80 7.68	10	100														
9		End of Borehole		120.44 8.99																
10																				
11																				
12																				
13																				
14																				
15																				

MISS. ROCK 021-1155-8 ROCK.GPJ GLDR_CAN.GDT 18/8/04

DEPTH SCALE

1 : 50



LOGGED: D.J.S.

CHECKED: *lll*



PROJECT 021-1155-8				RECORD OF BOREHOLE No 02-802				1 OF 1		METRIC			
W.P. 252-99-00				LOCATION N 5001252.6 E 336946.0				ORIGINATED BY D.J.S.					
DIST _____ HWY 7				BOREHOLE TYPE CME 55 Bombardier, 108 mm I.D. Hollow Stem Augers				COMPILED BY S.L.					
DATUM Geodetic				DATE May 28, 2003				CHECKED BY M.I.C.					
SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			'N' VALUES	SHEAR STRENGTH kPa					
							20 40 60 80 100	20 40 60 80 100	25 50 75				
129.3	Ground Surface												
0.0	Sandy Topsoil, trace gravel (Fill)												
129.0	Topsoil												
128.8													
0.6	Layered Clayey Silt to Silty Clay, with sand seams												
128.1	Very stiff		1	SS	4								
1.2	Clay (Weathered Crust)												
	Very stiff		2	SS	6								
	Gray brown												
	Wet												
			3	SS	9								
			4	SS	7								
125.2			5	SS	5								
4.1	Silty Clay to Clay												
	Very stiff		6	SS	5								
	Gray												
	Wet												
124.0													
5.3	Sandy Silt, some gravel and clay, occasional sand seam (Till)		7	SS	25								
	Compact												
	Gray												
	Wet												
123.2													
6.1	End of Borehole												
	Auger Refusal												

MISS_MTO 021-1155-8.GPJ ON_MOT.GDT 18/04

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

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



RECORD OF BOREHOLE No 02-803										2 OF 2		METRIC	
PROJECT 021-1155-8			LOCATION N 5001225.8 ; E 336976.3			ORIGINATED BY D.J.S.							
W.P. 252-99-00			BOREHOLE TYPE CME 55 Bombardier, 108 mm I.D. Hollow Stem Augers			COMPILED BY S.L.							
DIST _____ HWY 7			DATE May 22, 2003			CHECKED BY M.I.C.							
DATUM Geodetic													
SOIL PROFILE		SAMPLES				DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT		UNIT WEIGHT		REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	20 40 60 80 100	W _p W W _L	25 50 75	γ	GR SA SI CL	
--- CONTINUED FROM PREVIOUS PAGE ---													
	End of Borehole												
	Note: Water Level in piezometer at 0.6 m depth (Elev. 128.9 m) on August 1, 2003												
	* Split-spoon bouncing after 50 blows												

MISS_MTO 021-1155-8 GRJ ON MOT GDT 18/8/04

PROJECT: 021-1155-5050

RECORD OF DRILLHOLE: 02-803

SHEET 1 OF 1

LOCATION: N 5001225.8 ; E 336976.3

DRILLING DATE: May 22, 2003

DATUM: Geodetic

INCLINATION: -90°

AZIMUTH: ---

DRILL RIG: CME 55 Bombardier

DRILLING CONTRACTOR: Marathon Drilling

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN NO.	PENETRATION RATE (m/min)	FLUSH % RETURN	FR/FX-FRACTURE-FAULT				SM-SMOOTH		FL-FLEXURED		BC-BROKEN CORL		DIAMETRAL POINT LOAD INDEX (MPa)	NOTES WATER LEVELS INSTRUMENTATION
								CL-CLEAVAGE		J-JOINT		R-ROUGH		UE-UNEVEN		MB-MECH. BREAK			
								SH-SHEAR		P-POLISHED		ST-STEPPED		W-WAVY		B-BEDDING			
								VN-VEIN		S-SLICKENSIDED		PL-PLANAR		C-CURVED					
								RECOVERY		R.Q.D. %	FRACT. INDEX PER 0.3	DISCONTINUITY DATA		HYDRAULIC CONDUCTIVITY					
TOTAL CORE %		SOLID CORE %		TYPE AND SURFACE DESCRIPTION		K _f cm/sec													
				123.38 6.10															
		SANDSTONE (BEDROCK) Fresh Medium strong Thinly to medium bedded Grey green		122.84 6.64	9		100												
7		LIMESTONE and DOLOMITIC LIMESTONE (BEDROCK) with sandy intervals Fresh Medium strong Thinly to medium bedded Grey																	
8	Rotary Drilling NQ Core				10		100												
9																			
10		End of Borehole		119.60 9.89															
11																			
12																			
13																			
14																			
15																			
16																			

MISS ROCK 021-1155-8 ROCK GPJ GLDR CAN GDT 18/8/04

DEPTH SCALE

1 : 50



LOGGED: D.J.S.

CHECKED: *W*



PROJECT 021-1155-8				RECORD OF BOREHOLE No 02-804				1 OF 1		METRIC	
W.P. 252-99-00		LOCATION N 5001200.5 ; E 337000.7		ORIGINATED BY D.J.S.							
DIST HWY 7		BOREHOLE TYPE CME 55 Bombardier, 108 mm I.D. Hollow Stem Augers		COMPILED BY S.L.							
DATUM Geodetic		DATE May 26, 2003		CHECKED BY M.I.C.							
SOIL PROFILE		SAMPLES		DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT		UNIT WEIGHT		REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	*N VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	20 40 60 80 100	W _p W W _L	γ	GR SA SI CL
130.3	Ground Surface										
0.0	Asphalt										
0.1	Crushed stone (FILL)										
	Grey										
129.8	Crushed stone and silty clay, occ. sand and gravel pockets (FILL)										
0.5	Compact										
	Brown and grey brown										
	Moist										
129.1	Topsoil		1	SS	14						33 43 18 6
1.2											
128.7	Layered Silty Clay and Clayey Silt with some sand seams		2	SS	8						
1.6	Very stiff										
	Grey brown										
	Moist to wet										
128.0	Clay (Weathered Crust)		3	SS	7						
2.3	Very stiff										
	Grey brown										
			4	SS	9						
			5	SS	9						
			6	SS	8						
			7	SS	8						
124.8	Silty Clay to Clay										
124.3	Very stiff										
	Grey										
6.1	Wet										
	Sandy Silt (Till)										
	Grey										
	LIMESTONE and DOLOMITIC LIMESTONE (BEDROCK) with sandy intervals										
	Fresh										
	Medium strong										
	Thinly to medium bedded										
	Grey										
	Bedrock cored between 6.1m and 9.5m depth										
	For Bedrock coring details refer to Record of Drillhole 02-804										
120.9	End of Borehole										
9.5											

MISS_MTC 021-1155-8.GPJ ON_MOT.GDT 18/8/04

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

PROJECT: 021-1155-5050

RECORD OF DRILLHOLE: 02-804

SHEET 1 OF 1

LOCATION: N 5001200.5 ; E 337000.7

DRILLING DATE: May 26, 2003

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: CME 55 Bombardier

DRILLING CONTRACTOR: Marathon Drilling

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	CORING LOG																NOTES WATER LEVELS INSTRUMENTATION																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																												
				ELEV. DEPTH (m)	RUN No. PENETRATION RATE (mm/min)	COLOR RETURN	FVF-FRACTURE FAULT				SM-SMOOTH				FL-FLEXURED				BC-BROKEN CORE																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																													
							CL-CLEAVAGE	J-JOINT	R-ROUGH	UE-UNEVEN	MB-MECH. BREAK	B-BEDDING	SH-SHEAR	P-POLISHED	ST-STEPPED	W-WAVY	C-CURVED	S-SLICKENSIDED	PL-PLANAR		C-CURVED																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																											
RECOVERY		R.Q.D. %	FRACT. INDEX PER 0.3	DISCONTINUITY DATA				HYDRAULIC CONDUCTIVITY K, cm/sec																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
TOTAL CORE %	SOLID CORE %			TYPE AND SURFACE DESCRIPTION																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																												
8	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100

DEPTH SCALE

1 : 50



LOGGED: D.J.S.

CHECKED: *ll*

MISS. ROCK 021-1155-8 ROCK GRJ GLDR CAN GDT 18/8/04



PROJECT 021-1155-8				RECORD OF BOREHOLE No 02-805				1 OF 1		METRIC		
W.P. 252-99-00		LOCATION N 5001196.7 ; E 337003.4		ORIGINATED BY D.J.S.								
DIST _____ HWY 7		BOREHOLE TYPE CME 55 Bombardier, 108 mm I.D. Hollow Stem Augers		COMPILED BY S.L.								
DATUM Geodetic		DATE May 26, 2003		CHECKED BY M.I.C.								
SOIL PROFILE		SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	NUMBER	TYPE			'N' VALUES	20 40 60 80 100					
130.4	Ground Surface											
0.1	Asphalt											
0.1	Crushed stone (FILL)											
0.1	Grey											
129.9	Crushed stone and silty clay, trace cobbles, plastic and organic matter (FILL)											
0.5	Compact	1	SS	14								
	Brown and grey											
	Moist											
128.9	Topsoil											
128.7	Layered Clayey Silt and Silty Clay with sand seams	2	SS	8								
1.7	Very stiff											
	Grey											
	Very Moist											
128.0	Clay (Weathered Crust)	3	SS	8								
2.4	Very stiff											
	Grey brown											
	Wet											
		4	SS	10								
		5	SS	7								
125.5	Silty Clay to Clay	6	SS	6								
4.9	Very stiff											
	Grey											
	Wet											
		7	SS	7								
124.4	Sandy Silt (Fill)											
6.1	Grey											
	End of Borehole											
	Auger Refusal											
Note: Water Level in open hole at 1.5m depth (Elev. 128.9 m) on May 26, 2003												

MISS_MTO 021-1155-5.GPJ ON MOT.GDT 18/8/04



PROJECT 021-1155-8				RECORD OF BOREHOLE No 02-806				1 OF 1		METRIC					
W.P. 252-99-00		LOCATION N 5001242.9 ; E 336927.4		ORIGINATED BY D.J.S.				COMPILED BY S.L.							
DIST _____ HWY 7		BOREHOLE TYPE CME 55 Bombardier, 108 mm I.D. Hollow Stem Augers		CHECKED BY M.I.C.											
DATUM Geodetic		DATE May 27, 2003													
SOIL PROFILE		SAMPLES		GROUND WATER CONDITIONS		ELEVATION SCALE		DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT		UNIT WEIGHT		REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	*N* VALUES										
129.4	Ground Surface														
0.0	Sand, some gravel and topsoil (FILL)														
0.2	Dark brown Silty Clay Topsoil														
129.0	Layered Silty Clay and Clayey Silt with sand seams Very stiff Grey brown Wet														
0.4															
128.2	Clay (Weathered Crust) Very stiff Grey brown Wet		1	SS	8										
1.2															
			2	SS	9										
			3	SS	10										
			4	SS	6										
125.9	Silty Clay to Clay Very stiff Grey Wet														
3.5															
			5	SS	5										
			6	SS	8										
124.1	Sandy Silt, some gravel and clay (Till)														
5.3			7	SS	14/0.3*										
123.8	Compact Grey Wet														
5.6	End of Borehole Auger Refusal														
	Note: * Split-spoon bouncing after 14 blows														

MISS_MTO 021-1155-8.GPJ ON MOT.GDT 18/8/04



PROJECT		RECORD OF BOREHOLE		No 02-807		1 OF 1		METRIC											
W.P. 252-99-00		LOCATION		N 5001238.9 ; E 336930.4		ORIGINATED BY		D.J.S.											
DIST		HWY 7		BOREHOLE TYPE		CME 55 Bombardier, 108 mm I.D. Hollow Stem Augers		COMPILED BY		S.L.									
DATUM		Geodetic		DATE		May 27, 2003		CHECKED BY		M.I.C.									
SOIL PROFILE		SAMPLES		GROUND WATER CONDITIONS		ELEVATION SCALE		DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT		NATURAL MOISTURE CONTENT		LIQUID LIMIT		UNIT WEIGHT		REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	20 40 60 80 100	20 40 60 80 100	25 50 75	W _p	W	W _L	γ	GR	SA	SI	CL	
129.3	Ground Surface																		
0.0	Topsoil																		
129.1	Layered Clayey Silt and Silty Clay, occ. sand seams																		
0.2	Very stiff																		
	Grey brown																		
	Wet																		
128.2	Clay (Weathered Crust)		1	SS	8														
1.1	Very stiff																		
	Grey brown																		
	Wet																		
			2	SS	10														
			3	SS	10														
126.0	Silty Clay to Clay		4	SS	8														
3.4	Stiff																		
	Grey																		
	Wet																		
			5	SS	6														
			6	SS	5														
124.1	Sandy Silt, some gravel and clay		7	SS	15/0.08														
123.9	(Till)																		
5.4	Compact																		
	Grey																		
	Wet																		
	DOLOMITIC LIMESTONE (BEDROCK)																		
	Fresh																		
	Medium strong																		
	Thinly to medium bedded																		
	Dark grey																		
122.4	SANDSTONE (BEDROCK)																		
7.0	Fresh																		
	Medium strong																		
	Medium bedded																		
	Grey green																		
	LIMESTONE and DOLOMITIC LIMESTONE (BEDROCK) with sandy intervals																		
	Fresh																		
	Medium strong																		
	Thinly to medium bedded																		
	Grey																		
120.4	Bedrock cored between 5.4m and 8.9m depth																		
8.9	For Bedrock coring details refer to Record of Drilling 02-807																		
	End of Borehole																		
	Note: * Split-spoon bouncing after 15 blows																		

MISS_MTO 021-1155-8.GPJ ON_MOT.GDT 18/8/04

PROJECT: 021-1155-5050

RECORD OF DRILLHOLE: 02-807

SHEET 1 OF 1

LOCATION: N 5001238.9 ; E 336930.4

DRILLING DATE: May 27, 2003

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: CME 55 Bombardier

DRILLING CONTRACTOR: Marathon Drilling

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV.	RUN No.	PENETRATION RATE (mm/min)	COLOR % RETURN	F/FX-FRACTURE-F-FAULT				SM-SMOOTH		FL-FLEXURED		BC-BROKEN CORE		DIAMETRAL POINT LOAD INDEX (MPa)	NOTES WATER LEVELS INSTRUMENTATION	
				DEPTH (m)				CL-CLEAVAGE		J-JOINT		R-ROUGH		UE-UNEVEN		MB-MECH. BREAK				
								SH-SHEAR		P-POLISHED		ST-STEPPED		W-WAVY		B-BEDDING				
								VN-VEIN		S-SLICED		PL-PLANAR		C-CURVED						
		RECOVERY		R.Q.D. %		FRACT. INDEX PER 0.3		DISCONTINUITY DATA		HYDRAULIC CONDUCTIVITY K, cm/sec										
		TOTAL CORE %		SOLID CORE %				DIP w.r.t. CORE AXIS		TYPE AND SURFACE DESCRIPTION										
		100		100		100		0 90 180				10 ⁻⁵ 10 ⁻⁴ 10 ⁻³								
6	Rotary Drill NO Core	DOLOMITIC LIMESTONE (BEDROCK) Fresh Medium strong Thinly to medium bedded Dark grey		123.91																
				5.43																
				8		100														
7	Rotary Drill NO Core	SANDSTONE (BEDROCK) Fresh Medium strong Medium bedded Grey green		122.42																
				8.92																
				7.04																
8	Rotary Drill NO Core	LIMESTONE and DOLOMITIC LIMESTONE (BEDROCK) with sandy intervals Fresh Medium strong Thinly to medium bedded Grey																		
9		End of Borehole		120.44																
				8.90																
10																				
11																				
12																				
13																				
14																				
15																				

MISS. ROCK 021-1155-8 ROCK.GPJ GLDF. CAN.GDT 18/8/04

DEPTH SCALE

1 : 50



LOGGED: D.J.S.

CHECKED: *ll*



PROJECT		RECORD OF BOREHOLE		No 02-808		1 OF 1		METRIC						
W.P.		LOCATION		ORIGINATED BY		COMPILED BY		CHECKED BY						
DIST		BOREHOLE TYPE		CME 55 Bombardier, 108 mm I.D. Hollow Stem Augers		S.L.		M.I.C.						
DATUM		DATE		May 22, 2003										
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT			REMARKS & GRAIN SIZE DISTRIBUTION (%)					
ELEV	DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	N-VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	20 40 60 80 100	PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT	GR SA SI CL
129.5	0.0	Ground Surface												
129.0	0.2	Topsoil (FILL)												
129.0	0.2	Sand and gravel, occ. cobble (FILL)												
129.0	0.6	Topsoil												
127.9	1.6	Layered Clayey Silt and Silty Clay, with sand seams Very stiff Grey brown Moist to wet		1	SS	5		129						0 28 59 13
127.9	1.6	Clay (Weathered Crust) Very stiff Grey brown Wet		2	SS	12		120						
				3	SS	7		127						
				4	SS	7		126						
125.5	4.0	Silty Clay to Clay Very stiff Grey Wet		5	SS	6		125						
				6	SS	6								
124.2	5.3	Silty Sand, some gravel and clay (Till) Compact Grey Wet		7	SS	19		124						18 38 32 12
123.5	6.0	SANDSTONE (BEDROCK) Fresh Medium strong Thinly to medium bedded Grey green						123						
122.9	6.6	LIMESTONE and DOLOMITIC LIMESTONE (BEDROCK) with sandy intervals Fresh Medium strong Thinly to medium bedded Grey						122						
		Bedrock cored between 6.0 m and 9.3 m depth For Bedrock coring details refer to Record of Drillhole 02-808						121						
120.2	9.3	End of Borehole												

MISS_MTO 021-1155-8.GPJ ON MOT.GDT 18/8/04

PROJECT: 021-1155-5050

RECORD OF DRILLHOLE: 02-808

SHEET 1 OF 1

LOCATION: N 5001211.6 ; E 336959.1

DRILLING DATE: May 22, 2003

DATUM: Geodetic

INCLINATION: -90°

AZIMUTH: ---

DRILL RIG: CME 55 Bombardier

DRILLING CONTRACTOR: Marathon Drilling

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	PENETRATION RATE (mm/min)	FLUSH % RETURN	FVF/FX-FRACTURE-FAULT				SM-SMOOTH		FL-FLEXURED		BC-BROKEN CORE		DIAMETRAL POINT LOAD INDEX (MPa)	NOTES WATER LEVELS INSTRUMENTATION
								CL-CLEAVAGE	J-JOINT	R-ROUGH	UE-UNEVEN	MB-MECH. BREAK	B-BEDDING						
								SH-SHEAR	P-POLISHED	ST-STEPPED	W-WAVY								
								VN-VEIN	S-SLICKEY	SIDED	PL-PLANAR	C-CURVED							
RECOVERY								R.O.D. %	FRACT INDEX PER 0.3	DISCONTINUITY DATA		HYDRAULIC CONDUCTIVITY							
TOTAL CORE %	SOLID CORE %	TYPE AND SURFACE DESCRIPTION		K _f cm/sec															
								8888	8888	8888	8888	8888	8888	8888	8888	8888	8888	8888	
6	Rotary Drill NQ Core	SANDSTONE (BEDROCK) Fresh Medium strong Thinly to medium bedded Grey		123.47 6.00															
		LIMESTONE and DOLOMITIC LIMESTONE (BEDROCK) with sandy intervals Fresh Medium strong Thinly to medium bedded Grey		122.89 6.58	8	100													
7																			
8					9	100													
9		End of Borehole		120.20 9.27	10	100													
10																			
11																			
12																			
13																			
14																			
15																			
16																			

MISS. ROCK 021-1155-8 ROCK GRU GLDR CAN GDT 18/04

DEPTH SCALE

1 : 50



LOGGED: D.J.S.

CHECKED: *lll*

PROJECT <u>021-1155-8</u>				RECORD OF BOREHOLE No 02-809				1 OF 1		METRIC			
W.P. <u>252-99-00</u>		LOCATION <u>N 5001185.9 ; E 336984.5</u>				ORIGINATED BY <u>D.J.S.</u>							
DIST <u>HWY 7</u>		BOREHOLE TYPE <u>CME 55 Bombardier, 108 mm I.D. Hollow Stem Augers</u>				COMPILED BY <u>S.L.</u>							
DATUM <u>Geodetic</u>		DATE <u>May 23, 2003</u>				CHECKED BY <u>M.I.C.</u>							
SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE		DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT LIMIT		UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE		"N" VALUES	20 40 60 80 100	20 40 60 80 100	W _p W W _L	25 50 75			
129.8	Ground Surface												
0.0	Topsoil (FILL)												
0.2	Sand and Gravel, occ. cobble, trace silt (FILL)												
129.2	Brown												
129.2	Topsoil												
0.8	Layered Clayey Silt and Silty Clay with sand seams		1	SS	7								0 20 64 16
128.1	Very stiff												
1.7	Grey brown		2	SS	12								
128.1	Moist												
128.1	Clay (Weathered Crust)		3	SS	12								
1.7	Very stiff												
128.1	Grey brown		4	SS	7								
128.1	Wet												
125.5			5	SS	7								
4.3	Silty Clay to Clay												
125.5	Very stiff												
4.3	Grey		6	SS	7								0 2 45 53
124.4	Wet												
124.4	Sandy Silt, some gravel and clay (Till)		7	SS	17/0.28								
124.2	Loose												
5.6	Grey												
124.2	Wet												
124.2	End of Borehole												
5.6	Auger Refusal												
<p>Note: Water Level in piezometer at 1.02 m depth (Elev. 128.8 m) on August 1, 2003</p> <p>* Split-spoon bouncing after 17 blows</p>													

MISS_MTO 021-1155-8.GPJ ON_MOT.GDT 18/8/04

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



RECORD OF BOREHOLE No 02-810

1 OF 1

METRIC

PROJECT 021-1155-8

W.P. 252-99-00

LOCATION N 5001182.5 ; E 336987.4

ORIGINATED BY D.J.S.

DIST HWY 7

BOREHOLE TYPE CME 55 Bombardier, 108 mm I.D. Hollow Stem Augers

COMPILED BY S.L.

DATUM Geodetic

DATE May 23, 2003

CHECKED BY M.I.C.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	*N VALUES			SHEAR STRENGTH kPa				W _p	W	W _L		
129.8	Ground Surface							20	40	60	80	100				
0.0	Topsoil (Fill)															
0.2	Sand and Gravel, some silt, occ. cobble															
129.2	Brown (Fill)															
129.0	Topsoil															
0.9	Layered Clayey Silt and Silty Clay, with fine sand seams		1	SS	9		128									
	Very stiff															
	Grey brown															
	Moist															
128.1	Clay (Weathered Crust)		2	SS	15		128									
1.7	Very stiff															
	Grey brown															
	Wet															
			3	SS	12		127									
			4	SS	9		126									
125.8	Silty Clay to Clay		5	SS	7		125									
4.0	Very stiff															
	Grey															
	Wet															
			6	SS	6		125									
124.4	Sandy Silt, some gravel and clay		7	SS	26/0.23		124									
124.2	(Till)															
5.6	Compact															
	Grey															
	Wet															
	LIMESTONE and DOLOMITIC LIMESTONE (BEDROCK) with sandy intervals															
	Fresh															
	Medium strong															
	Thinly to medium bedded															
	Grey to dark grey															
	Bedrock cored between 5.6 m and 9.0 m depth															
	For Bedrock coring details refer to Record of Drillhole 02-810															
120.8	End of Borehole						121									
9.0																
	Note: * Split-spoon bouncing after 26 blows															

MISS_MTO_021-1155-8.GPJ CNL_MOT_GDT_18/0/04

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

PROJECT: 021-1155-5050

RECORD OF DRILLHOLE: 02-810

SHEET 1 OF 1

LOCATION: N 5001182.5 ;E 336987.4

DRILLING DATE: May 23, 2003

DATUM: Geodetic

INCLINATION: -90°

AZIMUTH: ---

DRILL RIG: CME 55 Bombardier

DRILLING CONTRACTOR: Marathon Drilling

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV.	RUN No.	FVF-FRACTURE F-FAULT										SM-SMOOTH		FL-FLEXURED		BC-BROKEN CORE		DIAMETRAL POINT LOAD INDEX (MPa)	NOTES WATER LEVELS INSTRUMENTATION
				DEPTH (m)	PENETRATION RATE (mm/min)	FLUSH	COLOUR % RETURN	CL-CLEAVAGE		J-JOINT		R-ROUGH		UE-UNEVEN		MB-MECH. BREAK		HYDRAULIC CONDUCTIVITY K _h cm/sec					
								TOTAL CORE %	SOLID CORE %	R.Q.D. %	FRACT. INDEX PER 0.3	DISCONTINUITY DATA											
												DIP w.r.t. CORE AXIS	TYPE AND SURFACE DESCRIPTION										
														VN-VEIN	S-SLICKENSIDED	PL-PLANAR	C-CURVED						
6	Rotary Drill NQ Core	LIMESTONE and DOLOMITIC LIMESTONE (BEDROCK) with sandy intervals Fresh Medium strong Thinly to medium bedded Grey to dark grey		124.19 5.58																			
				8	100																		
7					9	100																	
8					10	100																	
9		End of Borehole		120.81 8.96																			
10																							
11																							
12																							
13																							
14																							
15																							



PROJECT 021-1155-8				RECORD OF BOREHOLE No 02-820				1 OF 1		METRIC					
W.P. 252-99-00		LOCATION N 5001260.2 E 336915.7		ORIGINATED BY D.J.S.											
DIST _____ HWY 7		BOREHOLE TYPE CME 55 Bombardier, 108 mm I.D. Hollow Stem Augers		COMPILED BY S.L.											
DATUM Geodetic		DATE May 28, 2003		CHECKED BY M.I.C.											
SOIL PROFILE		SAMPLES		GROUND WATER CONDITIONS		ELEVATION SCALE		DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT		UNIT WEIGHT		REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES										
129.7	Ground Surface														
0.0	Asphalt														
0.2	Crushed Stone (FILL)														
	Gray Sand and Gravel (FILL)														
	Brown														
128.8	Layered Clayey Silt and Silty Clay with sand seams		1	SS	6										
0.9	Very stiff														
	Gray brown														
	Moist to wet														
128.0	Clay (Weathered Crust)		2	SS	10										
1.7	Very stiff														
	Gray brown														
	Wet														
			3	SS	11										
			4	SS	6										
125.9	Silty Clay to Clay		5	SS	4										
3.8	Very stiff														
	Gray														
	Wet														
			6	SS	5										
			7	SS	5										
123.5	Sandy Silt, some gravel and clay (Till)		8	SS	58										
6.3	Very dense														
	Gray														
123.0	Wet														
6.7	End of Borehole														

MISS_MTO 021-1155-8.GPJ ON MOT.GDT 18/9/04

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

PROJECT 021-1155-8				RECORD OF BOREHOLE No 02-820A				1 OF 1		METRIC	
W.P. 252-99-00		LOCATION N 5001259.5 ; E 336915.0		ORIGINATED BY P.A.H.							
DIST HWY 7		BOREHOLE TYPE CME 55 Bombardier, 108 mm I.D. Hollow Stem Augers		COMPILED BY P.M.							
DATUM Geodetic		DATE July 21, 2003		CHECKED BY M.I.C.							
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC NATURAL LIQUID UNIT WEIGHT REMARKS & GRAIN SIZE DISTRIBUTION		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	*N* VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	SHEAR STRENGTH kPa	WATER CONTENT (%)	γ	GR SA SI CL
129.7	Ground Surface										
0.1	Asphalt										
0.2	Crushed Stone (FILL)										
	Gray Sand and Gravel (FILL)										
	Brown										
128.8	Layered Clayey Silt and Silty Clay with sand seams										
0.9	Very stiff										
	Gray brown										
	Moist to wet										
128.0	Clay (Weathered Crust)										
1.7	Very stiff										
	Gray brown										
	Wet										
125.9	Silty Clay to Clay										
3.8	Very stiff										
	Gray										
	Wet										
123.8	End of Borehole										
6.1	Notes:										
	1. >>> Indicates shear strength greater than 130 KPa										
	2. Water level in open hole at 2.0 m depth during drilling										

MISS MTO 021-1155-8 GPJ ON MOT.GDT 19/8/04

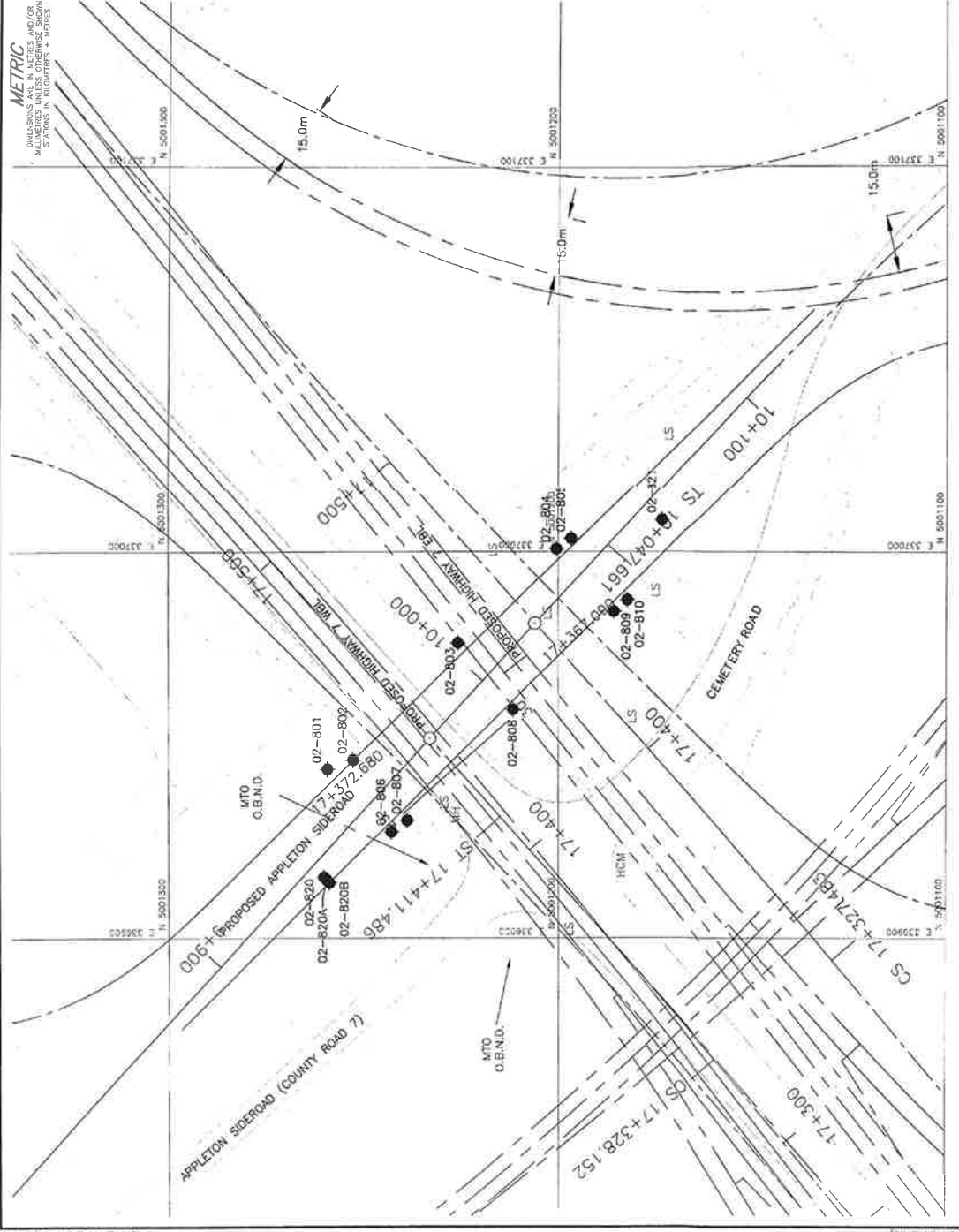
PROJECT 021-1155-8				RECORD OF BOREHOLE No 02-820B				1 OF 1		METRIC					
W.P. 252-99-00		LOCATION N 5001258.8; E 336914.3		ORIGINATED BY P.A.H.											
DIST HWY 7		BOREHOLE TYPE CME 55 Bombardier, 108 mm I.D. Hollow Stem Augers		COMPILED BY P.M.											
DATUM Geodetic		DATE July 21, 2003		CHECKED BY M.I.C.											
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT			UNIT WEIGHT		REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	*N* VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	20 40 60 80 100	20 40 60 80 100	25 50 75	W _p W W _L	γ	GR SA SI CL		
129.7	Ground Surface														
0.0	Asphalt														
0.2	Crushed Stone (FILL)														
	Gray Sand and Gravel (FILL)														
	Brown														
128.8	Layered Clayey Silt and Silty Clay with sand seams						129								
0.9	Very stiff														
	Grey brown														
	Moist to wet														
128.0	Clay (Weathered Crust)						120								
1.7	Very stiff														
	Grey brown														
	Wet														
125.9	Silty Clay to Clay						127								
3.8	Very stiff														
	Grey														
	Wet														
124.7	End of Borehole		1	TP	PH		125					19.4			
5.0															

MISS_MTO 021-1155-8.GPJ ON_MOT.GDT 19/8/04



PROJECT 021-1155-8				RECORD OF BOREHOLE No 02-821				1 OF 1		METRIC		
W.P. 252-99-00		LOCATION N 5001173.5; E 337008.2		ORIGINATED BY D.J.S.								
DIST _____ HWY 7		BOREHOLE TYPE CME 55 Bombardier, 108 mm I.D. Hollow Stem Augers		COMPILED BY S.L.								
DATUM Geodetic		DATE May 26, 2003		CHECKED BY M.L.C.								
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC NATURAL LIQUID UNIT WEIGHT REMARKS & GRAIN SIZE DISTRIBUTION			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	20 40 60 80 100	W _p W W _L	WATER CONTENT (%)	γ	GR SA SI CL
130.1	Ground Surface						130					
0.0	Topsoil (Fill)											
0.1	Sand and gravel, occ. cobble (FILL)											
	Loose											
	Brown											
	Moist											
129.2	Topsoil											
0.9	Dark brown		1	SS	6		125					
128.9	Moist											
1.2	Layered Clayey Silt and Silty Clay, with sand seams											
	Very stiff											
	Grey brown		2	SS	8		125					
128.3	Moist to wet											
1.8	Clay (Weathered Crust)											
	Very stiff											
	Grey brown											
	Wet											
			3	SS	10							
			4	SS	8		127					
126.0	Silty Clay to Clay		5	SS	7		120					
4.1	Very stiff											
	Grey											
	Wet											
			6	SS	6		125					
124.6	Sandy Silt, some clay and gravel		7	SS	20/0.23							
124.4	(Till)											
5.7	Compact											
	Grey											
	Wet											
	End of Borehole											
	Auger Refusal											
	Note: Water Level in piezometer at 1.45 m depth (Elev. 128.6 m) on August 1, 2003											
	* Split-spoon bouncing after 20 blows											

MISS_MTO 021-1155-8.GPJ ON MOT GDT 18/8/04



CONT No.
WP No. 251-99-00

SHEET
HIGHWAY 7 TWINNING
APPLETON SIDEROAD
BOREHOLE LOCATIONS

Golder Associates Ltd.
GOLDER ASSOCIATES LTD.
WATERLOO, ONTARIO, CANADA



LEGEND
Borehole - Current Investigation

No	ELEVATION	CO-ORDINATES	
		NORTHING	EASTING
02-801	125.5	5001759.2	339943.7
02-802	125.3	5001252.6	339946.0
02-803	125.5	5001225.8	339975.3
02-804	125.3	5001225.8	339975.3
02-805	130.4	5001196.7	337003.4
02-806	128.4	5001747.8	339927.4
02-807	128.4	5001747.8	339927.4
02-808	128.4	5001747.8	339927.4
02-809	128.8	5001185.9	339945.5
02-810	129.8	5001185.9	339945.5
02-811	129.8	5001185.9	339945.5
02-812	129.7	5001185.9	339945.5
02-820A	129.7	5001259.5	339915.0
02-820B	129.7	5001259.5	339915.0
02-821	130.1	5001743.5	337008.2

NOTES
The contractor shall provide the necessary support for this project and shall ensure that all borehole data is recorded in the appropriate format and that all data is entered into the database in the appropriate format. The contractor shall ensure that all data is entered into the database in the appropriate format. The contractor shall ensure that all data is entered into the database in the appropriate format.

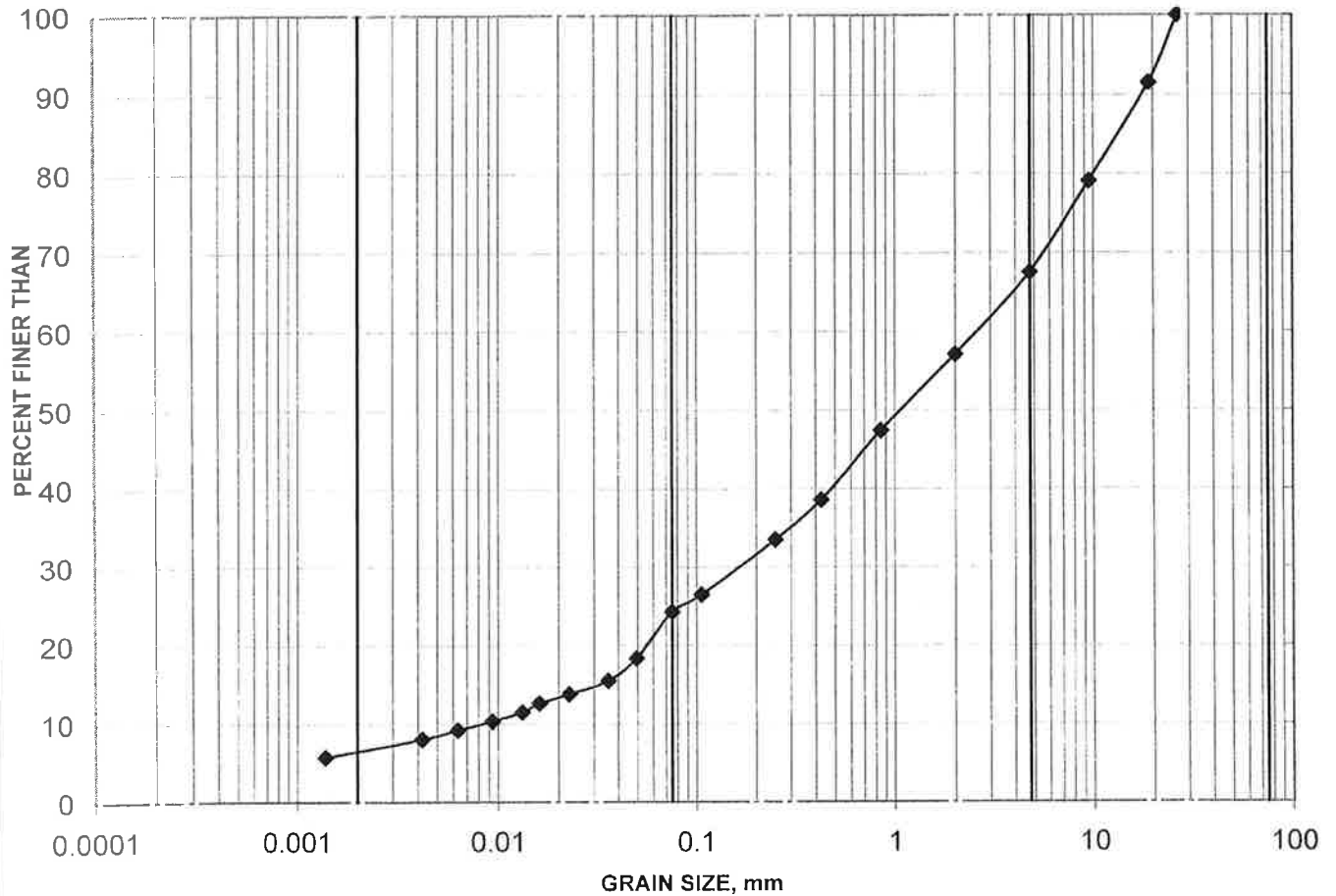
NO	DATE	BY	REVISION
1	2004	MC	ISSUED FOR CONSTRUCTION

PROJECT NO. 023-1155
DATE: AUG. 2004
SHEET: 15-275
DRAWN: JOR
CHECKED: MC
IN CHARGE: MC



GRAIN SIZE DISTRIBUTION TEST RESULT Fill

FIGURE 1



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

Borehole	Sample	Depth (m)
—◆— 02-804	1	0.8-1.4

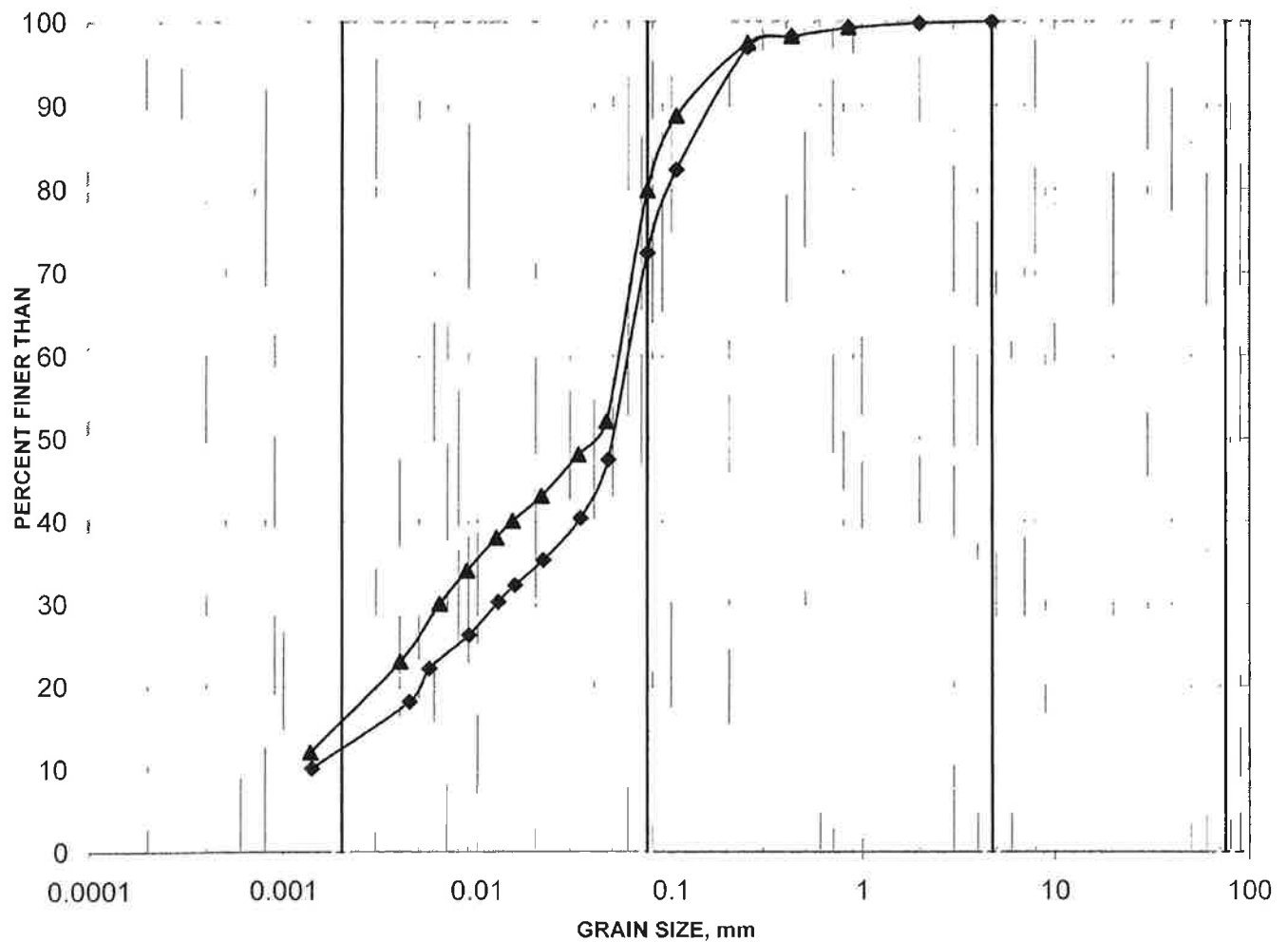
Project: 021-1155

Golder Associates

GRAIN SIZE DISTRIBUTION TEST RESULTS

Layered Clayey Silt and Silty Clay

FIGURE 2



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

Borehole	Sample	Depth (m)
—◆— 02-808	1	0.8-1.4
—▲— 02-809	1	0.8-1.4

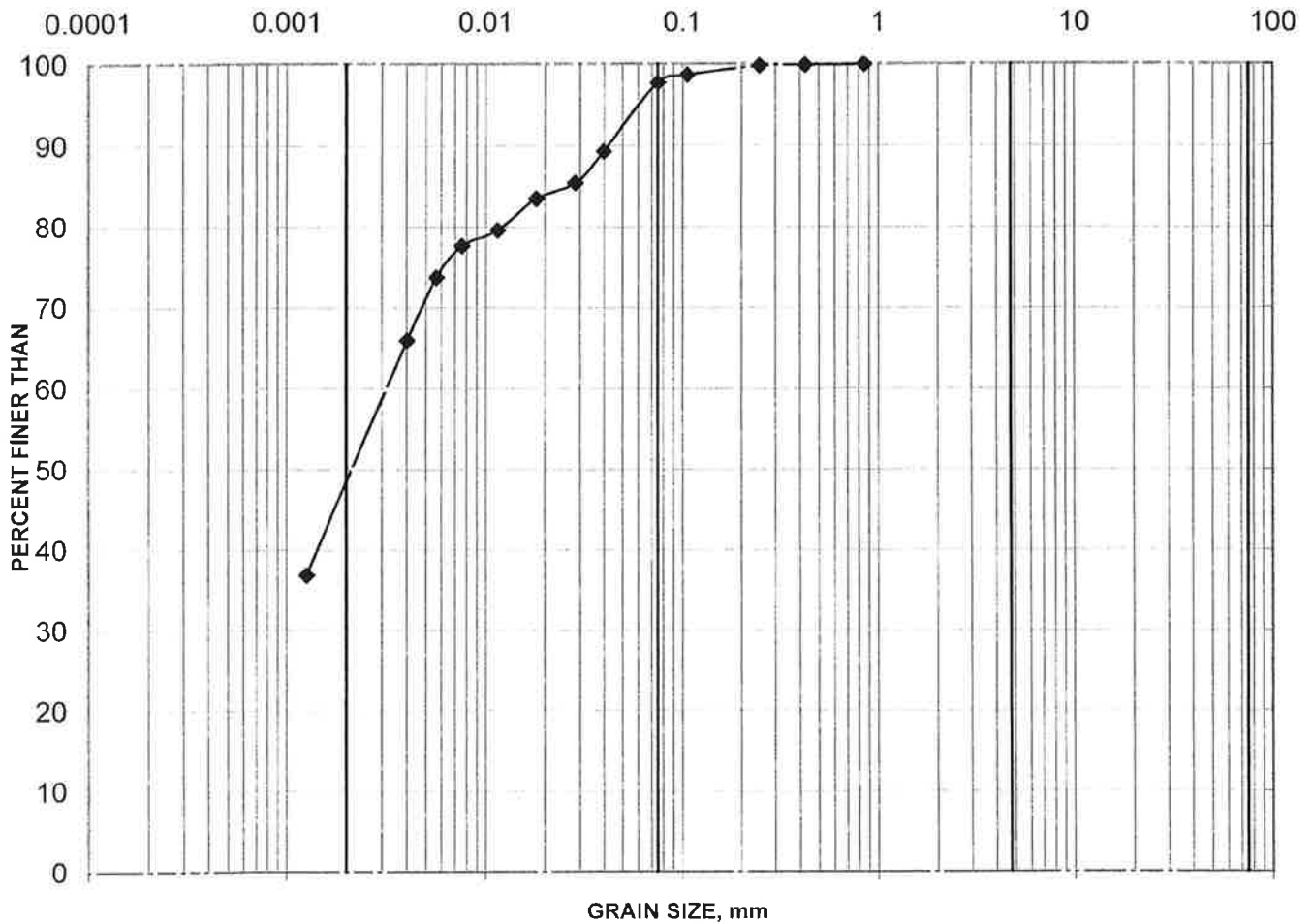
Project: 021-1155

Golder Associates

GRAIN SIZE DISTRIBUTION TEST RESULT

Weathered Clay Crust

FIGURE 3



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

Borehole	Sample	Depth (m)
02-802	3	2.3-2.9

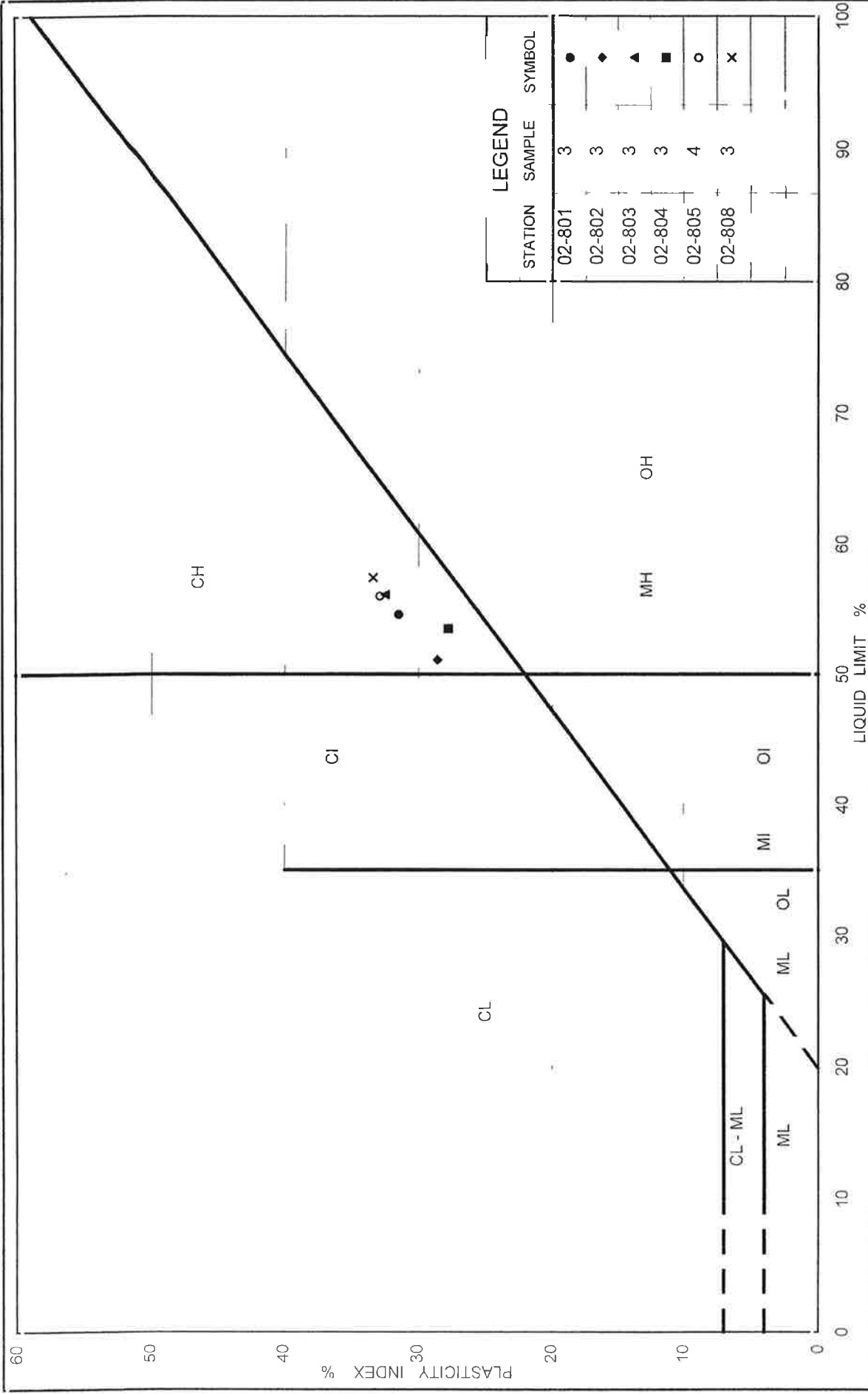
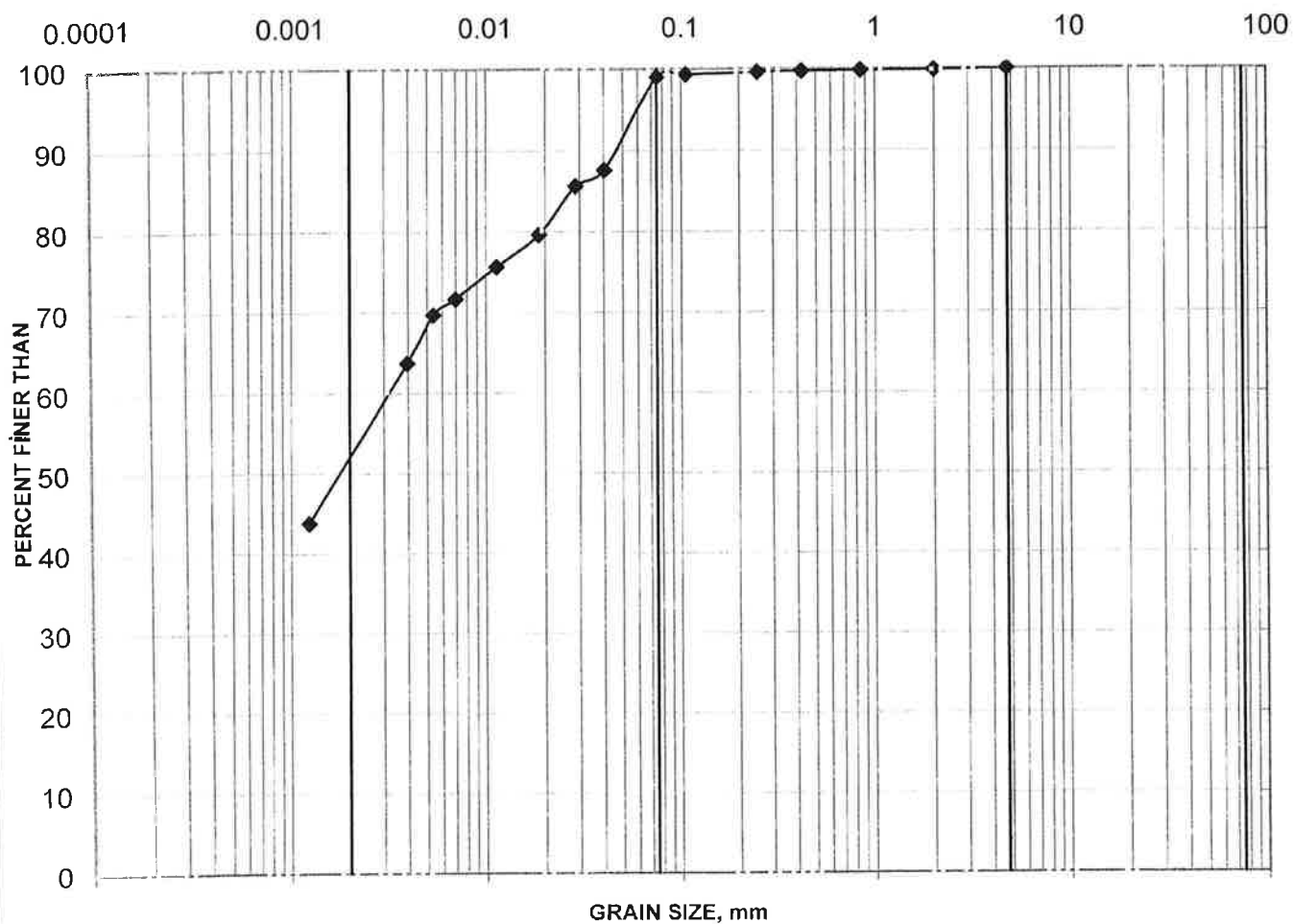


FIGURE 4

PLASTICITY CHART
Weathered Clay Crust

Project No. 021-1155-8

FIGURE 5



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

Borehole	Sample	Depth (m)
—◆— 02-809	6	4.6-5.2

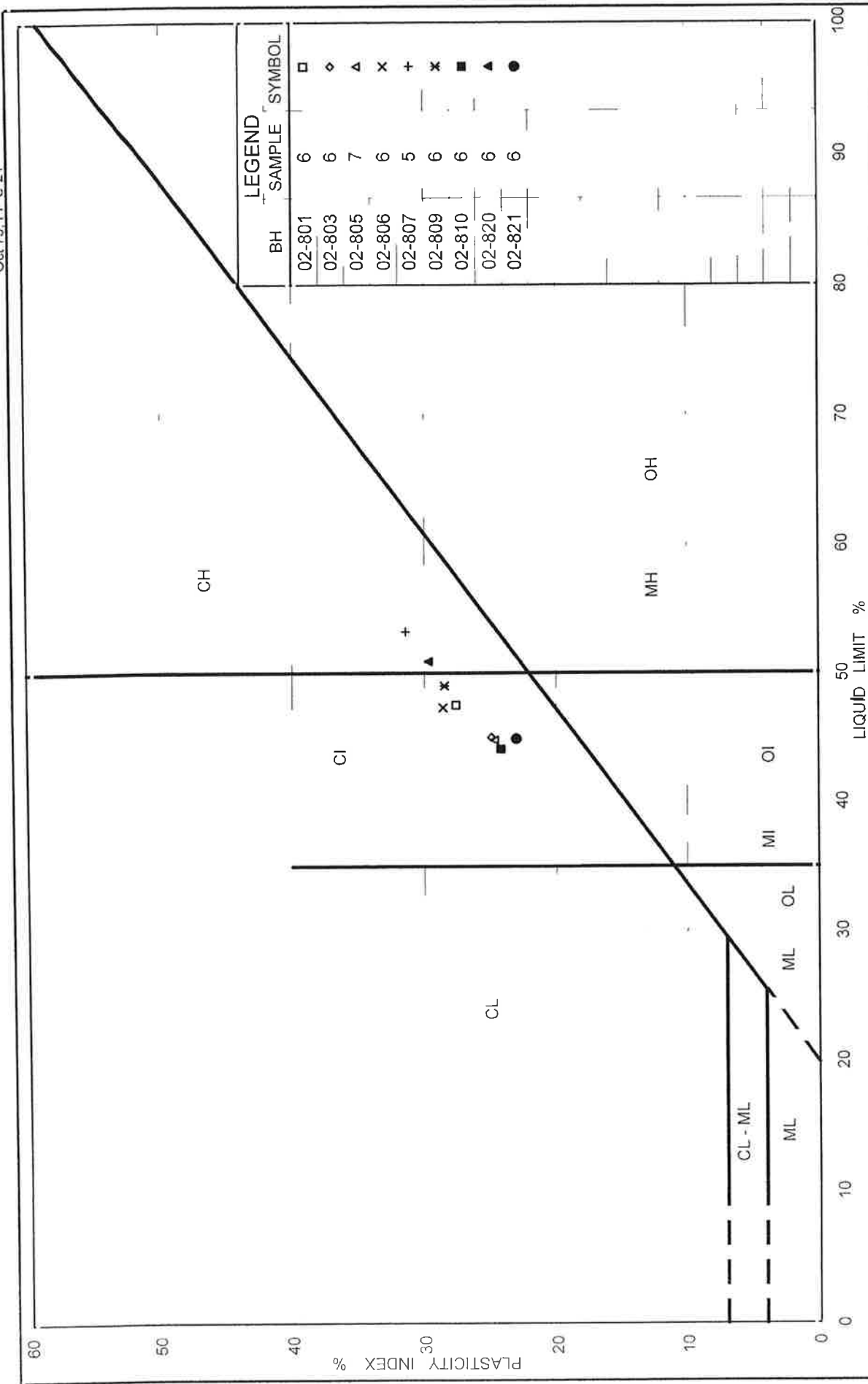
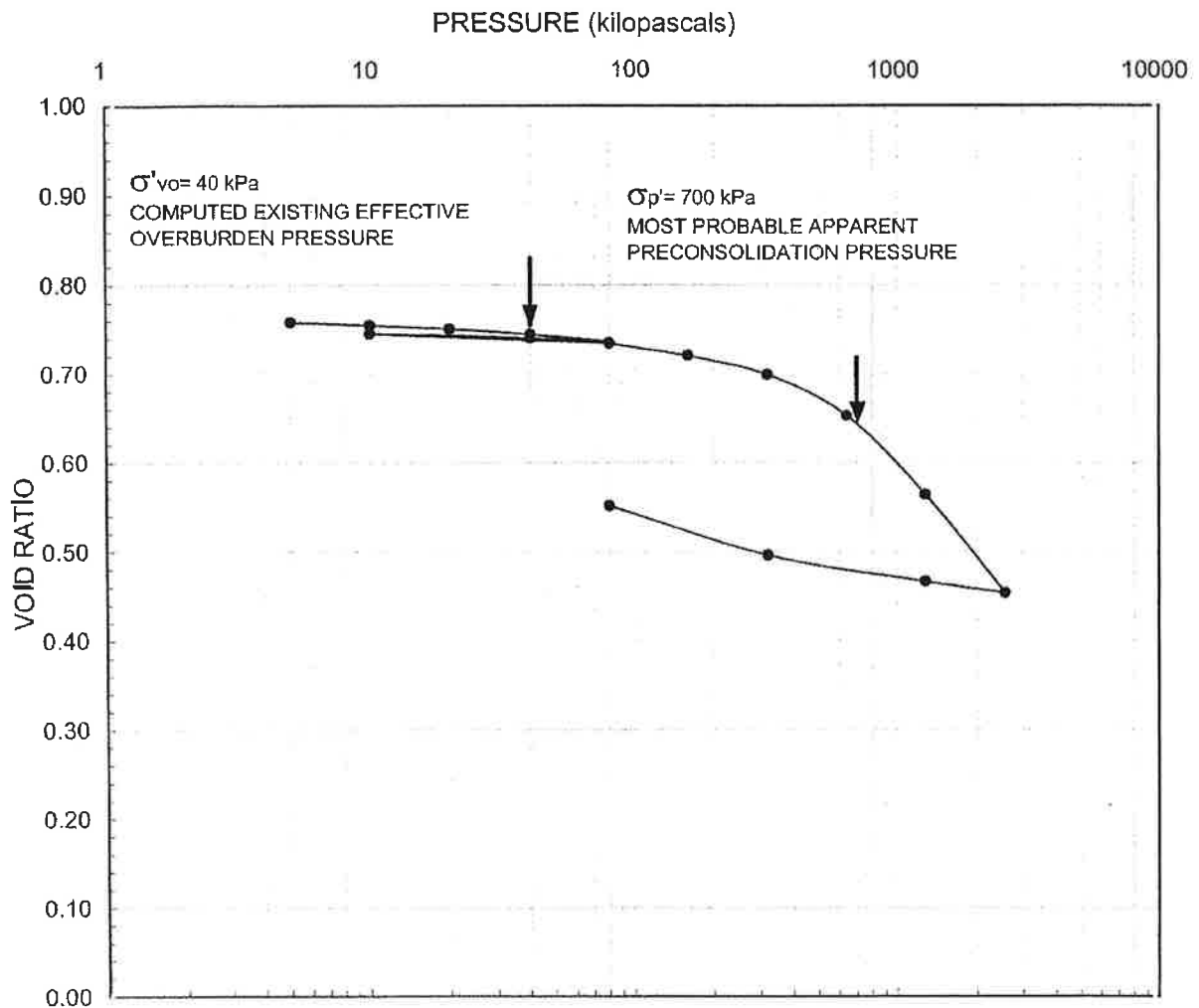


FIGURE 6

PLASTICITY CHART Grey Silty Clay to Clay

Project No. 021-1155-8



LEGEND

Borehole: 02-820t	$w_i = 28\%$	$S_o = 98\%$
Sample: 1	$w_r = 25\%$	$C_c = 0.37$
Depth (m): 5.0	$w_l = 46\%$	$C_r = 0.012$
	$w_p = 29\%$	



FILE No: Consolidation summary
PROJECT No: 021-1155 REV: 0

SCALE: AS SHOWN
DATE: 08/19/04
DESIGN:
CADD: EWK
CHECK: *[Signature]*
REVIEW:

TITLE

CONSOLIDATION TEST RESULTS

FIGURE

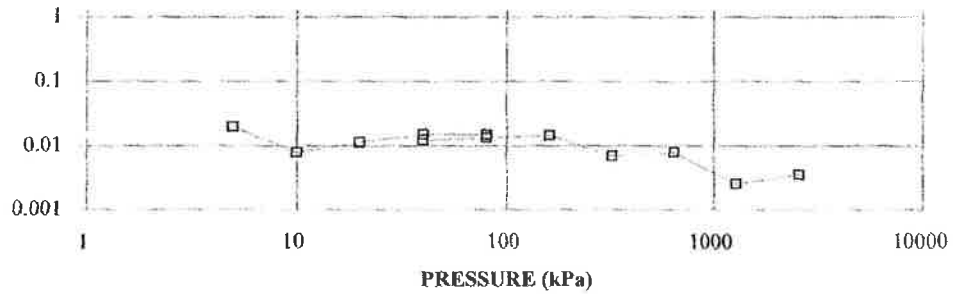
7a

OEDOMETER CONSOLIDATION SUMMARY

FIGURE 7b

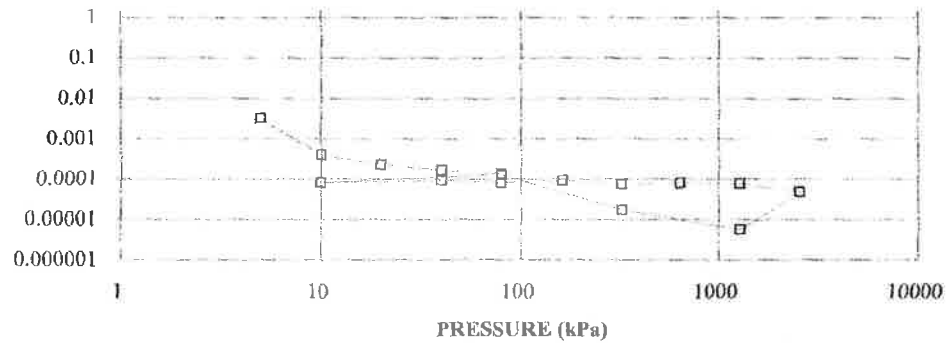
COEFFICIENT OF CONSOLIDATION, cm^2/s

CONSOLIDATION TEST
 $c_v \text{ cm}^2/\text{s}$ vs PRESSURE (kPa)



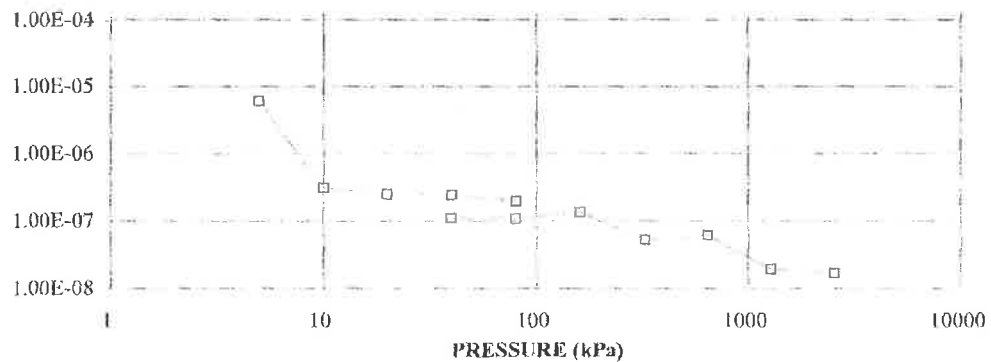
VOLUME
COMPRESSIBILITY,
 m^2/kN

CONSOLIDATION TEST
 $m_v, \text{m}^2/\text{kN}$ vs PRESSURE (kPa)



HYDRAULIC
CONDUCTIVITY, cm/s

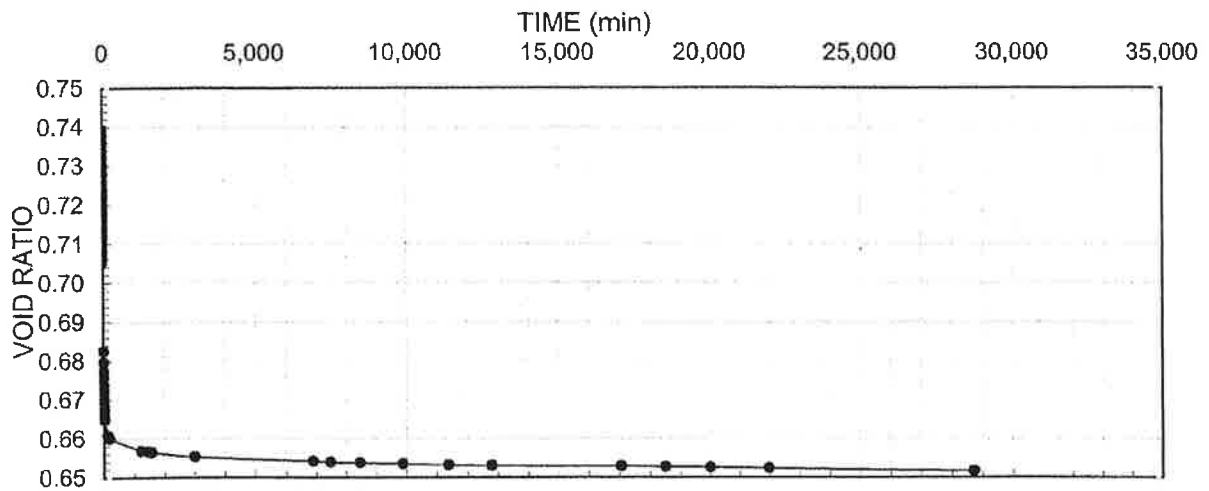
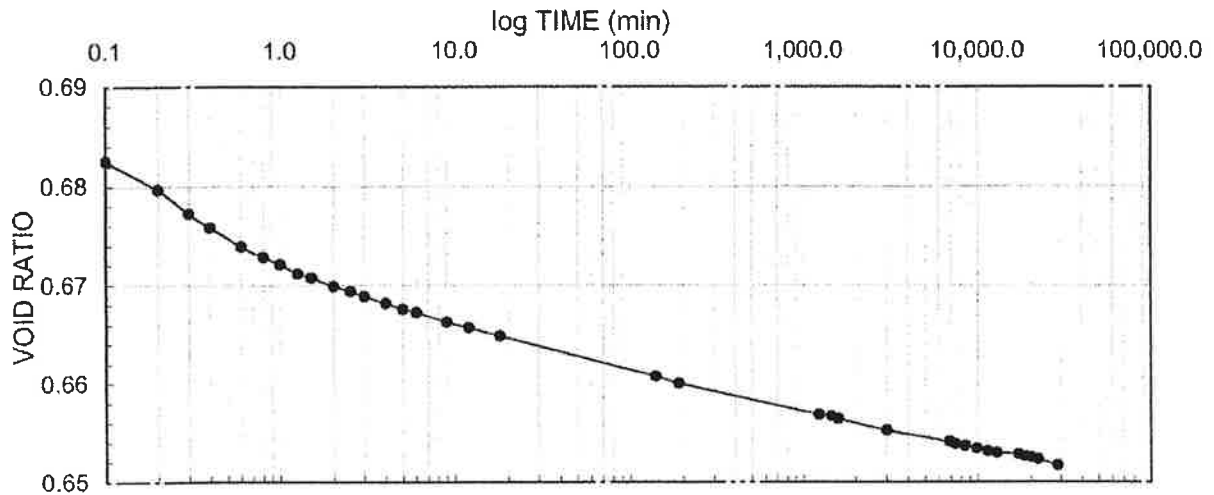
CONSOLIDATION TEST
HYDRAULIC CONDUCTIVITY vs PRESSURE



Project No. 021-1155

Golder Associates

Load = 280 kPa



LEGEND

Borehole: 02-820B

$C_{\alpha} = 0.0038$

Sample: 1

Depth (m): 5.00



SCALE	AS SHOWN
DATE	08/19/04
DESIGN	
CADD	EWK
CHECK	
REVIEW	

SUMMARY OF
SECONDARY COMPRESSION TEST

FILE No. Consolidation summary
PROJECT No. 021-1155 REV. 0

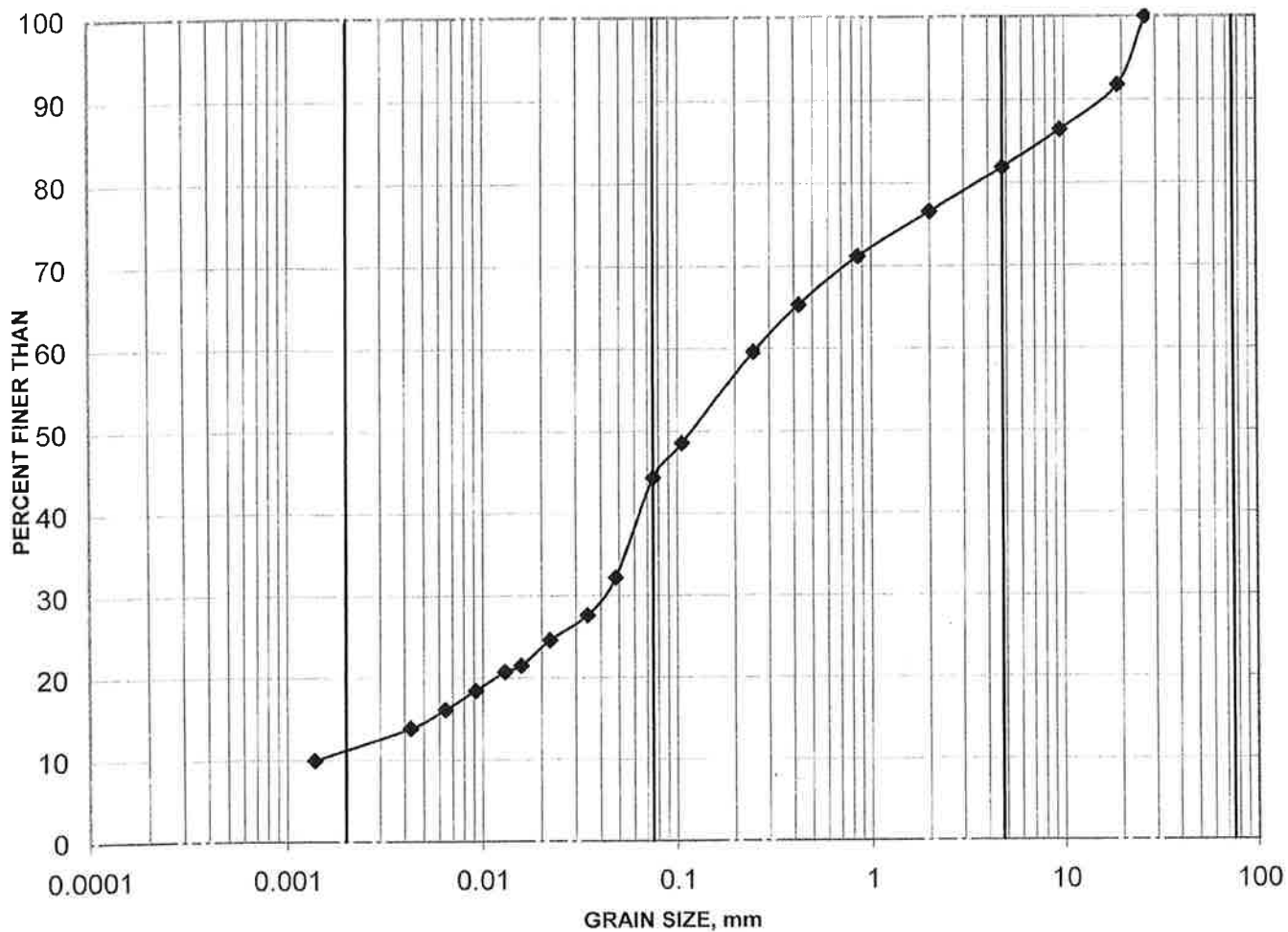
FIGURE

7c

GRAIN SIZE DISTRIBUTION TEST RESULT

Silty Sand to Sandy Silt Till

FIGURE 8



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

Borehole	Sample	Depth (m)
02-808	7	5.4-6.0

APPENDIX A

**CERTIFICATE OF ANALYSIS
SLS LAKEFIELD RESEARCH LIMITED
REPORT NO. CA9559-JUL03**

SGS Lakefield Research Limited
P.O. Box 4300 - 185 Concession St.
Lakefield - Ontario - K0L 2H0
Phone: 705-652-2038 FAX: 705-652-6441

Golder Associates
Attn : Emily Kwok

1796 Courtwood Crescent
Ottawa, Ontario, K2C 2B5
Canada


Phone: (613) 224-5864
Fax: (613) 224-9928
e-mail: ekwok@golder.com

Thursday, August 07, 2003

Date Rec. : 30 July 2003
LR Report : CA9559-JUL03
Project : 2302189
Client Ref : vProject #'s
021-1155(5050)

CERTIFICATE OF ANALYSIS

Sample ID	SiO2 %	Al2O3 %	Fe2O3 %	MgO %	CaO %	Na2O %	K2O %	TiO2 %	P2O5 %	MnO %	Cr2O3 %	V2O5 %	LOI %	Sum %
1: 02-801 A	61.6	13.7	3.21	2.75	4.58	0.84	5.67	0.55	0.30	0.03	0.02	< 0.01	7.03	100.3
2: 02-801 B	75.9	5.47	1.20	1.09	6.26	0.42	2.56	0.27	0.65	0.03	0.01	< 0.01	6.10	100.0
3: 02-801 C	3.12	0.35	2.34	15.6	34.0	< 0.05	0.16	0.02	< 0.01	0.31	< 0.01	< 0.01	44.1	100.0


Tim Elliott, B.Sc. (Geol)
Senior Project Coordinator

