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**FOUNDATION INVESTIGATION AND  
DESIGN REPORT  
PROPOSED BATTEAUX RIVER BRIDGE  
HIGHWAY 26, GWP 630-91-00  
AGREEMENT NUMBER 3005-A-000164**

Submitted to:

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February 2, 2006

001-3232-4-1  
Geocres No. 41A-162



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LIST OF ABBREVIATIONS

LIST OF SYMBOLS

LITHOLOGICAL AND GEOTECHNICAL ROCK DESCRIPTION TERMINOLOGY

RECORDS OF BOREHOLES

FIGURE 1 - Site Location Map

DRAWING 1 - Batteau River Crossing, Borehole Locations and Soil Strata

DRAWING 2 - Cross Sections and Soil Strata

APPENDIX A - Laboratory Test Data (Figure A-1)

APPENDIX B - Site Photographs

**PART A**

**FOUNDATION INVESTIGATION REPORT  
PROPOSED BATTEAUX RIVER BRIDGE  
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AGREEMENT NUMBER 3005-A-000164**

## **1.0 INTRODUCTION**

Golder Associates Ltd. (Golder) has been retained by Dillon Consulting Limited (Dillon) on behalf of the Ministry of Transportation, Ontario (MTO) to provide foundation engineering services for the structures on the proposed Highway 26 realignment near Collingwood, Ontario. The proposed realignment extends from Collingwood easterly to Wasaga Beach as shown on Figure 1. This report addresses the structure for the Batteaux River crossing.

The purpose of the foundation investigation is to determine the subsurface conditions at the site of the proposed new bridge by drilling boreholes and carrying out in-situ tests and laboratory tests on selected samples. The updated terms of reference for the scope of work are outlined in Golder's Proposal 001-3232 on Additional Foundation Engineering Services dated February 2002, and were updated in our letter dated November 13, 2002. The work was carried out in accordance with our Quality Control of TPM Services Plan, Agreement No. 3005-A-000164, dated October 2000.

Dillon provided Golder with a preliminary drawing for the proposed Batteaux River Bridge. The centreline and stations of the proposed alignments were surveyed by others prior to commencing the foundation investigation program. The General Arrangement plan showing the proposed abutment and pier layout of the structure dated April 2003 was provided to us in digital format.

## **2.0 SITE DESCRIPTION**

### **2.1 Site Location**

The project area covered by this report extends along the proposed realignment of Highway 26 at the crossing with the Batteaux River in the Town of Collingwood, Ontario (see Figure 1). The new highway runs approximately southeast-northwest at the proposed bridge location and the Batteaux River flows in a northerly direction towards Nottawasaga Bay.

The proposed bridge will be at about Station 22+600 and will have a deck elevation of about 195 metres.

### **2.2 Physiography**

Highway 26, in the area of the project, crosses the western extremity of the Nottawasaga Basin. The basin is part of the Simcoe Lowlands geographic region, which is identified in the Physiography of Southern Ontario by L.J. Chapman and D.F. Putnam (1984). The area contains rolling hills and some broad flatlands such as the Minesing Flats. The area is drained by the Nottawasaga River and its tributaries. The elevation of the land varies between 177 metres and 229 metres above sea level. The region is bordered by the northeast facing slope of the Niagara Escarpment Geographic Region.

The Nottawasaga Basin was covered by the Georgian Bay Lobe of the Laurentide Ice Sheet which formed the Edenvale Moraine east of the project area and the Cornhill Moraine south of the project area. This ice sheet deposited sandy, silty ground moraine till over most of the basin. Sandy, silty tills with boulders and cobbles were laid down south of the project area on the slope of the Niagara Escarpment as well as within the project area. The ice front receded some 14,000 years ago and gave way to the waters of Glacial Lake Algonquin and later to Glacial Lake Nipissing. During the occupation of the area by lake waters, sandy and gravelly beaches were formed along shorelines and on hillsides. On the Niagara Escarpment slope, shore cliffs were formed by wave action of lake waters. The Nottawasaga River deposited a large sandy delta as it entered Glacial Lake Nipissing and the current Georgian Bay. Sands, some gravel and silt were deposited along the shore forming the current Wasaga Beach.

The project area is underlain by the Collingwood Member of the Middle Ordovician Lindsay Formation, consisting of interbedded, black, organic-rich limestone and highly calcareous and fossiliferous black shale. Southwest of the project, at the lower part of the Niagara Escarpment, a blue-grey, non-calcareous, fissile shale of the Late Ordovician Blue Mountain Formation is located, which is overlain by the Georgian Bay Formation blue-grey shale with light grey to cream coloured limestone and dolostone. The deposition of these formations occurred in an approximate time period between 550 and 500 million years before present. During the wave

erosion process of the Niagara Escarpment, rocks from these formations contributed clay, boulders and cobbles to the till deposit of the project area.

The western and central part of the project area is underlain by a sandy, silty till with cobbles and boulders of mainly carbonate rocks, except near the present lakeshore, where sand and gravel beaches dominate.

Based on the available quaternary geology mapping for the Collingwood - Nottawasaga area (Ontario Division of Mines, Preliminary Map P.919, 1974), the project lies in an area of sandy silt till of low relief.

### **3.0 INVESTIGATION PROCEDURES**

The field work for the preliminary design investigation was carried out on August 15 and 16, 2002. At that time, two boreholes were put down at the site of the proposed bridge abutments and two additional boreholes were drilled at the approaches. The boreholes were drilled and sampled to depths of 0.7 to 4.7 metres. The bedrock surface and condition were proved in each of the two abutment boreholes by rock coring. The approach boreholes were terminated on refusal to augering on the bedrock surface.

The field work for the final design investigation was carried out between July 10 and 14, 2003. During this time, four boreholes were drilled, one at each abutment and two at the centre pier location. All of the borehole locations are shown on the Plan, Drawing 1.

The investigation was carried out using an all terrain vehicle mounted CME-750 drill rig supplied and operated by Lantech Drilling Services Inc. The boreholes were advanced using a combination of 152 millimetre outside diameter solid stem augers and using NQ and NW size casings for bedrock coring. The bedrock was cored in NQ size. In the boreholes, samples of the overburden were obtained using 50 millimetre outside diameter split-spoon samplers in accordance with the Standard Penetration Test (SPT) procedures. The cored length of bedrock in the boreholes ranged from 3.6 to 4.0 metres. Piezometers were installed in selected boreholes to measure the groundwater conditions at those locations. Groundwater conditions in the open boreholes were observed throughout the drilling operations. All of the boreholes were backfilled using Ministry of Transportation, Ontario (MTO) recommended procedures.

The field work was supervised on a full-time basis by members of our engineering staff who located the boreholes in the field, directed the drilling, sampling and in-situ testing operations, and logged the boreholes. The soil samples were identified in the field, placed in labeled containers and transported to our laboratory in London, Ontario for further examination. Index and classification tests consisting of grain size analyses and water content determinations were carried out on selected samples. The NQ rock core was arranged in NQ core boxes and transported to our London laboratory for further examination. The results of the field and laboratory testing are given on the Record of Borehole sheets and in Appendix A.

The as-drilled borehole locations and elevations were surveyed by our staff on completion of drilling and sampling.

## **4.0 SUBSURFACE CONDITIONS**

### **4.1 Site Stratigraphy**

The detailed subsurface soil and groundwater conditions encountered in the boreholes, together with the results of the laboratory tests carried out on selected soil samples, are given on the attached Record of Borehole sheets following the text of this report and in Appendix A. The stratigraphic boundaries shown on the borehole sheets are inferred from non-continuous sampling and, therefore, may represent transitions between soil types rather than exact planes of geological change. Subsurface conditions will vary between and beyond the borehole locations.

In summary, the subsoils at the site generally consist of a thin layer of topsoil underlain by 0.4 to 0.6 metres of very dense sandy silt till which was underlain by limestone bedrock below about elevation 190.5 metres. A pocket of clayey silt was encountered between the topsoil and the till at one borehole location.

Locations and elevations of the borings, together with interpreted stratigraphical profiles, are shown on the attached Drawings 1 and 2. A detailed description of the subsurface conditions encountered in the boreholes for this investigation is provided on the Record of Borehole sheets and is summarized in the following sections.

#### **4.1.1 Topsoil**

Silty topsoil layers were encountered at ground surface in all four boreholes. The topsoil layers were 0.1 to 0.3 metres thick.

#### **4.1.2 Clayey Silt**

Beneath the topsoil in borehole 4, drilled at the east abutment location, a 0.3 metre thick pocket of clayey silt was encountered at about elevation 191.4 metres.

#### **4.1.3 Sand**

Beneath the topsoil in borehole 7, a 0.6 metre thick layer of sand was encountered at about elevation 190.8 metres.

#### **4.1.4 Sandy Silt Till**

Beneath the topsoil in boreholes 1 to 3, 5, 6, 8 and the clayey silt in borehole 4, a very dense sandy silt till deposit was encountered. The till was 0.4 to 0.9 metres thick and extended to



elevation 190.1 to 190.5 metres at the borehole locations. The till had standard penetration test N values of 100 blows per 50 to 100 millimetres penetration.

Figure A-1 in Appendix A shows a grain size distribution curve for a sample recovered from the sandy silt till deposit in borehole 2. The deposit consists mainly of sand and silt size material with some gravel and trace to some clay. The water contents of the till samples collected from the boreholes were between about 3 and 8 per cent, with an average of about 5 per cent.

#### **4.1.5 Limestone Bedrock**

The bedrock surface was encountered at depths of 0.7 to 1.1 metres, or between elevations 190.1 and 190.5 metres, at the borehole locations. The top 3.6 to 4.0 metres of the bedrock was cored in NQ size in boreholes 1 and 4 to 8 drilled at the abutment and pier locations. The grey fossiliferous limestone is fine grained and fresh to slightly weathered with fossiliferous clasts moderately jointed/bedded with rock quality designation values as low as 0 per cent, becoming very strong and darker with depth with rock quality designation values as high as 100 per cent. A statistical summary of the rock core data is as follows:

<u>INDEX</u>	<u>NO. OF RUNS</u>	<u>PERCENT OF CORE RUN</u>		
		<u>Minimum</u>	<u>Maximum</u>	<u>Average</u>
Total Core Recovery (TCR)	21	74	100	91
Solid Core Recovery (SCR)	21	26	100	80
Rock Quality Designation (RQD)	21	0	100	70

#### **4.2 Groundwater Conditions**

Water levels were noted in the open boreholes during drilling and piezometers were installed in boreholes 1, 4, 6 and 7 upon completion of the drilling operations. The water levels encountered/measured in the boreholes during drilling and measured in the piezometers are detailed on the Record of Borehole sheets and are summarized in the following table. It should be noted that the groundwater level is subject to seasonal fluctuations.

<u>BOREHOLE</u>	<u>GROUND SURFACE ELEVATION (m)</u>	<u>GROUNDWATER LEVEL ENCOUNTERED/ FOLLOWING DRILLING (Elevation - m)</u>	<u>MEASURED GROUNDWATER LEVEL (Elevation - m)</u>			
			<u>2002</u>		<u>2003</u>	
			<u>Aug. 21</u>	<u>Aug. 27</u>	<u>Jul 17</u>	<u>Aug. 20</u>
1	191.21	189.84	189.39	189.29	189.72	189.17
2	191.06	Dry	-	-	-	-
3	191.14	Dry	-	-	-	-
4	191.18	190.62	189.15	189.21	190.19	189.68
5	191.33	189.81	-	-	-	-
6	191.26	189.61	-	-	189.89	189.53
7	191.05	189.95	-	-	189.92	189.87
8	191.54	190.47	-	-	-	-

The Batteaux River water level was at elevation 190.16 metres on August 16, 2002 and at elevation 190.25 metres on July 11, 2003.

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**PART B**

**FOUNDATION DESIGN REPORT  
PROPOSED BATTEAUX RIVER BRIDGE  
HIGHWAY 26, GWP 630-91-00  
AGREEMENT NUMBER 3005-A-000164**

## **5.0 ENGINEERING RECOMMENDATIONS**

### **5.1 General**

This section of the report provides our recommendations on the foundation aspects of the design of the proposed Batteaux River Bridge based on our interpretation of the factual information obtained during the investigation. It should be noted that the interpretation and recommendations are intended for use only by the design engineer. 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 and scheduling.

It is understood that a bridge will be constructed over the Batteaux River along the southern portion of the Highway 26 realignment at about Station 22+600 to provide one lane of traffic in each direction. The river water level at the proposed crossing location is at about elevation 190.2 metres at normal stage. Bedrock is exposed in the river bed. The bedrock consists of strong to very strong, grey, fine grained and fresh to slightly weathered fossiliferous limestone. The bridge will be a two-span structure some 35 metres long with a finished deck elevation at about 195 metres.

### **5.2 Bridge Foundations**

The subsurface conditions encountered in the boreholes put down during the investigations for the preliminary and final design typically consist of surficial topsoil over a thin, very dense sandy silt till deposit overlying limestone bedrock. The top of the bedrock is some 0.7 to 1.1 metres below ground surface at about elevation 190.1 to 190.5 metres. The groundwater level in the boreholes at the time of the investigation in July 2003 was at about 1.1 to 1.5 metres below ground surface, or at about elevation 189.7 to 190.2 metres.

Based on the understanding that the proposed structure is to be built with shallow foundations and the subsurface information noted above, consideration may be given to supporting the new structure on spread footings bearing on the bedrock at or below elevation 189.5 metres.

### **5.3 Shallow Foundations**

Spread footings may be used to support the new bridge abutments and pier. For the configuration of the proposed bridge and the profile for Highway 26, both the east and west abutments, as well as the centre pier, would be founded within the limestone bedrock. The extent of the rock excavation will depend on the chosen founding level. The excavation could be carried out using drilling and hoe ramming techniques where relatively shallow depths of cut into the bedrock are

required. This procedure will tend to result in an uneven founding surface and significant over excavation is likely. Line drilling and pre-shearing techniques will provide better control over the configuration of the founding surface, and this procedure would be the preferred approach where deeper excavation into the bedrock is required for footing construction.

There may be loose/fractured bedrock at the founding level that should be removed prior to placing concrete. In addition, the design for the pier footing should be flexible enough to allow for some variation in the bedrock surface elevation and allow for placement of mass concrete to raise the grade to the founding level after exposing the bedrock and removing any loosened / fractured bedrock, if required.

### **5.3.1 Axial Geotechnical Resistance**

Spread footings placed on the limestone bedrock at this site may be designed for a factored geotechnical resistance at Ultimate Limit States (ULS) of 3,000 kilopascals (kPa). This value is for vertical concentric loads only. Effects of load inclination and eccentricity need to be taken into account, as appropriate, in accordance with Section 6.7.4 of the Canadian Highway Bridge Design Code (CHBDC) using the curve for “cohesive soil or rock”. Serviceability Limit States (SLS) conditions do not apply to footings placed on the limestone bedrock which is classified as non-yielding.

The factored geotechnical resistance value given above assumes that controlled blasting for footing construction is used, that the bedrock at and below the founding level has not been fractured by the blasting and that no adverse jointing is present below the footings. As such, an inspection of the rock cut should be carried out prior to construction. The contract documents should contain the MTO Special Provision 902S01 – Excavation and Backfilling – which contains reference to the use of a Quality Verification Engineer.

All footing excavations should be inspected prior to placing concrete to ensure that the base has been adequately cleaned and that the bedrock conditions as exposed at the founding level are consistent with the design assumptions. All loose or shattered rock within the footprint of the footings should be removed from the base of the excavation and replaced with concrete.

### **5.3.2 Resistance to Lateral Forces**

Resistance to lateral forces/sliding resistance between the concrete footings and bedrock should be calculated in accordance with Section 6.7.5 of the CHBDC assuming an unfactored angle of friction of 35 degrees. If necessary, sliding resistance can be supplemented by doweling into bedrock.

A value of 350 kPa may be assumed for the grout-to-rock bond stress for ULS design. This value refers to the rock-grout interface and can be used for tension design. The actual bond stress along the rock-grout interface may vary from the typical design value given and should therefore be verified in the field. The dowels should be a minimum of one metre long within the rock (embedded length in the rock) and the structural strength of the dowel and the compressive strength of the grout should not be exceeded.

### **5.3.3 Frost Protection**

For spread footings placed on fresh limestone bedrock or mass concrete, frost protection cover is not required.

## **5.4 Deep Foundations**

Based on the subsurface conditions encountered in the boreholes drilled at the site, specifically the shallow bedrock surface, and the proposed structure type, deep foundations are not considered appropriate for this structure.

## **5.5 Seismic Design Considerations**

Table A3.1.7 of the CHBDC indicates that Collingwood has a Zonal Acceleration Ratio of 0.05 and Table 4.4.4.1 indicates that it corresponds to a Seismic Performance Zone of 1. Subsection 4.4.5.2 and Table 4.4. 5.3.1 of the CHBDC indicate that seismic analysis is not required for bridges in Zone 1.

## **5.6 Lateral Earth Pressures**

The lateral pressures acting on the bridge abutments and associated retaining walls will depend on the type and method of placement of the backfill materials, on the nature of the soils behind the backfill, on the freedom of lateral movement of the structure, and on the drainage conditions behind the walls. The following recommendations are made concerning the design of the abutments, in accordance with the CHBDC:

- Select, free-draining granular fill meeting the specifications of Ontario Provincial Standard Specifications (OPSS) Granular A or Granular B Type II but with less than 5 per cent passing the 0.075 millimetre sieve should be used as backfill behind the abutments and walls. This fill should be compacted in loose lifts not greater than 200 millimetres in thickness to 95 per cent of the material's standard Proctor maximum dry density in accordance with OPSS 501. Longitudinal drains and weep holes should be installed to provide positive drainage of the granular backfill. Other aspects of the abutment granular backfill requirements with respect to subdrains and frost taper should be in accordance with Ontario Provincial Standard Drawing (OPSD) 2501.00 and 2504.00.

- A compaction surcharge equal to 12 kPa should be included in the lateral earth pressures for the structural design of the abutment wall, in accordance with CHBDC Figure 6.9.3. Compaction equipment should be used in accordance with OPSS 501.06.
- The granular fill may be placed either in a zone with a width equal to at least 1.5 metres behind the back of the stem (Case i from Commentary on CHBDC Figure C6.9.1(I)) or within the wedge-shaped zone defined by a line drawn at 1.5 horizontal to 1 vertical extending up and back from the rear face of the footing (Case ii from Commentary on CHBDC Figure C6.9.1(I)).
- For Case i, the pressures are based on the proposed embankment fill materials and the following parameters (unfactored) may be assumed:

Soil unit weight:	21 kN/m <sup>3</sup>
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Coefficients of lateral earth pressure:

Active, $K_a$	0.33
At rest, $K_o$	0.50

- For Case ii, the pressures are based on the granular fill as placed and the following parameters (unfactored) may be assumed:

	<u>GRANULAR A</u>	<u>GRANULAR B TYPE II</u>
Soil unit weight:	22 kN/m <sup>3</sup>	21 kN/m <sup>3</sup>
Coefficients of lateral earth pressure:		
Active, $K_a$	0.27	0.31
At rest, $K_o$	0.43	0.47

- If the wall support and superstructure allow lateral yielding of the stem, active earth pressures may be used in the geotechnical design of the structure. If the wall support does not allow lateral yielding, at-rest earth pressures should be assumed for geotechnical design.

It should be noted that the above design parameters assume level backfill and ground surface behind the wall.

## 5.7 Embankments

It is understood that embankment fills up to 4 metres in height will be constructed for the proposed new bridge. Embankment side slopes formed no steeper than 2 horizontal to 1 vertical are considered suitable for this site. A Factor of Safety against deep seated failure of greater than 1.3 is obtained for embankments constructed with the native sandy silt till materials.

The topsoil and organic materials should be removed from within the area of the embankment and the exposed subgrade soils should be proofrolled prior to fill placement.

Construction of the embankment above the prepared subgrade may be carried out using clean earth fill (in accordance with OPSS 212) or select subgrade material (in accordance with OPSS 1010) depending on material availability. All embankment fill should be placed in regular lifts with loose thickness not exceeding 300 millimetres and compacted.

## **5.8 Excavations and Temporary Cut Slopes**

Excavations for footing construction will extend through topsoil materials and sandy silt till deposits. At the proposed new bridge location, the excavations for spread footing construction will be at least 1.2 metres in depth. Based on the subsurface conditions encountered in the boreholes, the base of the spread footing excavations will be about 0.3 metres below the groundwater level. Temporary open cut slopes should be maintained no steeper than 1 horizontal to 1 vertical.

Surficial water seepage into the excavations should be expected and will be heavier during periods of sustained precipitation. Pumping from well filtered sumps located at the base of the excavations may be required to provide groundwater control during foundation excavations.

The consideration with respect to protection/preparation of the founding surface must be recognized. Sumps should be maintained outside of the actual footing limits. Surface water runoff should be directed away from the excavations at all times. The appropriate Non Standard Special Provision (NSSP) should be included in the contract documents.



All excavations should be carried out in accordance with the guidelines outlined in the latest edition of the Ontario Occupational Health and Safety Act and Regulations For Construction Projects. The clayey silt and sandy silt till deposits at this site would be classified as Type 2 soil.

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## LIST OF ABBREVIATIONS

The abbreviations commonly employed on each "Record of Borehole", on the figures and in the text of the report, are as follows:

### I. SAMPLE TYPES

<i>AS</i>	auger sample
<i>CS</i>	chunk sample
<i>DO</i>	drive open
<i>DS</i>	Denison type sample
<i>FS</i>	foil sample
<i>RC</i>	rock core
<i>SC</i>	soil core
<i>ST</i>	slotted tube
<i>TO</i>	thin-walled, open
<i>TP</i>	thin-walled, piston
<i>WS</i>	wash sample
<i>SS</i>	split spoon

### II. PENETRATION RESISTANCES

#### Dynamic Penetration Resistance:

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 0.3 m (12 in.).

#### Standard Penetration Resistance, 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 0.3 m (12 in.).

<i>WH</i>	sampler advanced by static weight of hammer
<i>WR</i>	sampler advanced by weight of Sampler and rods
<i>PH</i>	sampler advanced by hydraulic force
<i>PM</i>	sampler advanced by manual force

### III. SOIL DESCRIPTION

#### (a) Cohesionless Soils

Relative Density	"N" Blows/0.3 m or Blow/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	<u>kPa</u>	"Cu" = "Su" <u>psf.</u>
Very soft	0 to 12	0 to 250
Soft	12 to 25	250 to 500
Firm	25 to 50	500 to 1000
Stiff	50 to 100	1000 to 2000
Very stiff	100 to 200	2000 to 4000
Hard	over 200	over 4000

### IV. SOIL TESTS

<i>C</i>	consolidation test
<i>H</i>	hydrometer analysis
<i>M</i>	sieve analysis
<i>MH</i>	combined analysis, sieve and hydrometer <sup>1</sup>
<i>Q</i>	undrained triaxial <sup>2</sup>
<i>R</i>	consolidated undrained triaxial <sup>2</sup>
<i>S</i>	drained triaxial
<i>U</i>	unconfined compression
<i>V</i>	field vane test
<i>Chem</i>	chemical analysis

#### NOTES:

1. Combined analyses when 5 to 95 per cent of the material passes the No. 200 sieve.
2. Undrained triaxial tests in which pore pressures are measured are shown as Q or R.

## LIST OF SYMBOLS

### I. GENERAL

$\pi$	= 3.1416
e	= base of natural logarithms 2.7183
$\log_e$	a or $\ln$ a, natural logarithm of a
$\log_{10}$	a or $\log$ a, logarithm of a to base 10
$t$	time
$g$	acceleration due to gravity
$V$	volume
$W$	weight
$m$	mass
$M$	moment
$F$	factor of safety

### II. STRESS AND STRAIN

$u$	pore pressure
$\sigma$	normal stress
$\sigma'$	normal effective stress ( $\sigma$ is also used)
$\tau$	shear stress
$\varepsilon$	linear strain
$\varepsilon_{sy}$	shear strain
$\nu$	Poisson's ration ( $\mu$ is also used)
$E$	modulus of linear deformation (Young's modulus)
$G$	modulus of shear deformation
$K$	modulus of compressibility
$\eta$	coefficient of viscosity

### III. SOIL PROPERTIES

#### (a) Unit weight

$\gamma$	unit weight of soil (bulk density)
$\gamma_s$	unit weight of solid particles
$\gamma_w$	unit weight of water
$\gamma_d$	unit dry weight of soil (dry density)
$\gamma'$	unit weight of submerged soil
$G_s$	specific gravity of solid particles $G_s = \gamma_s/\gamma_w$
$e$	void ratio
$n$	porosity
$w$	water content
$S_r$	degree of saturation

#### (b) Consistency

$w_L$	liquid limit
$w_P$	plastic limit
$I_P$	plasticity index
$w_S$	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
$D_r$	relative density = $(e_{max} - e)/(e_{max} - e_{min})$

#### (c) Permeability

$h$	hydraulic head or potential
$q$	rate of discharge
$v$	velocity of flow
$i$	hydraulic gradient
$\kappa$	coefficient of permeability
$j$	seepage force per unit volume

#### (d) Consolidation (one-dimensional)

$m_v$	coefficient of volume change = $-\Delta e/(1+e)\Delta\sigma'$
$C_c$	compression index = $-\Delta e/\Delta\log_{10}\sigma'$
$c_v$	coefficient of consolidation
$T_F$	time factor = $c_v t/d^2$ ( $d$ , drainage path)
$U$	degree of consolidation

#### (e) Shear strength

$\tau_f$	shear strength	$\left. \begin{array}{l} \text{in terms} \\ \text{of effective} \\ \text{stress} \end{array} \right\} \tau_f = c' + \sigma' \tan \phi$
$c'$	effective cohesion intercept	
$\phi'$	effective angle of shearing resistance, or friction	
$S_u$	apparent cohesion*	
$\phi_u$	apparent angle of shearing resistance, or friction	$\left. \begin{array}{l} \text{in terms of} \\ \text{total stress} \end{array} \right\} \tau_f = cu + \sigma \tan \phi_u$
$\mu$	coefficient of friction	
$S_t$	sensitivity	

\*For the case of a saturated cohesive soil,  $\phi_u = 0$  and the undrained shear strength  $\tau_f = S_u$  is taken as half the undrained compressive strength.

## 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

<u>Description</u>	<u>Bedding Plane Spacing-</u>
Very thickly bedded	>2 m
Thickly bedded	0.6 m to 2m
Medium bedded	0.2 m to 0.6m
Thinly bedded	60 m 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

<u>Description</u>	<u>Spacing</u>
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 (TCR)

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

#### 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
M F - Mechanical Fracture	C - Curved
- Parallel To	
⊥ - Perpendicular To	

**RECORD OF BOREHOLE No 1**

1 OF 1

**METRIC**

PROJECT 001-3232-4-1  
G.W.P. 630-91-00 LOCATION N 4927110.7 ; E 251521.6 ORIGINATED BY PJM  
DIST 30 HWY 26 BOREHOLE TYPE POWER AUGER (SOLID STEM & Nw CASING) COMPILED BY WDF  
DATUM GEODETIC DATE August 15, 2002 CHECKED BY AMH

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT w <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									WATER CONTENT (%)	
								○ UNCONFINED ● QUICK TRIAXIAL	+ FIELD VANE × LAB VANE									
191.21	GROUND SURFACE						20	40	60	80	100							
0.00	TOPSOIL, silty Black																	
190.94																		
0.27	SANDY SILT, some gravel (TILL)																	
190.39	Very dense Grey		1	SS	100/ 150mm							○						
0.82	FOSSILIFEROUS LIMESTONE, Moderately to slightly weathered, very fine grained, with fossiliferous clasts, moderately jointed/bedded Very strong		2	NQ CORE	-		100		50		20							
189.85	Light grey																	
1.36	FOSSILIFEROUS LIMESTONE, Slightly weathered, very fine grained, with fossiliferous clasts, moderately jointed/bedded Very strong		3	NQ CORE	-													
	Dark grey brown																	
188.25	FOSSILIFEROUS LIMESTONE, Slightly weathered to fresh, very fine grained, with abundant fossiliferous clasts, very widely jointed/bedded Very strong to extremely strong		4	NQ CORE	-													
2.96	Light to dark grey																	
186.52	END OF BOREHOLE																	
4.69	Groundwater measured at elev. 189.84m Aug. 16, 2002																	
	Groundwater measured at elev. 189.39m Aug. 21, 2002																	
	Groundwater measured at elev. 189.29m Aug. 27, 2002																	
	Groundwater measured at elev. 189.72m July 17, 2003																	
	Groundwater measured at elev. 189.17m Aug. 20, 2003																	

PROJECT <u>001-3232-4-1</u>		<b>RECORD OF BOREHOLE No 2</b>		1 OF 1	<b>METRIC</b>
G.W.P. <u>630-91-00</u>		LOCATION <u>N 4927121.1 ; E 251504.1</u>		ORIGINATED BY <u>PJM</u>	
DIST <u>30</u> HWY <u>26</u>		BOREHOLE TYPE <u>POWER AUGER (SOLID STEM)</u>		COMPILED BY <u>WDF</u>	
DATUM <u>GEODETIC</u>		DATE <u>August 16, 2002</u>		CHECKED BY <u>AMH</u>	

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT						PLASTIC LIMIT  w <sub>p</sub>	NATURAL MOISTURE CONTENT  w	LIQUID LIMIT  w <sub>L</sub>	UNIT WEIGHT  γ  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)  GR SA SI CL			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa											WATER CONTENT (%)		
								20	40	60	80	100	○ UNCONFINED						+ FIELD VANE	● QUICK TRIAXIAL	× LAB VANE
191.06	GROUND SURFACE																				
0.00	TOPSOIL, silty, trace gravel																				
190.76	Black																				
0.30	SANDY SILT, some gravel (TILL)																				
190.21	Very dense																				
0.85	Grey																				
	END OF BOREHOLE																				
	Auger refusal - Probably Bedrock																				
	Borehole dry during drilling Aug. 16, 2002.																				

# RECORD OF BOREHOLE No 3

1 OF 1

**METRIC**

PROJECT 001-3232-4-1

G.W.P. 630-91-00

LOCATION N 4927078.2 ; E 251567.6

ORIGINATED BY PJM

DIST 30 HWY 26

BOREHOLE TYPE POWER AUGER (SOLID STEM)

COMPILED BY WDF

DATUM GEODETIC

DATE August 16, 2002

CHECKED BY AMH

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT						PLASTIC LIMIT  w <sub>p</sub>	NATURAL MOISTURE CONTENT  w	LIQUID LIMIT  w <sub>L</sub>	UNIT WEIGHT  γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa											WATER CONTENT (%)		
								○ UNCONFINED	● QUICK TRIAXIAL	+	×	FIELD VANE	LAB VANE								
191.14	GROUND SURFACE																				
0.00	TOPSOIL, silty, trace gravel						191														
190.84	Black																				
0.30	SANDY SILT, some gravel																				
190.45	(TILL)																				
0.69	Very dense					100/ 75mm															
	Grey																				
	END OF BOREHOLE																				
	Auger refusal - Probably Bedrock																				
	Borehole dry during drilling																				
	Aug. 16, 2002.																				

**RECORD OF BOREHOLE No 4**

1 OF 1

**METRIC**

PROJECT 001-3232-4-1  
G.W.P. 630-91-00 LOCATION N 4927083.2 ; E 251546.4 ORIGINATED BY PJM  
DIST 30 HWY 26 BOREHOLE TYPE POWER AUGER (SOLID STEM & Nw CASING) COMPILED BY WDF  
DATUM GEODETIC DATE August 16, 2002 CHECKED BY AMH

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT w <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE							
191.50	GROUND SURFACE							20	40	60	80	100			
0.00	TOPSOIL, silty														
0.15	Black														
191.04	CLAYEY SILT, with gravel														
0.46	Brown														
190.50	SANDY SILT, some gravel (TILL)		1	SS	100/50mm		191								
1.00	Very dense Grey		2	NQ CORE	-			94	71	35					
	FOSSILIFEROUS LIMESTONE, Fresh to slightly weathered, very fine grained, fossiliferous clasts, moderately jointed/bedded Very strong Light to dark grey		3	NQ CORE	-		190	100	67	0					
188.35			4	NQ CORE	-		189	100	100	97					
3.15	FOSSILIFEROUS LIMESTONE, Fresh to slightly weathered, very fine grained, fossiliferous clasts, moderately jointed/bedded Very strong Light to dark grey		5	NQ CORE	-		188								
186.80							187								
4.70	END OF BOREHOLE														
	Groundwater measured at elev. 190.62m Aug. 16, 2002														
	Groundwater measured at elev. 189.15m Aug. 21, 2002														
	Groundwater measured at elev. 189.21m Aug. 27, 2002														
	Groundwater measured at elev. 190.19m July 17, 2003														
	Groundwater measured at elev. 189.68m Aug. 20, 2003														



**RECORD OF BOREHOLE No 5**

1 OF 1

**METRIC**

PROJECT 001-3232-4-1  
G.W.P. 630-91-00 LOCATION N 4927105.0 ; E 251514.7 ORIGINATED BY MR  
DIST 30 HWY 26 BOREHOLE TYPE POWER AUGER (SOLID STEM & Nw CASING) COMPILED BY BG  
DATUM GEODETIC DATE July 10, 2003 CHECKED BY AMH

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT w <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE								
191.33	GROUND SURFACE						20	40	60	80	100					
0.10	TOPSOIL, silty Black															
190.49	SANDY SILT, trace gravel, trace clay with cobbles (TILL.)															
0.84	Very dense Brown		1	SS	100/ 75mm											
189.67	FOSSILIFEROUS LIMESTONE, Slightly weathered, very fine grained, fossiliferous clasts, moderately jointed/bedded		2	NQ CORE	-		94	94	88							
1.66	Very strong Light to dark grey		3	NQ CORE	-											
	FOSSILIFEROUS LIMESTONE, Fresh, very fine grained, fossiliferous clasts, moderately jointed/bedded		4	NQ CORE	-		98	94	88							
	Very strong Light to dark grey		5	NQ CORE	-		T.C.R. (%) 100	S.C.R. (%) 100	R.Q.D. (%) 100							
							83	45	45							
186.51	END OF BOREHOLE															
4.82	Groundwater measured at elev. 189.81m July 10, 2003.															

**RECORD OF BOREHOLE No 6**

1 OF 1

**METRIC**

PROJECT 001-3232-4-1  
G.W.P. 630-91-00 LOCATION N 4927093.8 ; E 251528.9 ORIGINATED BY MR  
DIST 30 HWY 26 BOREHOLE TYPE POWER AUGER (SOLID STEM & Nw CASING) COMPILED BY BG  
DATUM GEODETIC DATE July 10, 2003 CHECKED BY AMH

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE									
191.26	GROUND SURFACE							20	40	60	80	100					
0.00 190.96	TOPSOIL, silty Black						191										
0.30	SANDY SILT, trace gravel, trace clay with cobbles (TILL)																
190.38	Very dense Brown		1	SS	100/ 125mm												
0.88	FOSSILIFEROUS LIMESTONE, Slightly weathered, very fine grained, fossiliferous clasts, moderately jointed/bedded Very strong Light to dark grey		2	NQ CORE	-		190	88		59		50					
1.14	FOSSILIFEROUS LIMESTONE, Fresh, very fine grained, fossiliferous clasts, moderately jointed/bedded Very strong Light to dark grey		3	NQ CORE	-		189	100		96		93					
			4	NQ CORE	-		188										
186.75	END OF BOREHOLE						187										
4.51	Groundwater measured at elev. 189.61m July 10, 2003.  Groundwater measured at elev. 189.61m July 11, 2003.  Groundwater measured at elev. 189.89m July 17, 2003.  Groundwater measured at elev. 189.53m Aug. 20, 2003																

**RECORD OF BOREHOLE No 7**

1 OF 1

**METRIC**

PROJECT 001-3232-4-1  
G.W.P. 630-91-00 LOCATION N 4927103.2 ; E 251540.1 ORIGINATED BY MR  
DIST 30 HWY 26 BOREHOLE TYPE POWER AUGER (SOLID STEM & Nw CASING) COMPILED BY BG  
DATUM GEODETIC DATE July 11, 2003 CHECKED BY AMH

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w <sub>L</sub>	UNIT WEIGHT  γ  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)  GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED      + FIELD VANE ● QUICK TRIAXIAL    × LAB VANE					WATER CONTENT (%)				
191.05	GROUND SURFACE							20	40	60	80	100					
0.00	TOPSOIL, silty Black																
190.75	SAND, trace gravel, some silt Very dense Brown																
0.30																	
190.14			1	SS	100/ 150mm												
0.91	FOSSILIFEROUS LIMESTONE, Fresh to slightly weathered, very fine grained, fossiliferous clasts, moderately jointed/bedded Very strong		2	NQ CORE	-			94	74	65							
189.23	Light to dark grey																
1.82	FOSSILIFEROUS LIMESTONE, Fresh, very fine grained, fossiliferous clasts, moderately jointed/bedded Very strong		3	NQ CORE	-			T.C.R. (%) 95	S.C.R. (%) 95	R.Q.D. (%) 95							
	Light to dark grey																
			4	NQ CORE	-			100	88	88							
186.54	END OF BOREHOLE																
4.51	Groundwater measured at elev. 189.95m July 11, 2003.  Groundwater measured at elev. 189.92m July 17, 2003  Groundwater measured at elev. 189.87m Aug. 20, 2003																

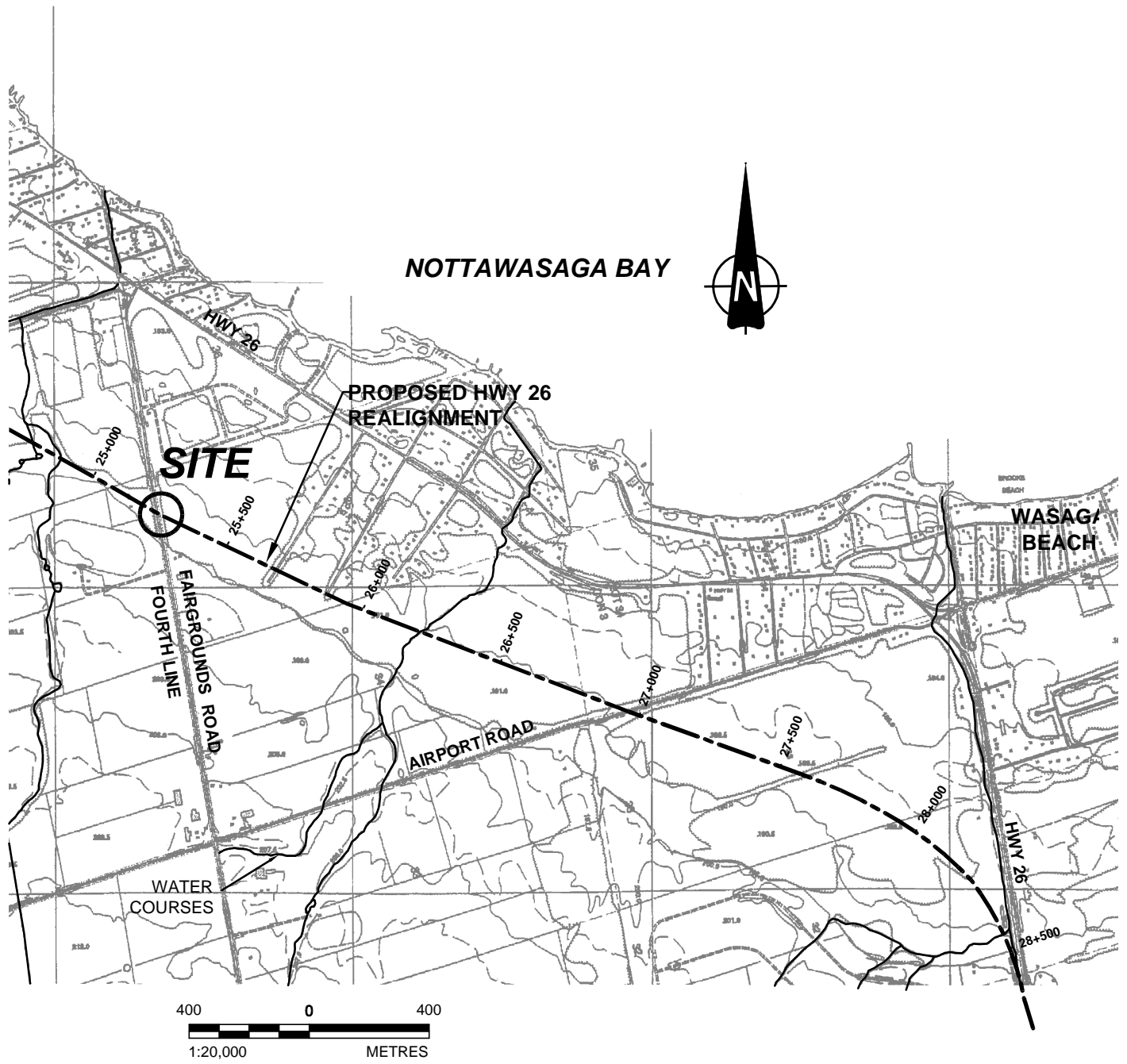
**RECORD OF BOREHOLE No 8**

1 OF 1

**METRIC**

PROJECT 001-3232-4-1  
G.W.P. 630-91-00 LOCATION N 4927093.3 ; E 251555.2 ORIGINATED BY MR  
DIST 30 HWY 26 BOREHOLE TYPE POWER AUGER (SOLID STEM & Nw CASING) COMPILED BY BG  
DATUM GEODETIC DATE July 11, 2003 - July 14, 2003 CHECKED BY AMH

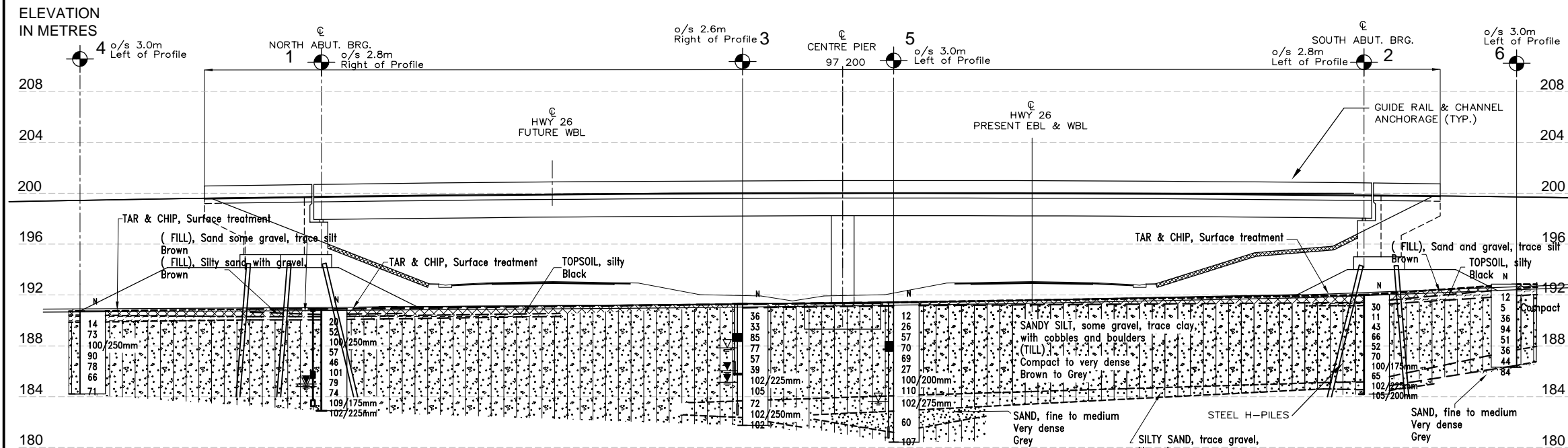
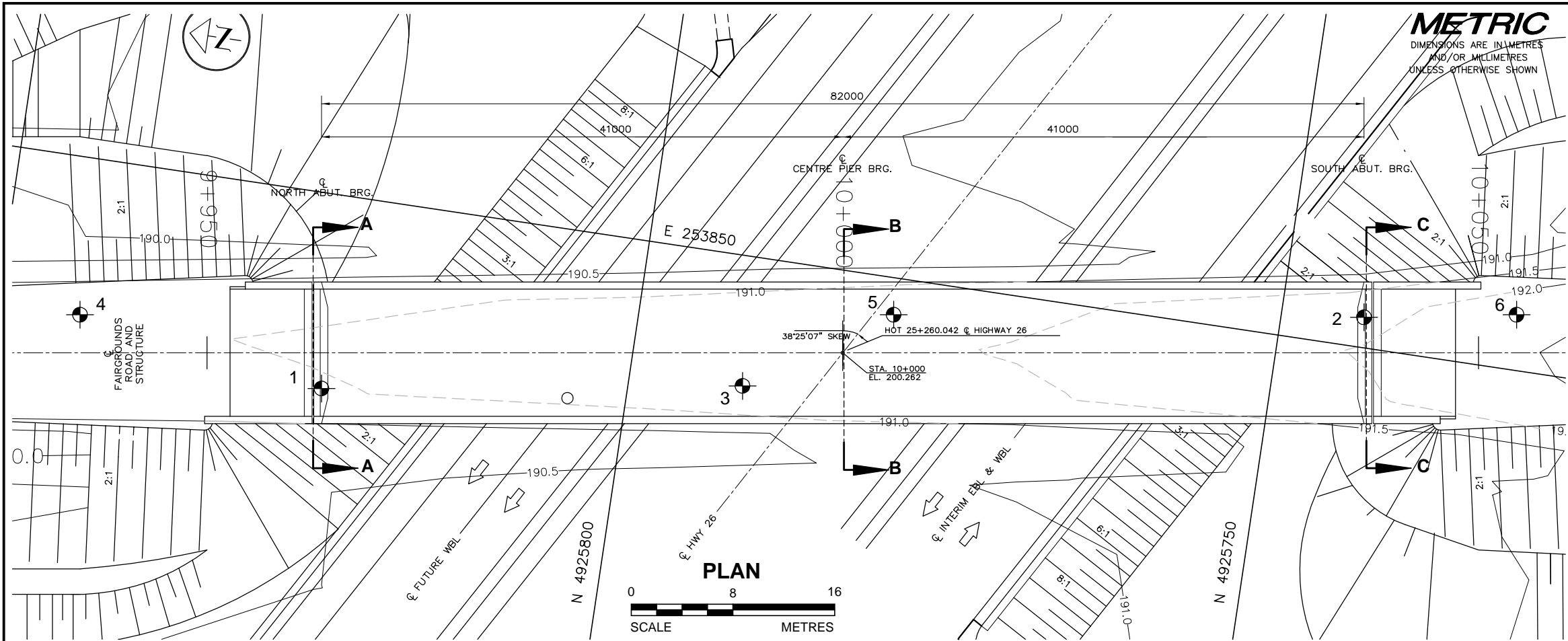
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w <sub>L</sub>	UNIT WEIGHT γ  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)  GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
								○ UNCONFINED	+	FIELD VANE							
191.54	GROUND SURFACE						20	40	60	80	100						
0.00	TOPSOIL, silty Black																
0.17	SANDY SILT, trace gravel, trace clay with cobbles & boulders (TILL) Very dense Brown		1	SS	100/ 75mm							○					
190.33																	
1.21	FOSSILIFEROUS LIMESTONE, Slightly weathered, very fine grained, fossiliferous clasts, moderately jointed/bedded		2	NQ CORE	-		100	26	17								
189.77	Very strong Light to dark grey																
1.77	FOSSILIFEROUS LIMESTONE, Fresh, very fine grained, fossiliferous clasts, moderately jointed/bedded Very strong Light to dark grey		3	NQ CORE	-		100	100	100								
			4	NQ CORE	-		T.C.R. (%) 74	S.C.R. (%) 74	R.Q.D. (%) 74								
			5	NQ CORE	-		97	83	83								
186.72	END OF BOREHOLE																
4.82	Groundwater measured at elev. 190.47m July 11, 2003.  Groundwater measured at elev. 190.47m July 14, 2003.																



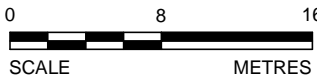
PROJECT		GWP 630-91-00 HIGHWAY 26 REALIGNMENT FAIRGROUNDS ROAD UNDERPASS	
TITLE		SITE LOCATION PLAN	
PROJECT No.		001-3232-4-2	FILE No. 001323242D002
CADD	WDF	Jan 30/06	SCALE AS SHOWN
CHECK	AMH	Jan 30/06	REV. 0
 <b>Golder Associates</b> LONDON, ONTARIO			<b>FIGURE 1</b>

D size dwg 22" x 32" 11" x 17" plot half scale

1 = 1 metric



PROFILE ALONG CENTRELINE OF PROPOSED STRUCTURE



**METRIC**  
DIMENSIONS ARE IN METRES  
AND/OR MILLIMETRES  
UNLESS OTHERWISE SHOWN

**DIST No. 30 HWY. 26**  
**CONT. No.**  
**WP No. 630-91-00**

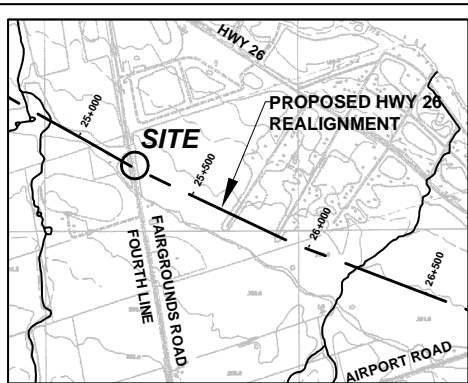
**FAIRGROUNDS ROAD UNDERPASS**  
**BOREHOLE LOCATIONS & SOIL STRATA**

**SHEET**



Golder Associates Ltd.  
LONDON, ONTARIO, CANADA

**REFERENCE**  
DRAWING SUPPLIED BY DILLON CONSULTING ENTITLED  
FAIRGROUNDS ROAD UNDERPASS  
PRELIMINARY GENERAL ARRANGEMENT  
DATED APRIL 03



**LEGEND**

- Borehole
- Seal
- Piezometer
- N Blows/0.3m (Std. Pen. Test, 475 j/blow)
- WL in piezometer Aug. 2003
- WL during drilling

No.	ELEVATION (metres)	LOCATION	
		NORTHING	EASTING
1	190.88	4925823.8	253834.7
2	192.02	4925743.5	253852.4
3	191.35	4925791.1	253839.8
4	190.76	4925843.5	253837.7
5	191.39	4925780.2	253847.1
6	192.86	4925731.7	253854.4

**NOTES**

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

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

NO.	DATE	BY	REVISION

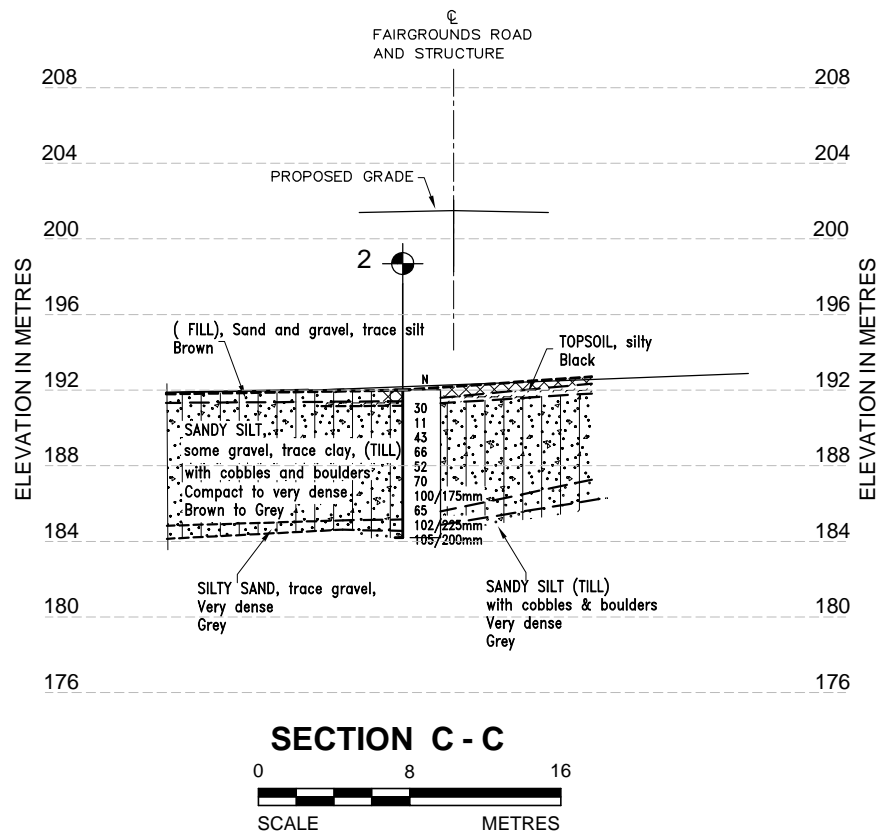
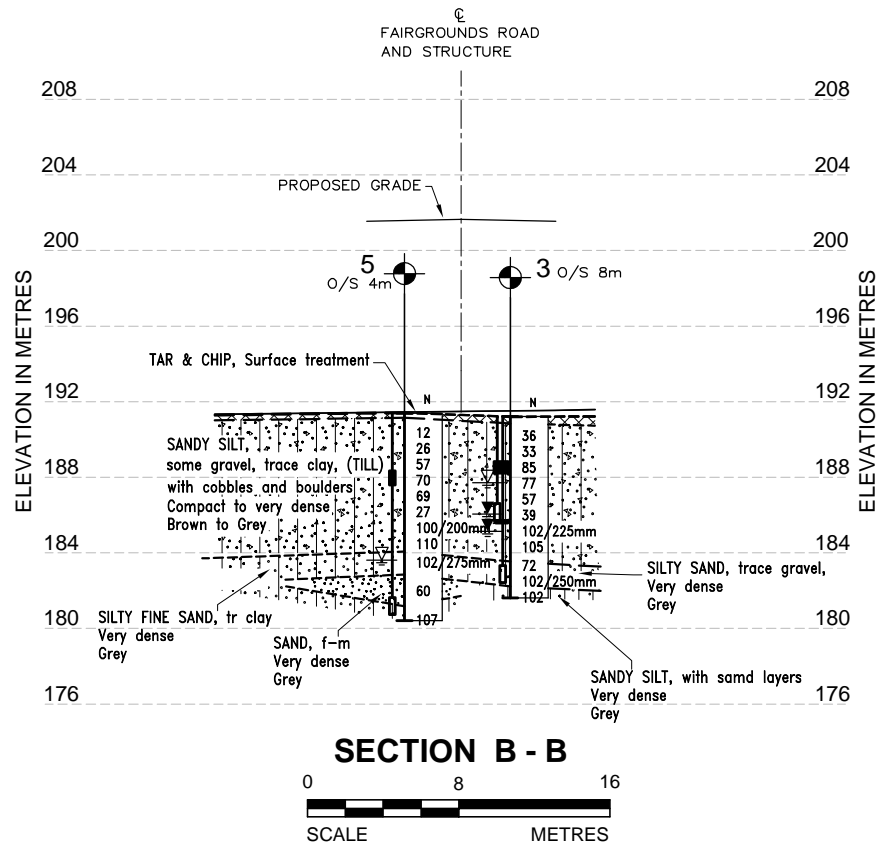
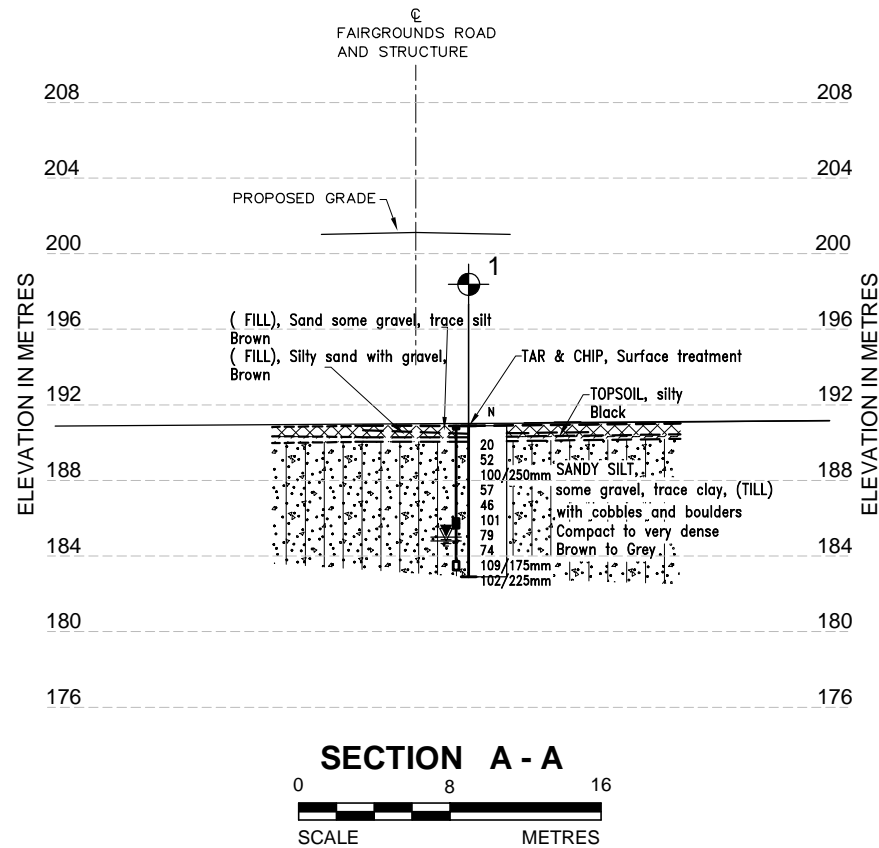
Geocres No. 41A-171

HWY. No. 26	PROJECT NO.: 001-3232-4-2		
SUBM'D. -	CHKD: -	DATE: JAN 2006	
DRAWN: WDF/BG	CHKD: AMH	APPD.	DWG. 1

1 = 1 metric  
D size dwg 22" x 32" 11" x 17" plot half scale

001-323223D001.DWG

**METRIC**  
DIMENSIONS ARE IN METRES  
AND/OR MILLIMETRES  
UNLESS OTHERWISE SHOWN



**DIST No. 30 HWY. 26**  
**CONT. No.**  
**WP No. 630-91-00**



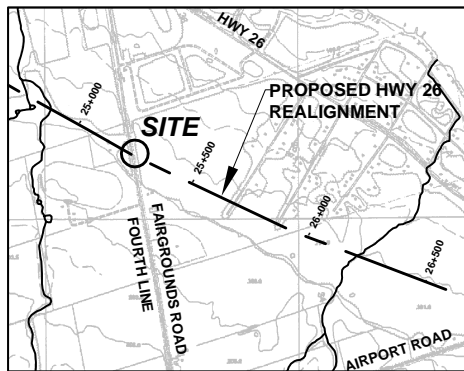
**FAIRGROUNDS ROAD UNDERPASS**  
**BOREHOLE LOCATIONS & SOIL STRATA**

**SHEET**



Golder Associates Ltd.  
LONDON, ONTARIO, CANADA

**REFERENCE**  
DRAWING SUPPLIED BY DILLON CONSULTING ENTITLED  
FAIRGROUNDS ROAD UNDERPASS  
PRELIMINARY GENERAL ARRANGEMENT  
DATED APRIL 03



**KEY PLAN**

**LEGEND**

- Borehole
- Seal
- Piezometer
- N Blows/0.3m (Std. Pen. Test, 475 j/blow)
- WL in piezometer Aug. 2003
- WL during drilling

No.	ELEVATION (metres)	LOCATION	
		NORTHING	EASTING
1	190.88	4925823.8	253834.7
2	192.02	4925743.5	253852.4
3	191.35	4925791.1	253839.8
5	191.39	4925780.2	253847.1

**NOTES**

The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.  
This drawing is for subsurface information only.

NO.	DATE	BY	REVISION

Geocres No. 41A-171

HWY. No.	26	PROJECT NO.:	001-3232-4-2
SUBM'D.	-	CHKD.	-
DRAWN:	BG	CHKD.	AMH
		APPD.	
		DWG.	2

**APPENDIX A**  
**LABORATORY TEST DATA**





## **APPENDIX B SITE PHOTOGRAPHS**

## **SITE PHOTOGRAPHS**



Photo 1      BATTEAUX RIVER CROSSING



Photo 2      BATTEAUX RIVER CROSSING