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GEOCRES No. 31E-137DIST. 52 REGION G.W.P. No. 209-97-00(A)CONT. No. W. O. No. STR. SITE No. 44-386~~44-388 N/S~~HWY. No. 69LOCATION Badger Rd. UnderpassNo of PAGES -

OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.REMARKS:

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REPORT

**FOUNDATION INVESTIGATION AND DESIGN
PROPOSED HIGHWAY 69
FOUR LANING OF THE PARRY SOUND BYPASS
BADGER ROAD UNDERPASS
G.W.P. 209-97-00, SITE 44-386
MTO DISTRICT 52, HUNTSVILLE**

Final

Submitted to:
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Thornhill, Ontario
L3T 7N9

Final



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Table 1

List of Abbreviations and Symbols

Lithological and Geotechnical Rock Description Terminology

Record of Borehole Sheets

Drawing Badger Road Underpass, Parry Sound Bypass, Borehole Locations and
Soil Strata

Figure 1 Grain Size Distribution

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1.0 INTRODUCTION

Golder Associates Ltd. has been retained by Cole, Sherman & Associates (Cole, Sherman) on behalf of the Ministry of Transportation, Ontario (MTO) to carry out a foundation investigation at the site of the proposed bridge to carry Badger Road Extension over the proposed Highway 69. The Badger Road underpass is part of the Parry Sound Bypass project which involves four laning of a section of Highway 69 from Badger Road northerly 10 km to Sequin River. The new alignment of Highway 69 at the bridge site is located approximately 300 m to the east of the existing Highway 69. This report addresses the proposed bridge and its approaches within 20 m of the structure. The site of the project is designated as Site 44-386.

The purpose of this investigation is to determine the subsurface conditions at the site of the proposed bridge structure by drilling boreholes, and carrying out in-situ tests and laboratory tests on selected samples. Based on our interpretation of the data obtained, recommendations on the geotechnical aspects of design of the proposed works are provided. Comments are also provided on anticipated construction problems where they may affect design of the proposed bridge and approach embankments.

The proposed horizontal and vertical alignment for the Highway 69 underpass and the location of the bridge were provided to us on the 1:5000 plan and profile route planning study drawings. The locations of the bridge abutments were staked in the field by Cole, Sherman.

The terms of reference for the scope of work are outlined in our proposal letter P71-1494, dated November 26, 1997. The work was carried out in accordance with our Quality Control Plan for Foundation Design Services, dated March 03, 1998. During the course of the field work, the number of boreholes was increased to accommodate the site conditions as encountered.

2.0 SITE DESCRIPTION

The site is located approximately 300 m to the east of the existing Highway 69 and 9 km to the south of Parry Sound, Ontario. The site is located within the MTO District 52, Huntsville and is designated as Site 44-386.

The site is situated in an area of massive bedrock outcrop with ridges, depressions and scattered boulders. The ground surface is undulating and varies between about Elevations 236 m and 250 m in the general vicinity of the site. The lower lying areas are typically swampy and an extensive swamp is present to the east of the site. There is a relatively thick vegetation cover within the lower lying portion of the site consisting of shrubs, trees and grass.

3.0 INVESTIGATION PROCEDURES

The field work for this investigation was carried out between May 15, 1998 and May 20, 1998. At this time eight boreholes and nine probeholes were drilled at the site of the proposed structure; Boreholes 2 and 3 and Probeholes PH1 to PH3 were put down at the location of the west abutment, Boreholes 4 and 5 and Probeholes PH4 to PH6 were drilled at the location of the pier and Boreholes 6 and 7 and Probeholes PH7 to PH9 were put down at the location of the east abutment. In addition, two boreholes, numbered Boreholes 1 and 8, were put down within the west and east approach embankments, respectively. The investigation was carried out using a bombardier mounted CME 55 drill rig supplied and operated by Marathon Drilling Inc. of Ottawa.

Soil samples were obtained at regular intervals of depth using 50 mm outside diameter split-spoon samplers in accordance with Standard Penetration Test (SPT) procedures. Boreholes 2, 4 and 6 were drilled to 5.6 m, 9.3 m and 6.8 m depths, respectively, with bedrock coring; BQ size core samples were obtained from the boreholes. The remainder of the boreholes and probeholes were drilled to refusal which was encountered between 0.2 m and 1.2 m depths. Groundwater conditions in the open holes were observed throughout the drilling operations and on completion of drilling. One piezometer was installed in Borehole 4 to monitor the groundwater level at the borehole location.

The field work was supervised on a full-time basis by a member of our technical staff who located the boreholes and probeholes in the field, directed the drilling, sampling and in-situ testing operations, and logged the borings. The soil samples were identified in the field, placed in labeled containers and transported back to our laboratory in Mississauga for further examination. Index and classification tests were carried out on selected samples.

The as-drilled borehole and probehole locations were determined by our field personnel based on the highway chainages and foundation unit limits as staked in the field. Surveyed borehole and probehole locations and elevations were provided by Cole, Sherman and we understand that the elevations are referenced to Geodetic Datum. The northing and easting co-ordinates of the borehole locations are indicated on the Record of Borehole sheets; the locations of the probeholes are summarized in Table 1. The locations of the boreholes and probeholes are shown on a drawing "Borehole Locations and Soil Strata", attached.

4.0 GENERAL SITE GEOLOGY AND STRATIGRAPHY

4.1 Site Geology

From published geologic information, the site is located in the physiographic region known as the Laurentian Highlands which forms the southernmost part of the Canadian Precambrian Shield (Geology of Ontario; OGS Special Volume 4). The Laurentian Highlands comprises a southeast-trending, slightly elevated region underlain by Precambrian bedrock which was eroded to form an undulating surface with frequent rounded knobs and ridges. The terrain comprises large expanses of intrusive and metamorphic rocks such as gneisses and gneissic or massive granitic rocks. The rocks are geologically complex with considerable folding, intrusive activity, regional metamorphism and faulting. The local physiography is characterized by shallow overburden consisting mainly of outwash sand and gravel and irregular, variable bedrock surface with frequent rock outcrops and shallow bedrock. Since irregular bedrock surface is typical in the area, terrain with organic deposits is widespread.

4.2 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. The results of the probeholes are summarized in Table 1. The stratigraphic boundaries shown on the Record of Borehole sheets 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, granitic biotite-hornblende gneiss bedrock is exposed at the ground surface or is encountered at shallow depths (less than 1.2 m). A detailed description of the subsurface conditions encountered in the boreholes is provided in the following sections.

4.2.1 Overburden Soils

In the central portion of the site, at the locations of Boreholes 4 and 5 and Probeholes 4 to 6, about 100 mm to 150 mm of topsoil was encountered at ground surface. The topsoil is underlain by about 0.2 m to 0.5 m of silty sand, except at the location of Borehole 4 where bedrock was encountered below 150 mm of topsoil.

In the remainder of the boreholes and probeholes located in the western and eastern portions of the site, as much as 0.7 m of fibrous peat was encountered extending from ground surface. The peat directly overlies bedrock, except in Borehole 8 where approximately 0.9 m of silty sand separates the peat and bedrock. Grain size distribution test results for a sample of sand are shown on Figure 1. Although boulders were not encountered during the investigation, boulders could be encountered directly overlying the bedrock.

4.2.2 Bedrock

Refusal to further auger penetration in the boreholes and probeholes was encountered at depths ranging from 0.2 m to 1.2 m (between Elevation 240.7 m and Elevation 247.3 m). Bedrock was cored in Boreholes 2, 4 and 6 commencing at 0.38 m, 0.15 m and 0.46 m depth, respectively, indicating that the auger refusal met at the remainder of the borehole and probehole locations was on the bedrock surface. The bedrock surface depths and elevations at the borehole and probehole locations are summarized below:

<i>Borehole / Probehole</i>		<i>Ground Surface</i>	<i>Bedrock Surface</i>	
<i>Number</i>	<i>Location</i>	<i>Elevation (m)</i>	<i>Depth (m)</i>	<i>Elevation (m)</i>
Borehole 1	West Approach	244.41	0.76	243.65
Borehole 2	West Abutment	244.65	0.38	244.27
Probehole PH11		244.57	0.51	244.06
Probehole PH12		244.59	0.71	243.88
Probehole PH13		244.63	0.00	244.63
Borehole 3		244.97	0.76	244.21
Borehole 4	Pier	245.73	0.15	245.58
Probehole PH14		245.81	0.46	245.35
Probehole PH15		246.09	0.49	245.60
Probehole PH16		246.00	0.30	245.70

<i>Borehole / Probehole</i>		<i>Ground Surface</i>	<i>Bedrock Surface</i>	
<i>Number</i>	<i>Location</i>	<i>Elevation (m)</i>	<i>Depth (m)</i>	<i>Elevation (m)</i>
Borehole 5		246.13	0.60	245.53
Borehole 6	East Abutment	245.17	0.46	244.71
Probehole PH7		245.52	0.23	245.29
Probehole PH8		246.17	0.38	245.79
Probehole PH9		246.55	0.25	246.30
Borehole 7		247.65	0.38	247.27
Borehole 8	East Approach	241.90	1.22	240.68

Based on the results of the boreholes and probeholes, the bedrock surface rises to the east from Elevation 243.7 m (Borehole 1) to Elevation 247.3 m (Borehole 7) and then decreases relatively steeply down to about Elevation 240.7 m (Borehole 8).

Rock coring was carried out in Boreholes 2, 4 and 6 for lengths of about 5.2 m, 9.2 m and 6.3 m, respectively. The rock core samples obtained consist of slightly weathered to fresh crystalline granitic biotite-hornblende gneiss. In Boreholes 2 and 6, the Rock Quality Designation (RQD) measured on the core samples ranged from 90 per cent to 100 per cent. In Borehole 4, the RQD measured on the core samples was typically greater than 90 per cent; however, at a depth of about 2 m a seam of broken core with sand infilling was noted. This seam was about 180 mm thick.

The presence of this sand infilled fractured zone within the cored length is indicative of the probable presence of a glacially induced shear zone within the rock mass. There are no bedrock outcrops in the immediate vicinity of the site; however, bedrock mapping carried out on sites located to the north suggests one sub-horizontal to 30° dipping joint set and two or three sub-vertical sets of joints. The spacing of the joint sets, where mapped, is typically moderately close (0.2 m to 0.6 m). In exposures, the joints exhibit apertures of a few millimeters with little or no infilling. Based on measurements of joints set orientations in the general area, the major sub-vertical set strikes approximately east-west and dips steeply towards the south. The second most prominent set is orthogonal to the major set and strikes approximately north-south with minor representation at other orientations. Because of the topography at the site it is presumed

that the sand-filled, weathered seam is associated with shearing on the sub-horizontal joint set as this type of feature is typical of the area.

4.3 Groundwater Conditions

The water level in the piezometer installed in Borehole 4 was at about 0.3 m depth on completion of installation and was at 1.7 m depth below ground surface on June 04, 1998 and at Elevation 244.7 m on April 29, 1999. The higher initial water level reading was likely as a consequence of the drilling water used for bedrock coring. The water level at Elevation 244.7 m is generally at or below the bedrock surface. It should be noted that the water level is subject to seasonal fluctuations. Given the relatively high water level within the bedrock, groundwater flow through the bedrock will be governed by the presence of sand infilled fractured zones and joints within the rock mass which are likely being recharged by adjacent topographical features.

May 1999

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PART B

FOUNDATION DESIGN

FOUNDATION INVESTIGATION AND DESIGN

PROPOSED HIGHWAY 69

FOUR LANING OF THE PARRY SOUND BYPASS

BADGER ROAD UNDERRPASS

G.W.P. 209-97-00, SITE 44-386

MTO DISTRICT 52, HUNTSVILLE

5.0 ENGINEERING RECOMMENDATIONS

5.1 General

This section of the report provides our recommendations on the geotechnical aspects of design of the Highway 69 underpass structure at Badger Road 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 method and scheduling.

The works described in this report are associated with the proposed bridge and its approaches within 20 m of the structure. It is understood that the proposed bridge will carry Badger Road Extension over the proposed Highway 69. The bridge will be a two span structure 86 m in length. It is understood that the final grade of Highway 69 will vary between Elevation 238 m and Elevation 238.5 and that the Badger Road Extension grade will vary between Elevation 245.3 m at the east abutment and Elevation 247.0 m at the west abutment.

The proposed horizontal and vertical alignment for Highway 69 underpass and the location of the bridge were provided to us on the 1:5000 Route Planning Study drawings and details were shown on the General Arrangement Plan prepared by Cole, Sherman in February 1999.

5.2 Bridge Foundations

At the location of the proposed west abutment, the bedrock surface is undulating between Elevation 243.9 m and Elevation 244.6 m, with as much as 0.7 m of peat directly overlying the bedrock.

At the location of the pier, about 100 mm to 150 mm of topsoil and 0.2 m to 0.5 m of silty sand overlie the bedrock. Bedrock was encountered between Elevation 245.4 m and Elevation 245.7 m (between 0.2 m and 0.6 m depths).

At the location of the proposed east abutment, the overburden cover (peat) varies from 0.2 m to 0.5 m at the borehole locations. The bedrock surface in effect follows the ground surface topography varying from about Elevation 247.3 m at the north end of the abutment to Elevation 244.7 m at the south end of the abutment.

It is understood that the founding level of the bridge abutments will be governed by the proposed grade of the Badger Road Extension and will be maintained as high as possible. A design founding level of 4.5 m below the proposed bridge deck / Badger Road grade has been shown on the General Arrangement Plan; i.e. Elevation 240.8 m at the east abutment and 242.5 m at the west abutment. A founding level of the pier at Elevation 239.0 m has been indicated on the General Arrangement Plan.

At the west abutment, the proposed founding level is about 1.5 m to 2.0 m below the bedrock surface and about 2 m to 2.5 m below the existing ground surface. At the east abutment, the founding level is 4.0 m to 6.5 m below the bedrock surface. At the pier, the proposed founding level is at about 7 m below the existing ground surface and about 6.5 m below the bedrock surface.

With the proposed grades, there will be substantial bedrock excavation required both for the general cut for the Highway 69 construction and for the footing construction.

The abutment footings will be maintained about 4 m to 5 m above the general cut / ditch level for Highway 69; the pier footing will be about 2 m above the adjacent ditch level. In order to maintain the integrity of the bedrock underlying the foundation, special precautions / inspection and controlled blasting with pre-shearing or cushion blasting will be required for the general cut where in close proximity to the footings. Good perimeter blasting control is key to being able to achieve the required competence of the foundations for the abutments, and as such, stringent specification of excavation and support standards is recommended.

It is further recommended that the general bedrock excavation be carried out initially to just above the proposed founding level. The rock cut faces should then be inspected by qualified geotechnical personnel to assess the potential for additional face support requirements for the cut face below and adjacent to the footings. Given the potential for adverse orientation of the joint sets with respect to

the rock cuts extending below the founding level, it is imperative that this inspection be completed as soon as the initial excavation is completed. A stereonet of the joint sets should be prepared by qualified geotechnical specialists and assessment made of where potential wedge failures are anticipated to take appropriate precautions with the next stage of rock excavation in order to avoid potential delays in footing construction. Depending on the joint set orientation, rock dowelling along the crest of the proposed cut adjacent to the footings and / or inclined rock bolting through / into the proposed rock face area from the base of the excavation may be necessary to pre-support the rock mass.

Based on the above, the use of spread footings placed on the bedrock is considered appropriate for support of the abutments and pier. In summary, the founding elevations that have been assumed for design based on the General Arrangement Plan are as follows:

<i>Foundation Location</i>	<i>Reference Borehole / Probehole</i>	<i>Assumed Design Founding Elevation (m)</i>
West Abutment	Boreholes 2 and 3 Probeholes PH1 to PH3	242.5 m
Pier	Boreholes 4 and 5 Probeholes PH4 to PH6	239.0 m
East Abutment	Boreholes 6 and 7 Probeholes PH7 to PH9	240.8 m

5.2.1 Factored Geotechnical Resistance

Spread footings placed on the fresh bedrock at or below the elevations as specified above may be designed for a factored geotechnical resistance at Ultimate Limit States (ULS) of 10,000 kPa. This value assumes that controlled blasting for road and 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 below the footing to permit wedge failure. The above bearing value is for vertical concentric loads only. Effects of load inclination and eccentricity need to be taken into account as appropriate. Serviceability Limit States (SLS) conditions do not apply to footings placed on the fresh bedrock.

The proposed Highway 69 will be about 6 m to 9.5 m below the bedrock surface in the immediate vicinity of the underpass. Abutment footings should be located far enough from the face of rock cuts such that the footing is maintained outside the zone defined by a 0.5 horizontal to 1 vertical line drawn from the toe of the rock cut. This criteria assumes that controlled blasting techniques have been used for the rock excavation such that the integrity of the bedrock within the zone is not adversely impacted. Some rock bolting and mass or dental concrete placement may be required depending on the joint patterns within the bedrock as exposed in the rock cut excavation.

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 and at the footing level should be removed and replaced with concrete.

5.2.2 Horizontal Resistance

Resistance to lateral forces / sliding resistance between the concrete footings and bedrock should be calculated in accordance with Section 6-8.4.3 of the OHBDC assuming an unfactored angle of friction of 35 degrees. If necessary, sliding resistance can be supplemented by doweling into bedrock.

A value of 500 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 1.0 m long within the rock and the structural strength of the dowel and the compressive strength of the grout should not be exceeded. Provision should also be made in the contract for longer dowels or for tensioned bolts in the event there are adversely oriented joints in the rock under the footing that could potentially result in a sliding failure toward the cut face.

5.2.3 Frost Protection

For spread footings placed on fresh granitic gneiss bedrock, frost protection cover is not required.

5.3 Lateral Earth Pressures

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

- Select free-draining granular fill meeting the specifications of OPSS Granular A or Granular B but with less than 5 per cent passing the 200 sieve should be used as backfill behind the walls. All granular fill should be compacted in lifts of loose thickness not greater than 200 mm to 95 per cent of the material's Standard Proctor maximum dry density.
- Longitudinal drains and weep holes should be installed to provide positive drainage of the granular backfill.
- The granular fill may be placed either in a zone with width equal to at least 1.6 m behind the back of the stem (Case I) or within the wedge-shaped zone defined by a 60 degree line extending up and back from the bottom of the rear face of the footing (Case II).
- If the wall support allows lateral yielding of the stem (unrestrained structure), active earth pressures may be used in the geotechnical design of the structure. If the abutment support does not allow lateral yielding (restrained structure), at-rest pressures should be assumed for geotechnical design.
- A compaction surcharge equal to 16 kPa should be included in the lateral earth pressures for the structural design of the abutment wall in accordance with OHBDC Figure 6-7.4.3.
- For Case I, the pressures are based on the embankment fill materials and the following parameters (unfactored) may be assumed:

Soil unit weight (assuming clean earth fill)	21 kN/m ³
---	----------------------

Coefficients of lateral earth pressure:

'active'	0.31
'at rest'	0.47

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

	Granular A	Granular B
Soil Unit Weight	22 kN/m ³	21 kN/m ³
Coefficient of Lateral Earth Pressure		
'active'	0.27	0.31
'at rest'	0.43	0.47

It should be noted that the above design parameters assume level backfill and ground surface behind the wall. Other aspects of the abutment granular backfill requirements with respect to sub-drains and frost taper should be in accordance with OPSD-3501.00.

5.4 Excavations and Permanent Cut Slopes

Excavations for footing and road construction will be up to about 9.5 m in depth below existing ground surface. The excavations will extend through the surficial peat and / or silty sand, through as much as 9.5 m of rock and will terminate within the bedrock.

Excavations extended through the soils, which will be open for a relatively short period of time can be made in temporary unsupported cut with side slopes maintained not steeper than 1.5 horizontal to 1 vertical.

The water level in the piezometer installed in Borehole 4 located within the pier area was at 1.0 m depth (Elevation 244.7 m) on April 29, 1998. Some water inflow should be anticipated through the peat, silty sand and at the overburden / bedrock interface as well as through fracture zones within the bedrock. Assuming that the general excavation for the highway is completed prior to footing preparation, gravity drainage should be sufficient for control of groundwater inflows. It should be noted, however, that significant flow through fractured zones / sand infilled seams could be encountered where these zones are intercepted and provision should be made for treatment of these water bearing seams if they are present within the final cut face. Treatment is required in order to provide protection against long-term erosion and to provide drainage control.

In general, treatment of these seams would involve cleaning out, placement of lean mix and installation of drain holes. The extent and details of treatment can only be established in the field after excavation.

For excavations extended through the bedrock, vertical sides will be suitable. For the permanent cut slopes through the bedrock, the overall slope to the cut face may be formed vertical to near vertical. The use of carefully controlled drill and blast excavation techniques will be required in order to ensure a neat excavation line and minimize face instabilities and long-term maintenance problems.

The blasting pattern and procedures for the rock excavation (both the general excavation and where adjacent to the proposed bridge footings) should be submitted for approval. The desired specification would be for 80% half barrels to be visible on the cut face after scaling. As discussed in Section 5.2, it is imperative that the joint set orientation be established in the field prior to significant excavation in order to ensure that the appropriate precautions are taken with respect to scaling and bolting. The permanent cut slopes will be up to 9 m in height within the bedrock and adverse jointing with inadequate bolting can result in wedge failures.

Inspection of the face by qualified geotechnical personnel immediately after blasting should be carried out in order to assess where scaling / loosened rock removal should be carried out adjacent to the footings and where additional rock bolting may be required.

5.5 Approach Embankments

Based on the Route Planning Study drawings showing the proposed horizontal and vertical alignment for Badger Road Extension underpass and on the General Arrangement drawing, the proposed Badger Road grade will be at about Elevation 245.3 m at the east abutment and at Elevation 247.0 m at the west abutment and will involve approach embankments between 2.5 m and 3.5 m in height. Based on the subsurface information, the subsoils within the approach embankments consist of about 0.8 m to 1.2 m of overburden comprising of loose fibrous peat and loose to dense silty sand. The overburden is underlain by granitic biotite-hornblende bedrock.

Given the above, stability of the proposed embankment is not a concern with respect to deep seated failure through the founding soils. There will be minimal settlement of the embankment due to consolidation of the loose sands and this settlement will occur during embankment construction assuming that all peat and organic materials will be removed before placement of the embankment fill.

5.6 Subgrade Preparation and Embankment Construction

Topsoil and organic deposits should be stripped from below the fill embankment areas and the exposed subgrade soils should be proof-rolled prior to fill placement.

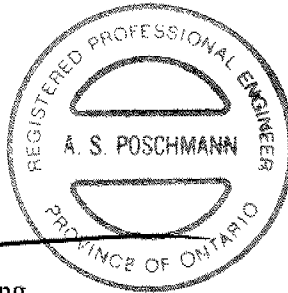
Construction of the embankment above the prepared subgrade may be carried out using clean earth fill (in accordance with OPSS 212) or Select Subgrade Material (in accordance with OPSS 1010), depending on material availability. All embankment fill should be placed in regular lifts with loose thickness not exceeding 300 mm, and be compacted to at least 95 per cent of the material's Standard Proctor maximum dry density. The final lift prior to placement of the granular subbase or base course should be compacted to 100 per cent of the Standard Proctor maximum dry density. Inspection and field density testing should be carried out by qualified geotechnical personnel during all fill placement operations to ensure that appropriate materials are used and that adequate levels of compaction have been achieved. The permanent soil slopes of the embankment should be maintained not steeper than 2 horizontal to 1 vertical. Vegetation cover should be established on all soil slopes to protect embankment fill against surficial erosion.

Alternatively, the approach embankments could be constructed using rockfill if available to the project. The permanent side slopes of the rockfill embankments should be maintained not steeper than 1.25 horizontal to 1 vertical.

GOLDER ASSOCIATES LTD.



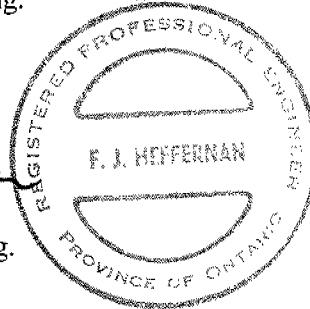
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AMP/ASP/FJH/DEB/clg
WORD S/FINALDAT/1100/981-1111/1999/81111DR1

TABLE 1
SUMMARY OF PROBEHOLE RESULTS
BADGER ROAD EXTENSION

Probehole Number	Ground Surface Elevation at Probehole Location	Probehole Location		Topsoil Thickness (m)	Silty Sand Thickness (m)	Fibrous Peat Thickness (m)	Depth to Bedrock (m)	Bedrock Elevation(m)
		Northing	Easting					
PH1	244.57	5018877.45	270513.10	-	-	0.51	0.51	244.06
PH2	224.59	5018878.69	270511.55	-	-	0.71	0.71	243.88
PH3	224.63	5018879.98	270510.47	-	-	-	0.0	244.63
PH4	245.81	5018906.26	270534.44	0.10	0.36	-	0.46	245.35
PH5	246.09	5018907.52	270532.63	0.15	0.34	-	0.49	245.60
PH6	246.00	5018908.23	270531.44	0.15	0.15	-	0.30	245.70
PH7	245.52	5018934.30	270560.92	-	-	0.23	0.23	245.29
PH8	246.17	5018935.41	270559.38	-	-	0.38	0.38	245.79
PH9	246.55	5018936.98	270557.96	-	-	0.25	0.25	246.30

EXCEL S\FINALDAT\1100\981-1111\1999\811111ET1

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

II PENETRATION RESISTANCE

Standard Penetration Resistance (SPT), N :

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

Dynamic 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):

An electronic cone penetrometer with a 60° conical tip and a projected 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.

III SOIL DESCRIPTION

(a) Cohesionless Soils

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

(b) Cohesive Soils

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

IV. SOIL TESTS

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

Note:

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

LIST OF SYMBOLS

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

I GENERAL

π	= 3.1416
$\ln x$,	natural logarithm of x
$\log_{10} x$ or $\log x$,	logarithm of x to base 10
g	acceleration due to gravity
t	time
F	factor of safety
V	volume
W	weight

II STRESS AND STRAIN

γ	shear strain
Δ	change in, e.g. in stress: $\Delta \sigma$
ϵ	linear strain
ϵ_v	volumetric strain
η	coefficient of viscosity
ν	Poisson's ratio
σ	total stress
σ'	effective stress ($\sigma' = \sigma - u$)
σ'_{vo}	initial effective overburden stress
$\sigma_1, \sigma_2, \sigma_3$	principal stresses (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
*	Density symbol is ρ . Unit weight symbol is γ where $\gamma = \rho g$ (i.e. mass density x acceleration due to gravity)

(a) Index Properties (con't.)

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)

(c) 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

(d) Consolidation (one-dimensional)

C_c	compression index (normally consolidated range)
C_r	recompression index (overconsolidated range)
C_s	swelling index
C_α	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	Overconsolidation ratio = σ'_p / σ'_{vo}

(e) Shear Strength

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

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

2. Shear strength = (Compressive strength)/2

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	

W.P. 209-97-00
DIST. 52, SITE: 44-386, HWY 69
LOCATION: N 5018863.28; E 270497.99

RECORD OF BOREHOLE 1

BORING DATE: MAY 15/98

SHEET 1 OF 1

DATUM: GEODETIC

PROJECT: 981-1111



DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE		SAMPLES		DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m	HYDRAULIC CONDUCTIVITY, k, cm/s		ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION		
		DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	NUMBER		TYPE	BLOWS/0.3m			SHEAR STRENGTH Cu, kPa	WATER CONTENT, PERCENT Wp — W — Wl
0	CME 55 BOMBARDIER 101mm SOLID STEM POWER AUGER	GROUND SURFACE		244.41								
		Fibrous Peat, some silt and sand Loose Dark brown		0.00	1	SS DO	4					
1		END OF BOREHOLE REFUSAL TO FURTHER AUGER PENETRATION PROBABLY ON BEDROCK		243.65 0.76								
2												
3												
4												
5												
6												
7												
8												
9												
10												

> 59.9

Note:
Open hole dry on
completion of
drilling.

DEPTH SCALE

1 to 50

Golder Associates

LOGGED: SB

CHECKED: AP

DATUM: GEODETIC

PROJECT: 981-1111

DEPTH SCALE METRES	SOIL PROFILE	SAMPLES				DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m	HYDRAULIC CONDUCTIVITY, K, cm/s	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION			
		DESCRIPTION	STRATA PLOT	ELEV.	NUMBER	TYPE	BLOWS/0.3m			SHEAR STRENGTH Cu, kPa	nat V - + O - ● rem V - ⊕ U - ○	WATER CONTENT, PERCENT Wp ——— W ——— Wl 10 20 30 40
				DEPTH (m)								
0	GROUND SURFACE		244.65									
	Fibrous Peat, some sand, trace silt		0.00	1	SO	4						
	Loose		244.27									
	Dark brown		0.38									
BOREHOLE CONTINUED; FOR BEDROCK CORING DETAILS REFER TO SHEET 2.												
1												
2												
3												
4												
5												
6												
7												
8												
9												
10												

CME 55 BOMBARDIER

101mm SOLID STEM POWER ROVING METHOD

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101mm SOLID

LOGGED: SB

W.P. 209-97-00
DIST. 52. SITE: 44-386, HWY 69
LOCATION: N 5018875.33; E 270514.05

RECORD OF BOREHOLE 2

DRILLING DATE: MAY 15/98
DRILL RIG: CME 55 BOMBARDIER
DRILLING CONTRACTOR: MARATHON

SHEET 2 OF 2
DATUM: GEODETIC
PROJECT: 981-1111



DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	PENETRATION RATE (mm/min)	FLUSH % RETURN	FR-FRACTURE		F-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			
								SH-SHEAR		P-POLISHED		ST-STEPPED		W-WAVY		B-BEDDING			
								VN-VEIN		S-SLICKENSIDED		PL-PLANAR		C-CURVED					
RECOVERY		R.Q.D.		FRACT.		DISCONTINUITY DATA		HYDRAULIC											
TOTAL CORE %	SOLID CORE %	%	INDEX PER 0.3	DIP w.r.t. CORE AXIS	TYPE AND SURFACE DESCRIPTION	CONDUCTIVITY K cm/sec													
000000	000000	000000	000000	000000															
000000	000000	000000	000000	000000															
000000	000000	000000	000000	000000															
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W.P. 209-97-00
DIST. 52, SITE: 44-386, HWY 69
LOCATION: N 5018881.76; E 270508.32

RECORD OF BOREHOLE 3

BORING DATE: MAY 15/98

SHEET 1 OF 1

DATUM: GEODETIC

PROJECT: 981-1111



DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE		SAMPLES		DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m		HYDRAULIC CONDUCTIVITY, K, cm/s		ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION	
		DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	NUMBER TYPE	SHEAR STRENGTH Cu, kPa	WATER CONTENT, PERCENT Wp W Wl					
0	CME 55 BOMBARDIER 101mm SOLID STEM POWER AUGER	GROUND SURFACE		244.97								
		Moss and Fibrous Peat Dark brown			0.00	1	50 DO	4			>230	
1		END OF BOREHOLE REFUSAL TO FURTHER AUGER PENETRATION PROBABLY ON BEDROCK			244.21 0.78							Note: Open hole dry on completion of drilling.
2												
3												
4												
5												
6												
7												
8												
9												
10												

DEPTH SCALE

1 to 50

Golder Associates

LOGGED: SB

CHECKED: AP

W.P. 209-97-00
DIST. 52, SITE: 44-386, HWY 69
LOCATION: N 5018905.52; E 270536.10

RECORD OF BOREHOLE 4

SHEET 1 OF 1
DATUM: GEODETIC
PROJECT: 981-1111



DRILLING DATE: MAY 19/98
DRILL RIG: CME 55 BOMBARDIER
DRILLING CONTRACTOR: MARATHON

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV.	RUN No.	PENETRATION RATE (mm/min)	FLUSH % RETURN	COLOUR	FR-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	VN-VEIN	P-POLISHED	S-SLICKENSIDED	ST-STEPPED	PL-PLANAR	W-WAVY	C-CURVED	B-BEDDING													
									RECOVERY		R.Q.D. %	FRACT. INDEX PER 0.3	DISCONTINUITY DATA		HYDRAULIC CONDUCTIVITY k, cm/sec															
TOTAL CORE %	SOLID CORE %	DP W/L CORE AMS	TYPE AND SURFACE DESCRIPTION																											
0		GROUND SURFACE	245.73																											
		Fibrous Peat	0.00																											
			0.15																											
1				1	0.42		100																							
2		Slightly weathered to fresh, grey crystalline granitic biotite-hornblende gneiss. (BEDROCK)		2			100																							
3																														
4				3	0.28		100																							
5																														
6				4	0.5		100																							
7																														
8				5	0.45		100																							
9																														
10				6	0.5		100																							
		END OF BOREHOLE		236.43																										
				9.30																										

3-28-98
000000

▽

BENTONITE SEAL

SAND

Note:
Water level in
piezometer at
Elev. 244.0m on
June 4/98 and at
Elev. 244.7m on
April 29/98.

Note:
Water level in
piezometer at
Elev. 244.0m on
June 4/98 and at
Elev. 244.7m on
April 29/99.

DEPTH SCALE:

1 to 50

Golder Associates

LOGGED: SB

DATE: JUNE 16/98

CHECKED: AP

W.P. 209-97-00

RECORD OF BOREHOLE 5

SHEET 1 OF 1

DIST. 52, SITE: 44-386, HWY 69

BORING DATE: MAY 15/98

DATUM: GEODETIC

LOCATION: N 5018909.15; E 270529.41

PROJECT: 981-1111



DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE		SAMPLES		DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m		HYDRAULIC CONDUCTIVITY, k, cm/s		ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION	
		DESCRIPTION	STRATA PLOT ELEV. DEPTH (m)	NUMBER	TYPE	SHEAR STRENGTH Cu, kPa	WATER CONTENT, PERCENT Wp — W — Wl					
0	CME 55 BOMBARDIER 101mm SOLID STEM POWER AUGER	GROUND SURFACE	248.13	1	SO 4							
		Topsoil	0.00									
		Silty Sand, some roots	0.15									
		Loose Brown	245.53									
1		END OF BOREHOLE REFUSAL TO FURTHER AUGER PENETRATION PROBABLY ON BEDROCK	0.60									
2												
3												
4												
5												
6												
7												
8												
9												
10												

Note:
Open hole dry on
completion of
drilling.

DEPTH SCALE

1 to 50

Golder Associates

LOGGED: SB

CHECKED: AP

W.P. 209-97-00
DIST. 52, SITE: 44-386, HWY 69
LOCATION: N 5018931.32; E 270582.09

RECORD OF BOREHOLE 6

BORING DATE: MAY 15/98

SHEET 1 OF 2

DATUM: GEODETIC

PROJECT: 981-1111



DEPTH SCALE METRES	SOIL PROFILE	SAMPLES		DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m	HYDRAULIC CONDUCTIVITY, K, cm/s	PIEZOMETER OR STANDPIPE INSTALLATION
		DESCRIPTION	STRATA PLAT			
0	GROUND SURFACE		245.17			
	Fibrous Peat, trace sand, trace silt		0.00			
	Very loose		244.71			
	Black		0.48			
1	BOREHOLE CONTINUED: FOR BEDROCK CORING DETAILS REFER TO SHEET 2.					
2						
3						
4						
5						
6						
7						
8						
9						
10						

CONTINUED ON NEXT PAGE

Note:
Water level in
open hole
influenced by
water used during
rock coring.

DEPTH SCALE

1 to 50

Golder Associates

LOGGED: SB

CHECKED: AP

W.P. 209-97-00
DIST. 52, SITE: 44-386, HWY 69
LOCATION: N 5018931.32; E 270562.09

RECORD OF BOREHOLE 6

DRILLING DATE: MAY 19/98
DRILL RIG: CME 55 BOMBARDIER
DRILLING CONTRACTOR: MARATHON

SHEET 2 OF 2
DATUM: GEODETIC
PROJECT: 981-1111



DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV.		RUN No.	PENETRATION RATE (mm/min)	FLUSH % RETURN	COLOUR % RETURN	FR-FRACTURE CL-CLEAVAGE SH-SHEAR VN-VEIN				F-FAULT J-JOINT P-POLISHED S-SUCKENSIDED				SM-SMOOTH R-ROUGH ST-STEPPED PL-PLANAR				FL-FLEXURED UE-UNEVEN W-WAVY C-CURVED				BC-BROKEN CORE MB-MECH. BREAK B-BEDDING		DIAMETRAL POINT LOAD INDEX (MPa)	NOTES WATER LEVELS INSTRUMENTATION																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																			
				DEPTH (m)	ELEV.					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																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																	
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DEPTH SCALE:

1 to 50

Golder Associates

LOGGED: SB
DATE: JUNE 16/98
CHECKED: AP

W.P. 209-97-00

DIST. 52, SITE: 44-386, HWY 69

BORING DATE: MAY 15/98

SHEET 1 OF 1

DATUM: GEODETIC

PROJECT: 981-1111

[illegible]

DEPTH SCALE

1 to 50

Golder Associates

LOGGED: SB

CHECKED: AP

W.P. 209-97-00
DIST. 52. SITE: 44-386, HWY 69
LOCATION: N 5018960.26, E 270577.01

RECORD OF BOREHOLE 8

BORING DATE: MAY 15/98

SHEET 1 OF 1

DATUM: GEODETIC

PROJECT: 981-1111



DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE		SAMPLES		DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m		HYDRAULIC CONDUCTIVITY, K, cm/s		ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		DESCRIPTION	STRATA PLOT ELEV. DEPTH (m)	NUMBER	TYPE	BLOWS/0.3m	SHEAR STRENGTH Cu, kPa	WATER CONTENT, PERCENT Wp W Wt			
0	CME 55 BOMBARDIER 101mm SOLID STEM POWER AUGER	GROUND SURFACE	241.90	1	SO DO	s					
		Fibrous Peat, some sand Loose Dark brown	0.00 241.80 0.30								
1		Sand, trace gravel, trace silt, trace organics Loose to dense Brown	240.88	2	SO DO	30/ 23					
2		END OF BOREHOLE REFUSAL TO FURTHER AUGER PENETRATION PROBABLY ON BEDROCK	1.22								
3											
4											
5											
6											
7											
8											
9											
10											

DEPTH SCALE

1 to 50

Golder Associates

LOGGED: SB

CHECKED: AP

Note:
Open hole dry on
completion of
drilling.

W.P. 209-97-00
DIST. 52. HWY 69
LOCATION: N 5019041.76; E 270644.32

RECORD OF BOREHOLE 9

BORING DATE: MAY 20/98

SHEET 1 OF 1

DATUM: GEODETIC

PROJECT: 981-1111



DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE		SAMPLES		DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m		HYDRAULIC CONDUCTIVITY, k, cm/s		ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION		
		DESCRIPTION	STRATA PLOT	ELEV.	NUMBER	TYPE	BLOWS/0.3m	SHEAR STRENGTH Cu, kPa	nat V - + rem V - ⊗			Q - ● U - ○	WATER CONTENT, PERCENT Wp — W — Wl
				DEPTH (m)									
0	CNE 55 BOMBARDIER 108mm HOLLOW STEM POWER AUGERS	GROUND SURFACE		234.44									
		Sand, trace gravel, trace silt, trace organics Very loose Grey		0.00	1	50 DO	3						
1				233.68									
		Silty Clay, trace sand Soft to firm Brown and grey		0.76	2	50 DO	4						
				232.92									
		Silty Sand, trace clay Loose Grey		1.52									
2				232.61	3	50 DO	7						
				1.83									
3					4	50 DO	3						
4			Sand, trace to some gravel, trace silt, trace organics Very loose to compact Brown										
5				5	50 DO	10							
6				6	50 DO	15							
7													
		END OF BOREHOLE REFUSAL TO FURTHER AUGER PENETRATION PROBABLY ON BEDROCK		227.12									
				7.32									

Note:
Water level in
open borehole at
0.6m depth on
completion of
drilling.

Note:
Water level in
open borehole at
0.8m depth on
completion of
drilling.

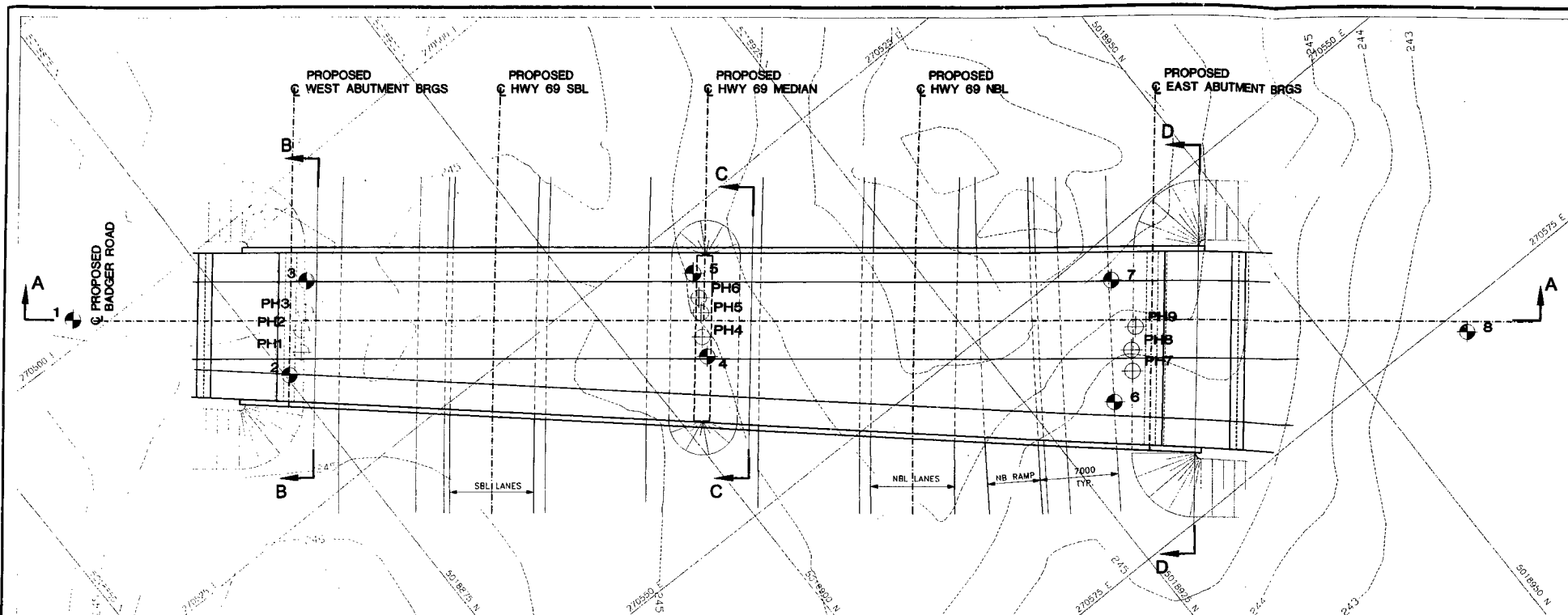
DEPTH SCALE

1 to 50

Golder Associates

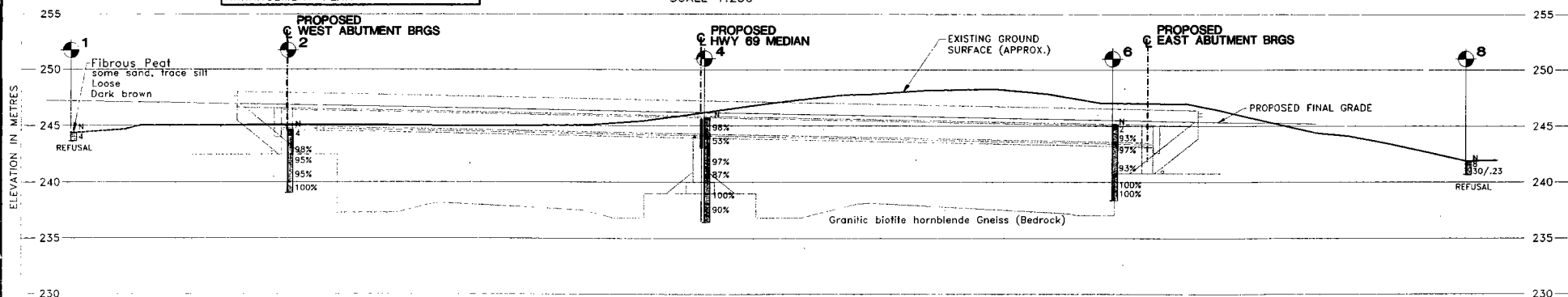
LOGGED: SB

CHECKED: AP

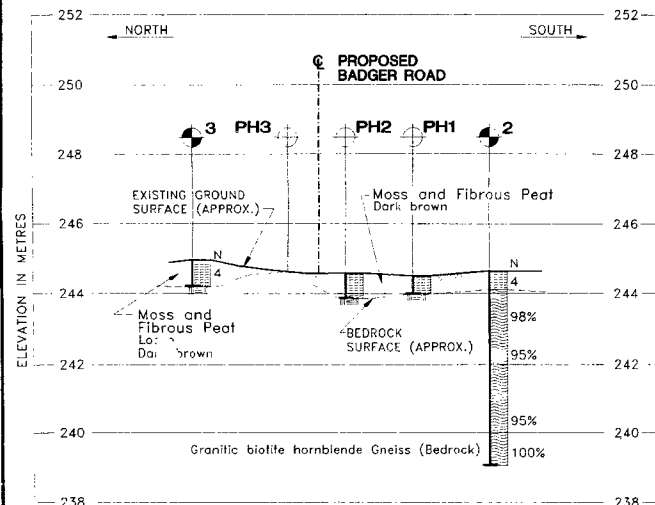


ABUTMENT LOCATIONS SHOWN ARE APPROXIMATE. FOR ACTUAL LOCATIONS OF ABUTMENTS REFER TO GENERAL ARRANGEMENT PLAN

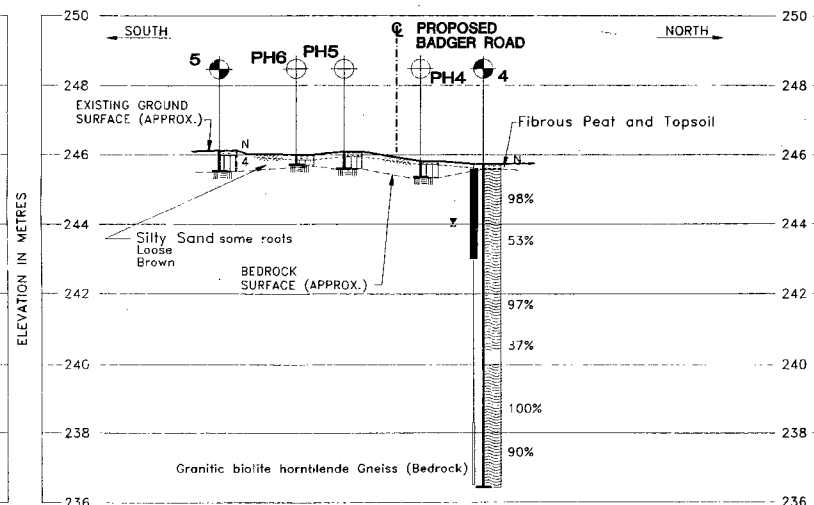
PLAN
SCALE 1:250



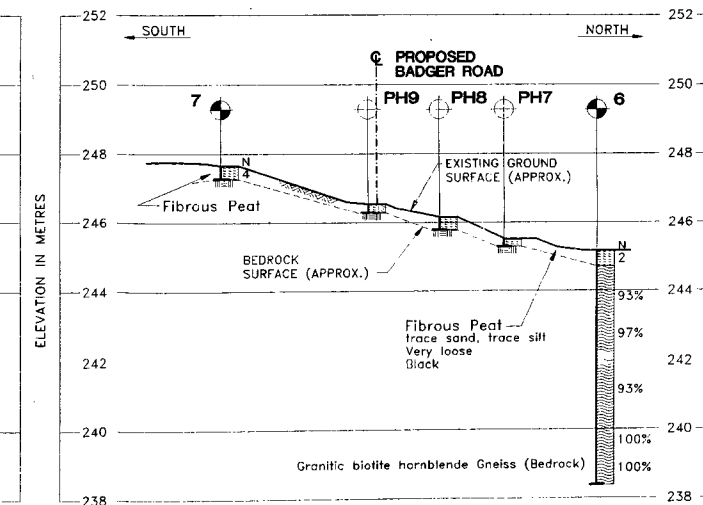
SECTION A-A
SCALE 1:250



SECTION B-B
WEST ABUTMENT
SCALE 1:100



SECTION C-C
PIER
SCALE 1:100



SECTION D-D
EAST ABUTMENT
SCALE 1:100

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

DIST 52 HWY 69
CONT. No.
WP No. 209-97-00

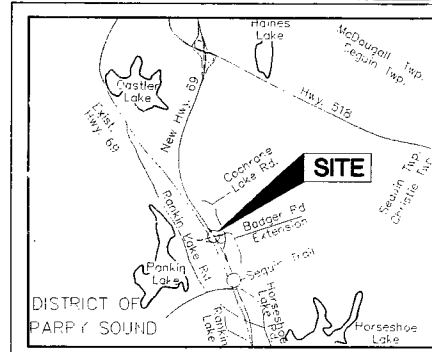
**BADGER RD. UNDERPASS
PARRY SOUND BYPASS**
BOREHOLE LOCATIONS & SOIL STRATA



SHEET



Golder Associates Ltd.
MISSISSAUGA, ONTARIO, CANADA



KEY PLAN

LEGEND

- Borehole
- Probehole
- Blows/0.3m (Std. Pen. Test, 475 j/blow)
- WL on June 4, 1998
- 90% Rock Quality Designation (RQD)

No.	ELEVATION	LOCATION	NORTHING	EASTING
1	244.41		5018863.28	270497.99
2	244.65		5018875.33	270514.05
3	244.97		5018881.76	270508.32
4	245.73		5018905.52	270536.10
5	246.13		5018909.15	270529.41
6	245.17		5018931.32	270562.09
7	247.65		5018937.88	270553.27
8	241.90		5018960.26	270577.01
PH1	244.57		5018877.45	270513.10
PH2	244.59		5018878.69	270511.55
PH3	244.63		5018879.98	270510.47
PH4	245.81		5018906.26	270534.44
PH5	246.09		5018907.52	270532.63
PH6	246.00		5018908.23	270531.44
PH7	245.52		5018934.30	270560.92
PH8	246.17		5018935.41	270559.38
PH9	245.55		5018936.98	270557.96

NOTES

The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence. General Arrangement drawing titled "Badger Road Underpass", dated February, 1999, provided by Cole Sherman in digital format.

NO.	DATE	AMP	BY	ISSUED FOR REVIEW	REVISION
A	?	AMP			

Geocres No.	PROJECT NO.: 981-1111(S001)	DIST. 52
HWY. No. 69	DATE: 1999 03 01	44-388
SUBM'D. AMP	CHKD. ASP	APPD.
DRAWN: JFC	CHKD. AMP	DWG. N111101B