

Golder Associates Ltd.

2180 Meadowvale Boulevard
Mississauga, Ontario, Canada L5N 5S3
Telephone (905) 567-4444
Fax (905) 567-6561



GEOCRES No:
41H-26

REPORT ON

**FOUNDATION INVESTIGATION AND DESIGN
PROPOSED HIGHWAY 69 FOUR LANING
FROM 3.5 km SOUTH OF HIGHWAY 124
NORTHERLY 6 km
TO THE SOUTH LIMIT OF THE TOWN OF NOBEL
SEGUIN RIVER CROSSING, NORTHBOUND LANES,
SITE #44-164N; W.P. 300-99-01
MINISTRY OF TRANSPORTATION, ONTARIO
DISTRICT 52, HUNTSVILLE**

Submitted to:
Cole, Sherman & Associates Ltd.
75 Commerce Valley Drive East
Thornhill, Ontario
L3T 7N9

GEOCRES No: 41H-26

DISTRIBUTION

- 6 Copies - Ministry of Transportation, Ontario,
North Bay, Ontario (Northern Region)
- 2 Copies - Cole, Sherman & Associates Ltd.,
Thornhill, Ontario
- 2 Copies - Golder Associates Ltd.,
Mississauga, Ontario

December 2000

001-1160 [002] (981-8043/6100N)

TABLE OF CONTENTS

<u>SECTION</u>	<u>PAGE</u>
PART A - FOUNDATION INVESTIGATION REPORT	
1.0 INTRODUCTION.....	1
2.0 SITE DESCRIPTION	2
3.0 INVESTIGATION PROCEDURES	3
4.0 GENERAL SITE GEOLOGY AND STRATIGRAPHY	5
4.1 Site Geology.....	5
4.2 Site Stratigraphy	5
4.2.1 River Bed Deposits	6
4.2.4 Bedrock	7
4.3 Groundwater Conditions	9
PART B - FOUNDATION DESIGN REPORT	
5.0 ENGINEERING RECOMMENDATIONS	10
5.1 General.....	10
5.2 Bridge Foundations.....	10
5.2.1 General	10
5.2.2 Foundation Alternatives.....	11
5.2.2.1 Shallow Foundations	12
5.2.2.2 Deep Foundations	14
5.2.3 Axial Geotechnical Resistance - Spread Footings	15
5.2.4 Axial Geotechnical Resistance - Driven Piles	15
5.2.5 Axial Geotechnical Resistance - Caissons	16
5.2.6 Horizontal Resistance - Spread Footings	17
5.2.7 Horizontal Resistance - Deep Foundations	17
5.2.8 Frost Protection	19
5.2.8.1 Spread Footings	19
5.2.8.2 Piled Foundations	19
5.3 Lateral Earth Pressures	19
5.4 Temporary Excavations.....	21
5.5 Approach Embankments	23

In Order
Following
Page 25

TABLE OF CONTENTS (continued)

Lists of Abbreviations and Symbols

Lithological and Geotechnical Rock Description Terminology

Record of Borehole Sheets

Drawing 1 Seguin River Bridge, Northbound Lanes, Borehole Locations and Soil Strata

Figure 1 Grain Size Distribution, Clayey Silt

Figure 2 Plasticity Chart, Clayey Silt / Silty Clay

Figure 3 Grain Size Distribution, Silty Sand

December 2000

001-1160 [002] (981-8043/6100N)

PART A

FOUNDATION INVESTIGATION REPORT

**PROPOSED HIGHWAY 69 FOUR LANING
FROM 3.5 km SOUTH OF HIGHWAY 124 NORTHERLY 6 km
TO THE SOUTH LIMIT OF THE TOWN OF NOBEL
SEGUIN RIVER BRIDGE, NORTHBOUND LANES,
SITE #44-164N; W.P. 300-99-01
MINISTRY OF TRANSPORTATION, ONTARIO
DISTRICT 52, HUNTSVILLE**

TABLE OF CONTENTS

<u>SECTION</u>	<u>PAGE</u>
PART A - FOUNDATION INVESTIGATION REPORT	
1.0 INTRODUCTION.....	1
2.0 SITE DESCRIPTION	2
3.0 INVESTIGATION PROCEDURES	3
4.0 GENERAL SITE GEOLOGY AND STRATIGRAPHY	5
4.1 Site Geology.....	5
4.2 Site Stratigraphy	5
4.2.1 River Bed Deposits	6
4.2.4 Bedrock	7
4.3 Groundwater Conditions	9

Lists of Abbreviations and Symbols

Lithological and Geotechnical Rock Description Terminology

Record of Borehole Sheets

Drawing 1 Seguin River Bridge, Northbound Lanes, Borehole Locations and Soil Strata

Figure 1 Grain Size Distribution, Clayey Silt

Figure 2 Plasticity Chart, Clayey Silt / Silty Clay

Figure 3 Grain Size Distribution, Silty Sand

1.0 INTRODUCTION

Golder Associates Ltd. has been retained by Cole, Sherman & Associates Ltd. (Cole, Sherman) on behalf of the Ministry of Transportation, Ontario (MTO) to carry out a foundation investigation at the site of the proposed Seguin River Bridge to carry the proposed Highway 69 Northbound Lanes (NBL) over Seguin River. The site is located about 3.5 km north of Parry Sound, Ontario and is designated as Site 44-164N. The new Seguin River Bridge NBL is part of the Highway 69 four laning project which involves four laning (twinning) of a section of Highway 69 from 3.5 km south of Highway 124 (Seguin River) northerly 6 km to the south limit of the Town of Nobel. This report addresses the proposed bridge and its approaches within 20 m of the structure.

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.

The proposed horizontal and vertical alignment for the proposed Highway 69 Northbound Lanes and the location of the bridge were provided to us on the 1:5000 plan and profile route planning study drawings and on the General Arrangement drawing prepared by Cole, Sherman and dated March 2000. The centerline of the highway was staked in the field by Cole, Sherman and the locations of the bridge abutments and piers were established based on the surveyed markings placed on the existing bridge.

The terms of reference for the scope of work are outlined in our proposal letter P81-8060, dated May 25, 1998 and in subsequent letters dated September 21, 1999 and July 24, 2000. The work was carried out in accordance with our Quality Control Plan for Foundation Design Services, dated October 8, 1998.

2.0 SITE DESCRIPTION

The site is located about 23 m (center-to-center) to the east of the existing bridge structure carrying Highway 69 over Seguin River. The site is located about 3.5 km to the north of Parry Sound, Ontario, within the MTO District 52, Huntsville, and is designated as Site 44-164N.

Seguin River is about 140 m in width at the bridge crossing. The riverbanks at the bridge crossing are approximately 2 m to 3 m in height and at relatively shallow slope. The land in the vicinity of the bridge has a gentle surface gradient toward the river. The water level in Seguin River / Mill Lake was at about Elevation 192.3 m in December 1999 and the river is up to 8 m in depth, as measured in the boreholes. The river water level in November 2000 was between Elevations 192.19 m and 192.33 m.

The existing Seguin River Bridge is a three span steel girder structure with a concrete riding deck, carrying one lane of traffic in each direction. The total length of the bridge is 90 m. The grade of the existing highway within the bridge limits is at about Elevation 197.7 m. The north and south approach embankments to the bridge encroach into the river for about 80 m and 130 m, respectively.

3.0 INVESTIGATION PROCEDURES

The field work for this investigation was initially carried out between March 10 and April 6, and between December 18 and 20, 1999. At this time sixteen (16) boreholes and eighteen (18) dynamic cone tests were put down at the site of the proposed structure. Boreholes 1 to 10 and Dynamic Cone Tests 1 to 12 were put down during investigation carried out in March and April at the locations of the foundation units as originally staked in the field. After revisions were made to the location of the proposed structure, the existing information was supplemented by additional investigation carried out in December 1999 and consisting of boreholes and Dynamic Cone Tests 63 through 74 at the new locations of the foundation units. Boreholes and dynamic cone tests were put down using a BBS-1 drill rig mounted on a raft, supplied and operated by Marathon Drilling Inc. of Ottawa.

After further revisions were made to the location of the proposed structure, the existing information was supplemented by additional investigation carried out between November 1 and 7, 2000 and consisting of seven (7) boreholes and two (2) probeholes put down at the locations of the new foundation units. Boreholes 00-05 through 00-08, 00-10, 00-11 were put down using a BBS-2 drill rig mounted on a raft and Borehole 00-14 was put down using a CME-55 track-mounted rig, both supplied and operated by Marathon Drilling Inc. of Ottawa. Proboholes 00-15 and 00-16 were put down using a hand shovel.

The boreholes were drilled to depths ranging from about 0.3 m to 14.9 m, with bedrock coring in Boreholes 2, 5, 6, 9, 00-11 and 00-14. NQ size core samples were obtained from these boreholes. Boreholes 00-05 through 00-08 and 00-10 were put down to sampler refusal on what is considered to be probable bedrock, at depths ranging from 6.3 m to about 13.5 m below the river water level. Proboholes 00-15 and 00-16 were put down to bedrock at depths of 0.6 m and 0.3 m, respectively.

The field work was supervised on a full-time basis by members of our technical staff who located the boreholes and dynamic cone tests in the field, directed the drilling, sampling and in-situ testing operations, and logged the borings. The soil and rock samples were described in the field, placed in labeled containers and transported to our laboratory in Mississauga for further examination and testing.

The as-drilled borehole and dynamic cone testing locations within the river were determined by our field personnel based on the highway chainages and foundation unit limits as staked in the field and based on the locations of the existing bridge features. The river water level elevation was surveyed during the drilling operations and elevations are referenced to the river water level. The elevations of the boreholes on land are referenced to the elevations given on the stakes as established in the field by Cole, Sherman. All elevations are referenced to Geodetic Datum. The northing and easting co-ordinates of the borehole and dynamic cone penetration test locations are indicated on the Record of Borehole sheets and the locations are shown on Drawing 1 titled "Seguin River Bridge, Highway 69, Northbound Lanes, Borehole Locations and Soil Strata", prepared based on the General Arrangement plan dated March 2000 obtained from Cole, Sherman in digital format.

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. Since irregular bedrock surface is typical in the area, terrain with organic deposits is widespread.

4.2 Site Stratigraphy

The detailed subsurface soil, bedrock and groundwater conditions encountered in the boreholes and probeholes and inferred from dynamic cone testing, together with the results of the laboratory tests carried out on selected soil samples, are given on the attached Record of Borehole, Probehole and Dynamic Cone Test Sheets following the text of this report. 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. Further, subsurface conditions will vary between and beyond the borehole locations.

The water level in Seguin River at the time of the December 1999 field investigation varied between Elevations 192.26 m and 192.36 m and in November 2000, the water level varied between Elevations 192.19 m and 192.33 m. The depth of water was up to 8.7 m at the borehole locations. In summary, the river bed deposits encountered in the boreholes are up to 7.1 m thick and consist of interlayered organic deposits, sand, silts, gravel and silty clay to clayey silt. The river bed deposits directly overlie bedrock surface. Bedrock forms the valley within the river and the bedrock surface varies along the bridge alignment from Elevation 178.5 m at the bottom of the valley to about

Elevations 187 m and 192.5 m on the north and south sides of the valley, respectively. A detailed description of the subsurface conditions encountered in the boreholes is provided in the following sections.

4.2.1 River Bed Deposits

The soils comprising the river bed deposits consist generally of sand and gravel, silty sand and silty clay to clayey silt. The thickness of the river bed deposits as encountered in the boreholes and dynamic cone penetration tests is extremely variable, ranging from 0 m to 1 m in the holes close to the river banks to as much as 7.1 m in the middle of the river. The river bed deposits are the thickest in the central portion of the river; particularly at Cone Penetration Tests 67 and 68 and Boreholes 00-06 and 00-10. Organic materials (about 0.4 m to 1 m in thickness) were encountered in Boreholes 70 and 71, respectively, at the river bed surface.

In the majority of the boreholes located in the middle of the river about 1 m to 3.5 m of cohesive deposits were encountered consisting of silty clay and clayey silt. The results of grain size analysis carried out on samples at the clayey silt are shown on Figure 1. Atterberg limit tests carried out on samples of the silty clay indicate liquid limits ranging from 23 percent to 42 percent and plasticity indices ranging from 9 percent to 24 percent. For samples of the clayey silt, the Atterberg limit tests indicate liquid limits ranging from 18 percent to 24 percent and plasticity indices of 4 percent to 6 percent. The results of the Atterberg Limit testing on samples of the silty clay / clayey silt are shown on Figure 2.

In the boreholes located in the middle of the river, the cohesive deposits are underlain by cohesionless deposits consisting of sand to silty sand. The results of one grain size analysis carried out on a silty sand sample are shown on Figure 3. Sand and gravel deposits were also encountered interlayered within the silty clay / clayey silt deposits. Towards the southern portion of the river, a thin deposit of sand directly overlies the bedrock. A thin surficial layer of sand containing roots and organics was encountered in the boreholes on the south side of the river bank. At the location of Borehole 11, about 1.2 m of rockfill was encountered at the river bed extending to the bedrock surface. Rockfill is also inferred to be present in the area of Borehole 3 and Cone Penetration Test C3. Rockfill should be expected elsewhere within the river channel where it may have shifted

from the existing approach embankments. The river bed deposits extend to the bedrock surface which was encountered between Elevations 178.5 m and 192.5 m at the borehole, probehole and dynamic cone test locations.

4.2.4 Bedrock

Bedrock was encountered in the boreholes and was inferred from refusal to further cone penetration during all dynamic cone testing, except in Dynamic Cone Test C3, where refusal to cone penetration was encountered at 0.12 m depth on rockfill. Refusal to further split spoon penetration in the boreholes and dynamic cone testing was encountered at variable depths ranging from 0.3 m to 13.8 m. The bedrock surface depths and elevations at the borehole and dynamic cone test locations are summarized below:

<i>Borehole / Dynamic Cone Test</i>		<i>Ground / River Bed Elevation (m)</i>	<i>Bedrock Surface</i>	
<i>Number</i>	<i>Location</i>		<i>Depth Below Road / River Water Level (m)</i>	<i>Elevation (m)</i>
1	South Approach	192.03	2.07	190.21
2	South Abutment	191.73	1.25	191.03
3		192.36*	0.30	192.06
63		190.30	2.80	189.50
64		191.49	0.94	191.36
65		191.49	1.07	191.23
C1		192.00	0.90	191.39
C2		191.85	0.45	190.85
C3		192.15	N/A	N/A
00-14		192.81	0.48	192.32
PH 00-15		192.80	0.61	192.20
PH 00-16		192.80	0.30	192.50
4	South Pier	185.36	9.33	182.95
5		185.06	8.81	183.47
66		184.98	11.89	180.41
67		185.52	13.36	178.94
68		185.52	13.79	178.51
C4		185.27	8.69	183.59
C5		184.33	8.13	184.15
C6		185.09	9.81	182.47
00-07		185.04	8.35	183.85
00-08		185.30	7.62	184.60
6	North Pier	185.62	10.91	181.35
7		185.31	10.67	181.59
69		185.39	9.10	183.20
70		185.39	9.65	182.65
71		185.34	10.49	181.81

<i>Borehole / Dynamic Cone Test</i>		<i>Ground / River Bed Elevation (m)</i>	<i>Bedrock Surface</i>	
<i>Number</i>	<i>Location</i>		<i>Depth Below Road / River Water Level (m)</i>	<i>Elevation (m)</i>
C7	North Abutment	185.55	10.55	181.71
C8		185.62	10.67	181.59
C9		185.59	9.97	182.33
00-06		185.79	13.47	178.72
00-10		185.31	12.44	179.75
8		186.78	5.73	186.63
9		190.14*	4.94	187.42
72		187.07	5.41	186.89
73		186.56	6.02	186.28
74		186.58	5.94	186.36
C10		186.63	6.40	185.96
C11		186.66	6.55	185.81
C12		186.93	5.48	186.88
00-05		186.46	6.34	185.85
00-11		188.13*	5.43	186.90
10	North Approach	186.72	6.25	186.11

* rockfill surface

N/A terminated on probable rockfill

The bedrock surface varies throughout the site generally forming a valley with the deepest part in the area of Dynamic Cone Tests 67 and 68 and Boreholes 00-06 and 00-10 in the central portion of the river channel. The bedrock surface slopes down toward the middle of the river, from about Elevation 192.5 m on the south side of the river to about Elevation 178.5 m at the locations of Dynamic Cone Test 68. The bedrock surface rises towards the north within the main river channel from Elevation 178.7 m at Boreholes 00-06 and 00-10 to between about Elevation 185.9 m and 186.9 m at Boreholes 00-05 and 00-11, respectively. In the east-west directions, variations in the bedrock surface of up to 1 m over a 10 m horizontal distance were encountered in this area. Local larger bedrock surface undulations are to be expected based on the investigation results.

Bedrock was cored in Boreholes 2, 5, 6, 9, 00-11 and 00-14 for lengths ranging from about 2.8 m to 5.9 m. The rock core samples obtained typically consist of fresh, foliated, medium to thinly bedded, grey, black, white and pink, fine to medium grained, strong to very strong quartz monzonite gneiss interlayered with occasional garnet. The Rock Quality Designation (RQD) measured on the core samples ranged from 74 percent to 100 percent indicating a rock mass of fair

to excellent quality and typically being good to excellent quality with RQD values ranging from 79 percent to 100 percent.

4.3 Groundwater Conditions

The water level in Seguin River was at Elevation 192.3 m in December 1999. In November 2000, the water level in the river was between Elevations 192.19 m and 192.33 m. The water level in the river is regulated by a dam located to the west of the existing bridge. It should be also noted that the water level is subject to seasonal fluctuations.

GOLDER ASSOCIATES LTD.

~~SP/1A~~

Sarah E.M. Poot, P.Eng.
Geotechnical Engineer

DR

Anne S. Poschmann, P.Eng.
Principal

J. J. Jeffers

Fintan J. Heffernan, P.Eng.
Designated MTO Contact

SEMP/ASP/FJH/clg

S:\FINALDATA\PROJECTS\2001\N01-116\N01-160\RPT\N02(N) DOC



December 2000

001-1160 [002] (981-8043/6100N)

PART B

**FOUNDATION DESIGN REPORT
PROPOSED HIGHWAY 69 FOUR LANING
FROM 3.5 km SOUTH OF HIGHWAY 124 NORTHERLY 6 km
TO THE SOUTH LIMIT OF THE TOWN OF NOBEL
SEGUIN RIVER CROSSING, NORTHBOUND LANES
SITE #44-164N; W.P. 300-99-01
MINISTRY OF TRANSPORTATION, ONTARIO
DISTRICT 52, HUNTSVILLE**

5.0 ENGINEERING RECOMMENDATIONS

5.1 General

This section of the report provides our recommendations on the foundation aspects of design of the proposed bridge structure to carry the proposed Highway 69 Northbound Lanes (NBL) over Seguin River, approximately 3.5 km to the north of Parry Sound, Ontario. 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 structure and its approaches within 20 m of the structure. The proposed bridge will be a three span structure 90 m in length and 14 m in width and will be located about 23 m (center-to-center) to the east of the existing bridge alignment. It is understood that the grade of the proposed Highway 69 NBL at the bridge will be at approximately Elevation 197.7 m, which is consistent with the existing grade. The new approach embankments will have to encroach into the river and will be about 5.5 m to 10.5 m in height.

The proposed horizontal and vertical alignment for Highway 69 and the location of the Seguin River Bridge structure were shown on the 1:5000 Route Planning Study drawings and on the General Arrangement drawing dated March 2000, provided to us by Cole, Sherman.

5.2 Bridge Foundations

5.2.1 General

The water level in Seguin River was at about Elevation 192.3 m in December 1999 and varied between about Elevations 192.2 m and 192.3 m in November 2000. The water depth is up to 8.7 m at the pier locations and there is up to 7.1 m of river bed deposits consisting of interlayered organics, sand, silts, gravel and silty clay to clayey silt overlying bedrock. Rockfill was

encountered overlying the bedrock in the area of the north abutment; rockfill should be expected elsewhere within the river channel. Rockfill will also be present in the location of the south abutment where it encroaches into the existing approach embankments.

The monzonite gneiss bedrock forms the valley with deepest part located at the proposed north pier. The bedrock is strong to very strong and is typically of good to excellent quality with RQD values ranging from 74 percent to 100 percent. In general, the bedrock is anticipated to be:

- between about Elevations 192.2 m and 192.5 m at the location of the proposed south abutment
- between about Elevations 183.9 m and 184.6 m at the location of the proposed south pier
- between about Elevations 178.7 m and 179.8 m at the location of the proposed north pier
- between about Elevations 185.9 m and 186.9 m at the location of the north abutment

Significant variations in the bedrock surface elevation over short horizontal distances should be expected.

5.2.2 Foundation Alternatives

The foundation alternatives for the bridge abutments and piers are summarized in the table below. The options of shallow footings and deep foundations are considered for all foundation units.

<i>Bridge Foundation Alternatives</i>				
<i>Foundation Unit</i>	<i>Shallow Foundation Option</i>	<i>Founding Elevation Alternatives</i>	<i>Deep Foundation Option</i>	<i>Design Pile Tip Elevation</i>
South Abutment Relevant Boreholes: Boreholes 00-14 and Probeholes 00-15, 00-16	Feasible <ul style="list-style-type: none"> • Cofferdam construction required • Generally thin sandy deposits overlying bedrock (less than 0.5 m) • Bedrock surface variable • Rockfill excavation up to 6.5 m required • Water level at about bedrock surface level 	<ul style="list-style-type: none"> • At or below Elevation 192.2 m nominal (less than 0.5 m) bedrock excavation required • Above Elevation 192.5 m; footing placed on mass concrete pad; variable thickness of concrete along footing length • Variable founding level to follow the bedrock surface; anticipated to vary between Elevation 192.2 m and 192.5 m 	Not Recommended due to the shallow depth of bedrock	N/A

<i>Bridge Foundation Alternatives</i>				
<i>Foundation Unit</i>	<i>Shallow Foundation Option</i>	<i>Founding Elevation Alternatives</i>	<i>Deep Foundation Option</i>	<i>Design Pile Tip Elevation</i>
South Pier Relevant Boreholes: Boreholes 00-07, 00-08	Feasible but not recommended <ul style="list-style-type: none"> Major cofferdam construction required; Generally thin (less than 1.5 m) sandy deposits overlying bedrock Bedrock surface variable Up to 7 m of water 	<ul style="list-style-type: none"> At or below Elevation 183.9 m; bedrock excavation required (less than 1 m) Stepped from about Elevation 183.9 m at the east end to about Elevation 184.6 m at the west end 	Feasible <ul style="list-style-type: none"> Caissons socketted or dowelled into bedrock Driven steel H-piles offer little lateral support unless by battering 	<ul style="list-style-type: none"> Ranges from about Elevation 183.9 m at the east end to about Elevation 184.6 m at the west end
North Pier Relevant Boreholes: Boreholes 00-06, 00-10	Feasible but not recommended <ul style="list-style-type: none"> Major cofferdam construction required Bedrock surface variable Up to 7 m of water Up to 7 m of overburden 	<ul style="list-style-type: none"> At or below Elevation 178.7 m, bedrock excavation required Stepped from about Elevation 178.7 m at the east end to about Elevation 179.8 m at the west end 	Feasible <ul style="list-style-type: none"> Caissons socketted or dowelled into bedrock Driven steel H-piles offer little lateral support unless by battering 	<ul style="list-style-type: none"> Ranges from about Elevation 178.7 m at the east end to about Elevation 179.8 m at the west end
North Abutment Relevant Boreholes: Boreholes 00-05, 00-11	Feasible but not recommended <ul style="list-style-type: none"> Major cofferdam construction required; Typically thin (less than 0.5 m) sandy deposits overlying bedrock Bedrock surface variable Rockfill excavation up to 3 m required at west limit Up to 5.8 m of water 	<ul style="list-style-type: none"> At or below Elevation 185.9 m; bedrock excavation required Above Elevation 186.9 m; footing placed on mass concrete pad Stepped from about Elevation 185.9 m at the east end to about Elevation 186.9 m at the west end 	Feasible <ul style="list-style-type: none"> Driven steel H-piles will achieve minimum 5 m pile length; excavation up to 3 m of rockfill required prior to driving piles Caissons socketted or dowelled into bedrock 	<ul style="list-style-type: none"> Ranges from about Elevation 185.9 m at the east end to about Elevation 186.9 m at the west end

The above elevations are given for design purposes only. It must be noted that there are variations in the bedrock surface elevation and significant variations could be encountered within the foundation units.

5.2.2.1 Shallow Foundations

Excavation of the rockfill forming the existing approach embankments and encroaching into the proposed abutment footprints will be required for spread footing construction at both abutment locations. The excavation through the rockfill / river bed deposits will be up to about 3 m in depth at the north abutment; up to 6.5 m of rockfill is anticipated at the west limit of the south abutment. The founding level would be at or above the river water level (Elevation 192.3 m) at the south abutment. With the spread footing option at the south pier, the founding level would be up to 14 m below the river water level; at the north pier and north abutment, the founding level would be about 6.5 m to 8.5 m below the river water level.

The footings may be placed directly on the exposed bedrock surface after sub-excavation of the rockfill and any riverbed deposits overlying the bedrock or any loose or fractured rock at the bedrock surface. The design founding level could be based on the lowest bedrock surface elevation encountered in the boreholes within the limits of the foundation unit; this would then require bedrock excavation of variable depth. Alternatively, in order to minimize the bedrock excavation requirements, the design founding level could be based on the highest or an intermediate bedrock surface elevation; this would then involve mass concrete placement to raise the founding level where required and some bedrock excavation. Alternatively, the footings could be placed above the bedrock surface on a mass concrete pad constructed on the bedrock surface. Provision should be noted in the contract for additional bedrock excavation and/or mass concrete placement to accommodate the variations in the bedrock surface.

The spread footing option for the piers would require major cofferdam construction and dewatering within the river (water depths up to 14 m above the bedrock surface). Difficulties could be met in achieving an effective seal to cut off water inflow to the cofferdam, particularly at the overburden / bedrock interface due to variations in the bedrock surface.

Depending on the chosen founding level, bedrock excavation may be required for the footing construction. The bedrock is classified as strong to very strong and is relatively unfractured making excavation, particularly where only small depths are needed, relatively difficult. In addition, the bedrock excavation would be carried out within the confines of a cofferdam where water inflow through the bedrock could be substantial.

The excavation could be carried out using drilling and hoe ramming techniques where a relatively shallow depth of cut into the bedrock is required. This procedure will tend to result in a very 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.

As noted above, excavations for spread footing construction will require river water control to construct the footings and place the concrete in the "dry" conditions.

5.2.2.2 Deep Foundations

Consideration could be given to supporting the north abutment and the piers on steel H-piles driven to bedrock. For the north abutment, the rockfill forming the existing approach embankment encroaches into the north abutment footprint. The rockfill would have to be excavated to allow driving of the piles. Variations in the bedrock surface should be anticipated and abrupt steps / ledges in the bedrock surface may be present. The piles should be equipped with suitable rock points to ensure penetration to and seating into the bedrock.

It is assumed that the piles would be driven through granular fill materials placed after sub-excavation of any rockfill within the abutment footing limits. The rockfill should be removed fully from within the limits of the pile installation to expose the bedrock surface. Granular fill such as OPSS Granular "A" could be placed within a cofferdam / crib wall confinement which would be constructed prior to driving the abutment piles.

If consideration is being given to the use of integral abutments, the design would incorporate steel H-piles placed within CSP pipe liners with the base of the liner at about 3 m below the top of the granular pad on which the pile cap is formed. The details of the integral abutment should be in accordance with the MTO Reference Report 50-96-01, "Integral Abutment Bridges".

Alternatively, for the support of the north abutment and the piers, consideration could be given to caisson foundations either socketted or dowelled into the bedrock. Unless the rockfill is removed where present, such as at the north abutment, the caissons would have to be formed through the rockfill and coring of the rockfill would be required in order to found caissons on bedrock surface.

The use of permanent steel liners will be required to construct the caissons. Due to the hardness of the bedrock and the probable variations in bedrock surface, it will likely be difficult to obtain a seal at the bedrock surface and additional dewatering measures would be required in order to construct the caissons in the "dry". Placement of a tremie plug at the base of the caisson will minimize the potential for migration of fines into the liner from the surrounding river bed deposit. However, due to the presence of fractures within the bedrock, the concrete will not likely provide a seal to the

river water inflow through the socket and / or dowel holes. Tremie placement techniques for caisson concrete placement will therefore be required.

5.2.3 Axial Geotechnical Resistance - Spread Footings

Spread footings placed on the fresh bedrock as encountered at this site may be designed for a factored geotechnical resistance at Ultimate Limit States (ULS) of 10,000 kPa. This value is for vertical concentric loads only. Effects of load inclination and eccentricity need to be taken into account in accordance with OHBDC using the curve for non-cohesive soils, as appropriate. For footings placed on a mass concrete pad, the factored geotechnical resistance at Ultimate Limit States (ULS) will be governed by the strength of the concrete used to form the pad. Serviceability Limit States (SLS) conditions do not apply to footings placed on the fresh bedrock or mass concrete pad.

These values assume that controlled blasting for the footing construction, if required, is used and that the bedrock at and below the founding level has not been fractured by the blasting. All loose, shattered and / or fractured rock within the footprint of the footings and at the footing level should be removed and replaced with concrete. All footing excavations should be inspected by a rock specialist prior to placing concrete to ensure that the base of excavation has been adequately cleaned and that the bedrock conditions as exposed at the founding level are consistent with the design assumptions.

5.2.4 Axial Geotechnical Resistance - Driven Piles

The factored geotechnical resistance at Ultimate Limit States (ULS) for piles driven to practical refusal on the quartz monzonite gneiss bedrock at this site will be greater than the factored structural capacity of the piles. A factored axial geotechnical resistance of 2,000 kN may be assumed for HP 310 x 110 piles for this site to account for subsurface variability and the sloping bedrock surface. The geotechnical resistance at SLS for 25 mm of settlement is not applicable to piles driven to refusal on the bedrock since the stresses required to induce 25 mm of settlement exceed those at ULS.

The steel H-piles should be equipped with suitable rock points to ensure penetration to and seating into the bedrock. The piles should be driven using a hammer with rated energy of about 50 kilojoules but not exceeding 60 kilojoules. On reaching the required set, the hammer energy should be reduced by about 75 percent and the pile should then be re-driven by increasing the hammer energy slowly up to the maximum rated energy over about 40 blows. This procedure is intended to improve the process of seating of the pile on the sloping bedrock surface.

The final set should be at the maximum hammer energy. Provision should be made to re-tap the piles to confirm the set after adjacent piles have been driven in accordance with Special Provision 903S01. The above set criteria should be reviewed at the time of construction in light of the contractor's proposed equipment, so that over-driving and possible damage to the piles is avoided. The appropriate note to be shown on the General Arrangement drawing are:

- "Piles to be driven to bedrock."

5.2.5 Axial Geotechnical Resistance - Caissons

The caissons may be founded on the surface of the bedrock. The use of dowels extended into the bedrock below the base of the caissons or socketting the caissons into the bedrock are feasible options to provide resistance to lateral forces. Due to the hardness and relatively unfractured nature of the quartz monzonite bedrock, rock coring will be required to form the caisson socket.

The factored axial geotechnical resistance for caissons dowelled into bedrock should be determined based on end-bearing resistance of the caisson on the bedrock surface. For caissons socketted into the bedrock, the factored axial geotechnical resistance should also be designed for end bearing where the rock socket length is less than 2 or 3 socket diameters. The end bearing resistance will be higher for the socketted caisson in comparison to one placed on the bedrock surface. The following values of factored geotechnical resistance at ULS can be used for design of the caissons.

<i>Caisson Diameter (m)</i>	<i>Factored Axial Geotechnical Resistance at ULS (kN)</i>	
	<i>Founded on the Bedrock Surface</i>	<i>Socketted into the Bedrock</i>
1.20	11,300	12,000
1.35	14,300	15,500

The geotechnical resistance at SLS does not apply to caissons placed on the rock at this site since the loads required to induce for 25 mm settlement will exceed those at ULS.

5.2.6 Horizontal Resistance - Spread Footings

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 38 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. Verification should be carried out on at least one dowel per foundation unit up to at least 10 percent of the total number of dowels at the site. The testing should be carried out on the first dowel installed at a site and the dowel should be tested to 125 percent of the maximum design load on the dowels. The test dowels must have a threaded length of at least 150 mm exposed in order to complete the testing.

The dowels should be a minimum of 1.0 m 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.

5.2.7 Horizontal Resistance - Deep Foundations

If vertical piles or caissons are to resist the lateral loading, the horizontal reaction to the pile / caisson within overburden soils can be calculated from the expression:

$$k_s = z \times n_h / d,$$

Where

k_s = coefficient of horizontal subgrade reaction (MPa/m)

d = pile / caisson diameter (m)

n_h = constant of horizontal subgrade reaction (MPa/m)

= 4 MPa/m assuming compacted granular fill for the north abutment

= 1.5 MPa/m for the loose sediment at the north pier and for the north abutment assuming non-compacted granular fill

z = depth below riverbed / ground surface (m)

The constant of horizontal subgrade reaction depends on the soil type and soil density / consistency around the pile shaft. For the north abutment, it is assumed that the soil around the piles will consist of the granular fill placed after excavation of the rockfill; the granular fill may be compacted if lateral resistance is required. In the case of the piers, lateral resistance could be derived from the very loose river bed sediments; these are present only at the north pier. The values for n_h which may be used for design are given above.

Group action for lateral loading should be considered when the pile spacing in the direction of loading is less than 6 to 8 pile diameters. Group action can be evaluated by reducing the coefficient of lateral subgrade reaction in the direction of loading by a reduction factor R as follows:

<i>Pile Spacing in Direction of Loading d = Pile Diameter</i>	<i>Subgrade Reaction Reduction Factor R</i>
8d	1.00
6d	0.70
4d	0.40
3d	0.25

The unfactored passive lateral earth pressure, P_p , distribution along the caisson socket within the rock acting over the socket depth d , in meters, should be based on a rectangular distribution and may be calculated using the following expression and parameters given below:

$$P_p = 2Dc$$

where D = diameter of the socket, m

c = cohesion of the rock mass which may be taken as 400 kPa

A resistance factor of 0.5 should be applied to the lateral resistance as calculated to obtain the factored lateral geotechnical resistance.

For caissons placed on the bedrock surface, lateral resistance can be provided by installation of dowels placed in and grouted into holes drilled into the bedrock at the base of the caisson. For the design of the dowels, a grout-to-rock bond stress at ULS of 500 kPa may be used. The dowels should be a minimum length of 1 m within the rock and should be spaced at a minimum center-to-center distance of 8 hole diameters. The structural strength of the dowel and the compressive strength of the grout should not be exceeded.

5.2.8 Frost Protection

5.2.8.1 Spread Footings

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

5.2.8.2 Piled Foundations

The pile caps should be provided with at least 1.8 m cover for frost protection.

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", Type II but with less than 5 percent 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 percent 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 will be based mainly on the proposed embankment fill. The following parameters (unfactored) may be assumed based on the use of fill materials meeting the specifications for Select Subgrade Material (OPSS 1010):

Soil unit weight	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" Type II
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.

It should also be noted that where the granular fill is placed in contact with either the existing or proposed rockfill forming the embankment, a geotextile separator must be provided to prevent loss of the granular fill into the rockfill.

5.4 Temporary Excavations

The water level in the river was at Elevation 192.3 m in December 1999 and at Elevation 192.2 m in November 2000. If the spread footing or the driven pile foundation option is adopted, excavation of the rockfill forming the existing approach embankments and encroaching into at least the north and south abutment footprints will be required. Excavations for both abutments will extend to the bedrock surface and will be about 6 m below the river water level at the north abutment and at about the water level for the south abutments.

Temporary excavations (i.e. those which are only open for a relatively short period) made through the rockfill above the river water level may be made with side slopes no steeper than 1 horizontal to 1 vertical. Excavations through the rockfill below the river water level will generally not stand steeper than 1.5 horizontal to 1 vertical. Some sloughing of the side slopes at these inclinations should be expected.

Some form of river water control will be required at the south abutment to permit concrete placement for footing construction in the "dry" condition. River water control will also be required at the north abutment if controlled placement and compaction of the granular fill is required; i.e. if lateral support to the piles is to be derived from the granular fill.

Given the presence of the rockfill forming the approach embankments and encroaching into the proposed abutment footprints, it will not be possible to install closed steel sheetpiling to form a cofferdam as a cut-off to river water flow. The rockfill will have to be removed to permit installation of the cofferdam. The closed steel sheetpiling could then be placed directly on the bedrock surface.

Due to the probable variation in the bedrock surface elevation, it will likely not be possible to obtain a seal at the bedrock surface through the use of only sheetpiling; additional works to seal at

the toe of the piling would likely be required. Further, internal bracing will be required for support of the cofferdam since it will not be possible to achieve any penetration into the bedrock for toe support.

The excavation support system where comprised of a sheet pile cofferdam should be designed to resist hydrostatic water pressure assuming a river water level at Elevation 192.3 m. If the rockfill is reinstated around the cofferdam after installation, the system should be designed to accommodate the lateral earth pressures from the rockfill as well as any sloping ground, which may be present around the cofferdam.

Due to the close proximity of the existing approach embankment to the south abutment footing, temporary support to the embankment will be required to permit footing construction. For this purpose, the temporary support system could consist of soldier piles and lagging where the piles would be socketted into pre-drilled holes extended to the bedrock. This type of system is considered suitable if additional works are provided for river water control.

The wall will be constructed through the rockfill and pre-drilling for the soldier pile installation would likely require coring through the rockfill. During drilling of the boreholes through the existing embankment, it was possible to auger through the upper 1.2 m of the embankment fill which consists of compact sand and gravel. Below this depth, coring of the rockfill was required to advance the hole.

Support to the soldier pile and lagging wall system could be in the form of rakers and walers. The design of braced soldier pile and lagging walls should be based on a rectangular earth pressure distribution using the design parameters given below. Where the support to the wall is provided by rakers, the wall design should be based on a triangular earth pressure distribution using the design parameters given below. The wall support must be designed to accommodate the loads applied from pressures and surcharge pressures from area, line or point loads as well as the impact of sloping ground behind the system.

Unfactored triangular earth pressure distribution (p in kN/m^2 ; increasing with depth), can be calculated as follows:

$$p = K_a \gamma H$$

where

$$H = \text{the height of the excavation at any point in metres}$$
$$K_a = 0.3 \text{ for level ground behind excavation}$$
$$\gamma = \text{soil unit weight} = 20 \text{ kN/m}^3$$

Unfactored rectangular earth pressure distribution (p in kN/m^2 ; constant with depth), can be calculated as follows:

$$p = K \gamma H$$

where

$$H = \text{the height of the excavation}$$
$$K = 0.2 \text{ for level ground behind excavation}$$
$$\gamma = \text{soil unit weight} = 20 \text{ kN/m}^3$$

Passive toe restraint to the soldier piles within the rockfill will be impacted by the configuration of the ground in front of the piles. Toe restraint to the piles if required should be provided in the form of rock sockets or dowels drilled into the rock below the base of the socket.

The rockfill unit weight should be taken as 18 kN/m^3 and the unit weight of water should be taken as 9.8 kN/m^3 . A groundwater level at Elevation 192.2 m can be assumed at the bridge footing locations.

All excavations should be carried out in accordance with the current Occupational Health and Safety Act.

5.5 Approach Embankments

Based on the General Arrangement drawing, the proposed Highway 69 Northbound Lanes (NBL) grade will be at approximately Elevation 197.7 m at the Seguin River Bridge and will involve approach embankments 10.5 m in height at the north abutment and 5.5 m in height at the south abutment above the river bed / ground surface. The approach embankment height will be approximately 5.5 m above the river water level.

Based on the borehole and dynamic cone test information, the soils at the north approach embankment consist of sandy silt river bed deposits extending to bedrock surface encountered between about Elevations 185.9 m and 186.9 m. The rockfill forming the existing highway embankment encroaches into the western limit of the proposed approach embankment. At the south approach embankment, river bed deposits about 1.8 m in thickness were encountered in Borehole 1. The river bed deposits consist of approximately 0.4 m of silty clay overlying silty sand and sandy silt and extend to bedrock surface encountered at about 2 m depth below the river water level (about Elevation 190 m). Similar to the north approach, the existing rockfill embankment encroaches into the western limit of the proposed approach embankment. The soils are underlain by quartz monzonite gneiss bedrock. The topsoil and organic deposits which may be present in the area of the south approach embankment should be removed prior to placing the embankment fill.

Given the above, stability of the proposed approach embankments 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 overburden soils consisting mainly of sands and silts and this settlement will occur during embankment construction.

Construction of the embankment may be carried out using rockfill. Rockfill embankment construction should be carried out in accordance with the Special Provision, Amendment to OPSS 206 dated September 1999.

It should be noted that in addition to the embankment settlement due to consolidation of the foundation soils, there would be settlement due to consolidation of the rockfill itself. Settlement of the rockfill embankment depends on the method and sequence of placement and compaction of rockfill. Assuming that the rockfill is end dumped to 1 m above the river water level and is placed in accordance with the requirements as outlined in the Special Provision, Amendment to OPSS 206, dated September 1999, the platform width design recommendations can be used as summarized below:

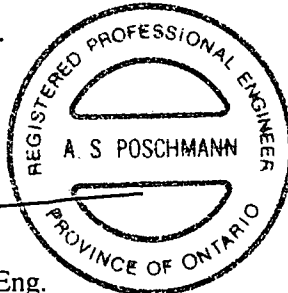
North Approach Embankment	170 mm settlement due to rockfill consolidation	1.5 m platform width each side including provision for 200 mm overlay
South Approach Embankment	60 mm settlement due to rockfill consolidation	1.0 m platform width each side including provision for 200 mm overlay

The permanent side slopes of the rockfill embankments should be maintained not steeper than 1.25 horizontal to 1 vertical above the river water level and not steeper than 1.5 horizontal to 1 vertical below the river water level.


GOLDER ASSOCIATES LTD.



Sarah E.M. Poot, P.Eng.
Geotechnical Engineer



Anne S. Poschmann, P.Eng.
Principal



Fintan J. Heffernan, P.Eng.
Designated MTO Contact

SEMP/ASP/FJH/clg

S:\FINAL\DATA\PROJECTS\2000\001-1160\01161RPT\02(N).DOC

LIST OF ABBREVIATIONS

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

I. SAMPLE TYPE

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

III. SOIL DESCRIPTION

(a) Cohesionless Soils

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

II. PENETRATION RESISTANCE

Standard Penetration Resistance (SPT), N:

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

Consistency

	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

(b) Cohesive Soils

Dynamic Cone Penetration Resistance; N_4 :

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

PH: Sampler advanced by hydraulic pressure

PM: Sampler advanced by manual pressure

WH: Sampler advanced by static weight of hammer

WR: Sampler advanced by weight of sampler and rod

Piezo-Cone Penetration Test (CPT)

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

IV. SOIL TESTS

w water content
w_p plastic limit
w_l liquid limit
C consolidation (oedometer) test
CHEM chemical analysis (refer to text)
CID consolidated isotropically drained triaxial test¹
CIU consolidated isotropically undrained triaxial test with porewater pressure measurement¹
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
SO₄ concentration of water-soluble sulphates
UC unconfined compression test
UU unconsolidated undrained triaxial test
V field vane (LV-laboratory vane test)
γ unit weight

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

LIST OF SYMBOLS

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

I GENERAL

π	= 3.1416
$\ln x$,	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	

PROJECT 001-1160 (N)				RECORD OF BOREHOLE No 00-05				1 OF 1		METRIC					
W.P. 300-99-01				LOCATION N 5024637.47; E 264473.86				ORIGINATED BY DJM							
DIST 52 HWY 69				BOREHOLE TYPE BBS-2, Rotary Wash Boring				COMPILED BY SEP							
DATUM Geodetic				DATE November 2, 2000				CHECKED BY ASP							
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							
192.19 0.00	WATER SURFACE Water							20 40 60 80 100							
186.46 5.73	Top of river bed Silty Sand, fine to medium, trace gravel Very loose Grey Wet		1	SS	3										
185.85 6.34	END OF BOREHOLE Refusal to split spoon penetration Probable bedrock														

ON MOT 1160N.GPJ ON MOT.GDT 6/12/00

ON_MOT 1160N.GPJ ON_MOT.GDT 11/12/00

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

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

ON_MOT 1160N.GPJ ON_MOT.GDT 8/12/00

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

ON_MOT 1160N.GPJ ON_MOT.GDT 8/12/00

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

PROJECT 001-1160 (N)				RECORD OF BOREHOLE No 00-11				1 OF 1		METRIC							
W.P. 300-99-01		LOCATION N 5024630.52; E 264465.33		ORIGINATED BY DJM													
DIST 52 HWY 69		BOREHOLE TYPE BBS-2, Rotary Wash Boring		COMPILED BY SEP													
DATUM Geodetic		DATE November 5, 2000		CHECKED BY ASP													
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
192.33 0.00	GROUND SURFACE Water							20	40	60	80	100					
188.13 4.20	Rockfill		1	RC													
186.90 5.43	Fresh, foliated, fine to thinly bedded, grey, black with pink and white bands, fine to medium grained, strong MONZONITE GNEISS with occasional gamets. (BEDROCK) Bedrock cored from 5.43m to 8.23m. For bedrock coring details refer to Record of Drillhole 00-11.		2	RC													
184.10 8.23	END OF BOREHOLE																

ON MOT 1160N.GPJ ON MOT.GDT 6/12/00

PROJECT: 001-1160

RECORD OF DRILLHOLE: BH00-11

SHEET 1 OF 1

LOCATION: N 5024630.52; E 264465.33 N 1 E 2

DRILLING DATE: November 5, 2000

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: BBS-2, Rotary Wash Boring

DRILLING CONTRACTOR: Marathon Drilling

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	PENETRATION RATE (mm/min)	FLUSH	COLOR & RETURN	FR-FRACTURE	F-FAULT	SM-SMOOTH	FL-FLEXURED	BC-BROKEN CORE	DIAMETRAL INDEX (NPS)	NOTES WATER LEVELS INSTRUMENTATION
									CL-CLEAVAGE	J-JOINT	R-ROUGH	UE-UNEVEN	MB-MECH. BREAK		
									SH-SHEAR	P-POLISHED	ST-STEPPED	W-WAVY	B-BEDDING		
									VN-VEIN	S-SLICKENSIDED	PL-PLANAR	C-CURVED			
RECOVERY		R Q D %	FRACT. INDEX PER 0.3	DISCONTINUITY DATA		HYDRAULIC CONDUCTIVITY k, cm/sec	2 3 4 5	6							
TOTAL CORE % 8888R	SOLID CORE % 8888R			DIP W.T.L. CORE AXIS	TYPE AND SURFACE DESCRIPTION										
		Refer to Previous Page		186.90											
6		Fresh, foliated, fine to thinly bedded, grey, black with pirl and white bands, fine to medium grained, strong MONZONITE GNEISS with occasional gamets. (BEDROCK)		5.43											
7					2										
8															
		END OF BOREHOLE		184.10 8.23											
9															
10															
11															
12															
13															
14															
15															

DEPTH SCALE

1 : 50



LOGGED: SEP

CHECKED: LCC

DRILLHOLE 1160 ROCK GPJ GLDR CAN GDT 12/12/00 MMZ

PROJECT 001-1160 (N)			RECORD OF BOREHOLE No BH00-14				1 OF 1		METRIC						
W.P. 300-99-01			LOCATION N 5024577.44; E 264527.25				ORIGINATED BY SEP								
DIST 52 HWY 69			BOREHOLE TYPE CME 55, Bombardier				COMPILED BY LCC								
DATUM Geodetic			DATE November 7, 2000				CHECKED BY ASP								
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							
192.81	GROUND SURFACE														
0.00	Sand with organics and roots Dark brown Wet														
192.33															
0.48	Fresh, thin to medium banded, grey, black, white, pink, fine to medium grained, strong to very strong QUARTZ MONZONITE GNEISS with abundant garnet. (BEDROCK)														
	Bedrock cored from 0.48m to 4.55m.														
	For bedrock coring details refer to Record of Drillhole 00-14.														
188.26															
4.55	END OF BOREHOLE														

ON MOT 1160N GPJ ON MOT GDT 6/12/00

PROJECT: 001-1160

RECORD OF DRILLHOLE: BH00-14

SHEET 1 OF 1

LOCATION: N 5024577.44; E 264527.25 N 7 E 8

DRILLING DATE: November 7, 2000

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: CME 55, Bombardier

DRILLING CONTRACTOR: Marathon Drilling

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No	PENETRATION RATE (mm/min)	COLOUR % RETURN FLUSH	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				C-CURVED
								SH-SHEAR		P-POLISHED		ST-STEPPED		W-WAVY		B-BEDDING				
								VN-VEIN		S-SLICKENSIDED		PL-PLANAR								
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												
0 0 0 0 R		0 0 0 0 R		0 0 0 0 R		0 0 0 0 R		0 0 0 0 R		0 0 0 0 R										
1	Refer to Previous Page		192.33																	
1	Fresh, thin to medium banded, grey, black, white, pink, fine to medium grained, strong to very strong QUARTZ MONZONITE GNEISS with abundant gamet. (BEDROCK)		0.48		1															
2					2															
3					3															
4																				
5	END OF BOREHOLE		188.26																	
6			4.55																	
7																				
8																				
9																				
10																				

DEPTH SCALE

1:50



LOGGED: SEP

CHECKED: LCC

DRILLHOLE 1160 ROCK GPJ GLDR CAN GDT 12/12/00 MMZ

PROJECT 001-1160 (N)										RECORD OF PROBEHOLE No PH00-15										1 OF 1		METRIC	
W.P. 300-99-01					LOCATION N 5024580.37; E 264529.98					ORIGINATED BY SEP													
DIST 52 HWY 69					BOREHOLE TYPE Manual, Hand shovel					COMPILED BY LCC													
DATUM Geodetic					DATE November 7, 2000					CHECKED BY ASP													
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	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 X REMOULDED					WATER CONTENT (%) w _p w w _L										
192.80	GROUND SURFACE																						
0.00	Sand with black organics and roots Dark brown Wet																						
192.19																							
0.61	END OF HOLE Bedrock surface						192																

ON MOT 1160N GPJ ON MOT GDT 12/12/00

PROJECT 001-1160 (N)										RECORD OF PROBEHOLE No PH00-16										1 OF 1		METRIC	
W.P. 300-99-01					LOCATION N 5024582.93; E 264532.36					ORIGINATED BY SEP													
DIST 52 HWY 69					BOREHOLE TYPE Manual, Hand shovel					COMPILED BY LCC													
DATUM Geodetic					DATE November 7, 2000					CHECKED BY ASP													
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT			LIQUID LIMIT		UNIT WEIGHT γ kN/m ³	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 x REMOULDED					W _p	W	W _L								
192.80	GROUND SURFACE																						
0.00	Sand with black organics and roots																						
192.50	Dark brown																						
0.30	Wet																						
	END OF HOLE																						
	Bedrock surface																						
							192																

ON MOT 1160N.GPJ ON MOT.GDT 12/12/00

PROJECT 981-8043 (6100N)			RECORD OF BOREHOLE No 1			1 OF 1			METRIC							
W.P. 292-97-00			LOCATION N 5024571.53, E 264540.19			ORIGINATED BY DRS										
DIST 52 HWY 69			BOREHOLE TYPE BBS-1, Hydraulic powered			COMPILED BY AP										
DATUM Geodetic			DATE Mar. 24/99			CHECKED BY AP										
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa								WATER CONTENT (%)
192.28								20	40	60	80	100				
192.08	Water															
0.25	Silty Clay, trace sand, trace organics Very stiff		1	50 DO	26		192									
191.67	Brown/grey, mottled Sandy Silt Compact Brown		2	50 DO	87											
0.71	Silty Sand, trace to some gravel Very dense Brown to grey		3	50 DO	60		191									
190.21			4	50 DO	60/05											
2.07	END OF BOREHOLE Refusal to further auger penetration Probable bedrock															

ON MOT 981-8043 GPJ ON MOT GDT 28/2/00

PROJECT <u>981-8043 (6100N)</u>		RECORD OF BOREHOLE No 2		1 OF 1		METRIC	
W.P. <u>292-97-00</u>		LOCATION <u>N 5024586 82; E 264527 32</u>		ORIGINATED BY <u>DRS</u>			
DIST <u>52</u> HWY <u>69</u>		BOREHOLE TYPE <u>BBS-1, Hydraulic powered</u>		COMPILED BY <u>AP</u>			
DATUM <u>Geodetic</u>		DATE <u>Mar.24/99</u>		CHECKED BY <u>AP</u>			

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT			UNIT WEIGHT γ kN/m ³	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							20 40 60		
192.28																	
0.00	Water						192										
191.73	Top of river bed																
191.52	Silt and Sand with organics																
0.76	Very loose		1	50	DO	5											
191.03	Dark brown																
1.25	Silty Sand						191										
	Loose																
	Grey with occ. orange oxidation staining																
	Fresh, thin to medium banded, grey, black, white, pink, fine to medium grained, strong to very strong QUARTZ MONZONITE GNEISS with abundant garnet. (BEDROCK)						190										
	Bedrock cored between 1.25m and 4.42m depth.						189										
	For bedrock coring details refer to Record of Drillhole 2																
187.86							188										
4.42	END OF BOREHOLE																

ON MOT 981-8043.GPJ ON MOT.GDT 25/2/00

PROJECT: 981-8043 (6100N)

RECORD OF DRILLHOLE: 2

SHEET 2 OF 2

LOCATION: N 5024586.82; E 264527.32

DRILLING DATE: Mar.24/99

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: —

DRILL RIG: BBS-1 Hydraulic powered

DRILLING CONTRACTOR: Marathon

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	PENETRATION RATE (mm/min)	FLUSH	COLOUR & RETURN	FR-FRACTURE CL-CLEAVAGE SH-SHEAR VN-VEIN	F-FAULT J-JOINT P-POLISHED S-SLICKENSIDED	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
		CONTINUED FROM PREVIOUS PAGE		191.03											
2		Fresh, thin to medium bedded, grey, black, white, pink, fine to medium grained, strong to very strong QUARTZ MONZONITE GNEISS with abundant garnet. (BEDROCK)		1.25											
3	NO CORE				1										
4					2										
5		END OF HOLE		187.86											
6				4.42											
7															
8															
9															
10															
11															

DRILLHOLE 8043 ROCK GPJ GLDR CAN GDT 25/200 PS

DEPTH SCALE

1:50



LOGGED: DJM

CHECKED: AP

PROJECT <u>981-8043 (6100N)</u>		RECORD OF BOREHOLE No 3		1 OF 1		METRIC	
W.P. <u>292-97-00</u>		LOCATION <u>N 5024576.40; E 264521.77</u>		ORIGINATED BY <u>DRS</u>			
DIST <u>52</u> HWY <u>69</u>		BOREHOLE TYPE <u>BBS-1, Hydraulic powered</u>		COMPILED BY <u>AP</u>			
DATUM <u>Geodetic</u>		DATE <u>Mar. 24/99</u>		CHECKED BY <u>AP</u>			

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE LIQUID CONTENT LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100	W _p	W	W _L		
192.36																	
0.00																	
192.05	Silty Sand, some gravel Very dense Brown		1	50 DO	55/15												
0.30	END OF BOREHOLE Refusal to further auger penetration Probable bedrock or rockfill																

ON MOT 981-8043.GPJ ON MOT GDT 28/200

PROJECT 981-8043 (6100N) RECORD OF BOREHOLE No 4 1 OF 1 METRIC

W.P. 292-97-00 LOCATION N 5024603.99; E 264509.73 ORIGINATED BY DRS

DIST 52 HWY 69 BOREHOLE TYPE BBS-1, Hydraulic powered COMPILED BY AP

DATUM Geodetic DATE Mar. 19/99 CHECKED BY AP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
192.28 0.00	Water													
							192							
							191							
							190							
							189							
							188							
							187							
							186							
185.36	Top of river bed													
185.12	Sand and Gravel, trace silt													
7.16	Very loose Brown/grey Clayey Silt, trace sand, occ. sand layers Very soft to firm Grey		1	50 DO	PM		185							
			2	50 DO	8		184							
182.95							183							
9.33	END OF BOREHOLE Refusal to further auger penetration Probable bedrock													

ON MOT 981-8043 GPJ ON MOT GDT 24/200

PROJECT 981-8043 (6100N)

RECORD OF BOREHOLE No 5

1 OF 1

METRIC

W.P. 292-97-00

LOCATION N 5024594.07; E 264501.97

ORIGINATED BY DRS

DIST 52

HWY 69

BOREHOLE TYPE BBS-1, Hydraulic powered

COMPILED BY AP

DATUM Geodetic

DATE Mar. 18/99

CHECKED BY AP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100					
192.28 0.00	Water						192										
							191										
							190										
							189										
							188										
							187										
							186										
185.06	Top of river bed						185										
184.87	Sand and Gravel, trace silt, trace organics		1	50 DO	PM												
7.41	Very loose Brown/grey																
184.20	Silty Clay, some sand																
8.08	Very soft Brown/grey						184										
183.47	Sand, trace silt, trace clay, some gravel																
8.81	Grey						183										
	Fresh, thin to medium banded, black and pink, fine grained, strong to very strong MONZONITE GNEISS with occasional garnet. (BEDROCK)						182										
							181										
	Bedrock cored between 8.81m and 11.98m depth. For bedrock coring details refer to Record of Drillhole 5																
180.30																	
11.98	END OF BOREHOLE																

ON MOT 981-8043.GPJ ON MOT.GDT 25/2/00

LOCATION: N 5024594.07: E 264501.97

DRILLING DATE: Mar. 18/99

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: —

DRILL RIG: BBS-1 Hydraulic powered

DRILLING CONTRACTOR: Marathon

[illegible]

DEPTH SCALE

1 : 50

LOGGED: DJM

CHECKED: AP

PROJECT <u>981-8043 (6100N)</u>		RECORD OF BOREHOLE No 6		1 OF 2	METRIC
W.P. <u>292-97-00</u>		LOCATION <u>N 5024624.01; E 264489.35</u>		ORIGINATED BY <u>DRS</u>	
DIST <u>52</u> HWY <u>69</u>		BOREHOLE TYPE <u>BBS-1, Hydraulic powered</u>		COMPILED BY <u>AP</u>	
DATUM <u>Geodetic</u>		DATE <u>Mar. 17/99</u>		CHECKED BY <u>AP</u>	

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	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	20 40 60 80 100						20 40 60	

192.26 0.00	Water						192							
							191							
							190							
							189							
							188							
							187							
							186							
185.62 6.64	Top of river bed Clayey Silt, some sand Very soft Grey		1	50 DO	1		185							
							184							
184.18 8.08	Silty Sand to Sand, trace silt, trace gravel Loose Grey		2	50 DO	10		183							
			3	50 DO	7		182							
							181							
181.90 10.36	Sand and Gravel, some silt Loose Grey						180							
181.35 10.91	Fresh, thin to medium bedded, grey, black, white, fine crystalline, strong MONZONITE GNEISS. (BEDROCK)						179							
							178							
177.36	Bedrock cored between 10.91m and 14.90m depth. For bedrock coring details refer to Record of Drillhole 6													

ON MOT 981-8043.GPJ ON MOT.GDT 25/2/00

Continued Next Page

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

+3, X3: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

PROJECT: 981-8043 (6100N)

RECORD OF DRILLHOLE: 6

SHEET 3 OF 3

LOCATION: N 5024624.01; E 264489.35

DRILLING DATE: Mar.17/99

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: —

DRILL RIG: BBS-1 Hydraulic powered

DRILLING CONTRACTOR: Marathon

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV.																NOTES WATER LEVELS INSTRUMENTATION																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																
				DEPTH (m)	RUN No.	PENETRATION RATE (mm/min)	FLUSH % RETURN	FR-FRACTURE		F-FAULT		SM-SMOOTH		FL-FLEXURED		BC-BROKEN CORE																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																				
								CL-CLEAVAGE	J-JOINT	R-ROUGH	UE-UNEVEN	MB-MECH. BREAK																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
								SH-SHEAR	P-POLISHED	ST-STEPPED	W-WAVY	B-BEDDING																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
								VN-VEIN	S-SUCKEN SIDED	PL-PLANAR	C-CURVED																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																									
RECOVERY		R.Q.D. %	FRACT. INDEX PER 0.3	DISCONTINUITY DATA		HYDRAULIC CONDUCTIVITY k, cm/sec			DIAMETRAL POINT LOAD INDEX (MPa)																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																											
TOTAL CORE %	SOLID CORE %			DIP w.r.t. CORE AXIS	TYPE AND SURFACE DESCRIPTION	10" 15" 10" 10"																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																														
11	NQ CORE	CONTINUED FROM PREVIOUS PAGE		181.35																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																

DEPTH SCALE

1:50



LOGGED: DJM

CHECKED: AP

DRILLHOLE 8043 ROCK GPJ GLDR CAN GDT 25/2/00 PS

PROJECT <u>981-8043 (6100N)</u>		RECORD OF BOREHOLE No 7		1 OF 1	METRIC
W.P. <u>292-97-00</u>	LOCATION <u>N 5024614.78; E 264479.86</u>	ORIGINATED BY <u>DRS</u>			
DIST <u>52</u> HWY <u>69</u>	BOREHOLE TYPE <u>BBS-1, Hydraulic powered</u>	COMPILED BY <u>AP</u>			
DATUM <u>Geodetic</u>	DATE <u>Mar. 10/99</u>	CHECKED BY <u>AP</u>			

[illegible]

ON_MOT 981-8043.GPJ ON_MOT.GDT 24/2/00

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

PROJECT <u>981-8043 (6100N)</u>		RECORD OF BOREHOLE No 8		1 OF 1		METRIC	
W.P. <u>292-97-00</u>		LOCATION <u>N 5024642.25; E 264469.20</u>		ORIGINATED BY <u>DRS</u>			
DIST <u>52</u> HWY <u>69</u>		BOREHOLE TYPE <u>BBS-1, Hydraulic powered</u>		COMPILED BY <u>AP</u>			
DATUM <u>Geodetic</u>		DATE <u>Mar.23/99</u>		CHECKED BY <u>AP</u>			

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	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 x REMOULDED						
192.36						20	40	60	80	100	20	40	60	
0.00	Water													
186.78	Top of river bed													
5.73	Clayey Silt, some sand Grey END OF BOREHOLE Refusal to split spoon penetration; Probable bedrock		1	50	DO	PM								

ON MOT 981-8043 GPJ ON MOT GDT 24/2/00

PROJECT 981-8043 (6100N)				RECORD OF BOREHOLE No 9				1 OF 1		METRIC					
W.P. 292-97-00				LOCATION N 5024633.43; E 264461.94				ORIGINATED BY DRS							
DIST 52 HWY 69				BOREHOLE TYPE BBS-1, Hydraulic powered				COMPILED BY AP							
DATUM Geodetic				DATE Apr 6/99				CHECKED BY AP							
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							
192.36 0.00	Water							20 40 60 80 100							
190.14 2.22	Rockfill							20 40 60 80 100							
187.42 4.94	Fresh, foliated, fine to thinly bedded, grey, black with pink and white bands, fine to medium grained, strong MONZONITE GNEISS with occasional garnets. (BEDROCK)							20 40 60 80 100							
181.57 10.79	Bedrock cored between 4.94m and 10.79m depth. For bedrock coring details refer to Record of Drilling 9							20 40 60 80 100							
	END OF BOREHOLE														

ON MOT 981-8043.GPJ ON MOT GDT 25/2/00

PROJECT: 981-8043 (6100N)

RECORD OF DRILLHOLE: 9

SHEET 2 OF 2

LOCATION: N 5024633.43; E 264461.94

DRILLING DATE: Apr.6/99

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: —

DRILL RIG: BBS-1 Hydraulic powered

DRILLING CONTRACTOR: Marathon

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	PENETRATION RATE (mm/min)	FLUSH % RETURN	COLOUR (mm)	FR-FRACTURE CL-CLEAVAGE SH-SHEAR VN-VEIN	F-FAULT J-JOINT P-POLISHED S-SUCKERSIDED	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 INDEX (DPI)	NOTES WATER LEVELS INSTRUMENTATION
		CONTINUED FROM PREVIOUS PAGE		187.82											
5		Fresh, foliated, fine to thinly bedded, grey/black with pink and white bands, fine to medium grained, strong MONZONITE GNEISS with occasional garnet. (BEDROCK)		4.54	1										
6					2										
7					3										
8															
9					4										
10					5										
11		END OF HOLE		181.57 10.79											
12															
13															
14															

DRILLHOLE 8043ROCK GPJ GLDR CAN GDT 25/200 PS

DEPTH SCALE

1: 50



LOGGED: DJM

CHECKED: AP

PROJECT <u>981-8043 (S100N)</u>		RECORD OF BOREHOLE No 10		1 OF 1		METRIC	
W.P. <u>292-97-00</u>		LOCATION <u>N 5024646.77; E 264454.35</u>		ORIGINATED BY <u>DRS</u>			
DIST <u>52</u> HWY <u>69</u>		BOREHOLE TYPE <u>BBS-1, Hydraulic powered</u>		COMPILED BY <u>AP</u>			
DATUM <u>Geodetic</u>		DATE <u>Mar. 19/99</u>		CHECKED BY <u>AP</u>			

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							WATER CONTENT (%)
								○ UNCONFINED	+ FIELD VANE						
192.36								20 40 60 80 100	20 40 60						
0.00	Water														
							192								
							191								
							190								
							189								
							188								
							187								
186.72	Top of river bed														
5.64	Silty Sand		1	50 DO	5										
186.11	Loose														
	Grey														
6.25	END OF BOREHOLE Refusal to split spoon penetration; Probable bedrock														

ON MOT 981-8043.GPJ ON MOT.GDT 24/200

PROJECT <u>981-8043 (6100N)</u>		RECORD OF DYNAMIC CONE TEST No 63		1 OF 1		METRIC	
W.P. <u>292-97-00</u>		LOCATION <u>N 5024582.04; E 264517.18</u>		ORIGINATED BY <u>DRS</u>			
DIST <u>52</u> HWY <u>69</u>		BOREHOLE TYPE <u>BBS-1, Hydraulic powered</u>		COMPILED BY <u>AP</u>			
DATUM <u>Geodetic</u>		DATE <u>Dec. 19/99</u>		CHECKED BY <u>AP</u>			

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
192.30	Water Surface													
0.00	Water						192							
190.30	Top of river bed						191							
2.00	For soil stratigraphy refer to record of Borehole 3.						190							
189.50														
2.80	End of dynamic cone testing Refusal to further cone penetration; probably on bedrock													

ON MOT 981-8043.GPJ ON MOT.GDT 25/2/00

PROJECT <u>981-8043 (6100N)</u>		RECORD OF BOREHOLE No 64		1 OF 1		METRIC	
W.P. <u>292-97-00</u>		LOCATION <u>N 5024585.33; E 264520.25</u>		ORIGINATED BY <u>DRS</u>			
DIST <u>52</u> HWY <u>69</u>		BOREHOLE TYPE <u>BBS-1, Hydraulic powered</u>		COMPILED BY <u>AP</u>			
DATUM <u>Geodetic</u>		DATE <u>Dec. 19/99</u>		CHECKED BY <u>AP</u>			

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	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					w _p w w _L				
192.30	Water Surface																
0.00	Water						192										
191.49	Top of river bed																
0.94	Silty Sand, trace gravel, trace organics Compact Grey Refusal to split spoon penetration; probably on bedrock		1	50 DO	60/12									7 Org 2%			

ON MOT 981-8043 GPJ ON MOT.CDT 28/2/00

PROJECT <u>981-8043 (6100N)</u>		RECORD OF DYNAMIC CONE TEST No 65		1 OF 1		METRIC	
W.P. <u>292-97-00</u>		LOCATION <u>N 5024588.62; E 264523.31</u>		ORIGINATED BY <u>DRS</u>			
DIST <u>52</u> HWY <u>69</u>		BOREHOLE TYPE <u>BBS-1, Hydraulic powered</u>		COMPILED BY <u>AP</u>			
DATUM <u>Geodetic</u>		DATE <u>Dec. 19/99</u>		CHECKED BY <u>AP</u>			

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100					
192.30	Water Surface																
0.00	Water																
191.49	Top of river bed																
191.23	Probably Silty Sand																
1.07	End of dynamic cone testing Refusal to further cone penetration; probably on bedrock																

ON MOT 981-8043 GPJ ON MOT.GDT 24/2/00

PROJECT 981-8043 (6100N) RECORD OF DYNAMIC CONE TEST No 66 1 OF 1 METRIC
W.P. 292-97-00 LOCATION N 5024599.09; E 264498.90 ORIGINATED BY DRS
DIST 52 HWY 69 BOREHOLE TYPE BBS-1, Hydraulic powered COMPILED BY AP
DATUM Geodetic DATE Dec.20/99 CHECKED BY AP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa	WATER CONTENT (%)					
192.30 0.00	Water Surface Water													
							192							
							191							
							190							
							189							
							188							
							187							
							186							
184.98 7.32	Top of river bed For soil stratigraphy refer to Record of Borehole 5.						185							
							184							
							183							
							182							
							181							
180.41 11.89	End of dynamic cone testing Refusal to further cone penetration; probably on bedrock													

ON_MOT_981-8043.GPJ ON_MOT_GDT_24/2/00

PROJECT <u>981-8043 (6100N)</u>		RECORD OF DYNAMIC CONE TEST No 67		1 OF 1	METRIC
W.P. <u>292-97-00</u>	LOCATION <u>N 5024602.38; E 264501.96</u>	ORIGINATED BY <u>DRS</u>			
DIST <u>52</u> HWY <u>69</u>	BOREHOLE TYPE <u>BBS-1, Hydraulic powered</u>	COMPILED BY <u>AP</u>			
DATUM <u>Geodetic</u>	DATE <u>Dec. 19/99</u>	CHECKED BY <u>AP</u>			

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	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 x REMOULDED						
192.30 0.00	Water Surface Water							20 40 60 80 100	20 40 60						
							192								
							191								
							190								
							189								
							188								
							187								
							186								
185.52 6.78	Top of river bed For soil stratigraphy refer to record of Borehole 4.						185								
							184								
							183								
							182								
							181								
							180								
178.94 13.36	End of dynamic cone testing Refusal to further cone penetration; probably on bedrock						179								

ON MOT 981-8043.GPJ ON MOT.GDT 24/2/00

PROJECT <u>981-8043 (6100N)</u>		RECORD OF DYNAMIC CONE TEST No 68		1 OF 1	METRIC
W.P. <u>292-97-00</u>	LOCATION <u>N 5024605 67; E 264505 03</u>	ORIGINATED BY <u>DRS</u>			
DIST <u>52</u> HWY <u>69</u>	BOREHOLE TYPE <u>BBS-1, Hydraulic powered</u>	COMPILED BY <u>AP</u>			
DATUM <u>Geodetic</u>	DATE <u>Dec. 19/99</u>	CHECKED BY <u>AP</u>			

[illegible]

ON MOT 981-8043.GPJ ON MOT.GDT 24/2/00

ON MOT 981-8043.GPJ ON MOT.GDT 28/2/00

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

PROJECT <u>981-8043 (6100N)</u>		RECORD OF BOREHOLE No 71		1 OF 1	METRIC
W.P. <u>292-97-00</u>	LOCATION <u>N 5024625.45; E 264483.82</u>	ORIGINATED BY <u>DRS</u>			
DIST <u>52</u> HWY <u>69</u>	BOREHOLE TYPE <u>BBS-1, Hydraulic powered</u>	COMPILED BY <u>AP</u>			
DATUM <u>Geodetic</u>	DATE <u>Dec. 18/99</u>	CHECKED BY <u>AP</u>			

[illegible]

ON MOT 981-8043.GPJ ON MOT.GDT 24/2/00

PROJECT 981-8043 (6100N)				RECORD OF BOREHOLE No 72				1 OF 1		METRIC					
W.P. 292-97-00		LOCATION N 5024635.91; E 264459.40				ORIGINATED BY DRS									
DIST 52 HWY 69		BOREHOLE TYPE BBS-1, Hydraulic powered				COMPILED BY AP									
DATUM Geodetic		DATE Dec 19/99				CHECKED BY AP									
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC NATURAL LIQUID LIMIT MOISTURE LIMIT CONTENT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa			WATER CONTENT (%)				
192.30	Water Surface														
0.00	Water														
							192								
							191								
							190								
							189								
							188								
187.07	Top of river bed						187								
186.89	Probably Sand		1	50 DO	60/15										
5.41	End of Hole Refusal to split spoon penetration; probably on bedrock														

ON MOT 981-8043.GPJ ON MOT GDT 24/200

PROJECT <u>981-8043 (6100N)</u>		RECORD OF BOREHOLE No 73		1 OF 1 METRIC	
W.P. <u>292-97-00</u>		LOCATION <u>N 5024639.20; E 264462.47</u>		ORIGINATED BY <u>DRS</u>	
DIST <u>52</u> HWY <u>69</u>		BOREHOLE TYPE <u>BBS-1, Hydraulic powered</u>		COMPILED BY <u>AP</u>	
DATUM <u>Geodetic</u>		DATE <u>Dec 19/99</u>		CHECKED BY <u>AP</u>	

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							WATER CONTENT (%)			
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED										
							20	40	60	80	100	20	40	60				
192.30	Water Surface						192											
0.00	Water						191											
							190											
							189											
							188											
							187											
186.56	Top of river bed																	
186.28	Sandy Silt, trace gravel		1	50 DO	60/ 15													
6.02	Compact Brown End of Hole Refusal to split spoon penetration; probably on bedrock																	

ON MOT 981-8043.GPJ ON MOT.GDT 24/2/00

PROJECT <u>981-8043 (6100N)</u>		RECORD OF DYNAMIC CONE TEST No 74		1 OF 1		METRIC	
W.P. <u>292-97-00</u>		LOCATION <u>N 5024542.49; E 264465.64</u>		ORIGINATED BY <u>DRS</u>			
DIST <u>52</u> HWY <u>69</u>		BOREHOLE TYPE <u>BBS-1, Hydraulic powered</u>		COMPILED BY <u>AP</u>			
DATUM <u>Geodetic</u>		DATE <u>Dec 19/99</u>		CHECKED BY <u>AP</u>			

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC NATURAL LIQUID LIMIT MOISTURE LIMIT CONTENT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100	W _p	W	W _L		
192.30 0.00	Water Surface Water						192										
							191										
							190										
							189										
							188										
							187										
186.58	Top of river bed																
186.36 5.94	For soil stratigraphy refer to Record of Borehole 8 End of dynamic cone testing Refusal to further cone penetration, probably on bedrock																

ON MOT 981-8043.GPJ ON MOT.GDT 24/2/00



PROJECT		RECORD OF DYNAMIC CONE TEST				No C1		1 OF 1		METRIC							
W.P.		LOCATION		N 5024589.57; E 264529.07		ORIGINATED BY		DJM									
DIST		HWY		BOREHOLE TYPE		BBS-1 Hydraulic powered		COMPILED BY		AP							
DATUM		DATE		Mar 24/99		CHECKED BY		AP									
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT			REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	20 40 60 80 100	20 40 60 80 100	20 40 60	W _p W W _L	γ	GR SA SI CL				
192.30	Water Surface																
0.00	Water																
192.00	Top of river bed						192										
0.30																	
191.39																	
0.91	End of dynamic cone testing Refusal to further cone penetration; probably on bedrock																

ON MOT 981-8043.GPJ ON MOT.GDT 25/2/00

PROJECT <u>981-8043</u>		RECORD OF DYNAMIC CONE TEST No C2		1 OF 1		METRIC	
W.P. <u>292-97-00</u>		LOCATION <u>N 5024582.99; E 264527.82</u>		ORIGINATED BY <u>DJM</u>			
DIST <u>52</u> HWY <u>69</u>		BOREHOLE TYPE <u>BBS-1, Hydraulic powered</u>		COMPILED BY <u>AP</u>			
DATUM <u>Geodetic</u>		DATE <u>Mar.24/99</u>		CHECKED BY <u>AP</u>			

SOIL PROFILE				SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL LIQUID LIMIT MOISTURE CONTENT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	SHEAR STRENGTH kPa			WATER CONTENT (%)						
192.30	Water Surface														
0.00	Water														
191.85							192								
0.45	End of dynamic cone testing Refusal to further cone penetration; probably on bedrock														

ON MOT 981-8043.CPJ ON MOT.GDT 25/2/00

PROJECT <u>981-8043</u>		RECORD OF DYNAMIC CONE TEST No C4		1 OF 1		METRIC	
W.P. <u>292-97-00</u>		LOCATION <u>N 5024602.12; E 264510.29</u>		ORIGINATED BY <u>DJM</u>			
DIST <u>52</u> HWY <u>69</u>		BOREHOLE TYPE <u>BBS-1, Hydraulic powered</u>		COMPILED BY <u>AP</u>			
DATUM <u>Geodetic</u>		DATE _____		CHECKED BY <u>AP</u>			

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa								WATER CONTENT (%)
								○ UNCONFINED	+ FIELD VANE	● QUICK TRIAXIAL						
192.28	Water Surface							20	40	60	80	100	20	40	60	GR SA SI CL
0.00	Water															
							192									
							191									
							190									
							189									
							188									
							187									
							186									
185.27	Top of river bed						185									
7.01	For soil stratigraphy refer to Record of Borehole 4						184									
183.59																
8.69	End of dynamic cone testing Refusal to further cone penetration; probably on bedrock															

ON MOT 981-8043 GPJ ON MOT GDT 25/2/00

PROJECT 981-8043		RECORD OF DYNAMIC CONE TEST No C5				1 OF 1		METRIC									
W.P. 292-97-00		LOCATION N 5024598.06; E 264506.71				ORIGINATED BY DJM											
DIST 52 HWY 69		BOREHOLE TYPE BBS-1, Hydraulic powered				COMPILED BY AP											
DATUM Geodetic		DATE				CHECKED BY AP											
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT		REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	SHEAR STRENGTH kPa					WATER CONTENT (%)			γ	GR SA SI CL
							20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100			
192.28 0.00	Water Surface Water						192										
							191										
							190										
							189										
							188										
							187										
							186										
185.33 6.95	Top of river bed For soil stratigraphy refer to Record of Borehole 4						185										
184.15 8.13	End of dynamic cone testing Refusal to further cone penetration; probably on bedrock																

ON MOT 981-8043.GPJ ON MOT.GDT 25/2/00

PROJECT 981-8043		RECORD OF DYNAMIC CONE TEST No C6		1 OF 1	METRIC
W.P. 292-97-00		LOCATION N 5024594.39; E 264503.30		ORIGINATED BY DJM	
DIST 52 HWY 69		BOREHOLE TYPE BBS-1, Hydraulic powered		COMPILED BY AP	
DATUM Geodetic		DATE		CHECKED BY AP	

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							WATER CONTENT (%)			
								20 40 60 80 100										
								○ UNCONFINED	+ FIELD VANE									
								● QUICK TRIAXIAL	x REMOULDED									
								20 40 60 80 100										
192.28	Water Surface																	
0.00	Water																	
												</						

ON MOT 981-8043.GPJ ON MOT.GDT 25/2/00

PROJECT 981-8043

RECORD OF DYNAMIC CONE TEST No C7

1 OF 1

METRIC

W.P. 292-97-00

LOCATION N 5024619.40; E 264485.36

ORIGINATED BY DJM

DIST 52 HWY 69

BOREHOLE TYPE BBS-1, Hydraulic powered

COMPILED BY AP

DATUM Geodetic

DATE

CHECKED BY AP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40						60	80	100	20
192.26 0.00	Water Surface Water						192											
							191											
							190											
							189											
							188											
							187											
							186											
185.55 6.71	Top of river bed For soil stratigraphy refer to Record of Borehole 7						185											
							184											
							183											
							182											
181.71 10.55	End of dynamic cone testing Refusal to further cone penetration; probably on bedrock																	

ON MOT 981-8043.GPJ ON MOT.GDT 25/2/00

PROJECT <u>981-8043</u>		RECORD OF DYNAMIC CONE TEST No C8		1 OF 1		METRIC	
W.P. <u>292-97-00</u>		LOCATION <u>N 5024624.86; E 264487.33</u>		ORIGINATED BY <u>DJM</u>			
DIST <u>52</u> HWY <u>69</u>		BOREHOLE TYPE <u>BBS-1, Hydraulic powered</u>		COMPILED BY <u>AP</u>			
DATUM <u>Geodetic</u>		DATE _____		CHECKED BY <u>AP</u>			

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	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 × REMOULDED						
192.26 0.00	Water Surface Water							20 40 60 80 100	20 40 60						
							192								
							191								
							190								
							189								
							188								
							187								
							186								
185.62 6.64	Top of river bed For soil stratigraphy refer to Record of Borehole 6						185								
							184								
							183								
							182								
181.59 10.67	End of dynamic cone testing Refusal to further cone penetration; probably on bedrock														

ON MOT 981-8043.GPJ ON MOT GDT 25/2/00

PROJECT 981-8043

RECORD OF DYNAMIC CONE TEST No C9

1 OF 1

METRIC

W.P. 292-97-00

LOCATION N 5024616.39; E 264479.69

ORIGINATED BY DJM

DIST 52 HWY 69

BOREHOLE TYPE BBS-1, Hydraulic powered

COMPILED BY AP

DATUM Geodetic

DATE

CHECKED BY AP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60 80 100					
192.30	Water Surface													
0.00	Water													
							192							
							191							
							190							
							189							
							188							
							187							
							186							
185.59	Top of river bed						185							
6.71	For soil stratigraphy refer to Record of Borehole 7						184							
							183							
182.33														
9.97	End of dynamic cone testing Refusal to further cone penetration; probably on bedrock													

ON MOT 981-8043.GPJ ON MOT.GDT 25/2/00

PROJECT 981-8043 RECORD OF DYNAMIC CONE TEST No C10 1 OF 1 METRIC
W.P. 292-97-00 LOCATION N 5024640.59; E 264471.18 ORIGINATED BY DJM
DIST 52 HWY 69 BOREHOLE TYPE BBS-1, Hydraulic powered COMPILED BY AP
DATUM Geodetic DATE Mar 22/99 CHECKED BY AP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							WATER CONTENT (%)			
								20 40 60 80 100										
192.36	Water Surface																	
0.00	Water																	
							192											
							191											
							190											
							189											
							188											
186.63	Top of river bed						187											
5.73	For soil stratigraphy refer to Record of Borehole 8																	
185.96							186											
6.40	End of dynamic cone testing Refusal to further cone penetration; probably on bedrock																	

ON MOT 981-8043.GPJ ON MOT.GDT 25/2/00

PROJECT <u>981-8043</u>		RECORD OF DYNAMIC CONE TEST No C11		1 OF 1		METRIC	
W.P. <u>292-97-00</u>		LOCATION <u>N 5024636.44, E 264466.5</u>		ORIGINATED BY <u>DJM</u>			
DIST <u>52</u> HWY <u>69</u>		BOREHOLE TYPE <u>BBS-1, Hydraulic powered</u>		COMPILED BY <u>AP</u>			
DATUM <u>Geodetic</u>		DATE <u>Mar.22/99</u>		CHECKED BY <u>AP</u>			

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa								WATER CONTENT (%)		
								○ UNCONFINED	+ FIELD VANE	● QUICK TRIAXIAL							x REMOULDED	
192.36	Water Surface							20	40	60	80	100						
0.00	Water																	
							192											
							191											
							190											
							189											
							188											
186.66	Top of river bed						187											
5.70	For soil stratigraphy refer to Record of Borehole B						186											
185.81	End of dynamic cone testing Refusal to further cone penetration; probably on bedrock																	
6.55																		

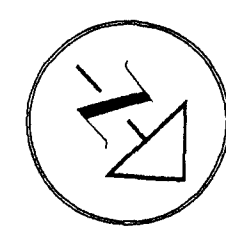
ON MOT 981-8043.GPJ ON MOT.GDT 25/2/00

PROJECT 981-8043										RECORD OF DYNAMIC CONE TEST No C12										1 OF 1										METRIC									
W.P. 292-97-00										LOCATION N 5024638.17; E 264465.21										ORIGINATED BY DJM																			
DIST 52 HWY 69										BOREHOLE TYPE BBS-1, Hydraulic powered										COMPILED BY AP																			
DATUM Geodetic										DATE										CHECKED BY AP																			
SOIL PROFILE					SAMPLES					DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT					UNIT WEIGHT					REMARKS & GRAIN SIZE DISTRIBUTION (%)														
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	SHEAR STRENGTH kPa					WATER CONTENT (%)					γ kN/m³	GR SA SI CL																				
							20	40	60	80	100	20	40	60	80	100																							
192.36 0.00	Water Surface Water						192																																
							191																																
							190																																
							189																																
							188																																
186.93	Top of river bed						187																																
5.48	End of dynamic cone testing Refusal to further cone penetration; probably on bedrock																																						

ON MOT 981-8043 GPJ ON MOT GDT 25/2/00

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

DIST 52 HWY 69
CONT. No.
WP No. 300-99-01

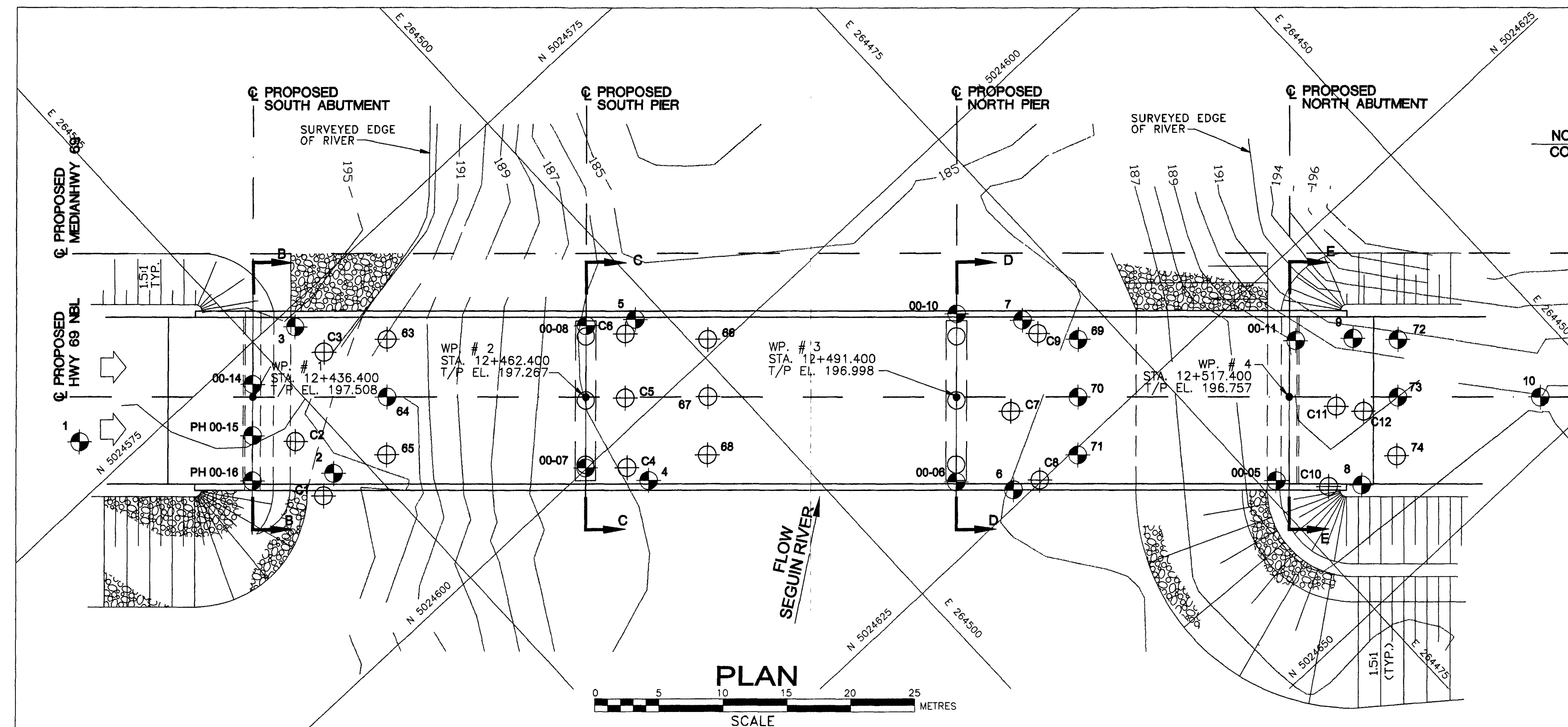


SEGUIN RIVER BRIDGE
HWY 69 NORTHBOUND LANES
BOREHOLE LOCATIONS & SOIL STRATA

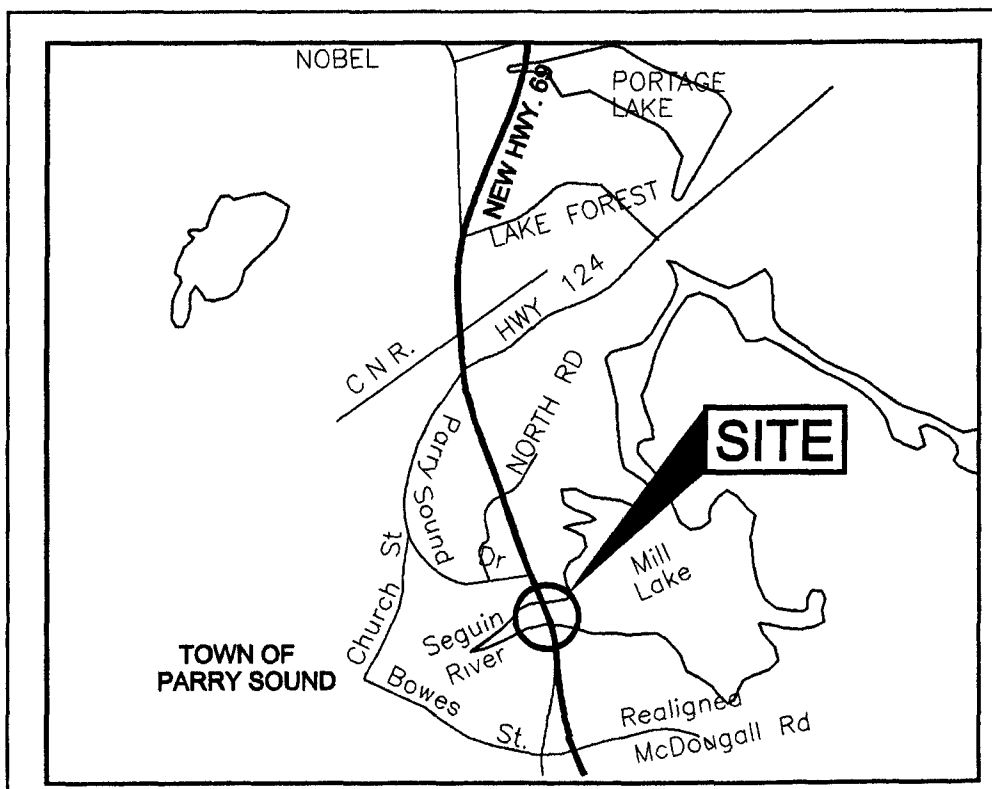
SHEET



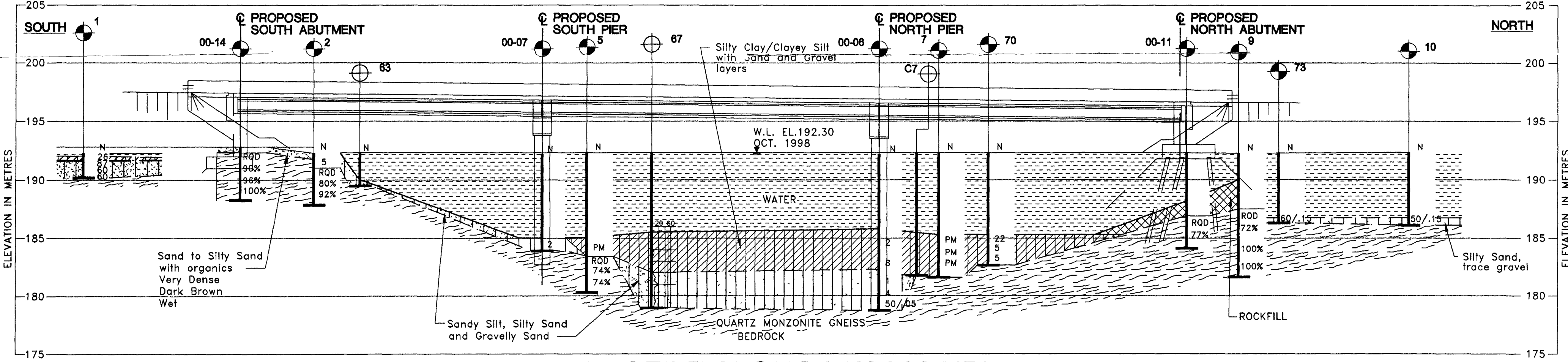
Golder Associates Ltd.
MISSISSAUGA, ONTARIO, CANADA



No.	ELEVATION	LOCATION	
		NORTHING	EASTING
C1	192.30	5024587.57	264529.07
C2	192.30	5024582.99	264527.82
C3	192.30	5024579.40	264521.45
C4	192.28	5024602.12	264510.29
C5	192.28	5024598.06	264506.71
C6	192.28	5024594.39	264503.30
C7	192.26	5024619.40	264485.36
C8	192.26	5024624.86	264487.33
C9	192.30	5024616.39	264479.69
C10	192.36	5024640.59	264471.18
C11	192.36	5024636.44	264466.50
C12	192.36	5024638.17	264465.21
00-05	192.19	5024637.47	264473.86
00-06	192.19	5024620.51	264492.20
00-07	192.20	5024599.93	264512.66
00-08	192.22	5024591.81	264505.09
00-10	192.19	5024610.92	264483.27
00-11	192.33	5024630.52	264465.33
00-14	192.81	5024577.44	264527.25
PH00-15	192.80	5024580.37	264529.98
PH00-16	192.80	5024582.93	264532.36



KEY PLAN

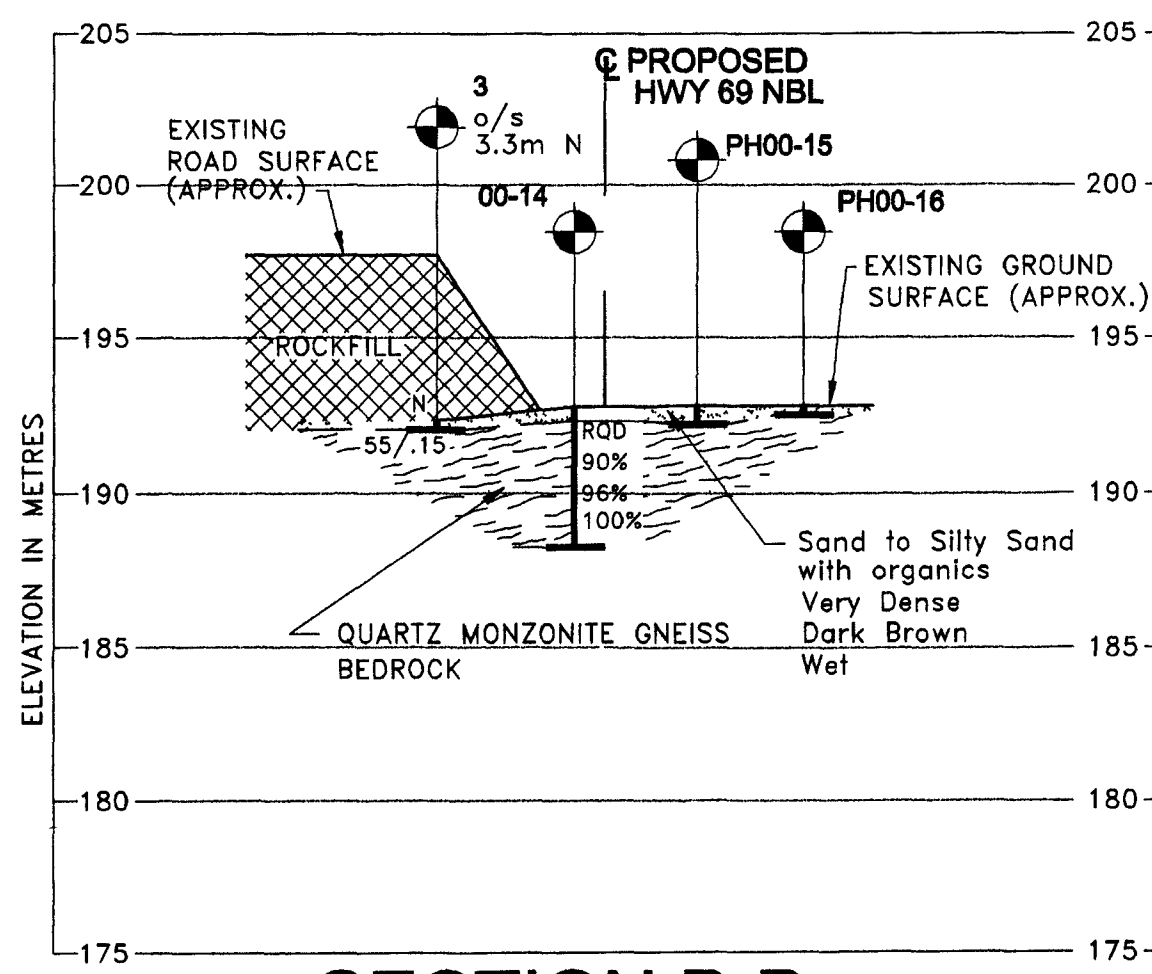


PROFILE ALONG HWY 69 NBL

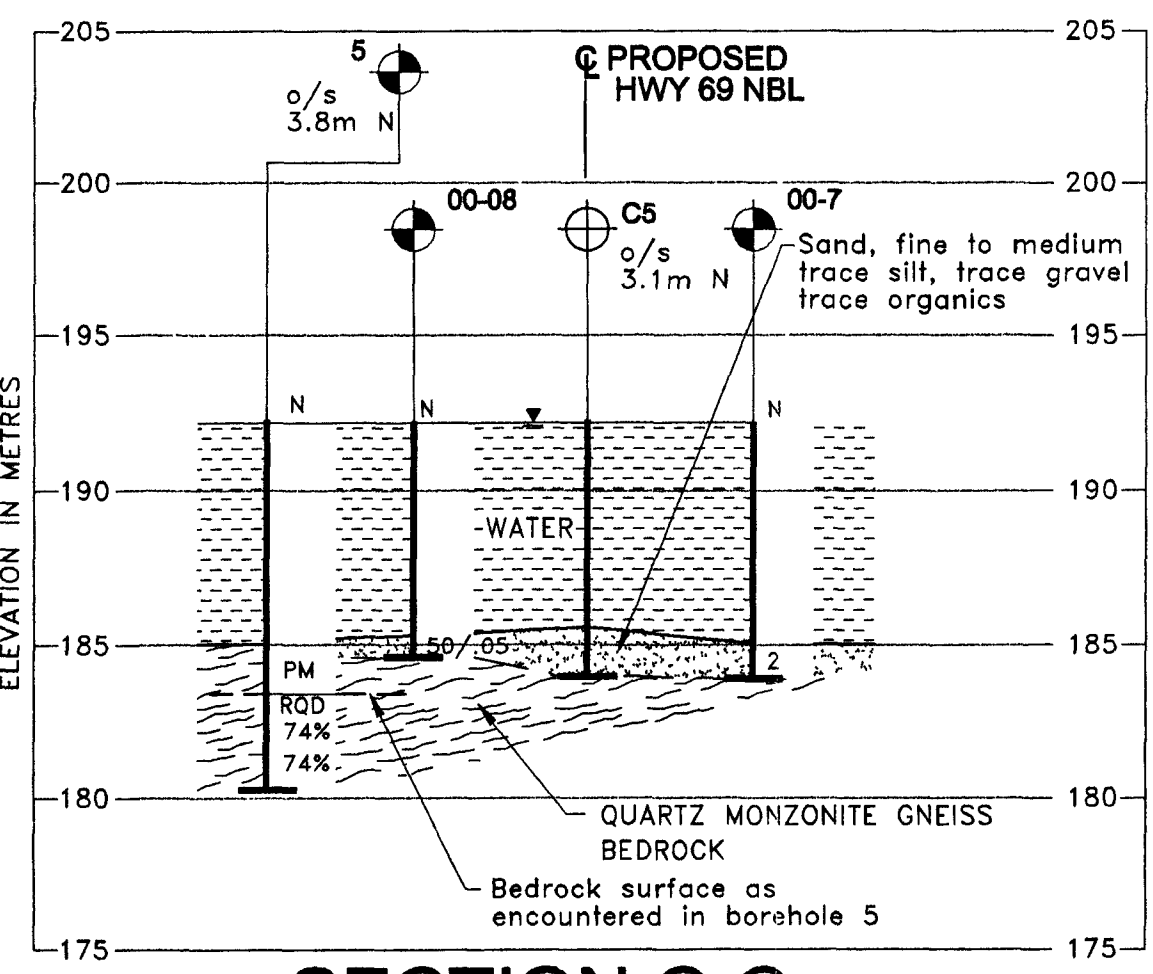
- LEGEND
- Borehole
 - Dynamic Cone Penetration Test (Cone)
 - N Standard Penetration Test value (475 j/blow)
 - 16 Blows/0.3m unless otherwise stated
 - 100% Rock Quality Designation (RQD)
 - WL at the time of investigation

No.	ELEVATION	LOCATION	
		NORTHING	EASTING
1	192.28	5024571.53	264540.19
2	192.28	5024586.82	264527.32
3	192.36	5024576.40	264521.77
4	192.28	5024603.99	264509.73
5	192.28	5024594.07	264501.97
6	192.26	5024624.01	264489.35
7	192.26	5024614.78	264479.86
8	192.36	5024642.25	264469.20
9	192.36	5024633.43	264461.94
10	192.36	5024646.77	264454.35
63	192.30	5024582.04	264517.18
64	192.30	5024585.33	264520.25
65	192.30	5024588.62	264523.31
66	192.30	5024599.09	264498.90
67	192.30	5024602.38	264501.96
68	192.30	5024605.67	264505.03
69	192.30	5024618.86	264477.68
70	192.30	5024622.16	264480.75
71	192.30	5024625.45	264483.82
72	192.30	5024635.91	264459.40
73	192.30	5024639.20	264462.47
74	192.30	5024642.49	264465.64

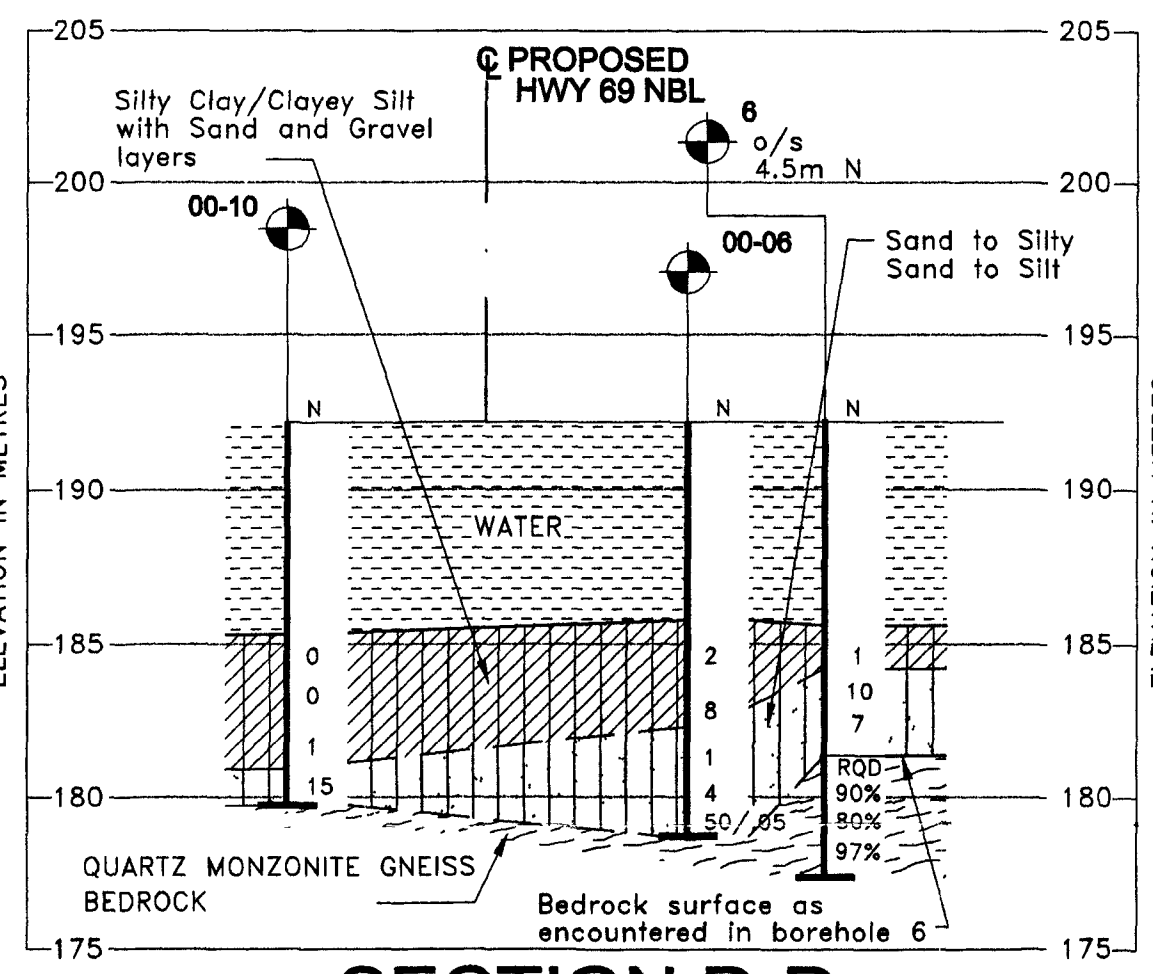
- NOTES
- The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.
 - The foundation locations are shown only for reference and may differ from those on the structural drawings.
 - General Arrangement plan / base plan provided by Cole Sherman in digital format in March, 2000



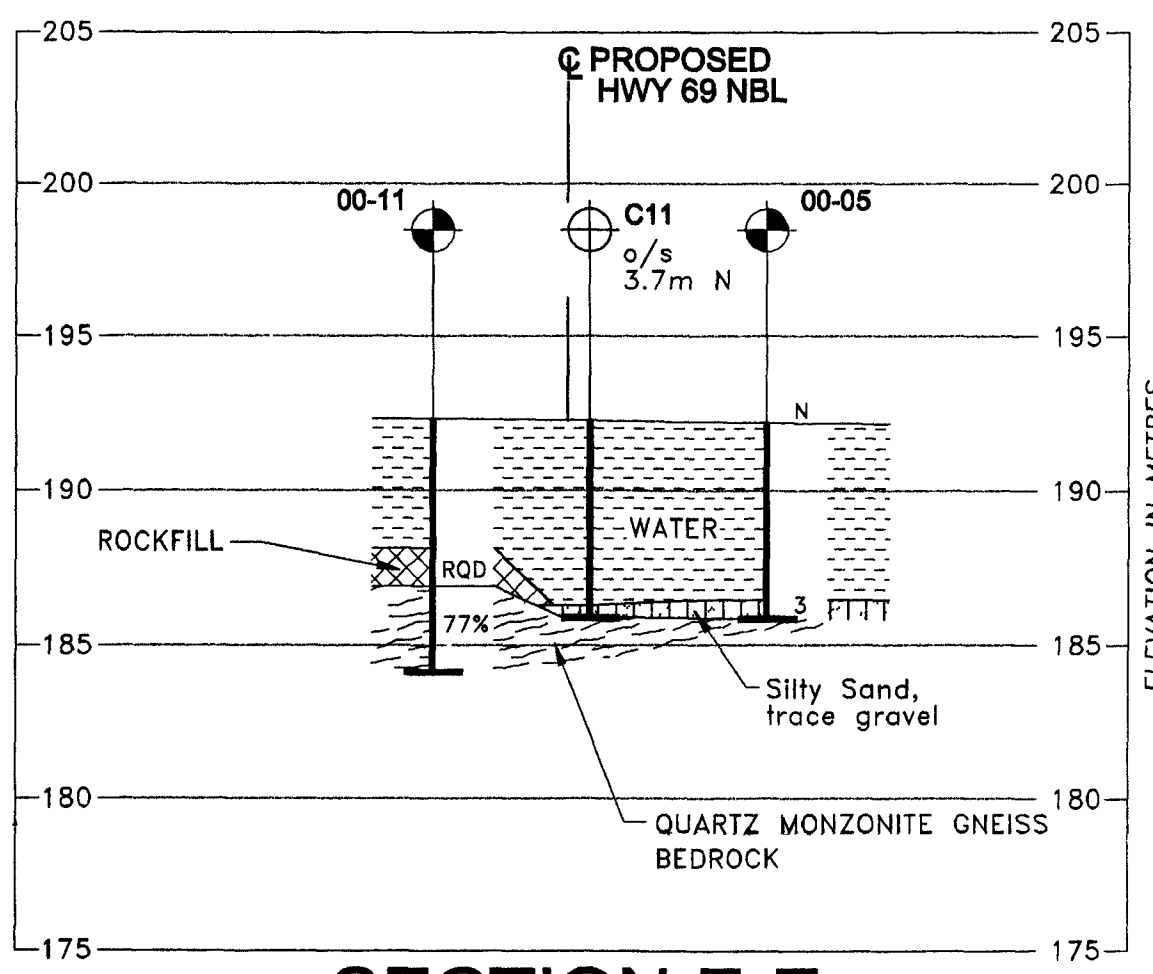
SECTION B-B



SECTION C-C



SECTION D-D

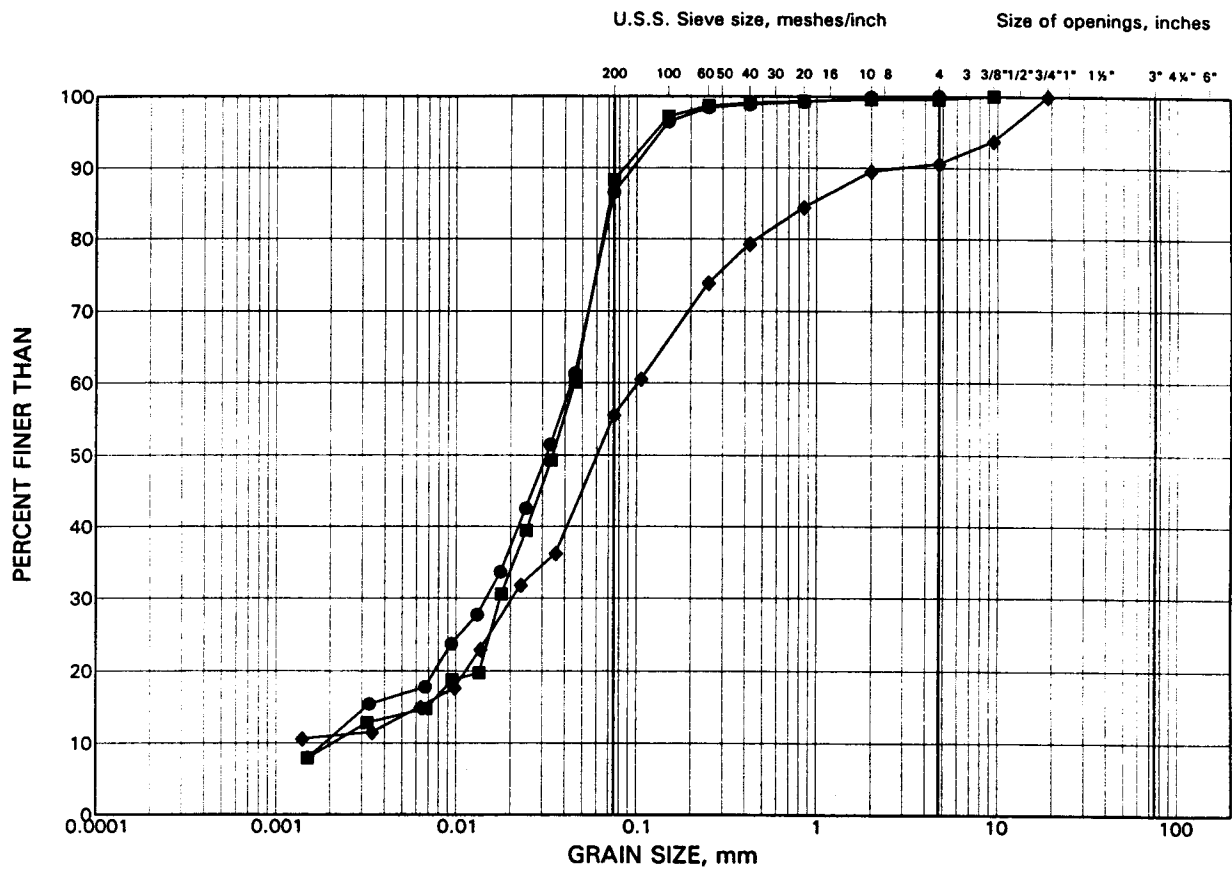


SECTION E-E

Geocres No. 41H-26					
HWY. No. 69		PROJECT NO.: 981-8043(6100)N			
SUBM'D. SEP	CHKD: ASP	DATE: 1999 09 14		SITE 44-164N	
DRAWN: JFC	CHKD. SEP	APPD.		DWG. 1	

GRAIN SIZE DISTRIBUTION CLAYEY SILT

FIGURE 1

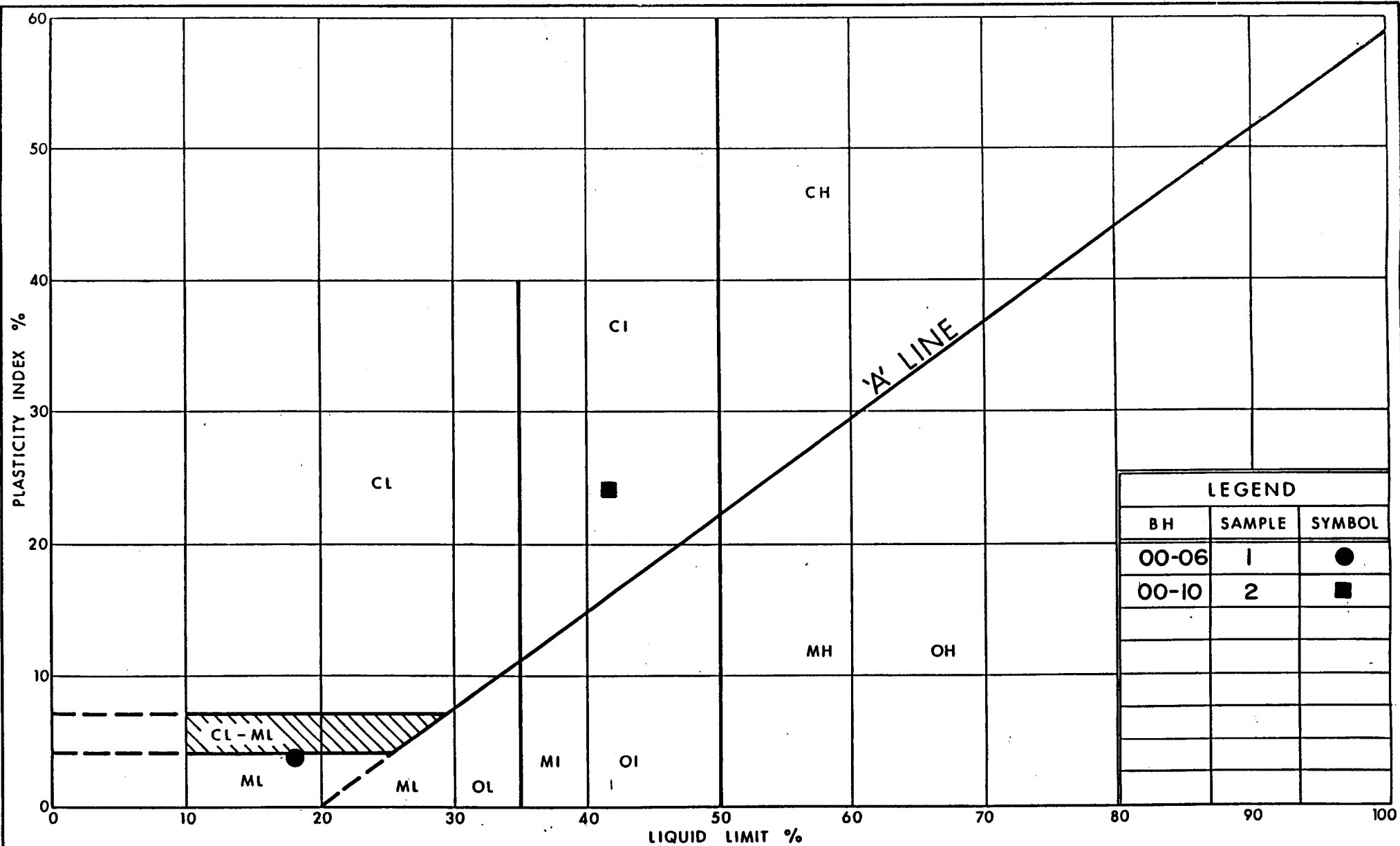


SILT AND CLAY SIZES		FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE
FINE GRAINED		SAND SIZE			GRAVEL SIZE		SIZE

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION (m)
●	70	2	183.5
■	71	2	184.0
◆	00-06	1	184.3

Oct 75, FF-S-21



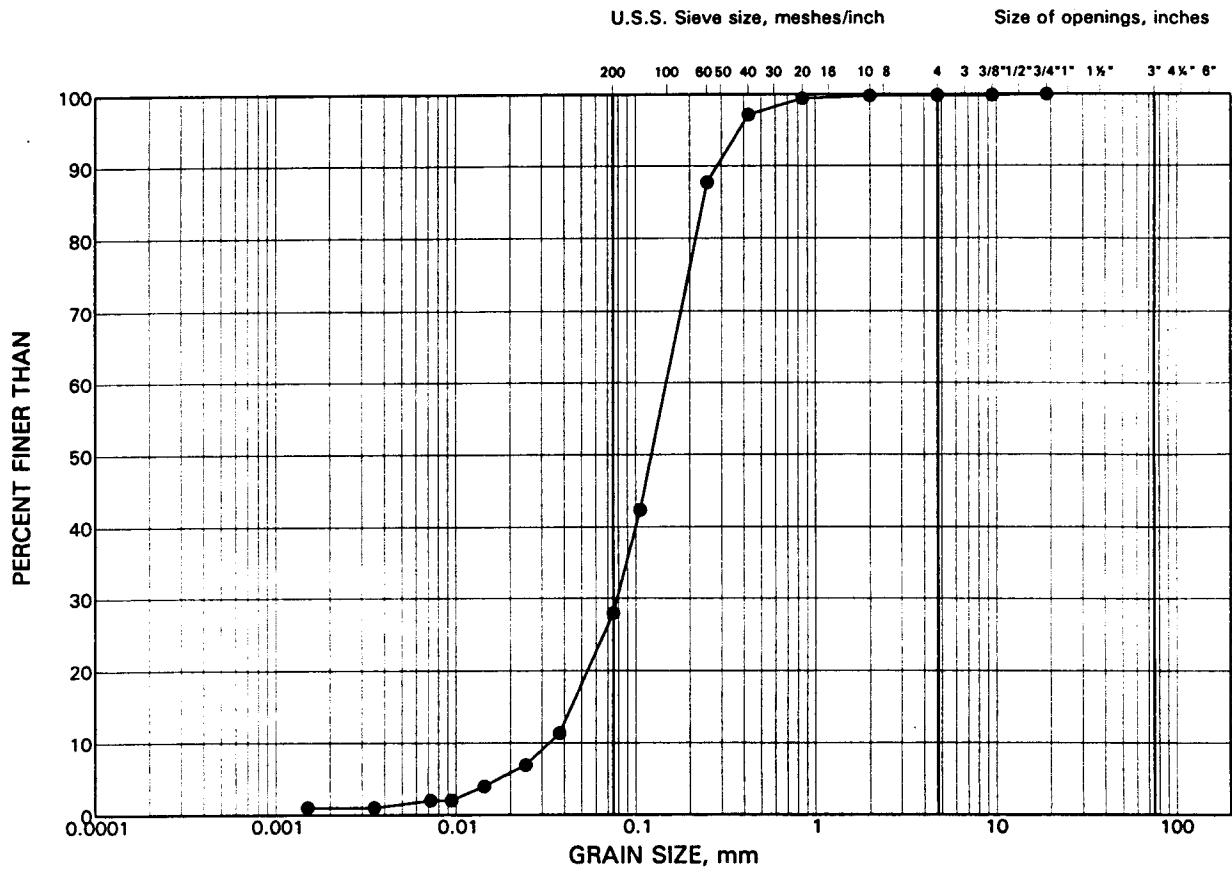
Ministry of
Transportation

PLASTICITY CHART CLAYEY SILT / SILTY CLAY

FIG No 2
W P 300-99-01

GRAIN SIZE DISTRIBUTION SILTY SAND

FIGURE 3



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

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION (m)
•	00-06	4	180.0