

G.I.-30 SEPT. 1976

GEOCRES No. 31L-69DIST. 54 REGION _____W.P. No. 90-94-00

CONT. No. _____

W. O. No. _____

STR. SITE No. _____

HWY. No. 17LOCATION From Hwy 94 to East
Junction of Hwy 11/17No. of PAGES -

OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT. _____REMARKS: _____



MERLEX ENGINEERING LTD.

CONSULTING GEOTECHNICAL ENGINEERS

GEOPRES No
31L-69

FOUNDATION INVESTIGATION AND DESIGN REPORT

for
Embankment Widening, Highway 17
From Hwy 94, Westerly 10.6 km to the East Junction of Hwy 11/17

G.W.P. 90-94-00

M.T.O. District 54, Sudbury

Merlex Reference No. 99/07/99063-F

November 1999

Prepared for

Ministry of Transportation
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1.0 INTRODUCTION

This report summarizes the results of the field investigation carried out along Highway 17 for the construction of embankment widenings on left (north) side of Highway 17 East, Township of East Ferris, to accommodate a westbound truck climbing lane and one right turn taper at Bayview Road in the Township of West Ferris.

The requirements of the foundation and geotechnical investigations were specified in the RFP documents for the TPM Agreement No. 5005-A-000038 by the Ministry of Transportation of Ontario, which identified the widenings would be approximately 4.0 m at the top and the existing embankments are 2.0 to 3.0 m high with no major planned changes to the existing grade in these areas. This report applies to the proposed embankment widening, left side of Highway 17 between the following stations:

Township of West Ferris, Station 10+275 to 10+475 Lt (Twin Lake)

Township of West Ferris, Station 10+675 to 10+810 Lt

Township of West Ferris, Station 12+325 to 12+400 Lt

2.0 SITE DESCRIPTION

The three sites are located within the Township of West Ferris (City of North Bay) within some 2 km east of the east junction of Hwy 11/17. The site is located in MTO District 54, Sudbury.

The North Bay area is located on the northwestern part of the Grenville Province of the Canadian Precambrian Shield. This area is underlain by a metamorphic complex of gneissic metasediments and plutonic rocks, although intrusive and sedimentary rocks younger than the metamorphic complex are also present.

The surficial geological deposits of the area are mapped on the Ontario Geological Survey Map 5041, Northern Ontario Engineering Geology Terrain Study Data Base Map, North Bay NTS 31L/SW (Gartner, J.F. 1979) as "rock knob" terrain with areas of glacialocustrine sands and pockets of organic terrain.

The existing Highway 17 is an asphalt covered two lane road with gravel shoulders in the areas under investigation. The road travels through several rock cuts and over rock fills. The highway pavement over these rock fills shows no apparent signs of distress which would be associated with settlement or instability of the existing embankment.

3.0 INVESTIGATION PROCEDURES

The field work for this investigation was carried out during the period of September 7 to 14, 1999. The boreholes for the proposed embankment widening in Twin Lake (Station 10+275 to 10+475 Lt) (also known as Twinline Lake) were put down with a Mobile B24 hydraulic "fly-in" skid mounted drill rig mounted on a raft. Due to the presence of cobbles/boulders in the subsurface soils, casing was rotary advanced following diamond core drilling ahead with BQ size coring equipment. At the other two areas of embankment widening (Station 10+675 to 10+810 Lt and Station 12+325 to 12+400 Lt) the borings were advanced with a muskeg mounted diesel CME with either 82 mm I.D. hollow stem or standard augers.

Soil samples were recovered by means of a 50 mm O.D. split spoon sampler driven into the soil according to the specifications of the Standard Penetration Test (ASTM D1586). Samples were generally retrieved at intervals ranging from 0.75 to 1.5 m. At all borehole locations, except Borehole 6, dynamic cone penetration resistance tests were carried out. Since cohesive soils were not encountered, undisturbed Shelby tube sampling nor field vane testing was not carried out. Groundwater was monitored during drilling and after completion of the boreholes.

Piezometers were not installed for longer term observation of groundwater levels in the completed boreholes.

The laboratory testing program for representative soil samples consisted of the following.

- Grain Size Analysis
- Natural Moisture Contents
- Atterberg Limits

The results of this testing are plotted on the borehole logs.

The boreholes were established in the field as per the RFP documents and the locations established by the forces of Merlex Engineering Ltd. and Earth Tech (Canada) Inc.

4.0 SUBSURFACE CONDITIONS

The subsurface conditions at the boring locations are recorded on the Borehole Logs, 1 to 10 inclusive and enclosed in Appendix A. The locations and elevations of the boreholes and cone tests, along with stratigraphical profile based on the borehole data are shown on Sheets 1 to 3, inclusive. Boreholes 2, 3 and 4 were terminated at depths ranging from 4.0 to 5.4 m below the lake bottom.

The predominant surficial deposit, underlying thin layers of organics, is a sand to sandy silt/silty sand with varying gravel content and numerous cobbles and boulders. The following is a description of soil strata encountered at the three assigned embankment widening locations.

4.1 Station 10+275 to 10+475 Lt - Twin Lake

4.1.1 Organics (Amorphous Peat)

At the location of all borings put down in the Twin Lake area (Boreholes 1 to 4, inclusive) a deposit of very soft organics (amorphous peat) was penetrated at the lake bottom. The deposit had sufficient consistency to resist penetration of a 300 gram weight attached to a cloth tape used to sound bottom, however it offered negligible resistance to penetration of the split spoon or dynamic penetration cone under the weight of 6 m length of AW rod or similar length of BW casing. Poor sample recovery was experienced, even with split spoon traps, indicating the very soft nature of the deposit. This deposit extended from the lake bottom to depths ranging between approximately 1.2 to 2.1 m below lake bottom.

Examination of some recovered material showed that the black organic soil had no structure and had a consistency of ooze. The moisture content ranged from 1200 to 1230%.

4.1.2 Sands

Underlying the organic lake bottom deposits, a stratum of fine and medium sands with silt, gravel and numerous cobbles and boulders was penetrated. The high concentration of boulders required rotary advance of the casing and diamond drilling ahead with BQ coring equipment. At the location of Borehole 1, the heavy concentration of boulder/cobbles in the sand matrix was such that once the BW casing broke through a boulder and the split spoon lowered to retrieve a sample, refusal to advance of the sampler was met on another boulder/cobble. Refusal to advance of the dynamic cone penetration test was met at depths varying from 0.7 to 3.7 m into the sand deposit.

Results of grain size distribution tests carried out on select samples indicated the material contains 2 to 18% gravel, 42 to 84% sand and 14 to 40% silt. The standard penetration test "N"

values of 8 to greater than 100 blows/0.3 m and dynamic cone penetration tests indicated the deposits was loose to compact (generally compact), to a depth of some 0.5 to 1.5 m, becoming dense to very dense with depth.

4.1.3 Bedrock/Boulder

At the location of Borehole 1, at a depth of some 4.5 m below lake bottom, a 0.8 m length of BQ size rock core was retrieved. The core recovery was 98% with an RQD value of 35%. It is interpreted that this core represents either the overburden/bedrock interface at this borehole location or a boulder.

4.1.4 Groundwater Conditions

The depth of water in Twin Lake (also known as Twinline Lake) varied from 0.7 m (close to shore) to 4.5 m at the boring locations which were at a distance of some 2 to 4 m beyond the existing submerged toe of rock fill slope. Water depth soundings were taken a further distance out, of some 6 to 10 m beyond the submerged slope toe, indicating depths of some 3.5 to 4.7 m to the lake bottom.

4.2 Station 10+675 to 10+810 Lt

Boreholes 5, 6, 7 and 8 were put down in this area of the proposed Hwy 17 embankment widening and indicated generally peat underlain by cohesionless sands of generally compact relative density, becoming very dense with depth.

4.2.1 Fill

A fill deposit consisting of brown sands, with varying silt content mixed with cobbles and organics was penetrated at the surface of Boreholes 5, 6, 7 and 8 and ranged in thickness

between 0.5 to 1.5 below existing grade. Based on a single "N" value of 4, the relative density can be described as loose.

4.2.2 Peat

Underlying the sand fill at Borehole 7, a deposit of black fine fibrous peat was penetrated at depths of 0.6 to 1.8 m below existing grade. A thin layer of this deposit was observed underlying the fill at Borehole 5 (at 0.8 m depth). The lateral extent of this deposit increases to the north, as indicated on the enclosed Plan, Sheet 2. The total thickness of the peat ranged from 75 mm to 1.2 m in the boreholes.

4.2.3 Sands

Underlying the surficial sand fills and peat, a deposit of fine and medium sand, with some silt and gravel was penetrated to depths varying from 2.0 to 4.2 m below grade at Boreholes 6, 7 and 8. Based on the standard penetration test values ("N" values) of 2 to 20 blows/0.3 m this deposit was loose to compact (generally compact). At the location of Borehole 8, at a depth of some 2.0 m below grade, the silt and gravel content of the sand deposit increased, with occasional cobbles/boulders being encountered. The lower part of this deposit exhibited a "till-like structure" and the relative density increased to very dense, with "N" values greater than 100 blows/0.3 m.

Grain size distribution tests carried out on samples from this deposit indicated 6 to 33% gravel, 66 to 48% sand and 28 to 19% fines (silt).

4.2.4 Boulders

At the location of Borehole 5, auger refusal was met at depths ranging between 0.7 to 1.5 m after four attempts. Based on drill response, it is our opinion this refusal was probably due to the presence of boulders.

4.3 Station 12+325 to 12+400 Lt

Boreholes 9 and 10 were put down in this area and indicated soils consist of a thin layer of peat underlain by cohesionless sand/silty sands in a loose to compact state of relative density.

4.3.1 Peat

At both borehole locations, a black fine fibrous peat was penetrated to depths ranging from 0.9 to 1.1 m below existing grade. The natural moisture content of this deposit was in the order of 580%.

4.3.2 Sands

Directly underlying the thin peat layer, a deposit of sands with trace to some silt and trace of gravel extended to a depth of 2.1 m at Borehole 10 and to the end of sampling (4.6 m) at Borehole 9.

Grain size distribution tests carried out in this deposit indicated 12 to 23% gravel, 83 to 74% sand and 5 to 3% fines (silt). The "N" values ranged from 2 to 14 indicating a very loose to compact relative density.

4.3.3 Silty Sand

At a depth of 2.1 m in Borehole 10, a deposit of silty fine sand, trace of gravel, was penetrated. The grain size distribution for this deposit indicated 3% gravel, 51% sand and 46% fines

(predominantly silt). Based on the dynamic cone penetration test values, the deposit was in a loose/compact state of relative density. Refusal to further penetration of the dynamic cone penetration test was met at a depth of 4.1 m in Borehole 10, probably on a boulder, whereas at Borehole 9 the dynamic cone penetrated a loose/compact deposit (probably silty sand) to a 13.0 m depth where refusal was encountered. It is believed that the ease of penetration of the dynamically driven cone at Borehole 9 was caused by the development of high pore pressures in the silty sand to sandy silt deposit, rather than by the presence of any soft cohesive soils.

5.0 DISCUSSIONS AND RECOMMENDATIONS

5.1 General

As part of constructing a westbound truck climbing lane, and westbound right turn lane at Bayview Road (Station 12+325 to 12+400 Lt) embankment widening of the existing Highway 17, on the left, will be required. All existing embankments, at locations investigated, are constructed with rock fill based on the geotechnical investigation carried out by our firm for pavement design. The existing road and pavement in these areas shows no apparent signs of distress which would be associated with excessive settlement or slope instability.

Based on typical sections provided to us, the approximate height of embankment widening at the three locations is as follows:

<u>Location</u>	<u>Height* (m)</u>
Sta 10+350 (Twin Lake)	10.5
Sta 10+250	8.5
Sta 12+350	4.5

* NOTE: Height measured from bottom of organic layer to top of pavement.

5.2 Foundations

The results of this investigation indicate that the natural inorganic cohesionless soils, underlying organic lake bottom deposits (amorphous peat) and/or surficial deposits of fine fibrous peat are capable of safely supporting the proposed embankment widenings constructed of rock fill at the standard 1.25:1 side slope provided the following procedures are followed during construction.

✓ At the Twin Lake widening, the rock fill should be constructed from the bottom up. Construction should commence from one end only and progress longitudinally along the face of the existing embankment. The embankment widening can be constructed by end dumping, from one end and constructed to full width. The advancing end of the rock embankment should be kept to a half concave face with the shoulder corner, adjacent to the existing embankment, in advance of the outside face to ensure displacement of the organic bottom deposit and sound contact between the rock fill and the underlying inorganic soils.

Muskeg (peat), to a depth of some 1.8 m, was present between approximately Station 10+717 and 10+747 and to a depth of some 1.1 m between approximately Station 12+340 to 12+395 and must be excavated as per OPSD 203.030 prior to construction of the standard rock fill embankment. Excavations parallel to the toe of the embankments will lower the factor of safety against instability therefore the widening should be carried out in an appropriate manner to limit this impact. A suggested method to limit this impact is to excavate windows perpendicular to the embankment toe and backfill immediately.

In accordance with MTO Northern Regional Engineering Directive NRE 98-200, all widenings greater than 6.0 m in height must be constructed with a 2.0 m wide berm at approximately mid height.

At the Twin Lake site, the elevation of the culvert extensions is approximately mid height. Standard bedding, as per OPSD 800 series, can be used for the culvert extensions.

The rock fills can be constructed by end dumping and pushing the fill forward parallel to the existing embankment. Voids in the rock fill at the top of the embankment shall be chinked with

rock fragments and spalls to form the subgrade. The rock fills, above the lake level, should be constructed in lifts up to 2.0 m in height.

Considering the cohesionless nature of the natural subgrade soils, below the lake bottom organics, embankment settlements will occur essentially concurrently with placement of the embankment widening fill. The effect of the embankment widening on the existing highway will be minor, due to stress increase below the existing embankment. However, the incremental stress increase at the centerline of the existing embankment is less than 10% to a 5.0 m height by 7.0 m wide embankment addition to one side.

6.0 CLOSURE

Information provided in this report is valid only at the locations drilled. Any assumptions of continuity of soil stratigraphy between boreholes, as shown on enclosed cross-sections, is intended as an aid for design purposes only and does not constitute a statement of existing conditions for contractual or construction purposes.

Details of the investigation, the material analysis and recommendation in this report are considered to be complete. However, should any questions arise, please do not hesitate to contact the undersigned.

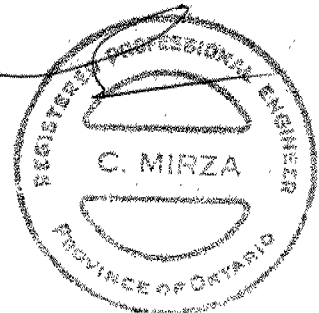
Yours very truly,

MERLEX ENGINEERING LTD.



M. A. Merleau, P. Eng.
Principal

C. Mirza, P. Eng.



Report Distribution: Earth Tech (Canada) Inc.
Merlex Engineering Ltd.

APPENDIX A

Abbreviations
Borehole Logs
Profile and Borehole Location Plans

LIST OF ABBREVIATIONS & DESCRIPTION OF TERMS

The abbreviations and terms commonly employed on the borehole logs, on the figures and in the report are as follows:

1. ABBREVIATIONS

AS	Auger Sample
CS	Chunk Sample
DO	Drive Open
DS	Denison type sample
FS	Foil Sample
HB	Hammer Bouncing
PH	Sampler advanced by hydraulic pressure
PM	Sampler advanced by manual pressure
RC	Rock core with size & percentage of recovery
ST	Slotted Tube
TO	Thin-walled, open
TP	Thin-walled, piston
WH	Sampler Advanced by static weight
WS	Wash Sample

2. PENETRATION RESISTANCE/"N"

Dynamic Cone Penetration Resistance:

A continuous profile showing the number of blows for each 300 mm of penetration of a 50 mm diameter 90° point cone driven by a 63 kg hammer falling 760 mm.

Plotted as —•••••

Standard Penetration Resistance or "N" Values

The number of blows of a 63 kg hammer falling 760 mm required to advance a 50 mm O.D. drive open sampler 300 mm. Plotted as "o".

3. SOIL DESCRIPTION

a) *Cohesionless Soils:*

"N" (blows/0.3 m)	Relative Density
0 to 4	very loose
4 to 10	loose
10 to 30	compact
30 to 50	dense
over 50	very dense

3. SOIL DESCRIPTION (Cont'd)

b) *Cohesive Soils:*

Undrained Shear Strength (kPa)	Consistency
Less than 12	very soft
12 to 25	soft
25 to 50	firm
50 to 100	stiff
100 to 200	very stiff
over 200	hard

c) *Method of Determination of Undrained Shear Strength of Cohesive Soils:*

+ 3.2 - Field Vane test in borehole.
The number denotes the sensitivity to remoulding.

D - Laboratory Vane Test

" - Compression test in laboratory

For a saturated cohesive soil the undrained shear strength is taken as one-half of the undrained compressive strength.

4. TERMINOLOGY

Terminology used for describing soil strata is based on the proportion of individual particle sizes present:

Trace, or occasional	Less than 10%
Some	10 to 20%
With	20 to 30%
Adjective (i.e. silty or sandy)	30 to 40%
And (i.e. sand and gravel)	40 to 60%

5. LABORATORY TESTS

P	Standard Proctor Test
A	Atterberg Limit Test
GS	Grain Size Analysis
H	Hydrometer Analysis
C	Consolidation



RECORD OF BOREHOLE No. 1

1 OF 1

METRIC

REFERENCE 99/06/99063 DATUM Geodetic LOCATION Sta 10+296 29.5 m Lt of Centreline, N'y 5129401.795 E'y 310813.867 ORIGINATED BY ELS
PROJECT G.W.P. 90-94-00, Hwy 17, W'y 10.6 km to Hwy 11/17 Jct. BOREHOLE TYPE Raft Mounted B24, BW Casing, BQ Core, DCPT COMPILED BY JRB
CLIENT Earth Tech (Canada) Inc. DATE (Started/Completed) 7/9/99 - 7/9/99 TIME _____ CHECKED BY MAM

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE	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								
202.2	Twin Lakes Water Surface												
0.0	WATER												
197.78							202						
4.45	ORAGNICS Black Fluid Amorphous Peat (Very Soft)						201						
195.68							200						
6.55	SANDS Grey Fine Sands some Silt to Silty Fine Sand trace Gravel with numerous Cobbles and Boulders (Dense/Very Dense)		1	DO	60		199						
			2	DO	20/0"		198						
			3	DO	20/0"		197						
			4	DO	20/0"		196						
193.24							195						
8.99	BEDROCK Grey Granite, poor quality (Possible Boulder)		5	RC			194						
192.50							193						
9.73	End of Borehole												
COMMENTS Cone Location at Sta 10+305 26.3 m Lt Centreline. Cone rod and casing sank through organic (ooze) under self weight.								+ ³ , x ³ : Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE		WATER LEVEL RECORDS Date (dd/mm/yy)/Time 7/9/99 Water Depth (m) 0 Cave In Level (m) N/A			

MEL-GEO 99063.GPJ MEL-GEO.GDT 18/11/99



MERLEX ENGINEERING LTD.
Consulting Geotechnical Engineers

ENCLOSURE NO.: 3

RECORD OF BOREHOLE No. 1A

1 OF 1

METRIC

REFERENCE 99/06/99063 DATUM Geodetic LOCATION Sta 10+300 26 m Lt of Centreline, N'y 5129397.481 E'y 310816.972 ORIGINATED BY ELS
PROJECT G.W.P 90-94-00, Hwy 17, W'y 10.6 km to Hwy 11/17 Jct. BOREHOLE TYPE Raft Mounted B24, Wash Boring COMPILED BY JRB
CLIENT Earth Tech (Canada) Inc. DATE (Started/Completed) 7/9/99 - 7/9/99 TIME _____ CHECKED BY MAM

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					
202.2 0.0	Twin Lakes Water Surface WATER															
						202										
						201										
						200										
						199										
						198										
197.86 4.37 197.86 4.57	Refusal on ROCK FILL Borehole moved off toe of rock fill embankment slope.															
COMMENTS							+ ³ . X ³ : Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE					WATER LEVEL RECORDS Date (dd/mm/yy)/Time Water Depth (m) Cave In Level (m) 7/9/99 0 N/A				

MEL-GEO 99063.GPJ MEL-GEO.GDT 18/11/99



RECORD OF BOREHOLE No. 2

1 OF 1

METRIC

REFERENCE 99/06/99063 DATUM Geodetic LOCATION Sta 10+351.28.0 m Lt of Centreline, N'y 5129387.891 E'y 310867.102 ORIGINATED BY ELS
PROJECT G.W.P 90-94-00, Hwy 17, W'y 10.6 km to Hwy 11/17 Jct. BOREHOLE TYPE Raft Mounted B24, Wash Boring, BQ Core, DCPT COMPILED BY JRB
CLIENT Earth Tech (Canada) Inc. DATE (Started/Completed) 8/9/99 - 8/9/99 TIME _____ CHECKED BY MAM

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE	PLASTIC LIMIT W _p NATURAL MOISTURE CONTENT W LIQUID LIMIT W _L WATER CONTENT (%)	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES							
202.2 0.0	Twin Lakes Water Surface WATER						202					
197.96 4.27	ORAGNICS Black Fluid Amorphous Peat (Very Soft)		1	DO	0		197					
196.29 5.94	SANDS Grey Fine Sands some Silt to Silty Fine Sand trace Gravel with numerous Cobbles and Boulders (Dense/Very Dense) Cored through 200 mm boulder at 7.3 m. Cored through till and cobbles/boulders to 9.14 m.		2	DO	0		196					
			3	DO	107		195					
			1C	RC	20/0"		194					
			2C	RC								
193.09 9.14	End of Borehole											
COMMENTS Cone Location at Sta 10+352.28.8 m Lt Centreline. Cone rod and casing sank through organic (ooze) under self weight.								+ 3, X ³ : Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE		WATER LEVEL RECORDS Date (dd/mm/yyyy) Time Water Depth (m) Cave in Level (m) 8/9/99 0 N/A		

MEL-GEO 99063 GPJ MEL-GEO GDT 18/1/99



RECORD OF BOREHOLE No. 3

1 OF 1

METRIC

REFERENCE 99/06/99063 DATUM Geodetic LOCATION Sta 10+400 26.0 m Lt of Centreline, N'y 5129374.857 E'y 310914.379 ORIGINATED BY ELS
PROJECT G.W.P 90-94-00, Hwy 17, W'y 10.6 km to Hwy 11/17 Jct. BOREHOLE TYPE Raft Mounted B24, Wash Boring, BQ Core, DCPT COMPILED BY JRB
CLIENT Earth Tech (Canada) Inc. DATE (Started/Completed) 9/9/99 - 9/9/99 TIME CHECKED BY MAM

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE 20 40 60 80 100	PLASTIC LIMIT W _p NATURAL MOISTURE CONTENT W LIQUID LIMIT W _L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ KN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES							
202.2 0.0	Twin Lakes Water Surface WATER						202					
199.30 2.93	ORAGNICS Black Fluid Amorphous Peat (Very Soft)		1	DO	1		199					
197.66 4.57	SANDS Grey Fine Sands some Silt to Silty Fine Sand trace Gravel with numerous Cobbles and Boulders (Dense/Very Dense)		2	DO	8		197					
			3	DO	15		196					
			4	DO	41		195					
195.02 7.21	ROCK (Boulder)		1C	RC			194					
194.10 8.31	SAND Silty Fine Sands with Gravel End of Borehole											
COMMENTS Cone Location at Sta 10+398 25.5 m Lt Centreline. Cone rod and casing sank through organic (ooze) under self weight.								+ 3, x 3: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE		WATER LEVEL RECORDS Date (dd/mm/yy) Time Water Depth (m) Cave in Level (m) 9/9/99 0 N/A		

MEL-GEO 99063 GPJ MEL-GEO.GDT 18/11/99



RECORD OF BOREHOLE No. 4

1 OF 1

METRIC

REFERENCE 99/06/99063 DATUM Geodetic LOCATION Sta 10+447 25.6 m Lt of Guardrail, N'y 5129363.834 E'y 310960.07 ORIGINATED BY ELS
PROJECT G.W.P 90-94-00, Hwy 17, W'y 10.6 km to Hwy 11/17 Jct. BOREHOLE TYPE Raft Mounted B24, Wash Boring, DCPT COMPILED BY JRB
CLIENT Earth Tech (Canada) Inc. DATE (Started/Completed) 9/9/99 - 9/9/99 TIME CHECKED BY MAM

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL X LAB VANE 20 40 60 80 100	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								
202.2 0.0	Twin Lakes Water Surface WATER						202						
201.52 0.71	ORAGNICS Black Fluid Amorphous Peat (Very Soft)		1	DO			201						
200.20 2.03	SANDS Grey Fine Sands some Silt to Silty Fine Sand trace Gravel with numerous Cobbles and Boulders Till Structure Evident with depth (Compact/Very Dense)		2	DO	11		200						14 56 (40)
			3	DO	15		199						18 42 (40)
			4	DO	49		198						11 61 (28)
197.66 4.57	End of Sampling						197						
196.49 5.74	End of DCPT												

COMMENTS
Cone Location at Sta 10+445 25.0 m Lt Centreline. Cone rod and casing sank through organic (ooze) under self weight.

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

WATER LEVEL RECORDS		
Date (dd/mm/yy)/Time	Water Depth (m)	Cave In Level (m)
9/9/99	0	N/A

MEL-GEO 99063.GPJ MEL-GEO.GDT 18/11/99

RECORD OF BOREHOLE No. 5

1 OF 1

METRIC

REFERENCE	99/06/99063	DATUM	Geodetic	LOCATION	Sta 10+710 22.0 m Lt of Centreline, N'y 5129300.826 E'y 311215.436	ORIGINATED BY	ELS
PROJECT	G.W.P 90-94-00, Hwy 17, W'y 10.6 km to Hwy 11/17 Jct.	BOREHOLE TYPE	CME 45 Muskeg, Standard Augers, Dynamic Cone Penetration	COMPILED BY	JRB		
CLIENT	Earth Tech (Canada) Inc.	DATE (Started/Completed)	14/9/99 - 14/9/99	TIME		CHECKED BY	MAM

SOIL PROFILE						DYNAMIC CONE PENETRATION RESISTANCE PLOT											REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	SHEAR STRENGTH kPa							WATER CONTENT (%)			UNIT WEIGHT	
								PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT w_p w w_L ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE										γ	
								20 40 60 80 100							20 40 60			kN/m³	GR SA SI CL
202.1	Ground Surface																		
0.0	SANDS (FILL) Grass cover over Brown Sands with trace to Silty, trace Gravel and Organics over 75 mm thick layer of black Peat						202												
			1	AS															
201.19	Auger Refusal on Boulder		2	DO	3		201												
0.91	End of Borehole Move Borehole to Sta 10+711 22 m Lt Centreline Auger Refusal at 1.37 m. Move Borehole to Sta 10+714 22 m Lt Centreline Auger Refusal at 1.52 m. Move Borehole to Sta 10+708 22 m Lt Centreline Auger Refusal at 0.71 m.				20/0"			Hammer Bouncing											

COMMENTS
Cone Location at Sta 10+710 23.0 m Lt of Centreline. Water level recorded on completion of borehole.

+ 3 X 3 : Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

WATER LEVEL RECORDS

Date (dd/mm/yy)/Time	Water Depth (m)	Cave in Level (m)
14/9/99	0.3	

MEL-GEO 99063.GPJ MEL-GEO.GDT 18/11/99



RECORD OF BOREHOLE No. 6

1 OF 1

METRIC

REFERENCE 99/06/99063 DATUM Geodetic LOCATION Sta 10+716 22.0 m Lt of Centreline, N'y 5129299.469 E'y 311221.28 ORIGINATED BY ELS
PROJECT G.W.P 90-94-00, Hwy 17, W'y 10.6 km to Hwy 11/17 Jct. BOREHOLE TYPE CME 45 Muskeg, Standard Augers COMPILED BY JRB
CLIENT Earth Tech (Canada) Inc. DATE (Started/Completed) 14/9/99 - 14/9/99 TIME CHECKED BY MAM

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa								
								20	40	60	80	100				
202.1	Ground Surface															
0.0	SILTY SAND															
	Brown Silty Sand with trace Organics, some Cobbles/Boulders (Possible Fill)															
200.60																
1.50	SANDS															
	Grey Fine Sands some Silt to Silty Fine Sand trace Gravel some Cobbles/Boulders (Loose)		2	DO	11											
			3	DO	6											
			4	DO	2											
197.88																
4.22	Auger Refusal (Possibly Bedrock) End of Borehole															
COMMENTS								+ 3, X 3 : Numbers refer to Sensitivity				WATER LEVEL RECORDS				
								O 3% STRAIN AT FAILURE				Date (dd/mm/yy) / Time		Water Depth (m)	Cave In Level (m)	
														Not Recorded		

MEL-GEO 99063 GPJ MEL-GEO.GDT 18/11/99



RECORD OF BOREHOLE No. 7

1 OF 1

METRIC

REFERENCE 99/06/99063 DATUM Geodetic LOCATION Sta 10+720 22 m Lt of Centreline, N'y 5129298.564 E'y 311225.177 ORIGINATED BY ELS
PROJECT G.W.P 90-94-00, Hwy 17, W'y 10.6 km to Hwy 11/17 Jct. BOREHOLE TYPE CME 45 Muskeg, Standard Augers, Dynamic Cone Penetration COMPILED BY JRB
CLIENT Earth Tech (Canada) Inc. DATE (Started/Completed) 14/9/99 - 14/9/99 TIME _____ CHECKED BY MAM

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE	PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT W _p W W _L WATER CONTENT (%)	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
202.1 0.0	Ground Surface SAND						202				
201.51 0.61	Fine to Medium Sands trace Gravel (Probably Fill) PEAT		1	AS			201				
200.29 1.83	SAND Fine to Medium Sands with Silt		2	AS			200				
199.07 3.05	End of Sampling						199				
197.98 4.14	End of DCPT						198				

COMMENTS
Cone Location at Sta 10+726 25 m Lt Centreline.

+³, x³: Numbers refer to Sensitivity
○ 3% STRAIN AT FAILURE

WATER LEVEL RECORDS

Date (dd/mm/yy)/Time	Water Depth (m)	Cave In Level (m)
	Not Recorded	

MEL-GEO 99063.GPJ MEL-GEO.GDT 18/11/99



RECORD OF BOREHOLE No. 8

1 OF 1

METRIC

REFERENCE 99/06/99063 DATUM Geodetic LOCATION Sta 10+750 22.0 m Lt of Centreline, N'y 5129291.777 E'y 311254.399 ORIGINATED BY ELS
PROJECT G.W.P 90-94-00, Hwy 17, W'y 10.6 km to Hwy 11/17 Jct. BOREHOLE TYPE CME 45 Muskeg, Standard Augers, Dynamic Cone Penetration COMPILED BY JRB
CLIENT Earth Tech (Canada) Inc. DATE (Started/Completed) 13/9/99 - 13/9/99 TIME _____ CHECKED BY MAM

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL X LAB VANE	PLASTIC LIMIT W _p NATURAL MOISTURE CONTENT W LIQUID LIMIT W _L WATER CONTENT (%)	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
202.5 0.0	Ground Surface SILTY SAND										
202.02 0.45	Grass over Brown Silty Sand trace Gravel trace Organics (Probably Fill) SANDS		1	DO	4		202				
	Grey Fine to Medium Sands (Compact)		2	DO	14		201				
200.49 1.98	SAND		3	DO	20		200				
	Grey Fine Sand some/with Silt trace Gravel occasional Cobbles/Boulders Till Structure evident with depth (Compact/Very Dense)		4	DO	10		199				6 66 (28)
			5	DO	28		198				33 48 (19)
			6	DO	100		197				
196.07 6.40	End of Borehole		7	DO	100						
COMMENTS Cone Location at Sta 10+746 22.0 m Lt of Centreline. Water level recorded on completion of borehole.								+ 3, X ³ : Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE		WATER LEVEL RECORDS Date (dd/mm/yy)/Time 13/9/99 Water Depth (m) 0.15 Cave In Level (m)	

MEL-GEO 99063.GPJ MEL-GEO.GDT 18/11/99



RECORD OF BOREHOLE No. 9

1 OF 2

METRIC

REFERENCE 99/06/99063 DATUM Geodetic LOCATION Sta 12+349 19.0 m Lt of Centreline, N'y 5129197.661 E'y 312627.002 ORIGINATED BY ELS
PROJECT G.W.P 90-94-00, Hwy 17, W'y 10.6 km to Hwy 11/17 Jct. BOREHOLE TYPE CME 45 Muskeg, Standard Augers, Dynamic Cone Penetration COMPILED BY JRB
CLIENT Earth Tech (Canada) Inc. DATE (Started/Completed) 14/9/99 - 14/9/99 TIME _____ CHECKED BY MAM

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE	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									
205.1 0.0	Ground Surface PEAT Fine Fibrous Peat		1	AS			205							
204.22 0.90	SANDS Grey Fine to Coarse Sands trace/some Silt (Loose/Compact)		2	AS			204							
			3	DO	13		203							
			4	AS	2		202							
			5	AS	2		201							
			6	AS			200							
200.55 4.57	End of Sampling Probably Silty Sand to Sandy Silt						199							
							198							
							197							
							196							

COMMENTS
Cone Location at Sta 12+346 19.0 m Lt of Centreline. Water level recorded on completion of borehole.

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

WATER LEVEL RECORDS

Date (dd/mm/yy)/Time	Water Depth (m)	Cave In Level (m)
14/9/99	0.46	2.1

MEL-GEO 99063 GPJ MEL-GEO.GDT 18/11/99

Continued Next Page

RECORD OF BOREHOLE No. 9

2 OF 2

METRIC

REFERENCE 99/06/99063 DATUM Geodetic LOCATION Sta 12+349 19.0 m Lt of Centreline, N'y 5129197.861 E'y 312827.002 ORIGINATED BY ELS

PROJECT G.W.P 90-94-00, Hwy 17, Wly 10.6 km to Hwy 11/17 Jct. BOREHOLE TYPE CME 45 Muskeg, Standard Augers, Dynamic Cone Penetration COMPILED BY JRB

CLIENT Earth Tech (Canada) Inc. DATE (Started/Completed) 14/9/99 - 14/9/99 TIME CHECKED BY MAM

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
192.17	Probably Silty Sand to Sandy Silt						195											
12.95	End of DCPT																	
COMMENTS								+ 3, X 3 : Numbers refer to Sensitivity		WATER LEVEL RECORDS								
Cone Location at Sta 12+346 19.0 m Lt of Centreline. Water level recorded on completion of borehole.								O 3% STRAIN AT FAILURE		Date (dd/mm/yy)/Time		Water Depth (m)		Cave In Level (m)				
										14/9/99		0.45		2.1				

MEL-GEO 99063.GPJ MEL-GEO.GDT 18/11/99



RECORD OF BOREHOLE No. 10

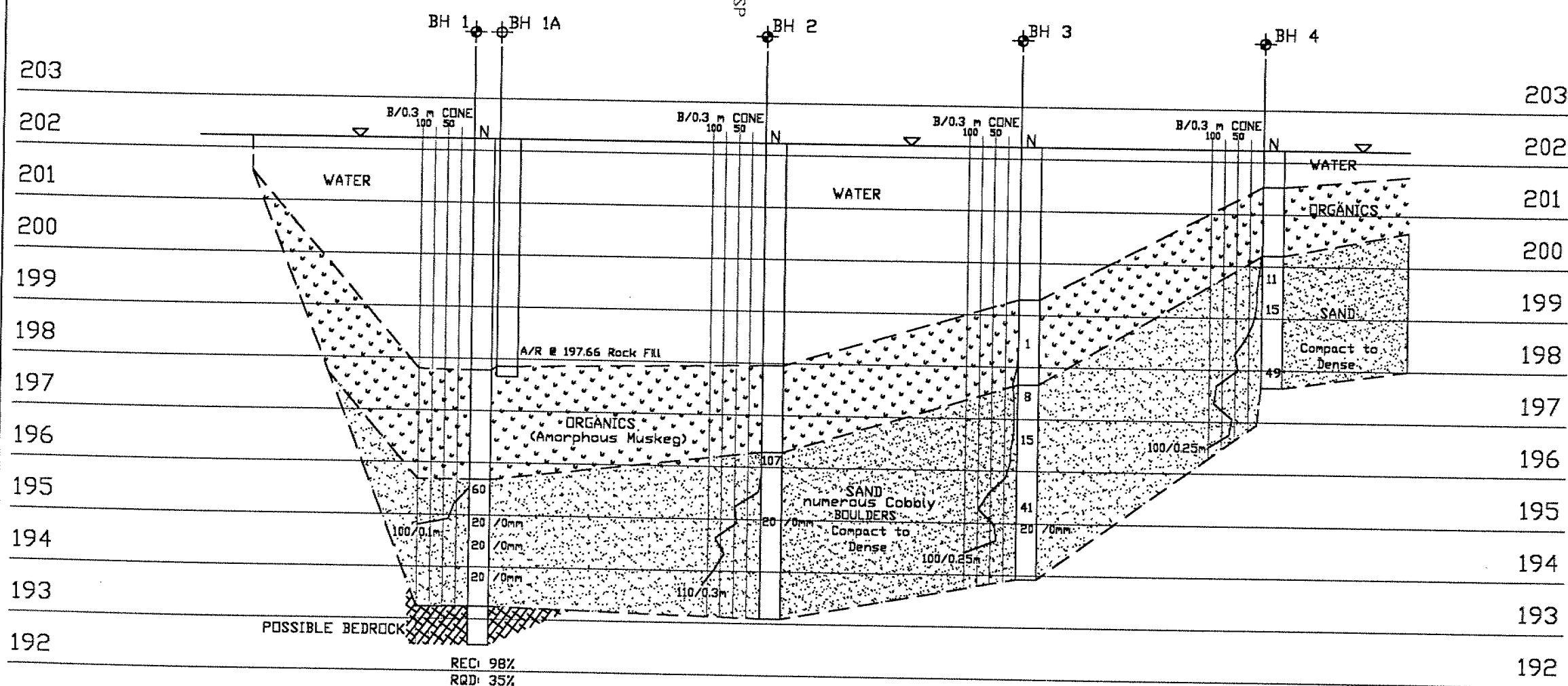
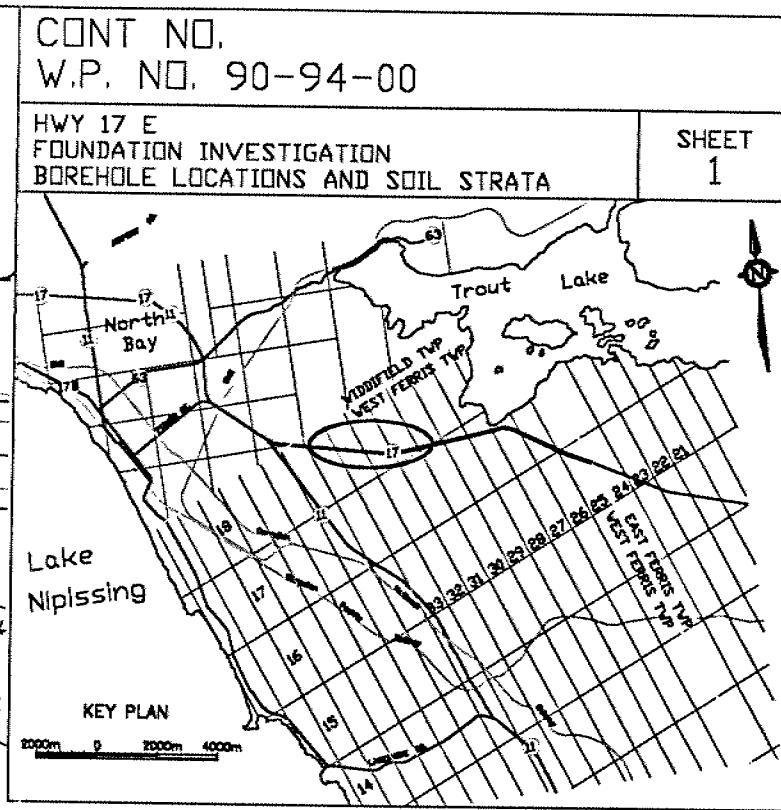
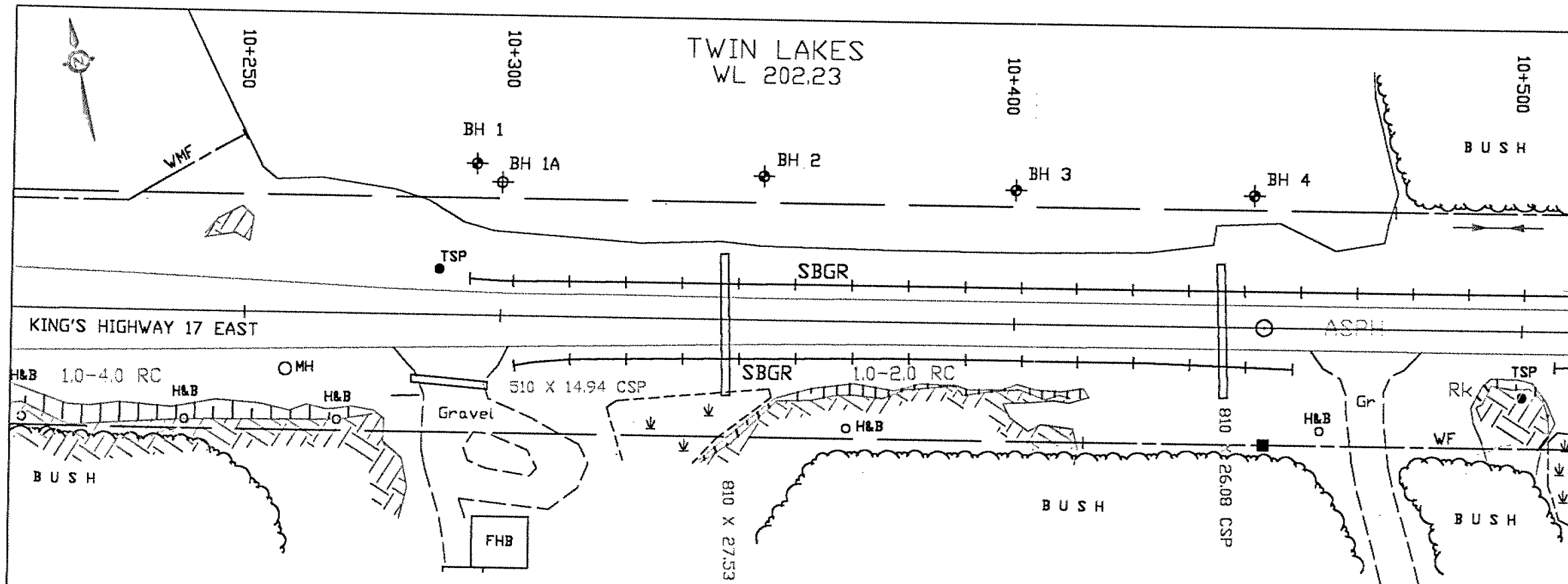
1 OF 1

METRIC

REFERENCE 99/06/99063 DATUM Geodetic LOCATION Sta 12+375 19.0 m Lt of Centreline, N'y 5129199.871 E'y 312852.908 ORIGINATED BY ELS
PROJECT G.W.P 90-94-00, Hwy 17, W'y 10.6 km to Hwy 11/17 Jct. BOREHOLE TYPE Standard Augers, Dynamic Cone Penetration Test COMPILED BY JRB
CLIENT Earth Tech (Canada) Inc. DATE (Started/Completed) 14/9/99 - 14/9/99 TIME CHECKED BY MAM

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								
205.2 0.0	Ground Surface												
	PEAT												
	Fine Fibrous Peat		1	AS									
204.10 1.07	SANDS												
	Grey Fine to Medium Sands some Silt trace Gravel (Loose/Compact)		2	AS									12 83 (5)
			3	DO	14								23 74 (3)
203.04 2.13	SILTY SAND												
	Grey Silty Fine Sand trace Gravel (Compact)												
202.12 3.05	End of Sampling		4	AS									3 51 (46)
201.05 4.12	End of DCPT												
	Probably Boulder												
COMMENTS Cone Location at Sta 12+375 19.0 m Lt of Centreline.								+ 3, X ³ : Numbers refer to Sensitivity			WATER LEVEL RECORDS		
								O 3% STRAIN AT FAILURE			Date (dd/mm/yy)/Time	Water Depth (m)	Cave In Level (m)
											Not Recorded		

MEL-GEO 99063 GPJ MEL-GEO.GDT 18/11/99



LEGEND

- Borehole and Dynamic Cone Penetration Test
- Borehole
- N Blows/0.3 m
- ≡ Water Level at Time of Investigation
- A/R Auger Refusal at Elevation

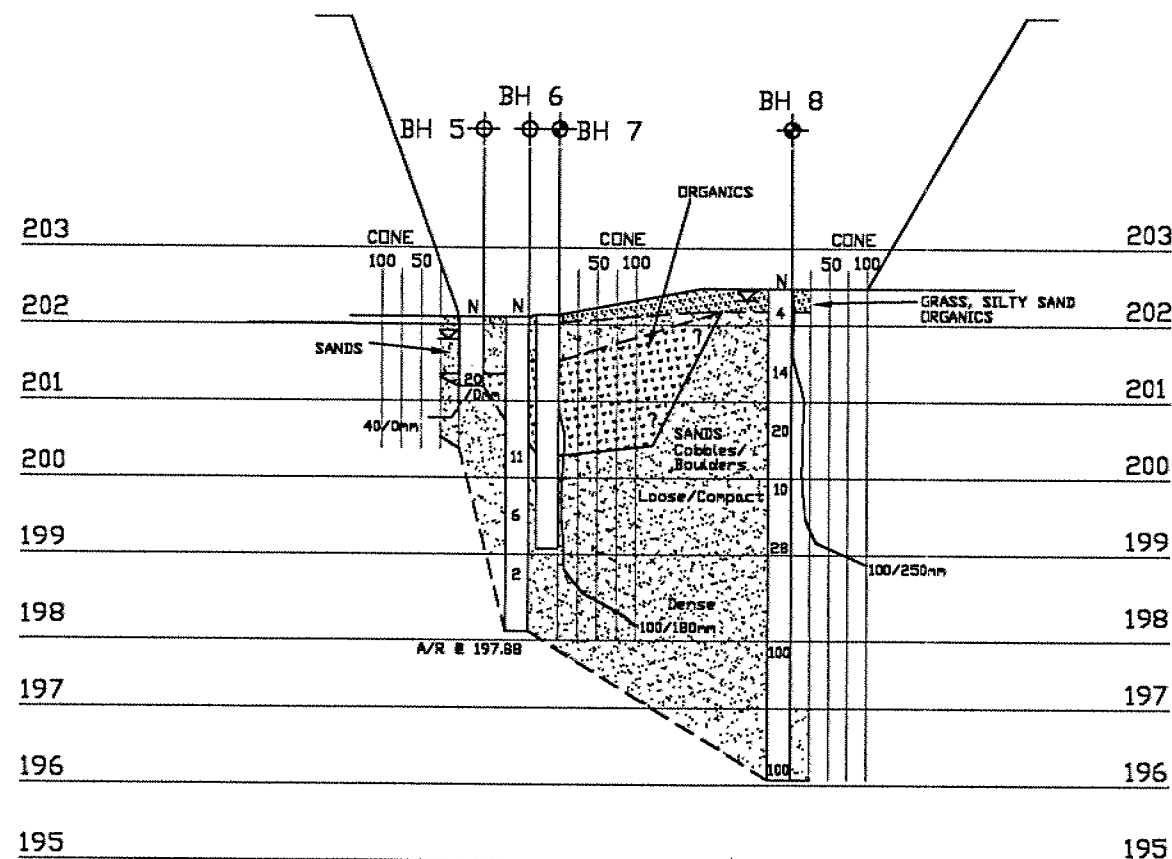
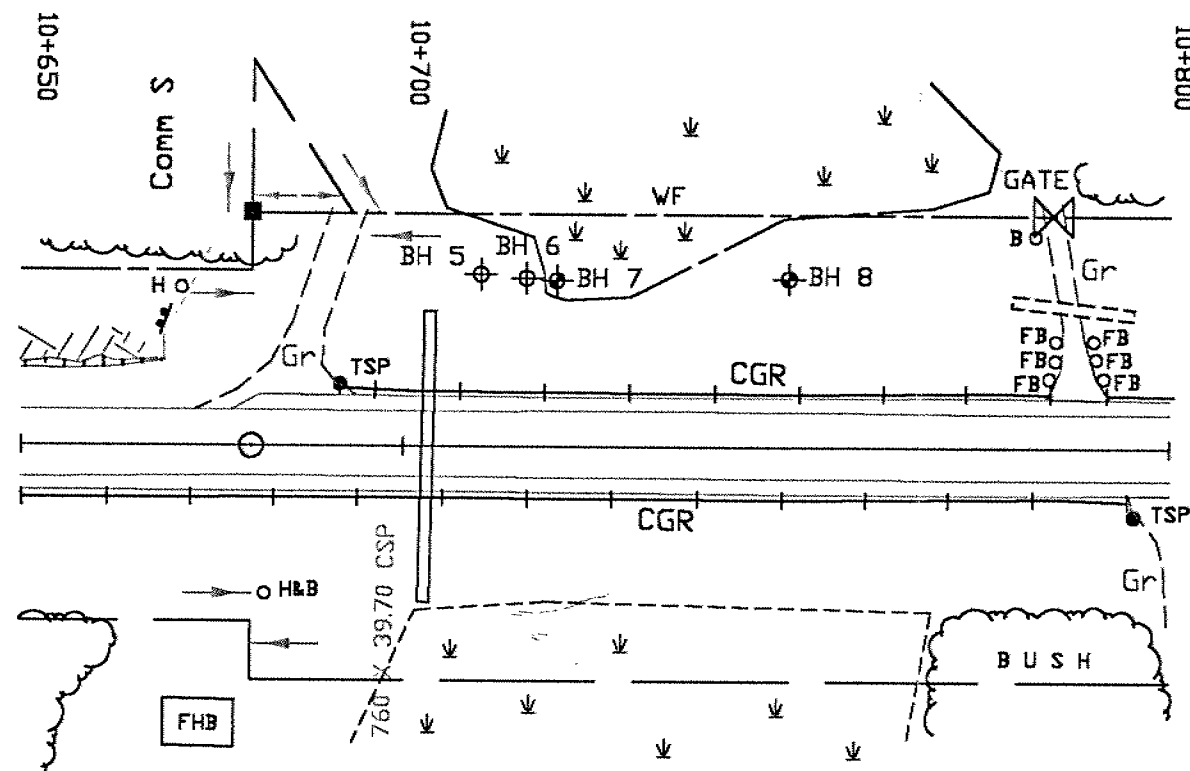
Borehole No.	Elevation	Co-ordinates	
		North	East
1	202.23	5129401.795	310813.867
1A	202.23	5129397.481	310816.972
2	202.23	5129387.891	310867.102
3	202.23	5129374.857	310914.379
4	202.23	5129363.834	310960.070

NOTE 1:
The boundaries between soil strata have been established at the borehole locations only. The boundaries between boreholes are assumed based on borehole data.

MERLEX ENGINEERING LTD.
CONSULTING GEOTECHNICAL ENGINEERS

PROJECT: HWY. 17E, Foundation Investigation
REFERENCE NO: 99063F DATE: October 26, 1999
DRAWN BY: JRB CHECKED BY: MAM

NOTE: FOR DETAILED SUBSOIL AND BOREHOLE INFORMATION REFER TO RECORD OF BOREHOLE



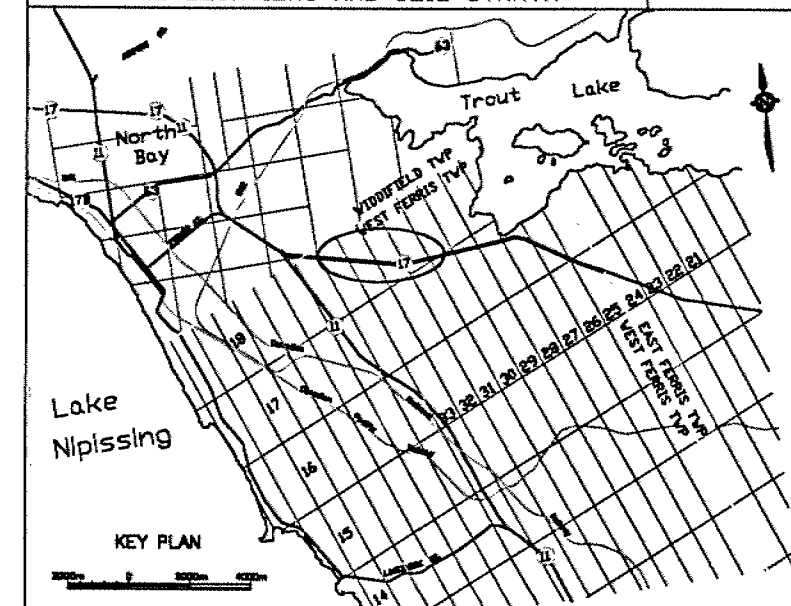
PROFILE Possible Right Turn Taper

NOTE: FOR DETAILED SUBSOIL AND BOREHOLE INFORMATION REFER TO RECORD OF BOREHOLE

CONT NO.
W.P. NO. 90-94-00

HWY 17 E
FOUNDATION INVESTIGATION
BOREHOLE LOCATIONS AND SOIL STRATA

SHEET
2



SCALE
10m 5 0 10m Hor
1m 0.5 0 1m Vert

LEGEND

- Borehole and Dynamic Cone Penetration Test
- ⊙ Borehole
- N Blows/0.3 m
- W Water Level at Time of Investigation
- A/R Auger Refusal at Elevation

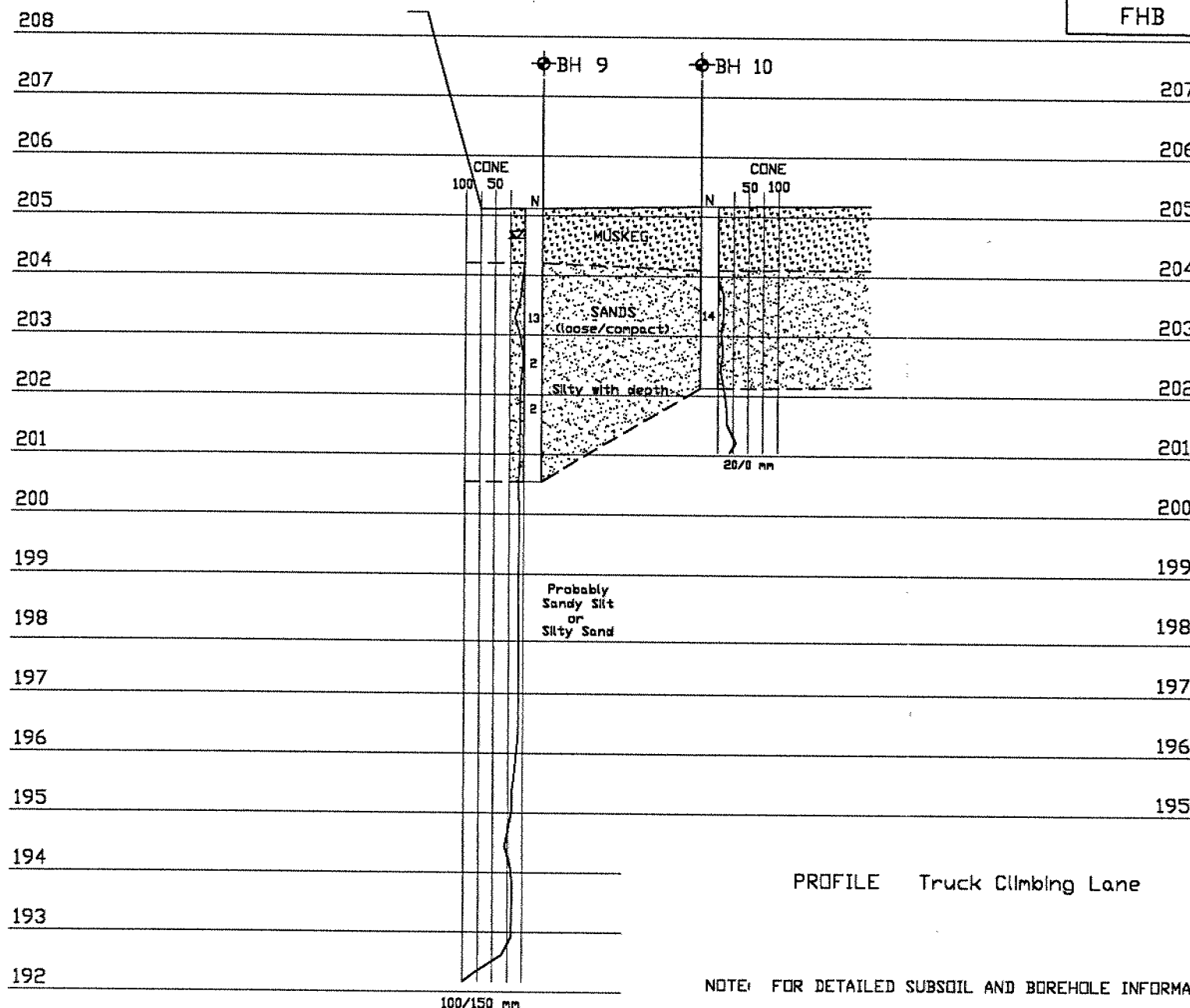
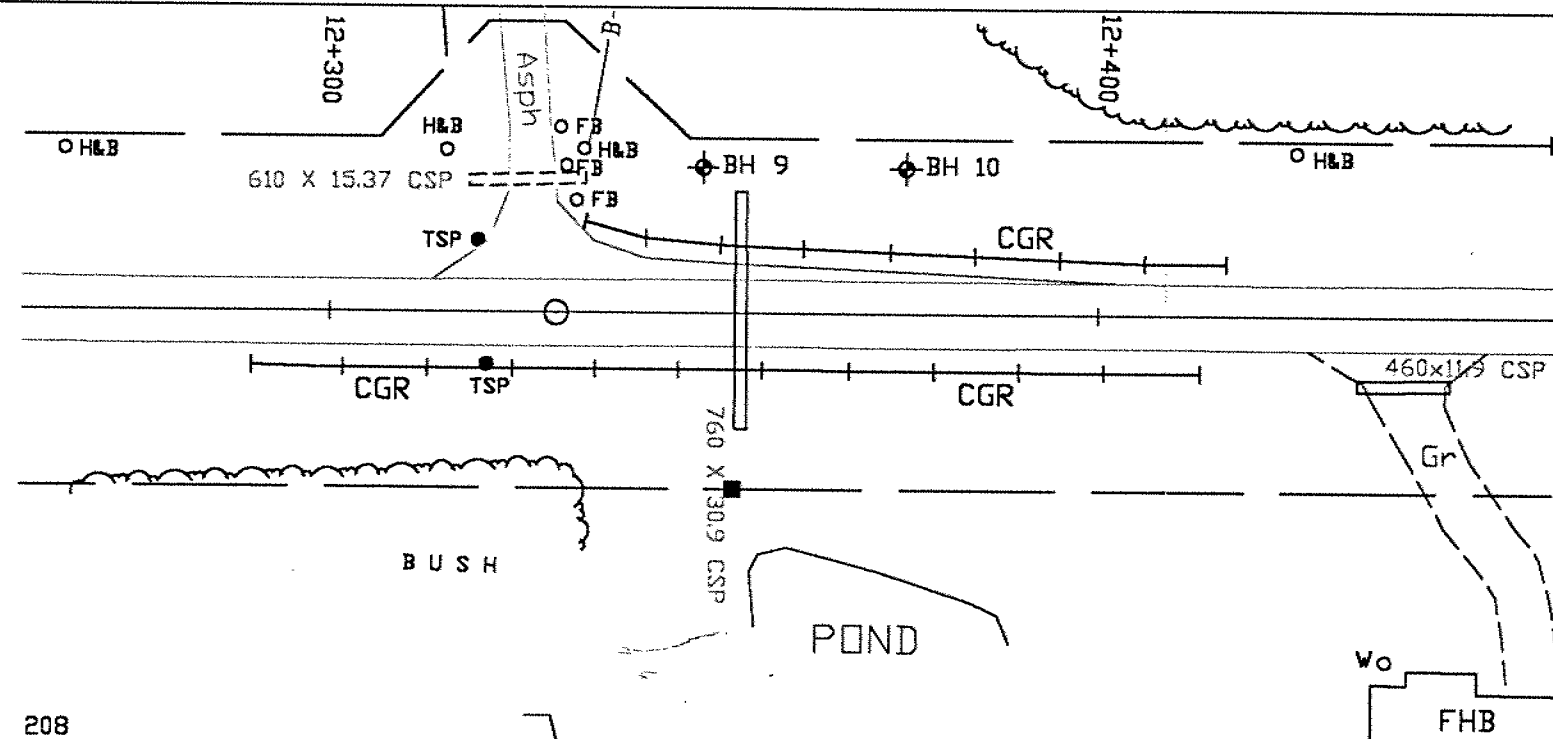
Borehole No.	Elevation	Co-ordinates	
		North	East
5	202.100	5129300.826	311215.436
6	202.101	5129299.469	311221.280
7	202.122	5129298.564	311225.177
8	202.472	5129291.777	311254.399

NOTE 1:
The boundaries between soil strata have been established at the borehole locations only. The boundaries between boreholes are assumed based on borehole data.



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PROJECT: HWY. 17E, Foundation Investigation
REFERENCE NO: 99063F DATE: October 26, 1999
DRAWN BY: JRB CHECKED BY: MAM



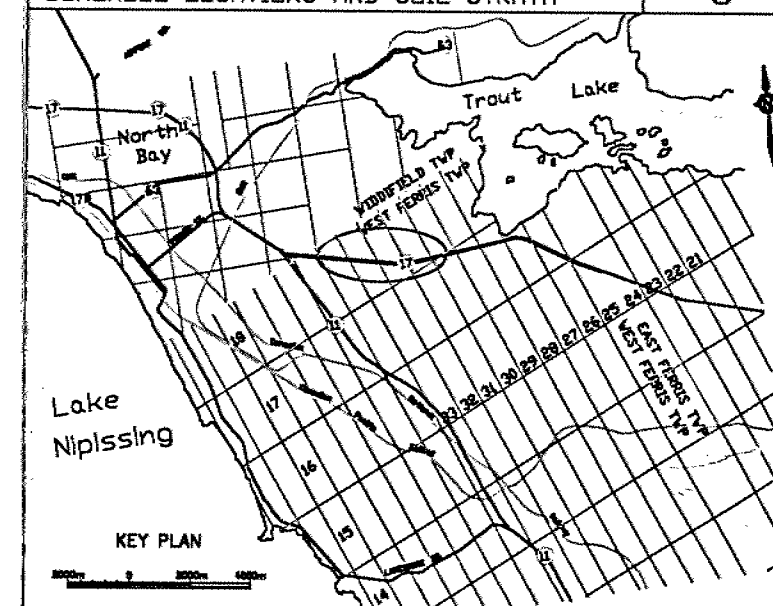
PROFILE Truck Climbing Lane

NOTE: FOR DETAILED SUBSOIL AND BOREHOLE INFORMATION REFER TO RECORD OF BOREHOLE

CONT NO.
W.P. NO. 90-94-00

HWY 17 E
FOUNDATION INVESTIGATION
BOREHOLE LOCATIONS AND SOIL STRATA

SHEET
3



SCALE
10m 5 0 10m Hor
1m 0.5 0 1m Vert

LEGEND

- Borehole and Dynamic Cone Penetration Test
- Borehole
- N Blows/0.3 m
- Water Level at Time of Investigation
- Auger Refusal at Elevation

Borehole No.	Elevation	Co-ordinates	
		North	East
9	205.118	5129197.661	312827.002
10	205.174	5129199.871	312852.908

NOTE 1:
The boundaries between soil strata have been established at the borehole locations only. The boundaries between boreholes are assumed based on borehole data.



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PROJECT: HWY. 17E, Foundation Investigation
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