GEOCRES No: 31E-321

amec

FINAL SUPPLEMENTARY FOUNDATION INVESTIGATION REPORT FOR PROPOSED SIGN STRUCTURES HIGHWAY 11 FOUR LANING FROM EMSDALE TO KATRINE G.W.P. 466-93-00, DISTRICT 52, HUNTSVILLE

Submitted to:

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Submitted by:

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14 January 2003

TT22812

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RECORD OF BOREHOLE SHEETS

1.0 INTRODUCTION

AMEC Earth and Environmental Limited (AMEC) has been retained by Delcan Corporation (Delcan) to carry out a subsurface investigation at the proposed location of four highway signs along the proposed Highway 11 four laning, from Emsdale to Katrine, in the Townships of Perry and Armour, District of Parry Sound, and form part of the project designated as G.W.P. 466-93-00 in District 52, Huntsville.

The investigation was carried out to obtain subsurface information to facilitate design and construction of the four proposed sign foundations. Based on our interpretation of the data obtained, recommendations on the foundation design of the proposed works are provided. Comments are also provided on anticipated construction problems where they may affect the foundation design.

2.0 SITE DESCRIPTION AND PHYSIOGRAPHY

The proposed sign locations are distributed along an about 2 km section of the proposed Highway 11, two sign locations immediately south and two locations immediately north of the Highway 518 East interchange. The existing Highway 11 will become the new southbound lane north of Highway 518 East.

The area of Boreholes H1 and H2 are west of the existing Highway 11 along a gentle slope and sparsely wooded. Borehole J1 is to the east of Highway 11 in the driveway of an existing service station. Boreholes K1 and K2 are on the west side of the Highway 11 rockfill embankment. Boreholes L1 and L2 are on the shoulders of the existing Highway 11, which is in cut at this location.

Based on available geologic information, the site is in an area intersected by small braided eskers partially buried by glaciofluvial sediments. Generally, after the last glacial withdrawal, ice-contact sediments (eskers and kames consisting of gravelly sands to sandy gravels with a high boulder content) and glaciofluvial outwash sediments were deposited on top of the existing sandy glacial till or Precambrian bedrock (ranging from granite to gneiss). The area was then inundated by glacial Lake Algonquin depositing sands, silts and clays in low lying areas.

3.0 INVESTIGATION PROCEDURES

The field work of this investigation was carried out during the period of March 6 to 8, 2002 and on November 4, 2002. The fieldwork consisted of drilling and sampling seven boreholes (Boreholes H1, H2, J1, K1, K2, L1 and L2).

The boreholes (except Boreholes K1 and K2) were advanced using a track-mounted power auger drilling rig owned and operated by Master Soil Investigation Inc. under the full-time supervision of

a member of AMEC's geotechnical staff. As Boreholes K1 and K2 were not accessible with a drill rig, the borehole was advanced using portable hand drilling equipment, owned and operated by AMEC geotechnical staff.

Sampling in the boreholes (except Boreholes K1 and K2) was carried out at regular intervals of depth by the Standard Penetration Test (SPT), as specified in ASTM Method D 1586. This consists of freely dropping a 63.5 kg hammer for a vertical distance of 0.76 m to drive a 50 mm diameter o.d. split barrel (split spoon) sampler into the ground. The number of blows of the hammer required to drive the sampler into the relatively undisturbed ground for a vertical distance of 0.30 m is recorded as the Standard Penetration Resistance, or the 'N'-value of the soil, which gives an indication of the consistency or the relative density of the soil deposit.

Borehole K2 was sampled continuously by freely dropping a 31.75 kgs. hammer a vertical distance of 0.76 m to drive a 51 mm diameter o.d. split barrel (split-spoon) sampler into the ground. The number of blows of the hammer to drive the sampler into the relatively undisturbed ground by a vertical distance of 0.30 m was recorded. These values were then correlated with the SPT, as specified in ASTM Method D 1586. The correlated values are reported as Standard Penetration Resistances or the 'N'-values of the soil and this gives an indication of the consistency or the relative density of the soil deposit.

Borehole K1 was probed with a hand auger, but refusal on the rockfill embankment was obtained. Borehole J2 was canceled as the proposed sign location is over an existing gasoline tank and piping.

In order to assess the quality of the bedrock, Boreholes L1 and L2 were cored. This was carried out by rotary drilling methods using NX and BX size core barrels.

The borehole locations were established in the field by our technical staff, in relation to the already staked out median centreline of the proposed Highway 11. The ground surface elevations at the boreholes are referenced to the geodetic datum.

The rock and soil samples were identified in the field and transported to our geotechnical laboratory in Toronto (Scarborough) for further examination and classification. A laboratory testing programme, consisting of natural moisture content determination, rock compressive strength tests and grain size distribution analyses, was carried out on selected representative soil samples. The results of the laboratory tests are presented on the Record of Borehole sheets and in Figure Nos. 1 to 7.

The boreholes were left open until the end of each work day to enable us to observe and record the groundwater conditions. All boreholes were backfilled with auger cuttings, while Boreholes L1 and L2 were backfilled with cement.

4.0 SUBSURFACE CONDITIONS

Details of the subsurface conditions encountered in these boreholes are presented in the Record of Borehole sheets. The following paragraphs are intended to complement and summarize this data.

4.1 TOPSOIL

Topsoil was encountered at the surface of Boreholes H1, H2 and K2 to depths of between 0.2 to 0.25m.

4.2 FILL

Asphaltic concrete was encountered at the surface of Borehole J1, about 125 mm in thickness. Underlying this paved surface, and encountered at the surface of Boreholes L1 and L2, a sand and gravel to gravelly sand fill was encountered to depths of about 0.3 to 1.7m below existing ground surface. The fill in Borehole L1 contained asphalt fragments. Measured 'N'-values within the fill range from 6 to 35 blows per 0.3m, indicating a loose to dense relative density. Measured moisture contents range from 6 to 12%. One grain size analysis was carried out on a sample of the fill and the resulting grain size curve is presented in Figure No. 1. The results of the grain size analysis are also presented on the Record of Borehole sheet, and consist of 39% gravel, 52 % sand and 9% fines.

Borehole K1 encountered rockfill at the surface of the embankment slope and refusal to advance was obtained.

4.3 SANDS AND SILTS

Underlying the topsoil or fill deposits, a sand to silty sand/sandy silt deposit was encountered in all boreholes, except Borehole L1. Boreholes H2, J1 and K2 encountered silty sand to sandy silt deposits to depths of about 1.4 to 8.1m below existing ground surface. These deposits also contained in some boreholes, sand seams, cobbles and/or gravel. Boreholes H1 and H2 encountered a sand deposit underlying the silty sand or topsoil layers, which extended to the full depth of the boreholes (to a depth of 6.6 and 8.1m). Borehole L2 encountered a sand deposit with cobbles and boulders to a depth of 5.0m. Measured 'N'-values within these cohesionless deposits range from 5 to greater than 50 blows per 0.3m, indicating a loose to very dense relative density, but generally compact. Measured moisture contents range from 3 to 22%.

Grain size analyses were carried out on six samples of the cohesionless sands and silts, and the resulting grain size curves are presented in Figure Nos. 2 to 7. The results are also summarized on the Record of Borehole sheets and as follows:

Sand to Gravelly Sand(4 samples)

Gravel	0 to 46%
Sand	50 to 93%
Fines	4 to 7%

Silty Sand to Sandy Silt (2 samples)

Gravel	0%
Sand	37 to 81%
Fines	19 to 63%

Rock coring was required in order to advance Borehole L2 past the cobbles and boulders encountered within the sand.

4.4 BEDROCK

Bedrock was encountered in Boreholes L1 and L2 at a depth of 1.7 and 5.0m respectively. Bedrock was cored using NX and BX size core barrels a distance of about 2.9m and 1.3m in Boreholes L1 and L2. Borehole L2 was abandoned after 1.3m of coring due to the end of the work day and due to traffic safety concerns. The bedrock was logged by experienced AMEC engineering staff and consists of a massive, fresh to slightly weathered Gneiss. The jointing of the rock is close to moderately close, while the joints are slightly to moderately weathered. Occasional joints were coated with sand in the rock cored in Borehole L2. Measured rock core recoveries range from 92 to 95% in Borehole L1, and 50 to 83% in Borehole L2. Rock quality designation (RQD) in Borehole L1 ranged from 71 to 82%, while in Borehole L2 the RQD ranged from 0 to 21%. Based on visual examination of the rock cores and the above measurements, the rock in Borehole L1 is considered to be of good quality, while the rock in Borehole L2 is considered to be of very poor quality.

4.5 GROUNDWATER CONDITIONS

Groundwater conditions in the open boreholes were observed during the drilling and on completion of each borehole. No free-standing water was encountered in any of the boreholes.

It should be noted however that the groundwater at the site will fluctuate seasonally and can be expected to rise during the spring months or in response to heavy rains.

5.0 CLOSURE

We recommend that once the details of the structures are finalized, our recommendations should be reviewed for their specific applicability.

AMEC Earth and Environmental Limited

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Geotechnical Services

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A. R. DREVININKAS
14 Jan 03
PROVINCE OF ONTARIO

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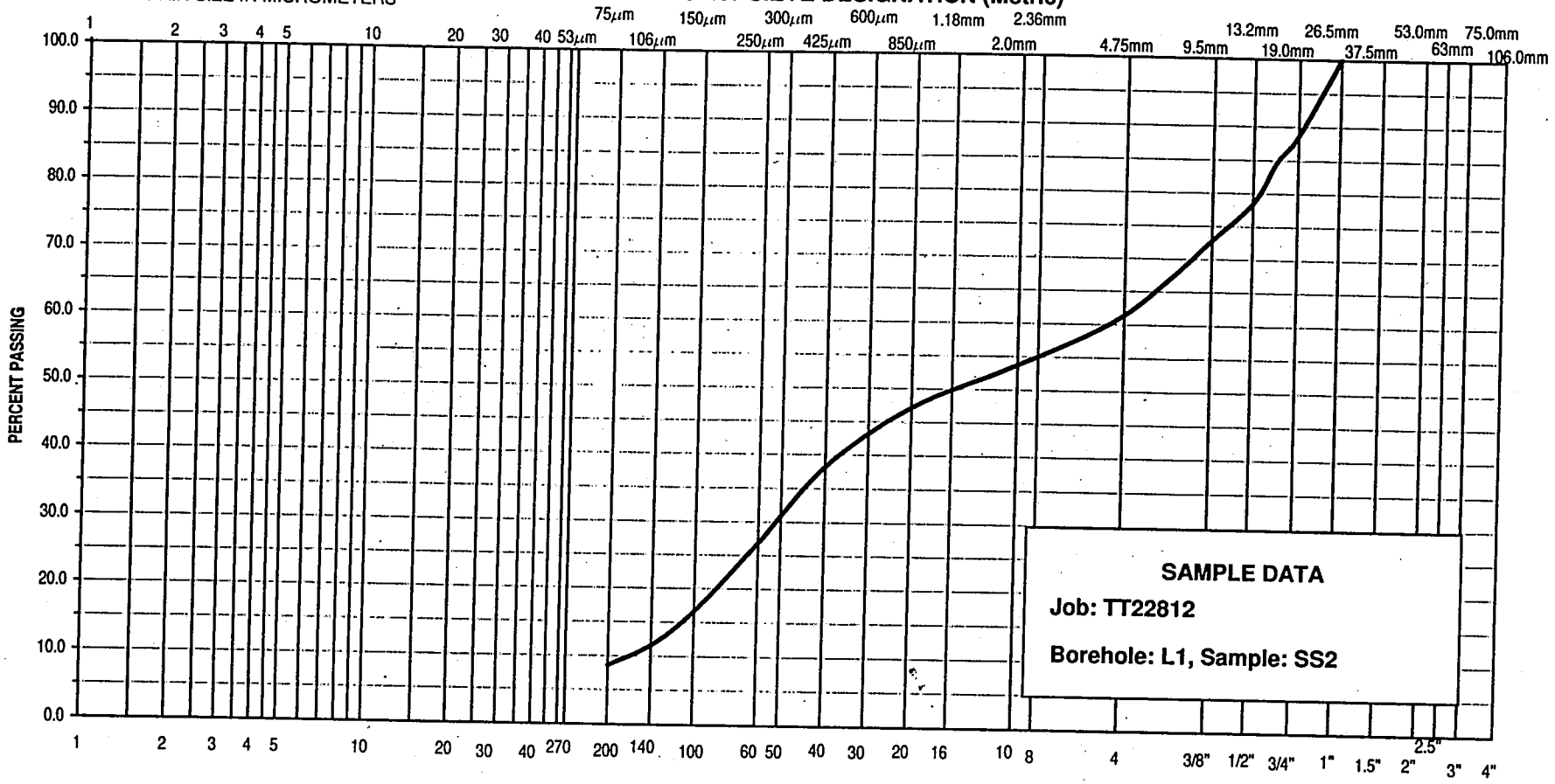
LICENSED PROFESSIONAL ENGINEER
K. S. HO
14 Jan 03
PROVINCE OF ONTARIO

FIGURES

UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY & SILT	SAND			GRAVEL	
	Fine	Medium	Coarse	Fine	Coarse



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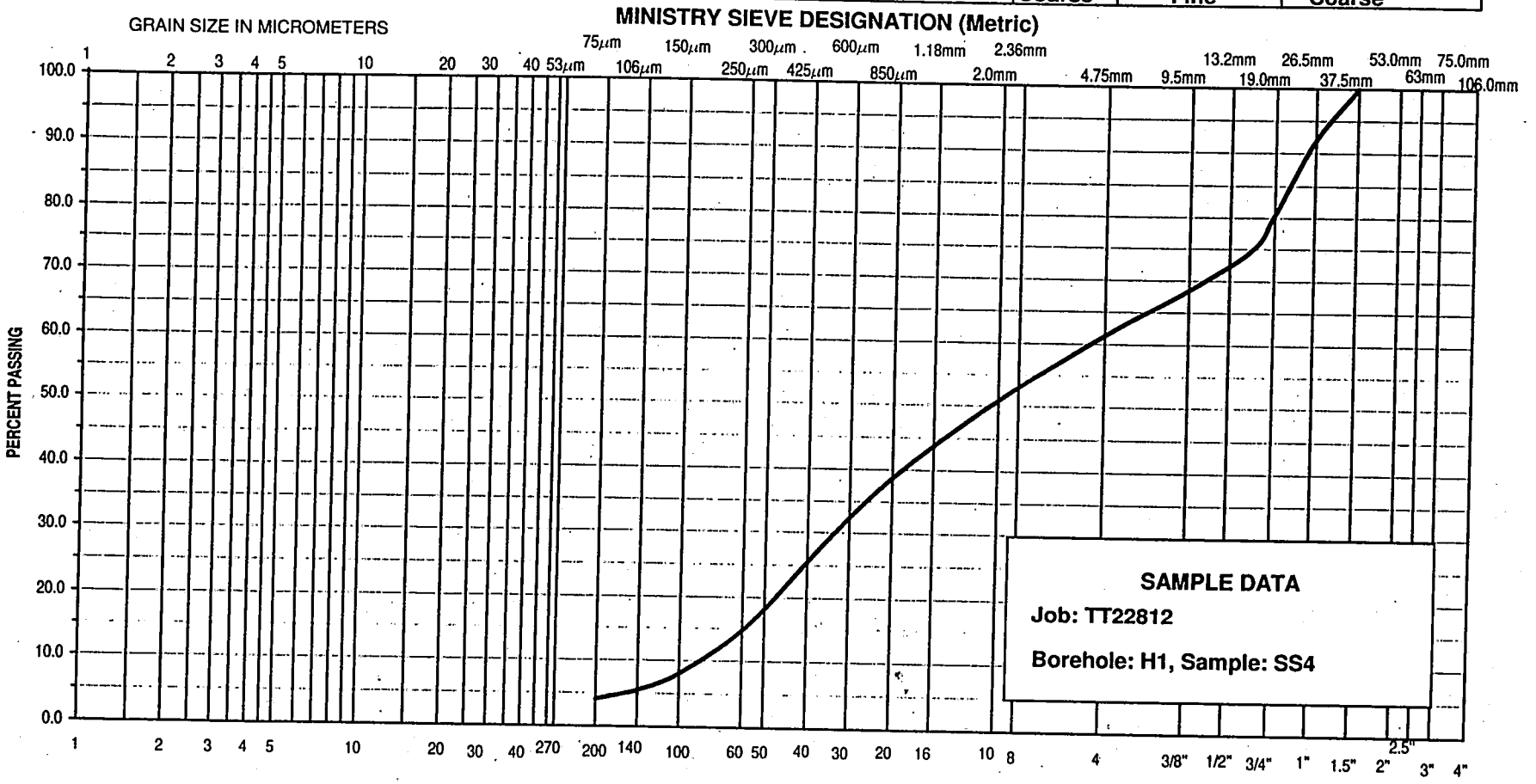
GRAIN SIZE DISTRIBUTION	Client :- Delcan Corporation	
	Project:- Sign Structures	
Gravelly Sand FILL trace Silt	Location: - Highway 11 Four Laning	
	G.W.P. 466-93-00	Date :- 13 March 2002

FIGURE NO. 1

UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY & SILT	SAND			GRAVEL	
	Fine	Medium	Coarse	Fine	Coarse



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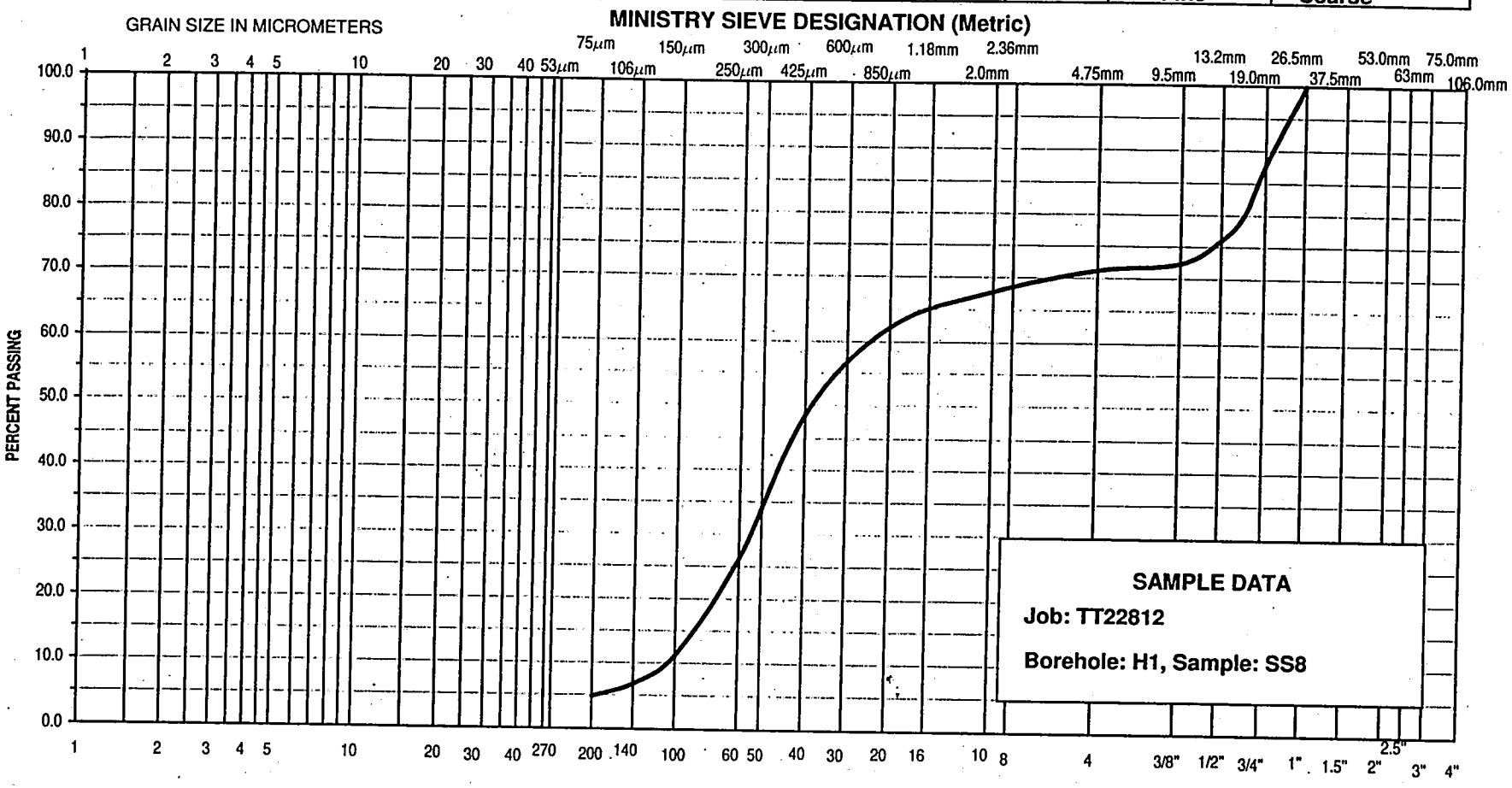
GRAIN SIZE DISTRIBUTION	Client :- Delcan Corporation	
	Project:- Sign Structures	
GRAVELLY SAND	Location: - Highway 11 Four Laning	
trace Silt	G.W.P. 466-93-00	Date :- 13 March 2002

FIGURE NO. 2

UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY & SILT	SAND			GRAVEL	
	Fine	Medium	Coarse	Fine	Coarse



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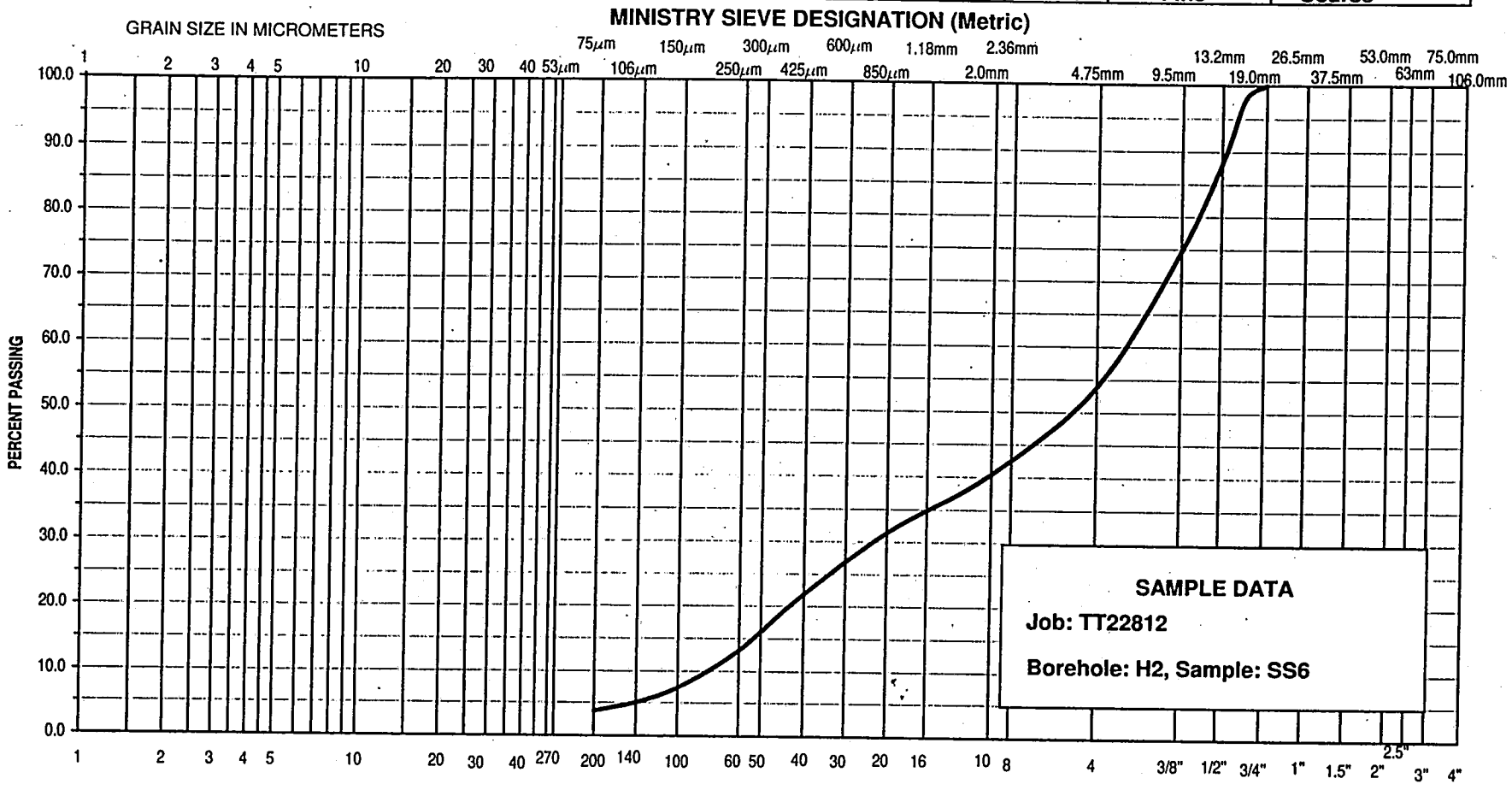
GRAIN SIZE DISTRIBUTION	Client :- Delcan Corporation	
	Project:- Sign Structures	
SAND with Gravel trace Silt	Location: - Highway 11 Four Laning	
	G.W.P. 466-93-00	Date :- 13 March 2002

FIGURE NO. 3

UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY & SILT	SAND			GRAVEL	
	Fine	Medium	Coarse	Fine	Coarse



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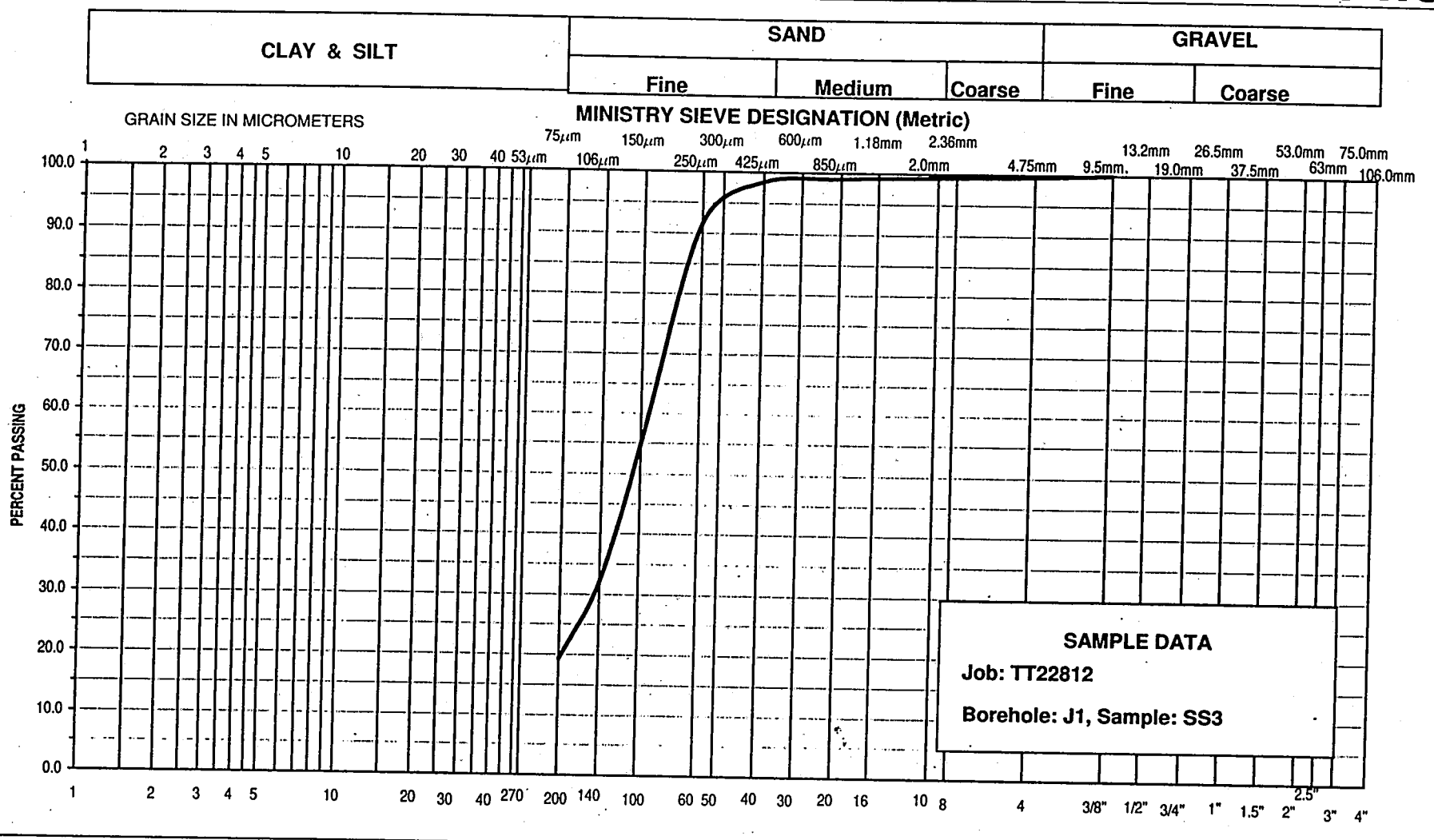
GRAIN SIZE DISTRIBUTION	Client :- Delcan Corporation	
	Project:- Sign Structures	
GRAVELLY SAND trace Silt	Location: - Highway 11 Four Laning	
	G.W.P. 466-93-00	Date :- 13 March 2002

FIGURE NO. 4

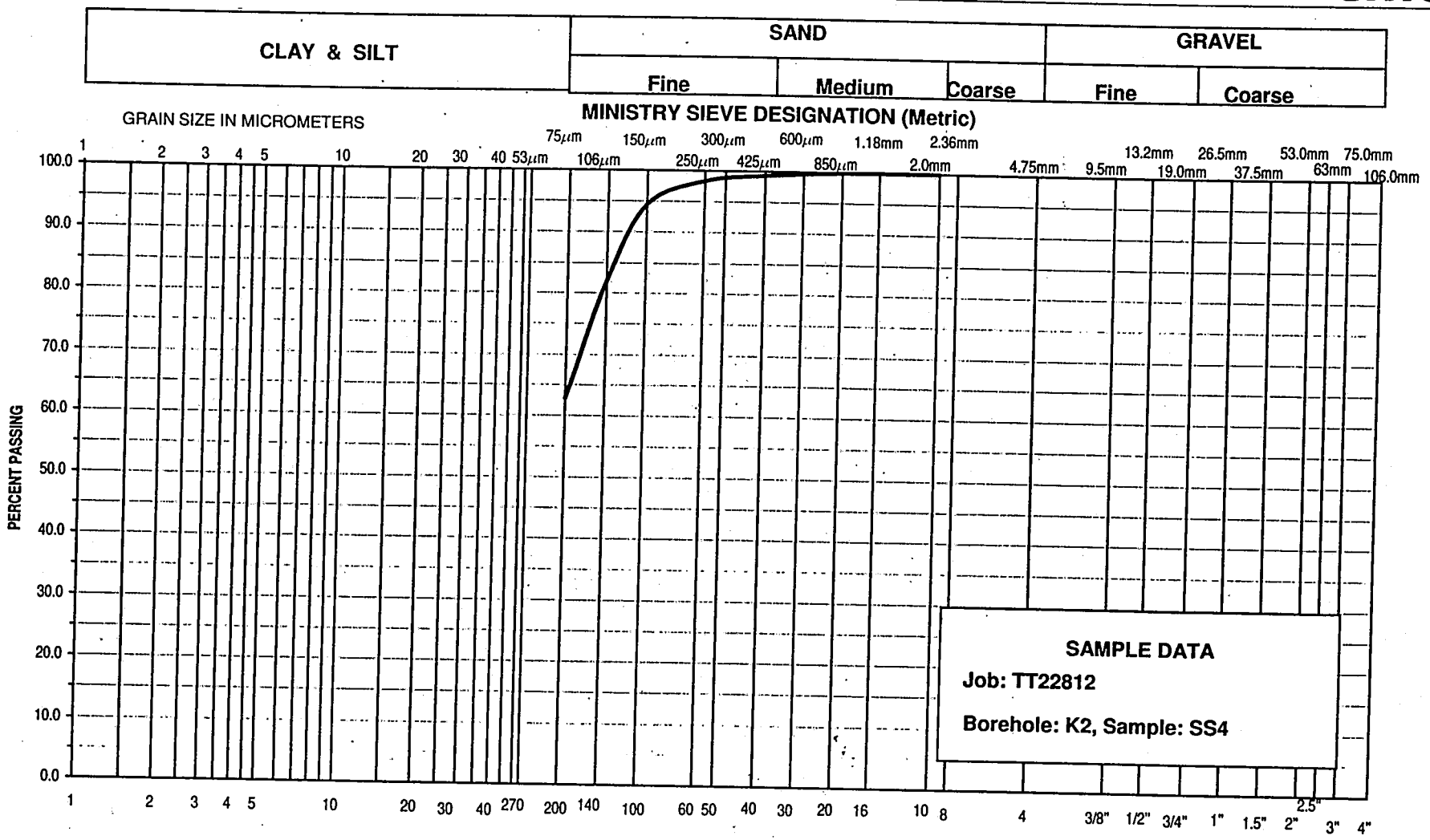
UNIFIED SOIL CLASSIFICATION SYSTEM



AMEC Earth & Environmental Limited 104 Crockford Blvd., Scarborough, Ontario Canada, M1R 3C6 Tel +1 (416) 751 6565, Fax +1 (416) 751 7592 www.amec.com	GRAIN SIZE DISTRIBUTION	Client :- Delcan Corporation
		Project:- Sign Structures
	Fine SAND some Silt	Location: - Highway 11 Four Laning
		G.W.P. 466-93-00 — Date :- 13 March 2002

FIGURE NO. 5

UNIFIED SOIL CLASSIFICATION SYSTEM



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GRAIN SIZE DISTRIBUTION

SANDY SILT

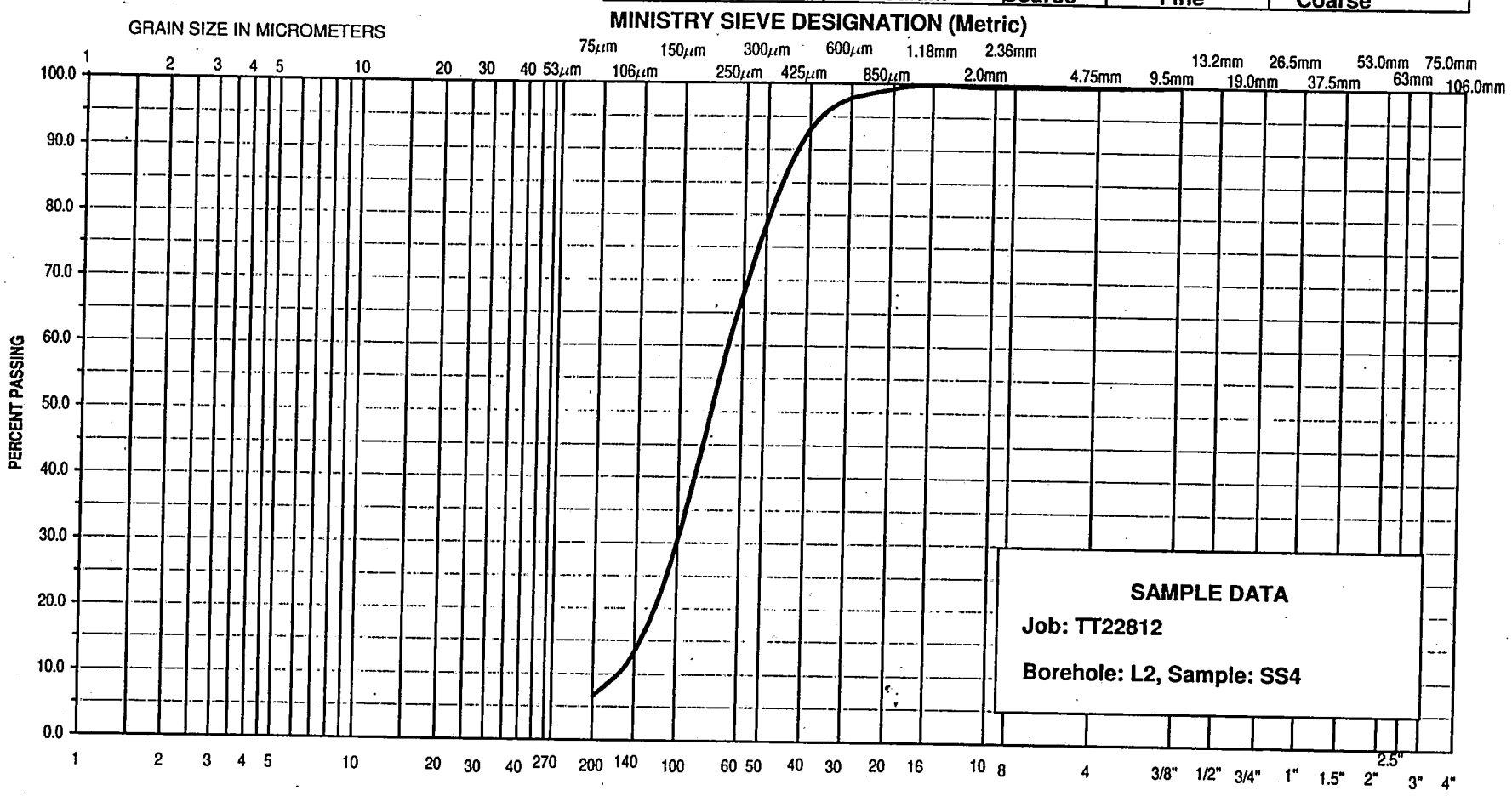
Client :- Delcan Corporation	
Project:- Sign Structures	
Location: - Highway 11 Four Laning	
G.W.P. 466-93-00	Date :- 13 March 2002

FIGURE NO. 6

UNIFIED SOIL CLASSIFICATION SYSTEM

amec

CLAY & SILT	SAND			GRAVEL	
	Fine	Medium	Coarse	Fine	Coarse



AMEC Earth & Environmental Limited 104 Crockford Blvd., Scarborough, Ontario Canada, M1R 3C6 Tel +1 (416) 751 6565, Fax +1 (416) 751 7592 www.amec.com	GRAIN SIZE DISTRIBUTION	Client :- Delcan Corporation
		Project:- Sign Structures
	Fine SAND trace Silt	Location: - Highway 11 Four Laning
		G.W.P. 466-93-00 — Date :- 13 March 2002

FIGURE NO. 7

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RECORD OF BOREHOLE SHEETS

AMEC EARTH AND ENVIRONMENTAL LIMITED
NOTES TO BOREHOLE LOGS

DRILLING DATA

Method:

SolSt Augering	-	Solid Stem Augering
HolSt Augering	-	Hollow Stem Augering
WB	-	Washed Boring

SAMPLES

TYPE:

SS	-	Split Spoon
AS	-	Auger Sample
TW	-	Thinwall Open
TP	-	Thinwall Piston
WS	-	Washed Sample
BS	-	Block Sample
RC	-	Rock Core
PH	-	Sample Advanced Hydraulically
PM	-	Sample Advanced Manually

LABORATORY DATA

WP	-	Plastic Limit (%)
W	-	Water Content (%)
WL	-	Liquid Limit (%)
γ	-	Natural Unit Weight (kN/m^3)
UNDR STRNG or C_u	-	Undrained Shear Strength (kPa)
		Field Vane: St-sensitivity
pp	-	Pocket Penetrometer
UC	-	Unconfined Compression
UU	-	Unconsolidated Undrained at Overburden Pressure
CU	-	Consolidated Undrained
CD	-	Consolidated Drained
TOV	-	Total Organic Vapours

Standard Penetration Test, 'N'-values: The Standard Penetration Test (SPT) 'N'-values are the number of blows required to cause a standard 51 millimetre o.d. split barrel sample to penetrate 0.3 metres into undisturbed ground in a borehole when driven by a hammer with a mass of 63.5 kilograms falling freely a distance of a 0.76 metres. For penetrations of less than 0.3 metres, N-values are indicated as the number of blows for the penetration achieved (e.g. 50/25: 50 blows for 25 centimetre penetration).

Dynamic Cone Penetration Test: Continuous penetration of a conical steel point (51 millimetre o.d. 60° cone angle) driven by 475 J impact energy on a size drill rods. The resistance to cone penetration is measured as the number of blows for each 0.3 metres advance of the conical point into the undisturbed ground.

Soils are described by their composition and consistency or compactness.

CONSISTENCY: Cohesive soils are described on the basis of their undrained shear strength (C_u) or 'N'-values as follows:

C_u (kPa)	0 - 12	12 - 25	25 - 50	50 - 100	100 - 200	>200
	VERY SOFT	*SOFT*	*FIRM*	*STIFF*	*VERY STIFF*	*HARD*
N (blows/0.3 metres)	0 - 2	2 - 4	4 - 8	8 - 15	15 - 30	>30

COMPACTNESS: Cohesionless soils are described on the basis of compactness as indicated by 'N'–values as follows:

N (blows/0.3 metres)	0 - 4	4 - 10	10 - 30	30 - 50	>50
	VERY LOOSE	*LOOSE*	*COMPACT*	*DENSE*	*VERY DENSE*

Rocks are described by their composition and structural features and/or strength.

RECOVERY: Sum of all recovered rock core pieces from a coring run expressed as a percent of the total length of the coring run.

ROCK QUALITY DESIGNATION (RQD): Sum of those intact core pieces, 100 millimetres in length expressed as a percent of the length of the coring run. Classification of a rock based on the RQD value as follows:

RQD (%)	0 - 25	25 - 50	50 - 75	75 - 90	90 - 100
	VERY POOR	*POOR*	*FAIR*	*GOOD*	*EXCELLENT*

JOINTING AND BEDDING:

SPACING	50 millimetres	50 - 300 millimetres	0.3 - 1.0 millimetres	1.0 - 3.0 millimetres	>3.0 millimetres
JOINTING	*VERY CLOSE*	*CLOSE*	*MOD. CLOSE*	*WIDE*	*VERY WIDE*
BEDDING	*VERY THIN*	*THIN*	*MEDIUM*	*THICK*	*VERY THICK*

RECORD OF BOREHOLE No H1

amec

1 OF 1

G.W.P. 466-93-00 LOCATION Station 22+150 O/S 7.0m RT SBL C/L ORIGINATED BY NNK

DIST 52 HWY 11 BOREHOLE TYPE Solid Stem Auger COMPILED BY NNK

DATUM Geodetic DATE 7 March 2002 - 7 March 2002 CHECKED BY AD

PROJECT Sign Structures for HWY 11 Four Laning, from Emsdale to Katrine JOB NO. TT22812

ELEV / DEPTH (m)	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	DEPTH m	ELEVATION SCALE m	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa O UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
336.4												
0.0	brown SAND compact, damp		1	SS	14		0	336				
			2	SS	10		1	335				
			3	SS	15		2	334				
			4	SS	18		3	333				39 57 (4)
	Gravelly ---------- with Gravel		5	SS	15		4	332				
			6	SS	20		5	331				
			7	SS	18		6	330				
329.9			8	SS	24							29 66 (5)
6.6	End of Borehole Groundwater in open bore on completion none											

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

RECORD OF BOREHOLE No H2

amec

1 OF 1

G.W.P. 466-93-00 LOCATION Station 22+150 O/S 6.0m LT SBL C/L ORIGINATED BY NNK

DIST 52 HWY 11 BOREHOLE TYPE Solid Stem Auger COMPILED BY NNK

DATUM Geodetic DATE 7 March 2002 - 7 March 2002 CHECKED BY AD

PROJECT Sign Structures for HWY 11 Four Laning, from Emsdale to Katrine JOB NO. TT22812

ELEV / DEPTH (m)	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	DEPTH m	ELEVATION SCALE m
337.2 / 0.0	0.25m TOPSOIL							337
	dark brownSILTY SAND with Gravel, loose , moist		1	SS	8			
			2	SS	50/23		1	
335.8 / 1.4								336
	dense		3	SS	30		2	
	brownSAND compact, damp		4	SS	29			335
			5	SS	26		3	
								334
	Gravelly with Gravel		6	SS	25		4	
								333
			7	SS	23		5	
								332
							6	
			8	SS	18			331
							7	
								330
329.1 / 8.1			9	SS	22		8	
	End of Borehole							
	Groundwater in open bore on completion, none							

DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100

SHEAR STRENGTH kPa
○ UNCONFINED + FIELD VANE
● QUICK TRIAXIAL × LAB VANE
20 40 60 80 100

PLASTIC LIMIT w_P | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w_L

WATER CONTENT (%) 10 20 30

UNIT WEIGHT γ kN/m³

REMARKS & GRAIN SIZE DISTRIBUTION (%)

GR SA SI CL

SS2: sampler driving gravel.

46 50 (4)

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

RECORD OF BOREHOLE No J1

amec

1 OF 1

W.P. 466-93-00 LOCATION 22+360 Rt 11.0 NBL C/L ORIGINATED BY PPM

DIST 52 HWY 11 BOREHOLE TYPE Solid Stem Augering COMPILED BY PPM

DATUM Geodetic DATE 4 November 2002 - 4 November 2002 CHECKED BY AD

PROJECT Sign Structures for Highway 11 Four Laning, from Emsdale to Katrine JOB NO. TT22811

ELEV / DEPTH (m)	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	DEPTH m	ELEVATION SCALE m
334.3 / 0.0	125mm ASPHALTIC CONCRETE						0	334
334.2 / 0.1	0.2m SAND and GRAVEL							
334.0 / 0.3	SANDY SILT, frequent sand seams, loose, moist, brown		1	SS	6			
	trace cobbles		2	SS	8		1	
332.9 / 1.4	SAND, some silt, fine, compact, damp, brown		3	SS	16		2	333
			4	SS	16			332
331.4 / 2.9	SANDY SILT, frequent sand seams, compact, moist, brown		5	SS	13		3	331
330.7 / 3.6	SILTY SAND, fine, compact, damp, brown		6	SS	14		4	330
			7	SS	15		5	
329.1 / 5.2	SAND, trace silt seams, compact, damp, light brown		8	SS	28		6	329
	trace gravel, occasional cobbles, very dense		9	SS	50/13		7	328
	some gravel, dense							327
326.2 / 8.1	End of Borehole		10	SS	42		8	

Groundwater in open bore on completion: none

Cave on completion: 7.3m

DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100

SHEAR STRENGTH kPa
O UNCONFINED + FIELD VANE
● QUICK TRIAXIAL × LAB VANE
20 40 60 80 100

PLASTIC LIMIT w_P | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w_L

WATER CONTENT (%) 10 20 30

UNIT WEIGHT γ kN/m³

REMARKS & GRAIN SIZE DISTRIBUTION (%)

GR SA SI CL

0 81 (19)

Auger refusal at 5.2m on boulder

March 8, 2002

Borehole continued on Nov. 4, 2002

$+^{3}$, $\times^{3}$: Numbers refer to Sensitivity

O 3% STRAIN AT FAILURE

RECORD OF BOREHOLE No K1

amec

1 OF 1

G.W.P. 466-93-00 LOCATION Station 23+650 O/S 11.0m LT SBL C/L ORIGINATED BY JF/IH

DIST 52 HWY 11 BOREHOLE TYPE Solid Stem Auger COMPILED BY NNK

DATUM Geodetic DATE 6 March 2002 - 6 March 2002 CHECKED BY AD

PROJECT Sign Structures for HWY 11 Four Laning, from Emsdale to Katrine JOB NO. TT22812

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	DEPTH	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT	PLASTIC LIMIT / NATURAL MOISTURE CONTENT / LIQUID LIMIT	UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH (m)	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES				SHEAR STRENGTH kPa	WATER CONTENT (%)		
342.7							m	m	20 40 60 80 100	10 20 30	kN/m³	GR SA SI CL
0.0	Auger Refusal on Rockfill Slope							342				

+3, ×3: Numbers refer to Sensitivity O3% STRAIN AT FAILURE

RECORD OF BOREHOLE No K2

amec

1 OF 1

G.W.P. 466-93-00 LOCATION Station 23+650 O/S 19.0m LT SBL C/L ORIGINATED BY JF/IH

DIST 52 HWY 11 BOREHOLE TYPE Solid Stem Auger COMPILED BY NNK

DATUM Geodetic DATE 6 March 2002 - 6 March 2002 CHECKED BY AD

PROJECT Sign Structures for HWY 11 Four Laning, from Emsdale to Katrine JOB NO. TT22812

ELEV / DEPTH (m)	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	DEPTH m	ELEVATION SCALE m	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
339.7												
0.0	**0.2m TOPSOIL**											
	brown, SILTY SAND trace Gravel, Rootlets loose, moist		1	SS	5							
339.0								339				
0.8	brownSILT with SAND loose, moist		2	SS	6		1					
338.5												
1.2	brown SANDY SILT compact to v.dense, damp		3	SS	24			338				
			4	SS	50		2					0 37 (63)
336.8			5	SS	87			337				
2.9	End of Borehole											
	Groundwater in open bore on completion: none											

$+^{3}$, $\times^{3}$: Numbers refer to Sensitivity $\circ^{3\%}$ STRAIN AT FAILURE

RECORD OF BOREHOLE No L1

amec

G.W.P. 466-93-00 LOCATION Station 23+850 O/S 7.3m RT SBL C/L ORIGINATED BY NNK

DIST 52 HWY 11 BOREHOLE TYPE Solid Stem Auger and Rock Coring COMPILED BY NNK

DATUM Geodetic DATE 7 March 2002 - 7 March 2002 CHECKED BY AD

PROJECT Sign Structures for HWY 11 Four Laning, from Emsdale to Katrine JOB NO. TT22812

ELEV / DEPTH (m)	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	DEPTH m	ELEVATION SCALE m	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
344.8 0.0	brown Gravelly Sand FILL trace Asphalt fragments, compact to dense, damp to moist		1	SS	20					○		
			2	SS	18		1	344		○		39 52 (9)
343.2 1.7			3	SS	36					○		
	GNEISS BEDROCK fresh to slightly weathered, moderately closely jointed, slightly to moderately weathered joints		4	RC	-		2	343				RC4: REC = 95% RQD = 71% RC4 at 2.0m depth, comp. strength of 84 MPa
			5	RC	-		3	342				RC5: REC = 92% RQD = 78%
340.2 4.6	End of Borehole		6	RC	-		4	341				RC6: REC = 92% RQD = 82%
	Groundwater in open bore on completion: none											

+3, ×3: Numbers refer to Sensitivity

○3% STRAIN AT FAILURE

RECORD OF BOREHOLE No L2

amec

G.W.P. 466-93-00 LOCATION Station 23+850 O/S 9.7m LT SBL C/L ORIGINATED BY NNK

DIST 52 HWY 11 BOREHOLE TYPE Solid Stem Auger and Rock Coring COMPILED BY NNK

DATUM Geodetic DATE 6 March 2002 - 6 March 2002 CHECKED BY AD

PROJECT Sign Structures for HWY 11 Four Laning, from Emsdale to Katrine JOB NO. TT22812

ELEV / DEPTH (m)	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	DEPTH m	ELEVATION SCALE m	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
345.4												
0.0	brown Sand FILL with Gravel, loose, moist		1	SS	6			345				
344.3			2	SS	6		1					
1.1	brown SAND, trace Gravel, occasional Silt layers, compact to dense, moist		3	SS	14			344				
			4	SS	18		2					0 93 (7)
			5	SS	38			343				
	-------- with Cobbles and Boulders						3					
			6	RC	-		4	342				Auger refusal, advance borehole by Rock Coring and Tricone
340.5								341				
5.0	GNEISS BEDROCK occasional Sand filled joints, fresh to slightly weathered, closely to moderately jointed.		7	RC	-		5					RC7: (Rock coring using NX core barrel) REC = 67% RQD = 21%
			8	RC	-			340				RC8: (Rock coring using BX core barrel) REC = 83% RQD = 0%
339.1			9	RC	-		6					RC9: (Rock coring using BX core barrel) REC = 50% RQD = 17% RC7 at 5.1m depth, comp. strength of 56 MPa
6.3	End of Borehole Groundwater in open bore on completion: none											

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

FINAL SUPPLEMENTARY FOUNDATION INVESTIGATION AND DESIGN REPORT FOR PROPOSED SIGN STRUCTURES HIGHWAY 11 FOUR LANING FROM EMSDALE TO KATRINE G.W.P. 466-93-00, DISTRICT 52, HUNTSVILLE

Submitted to:

Delcan Corporation
133 Wynford Drive
North York, Ontario, M3C 1K1
Canada

Submitted by:

AMEC Earth & Environmental Limited
104 Crockford Boulevard
Scarborough, Ontario, M1R 3C3
Canada
Tel 416-751-6565
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14 January 2003

TT22812

amec

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FIGURES

RECORD OF BOREHOLE SHEETS

TABLE

1.0 INTRODUCTION

AMEC Earth and Environmental Limited (AMEC) has been retained by Delcan Corporation (Delcan) to carry out a subsurface investigation at the proposed location of four highway signs along the proposed Highway 11 four laning, from Emsdale to Katrine, in the Townships of Perry and Armour, District of Parry Sound, and form part of the project designated as G.W.P. 466-93-00 in District 52, Huntsville.

The investigation was carried out to obtain subsurface information to facilitate design and construction of the four proposed sign foundations. Based on our interpretation of the data obtained, recommendations on the foundation design of the proposed works are provided. Comments are also provided on anticipated construction problems where they may affect the foundation design.

2.0 SITE DESCRIPTION AND PHYSIOGRAPHY

The proposed sign locations are distributed along an about 2 km section of the proposed Highway 11, two sign locations immediately south and two locations immediately north of the Highway 518 East interchange. The existing Highway 11 will become the new southbound lane north of Highway 518 East.

The area of Boreholes H1 and H2 are west of the existing Highway 11 along a gentle slope and sparsely wooded. Borehole J1 is to the east of Highway 11 in the driveway of an existing service station. Boreholes K1 and K2 are on the west side of the Highway 11 rockfill embankment. Boreholes L1 and L2 are on the shoulders of the existing Highway 11, which is in cut at this location.

Based on available geologic information, the site is in an area intersected by small braided eskers partially buried by glaciofluvial sediments. Generally, after the last glacial withdrawal, ice-contact sediments (eskers and kames consisting of gravelly sands to sandy gravels with a high boulder content) and glaciofluvial outwash sediments were deposited on top of the existing sandy glacial till or Precambrian bedrock (ranging from granite to gneiss). The area was then inundated by glacial Lake Algonquin depositing sands, silts and clays in low lying areas.

3.0 INVESTIGATION PROCEDURES

The field work of this investigation was carried out during the period of March 6 to 8, 2002 and on November 4, 2002. The fieldwork consisted of drilling and sampling seven boreholes (Boreholes H1, H2, J1, K1, K2, L1 and L2).

The boreholes (except Boreholes K1 and K2) were advanced using a track-mounted power auger drilling rig owned and operated by Master Soil Investigation Inc. under the full-time supervision of

a member of AMEC's geotechnical staff. As Boreholes K1 and K2 were not accessible with a drill rig, the borehole was advanced using portable hand drilling equipment, owned and operated by AMEC geotechnical staff.

Sampling in the boreholes (except Boreholes K1 and K2) was carried out at regular intervals of depth by the Standard Penetration Test (SPT), as specified in ASTM Method D 1586. This consists of freely dropping a 63.5 kg hammer for a vertical distance of 0.76 m to drive a 50 mm diameter o.d. split barrel (split spoon) sampler into the ground. The number of blows of the hammer required to drive the sampler into the relatively undisturbed ground for a vertical distance of 0.30 m is recorded as the Standard Penetration Resistance, or the 'N'-value of the soil, which gives an indication of the consistency or the relative density of the soil deposit.

Borehole K2 was sampled continuously by freely dropping a 31.75 kgs. hammer a vertical distance of 0.76 m to drive a 51 mm diameter o.d. split barrel (split-spoon) sampler into the ground. The number of blows of the hammer to drive the sampler into the relatively undisturbed ground by a vertical distance of 0.30 m was recorded. These values were then correlated with the SPT, as specified in ASTM Method D 1586. The correlated values are reported as Standard Penetration Resistances or the 'N'-values of the soil and this gives an indication of the consistency or the relative density of the soil deposit.

Borehole K1 was probed with a hand auger, but refusal on the rockfill embankment was obtained. Borehole J2 was canceled as the proposed sign location is over an existing gasoline tank and piping.

In order to assess the quality of the bedrock, Boreholes L1 and L2 were cored. This was carried out by rotary drilling methods using NX and BX size core barrels.

The borehole locations were established in the field by our technical staff, in relation to the already staked out median centreline of the proposed Highway 11. The ground surface elevations at the boreholes are referenced to the geodetic datum.

The rock and soil samples were identified in the field and transported to our geotechnical laboratory in Toronto (Scarborough) for further examination and classification. A laboratory testing programme, consisting of natural moisture content determination, rock compressive strength tests and grain size distribution analyses, was carried out on selected representative soil samples. The results of the laboratory tests are presented on the Record of Borehole sheets and in Figure Nos. 1 to 7.

The boreholes were left open until the end of each work day to enable us to observe and record the groundwater conditions. All boreholes were backfilled with auger cuttings, while Boreholes L1 and L2 were backfilled with cement.

4.0 SUBSURFACE CONDITIONS

Details of the subsurface conditions encountered in these boreholes are presented in the Record of Borehole sheets. The following paragraphs are intended to complement and summarize this data.

4.1 TOPSOIL

Topsoil was encountered at the surface of Boreholes H1, H2 and K2 to depths of between 0.2 to 0.25m.

4.2 FILL

Asphaltic concrete was encountered at the surface of Borehole J1, about 125 mm in thickness. Underlying this paved surface, and encountered at the surface of Boreholes L1 and L2, a sand and gravel to gravelly sand fill was encountered to depths of about 0.3 to 1.7m below existing ground surface. The fill in Borehole L1 contained asphalt fragments. Measured 'N'-values within the fill range from 6 to 35 blows per 0.3m, indicating a loose to dense relative density. Measured moisture contents range from 6 to 12%. One grain size analysis was carried out on a sample of the fill and the resulting grain size curve is presented in Figure No. 1. The results of the grain size analysis are also presented on the Record of Borehole sheet, and consist of 39% gravel, 52 % sand and 9% fines.

Borehole K1 encountered rockfill at the surface of the embankment slope and refusal to advance was obtained.

4.3 SANDS AND SILTS

Underlying the topsoil or fill deposits, a sand to silty sand/sandy silt deposit was encountered in all boreholes, except Borehole L1. Boreholes H2, J1 and K2 encountered silty sand to sandy silt deposits to depths of about 1.4 to 8.1m below existing ground surface. These deposits also contained in some boreholes, sand seams, cobbles and/or gravel. Boreholes H1 and H2 encountered a sand deposit underlying the silty sand or topsoil layers, which extended to the full depth of the boreholes (to a depth of 6.6 and 8.1m). Borehole L2 encountered a sand deposit with cobbles and boulders to a depth of 5.0m. Measured 'N'-values within these cohesionless deposits range from 5 to greater than 50 blows per 0.3m, indicating a loose to very dense relative density, but generally compact. Measured moisture contents range from 3 to 22%.

Grain size analyses were carried out on six samples of the cohesionless sands and silts, and the resulting grain size curves are presented in Figure Nos. 2 to 7. The results are also summarized on the Record of Borehole sheets and as follows:

Sand to Gravelly Sand(4 samples)

Gravel	0 to 46%
Sand	50 to 93%
Fines	4 to 7%

Silty Sand to Sandy Silt (2 samples)

Gravel	0%
Sand	37 to 81%
Fines	19 to 63%

Rock coring was required in order to advance Borehole L2 past the cobbles and boulders encountered within the sand.

4.4 BEDROCK

Bedrock was encountered in Boreholes L1 and L2 at a depth of 1.7 and 5.0m respectively. Bedrock was cored using NX and BX size core barrels a distance of about 2.9m and 1.3m in Boreholes L1 and L2. Borehole L2 was abandoned after 1.3m of coring due to the end of the work day and due to traffic safety concerns. The bedrock was logged by experienced AMEC engineering staff and consists of a massive, fresh to slightly weathered Gneiss. The jointing of the rock is close to moderately close, while the joints are slightly to moderately weathered. Occasional joints were coated with sand in the rock cored in Borehole L2. Measured rock core recoveries range from 92 to 95% in Borehole L1, and 50 to 83% in Borehole L2. Rock quality designation (RQD) in Borehole L1 ranged from 71 to 82%, while in Borehole L2 the RQD ranged from 0 to 21%. Based on visual examination of the rock cores and the above measurements, the rock in Borehole L1 is considered to be of good quality, while the rock in Borehole L2 is considered to be of very poor quality.

4.5 GROUNDWATER CONDITIONS

Groundwater conditions in the open boreholes were observed during the drilling and on completion of each borehole. No free-standing water was encountered in any of the boreholes.

It should be noted however that the groundwater at the site will fluctuate seasonally and can be expected to rise during the spring months or in response to heavy rains.

5.0 DISCUSSION AND RECOMMENDATIONS

The proposed Highway 11 realignment will consist of a four lane divided highway with an approximately 28 m wide median. It is proposed to construct four highway signs at the following locations:

- Overhead Transition Sign at Station 22+150 offset 7 m right to 6m left (SBL) - proposed Highway 11 SBL in 1 m cut
- Ground-mounted Sign at Station 22+360 offset 11 m to 18 m right (NBL) - proposed Highway 11 in 2 m cut
- Ground-mounted Sign at Station 23+650 offset 11 m to 18 m left (SBL) - Existing Highway 11 on grade (mid-slope)
- Overhead Transition Sign at Station 23+850 offset 7 m right to 6m left (SBL) - Existing Highway 11 in 1 to 2m cut

Information on proposed cuts and fills along the Highway 11 realignment, cuts and fills information was obtained from profile drawings titled "Highway 11 - Emsdale, Proposed Profile, G.W.P. 466-93-00", provided by Delcan.

5.1 FOUNDATIONS

It is understood that the proposed sign structure foundations will be supported on augered caissons. Recommended design parameters for the soils as encountered in the boreholes are given in the following Table 1. Where the caissons will likely be fully or partially embedded within proposed embankment fill, design parameters are provided for engineered fill.

The estimation of the ultimate resistance of a vertical pile to a lateral load and the deflection of the pile as the load builds up to its ultimate value are complex involving the interaction between a semi rigid structural member (the pile) and the elasto-plastic soil. A short/rigid pile tends to fail by rotation or translation with the yielding of the surrounding soils while a long/flexible pile tends to fracture by bending (or shear) at the upper portion of the pile. The lateral resistance of a vertical pile should be designed with the consideration of the following:

- geotechnical resistance of the surrounding sub-soils,
- structural resistance against bending and shear of the pile materials,
- deflection of the pile head (serviceability).

The analysis and design should be carried out in accordance with Section 6 - 9.8 of the Ontario Highway Bridge Design Code, 3rd Edition (OHBDC). The ultimate lateral resistance of the pile may be estimated using the Broms' Method (Canadian Foundation Engineering Manual, 3rd Edition, Section 20.4.1).

For the calculation of the lateral pile deflection using the subgrade reaction model, the soil parameters provided in Table 1 are recommended. The following notation has been adopted:

ϕ	=	angle of friction for cohesionless soils in degrees
γ	=	bulk unit weight in kN/m^3
n_h	=	coefficient related to soil density (kN/m^3)
Cu	=	undrained shear strength (kPa)
Kp	=	Coefficient of passive earth pressure

For lateral soil-pile interaction analysis, in cohesionless soils, the horizontal subgrade reaction to the pile can be calculated from the expression:

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

... where k_s = coefficient of horizontal subgrade reaction (kN/m^3)
n_h = coefficient related to soil density as given in Table 3
d = pile width (m)
z = depth (m)

In cohesive soils the coefficient of horizontal subgrade reaction may be estimated from;

$$k_s = 67\ c_u / d$$

... where k_s = coefficient of horizontal subgrade reaction (kN/m^3)
c_u = undrained shear strength of the soil as given in Table 3
d = pile width (m)

The materials within the zone of frost penetration depth should not be included in the calculations of lateral resistance. At this site, the depth of frost penetration is 1.8m.

If the caissons are to be installed on slope, the lateral resistance for the wall foundations founded on or near a slope should be reduced as per MTO practice, as follows,

- For subgrade within 3m of the edge of an adjacent slope, the soil should not be included in the calculations of lateral resistance.
- For subgrade within 6m, but more than 3m, from the edge of an adjacent slope, the calculated lateral resistance of the soil should be reduced by one half.

Where the groundwater table is below the proposed founding level of the caissons, the caissons can be advanced unlined. Sands and silts above the groundwater table may have a temporary "stand-up" time. Caissons which extend below the groundwater table will need to be lined. For caissons extended below the groundwater table within sands and silts, the pervious soils should be dewatered prior to excavation to avoid disturbance to the founding subgrade.

Due to the presence of cobbles and/or boulders at some locations, the method(s) of caisson

construction should allow for break-up and removal of cobbles and boulders where necessary.

The ground-mounted sign at Station 22+360 will be constructed in the area of an existing underground gas tank and underground piping. This will require excavation and removal of the underground tank and replacement with compacted fill, as discussed in Section 5.3.

5.2 Foundations in Rock

At the ground-mounted sign structure at Station 23+850, bedrock was confirmed near the ground surface. At Station 23+650, rockfill is present where foundations are proposed within the existing embankment.

As an alternative to caisson foundations, the sign foundation may be placed on a concrete spread footing poured directly on the bedrock or rockfill surface. In order to resist lateral loads imposed by wind forces, the foundation could be anchored into the bedrock or rockfill by rock anchors or dowels.

No frost protection is required for footings placed on massive bedrock, provided blasting of the bedrock is monitored closely to ensure minimal fracturing of the founding rock occurs. Bedrock would however be prone to possible deterioration due to opening of existing joints or fractures in the bedrock, as a result of frost action. Provided that surface water is diverted away from the footings, frost protection need not be provided for footings placed on massive, sound bedrock, although for added protection an earth cover of at least 0.3 m is recommended. The surface of the earth protection should be clayey to minimize the infiltration of surface water or the protection could be provided by concrete. If however, the bedrock is not massive and water can accumulate in the joints or fractures of the rock (thus causing deterioration of the founding medium by expansion due to freezing) then there may be a requirement to provide some frost protection. For this purpose, the proposed bearing surface should be inspected by the Quality Certification Engineer. If the bedrock is not massive, then the excavation can be extended deeper until acceptable rock is found. In the case of rockfill, due to the voided nature of the fill, frost protection is not required.

Sliding resistance can be provided by penetrating into the bedrock or rockfill(i.e. keying-in and utilizing passive rock resistance), utilizing the sliding resistance between concrete and bedrock/rockfill, shear in grouted dowels and/or rock anchors. For the evaluation of the sliding resistance of the foundation (O.H.B.D.C. 6-8.4.3) the ultimate angle of friction between the underside of the foundations and the clean, intact bedrock surface surface can be taken as 30 degrees and 35 degrees for rockfill. If additional horizontal resistance is required or if the rock surface is not sufficiently level, dowelling or keying-in into the bedrock/rockfill can be considered. Alternatively, the surface of the bedrock can be chiseled (i.e. roughened), increasing the ultimate angle of friction to 35 degrees. This, in our opinion, is likely to be the most cost effective method. On the other hand if the presence of weaker rock zones/seams/layers is noted during construction, especially with an unfavourable orientation, then dowelling may be a more suitable solution. In our

opinion, chiseled rockfill surfaces are not required due to the rough nature of the rockfill and dowels may not be effective due to the heterogeneous nature of the rockfill.

If there are net uplift forces which need to be resisted by rock anchors, or for increasing sliding or overturning resistance, for design purposes, the following O.H.B.D.C. capacities may be assumed for the bond between bedrock and grout.

Factored Bearing Capacity @ U.L.S. = 500 kPa
Bearing Capacity @ S.L.S. will not govern

The horizontal capacity of rock that can be derived from a shear key extending from the base of a footing depends on many factors including the degree of fracture of the upper portion of the bedrock (massiveness), joint orientation and properties, the proximity of weaker zones, seams and layers. As outlined above, the proposed bearing surface should be inspected during construction by an experienced personnel to determine if the shear key option is feasible. In addition, the integrity of the rock face after the rock drilling and/or blasting should be checked by a competent Rock Engineer or Geologist to confirm that the rock subgrade below the proposed sign foundation is sound and stable and capable of supporting the proposed load. If this rock was found to be fractured and/or unfavourably jointed, corrective measures such as grouting and/or rock anchors or further set back distance from the rock face, should be implemented.

The upper 0.5m of the rock should not be included in calculating the resistance and the minimum dowel embedment should be 1.5 m into sound rock. Neither the structural strength of the dowel, nor the compressive strength of the grout should be exceeded. The anchors should also be checked for rock wedge pull out assuming a 60 degree cone/wedge and the anchor group resistance should also be checked. Under inclined loading conditions the Bearing Resistance at U.L.S. should be reduced in accordance with Clause 6-8.4.2 of O.H.B.D.C., 3rd Edition.

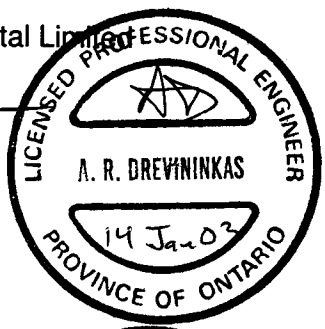
5.3 Compacted Fill

For caissons extended through proposed fill embankments, it should be ensured that the material consist of earth fill, preferably granular (cohesionless soil). The subgrade should be adequately prepared to receive the sub-base course. Disturbed and wet subgrade materials should be removed and the top of the subgrade should then be inspected and approved, by proof-rolling, by qualified geotechnical personnel. Cavities created by the removal of unsuitable materials should be backfilled with approved, inorganic fill materials similar to the existing subgrade material. All new fill should be placed in maximum 200 mm loose lifts within $\pm$ 2% of its optimum moisture content, and each lift compacted with suitable equipment to minimum 95% Standard Proctor Maximum Dry Density, before placing the next lift.

6.0 CLOSURE

We recommend that once the details of the structures are finalized, our recommendations should be reviewed for their specific applicability.

AMEC Earth and Environmental Limited



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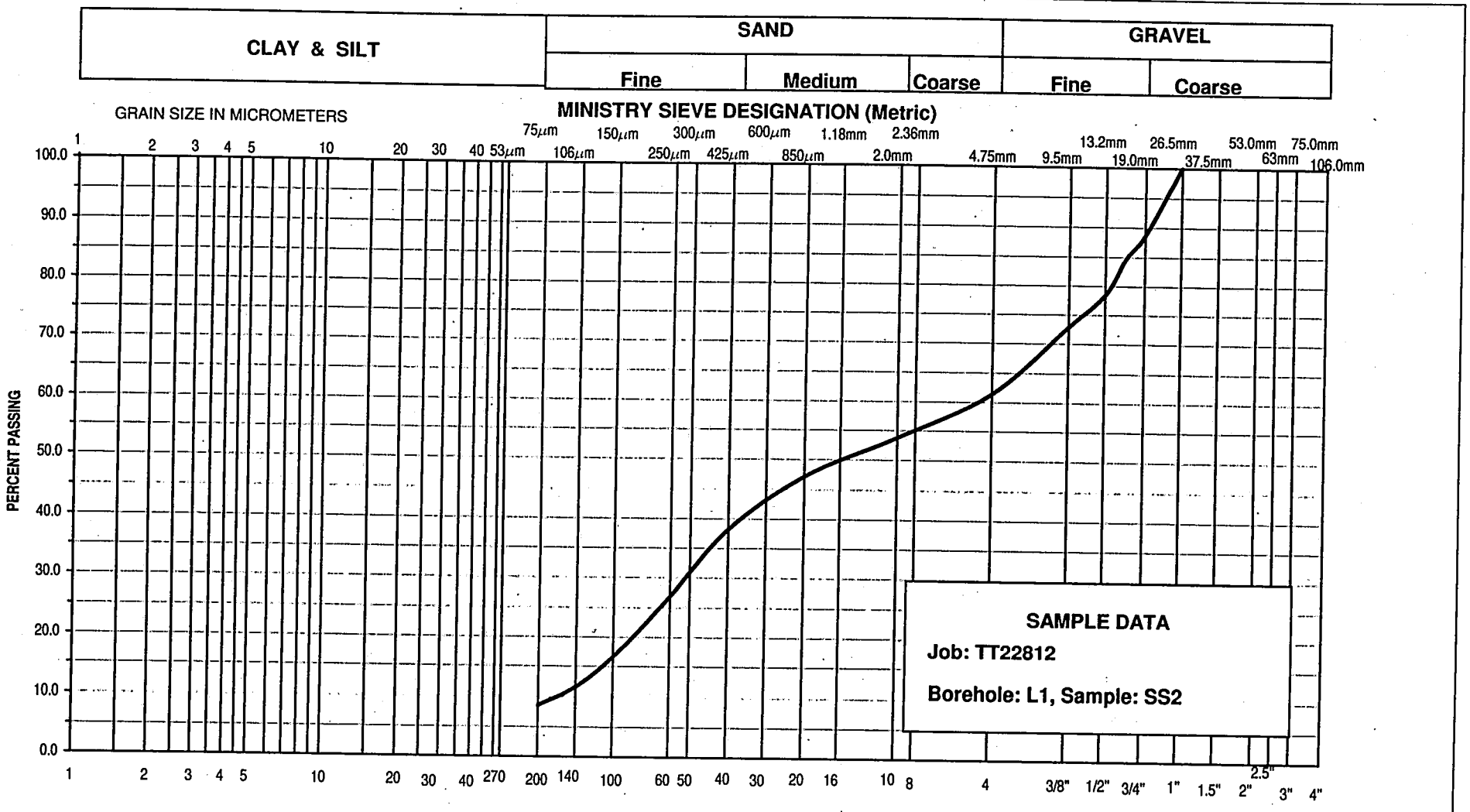
Geotechnical Services

Kai-Sing Ho, Ph.D., P. Eng.
Principal Geotechnical Consultant
Designated MTO Contact

FIGURES

UNIFIED SOIL CLASSIFICATION SYSTEM



MINISTRY SIEVE DESIGNATION (Imperial)

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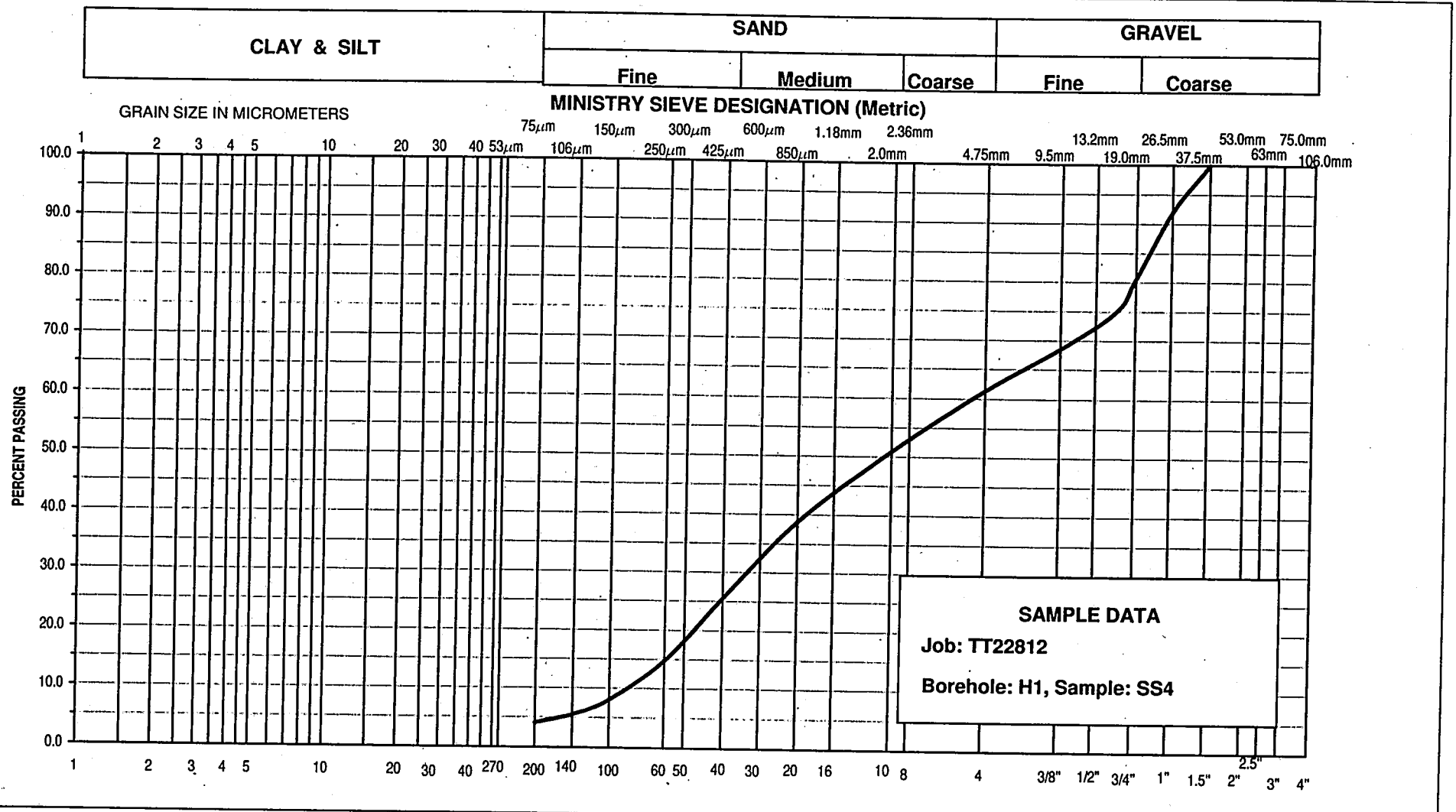
www.amec.com

GRAIN SIZE DISTRIBUTION	Client :- Delcan Corporation
	Project:- Sign Structures
Gravelly Sand FILL trace Silt	Location: - Highway 11 Four Laning
	G.W.P. 466-93-00 — Date :- 13 March 2002

FIGURE NO. 1

UNIFIED SOIL CLASSIFICATION SYSTEM



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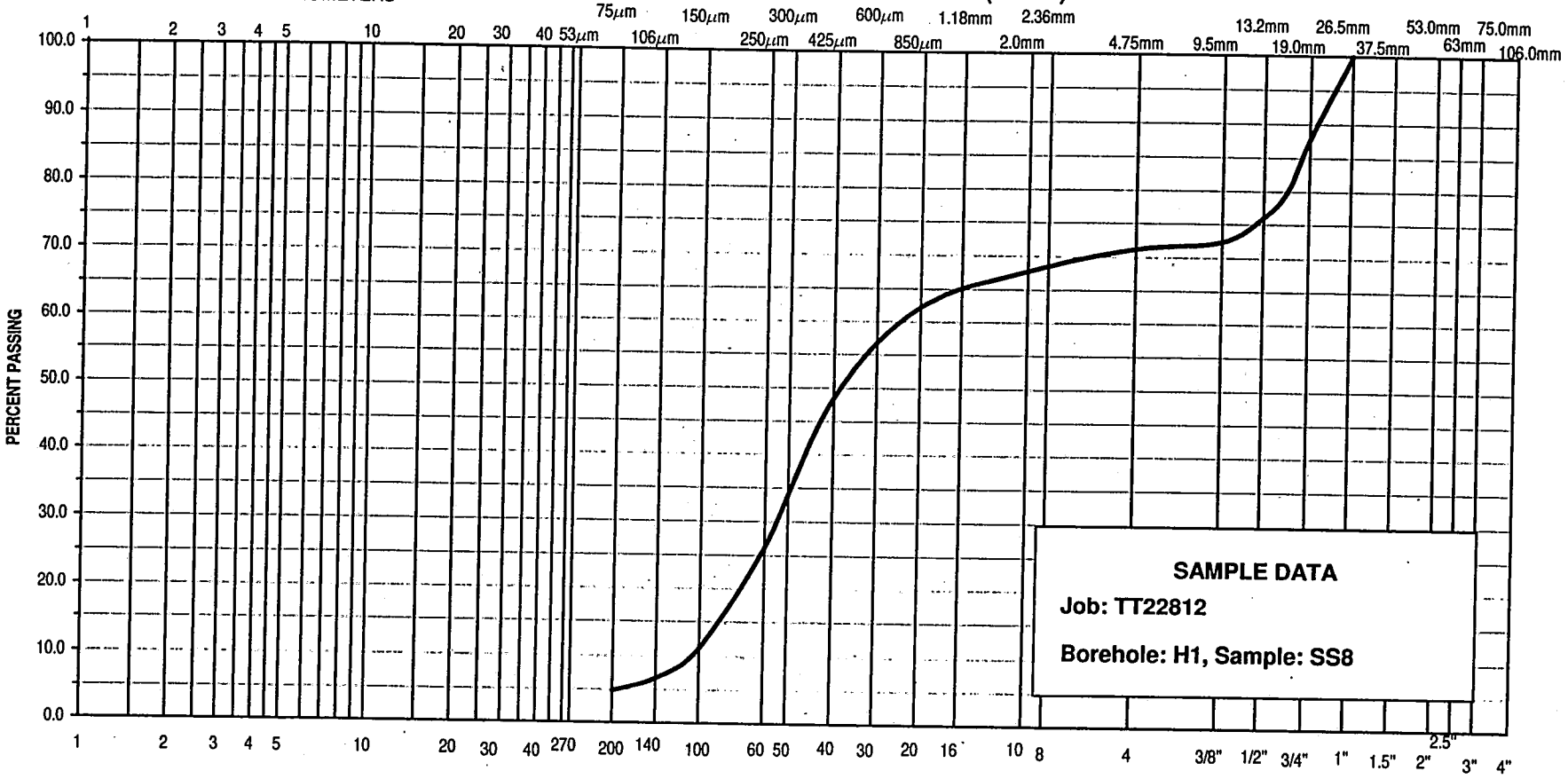
GRAIN SIZE DISTRIBUTION	Client :- Delcan Corporation
	Project:- Sign Structures
GRAVELLY SAND trace Silt	Location: - Highway 11 Four Laning
	G.W.P. 466-93-00 — Date :- 13 March 2002

FIGURE NO. 2

UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY & SILT	SAND			GRAVEL	
	Fine	Medium	Coarse	Fine	Coarse



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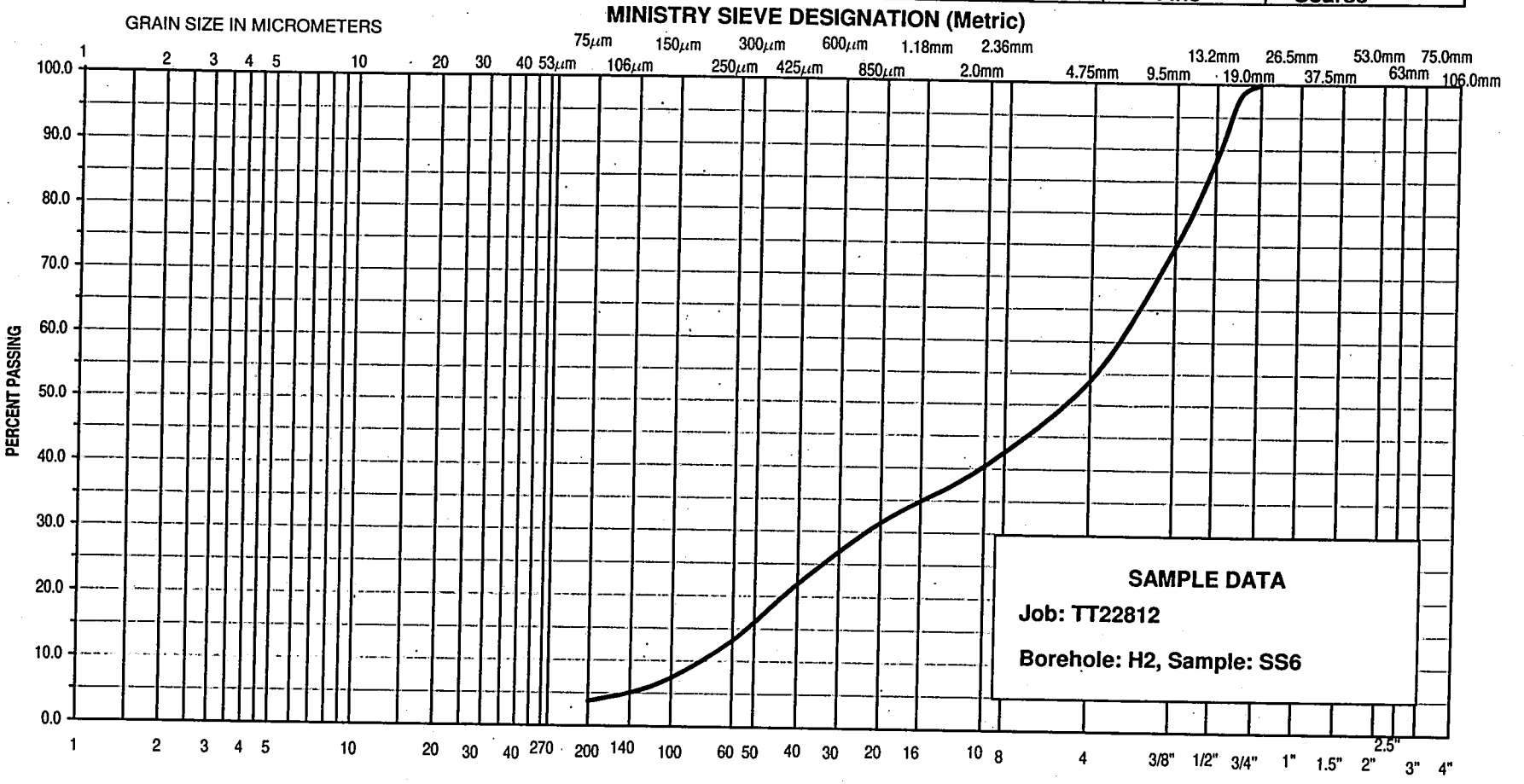
GRAIN SIZE DISTRIBUTION	Client :- Delcan Corporation	
	Project:- Sign Structures	
SAND with Gravel trace Silt	Location: - Highway 11 Four Laning	
	G.W.P. 466-93-00	Date :- 13 March 2002

FIGURE NO. 3

UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY & SILT	SAND			GRAVEL	
	Fine	Medium	Coarse	Fine	Coarse



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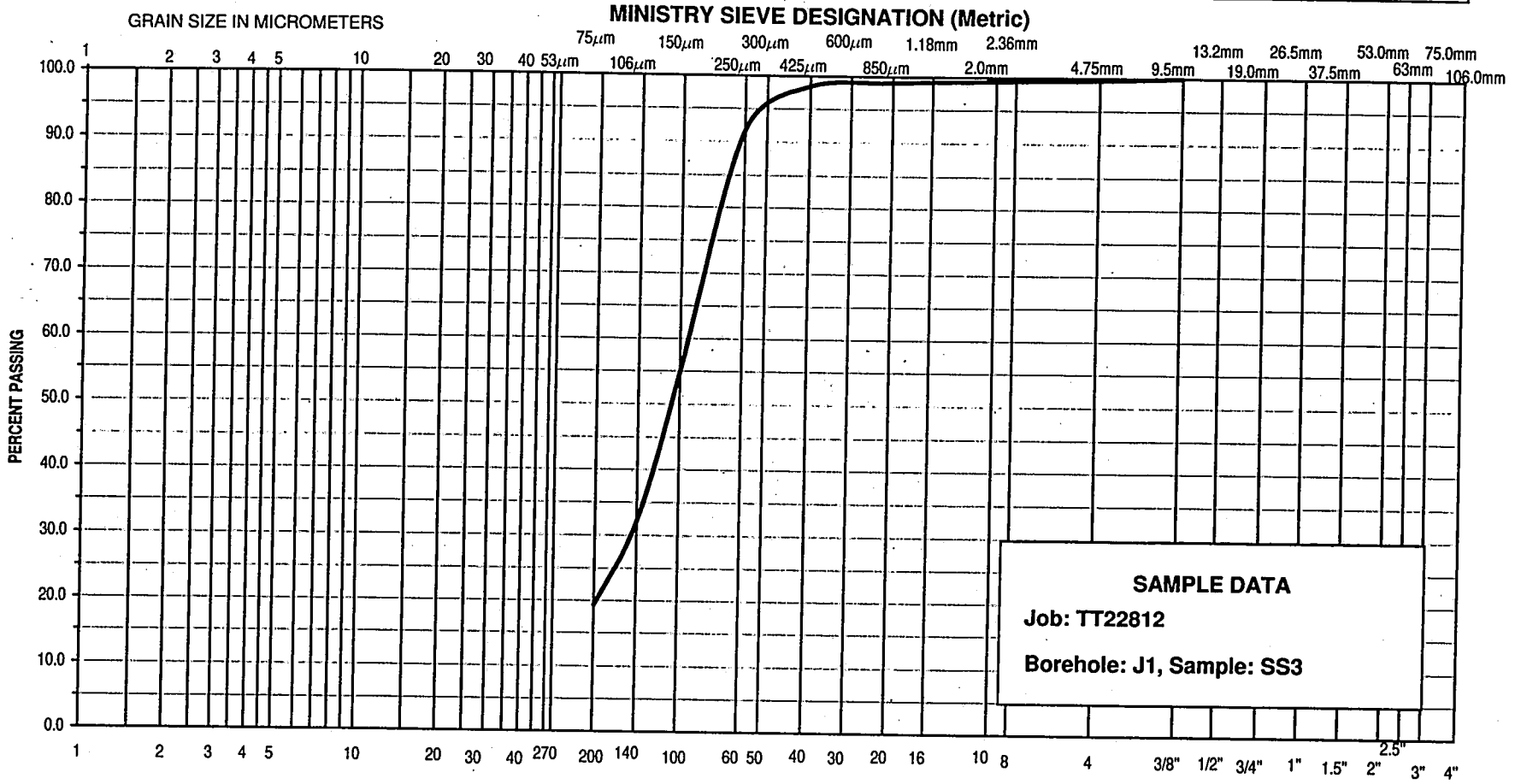
GRAIN SIZE DISTRIBUTION	Client :- Delcan Corporation
	Project:- Sign Structures
GRAVELLY SAND	Location: - Highway 11 Four Laning
trace Silt	G.W.P. 466-93-00 / Date :- 13 March 2002

FIGURE NO. 4

UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY & SILT	SAND			GRAVEL	
	Fine	Medium	Coarse	Fine	Coarse



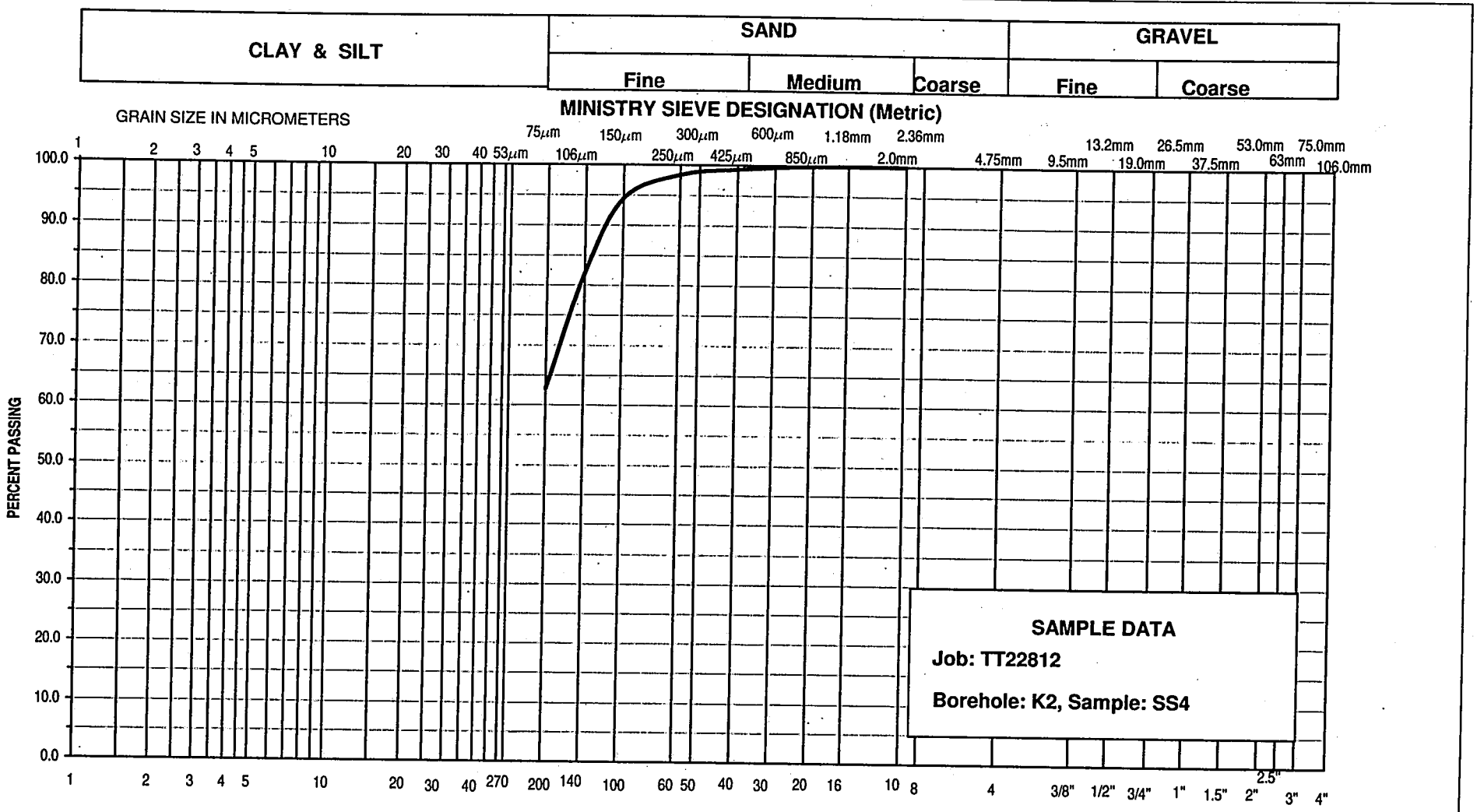
MINISTRY SIEVE DESIGNATION (Imperial)

AMEC Earth & Environmental Limited
104 Crockford Blvd., Scarborough, Ontario
Canada, M1R 3C6
Tel +1 (416) 751 6565, Fax +1 (416) 751 7592
www.amec.com

GRAIN SIZE DISTRIBUTION	Client :- Delcan Corporation	
	Project:- Sign Structures	
Fine SAND	Location: - Highway 11 Four Laning	
some Silt	G.W.P. 466-93-00	Date :- 13 March 2002

FIGURE NO. 5

UNIFIED SOIL CLASSIFICATION SYSTEM



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www.amec.com

GRAIN SIZE DISTRIBUTION

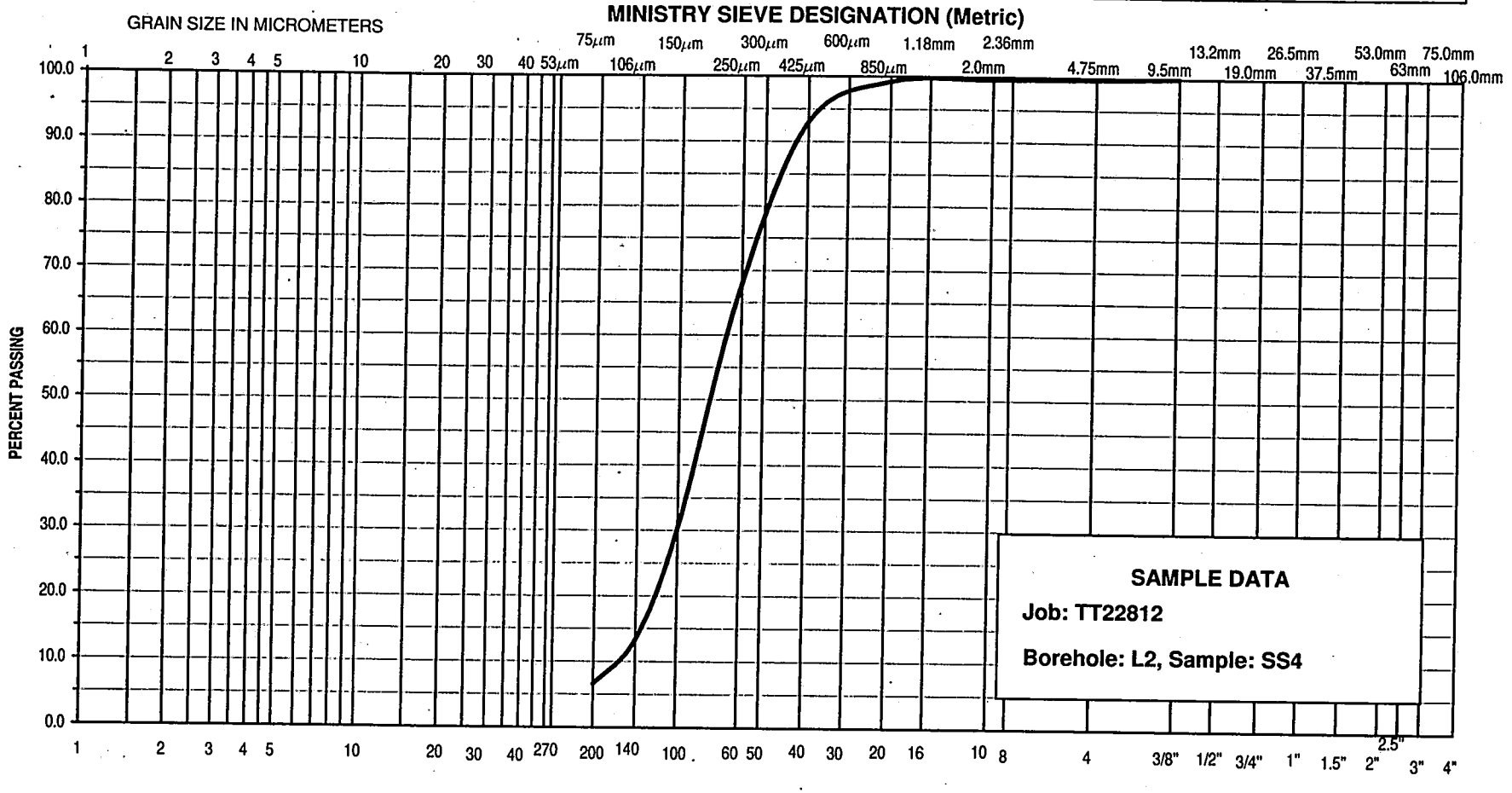
SANDY SILT

Client :- Delcan Corporation	
Project:- Sign Structures	
Location: - Highway 11 Four Laning	
G.W.P. 466-93-00	Date :- 13 March 2002

FIGURE NO. 6

UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY & SILT	SAND			GRAVEL	
	Fine	Medium	Coarse	Fine	Coarse



MINISTRY SIEVE DESIGNATION (Imperial)

AMEC Earth & Environmental Limited
104 Crockford Blvd., Scarborough, Ontario
Canada, M1R 3C6
Tel +1 (416) 751 6565, Fax +1 (416) 751 7592
www.amec.com

GRAIN SIZE DISTRIBUTION	Client :- Delcan Corporation	
	Project:- Sign Structures	
Fine SAND trace Silt	Location: - Highway 11 Four Laning	
	G.W.P. 466-93-00	Date :- 13 March 2002

FIGURE NO. 7

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RECORD OF BOREHOLE SHEETS

AMEC EARTH AND ENVIRONMENTAL LIMITED
NOTES TO BOREHOLE LOGS

DRILLING DATA

Method:

SolSt Augering	-	Solid Stem Augering
HolSt Augering	-	Hollow Stem Augering
WB	-	Washed Boring

SAMPLES

TYPE:

SS	-	Split Spoon
AS	-	Auger Sample
TW	-	Thinwall Open
TP	-	Thinwall Piston
WS	-	Washed Sample
BS	-	Block Sample
RC	-	Rock Core
PH	-	Sample Advanced Hydraulically
PM	-	Sample Advanced Manually

LABORATORY DATA

WP	-	Plastic Limit (%)
W	-	Water Content (%)
WL	-	Liquid Limit (%)
γ	-	Natural Unit Weight (kN/m^3)
UNDR STRNG or C_u	-	Undrained Shear Strength (kPa)
		Field Vane: St-sensitivity
pp	-	Pocket Penetrometer
UC	-	Unconfined Compression
UU	-	Unconsolidated Undrained at Overburden Pressure
CU	-	Consolidated Undrained
CD	-	Consolidated Drained
TOV	-	Total Organic Vapours

Standard Penetration Test, 'N'-values The Standard Penetration Test (SPT) 'N'-values are the number of blows required to cause a standard 51 millimetre o.d. split barrel sample to penetrate 0.3 metres into undisturbed ground in a borehole when driven by a hammer with a mass of 63.5 kilograms falling freely a distance of a 0.76 metres. For penetrations of less than 0.3 metres, N-values are indicated as the number of blows for the penetration achieved (e.g. 50/25: 50 blows for 25 centimetre penetration).

Dynamic Cone Penetration Test: Continuous penetration of a conical steel point (51 millimetre o.d. 60° cone angle) driven by 475 J impact energy on a size drill rods. The resistance to cone penetration is measured as the number of blows for each 0.3 metres advance of the conical point into the undisturbed ground.

Soils are described by their composition and consistency or compactness.

CONSISTENCY: Cohesive soils are described on the basis of their undrained shear strength (C_u) or 'N'-values as follows:

C_u (kPa)	0 - 12	12 - 25	25 - 50	50 - 100	100 - 200	>200
	VERY SOFT	*SOFT*	*FIRM*	*STIFF*	*VERY STIFF*	*HARD*
N (blows/0.3 metres)	0 - 2	2 - 4	4 - 8	8 - 15	15 - 30	>30

COMPACTNESS: Cohesionless soils are described on the basis of compactness as indicated by 'N'–values as follows:

N (blows/0.3 metres)	0 - 4	4 - 10	10 - 30	30 - 50	>50
	VERY LOOSE	*LOOSE*	*COMPACT*	*DENSE*	*VERY DENSE*

Rocks are described by their composition and structural features and/or strength.

RECOVERY: Sum of all recovered rock core pieces from a coring run expressed as a percent of the total length of the coring run.

ROCK QUALITY DESIGNATION (RQD): Sum of those intact core pieces, 100 millimetres in length expressed as a percent of the length of the coring run. Classification of a rock based on the RQD value as follows:

RQD (%)	0 - 25	25 - 50	50 - 75	75 - 90	90 - 100
	VERY POOR	*POOR*	*FAIR*	*GOOD*	*EXCELLENT*

JOINTING AND BEDDING:

SPACING	50 millimetres	50 - 300 millimetres	0.3 - 1.0 millimetres	1.0 - 3.0 millimetres	>3.0 millimetres
JOINTING	*VERY CLOSE*	*CLOSE*	*MOD. CLOSE*	*WIDE*	*VERY WIDE*
BEDDING	*VERY THIN*	*THIN*	*MEDIUM*	*THICK*	*VERY THICK*

RECORD OF BOREHOLE No H1

amec

1 OF 1

G.W.P. 466-93-00 LOCATION Station 22+150 O/S 7.0m RT SBL C/L ORIGINATED BY NNK

DIST 52 HWY 11 BOREHOLE TYPE Solid Stem Auger COMPILED BY NNK

DATUM Geodetic DATE 7 March 2002 - 7 March 2002 CHECKED BY AD

PROJECT Sign Structures for HWY 11 Four Laning, from Emsdale to Katrine JOB NO. TT22812

ELEV / DEPTH (m)	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	DEPTH m	ELEVATION SCALE m	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
336.4												
0.0	brown **SAND** compact, damp		1	SS	14		1	336		○		
			2	SS	10		2	335		○		
			3	SS	15		3	334		○		
	Gravelly --- with Gravel		4	SS	18		4	333		○		39 57 (4)
			5	SS	15		5	332		○		
			6	SS	20		6	331		○		
			7	SS	18					○		
329.9			8	SS	24			330		○		29 66 (5)
6.6	**End of Borehole** Groundwater in open bore on completion: none											

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

RECORD OF BOREHOLE No H2

amec

G.W.P. 466-93-00 LOCATION Station 22+150 O/S 6.0m LT SBL C/L ORIGINATED BY NNK

DIST 52 HWY 11 BOREHOLE TYPE Solid Stem Auger COMPILED BY NNK

DATUM Geodetic DATE 7 March 2002 - 7 March 2002 CHECKED BY AD

PROJECT Sign Structures for HWY 11 Four Laning, from Emsdale to Katrine JOB NO. TT22812

ELEV / DEPTH (m)	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	DEPTH (m)	ELEVATION SCALE (m)	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: O UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
337.2												
0.0	0.25m TOPSOIL		1	SS	8			337				
	dark brownSILTY SAND with Gravel, loose , moist		2	SS	50/23		1					SS2: sampler driving gravel.
335.8								336				
1.4	dense		3	SS	30		2					
	brownSAND compact, damp		4	SS	29			335				
			5	SS	26		3					
			6	SS	25		4	334				46 50 (4)
	Gravelly with Gravel		7	SS	23		5	333				
			8	SS	18		6	332				
			9	SS	22		7	331				
329.1							8	330				
8.1	End of Borehole											
	Groundwater in open bore on completion: none											

$+^{3}$, $\times^{3}$: Numbers refer to Sensitivity $O^{3\%}$ STRAIN AT FAILURE

RECORD OF BOREHOLE No J1

amec

1 OF 1

W.P. 466-93-00 LOCATION 22+360 Rt 11.0 NBL C/L ORIGINATED BY PPM

DIST 52 HWY 11 BOREHOLE TYPE Solid Stem Augering COMPILED BY PPM

DATUM Geodetic DATE 4 November 2002 - 4 November 2002 CHECKED BY AD

PROJECT Sign Structures for Highway 11 Four Laning, from Emsdale to Katrine JOB NO. TT22811

ELEV / DEPTH (m)	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	DEPTH m	ELEVATION SCALE m	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: O UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE, 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
334.3												
334.0 / 0.3	125mm ASPHALTIC CONCRETE											
	0.2m SAND and GRAVEL											
0.3	SANDY SILT, frequent sand seams, loose, moist, brown		1	SS	6		1	334				
	trace cobbles		2	SS	8							
332.9							2	333				
1.4	SAND, some silt, fine, compact, damp, brown		3	SS	16							0 81 (19)
			4	SS	16			332				
331.4							3					
2.9	SANDY SILT, frequent sand seams, compact, moist, brown		5	SS	13			331				
330.7							4					
3.6	SILTY SAND, fine, compact, damp, brown		6	SS	14			330				
			7	SS	15		5					Auger refusal at 5.2m on boulder
329.1												March 8, 2002
5.2	SAND, trace silt seams, compact, damp, light brown		8	SS	28			329				Borehole continued on Nov. 4, 2002
	trace gravel, occasional cobbles, very dense		9	SS	50/13		6	328				
	some gravel, dense						7	327				
326.2			10	SS	42		8					
8.1	End of Borehole											
	Groundwater in open bore on completion: none											
	Cave on completion: 7.3m											

+3, ×3, Numbers refer to Sensitivity O3% STRAIN AT FAILURE

RECORD OF BOREHOLE No K1

amec

G.W.P. 466-93-00 LOCATION Station 23+650 O/S 11.0m LT SBL C/L ORIGINATED BY JF/IH

DIST 52 HWY 11 BOREHOLE TYPE Solid Stem Auger COMPILED BY NNK

DATUM Geodetic DATE 6 March 2002 - 6 March 2002 CHECKED BY AD

PROJECT Sign Structures for HWY 11 Four Laning, from Emsdale to Katrine JOB NO. TT22812

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	DEPTH	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT	PLASTIC LIMIT / NATURAL MOISTURE CONTENT / LIQUID LIMIT	UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH (m)	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES				SHEAR STRENGTH kPa: O UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE	WATER CONTENT (%)		
342.7							m	m	20 40 60 80 100 / 20 40 60 80 100	w_P w w_L / 10 20 30	γ kN/m³	GR SA SI CL
0.0	Auger Refusal on Rockfill Slope							342				

$+^{3}, \times^{3}$: Numbers refer to Sensitivity $O^{3\%}$ STRAIN AT FAILURE

RECORD OF BOREHOLE No K2

amec

G.W.P. 466-93-00 LOCATION Station 23+650 O/S 19.0m LT SBL C/L ORIGINATED BY JF/IH

DIST 52 HWY 11 BOREHOLE TYPE Solid Stem Auger COMPILED BY NNK

DATUM Geodetic DATE 6 March 2002 - 6 March 2002 CHECKED BY AD

PROJECT Sign Structures for HWY 11 Four Laning, from Emsdale to Katrine JOB NO. TT22812

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	DEPTH	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT	PLASTIC LIMIT / NATURAL MOISTURE CONTENT / LIQUID LIMIT	UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH (m)	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES				SHEAR STRENGTH kPa: O UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE	WATER CONTENT (%)		
339.7							m	m	20 40 60 80 100	w_P w w_L 10 20 30	kN/m³	GR SA SI CL
0.0	**0.2m TOPSOIL**											
339.0	brown, SILTY SAND trace Gravel, Rootlets loose, moist		1	SS	5			339				
0.8	brownSILT with SAND											
338.5	loose, moist		2	SS	6		1					
1.2	brown SANDY SILT compact to v.dense, damp		3	SS	24			338				
			4	SS	50		2					0 37 (63)
336.8			5	SS	87			337				
2.9	**End of Borehole**											
	Groundwater in open bore on completion: none											

+3, ×3: Numbers refer to Sensitivity O3% STRAIN AT FAILURE

RECORD OF BOREHOLE No L1

amec

1 OF 1

G.W.P. 466-93-00 LOCATION Station 23+850 O/S 7.3m RT SBL C/L ORIGINATED BY NNK

DIST 52 HWY 11 BOREHOLE TYPE Solid Stem Auger and Rock Coring COMPILED BY NNK

DATUM Geodetic DATE 7 March 2002 - 7 March 2002 CHECKED BY AD

PROJECT Sign Structures for HWY 11 Four Laning, from Emsdale to Katrine JOB NO. TT22812

ELEV / DEPTH (m)	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	DEPTH m	ELEVATION SCALE m	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: o UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
344.8 0.0	brown Gravelly Sand FILL trace Asphalt fragments, compact to dense, damp to moist		1	SS	20					o		
			2	SS	18		1	344		o		39 52 (9)
343.2 1.7			3	SS	36					o		
	GNEISS BEDROCK fresh to slightly weathered, moderately closely jointed, slightly to moderately weathered joints		4	RC	-		2	343				RC4: REC = 95% RQD = 71% RC4 at 2.0m depth, comp. strength of 84 MPa
			5	RC	-		3	342				RC5: REC = 92% RQD = 78%
340.2 4.6			6	RC	-		4	341				RC6: REC = 92% RQD = 82%
	End of Borehole Groundwater in open bore on completion: none											

$+^{3}$ $\times^{3}$: Numbers refer to Sensitivity O 3% STRAIN AT FAILURE

RECORD OF BOREHOLE No L2

amec

1 OF 1

G.W.P. 466-93-00 LOCATION Station 23+850 O/S 9.7m LT SBL C/L ORIGINATED BY NNK

DIST 52 HWY 11 BOREHOLE TYPE Solid Stem Auger and Rock Coring COMPILED BY NNK

DATUM Geodetic DATE 6 March 2002 - 6 March 2002 CHECKED BY AD

PROJECT Sign Structures for HWY 11 Four Laning, from Emsdale to Katrine JOB NO. TT22812

ELEV / DEPTH (m)	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	DEPTH m	ELEVATION SCALE m	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: O UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE, 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L; WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
345.4 / 0.0	brown Sand **FILL** with Gravel, loose, moist		1	SS	6			345				
			2	SS	6		1					
344.3 / 1.1	brown **SAND**, trace Gravel, occasional Silt layers, compact to dense, moist		3	SS	14			344				
			4	SS	18		2					0 93 (7)
			5	SS	38			343				
	with Cobbles and Boulders						3					
340.5 / 5.0	**GNEISS BEDROCK** occasional Sand filled joints, fresh to slightly weathered, closely to moderately jointed,		6	RC	-		4	342				Auger refusal. advance borehole by Rock Coring and Tricone
			7	RC	-			341				**RC7:** (Rock coring using NX core barrel) REC = 67% RQD = 21%
			8	RC	-		5					**RC8:** (Rock coring using BX core barrel) REC = 83% RQD = 0%
339.1 / 6.3	**End of Borehole**		9	RC	-		6	340				**RC9:** (Rock coring using BX core barrel) REC = 50% RQD = 17% RC7 at 5.1m depth, comp. strength of 56 MPa
	Groundwater in open bore on completion: none											

$+^3, \times^3$: Numbers refer to Sensitivity $O^{3\%}$ STRAIN AT FAILURE

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TABLE

TABLE 1
GEOTECHNICAL DESIGN PARAMETERS

APPROXIMATE STATION/OFFSET	REFERENCE BOREHOLES	STRATA	ELEVATION (m)	DEPTH BELOW EXISTING ORIGINAL GROUND SURFACE (m)	DESIGN PARAMETERS				
					n_h (kN/m³)	ϕ (degrees)	γ (kN/m³)	K_p	DEPTH BELOW EXISTING G.S. TO WATER LEVEL (m)
OVERHEAD TRANSITION SIGN 22+150 / 7.0m RT SBL C/L	H1	compact SAND	335.4 - 329.8	1.0 - 6.6	5	32	20	3.3	>6.6
22+150 / 6.0 m LT SBL C/L	H2	loose SILTY SAND dense SAND compact SAND	336.2 - 335.8 335.7 - 335.1 335.0 - 329.1	1.0 - 1.4 1.5 - 2.1 2.2 - 8.1	1 5 3	29 35 34	19 21 20	2.9 3.7 3.5	
GROUND-MOUNTED SIGN 22+360 / 11.0 m RT NBL C/L	J1	compact SANDY SILT to SILTY SAND very dense SILTY SAND	332.3 - 328.2 328.1 - 326.2	2.0 - 6.1 6.2 - 8.1	5 9	30 35	20 21	3.0 3.7	>8.1
22+360 / 18.0m RT NBL C/L	J2	compacted fill (cohesionless) (see Note 1)	332 - 329	2.0 - 5.0	4	30	20	3.0	
GROUND-MOUNTED SIGN 23+650 / 11.0 m LT SBL C/L	K1	embankment ROCKFILL (see Note 2)	342.7 - 339.7	0 - 3	9	45	20	5.8	>3
23+650 / 19.0m LT SBL C/L	K2	loose SILTY SAND TO SANDY SILT compact to very dense SILTY SAND	338.7 - 338.5 338.4 - 336.8	0.2 - 1.2 1.3 - 2.9	1 5	28 35	19 21	2.8 3.7	
OVERHEAD TRANSITION SIGN 23+850 / 7.3m RT SBL C/L	L1	embankment fill BEDROCK	343.8 - 343.2 343.1 - 340.2	1.0 - 1.6 1.7 - 4.6	1 -	30 -	20 -	3.0 -	>6
23+850 / 6/0 m LT SBL C/L	L2	compact SAND dense SAND BEDROCK	343.4 - 342.4 342.3 - 340.5 340.4 - 339.1	1.0 - 3.0 3.1 - 4.9 5.0 - 6.3	3 5 -	34 35 -	20 21 -	3.5 3.7 -	

TABLE 1
GEOTECHNICAL DESIGN PARAMETERS

NOTES

1. Borehole J2 was not drilled due to the presence of underground tanks and utilities. Design parameters are quoted only for cohesionless fill.

2. Refusal to auger advance by rockfill embankment.

3. The design compressive rock strength at L1should be 50 MPa, while at L2 25 MPa should be used. The compressive rock strength at Borehole L2 has been reduced from that measured in the laboratory to account for the poor quality of the rock.