GEOCRES #31E-163

FOUNDATION INVESTIGATION REPORT
FOR PROPOSED CULVERT
AT STATION 19+984 MEDIAN CENTRELINE
STRUCTURE SITE NO.44-304
DISTRICT 52, HUNTSVILLE
W.P. 466-93-00

Submitted To:

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

Submitted By:

AGRA
104 Crockford Blvd.
Scarborough, Ontario, M1R 3C6
Canada

February 2000
TT98820

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February 18, 2000
Ref. No.: TT98820

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

Attention: **Mr. Khaled El-Dalati, P. Eng.**
Manager, Transportation and Design

Dear Sir:

Re: **FOUNDATION INVESTIGATION REPORT**
FOR
PROPOSED CULVERT AT STATION 19+984 MEDIAN CENTRELINE
STRUCTURE SITE NO.44-304
DISTRICT 52, HUNTSVILLE
W.P. 466-93-00

We take pleasure in enclosing eight (8) copies of our Foundation Investigation Report carried out for the above mentioned project and we will be glad to discuss any questions arising from this work.

Soil samples will be retained for a period of one year, and will thereafter be disposed of unless we are otherwise instructed.

We thank you for giving us this opportunity to be of service to you.

Sincerely,

George S.W. Chow, P. Eng.,
Senior Vice President

GSC

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1.0 INTRODUCTION

AGRA, Consulting Geotechnical Engineers, has been retained by Delcan Corporation (Delcan) to conduct a foundation investigation at the site of a proposed rigid frame concrete culvert to be used to realign the water flow of the existing P-3 Tributary. The culvert of 130 m in length will cross the proposed Highway 11 median centreline at about Station 19+984. The proposed works are part of the Highway 11 Four Laning Project, from Emsdale to Burk's Falls, W.P. 466-93-00, District 52, Huntsville, Ontario.

The purpose of this investigation is to obtain more detailed information about the subsurface conditions at the site of the proposed culvert by means of exploratory boreholes. Based on our interpretation of the data obtained from this and previous geotechnical investigations carried out in the vicinity, recommendations for the foundation design of the proposed culvert are provided. Comments are also provided on anticipated construction issues where they may affect the design of the proposed works, from a geotechnical point of view.

At the time of this investigation, the proposed, revised horizontal alignment of the culvert and the existing ground surface profile along the P-3 Tributary were provided to us on plan and profile by Delcan via facsimile transmission on August 10, 1999. The terms of reference for our scope of work are as outlined in our proposal letter, dated August 18, 1999.

2.0 SITE DESCRIPTION AND PHYSIOGRAPHY

The site is located about 900 m south of Star Lake Road at the existing P-3 Tributary crossing of the proposed Highway 11. The existing ground surface elevation at the proposed culvert location slopes gently in a easterly direction along the tributary, from about Elevations 324 m to 323 m. The surrounding area is generally moderately wooded with trees and brushes. The water in the creek is up to about 1 m deep. The proposed grade of Highway 11 above the culvert is at about Elevation 341 m for both the NBL and SBL.

Based on available geologic information, the site is in an area of ice-contact sediments. Generally after the last glacial withdrawal, ice-contact sediments (sands and gravels) followed by glaciofluvial sediments (ranging from deltaic and nearshore sands and gravels to prodeltaic and lake bottom silts and clays) were deposited on top of the existing sandy glacial till or Precambrian bedrock. The area was then inundated by glacial Lake Algonquin, depositing sands, silts and clays in low lying areas. The bedrock generally consists of strongly foliated gneissic to migmatic rocks of the Central Gneiss Belt, which is part of the Grenville Province (a structural subdivision of the Canadian Shield).

3.0 INVESTIGATION PROCEDURES

The field work for the investigation was carried out during the period of August 19, 20, 23 and 24, 1999, and consisted of drilling and sampling five boreholes (Borehole Nos. 1001 to 1005, inclusive) to depths of 6.0 to 15.3 m below the existing ground surface.

The plan locations of the boreholes along with a stratigraphic section parallel to the culvert alignment are shown on Drawing No. 1. Details of subsurface conditions encountered at each borehole location, including the results of in-situ testing, are presented on the Record of Borehole sheets.

The boreholes were advanced, using a combination of hollow stem continuous flight augers, casings, wash boring and coring equipment, with a track-mounted power auger drill rig (BOA 6M2) owned and operated by Groundworks Drilling Inc., under the full-time supervision of experienced geotechnical personnel from AGRA.

Sampling in the boreholes were carried out at regular intervals of depth by the Standard Penetration Test Method (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 51 mm diameter outside diameter split barrel (split-spoon) sampler into the ground. The number of blows of the hammer 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, and this gives an indication of the consistency or the compactness condition of the soil deposit.

In order to advance the boreholes through cobbles and boulders and to prove bedrock, rotary core drilling was carried out in Boreholes 1001 and 1005 utilizing NW size casings and cores were retrieved using an NXL size core barrel.

The borehole locations were established in the field by our engineering staff, in relation to the proposed centreline of Highway 11 already staked out by Dearden and Stanton Limited (retained by Delcan). Due to restrictions by the topography and the vegetation, all five boreholes were positioned along the south bank of the tributary. The borehole co-ordinates and elevations were later taken by Dearsen and Stanton Limited.

The soil samples were transported to our geotechnical laboratory in Toronto (Scarborough) for further examination and classification. A laboratory testing programme, consisting of natural moisture content determinations and grain size analyses, was performed on selected representative soil samples. The results of the laboratory tests are presented on the appropriate Record of Borehole Sheets and also on Figure Nos. 1 and 2, inclusive.

The boreholes were left open until the end of each work day to enable us to take additional water level readings. The boreholes were adequately grouted on completion.

4.0 SUBSURFACE CONDITIONS

The subsurface conditions were explored at five boreholes (Borehole Nos. 1001 to 1005) during the current investigation. Boreholes SB5 and G1 from previous investigations were utilized. The plan locations of the boreholes along with the stratigraphic section along the culvert alignment are shown on Drawing No. 1. Details of subsurface conditions encountered at each borehole location, including the results of in-situ testing, groundwater observations and laboratory test results are presented on the Record of Borehole sheets. The subsurface conditions are summarized in the following.

In general, the subsurface stratigraphy comprises surficial peat and/or topsoil overlying loose to compact sand, which is in turn underlain by dense to very dense sand and gravel to gravelly sand with frequent cobbles and boulders. The depth to the sand and gravel remains relatively constant from the west culvert limit to about the east crest of the SBL, but increases towards the east. The groundwater level is within 1 m depth of the existing ground surface.

4.1 Peat and Topsoil

Peat of 0.8 m to 1.0 m in thickness was encountered at ground surface in Boreholes 1001 and G1.

Topsoil was encountered in Boreholes 1002 to 1005 and SB5, ranging in thickness from 0.15 m to 0.4 m.

4.2 Sand

Below the surficial topsoil or peat, a cohesionless sand deposit with trace to some gravel was encountered to depths of about 9.8 m to 12.8 m in Boreholes 1001, 1002 and G1, and to depths of 4.9 m to 7.0 m in Boreholes 1003 to 1005, and SB5. Occasional sand and gravel to gravelly sand interlayers were present within this deposit.

One grain size analysis was conducted on a sample of each of the sand, sand and gravel and gravelly sand. The grain size curves are presented on Figures 1 and 2. For the sand, the results indicate 0% gravel, 95% sand, 5% silt and 0% clay size particles.

Most measured 'N'-values within the sand in Boreholes 1001, 1002, 1005 and SB5 range from 10 to 21 blows per 0.3 m, indicating a typically compact condition; occasional loose zones are present with 'N' values less than 10 blows per 0.3 m. The sand is loose to very loose throughout Borehole 1003. In Borehole 1005, a high 'N'-value of 80 was measured at 1 m depth and may be attributed to probable cobbles. Measured moisture contents range from about 12 to 28%.

For the sand and gravel to gravelly sand interlayers, the results indicate 28 to 41% gravel, 52 to 64% sand, 7 to 8% silt and 0% clay. It is noted that the cobbles and boulders could not be sampled with the spoon sampler.

4.3 Sand and Gravel to Gravelly Sand

A layer of sand and gravel to gravelly sand underlies the upper sand in Boreholes 1001, 1002 and 1005. Frequent cobbles and/or boulders were inferred or encountered within this layer. This layer extends to the full depth of Boreholes 1001, 1002 and is about 3.3 m thick in 1005. Auger refusal was encountered below the upper sand in Boreholes 1003, 1004, G1 and SB5 at levels which may be inferred as the upper surface of the cobbles and/or boulders. Measured 'N'-values range from 21 to greater than 50 blows per 0.3 m, indicating a compact to very dense, but typically dense to very dense condition. Measured moisture contents range from 12 to 17%.

One grain size distribution analysis was conducted on a sample from this cohesionless deposit, and the resulting grain size curve is presented in Figure 2. The analysis indicates 24% gravel, 48% sand, and 28% silt and clay size particles.

4.4 Bedrock

Bedrock was encountered and cored in Borehole 1005 from 8.2 to 11.0 m depths below existing ground surface. The recovered core samples show that the Precambrian bedrock consists of a massive, moderately closely to closely jointed gneiss with occasional micaceous layer. The percentage of core recovery varies from 78 to 100%. The Rock Quality Designation (R.Q.D.) values increase with depth from 42 to 76%. Based on these values and visual examination of the cores, the rock is considered to be of poor to good quality.

4.5 Groundwater Conditions

Groundwater conditions were observed in the open boreholes during the drilling and at the completion of each borehole. Observed groundwater levels in the open boreholes are within 1 m of the existing ground surface. It should, however, be pointed out that the groundwater at the site would fluctuate seasonally and in response to severe weather events.

5.0 CLOSURE

Sincerely,

Sydney Pang, Ph.D., P. Eng.

Andrew Drevininkas, P. Eng.

Eric Chung, M. Eng., P. Eng.
Designated MTO Contact.

.../...
M:reports\1999\culvert.wpd

APPENDIX A

EXPLANATION OF TERMS USED IN REPORT

N VALUE: THE STANDARD PENETRATION TEST (SPT) N VALUE IS THE NUMBER OF BLOWS REQUIRED TO CAUSE A STANDARD 51mm O.D SPLIT BARREL SAMPLER TO PENETRATE 0.3m INTO UNDISTURBED GROUND IN A BOREHOLE WHEN DRIVEN BY A HAMMER WITH A MASS OF 63.5kg, FALLING FREELY A DISTANCE OF 0.76m FOR PENETRATIONS OF LESS THAN 0.3m N VALUES ARE INDICATED AS THE NUMBER OF BLOWS FOR THE PENETRATION ACHIEVED. AVERAGE N VALUE IS DENOTED THUS $\bar{N}$.

DYNAMIC CONE PENETRATION TEST: CONTINUOUS PENETRATION OF A CONICAL STEEL POINT (51mm 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 0.3m ADVANCE OF THE CONICAL POINT INTO THE UNDISTURBED GROUND

SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSENESS.

CONSISTENCY: COHESIVE SOILS ARE DESCRIBED ON THE BASIS OF THEIR UNDRAINED SHEAR STRENGTH (c_u) AS FOLLOWS:

c_u (kPa)	0 - 12	12 - 25	25 - 50	50 - 100	100 - 200	>200
	VERY SOFT	*SOFT*	*FIRM*	*STIFF*	*VERY STIFF*	*HARD*

DENSENESS: COHESIONLESS SOILS ARE DESCRIBED ON THE BASIS OF DENSENESS AS INDICATED BY SPT N VALUES AS FOLLOWS:

N (BLOWS/0.3m)	0 - 5	5 - 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.

MODIFIED RECOVERY: SUM OF THOSE INTACT CORE PIECES, 100mm+ IN LENGTH EXPRESSED AS A PERCENT OF THE LENGTH OF THE CORING RUN. THE ROCK QUALITY DESIGNATION (RQD), FOR MODIFIED RECOVERY, IS:

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

JOINTING AND BEDDING:

SPACING	50mm	50 - 300mm	0.3m - 1m	1m - 3m	>3m
JOINTING	*VERY CLOSE*	*CLOSE*	*MOD. CLOSE*	*WIDE*	*VERY WIDE*
BEDDING	*VERY THIN*	*THIN*	*MEDIUM*	*THICK*	*VERY THICK*

ABBREVIATIONS AND SYMBOLS

FIELD SAMPLING

S S	SPLIT SPOON	T P	THINWALL PISTON
W S	WASH SAMPLE	O S	OSTERBERG SAMPLE
S T	SLOTTED TUBE SAMPLE	R C	ROCK CORE
B S	BLOCK SAMPLE	P H	T W ADVANCED HYDRAULICALLY
C S	CHUNK SAMPLE	P M	T W ADVANCED MANUALLY
T W	THINWALL OPEN	F S	FOIL SAMPLE

STRESS AND STRAIN

u_w	kPa	PORE WATER PRESSURE
r_u	1	PORE PRESSURE RATIO
σ	kPa	TOTAL NORMAL STRESS
σ'	kPa	EFFECTIVE NORMAL STRESS
τ	kPa	SHEAR STRESS
$\sigma_1, \sigma_2, \sigma_3$	kPa	PRINCIPAL STRESSES
ϵ	%	LINEAR STRAIN
$\epsilon_1, \epsilon_2, \epsilon_3$	%	PRINCIPAL STRAINS
E	kPa	MODULUS OF LINEAR DEFORMATION
G	kPa	MODULUS OF SHEAR DEFORMATION
μ	1	COEFFICIENT OF FRICTION

MECHANICAL PROPERTIES OF SOIL

m_v	kPa^{-1}	COEFFICIENT OF VOLUME CHANGE
C_c	1	COMPRESSION INDEX
C_s	1	SWELLING INDEX
C_α	1	RATE OF SECONDARY CONSOLIDATION
c_v	m^2/s	COEFFICIENT OF CONSOLIDATION
H	m	DRAINAGE PATH
T_v	1	TIME FACTOR
U	%	DEGREE OF CONSOLIDATION
σ'_{vo}	kPa	EFFECTIVE OVERBURDEN PRESSURE
σ'_p	kPa	PRECONSOLIDATION PRESSURE
τ_f	kPa	SHEAR STRENGTH
c'	kPa	EFFECTIVE COHESION INTERCEPT
ϕ'	-°	EFFECTIVE ANGLE OF INTERNAL FRICTION
c_u	kPa	APPARENT COHESION INTERCEPT
ϕ_u	-°	APPARENT ANGLE OF INTERNAL FRICTION
τ_R	kPa	RESIDUAL SHEAR STRENGTH
τ_r	kPa	REMOULDED SHEAR STRENGTH
S_t	1	SENSITIVITY = $\frac{c_u}{\tau_r}$

PHYSICAL PROPERTIES OF SOIL

ρ_s	kg/m^3	DENSITY OF SOLID PARTICLES
γ_s	kN/m^3	UNIT WEIGHT OF SOLID PARTICLES
ρ_w	kg/m^3	DENSITY OF WATER
γ_w	kN/m^3	UNIT WEIGHT OF WATER
ρ	kg/m^3	DENSITY OF SOIL
γ	kN/m^3	UNIT WEIGHT OF SOIL
ρ_d	kg/m^3	DENSITY OF DRY SOIL
γ_d	kN/m^3	UNIT WEIGHT OF DRY SOIL
ρ_{sat}	kg/m^3	DENSITY OF SATURATED SOIL
γ_{sat}	kN/m^3	UNIT WEIGHT OF SATURATED SOIL
ρ'	kg/m^3	DENSITY OF SUBMERGED SOIL
γ'	kN/m^3	UNIT WEIGHT OF SUBMERGED SOIL

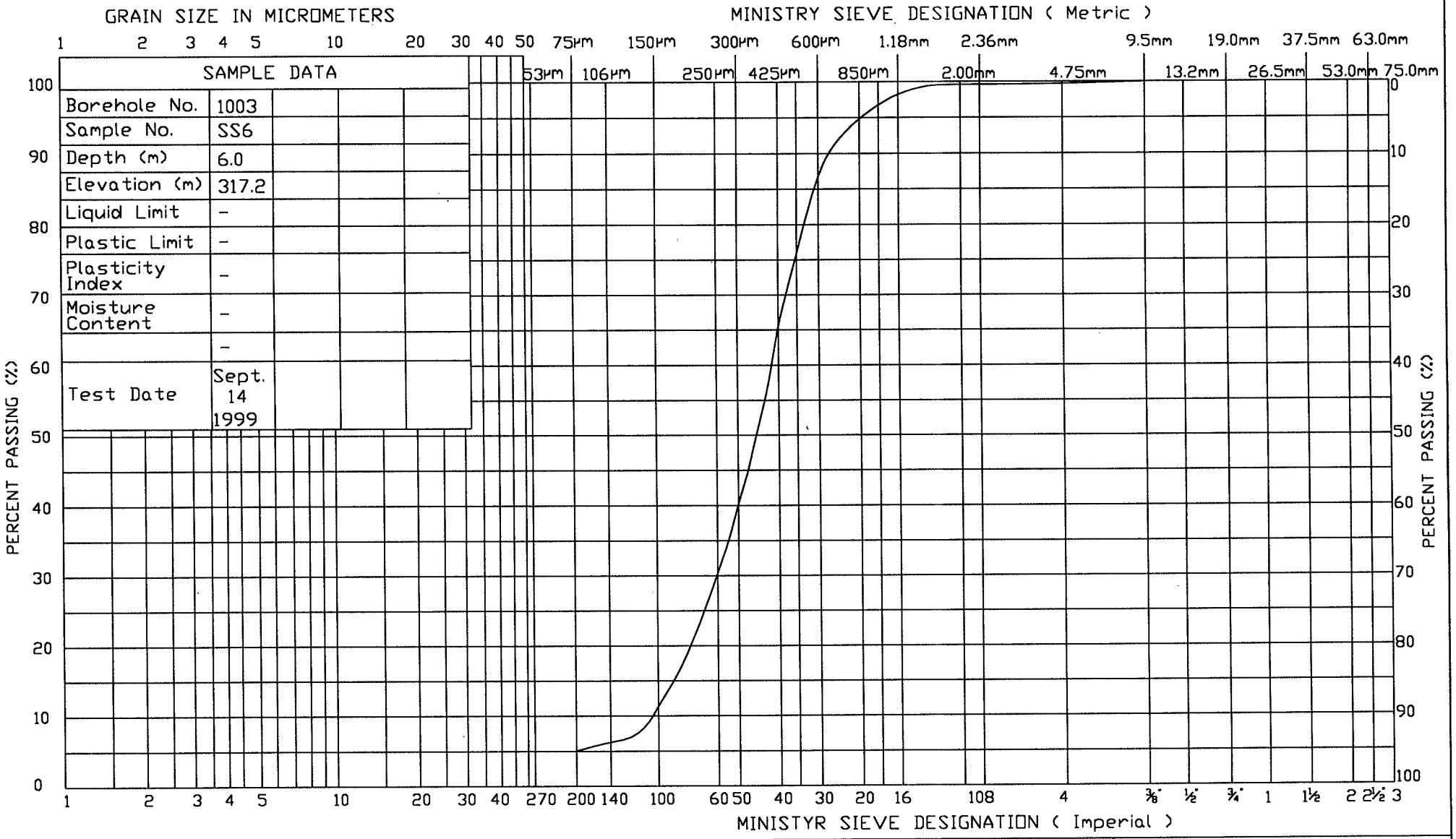
e	1,%	VOID RATIO
n	1,%	POROSITY
w	1,%	WATER CONTENT
S_r	%	DEGREE OF SATURATION
w_L	%	LIQUID LIMIT
w_P	%	PLASTIC LIMIT
w_S	%	SHRINKAGE LIMIT
I_P	%	PLASTICITY INDEX = $w_L - w_P$
I_L	1	LIQUIDITY INDEX = $\frac{w - w_P}{I_P}$
I_C	1	CONSISTENCY INDEX = $\frac{w_L - w}{I_P}$
e_{max}	1,%	VOID RATIO IN LOOSEST STATE

e_{min}	1,%	VOID RATIO IN DENSEST STATE
I_D	1	DENSITY INDEX = $\frac{e_{max} - e}{e_{max} - e_{min}}$
D	mm	GRAIN DIAMETER
D_n	mm	n PERCENT - DIAMETER
C_U	1	UNIFORMITY COEFFICIENT
h	m	HYDRAULIC HEAD OR POTENTIAL
q	m^3/s	RATE OF DISCHARGE
v	m/s	DISCHARGE VELOCITY
i	1	HYDRAULIC GRADIENT
k	m/s	HYDRAULIC CONDUCTIVITY
j	kN/m^3	SEEPAGE FORCE

FIGURES

UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY & SILT	SAND			GRAVEL	
	Fine	Medium	Coarse	Fine	Coarse



SAMPLE DATA	
Borehole No.	1003
Sample No.	SS6
Depth (m)	6.0
Elevation (m)	317.2
Liquid Limit	-
Plastic Limit	-
Plasticity Index	-
Moisture Content	-
	-
Test Date	Sept. 14 1999

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GRAIN SIZE DISTRIBUTION

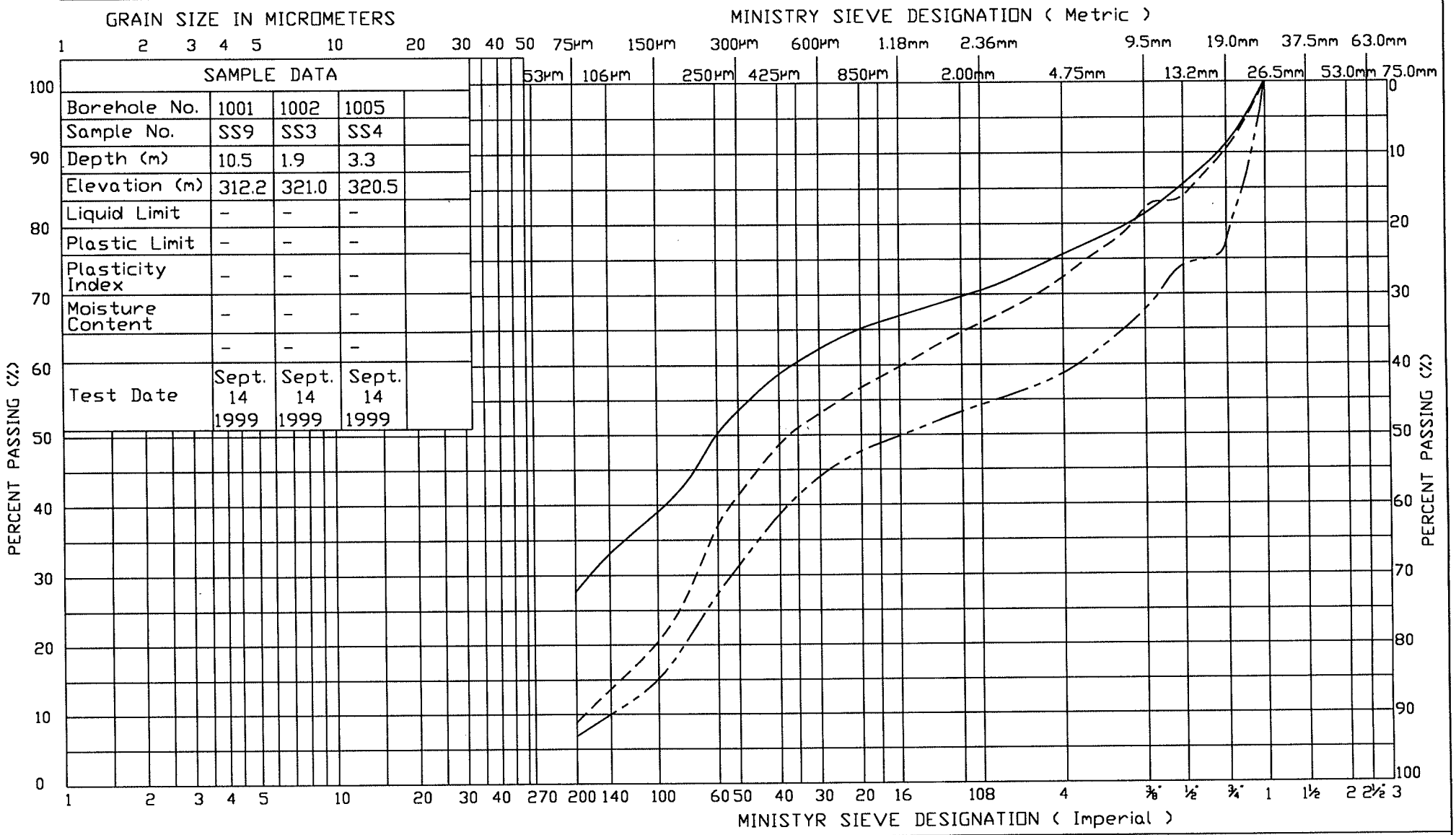
SAND

1003: SS6

CLIENT:	DELCAN
JOB NO.:	TT98820 W P 466-93-00
PROJECT:	HWY 11, EMSDALE
LOCATION:	CULVERT @ STATION 19+984
DATE:	SEPTEMBER 15, 1999 FIGURE: 1

UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY & SILT	SAND			GRAVEL	
	Fine	Medium	Coarse	Fine	Coarse



SAMPLE DATA			
Borehole No.	1001	1002	1005
Sample No.	SS9	SS3	SS4
Depth (m)	10.5	1.9	3.3
Elevation (m)	312.2	321.0	320.5
Liquid Limit	-	-	-
Plastic Limit	-	-	-
Plasticity Index	-	-	-
Moisture Content	-	-	-
	-	-	-
Test Date	Sept. 14 1999	Sept. 14 1999	Sept. 14 1999

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GRAIN SIZE DISTRIBUTION

SAND and GRAVEL
to
GRAVELLY SAND

1001: SS9
1002: SS3
1005 SS4

CLIENT:	DELCAN
JOB NO.:	TT98820 | W P 466-93-00
PROJECT:	HWY 11, EMSDALE
LOCATION:	CULVERT @ STATION 19+984
DATE:	SEPTEMBER 15, 1999 | FIGURE: 2

ENCLOSURES

RECORD OF BOREHOLE No 1001

1 OF 2

METRIC

W.P. 466-93-00 LOCATION Site No.44-304 N 5042393.3 E319147.3 ORIGINATED BY MA

DIST 52 HWY 11 BOREHOLE TYPE Hollow Stem Augering / Wash Boring / Casing COMPILED BY AD

DATUM Geodetic DATE 20 August 1999 CHECKED BY SP/EYC

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	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
323.4											
0.0	**PEAT**		1	SS	1	▼	323		○		Station 19+945 59m Rt Med C/L
322.6											
0.8	light brown **SAND** some Gravel, some Silt occasional Cobbles, some oxidized stains compact wet		2	SS	15		322				
			3	SS	11		321		○		
	loose		4	SS	7		320				
			5	SS	13		319				
	grey brown		6	SS	22		318		○		
	trace Gravel loose		7	SS	9		317				
			8	SS	11		316				Started using NW casing @ 9m depth.
313.6							315		○		
9.8	grey **SAND and GRAVEL to GRAVELLY SAND** trace to some Silt frequent Cobbles and Boulders dense to very dense wet		9	SS	41		314				24 48 (28)
			10	SS	70		313				Coring commenced @ 11.5m depth
			11	SS	70/18		312				
							311				
							310				
							309				

Continued Next Page

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

$\circ^{3\%}$ STRAIN AT FAILURE

RECORD OF BOREHOLE No 1001

2 OF 2

METRIC

W.P. 466-93-00 LOCATION Site No.44-304 N 5042393.3 E319147.3 ORIGINATED BY MA

DIST 52 HWY 11 BOREHOLE TYPE Hollow Stem Augering / Wash Boring / Casing COMPILED BY AD

DATUM Geodetic DATE 20 August 1999 CHECKED BY SP/EYC

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	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 (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
308.2											
15.3	END OF BOREHOLE WL in open borehole on completion: 0.8m						308				

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

AGRA

Foundation Design

Enclosure # 3

RECORD OF BOREHOLE No 1002

1 OF 1

METRIC

W.P. 466-93-00 LOCATION Site No.44-304 N 5042382.2 E319131.9 ORIGINATED BY MA

DIST 52 HWY 11 BOREHOLE TYPE Hollow Stem Augering COMPILED BY AD

DATUM Geodetic DATE 19 August 1999 CHECKED BY SP/EYC

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE
323.3							
0.0	0.15m **TOPSOIL**		1	SS	1		323
	Sand and Gravel		2	SS	20	▼	322
			3	SS	14		
	light brown **SAND** trace to some Gravel, some Silt compact wet		4	SS	10		321
			5	SS	16		320
	grey brown Gravelly Sand		6	SS	11		319
			7	SS	16		318
	fine Sand		8	SS	5		317
312.8							316
10.5	grey **SAND and GRAVEL to GRAVELLY SAND** trace to some Silt frequent Cobbles and Boulders very dense wet		9	SS	66		315
311.4							314
11.9	END OF BOREHOLE						313
311.0	REFUSAL TO AUGER ADVANCE						312
12.3	END OF DCPT REFUSAL TO CONE ADVANCE						311
	WL in open borehole on completion: 0.8m						310

DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100

SHEAR STRENGTH kPa 20 40 60 80 100

○ UNCONFINED + FIELD VANE

● QUICK TRIAXIAL × LAB VANE

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

Station 19+948
40m Rt Med C/L

41 52 7 0

+3, ×3: Numbers refer to Sensitivity

○3%: STRAIN AT FAILURE

RECORD OF BOREHOLE No 1003

1 OF 1 **METRIC**

W.P. 466-93-00 LOCATION Site No.44-304 N 5042372.9 E319083.1 ORIGINATED BY MA

DIST 52 HWY 11 BOREHOLE TYPE Hollow Stem Augering COMPILED BY AD

DATUM Geodetic DATE 19 August 1999 CHECKED BY SP/EYC

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 × 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 (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
324.0											
0.0	0.2m **TOPSOIL**		1	SS	4						Station 19+975 2m Lt Med C/L
			2	SS	3	▼	323				
	brown **SAND** trace Silt, trace Gravel very loose to loose wet		3	SS	6		322				
			4	SS	8		321				
			5	SS	9		320				
			6	SS	7		319				
							318				0 95 5 0
317.0							317				
7.0	END OF BOREHOLE REFUSAL TO AUGER ADVANCE DCPT attempts at between 6.1m and 6.7m WL in open borehole on completion: 0.9m										

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

RECORD OF BOREHOLE No 1004

1 OF 1

METRIC

W.P. 466-93-00 LOCATION Site No.44-304 N 5042362.5 E319049.7 ORIGINATED BY MA

DIST 52 HWY 11 BOREHOLE TYPE Hollow Stem Augering COMPILED BY AD

DATUM Geodetic DATE 24 August 1999 CHECKED BY SP/EYC

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
324.4								20 40 60 80 100	10 20 30		
0.0	0.15m **TOPSOIL**										Station 19+990 33m Lt Med C/L
	brown **SAND** some Gravel trace Silt occasional Cobbles wet		1	AS			324				
			2	AS			323				
							322				
							321				
							320				
			3	AS			319				
318.4											
6.0	END OF BOREHOLE REFUSAL TO AUGER ADVANCE										

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

AGRA

Foundation Design

Enclosure # 6

RECORD OF BOREHOLE No 1005

1 OF 1

METRIC

W.P. 466-93-00 LOCATION Site No.44-304 N 5042361.5 E319020.3 ORIGINATED BY MA

DIST 52 HWY 11 BOREHOLE TYPE Hollow Stem Augering / Wash Boring / Casing COMPILED BY AD

DATUM Geodetic DATE 23 August 1999 CHECKED BY SP/EYC

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	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
324.5											
0.0	0.15m **TOPSOIL** dark brown **SAND**, trace Silt and organics		1	SS	4	▼	324				Station 20+010 55m Lt Med C/L
323.8											
0.7	brown **SAND** some Gravel trace Silt compact to dense wet		2	SS	80				○		Probable cobble
			3	SS	22		323				
							322				
			4	SS	31						28 64 8 0
							321				
	---------- grey										
319.7			5	SS	18		320		○		Auger refusal @ 5m depth, started using NW casing @ 5m depth.
4.9	grey **SAND and GRAVEL** **to GRAVELLY SAND** trace Silt frequent Cobbles and Boulders						319		○		
			6	SS	21						
							318				
			7	SS	32						
316.3							317				Coring commenced @ 7.9m depth
8.2	**GNEISS BEDROCK** massive, moderately closely to closely jointed. occasional micaceous layer		8	RC							RC 8 REC=83% RQD=42%
			9	RC			316				RC 9 REC=100% RQD=57%
			10	RC							
							315				RC 10 REC=78% RQD=72%
			11	RC							RC 11 REC=100% RQD=76%
313.5							314				
11.0	END OF BOREHOLE WL on completion: Not stabilized due to water used for coring, but likely at about 0.8m depth										

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

RECORD OF BOREHOLE No G1

1 OF 1

METRIC

W.P. 466-93-00 LOCATION Station 19+950 30m Rt Med C/L ORIGINATED BY MA

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

DATUM Geodetic DATE 20 January 1999 CHECKED BY SP/EYC

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 × 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 (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
323.2											
0.0	**PEAT**						323				
322.1							322				
1.1	some Gravel			AS			321				
	grey **SAND** trace Gravel wet						320				
							319				
							318				
							317				
							316				
	occasional cobbles						315				
							314				
							313				
							312				
							311				
310.4											
12.8	END OF BOREHOLE REFUSAL TO AUGER ADVANCE										

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

RECORD OF BOREHOLE No SB5

1 OF 1

METRIC

W.P. 466-93-00 LOCATION Station 20+000 19m Lt Med C/L ORIGINATED BY MA

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

DATUM Geodetic DATE 20 January 1999 CHECKED BY SP/EYC

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (O UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
323.5											
0.0	**0.4m TOPSOIL**		1	SS	5		323				
			2	SS	14		322				
	SAND trace Gravel compact wet		3	SS	13		321 320				Flowing sand encountered @1.5m-6.0m Back-up in open hole
			4	SS	10		319 318				
317.5											
6.0	END OF BOREHOLE REFUSAL TO AUGER ADVANCE										

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100

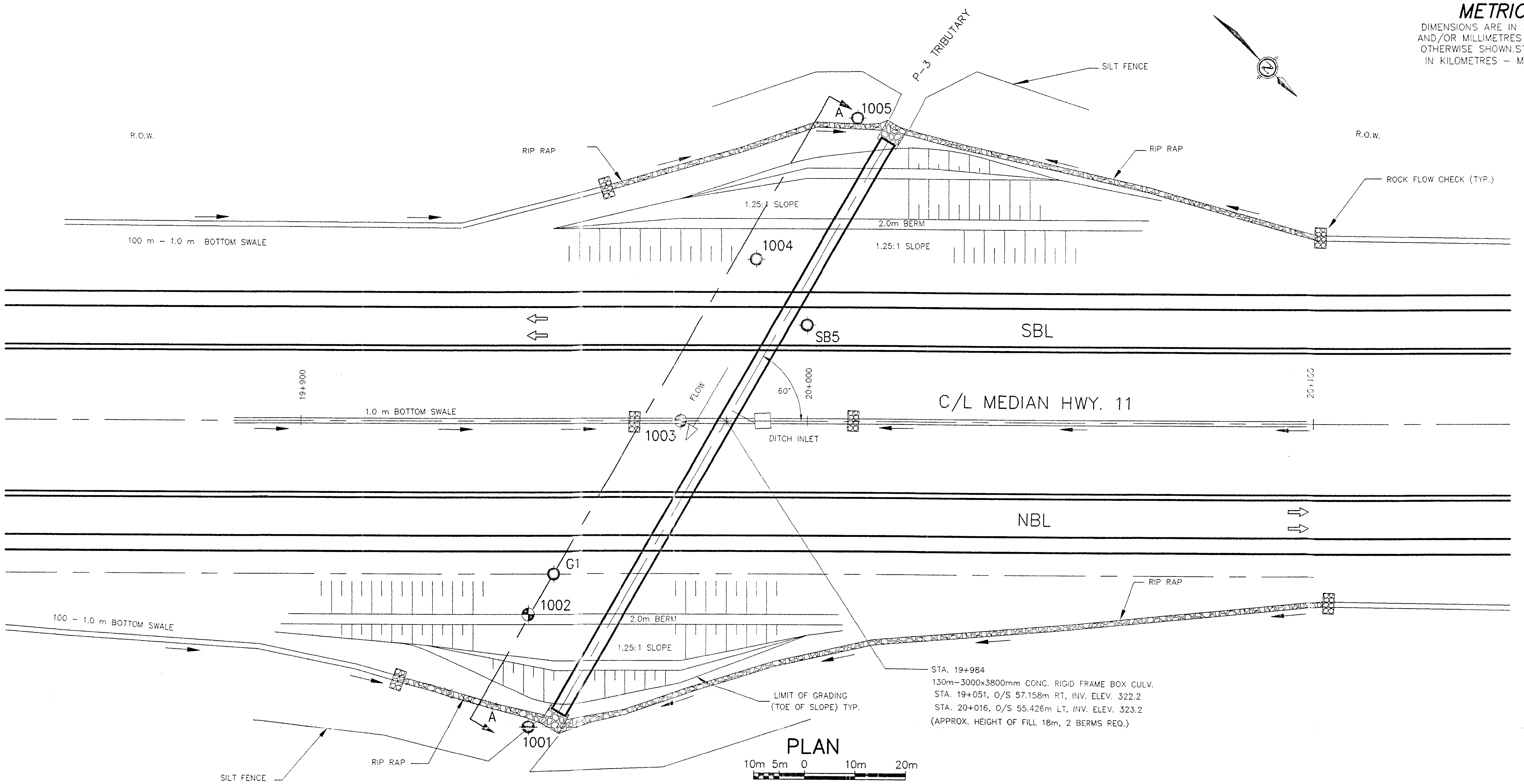
SHEAR STRENGTH kPa: 20 40 60 80 100

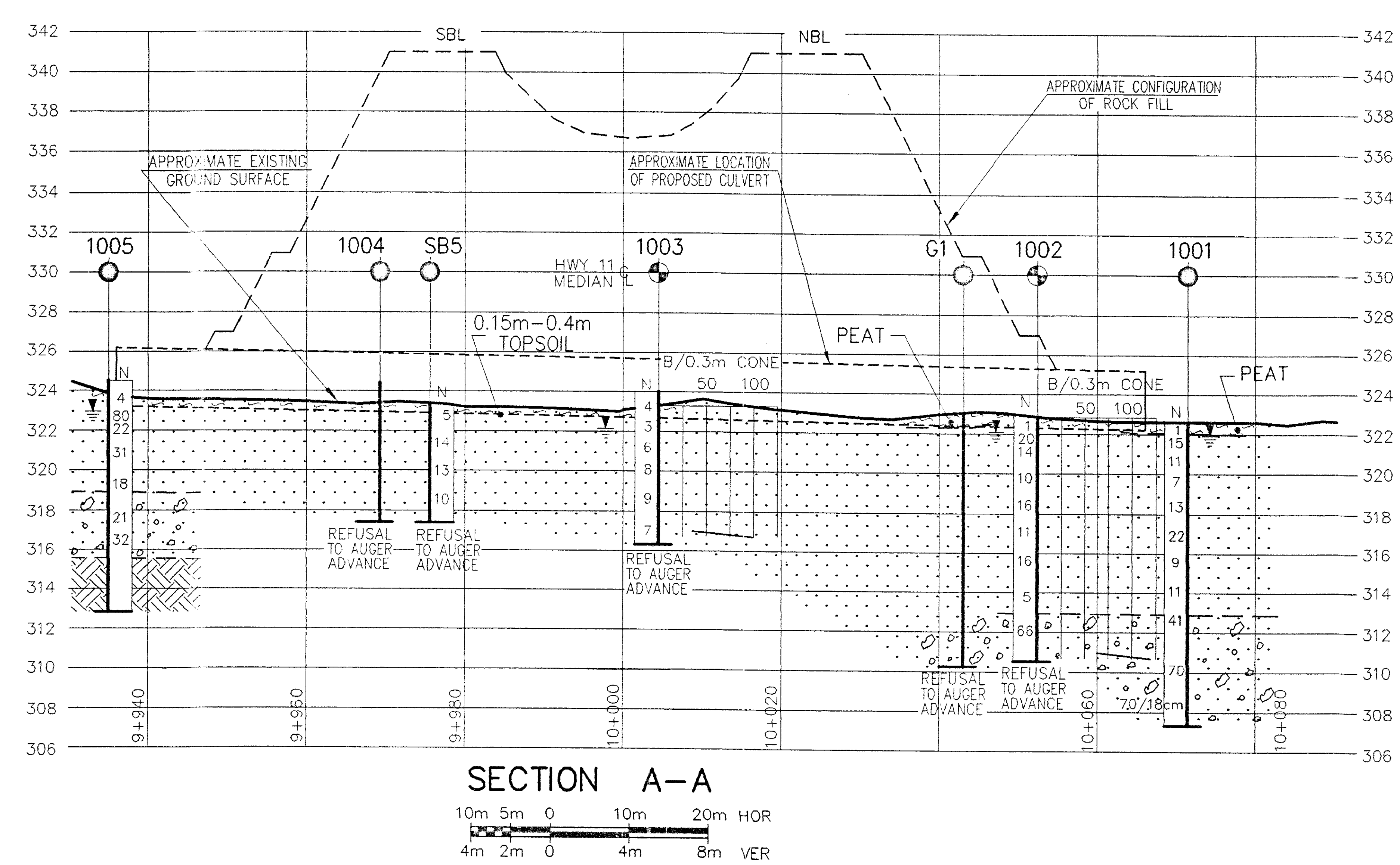
WATER CONTENT (%): 10 20 30

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

$O^{3\%}$ STRAIN AT FAILURE

METRIC
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN. STATIONS IN KILOMETRES – METRES.





SOIL STRATIGRAPHY LEGEND

- SAND, SOME GRAVEL, TRACE SILT – Loose to Compact
- SAND & GRAVEL TO GRAVELLY SAND WITH FREQUENT COBBLES & BOULDERS – Compact to Very Dense
- GNEISS BEDROCK

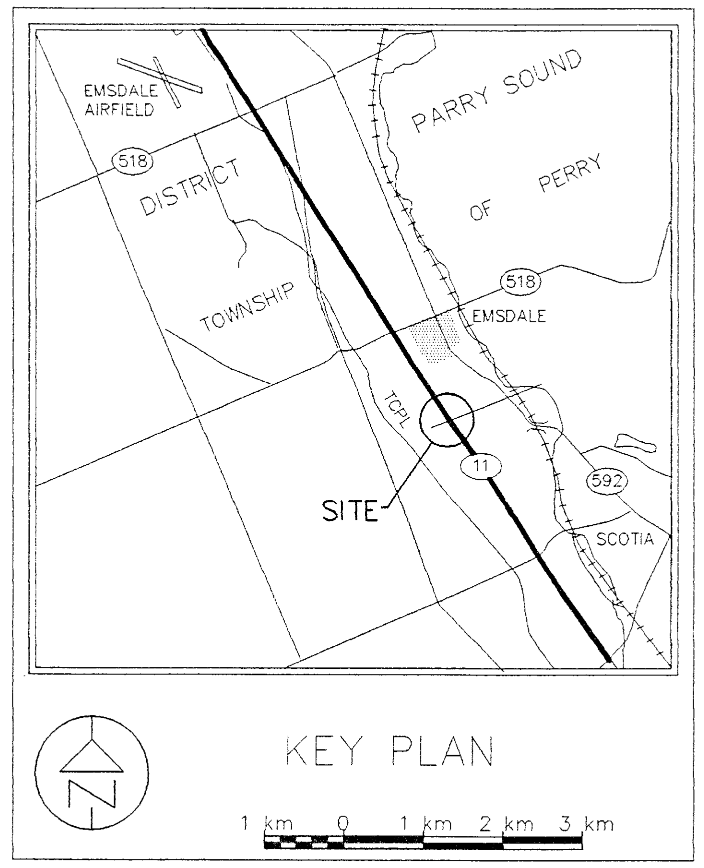
REF. Hwy 11 Site Plan
Dwg. by DELCAN; Dec., 1999

CONT. No.
W.P. No. 466-93-00

PROPOSED CULVERT AT ST.19+984 & MED. C/L HWY 11
BORE HOLE LOCATIONS & SOIL STRATA

SHEET

AGRA Earth & Environmental Limited



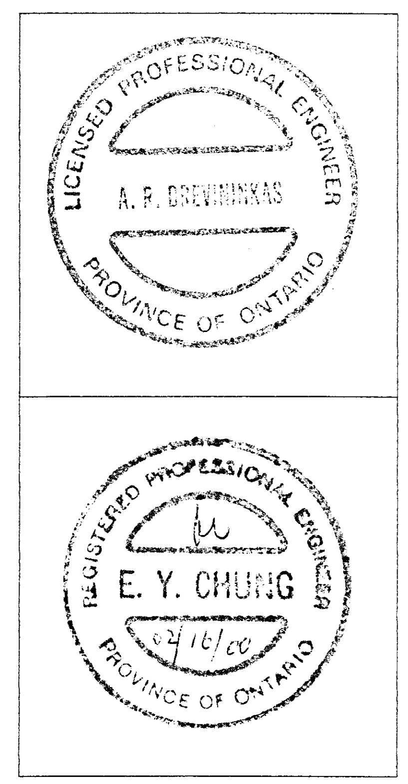
KEY PLAN
1 km 0 1 km 2 km 3 km

LEGEND

- Bore Hole
- Dynamic Cone Penetration Test (Cone)
- Bore Hole & Cone
- 'N' Blows/0.3m (Std Pen Test, 475 J/blow)
- CONE Blows/0.3m (60° Cone, 475 J/blow)
- WL at time of investigation – Aug.1999
- WL in Piezometer
- Piezometer

No	ELEV.	CO-ORDINATES STATION	OFFSET	NORTH	EAST
1001	323.4	19+945	59 Rt Med C/L	5 042 393	319 147
1002	323.3	19+948	40 Rt Med C/L	5 042 382	319 132
1003	324.0	19+975	2.0 Lt Med C/L	5 042 373	319 083
1004	324.4	19+990	33 Lt Med C/L	5 042 362	319 150
1005	324.5	20+010	55 Lt Med C/L	5 042 361	319 020
G1	323.2	19+950	30 Rt Med C/L	–	–
SB5	323.5	20+000	19 Lt Med C/L	–	–

NOTE: Boreholes G1 and SB5 are documented in AGRA Pavement Design Report for W.P.466-93-00, Highway 11 Four Lanining, from 2.5 km South of Highway 518E, Northerly 7.3 km at Emsdale.



–NOTE–
The boundaries between soil strata have been established only at Bore Hole locations. Between Bore Holes the boundaries are assumed from geological evidence.

NOTE: The complete foundation investigation and design report for this project and other related documents may be examined at the Engineering Materials Office, Downsview. Information contained in this report and related documents is specifically excluded in accordance with the conditions of Section GC 2.01 of OPS Gen.Cond.

REV.	DATE	BY	DESCRIPTION
	Feb.2000	MA	Revision 1

HWY No 11			DIST 52 HUNTSVILLE
SUBM'D SP	CHECKED AD	DATE Sept.1999	SITE 44-304
DRAWN MA	CHECKED EYC	APPROVED	DWG 1