

DOCUMENT MICROFILMING IDENTIFICATION

G.I.-30 SEPT. 1976

GEOCRES No. 40116-20

DIST. 2 REGION

W.P. No. 38-90-01

CONT. No. 94-04

W. O. No.

STR. SITE No. 9-25

HWY. No. 6

LOCATION Hwy 6 & Nanticoke Creek

No. of PAGES -

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OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.

REMARKS:



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REMARKS NEAREST GEOGRES # 40I16-9
40I16-18

DRILLING CONT. #S90-0291

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Ontario

OVERSIZE DRAWING

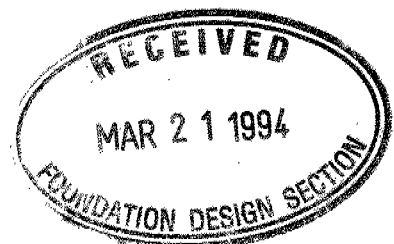
FOUNDATION INVESTIGATION REPORT

CONTRACT NO. 94-04



Ontario

**Ministry of
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Note: For purposes of the contract, this report supersedes all other Foundation Reports prepared by, or for the Ministry in connection with the above mentioned projects.

EXPLANATION OF TERMS USED IN REPORT

2

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

SS SPLIT SPOON	TP THINWALL PISTON
WS WASH SAMPLE	OS OSTERBERG SAMPLE
ST SLOTTED TUBE SAMPLE	RC ROCK CORE
BS BLOCK SAMPLE	PH TW ADVANCED HYDRAULICALLY
CS CHUNK SAMPLE	PM TW ADVANCED MANUALLY
TW THINWALL OPEN	FS 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	e 1, %	VOID RATIO	e_{min} 1, %	VOID RATIO IN DENSEST STATE
γ_s kN/m ³	UNIT WEIGHT OF SOLID PARTICLES	n 1, %	POROSITY	I_D 1	DENSITY INDEX = $\frac{e_{max} - e}{e_{max} - e_{min}}$
ρ_w kg/m ³	DENSITY OF WATER	w 1, %	WATER CONTENT	D mm	GRAIN DIAMETER
γ_w kN/m ³	UNIT WEIGHT OF WATER	S_r %	DEGREE OF SATURATION	D_n mm	n PERCENT - DIAMETER
ρ kg/m ³	DENSITY OF SOIL	w_L %	LIQUID LIMIT	C_u 1	UNIFORMITY COEFFICIENT
γ kN/m ³	UNIT WEIGHT OF SOIL	w_p %	PLASTIC LIMIT	h m	HYDRAULIC HEAD OR POTENTIAL
ρ_d kg/m ³	DENSITY OF DRY SOIL	w_s %	SHRINKAGE LIMIT	q m ³ /s	RATE OF DISCHARGE
γ_d kN/m ³	UNIT WEIGHT OF DRY SOIL	I_p %	PLASTICITY INDEX = $w_L - w_p$	v m/s	DISCHARGE VELOCITY
ρ_{sat} kg/m ³	DENSITY OF SATURATED SOIL	I_L 1	LIQUIDITY INDEX = $\frac{w - w_p}{I_p}$	i 1	HYDRAULIC GRADIENT
γ_{sat} kN/m ³	UNIT WEIGHT OF SATURATED SOIL	I_C 1	CONSISTENCY INDEX = $\frac{w_L - w}{I_p}$	k m/s	HYDRAULIC CONDUCTIVITY
ρ' kg/m ³	DENSITY OF SUBMERGED SOIL	e_{max} 1, %	VOID RATIO IN LOOSEST STATE	j kN/m ³	SEEPAGE FORCE
γ' kN/m ³	UNIT WEIGHT OF SUBMERGED SOIL				

FOUNDATION INVESTIGATION REPORT

For

Nanticoke Creek Bridge

W.P. 38-90-01; Site No. 9-25

Highway 6, District 2, London

INTRODUCTION

This report contains the results of a soils investigation carried out at the above mentioned site. The field work for this project was carried out between 91 06 20 and 91 06 24, and comprised of two sampled boreholes and Dynamic Cone Penetration Test adjacent to one of the boreholes. However, the borings for the existing structure were put down in February 1930.

Boreholes were advanced to a maximum depth of 17.8 m (El. 182.5 m) below the existing ground level using a 82 mm I.D. continuous flight hollow stem auger and BW casing. Rock cores were obtained in both boreholes using BXL size core barrel.

SITE DESCRIPTION

The site under investigation is located about 1.5 km south of Hwy. 3 at the crossing of Hwy. 6 and Nanticoke Creek in the City of Nanticoke. The width of the creek at the crossing is about 11.0 m and the river bed is approximately 4.2 m below the existing grade level.

The topography of the site is generally flat to gently undulating. Physiographically the area is located in the region known as the "Ekfrid Clay Plain".

SUBSURFACE CONDITIONS

The subsoil at this site consists of 3.2 m to 4.6 m fill underlain by 0.6 m to 1.7 m clayey silt containing wood pieces and this layer is followed by 9.1 m to 10.7 m stiff clayey silt to silty clay. The clayey deposit is underlain by 0.8 m to 0.9 m heterogeneous mixture of gravel, sand and silt (glacial till) which

overlies the limestone bedrock at a depth of about 14.5 m to 16.0 m below ground level. For classification purposes, the soils encountered at this site can be divided into five different zones.

- a) Clayey Silt to Silty Clay, Trace of Sand (Fill)
- b) Clayey Silt, Wood Pieces
- c) Clayey Silt to Silty Clay
- d) Heterogeneous Mixture of Gravel, Sand & Silt (Glacial Till)
- e) Limestone Bedrock

The subsurface conditions encountered during the course of the investigation, together with the field and laboratory test results are shown on the Record of Borehole Sheets contained in the Appendix of this report. A stratigraphical section is shown on Drawing No. 389001-A*. This drawing also shows the locations and elevations of the borings. Description of the strata encountered are given below.

The borehole information obtained from the site investigation carried out for the existing bridge are recompiled and are also included in this report.

a) Clayey Silt to Silty Clay, Trace of Sand (Fill)

This approach fill consists of clayey silt to silty clay, trace of sands. The thickness of this fill varies from 3.2 m to 4.6 m and extends to elevation 197.1 m to 196.0 m. The natural moisture content was observed in the range of 18.5% to 21%. The Atterberg Limits determined for the representative soil samples of this fill are shown on Figure 1. The Standard Penetration Test values vary from 5 blows/0.3 m to 13 blows/0.3 m. The consistency may be classified as firm to stiff.

* Dwg. No. 2 (Sheet 172) of the Contract Drawings.

b) Clayey Silt, Wood Pieces

The clayey fill is underlain by this clayey silt deposit containing partially decomposed wood pieces. The thickness of this deposit varies from 0.6 m to 1.7 m and extends to elevations 196.4 to 195.4 m. The Standard Penetration Test values vary from 5 blows/0.3 m to 11 blows/0.3 m.

c) Clayey Silt to Silty Clay

This deposit was encountered at about 3.9 m to 5.2 m below the existing ground level. The thickness of this layer varies from 9.1 m to 10.7 m and extends to elevations 187.0 m to 185.4 m. The natural moisture content was observed in the range of 26% to 28%. The Atterberg Limits determined for the representative soil samples of this deposit are shown on Figure 2. The in-situ Vane Test results were observed to vary from 76 kPa to over 100 kPa and these shear strength values indicate stiff to very stiff consistency. The Standard Penetration Test results were observed to vary from 7 blows/0.3 m to 12 blows/0.3 m.

Consolidation Test was carried out on undisturbed sample and this test indicated preconsolidation pressure (P_c) in the order of 300 kPa, compression index (C_c) in the order of 0.26 and an initial void ratio of 0.70.

d) Heterogeneous Mixture of Gravel, Sand & Silt (Glacial Till)

The clayey silt to silty clay layer is underlain by this heterogeneous mixture of gravel, sand and silt (glacial till) deposit. The thickness of this deposit varies from 0.8 m to 0.9 m and extends to elevation 186.2 m to 184.5 m. The results of the Grain Size Distribution Test carried out on two samples are shown on Figure 3. These results indicate 8% to 16% gravel, 37% to 46% sand and 38% to 55% silt. Only one Standard Penetration Test was carried out in this stratum and this indicates compact denseness.

e) Limestone Bedrock

The rock cores were obtained using BXL core barrel and the description of the bedrock is included in the Appendix of this report.

The bedrock at this site was encountered at a depth of 14.5 m to 16.0 m which corresponds to elevation 186.2 m to 184.5 m. The RQD values measured from BX cores (0% to 83%) indicate that the quality of the bedrock improves with the depth. However, the upper 0.9 m of the bedrock may be described as very poor quality rock. The bedrock at this site may be classified as unweathered limestone of Dundee Formation.

Groundwater Conditions

The groundwater level measurements were taken in open boreholes during investigation and was observed about 11.5 m to 14.9 m (elevation 188.8 m to 185.6 m) below the existing ground level. Seasonal fluctuation of the groundwater level may be expected. The groundwater level at each borehole location is as follows:

<u>Borehole No.</u>	<u>Elevation</u>	<u>Remarks</u>
1	185.6 m	Not Stabilized
2	188.8 m	Not Stabilized
101		Not Established
102		Not Established

MISCELLANEOUS

The field work for this investigation was carried out under the supervision of G. Petruzzello. The equipment used was owned and operated by Master Soil Investigation Ltd. This report was prepared by M. Vasavithasan, Foundation Engineer, reviewed by Mr. P. Payer, Senior Foundation Engineer, and approved by Mr. M. Devata, Chief Foundation Engineer.



M. Vasavithasan

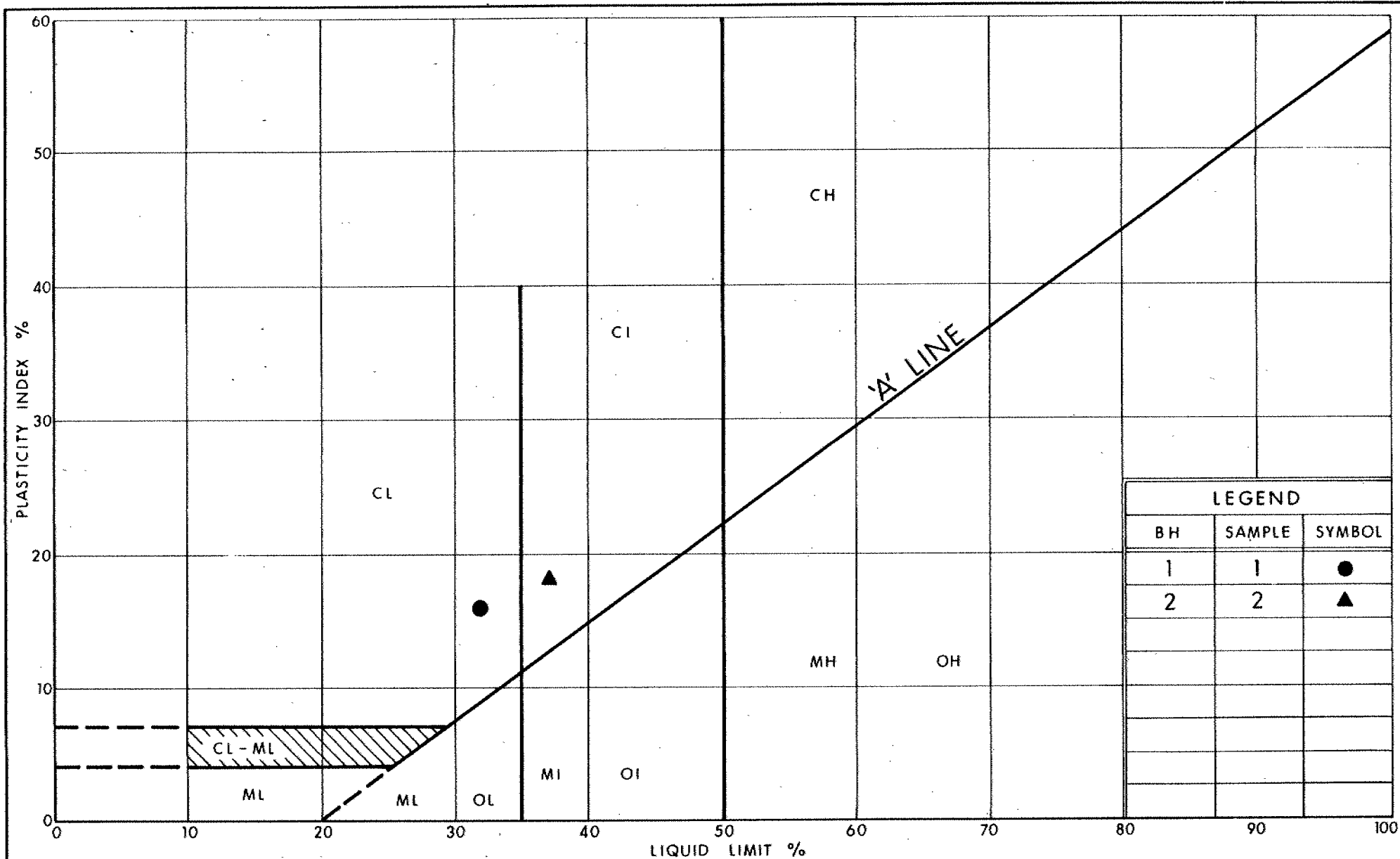
M. Vasavithasan, P. Eng.
Foundation Engineer



D. Dundas

D. Dundas, P. Eng.
Chief Foundation Engineer
(Acting)

APPENDIX

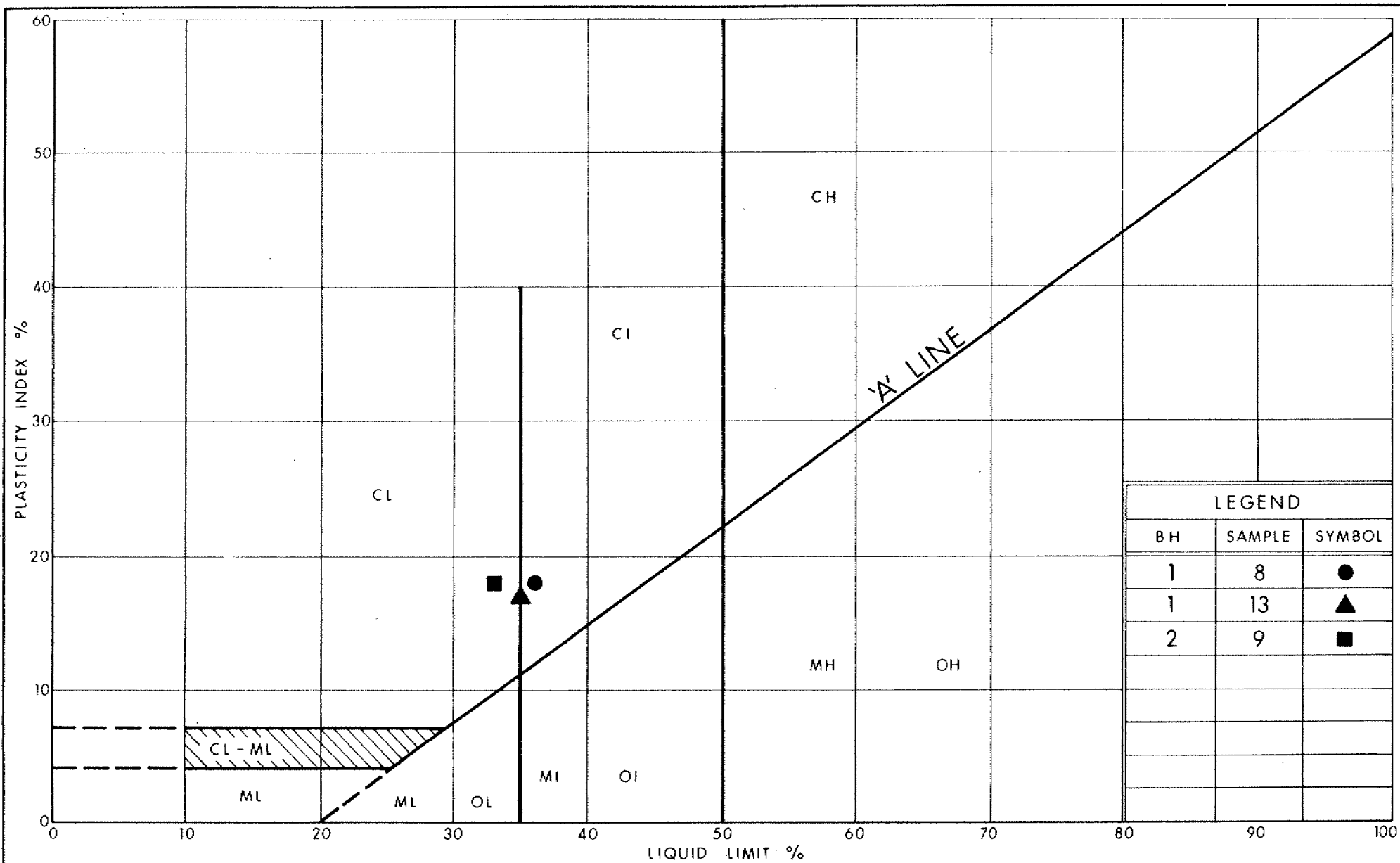


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PLASTICITY CHART CLAYEY SILT TO SILTY CLAY TRACE OF SAND (FILL)

FIG No 1

W P 38-90-01



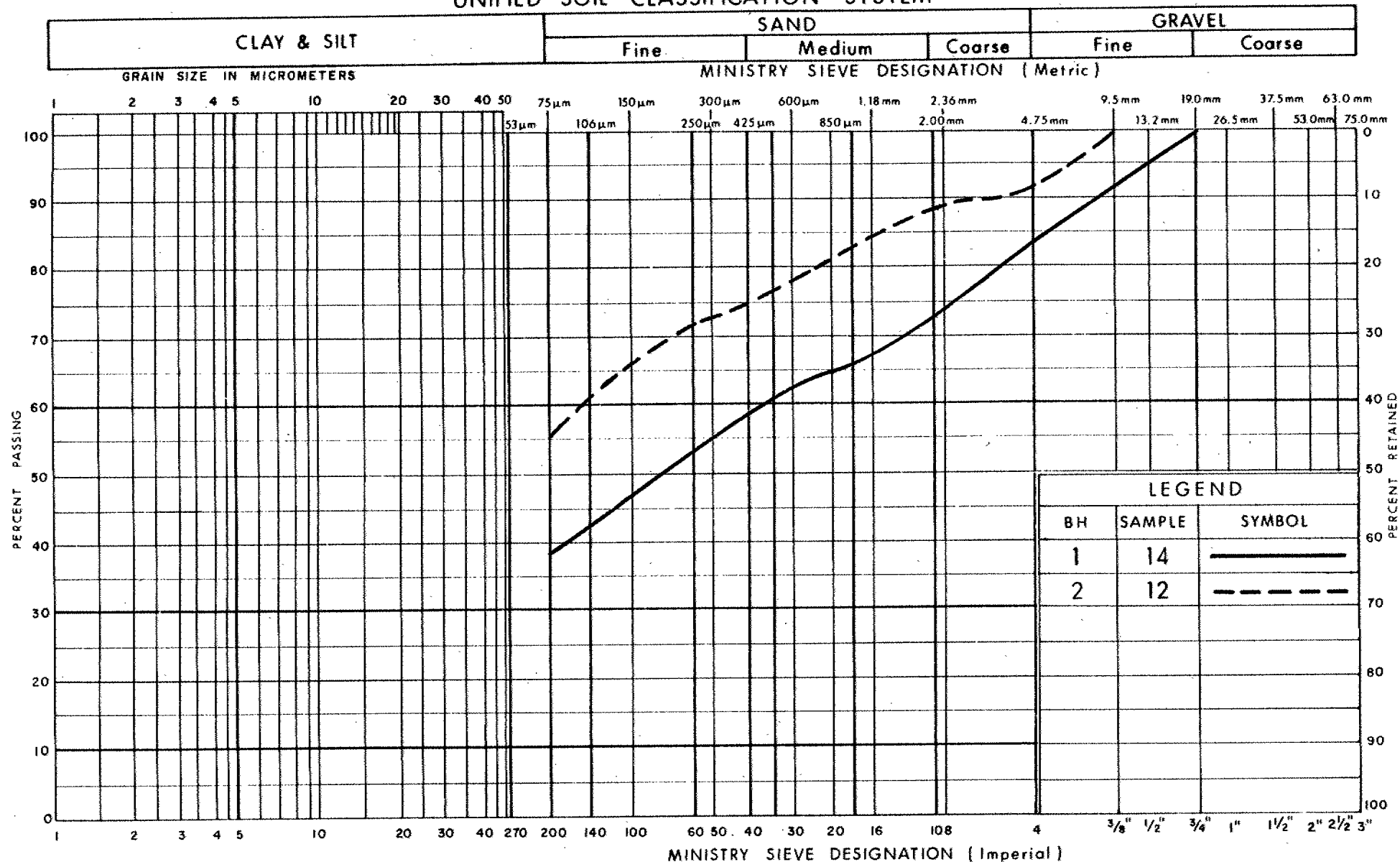
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PLASTICITY CHART CLAYEY SILT TO SILTY CLAY

FIG No 2

W P 38-90-01

UNIFIED SOIL CLASSIFICATION SYSTEM



GRAIN SIZE DISTRIBUTION
HET MIXTURE OF
GRAVEL, SAND & SILT (Glacial Till)

FIG No 3

W P 38 - 90 - 01



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RECORD OF BOREHOLE No 1

1 OF 1

METRIC

W.P. 38 - 90 - 01 LOCATION STA. 28 + 740.9, O/S 1.3m LT. CL. HWY. 6 ORIGINATED BY G.P.
 DIST 2 HWY 6 BOREHOLE TYPE CONE, HOLLOW STEM AUGER & BW CASING COMPILED BY M.V.
 DATUM GEODETIC DATE 91 06 20 CHECKED BY P.P.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH kPa						
200.5	Hwy. 6 Shoulder							20 40 60 80 100						
								○ UNCONFINED + FIELD VANE						
								● QUICK TRIAXIAL × LAB VANE						
								20 40 60 80 100						

RECORD OF BOREHOLE No 2

1 OF 1

METRIC

W.P. 38 - 90 - Q1 LOCATION STA. 28 + 770.0, O/S 5.8m LT. CL. HWY. 6 ORIGINATED BY G.P.
DIST 2 HWY 6 BOREHOLE TYPE CONE, HOLLOW STEM AUGER & BW CASING COMPILED BY M.V.
DATUM GEODETIC DATE 91.06.21 TO 91.06.24 CHECKED BY P.P.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100		
200.3	Ground Surface													
0.0	CLAYEY SILT to SILTY CLAY, Trace of Sand, Stiff (Fill)		1	SS	13									
197.1			2	SS	12									
196.4	CLAYEY SILT, Decayed Wood Pieces		3	SS	11									
3.9			4	SS	12									
			5	SS	7									
			6	SS	9									
			7	SS	12									
			8	SS	12									
	CLAYEY SILT to SILTY CLAY, Stiff		9	SS	12									
			10	SS	11									
			11	SS	12									
185.7			12	SS	50	/13cm								
184.9	Het. Mix. of GRAVEL, SAND & SILT Compact (Glacial Till)		13	RC BX	REC 58%									8 37 (55)
15.4	LIMESTONE BEDROCK, Unweathered		14	RC BX	REC 100%									RQD 0%
182.5														RQD 83%
17.8	End of Borehole * Note: Water Level Not Stabilized													

RECORD OF BOREHOLE No 101

1 OF 1

METRIC

W.P. 38 - 90 - 01 LOCATION STA. 28 + 773.8; O/S 6.0m RT. CL. HWY. 6 ORIGINATED BY
DIST 2 HWY 6 BOREHOLE TYPE WASHBORING COMPILED BY M V
DATUM GEODETTIC DATE 1930 02 CHECKED BY P P

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
200.7	Ground Surface																
0.0	CLAYEY SILT to SILTY CLAY (Fill)					*	200										
196.1							198										
4.6	CLAYEY SILT to SILTY CLAY						196										
							194										
							192										
							190										
							188										
187.0							186										
13.7 186.2	Het. Mix. of GRAVEL, SAND & SILT (Glacial Till)																
14.5	LIMESTONE BEDROCK																
184.5																	
16.2	End of Borehole * Note: Water Level Not Established																

RECORD OF BOREHOLE No 102

1 OF 1

METRIC

W.P. 38 - 90 - 01 LOCATION STA. 28 + 744.8; O/S 1.2m LT. CL. HWY. 6 ORIGINATED BY
DIST. 2 HWY. 6 BOREHOLE TYPE WASHBORING COMPILED BY M.V.
DATUM GEODETIC DATE 1930 02 CHECKED BY P.P.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
200.6	Ground Surface																
0.0	CLAYEY SILT to SILTY CLAY (Fill)					*	200										
196.0							198										
4.6	CLAYEY SILT, Decayed Wood Pieces						196										
5.2	CLAYEY SILT to SILTY CLAY						194										
							192										
							190										
							188										
185.4							186										
15.2	End of Borehole Note: Water Level Not Established																

ROCK CORE DESCRIPTION **WP 38-90-01**

Page 1 of 1

CORE RECOVERY					CORE DESCRIPTION	
BH#	RC#	DEPTH (m)	% CR*	% RQD*	DEPTH (m)	DESCRIPTION
1	15	16.00-16.31	58	0	16.00-16.31	LIMESTONE with stylolites and abundant corals, medium dark grey to light grey (matrix) to white to pale yellowish brown (fossils); medium to coarse grained; medium strong; unweathered to slightly weathered; fractures close to very close spaced, flat to dipping, undulating, smooth.
2	13	15.37-16.46	58	0	15.37-17.83	LIMESTONE with stylolites and abundant corals, medium dark grey to light grey (matrix) to white to pale yellowish brown (fossils); medium to coarse grained; medium strong; unweathered to slightly weathered; fractures moderately close to extremely close spaced, flat to dipping, undulating, smooth to rough.
	14	16.46-17.83	100	83		

*CR = CORE RECOVERY

*RQD = ROCK QUALITY DESIGNATION

(NOTE: Depths are approximated where core recovery is less than 100%)

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FOUNDATION DESIGN SECTION

**foundation
investigation and
design report**

ENGINEERING MATERIALS OFFICE
FOUNDATION DESIGN SECTION

WP 38-90-01

DIST 2

HWY 6

STR SITE 9-25

Nanticoke Creek Bridge

CONT. 94-04

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FOUNDATION INVESTIGATION REPORT

For

Nanticoke Creek Bridge

W.P. 38-90-01; Site No. 9-25

Highway 6, District 2, London

INTRODUCTION

This report contains the results of a soils investigation carried out at the above mentioned site. The field work for this project was carried out between 91 06 20 and 91 06 24, and comprised of two sampled boreholes and Dynamic Cone Penetration Test adjacent to one of the boreholes. However, the borings for the existing structure were put down in February 1930.

Boreholes were advanced to a maximum depth of 17.8 m (El. 182.5 m) below the existing ground level using a 82 mm I.D. continuous flight hollow stem auger and BW casing. Rock cores were obtained in both boreholes using BXL size core barrel.

SITE DESCRIPTION

The site under investigation is located about 1.5 km south of Hwy. 3 at the crossing of Hwy. 6 and Nanticoke Creek in the City of Nanticoke. The width of the creek at the crossing is about 11.0 m and the river bed is approximately 4.2 m below the existing grade level.

The topography of the site is generally flat to gently undulating. Physiographically the area is located in the region known as the "Ekfrid Clay Plain".

SUBSURFACE CONDITIONS

The subsoil at this site consists of 3.2 m to 4.6 m fill underlain by 0.6 m to 1.7 m clayey silt containing wood pieces and this layer is followed by 9.1 m to 10.7 m stiff clayey silt to silty clay. The clayey deposit is underlain by 0.8 m to 0.9 m heterogeneous mixture of gravel, sand and silt (glacial till) which

overlies the limestone bedrock at a depth of about 14.5 m to 16.0 m below ground level. For classification purposes, the soils encountered at this site can be divided into five different zones.

- a) Clayey Silt to Silty Clay, Trace of Sand (Fill)
- b) Clayey Silt, Wood Pieces
- c) Clayey Silt to Silty Clay
- d) Heterogeneous Mixture of Gravel, Sand & Silt (Glacial Till)
- e) Limestone Bedrock

The subsurface conditions encountered during the course of the investigation, together with the field and laboratory test results are shown on the Record of Borehole Sheets contained in the Appendix of this report. A stratigraphical section is shown on Drawing No. 389001-A. This drawing also shows the locations and elevations of the borings. Description of the strata encountered are given below.

The borehole information obtained from the site investigation carried out for the existing bridge are recompiled and are also included in this report.

a) Clayey Silt to Silty Clay, Trace of Sand (Fill)

This approach fill consists of clayey silt to silty clay, trace of sands. The thickness of this fill varies from 3.2 m to 4.6 m and extends to elevation 197.1 m to 196.0 m. The natural moisture content was observed in the range of 18.5% to 21%. The Atterberg Limits determined for the representative soil samples of this fill are shown on Figure 1. The Standard Penetration Test values vary from 5 blows/0.3 m to 13 blows/0.3 m. The consistency may be classified as firm to stiff.

b) Clayey Silt, Wood Pieces

The clayey fill is underlain by this clayey silt deposit containing partially decomposed wood pieces. The thickness of this deposit varies from 0.6 m to 1.7 m and extends to elevations 196.4 to 195.4 m. The Standard Penetration Test values vary from 5 blows/0.3 m to 11 blows/0.3 m.

c) Clayey Silt to Silty Clay

This deposit was encountered at about 3.9 m to 5.2 m below the existing ground level. The thickness of this layer varies from 9.1 m to 10.7 m and extends to elevations 187.0 m to 185.4 m. The natural moisture content was observed in the range of 26% to 28%. The Atterberg Limits determined for the representative soil samples of this deposit are shown on Figure 2. The in-situ Vane Test results were observed to vary from 76 kPa to over 100 kPa and these shear strength values indicate stiff to very stiff consistency. The Standard Penetration Test results were observed to vary from 7 blows/0.3 m to 12 blows/0.3 m.

Consolidation Test was carried out on undisturbed sample and this test indicated preconsolidation pressure (P_c) in the order of 300 kPa, compression index (C_c) in the order of 0.26 and an initial void ratio of 0.70.

d) Heterogeneous Mixture of Gravel, Sand & Silt (Glacial Till)

The clayey silt to silty clay layer is underlain by this heterogeneous mixture of gravel, sand and silt (glacial till) deposit. The thickness of this deposit varies from 0.8 m to 0.9 m and extends to elevation 186.2 m to 184.5 m. The results of the Grain Size Distribution Test carried out on two samples are shown on Figure 3. These results indicate 8% to 16% gravel, 37% to 46% sand and 38% to 55% silt. Only one Standard Penetration Test was carried out in this stratum and this indicates compact denseness.

e) Limestone Bedrock

The rock cores were obtained using BXL core barrel and the description of the bedrock is included in the Appendix of this report.

The bedrock at this site was encountered at a depth of 14.5 m to 16.0 m which corresponds to elevation 186.2 m to 184.5 m. The RQD values measured from BX cores (0% to 83%) indicate that the quality of the bedrock improves with the depth. However, the upper 0.9 m of the bedrock may be described as very poor quality rock. The bedrock at this site may be classified as unweathered limestone of Dundee Formation.

Groundwater Conditions

The groundwater level measurements were taken in open boreholes during investigation and was observed about 11.5 m to 14.9 m (elevation 188.8 m to 185.6 m) below the existing ground level. Seasonal fluctuation of the groundwater level may be expected. The groundwater level at each borehole location is as follows:

<u>Borehole No.</u>	<u>Elevation</u>	<u>Remarks</u>
1	185.6 m	Not Stabilized
2	188.8 m	Not Stabilized
101		Not Established
102		Not Established

DISCUSSION AND RECOMMENDATIONS

General

Initially, it was planned to widen the existing bridge at the crossing of Hwy. 6 and Nanticoke Creek by approximately 4.0 m to the west. A foundation investigation was carried out in June 1991 to provide information for the design. The recommendations for the widening of the bridge was given in the Foundation Investigation Report issued in August 1991. Subsequent to this, it was decided to replace the existing structure instead of widening.

This report supersedes the Foundation Investigation Report issued in August 1991.

The replacement structure will be precast prestressed concrete beams. The abutments will be integral with the concrete deck. The clear span between the face of the abutments will be about 19.5 m.

The existing bridge is a single span simply supported cast-in-place reinforced concrete structure. The clear span between the face of the abutment is about 15 m. The structure as well as the side slopes of the approaches are in satisfactory condition without any distresses. Based on the available information, it appears that the existing bridge is supported on piles, however, the pile detail or the tip elevations of the piles are not given.

Structure Foundation

Considering the subsoil conditions at this site, it is recommended that the abutments be supported on steel H-piles driven to bedrock which will be encountered at about elevation 186.2 to 184.5 m.

The maximum allowable load for the steel H-pile selected may be used for the design purposes. For the purposes of O.H.B.D.C., the following values are recommended.

	<u>HP 310 X 110</u>	<u>HP 310 X 79</u>
Axial Capacity at U.L.S.	1600 kN	1150 kN
Axial Capacity at S.L.S. Type II	1150 kN	900 kN

The following parameters are recommended for the calculation of modulus of horizontal subgrade reaction and to estimate the point of contraflexure of piles.

<u>Soil Boundary</u>	<u>Soil Type</u>	<u>ϕ</u>	<u>q_u (kPa)</u>	<u>γ (kN/m³)</u>
El: 200.5 - El. 195.5	Cohesive (Fill)	0	100	17.5
El: 195.5 - El. 186.0	Cohesive	0	170	18.5
El: 186.0 - El. 185.0	Cohesionless	36°	0	21

Note: q_u = Unconfined Compressive Strength (kPa)
 γ = Bulk Unit Weight (kN/m³)
 ϕ = Angle of Internal Friction

Earth pressure should be computed as per Section 6.6.1.2.2 of the O.H.B.D.C., and an unyielding foundation condition may be assumed for the computations. The Granular "A" or "B" backfill should be in accordance with the Special Provision No. 109F03. The following parameters are recommended for the granular backfill.

	<u>Granular "A"</u>	<u>Granular "B"</u>
Angle of Internal Friction	$\phi = 35^\circ$	$\phi = 30^\circ$
Unit Weight (kN/m ³)	$\gamma = 22.8$	$\gamma = 21.2$

The pile caps should have a minimum of 1.2 m earth cover to protect against the frost penetration.

Approach Embankments

The maximum height of approach fill above the original ground level will be about 5.0 m. If the fill height is limited to about 5.0 m, no major stability problems are anticipated for the approach embankments constructed with 2H:1V side slopes.

The fill material should consist of well compacted acceptable material. The topsoil as well as any spongy or soft area observed within the base width of the embankment should be removed. The benching for the new approach fill should be in accordance with the OPSD 208.01.

Other Considerations

If closed-end abutments with pile caps are proposed at this site, it will have to be constructed below the creek water level which may be expected to fluctuate. In view of impervious nature of the subsurface at the pile cap formation level, no major dewatering problems are anticipated during construction. Any minor seepage or surface run-off into the excavation may be readily handled by pumping from the sump. Care shall be exercised during construction to prevent any flow of water from the creek into the excavation.

Alternatively, pile bents may be used to support the bridge deck instead of pile caps.

MISCELLANEOUS

The field work for this investigation was carried out under the supervision of G. Petruzzello. The equipment used was owned and operated by Master Soil Investigation Ltd. This report was prepared by M. Vasavithasan, Foundation Engineer, reviewed by Mr. P. Payer, Senior Foundation Engineer, and approved by Mr. M. Devata, Chief Foundation Engineer.



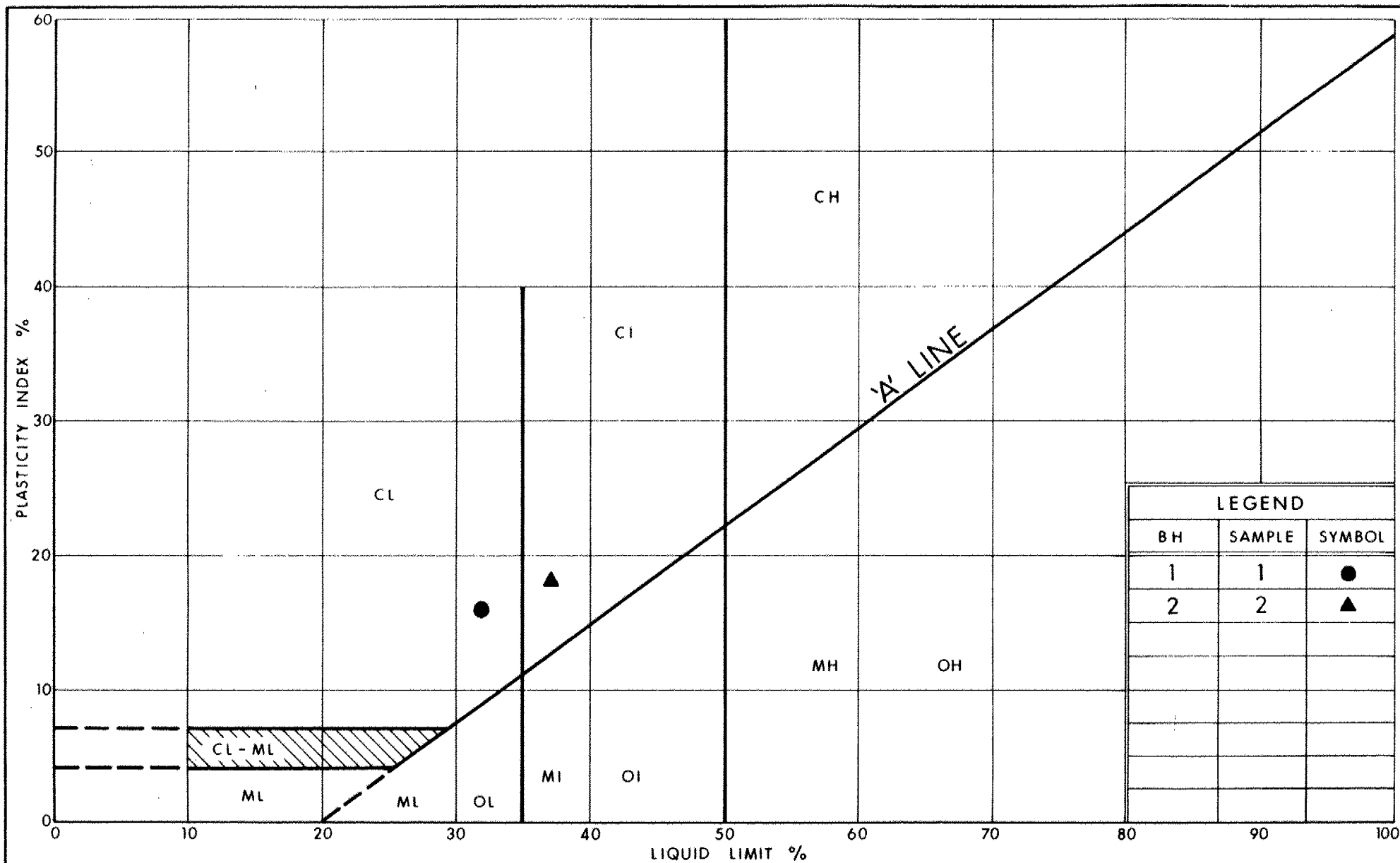
M. Vasavithasan

M. Vasavithasan, P. Eng.
Foundation Engineer

M. Devata

M. Devata, P. Eng.
Chief Foundation Engineer

APPENDIX

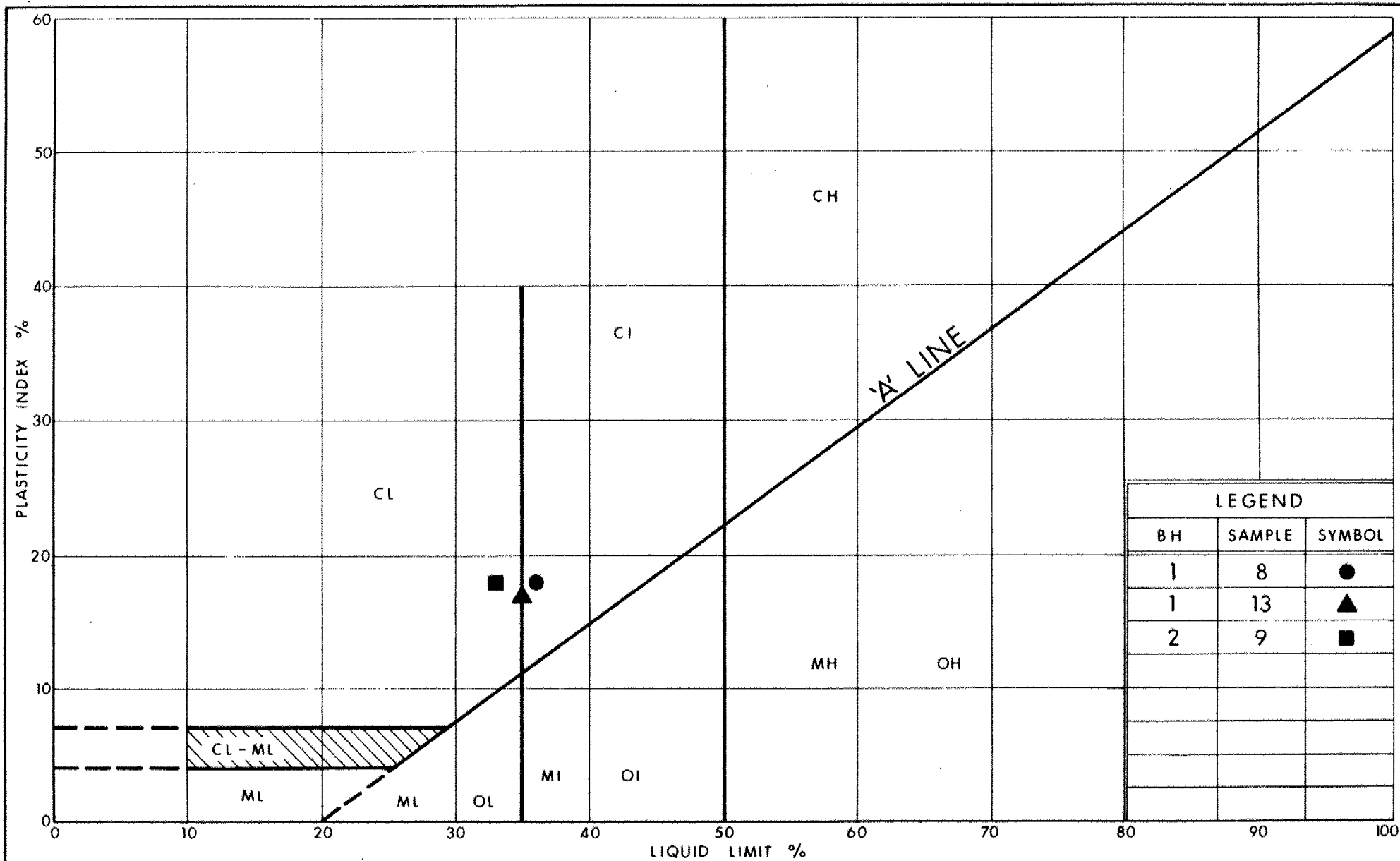


Ministry of
Transportation

PLASTICITY CHART
CLAYEY SILT TO SILTY CLAY
TRACE OF SAND (FILL)

FIG No 1

W P 38-90-01



Ministry of
Transportation

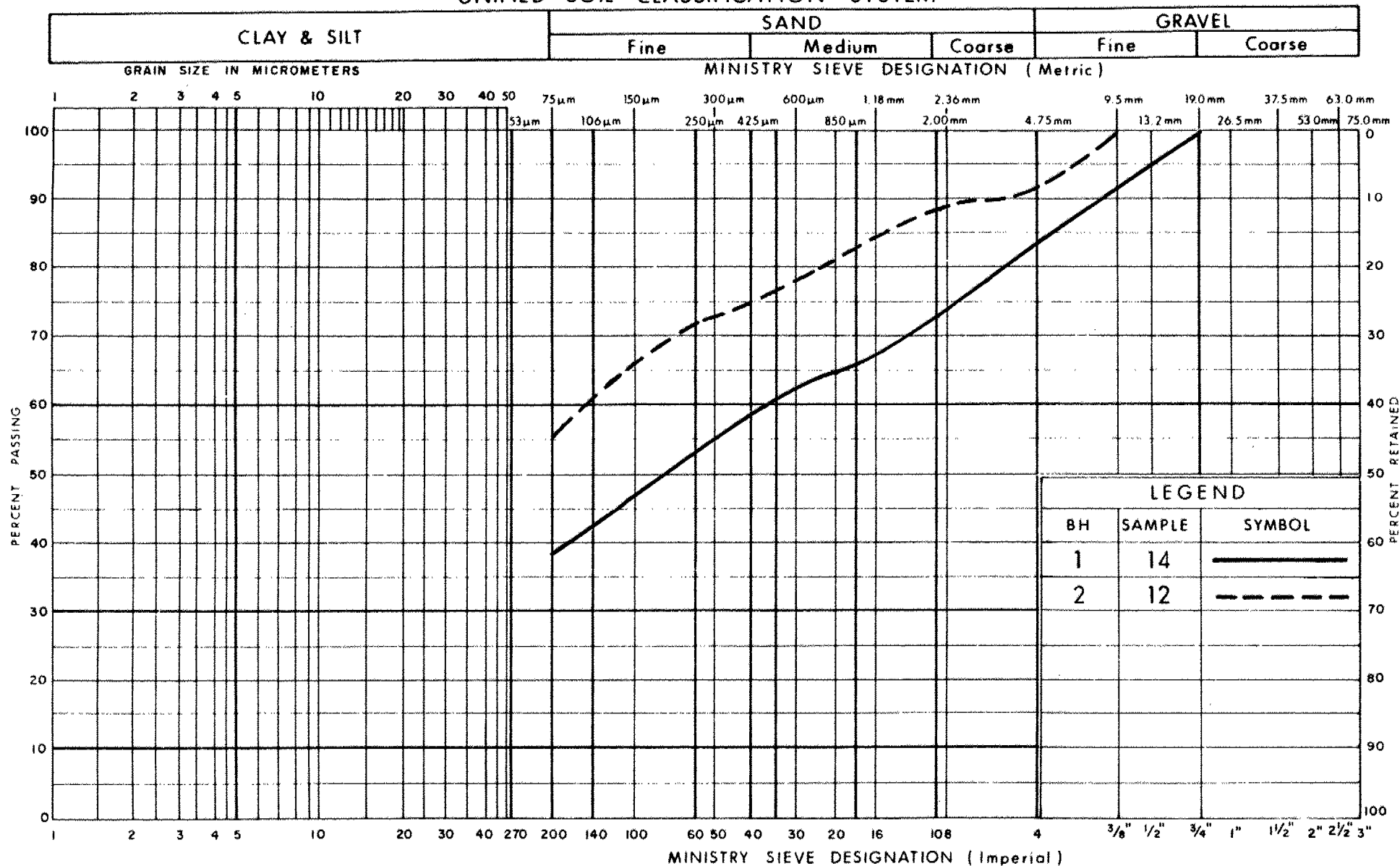
Ontario

PLASTICITY CHART CLAYEY SILT TO SILTY CLAY

FIG No 2

W P 38-90-01

UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of
Transportation

GRAIN SIZE DISTRIBUTION

HET MIXTURE OF GRAVEL, SAND & SILT (Glacial Till)

FIG No 3

W P 38 - 90 - 01

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	e	1, %	VOID RATIO	e_{min}	1, %	VOID RATIO IN DENSEST STATE
γ_s	kN/m ³	UNIT WEIGHT OF SOLID PARTICLES	n	1, %	POROSITY	I_D	1	DENSITY INDEX = $\frac{e_{max} - e}{e_{max} - e_{min}}$
ρ_w	kg/m ³	DENSITY OF WATER	w	1, %	WATER CONTENT	D	mm	GRAIN DIAMETER
γ_w	kN/m ³	UNIT WEIGHT OF WATER	S_r	%	DEGREE OF SATURATION	D_n	mm	n PERCENT - DIAMETER
ρ	kg/m ³	DENSITY OF SOIL	w_L	%	LIQUID LIMIT	C_u	1	UNIFORMITY COEFFICIENT
γ	kN/m ³	UNIT WEIGHT OF SOIL	w_p	%	PLASTIC LIMIT	h	m	HYDRAULIC HEAD OR POTENTIAL
ρ_d	kg/m ³	DENSITY OF DRY SOIL	w_s	%	SHRINKAGE LIMIT	q	m ³ /s	RATE OF DISCHARGE
γ_d	kN/m ³	UNIT WEIGHT OF DRY SOIL	I_p	%	PLASTICITY INDEX = $w_L - w_p$	v	m/s	DISCHARGE VELOCITY
ρ_{sat}	kg/m ³	DENSITY OF SATURATED SOIL	I_L	1	LIQUIDITY INDEX = $\frac{w - w_p}{I_p}$	i	1	HYDRAULIC GRADIENT
γ_{sat}	kN/m ³	UNIT WEIGHT OF SATURATED SOIL	I_C	1	CONSISTENCY INDEX = $\frac{w_L - w}{I_p}$	k	m/s	HYDRAULIC CONDUCTIVITY
ρ'	kg/m ³	DENSITY OF SUBMERGED SOIL	e_{max}	1, %	VOID RATIO IN LOOSEST STATE	j	kN/m ³	SEEPAGE FORCE
γ'	kN/m ³	UNIT WEIGHT OF SUBMERGED SOIL						

RECORD OF BOREHOLE No 1

1 OF 1

METRIC

W.P. 38 - 90 - 01 LOCATION STA. 28 + 740.9, O/S 1.3m LT. CL. HWY. 6 ORIGINATED BY G P
 DIST 2 HWY 6 BOREHOLE TYPE CONE, HOLLOW STEM AUGER & BW CASING COMPILED BY M V
 DATUM CEODETIC DATE 91 06 20 CHECKED BY P P

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH kPa							WATER CONTENT (%)
								○ UNCONFINED ● QUICK TRIAXIAL	+ FIELD VANE x LAB VANE						
200.5	Hwy. 6 Shoulder					20 40 60 80 100	20 40 60 80 100	10 20 30							
0.0	CLAYEY SILT to SILTY CLAY, Trace of Sand, Firm (Fill)		1	SS	8										
			2	SS	5										
			3	SS	7										
197.1			4	SS	9										
3.4	CLAYEY SILT, Pockets of Organic Silt, Wood Pieces, Firm		5	SS	8										
195.4			6	SS	5										
5.1	CLAYEY SILT to SILTY CLAY, Stiff		7	SS	12										
			8	TW	PH										
			9	SS	11										
			10	SS	11										
			11	SS	9										
			12	SS	9										
			13	SS	11										
185.4															
15.1		Het. Mix. of GRAVEL, SAND & SILT Compact (Glacial Till)		14	SS	29									16 46 (38)
184.5															
184.2		LIMESTONE BEDROCK		15	RC	58%									ROD 0%
16.3		End of Borehole													
		* Note: Water Level Not Stabilized													

+3, x5: Numbers refer to
Sensitivity

20
15-25 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 2

1 OF 1

METRIC

W.P. 38 - 90 - 01 LOCATION STA. 28 + 770.0, O/S 5.8m LT. CL. HWY. 6 ORIGINATED BY G.P.
 DIST 2 HWY 6 BOREHOLE TYPE CONE, HOLLOW STEM AUGER & BW CASING COMPILED BY M.V.
 DATUM GEODETIC DATE 91 06 21 TO 91 06 24 CHECKED BY P.P.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
200.3	Ground Surface																
0.0	CLAYEY SILT to SILTY CLAY, Trace of Sand, Stiff (Fill)		1	SS	13		200										
197.1			2	SS	12		198										
196.4	CLAYEY SILT, Decayed Wood Pieces		3	SS	11												
3.9			4	SS	12		196										
			5	SS	7												
			6	SS	9		194										
			7	SS	12												
			8	SS	12		192										
	CLAYEY SILT to SILTY CLAY, Stiff		9	SS	12		190										
185.7			10	SS	11												
			11	SS	12		188										
184.9	Het. Mix. of GRAVEL, SAND & SILT Compact (Glacial Till)		12	SS	50	/13cm	186										8 37 (55)
15.4	LIMESTONE BEDROCK, Unweathered		13	RC BX	REC 58%		184										RQD 0%
182.5			14	RC BX	REC 100%												RQD 83%
17.8	End of Borehole * Note: Water Level Not Stabilized																

+3, x5: Numbers refer to
Sensitivity

20
15-5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 101

1 OF 1

METRIC

W.P. 38 - 90 - 01 LOCATION STA. 28 + 773.8; O/S 6.0m RT. CL. HWY. 6 ORIGINATED BY
DIST 2 HWY 6 BOREHOLE TYPE WASHBORING COMPILED BY M.V.
DATUM GEODETIC DATE 1930 02 CHECKED BY P.P.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL * LAB VANE					WATER CONTENT (%) w _p w w _L			
200.7	Ground Surface																
0.0	CLAYEY SILT to SILTY CLAY (Fill)					*	200										
							198										
196.1							196										
4.6							194										
	CLAYEY SILT to SILTY CLAY						192										
							190										
							188										
187.0							186										
13.7 186.2	Het. Mix. of GRAVEL SAND & SILT (Glacial Till)						186										
14.5	LIMESTONE BEDROCK																
184.5																	
16.2	End of Borehole * Note: Water Level Not Established																

RECORD OF BOREHOLE No 102

1 OF 1

METRIC

W.P. 38 - 90 - 01 LOCATION STA. 28 + 744.8; O/S 1.2m LT. CL. HWY. 6 ORIGINATED BY
DIST 2 HWY 5 BOREHOLE TYPE WASHBORING COMPILED BY M.V.
DATUM GEODETIC DATE 1930 02 CHECKED BY P.P.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
200.6	Ground Surface																
0.0	CLAYEY SILT to SILTY CLAY (Fill)					*	200										
							198										
196.0							196										
4.6	CLAYEY SILT, Decayed Wood Pieces						194										
5.2	CLAYEY SILT to SILTY CLAY						192										
							190										
							188										
							186										
185.4																	
15.2	End of Borehole * Note: Water Level Not Established																

ROCK CORE DESCRIPTION **WP 38-90-01**

Page 1 of 1

CORE RECOVERY					CORE DESCRIPTION	
BH#	RC#	DEPTH (m)	% CR*	% RQD*	DEPTH (m)	DESCRIPTION
1	15	16.00-16.31	58	0	16.00-16.31	LIMESTONE with stylolites and abundant corals, medium dark grey to light grey (matrix) to white to pale yellowish brown (fossils); medium to coarse grained; medium strong; unweathered to slightly weathered; fractures close to very close spaced, flat to dipping, undulating, smooth.
2	13	15.37-16.46	58	0	15.37-17.83	LIMESTONE with stylolites and abundant corals, medium dark grey to light grey (matrix) to white to pale yellowish brown (fossils); medium to coarse grained; medium strong; unweathered to slightly weathered; fractures moderately close to extremely close spaced, flat to dipping, undulating, smooth to rough.
	14	16.46-17.83	100	83		

*CR = CORE RECOVERY

*RQD = ROCK QUALITY DESIGNATION

(NOTE: Depths are approximated where core recovery is less than 100%)

Logged by: DAW, Soils and Aggregates Section

METRIC

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

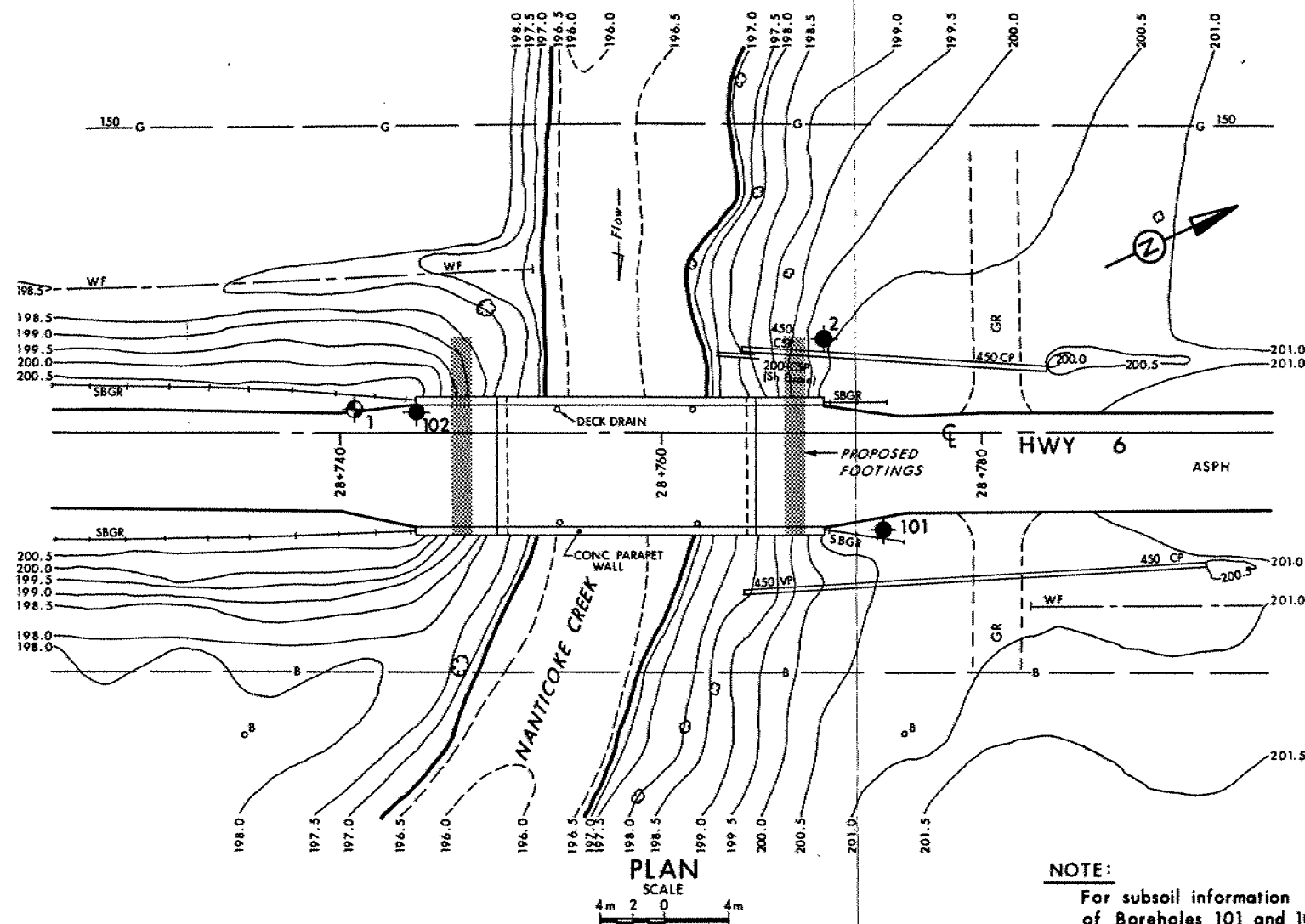
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WP No 38-90-01

NANTICOKE CREEK

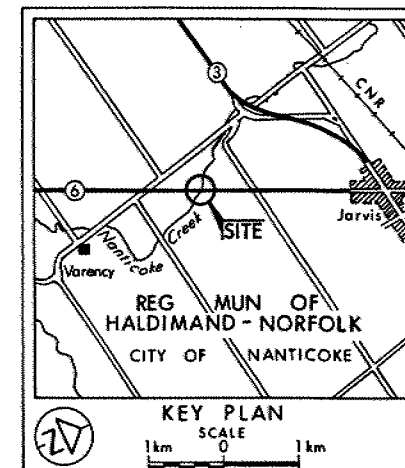
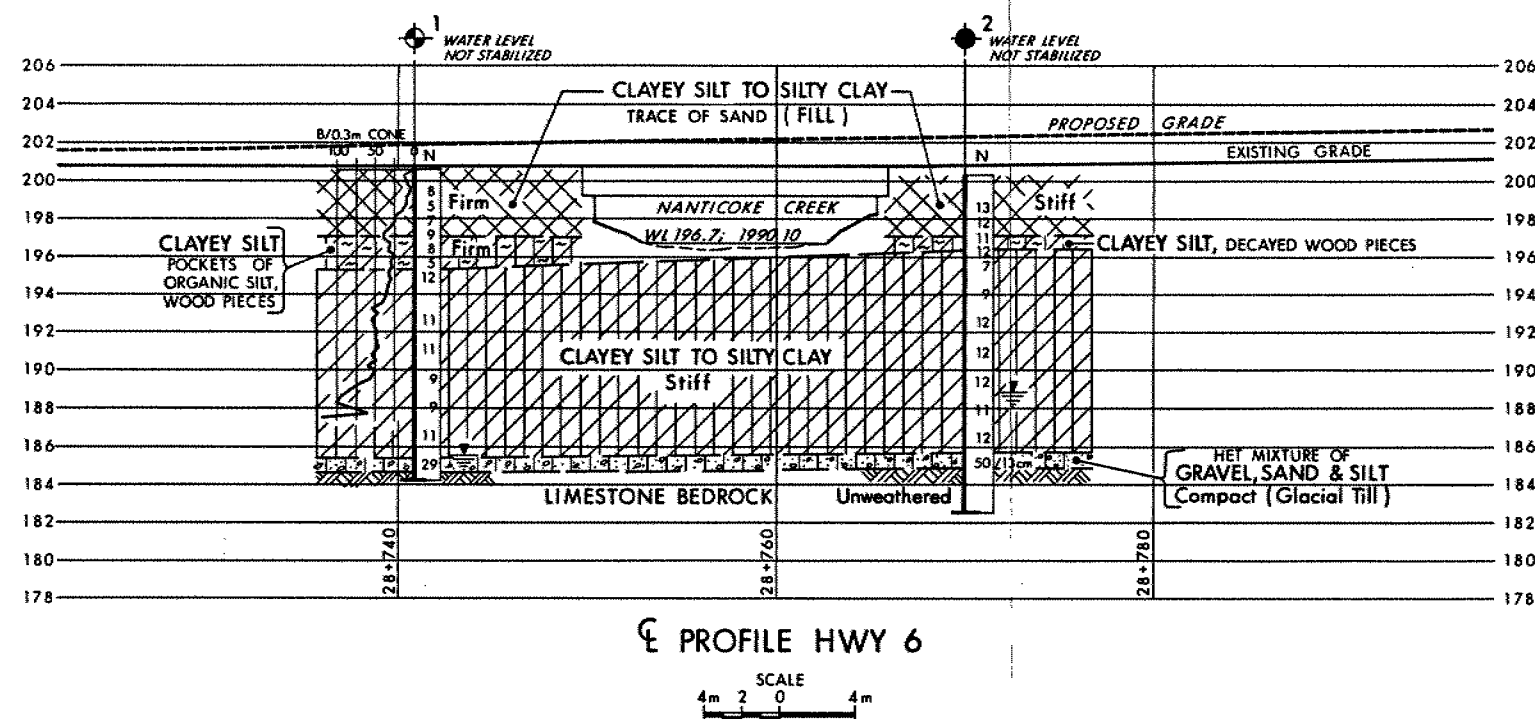
BORE HOLE LOCATIONS & SOIL STRATA



SHEET



NOTE:
For subsoil information
of Boreholes 101 and 102
refer to Record of Borehole Sheets.



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)
- W L at time of investigation 1991 06

HOLES
DRILLED
1930 02

No	ELEVATION	STATION	OFFSET
1	200.5	28+740.9	1.3m LT
2	200.3	28+770.0	5.8m LT
101	200.7	28+773.8	6.0m RT
102	200.6	28+744.8	1.2m LT

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 102-2 of Form 100.

DATE	BY	DESCRIPTION
1992 05	G.P.	BOREHOLES 101 & 102 ADDED ON PLAN

Geocres No 40116-20

HWY No 6	SUBMD M.V.	CHECKED R.S.	DATE 1991 07 12	SITE 9-25
DRAWN R.S.	CHECKED R.S.	APPROVED		DWG 389001-A

REPLY
COPYSEND
TO

DEPT

DATE

SUBJECT

C-100-4500, 7-6, 1-2

Road to creek bridge

Added to the list of plans. The proposed
replacement. Please refer to your comments in the
reference to 2nd pile between existing and shore
piles 3 & 4 and the edge of Abutment walls
on East side in the field by the first occurrence.

REPLY

Further to the telephone conversation we
had on 92/08/31. It appears that there
is adequate space for driving new pile
between the existing timber piles. The existing
timber piles may be pushed up due to driving of new pile
and in such event, the timber pile may be cut off at the required
level. No major cost problems are anticipated on the East side of the structure.

REPLY FROM

Mark Vasavitharan

REPLY DATE

92-08-31

memorandum



To: Alfred Ho
Head, Structural Section
Southwestern Region

From: Foundation Design Section
Room 315, Central Bldg.
Downsview

Re: Nanticoke Creek Replacement Bridge
W.P. 38-90-01, Site 9-25
Highway 6, District 2, London

Date: 1992 06 16

The Preliminary General Arrangement Drawing 9-25-P1 for the above mentioned structure was reviewed and the following comments are submitted.

- 1) Considering the subsoil condition and the span of the bridge, piles need not to be lowered in pre-augered holes.
- 2) Driving shoes for the steel "H" piles are not required.

A handwritten signature in cursive script, appearing to read "M. Vasavithasan".

M. Vasavithasan, P. Eng.
Foundation Engineer

for

P. Payer, P. Eng.
Sr. Foundation Engineer

PP/MV/jb

memorandum



To: Alfred Ho
Head, Structural Section
Southwestern Region

Attn: J.F. Meyer

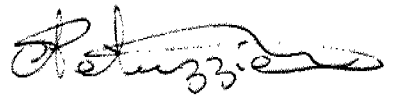
From: Foundation Design Section
Room 315, Central Bldg.

Re: Nanticoke Creek Replacement Bridge
W.P. 38-90-01, Site 9-25
Highway 6, District 2, London

Date: 1992 04 06

In reference to the telephone conversation we had on the above subject on 92 04 01, the following comments are submitted.

- 1) The proposed finished grade in the vicinity of the bridge varies from El: 202.4 to El: 201.8, ie. approximately 1.0 m to 1.4 m higher than the existing grade. If the fill height is limited to the elevations indicated above, no major stability problems are anticipated for the approach embankments constructed with 2H:1V side slopes.
- 2) If the existing piles are not allowed to carry any load, the minimum spacings between the existing and new piles need not meet the O.H>B.D.C. requirement. However, the existing pile cap will have to be removed to facilitate the driving of new piles.
- 3) The recommendations given in the Foundation Investigation and Design Report issued in August 1991, should be used for the design of the replacement bridge.


for M. Vasavithasan, P. Eng.
Foundation Engineer

for

P. Payer, P. Eng.
Sr. Foundation Engineer

PP/MV/jb

memorandum



To: A. Ho
Head Structural Section
Southwestern Region
London

Date: 1991 09 09

From: Foundation Design Section
Room 315, Central Building

Re: Nanticoke Creek Bridge
W.P. 38-90-01, Site 9-25
Highway 6; District 2, London

In reference to your letter dated 91 08 27. This memo summarizes our comments.

We understand that the structure at this location is supported on piles. However, we do not have any information about the pile foundation. In the absence of any information, recommendations or an evaluation of the substructure cannot be made.

In order to avoid construction difficulties and interference with the existing piles, it is advisable if the foundation for the replacement structure be located away from the existing piles.

A handwritten signature in cursive script, appearing to read "M. Vasavithasan".

M. Vasavithasan, P. Eng.
Foundation Engineer

for

P. Payer, P. Eng.
Sr. Foundation Engineer

PP/MV/mmj

memorandum



To: A. Ho
Head Structural Section
Southwestern Region
London

Date: 7 11 06 05

From: Foundation Design Section
Room 315, Central Building
Downsview

Re: W.P. 38-90-01, Site 9-25
Nanticoke Creek Bridge
Highway 6, District 2

It is proposed to widen the existing bridge at the crossing of Highway 6 and Nanticoke Creek by approximately 4 m to the west.

A preliminary recommendation is submitted based on the information available with this office. The final report will be submitted at a later date upon completion of the field work.

The existing structure is a single span simply supported reinforced concrete structure. The clear span between the face of the abutments is about 15 m. It appears that the existing bridge is supported on piles, however, the pile detail or the founding level of the piles is not available.

It is recommended that the abutments be supported on steel H-piles driven to bedrock which is expected to be encountered at about El. 185 \pm . However, the bedrock elevation will be confirmed upon completion of the field work which will be carried out very shortly. For the purpose of the O.H.B.D.C., the following values are recommended:

	HP 310 x 110	HP 310 x 79
Factored Bearing Capacity at U.L.S.	1600 kN	1150 kN
Bearing Capacity at S.L.S. Type II	1150 kN	900 kN

The pile tips should be reinforced with pile driving shoes as per M.T.O. Standards.

Earth pressure for the design of the abutments should be computed as per 6.1.2.2 of the code and an unyielding foundation condition may be assumed for the computations. The Granular 'A' or 'B' backfill should be in accordance with the special provision No. 109F03. The following parameters are recommended for the granular fill.

	Granular 'A'	Granular 'B'
Angle of Internal Friction	$\phi = 35^{\circ}$	$\phi = 30^{\circ}$
Unit Weight (kN/m ³)	$\gamma = 22.8$	$\gamma = 21.2$

The benching for the new approach fill should be in accordance with the OPSD 208.01 dated 88 12 01. The pile caps should have a minimum of 1.2 m earth cover to protect against the frost penetration.

M. Vasavithasan

M. Vasavithasan, P. Eng.
Foundation Engineer

for

P. Payer, P. Eng.
Sr. Foundation Engineer

PP/MV/mmj

METRIC

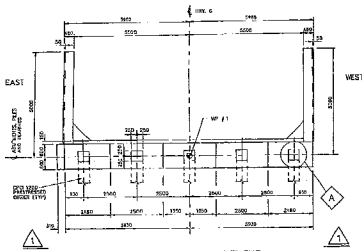
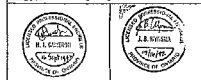
DIMENSIONS ARE IN MILLIMETRES
UNLESS OTHERWISE SHOWN

DIST. 2 HWY. 6
CONT No 94-04
WP No 38-90-01

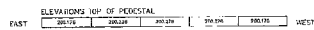
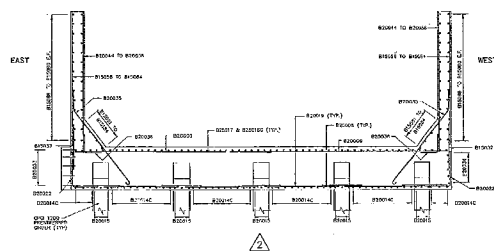
NANTICOKE CREEK BRIDGE
(2.4km SOUTH OF HWY 3 IN JARVIS)

SHEET
173

CC Cumming Cockburn Limited
Consulting Engineers and Planners



PLAN OF SOUTH ABUTMENT

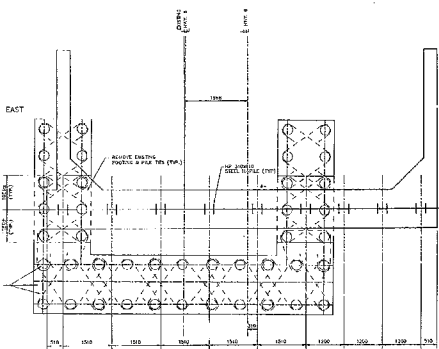
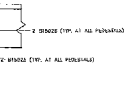
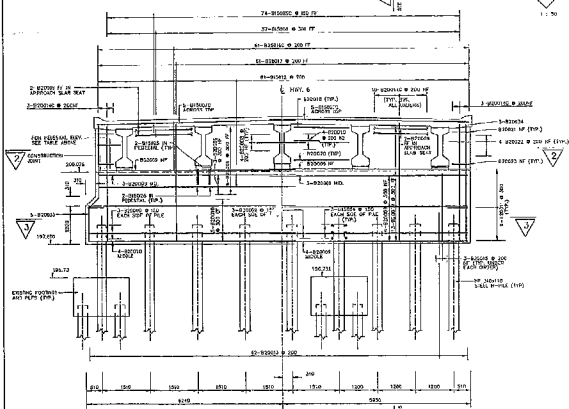


PLF DATA

LOCATION	NO. REQUIRED	LENGTH	BATTER
SOUTH ABUTMENT	8	1.00	VERTICAL

NOTES:

- ALL PILES TO BE HP 200 X 105.
- PILES TO BE DRIVEN TO ELEVATION OF 266.15 TO 266.26 AND AVERAGE CAPACITY OF PILES TO BE 1000 KIP (4448 KN) OR 2000 KIP (8896 KN) FOR EACH PILE.
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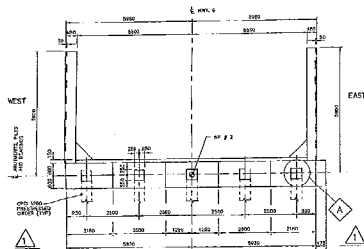


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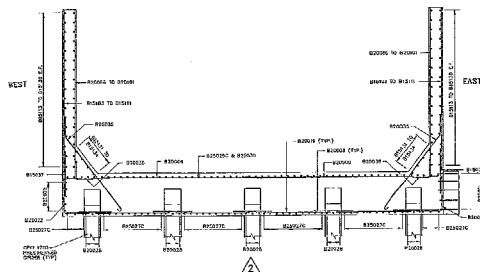
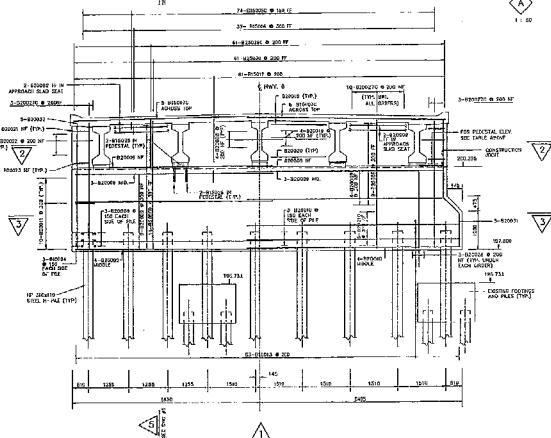
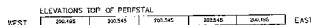
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- LF: LOWER FILL FACE
- EF: EXPOSED FILL FACE
- LF: LOWER FILL FACE
- EF: EXPOSED FILL FACE
- LF: LOWER FILL FACE

DRAWINGS NOT TO BE REPRODUCED
WITHOUT THE ORIGINAL DRAWING

DATE	BY	CHECKED	DATE

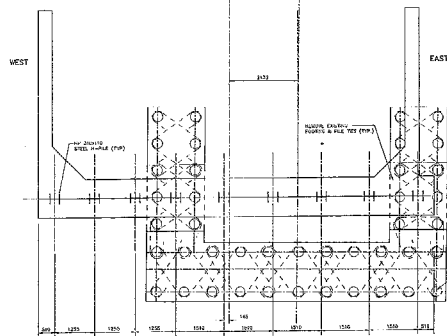


PLAN OF NORTH ABUTMENT



FILE DATA

LOCATION	NO. REQUIRED	LENGTH	BATTER
NORTH ABUTMENT	9	12000	VERTICAL



DIST. 2	HWY. 6
CONT No	94-04
WP No	38-90-01

NANTICOKE CREEK BRIDGE (2.4km SOUTH OF HWY.3 IN JARVIS)	SHEET 174
NORTH ABUTMENT	

 Cumming Cockburn Limited
Consulting Engineers and Planners

NOTES

- [illegible]

LEGEND:

- F.F. DENOTES FAR FACE
N.F. DENOTES NEAR FACE
B.F. DENOTES BOTH FACE
U. DENOTES UNDER PAGE
O.F. DENOTES OUTSIDE PAGE

DRAWINGS NOT TO BE SCALED

