

DOCUMENT MICROFILMING IDENTIFICATION

GEOCRES No. 40P15-029

DIST. 3 REGION                     

W.P. No. 74-85-05

CONT. No. 89-35

W. O. No.                     

STR. SITE No. 35-156-136

HWY. No. 6

LOCATION Mitchell's Geer Structure  
on Hwy 6

No of PAGES -                     

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OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.                     

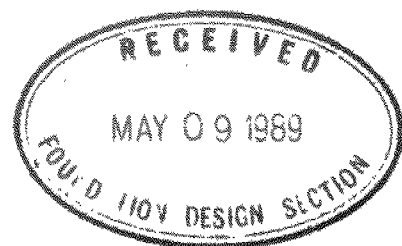
REMARKS:

# FOUNDATION INVESTIGATION REPORT

CONTRACT NO 89-35



Ministry of  
Transportation and  
Communications



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NOTE: For the purpose of this contract this report supercedes all other foundation reports prepared by or for the Ministry in connection with above-noted project.

## 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

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
$\sigma$	kPa	TOTAL NORMAL STRESS
$\sigma'$	kPa	EFFECTIVE NORMAL STRESS
$\tau$	kPa	SHEAR STRESS
$\sigma_1, \sigma_2, \sigma_3$	kPa	PRINCIPAL STRESSES
$\epsilon$	%	LINEAR STRAIN
$\epsilon_1, \epsilon_2, \epsilon_3$	%	PRINCIPAL STRAINS
E	kPa	MODULUS OF LINEAR DEFORMATION
G	kPa	MODULUS OF SHEAR DEFORMATION
$\mu$	1	COEFFICIENT OF FRICTION

### MECHANICAL PROPERTIES OF SOIL

$m_v$	kPa <sup>-1</sup>	COEFFICIENT OF VOLUME CHANGE
$C_c$	1	COMPRESSION INDEX
$C_s$	1	SWELLING INDEX
$C_\alpha$	1	RATE OF SECONDARY CONSOLIDATION
$c_v$	m <sup>2</sup> /s	COEFFICIENT OF CONSOLIDATION
H	m	DRAINAGE PATH
$T_v$	1	TIME FACTOR
U	%	DEGREE OF CONSOLIDATION
$\sigma'_{vo}$	kPa	EFFECTIVE OVERBURDEN PRESSURE
$\sigma'_p$	kPa	PRECONSOLIDATION PRESSURE
$\tau_f$	kPa	SHEAR STRENGTH
$c'$	kPa	EFFECTIVE COHESION INTERCEPT
$\phi'$	-°	EFFECTIVE ANGLE OF INTERNAL FRICTION
$\phi_u$	kPa	APPARENT COHESION INTERCEPT
$\phi_u$	-°	APPARENT ANGLE OF INTERNAL FRICTION
$\tau_R$	kPa	RESIDUAL SHEAR STRENGTH
$\tau_r$	kPa	REMOULDED SHEAR STRENGTH
$S_t$	1	SENSITIVITY = $\frac{c_u}{\tau_r}$

### PHYSICAL PROPERTIES OF SOIL

$\rho_s$	kg/m <sup>3</sup>	DENSITY OF SOLID PARTICLES	e	1, %	VOID RATIO	$e_{min}$	1, %	VOID RATIO IN DENSEST STATE
$\gamma_s$	kN/m <sup>3</sup>	UNIT WEIGHT OF SOLID PARTICLES	n	1, %	POROSITY	$I_D$	1	DENSITY INDEX = $\frac{e_{max} - e}{e_{max} - e_{min}}$
$\rho_w$	kg/m <sup>3</sup>	DENSITY OF WATER	w	1, %	WATER CONTENT	D	mm	GRAIN DIAMETER
$\gamma_w$	kN/m <sup>3</sup>	UNIT WEIGHT OF WATER	$S_r$	%	DEGREE OF SATURATION	$D_n$	mm	n PERCENT - DIAMETER
P	kg/m <sup>3</sup>	DENSITY OF SOIL	$w_L$	%	LIQUID LIMIT	$C_u$	1	UNIFORMITY COEFFICIENT
$\gamma$	kN/m <sup>3</sup>	UNIT WEIGHT OF SOIL	$w_p$	%	PLASTIC LIMIT	h	m	HYDRAULIC HEAD OR POTENTIAL
$\rho_d$	kg/m <sup>3</sup>	DENSITY OF DRY SOIL	$w_s$	%	SHRINKAGE LIMIT	q	m <sup>3</sup> /s	RATE OF DISCHARGE
$\gamma_d$	kN/m <sup>3</sup>	UNIT WEIGHT OF DRY SOIL	$I_p$	%	PLASTICITY INDEX = $w_L - w_p$	v	m/s	DISCHARGE VELOCITY
$\rho_{sat}$	kg/m <sup>3</sup>	DENSITY OF SATURATED SOIL	$I_L$	1	LIQUIDITY INDEX = $\frac{w - w_p}{I_p}$	i	1	HYDRAULIC GRADIENT
$\gamma_{sat}$	kN/m <sup>3</sup>	UNIT WEIGHT OF SATURATED SOIL	$I_C$	1	CONSISTENCY INDEX = $\frac{w_L - w}{I_p}$	k	m/s	HYDRAULIC CONDUCTIVITY
$\rho'$	kg/m <sup>3</sup>	DENSITY OF SUBMERGED SOIL	$e_{max}$	1, %	VOID RATIO IN LOOSEST STATE	j	kn/m <sup>3</sup>	SEEPAGE FORCE
$\gamma'$	kN/m <sup>3</sup>	UNIT WEIGHT OF SUBMERGED SOIL						

FOUNDATION INVESTIGATION REPORT  
For  
Mitchells Creek Structure Replacement  
W.P. 74-85-05, Site 35-156-136  
Highway 6, District 3, Stratford

INTRODUCTION

This report contains the results obtained from a Foundation Investigation carried out at the above mentioned site for the proposed structure replacement. The fieldwork was performed during the period from 87 08 04 to 87 08 11, utilizing a skid mounted diamond drill equipped with washboring equipment including NX and BX casing. At this site four sampled boreholes were advanced and two dynamic cone penetration tests were conducted. The borings were located at the abutment locations in the vicinity of the structure replacement.

In addition to the results of the field investigation, this report contains recommendations for the design and construction of the proposed structure replacement.

SITE DESCRIPTION

The site is located just north of Arthur, Ontario on Highway 6 approximately 4.3 km north of Junction Hwy. #89 and Hwy. 6, in the Township of Arthur, Wellington County.

Land use in this area is dominantly agricultural. The location is characterized by gently rolling terrain comprised of a thick deposit of hard silty clay.

The existing structure spans a small seasonally varying course of water which flows westwardly in the immediate vicinity of the site.

At the time of the investigation Mitchells Creek measured approximately 1 m across and 3/4 m deep, widening to approximately 3 m in width directly beneath the structure. The slopes of the creek bank range from vertical erosion faces to inclined slopes.

SUBSURFACE CONDITIONS

General

The native subsoil encountered at this location consists largely of hard silty clay, with varying amounts of sand and gravel.

The boundaries of the different strata, together with the field and laboratory tests results appear on the Record of Borehole sheets appended to this report. Refer to these sheets for locations and elevations of these boreholes.

A brief description of the different soil is given below.

Silty Clay (with to trace sand, trace to some gravel)

The material encountered in all the boreholes was silty clay with varying amounts of sand and gravel. In three of the four boreholes traces of organics were found from the surface to elevation 436.7 m. The deposit contained from the surface to elevation 438.4 to 436.7 m some/with sand, trace of gravel (3.5 to 5.9 m).

The sand content within the deposit decreased to traces 3.5 to 5.9 m below the surface.

The physical properties of the material as determined by field and laboratory tests are listed below:

	<u>Mean</u>
Natural Moisture Content (w)	14.5%
Liquid Limit ( $W_L$ )	27%
Plastic Limit ( $W_p$ )	14%

The consistency of the deposit ranged from very stiff to hard. Figure 1 indicates that the deposit plotted as a CL on the Plasticity Chart. The grain size distribution is shown in envelope form in Figure 2 in the Appendix.

GROUNDWATER CONDITIONS

The following groundwater levels were observed during the field investigation:

<u>Borehole</u>	<u>Groundwater Elevation</u>
1	440.8 m
2	440.7 m
3	441.8 m
4	441.0 m

No artesian groundwater conditions were encountered.

During the time of the investigation, the creek level was observed to fluctuate up to 0.5 m. During the dry spells the creek was observed to be dry to very low flow rates and during heavy rain conditions rose to higher flow rates and erosive potential levels. The creek water level elevation as measured on 87 08 14 was 441.8 m. The groundwater levels may be expected to vary seasonally and with the creek water level.



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

M. Devata, P. Eng.  
Chief Foundation Engineer


**APPENDIX**



# RECORD OF BOREHOLE No 1

METRIC

W P 74-85-05 LOCATION Sta. 14 + 332.1; O/S 10.0 m Rt. of C ORIGINATED BY JM  
 DIST 3 HWY 6 BOREHOLE TYPE WASHBORE - Nx Casing COMPILED BY JM  
 DATUM Geodetic DATE 87-08-04 to 87-08-05 CHECKED BY \_\_\_\_\_

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 					UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100		
442.4	Ground Level													
0.0	Silty clay with Sand Trace <u>Organic</u>		1	SS	5		442							
			2	SS	11									
			3	SS	35									
			4	SS	75		440							
	TRACE GRAVEL		5	SS	65									6 28 (66)
			6	SS	85									
			7	SS	60		438							1 3 (96)
			8	SS	86									
			9	SS	86		436							2 5 (93)
	TO TRACE SAND		10	SS	56		434							
	HARD													
432.8	To some Sand		11	SS	116/25cm									2 23 (75)
9.6	END OF BOREHOLE													

OFFICE REPORT ON SOIL EXPLORATION

# RECORD OF BOREHOLE No 2

METRIC

W P 74-85-05 LOCATION Sta. 14 + 342.8; O/S 7.2 m RT of G ORIGINATED BY JM  
 DIST 3 HWY 6 BOREHOLE TYPE Washbore - Nx Casing COMPILED BY JM  
 DATUM Geodetic DATE 87 08 06 CHECKED BY \_\_\_\_\_

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100							WATER CONTENT (%)			
								SHEAR STRENGTH										
								○ UNCONFINED	+ FIELD VANE									
								● QUICK TRIAXIAL	x LAB VANE									
442.3	Ground Level													GR SA SI CL				
0.0	Trace of organics		1	SS	27		442							19 17 (64)				
			2	SS	52									2 19 (79)				
	Silty clay		3	SS	39													
	some sand		4	SS	59			440						7 29 (64)				
	trace of Gravel		5	SS	68													
			6	SS	48			438										
	To		7	SS	72													
	Trace of sand		8	SS	57									1 2 (97)				
			9	SS	75			436										
			10	SS	92													
434.2	Hard																	
8.1	End of Borehole																	

OFFICE REPORT ON SOIL EXPLORATION

# RECORD OF BOREHOLE No 3

METRIC

W P 74-85-05 LOCATION Sta. 14 + 342.4; O/S 8.0 m LT of G ORIGINATED BY JM  
 DIST 3 HWY 6 BOREHOLE TYPE Washbore - Nx Casing COMPILED BY JM  
 DATUM Geodetic DATE 87 08 07 to 87 08 10 CHECKED BY \_\_\_\_\_

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100	PLASTIC LIMIT Wp	NATURAL MOISTURE CONTENT W	LIQUID LIMIT Wl	UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE								
442.6	Ground Level											
0.0			1	SS	26							
	Silty clay		2	SS	52							1 19 (80)
	Trace of Organics		3	SS	69							
	Some sand		4	SS	46							
	To trace Gravel		5	SS	41							7 20 (73)
			6	SS	37							
			7	SS	42							
			8	SS	54							
	To trace of sand		9	SS	35							
			10	SS	19							2 2 (96)
	To some Gravel		11	SS	52							
432.6	V.stiff to hard		12	SS	75	15 cm						29 17 (54)
10.0	End of Borehole											

OFFICE REPORT ON SOIL EXPLORATION

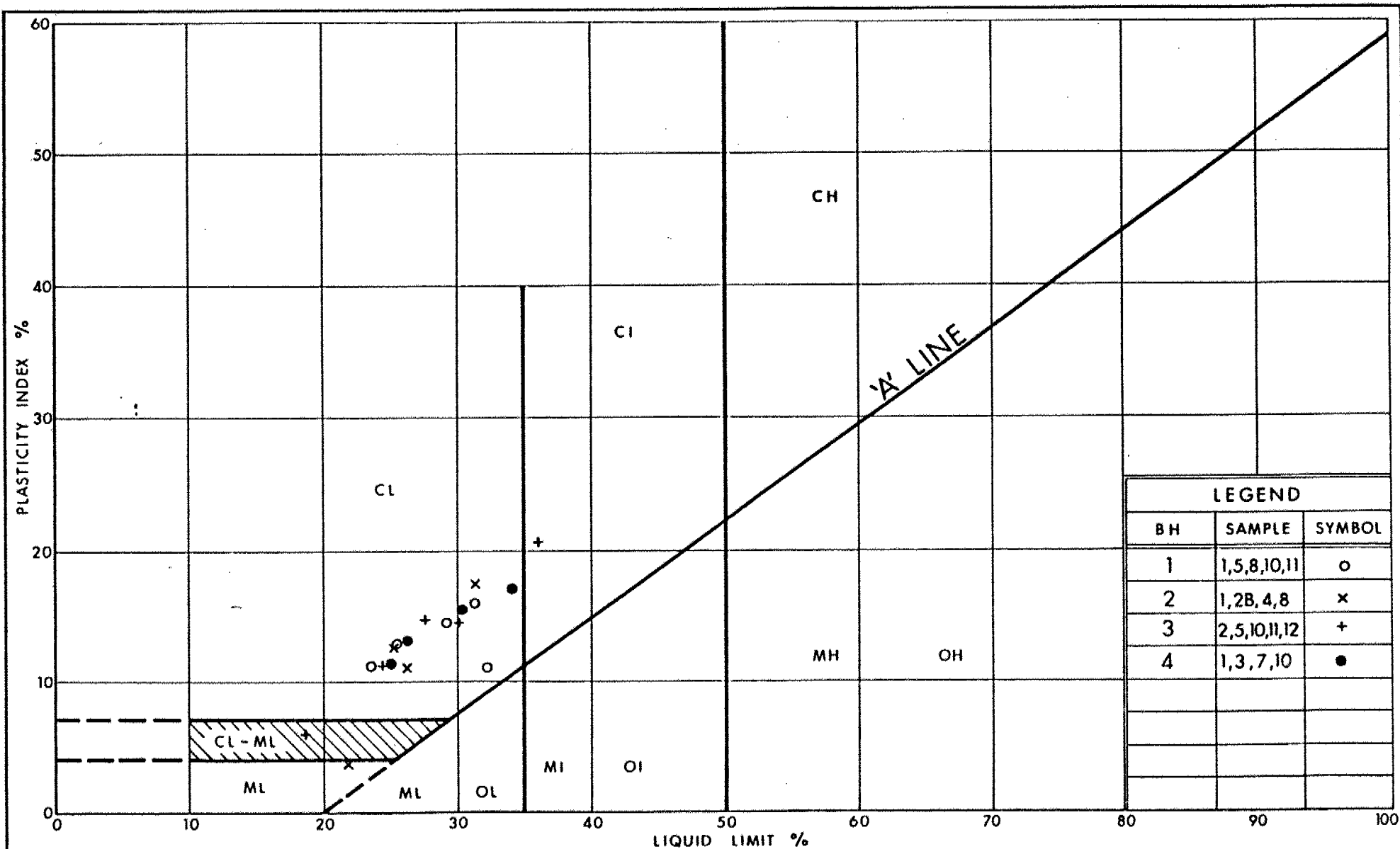
# RECORD OF BOREHOLE No 4

METRIC

W P 74-85-05 LOCATION Sta. 14 + 333.7; O/S 7.0 m Lt of C ORIGINATED BY JM  
 DIST 3 HWY 6 BOREHOLE TYPE Washbore - Nx.Casing COMPILED BY JM  
 DATUM Geodetic DATE 87 08 11 CHECKED BY \_\_\_\_\_

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			20	40	60	80	100	
441.6	Ground level											
0.0			1	SS	25							2 18 (80)
			2	SS	29							
	Silty clay		3	SS	38							6 19 (75)
	Some sand		4	SS	37							
	Trace of Gravel		5	SS	33							
	V.stiff to hard		6	SS	64							
			7	SS	77							1 1 (98)
	To trace sand		8	SS	40							
			9	SS	18							
	With thin layers of silt		10	SS	25							2 6 (92)
432.9			11	SS	60	10 cm						
8.7	End of Borehole											

OFFICE REPORT ON SOIL EXPLORATION



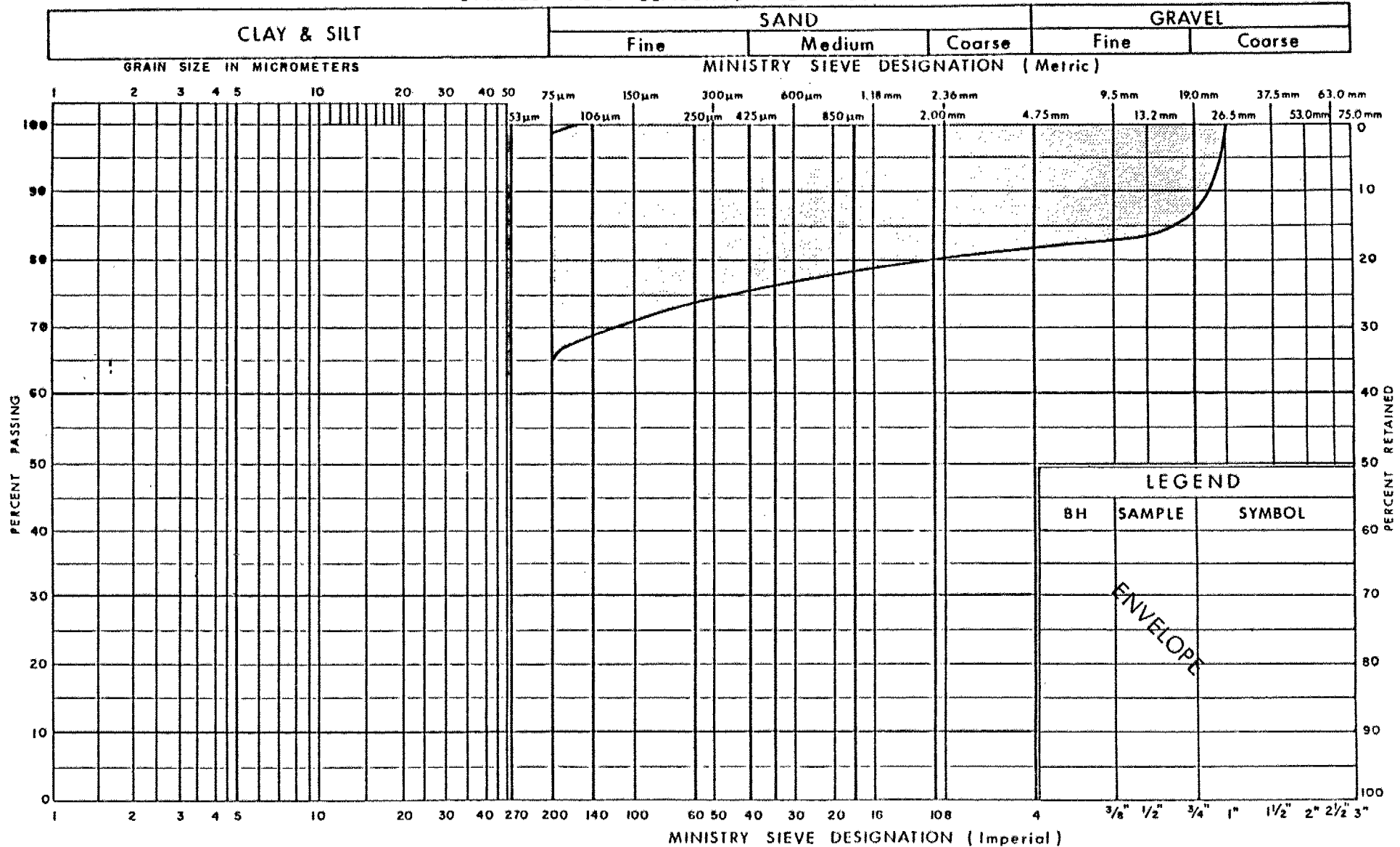
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# PLASTICITY CHART SILTY CLAY - CL

FIG No 1

W P 74 - 85 - 05

## UNIFIED SOIL CLASSIFICATION SYSTEM



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## GRAIN SIZE DISTRIBUTION

SILTY CLAY WITH TO TR OF SAND, TR TO SOME GRAVEL

FIG No 2

W P 74-85-05

ENGINEERING MATERIALS OFFICE  
FOUNDATION DESIGN SECTION

WP 74-85-05

DIST 3

HWY 6

STR SITE 35-156-136

Mitchells Creek Structure Replacement

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For  
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## DISCUSSION AND RECOMMENDATIONS

### General

The structure at Mitchells Creek was built under Contract 32 - 36. The original design drawing shows a single span beam type structure of length 12.2 m. It is reported from bridge plans that foundation support was provided by spread footings. The structure has been determined to be in an advanced state of deterioration and requires replacement. This deterioration takes the form of corroded beams, deteriorated concrete, and severe undercutting and washout at the footings. There are no obvious indications of either uniform or differential settlement.

### New Structure Foundations

It is proposed to replace the present structure with a single span (10.5± metres) concrete rigid frame on beam type structure, located along the same alignment and location as the present structure.

It is recommended that the abutments of the proposed single span structure be founded on spread footings placed at or below elevation 440.2 m and above the existing spread footings.

The following design values are recommended:

- 1) Allowable bearing pressures of 360 kPa may be used for the design of footings. For purposes of the Ontario Highway Bridge Design Code (O.H.B.D.C.) the following values are recommended:

Factored Capacity at U.L.S.: 550 kPa  
Capacity at S.L.S. Type II: 360 kPa

- 2) Earth pressures should be computed as per O.H.B.D.C. Subsection 6.6.1.2.2. of the code. A unyielding foundation condition may be assumed.

- 3) The Granular 'A' or 'B' backfill to the abutments should be in accordance with Special Provision No. 121 (dated October, 1983). The following parameters are recommended for the granular backfill:

	Gran. 'A'	Gran. 'B'
Angle of Internal Friction ( $\phi$ )	= 35°	30°
Unit Weight (kN/m <sup>3</sup> ) ( $\gamma$ )	= 22.8	21.2
Coefficient of Active Earth Pressure (Ka)	= 0.426	0.5

- 4) The footings should be placed so as to have a minimum earth cover of 1.7 m to allow for frost protection.

#### Dewatering

No difficulties are anticipated with water during excavation due to the high fines content and hardness of the silty clay. As no major dewatering problems are anticipated a dewatering program is not recommended. It should however be noted that concrete for the footing should be poured in a dry environment. It is also recommended that 15 cm of lean concrete should be poured at the bottom of the footing excavation immediately after completion so as to guard against softening of the foundation material from weathering and seepage effects.

#### SETTLEMENT

No undue settlements are anticipated during or after construction of the structure foundations since the load required to cause unacceptable settlement would be much greater than the recommended values for factored bearing capacity at U.L.S. (O.H.B.D.C. Subsection 6.5.3.2.)

#### SCOUR PROTECTION

Scour protection for the footings should be utilized for this structure. The present structure show evidence of extensive scouring, possibly as a result of the very sporadic high energy flow conditions common to the site.

For this purpose it is recommended that rip-rap be utilized for protection of the river bed and embankments. This rip-rap should be placed so as to be effective from the creek bed to a height of 0.5 m above high water level and for a span of 10 m upstream and downstream of the structure.

### Approaches

Top soil and surficial material should be removed prior to the placing of fill. The fill should be acceptable well compacted material. Any fill placed below the water table should be a granular material.

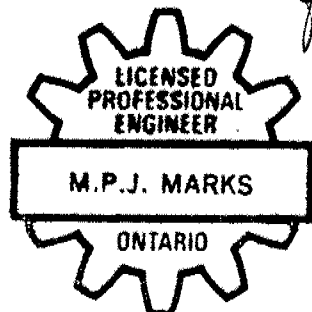
The embankments should be designed with forward and side slopes not exceeding 2 horizontal to 1 vertical.

### Forces Resisting Sliding Failure

In order to prevent sliding failure at the footings of the structure it is recommended that a coefficient of friction of 75 kPa be utilized. It is further recommended that the surface be roughened before the placing of the lean concrete mixture at the base of the footing excavation, so as to increase the bond and resistance to sliding.

### MISCELLANEOUS

The fieldwork for this investigation was carried out by Mr. J. G. Matthews, under the supervision of Mr. K. G. Selby, Chief Foundations Engineer - West and Mrs. P. Marks, Project Foundation Engineer. The equipment used for the field investigation was owned and operated by Marathon Drilling Company Ltd. This report was prepared by Mr. Jonathan Matthews and Mrs. Pamela Marks and reviewed by Mr. Ken Selby.



*B. Bennett*

*for* Jonathan Matthews  
Student Engineer

*Pamela Marks*  
P. Marks, P. Eng.  
Project Foundations Engineer

*K. G. Selby*  
K. G. Selby, P. Eng.  
Chief Foundations Engineer  
(West)

## **APPENDIX**

## 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

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

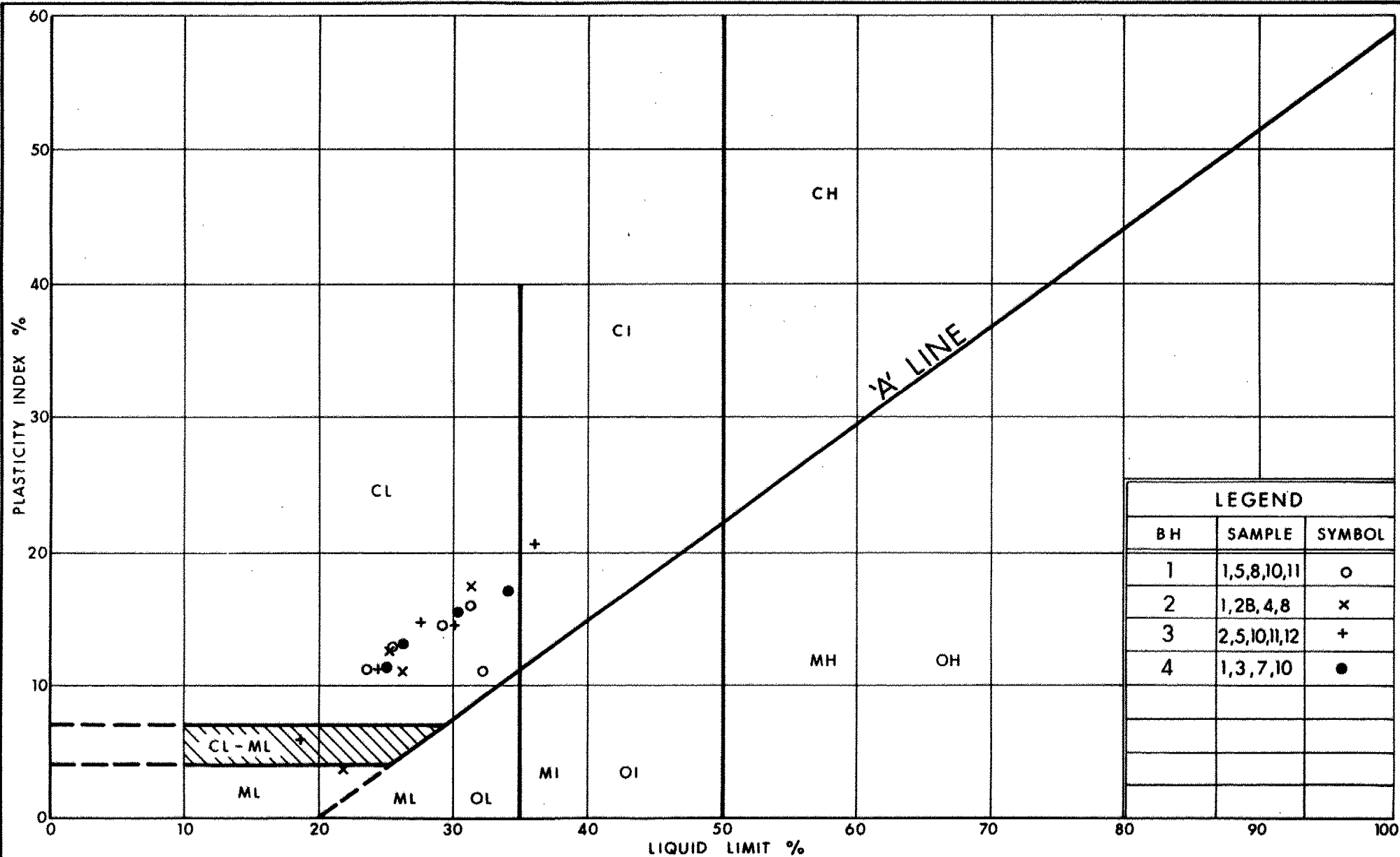
$u_w$	kPa	PORE WATER PRESSURE
$r_u$	1	PORE PRESSURE RATIO
$\sigma$	kPa	TOTAL NORMAL STRESS
$\sigma'$	kPa	EFFECTIVE NORMAL STRESS
$\tau$	kPa	SHEAR STRESS
$\sigma_1, \sigma_2, \sigma_3$	kPa	PRINCIPAL STRESSES
$\epsilon$	%	LINEAR STRAIN
$\epsilon_1, \epsilon_2, \epsilon_3$	%	PRINCIPAL STRAINS
E	kPa	MODULUS OF LINEAR DEFORMATION
G	kPa	MODULUS OF SHEAR DEFORMATION
$\mu$	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
$C_\alpha$	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
$\sigma'_{vo}$	kPa	EFFECTIVE OVERBURDEN PRESSURE
$\sigma'_p$	kPa	PRECONSOLIDATION PRESSURE
$\tau_f$	kPa	SHEAR STRENGTH
$c'$	kPa	EFFECTIVE COHESION INTERCEPT
$\phi'$	-°	EFFECTIVE ANGLE OF INTERNAL FRICTION
$c_u$	kPa	APPARENT COHESION INTERCEPT
$\phi_u$	-°	APPARENT ANGLE OF INTERNAL FRICTION
$\tau_R$	kPa	RESIDUAL SHEAR STRENGTH
$\tau_r$	kPa	REMOULDED SHEAR STRENGTH
$S_t$	1	SENSITIVITY = $\frac{c_u}{\tau_r}$

### PHYSICAL PROPERTIES OF SOIL

$\rho_s$	$kg/m^3$	DENSITY OF SOLID PARTICLES	e	1, %	VOID RATIO	$e_{min}$	1, %	VOID RATIO IN DENSEST STATE
$\gamma_s$	$kn/m^3$	UNIT WEIGHT OF SOLID PARTICLES	n	1, %	POROSITY	$I_D$	1	DENSITY INDEX = $\frac{e_{max} - e}{e_{max} - e_{min}}$
$\rho_w$	$kg/m^3$	DENSITY OF WATER	w	1, %	WATER CONTENT	D	mm	GRAIN DIAMETER
$\gamma_w$	$kn/m^3$	UNIT WEIGHT OF WATER	$S_r$	%	DEGREE OF SATURATION	$D_n$	mm	n PERCENT - DIAMETER
$\rho$	$kg/m^3$	DENSITY OF SOIL	$w_L$	%	LIQUID LIMIT	$C_u$	1	UNIFORMITY COEFFICIENT
$\gamma$	$kn/m^3$	UNIT WEIGHT OF SOIL	$w_p$	%	PLASTIC LIMIT	h	m	HYDRAULIC HEAD OR POTENTIAL
$\rho_d$	$kg/m^3$	DENSITY OF DRY SOIL	$w_s$	%	SHRINKAGE LIMIT	q	$m^3/s$	RATE OF DISCHARGE
$\gamma_d$	$kn/m^3$	UNIT WEIGHT OF DRY SOIL	$I_p$	%	PLASTICITY INDEX = $w_L - w_p$	v	m/s	DISCHARGE VELOCITY
$\rho_{sat}$	$kg/m^3$	DENSITY OF SATURATED SOIL	$I_L$	1	LIQUIDITY INDEX = $\frac{w - w_p}{I_p}$	i	1	HYDRAULIC GRADIENT
$\gamma_{sat}$	$kn/m^3$	UNIT WEIGHT OF SATURATED SOIL	$I_C$	1	CONSISTENCY INDEX = $\frac{w_L - w}{I_p}$	k	m/s	HYDRAULIC CONDUCTIVITY
$\rho'$	$kg/m^3$	DENSITY OF SUBMERGED SOIL	$e_{max}$	1, %	VOID RATIO IN LOOSEST STATE	j	$kn/m^3$	SEEPAGE FORCE
$\gamma'$	$kn/m^3$	UNIT WEIGHT OF SUBMERGED SOIL						



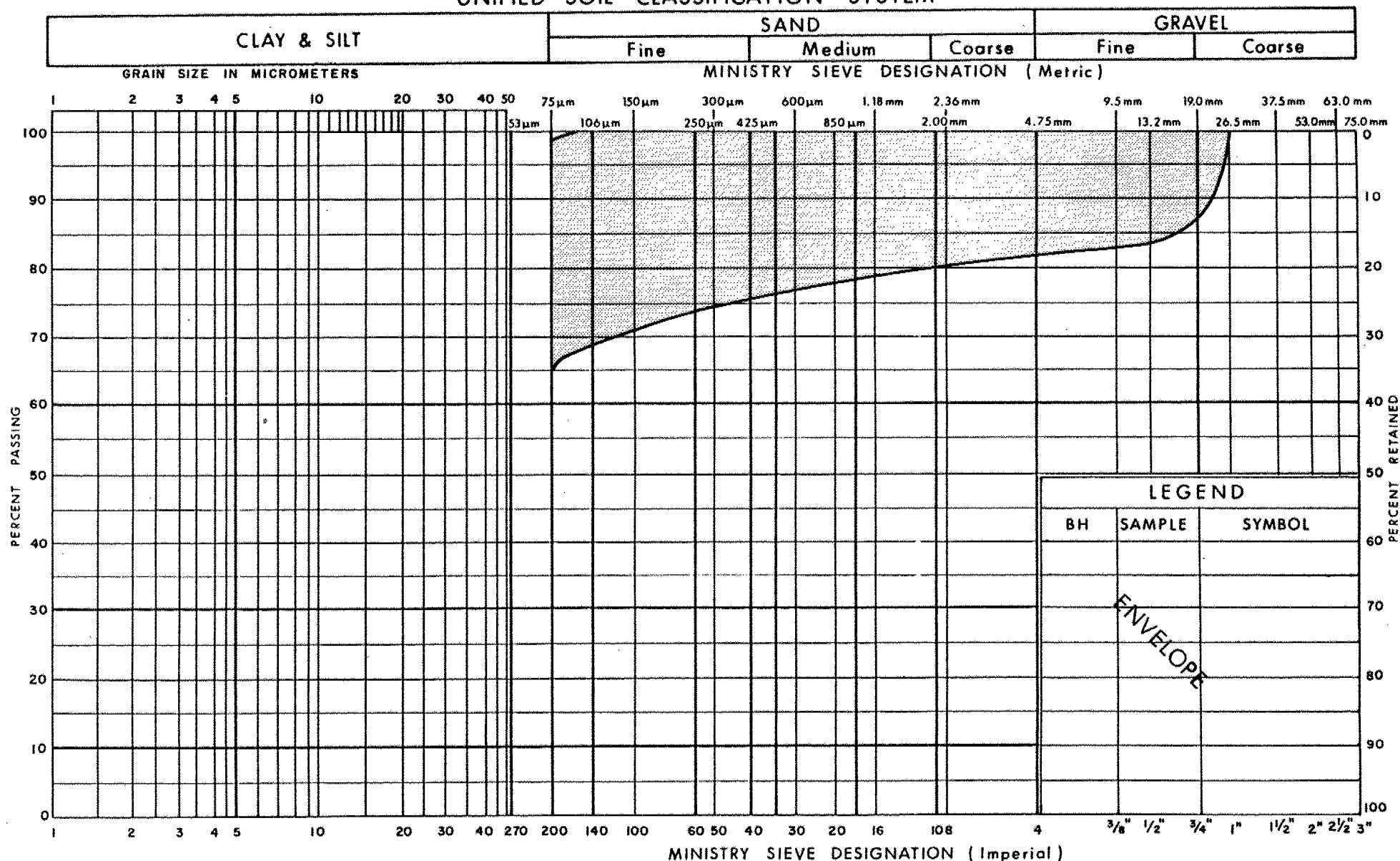
Ministry of  
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# PLASTICITY CHART SILTY CLAY - CL

FIG No 1

W P 74 - 85 - 05

## UNIFIED SOIL CLASSIFICATION SYSTEM



Ontario

 Ministry of  
Transportation and  
Communications

## GRAIN SIZE DISTRIBUTION

SILTY CLAY WITH TO TR OF SAND, TR TO SOME GRAVEL

FIG No 2

W P 74-85-05





# RECORD OF BOREHOLE No 1

METRIC

W P 74-85-05 LOCATION Sta. 14 + 332.1; O/S 10.0 m Rt. of C ORIGINATED BY JM  
DIST 3 HWY 6 BOREHOLE TYPE WASHBORE - Nx Casing COMPILED BY JM  
DATUM Geodetic DATE 87-08-04 to 87-08-05 CHECKED BY \_\_\_\_\_

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT $\gamma$	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100		
442.4	Ground Level													
0.0	Silty clay with Sand Trace Organics		1	SS	5		442							
			2	SS	11									
			3	SS	35									
			4	SS	75		440							
	TRACE GRAVEL		5	SS	65									
			6	SS	85									
			7	SS	60		438							6 28 (66)
			8	SS	86									
			9	SS	86		436							1 3 (96)
	TO TRACE SAND													
			10	SS	56		434							2 5 (93)
	HARD													
432.8	To some Sand		11	SS	116/25cm									2 23 (75)
9.6	END OF BOREHOLE													

+3, x5: Numbers refer to  
Sensitivity

20  
15  $\phi$  5 (%) STRAIN AT FAILURE  
10



# RECORD OF BOREHOLE No 2

METRIC

W P 74-85-05 LOCATION Sta. 14 + 342.8; O/S 7.2 m RT of G ORIGINATED BY JM  
DIST 3 HWY 6 BOREHOLE TYPE Washbore - Nx Casing COMPILED BY JM  
DATUM Geodetic DATE 87 08 06 CHECKED BY \_\_\_\_\_

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE	PLASTIC LIMIT W <sub>p</sub> NATURAL MOISTURE CONTENT W LIQUID LIMIT W <sub>L</sub> WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
442.3	Ground Level										
0.0	Trace of organics		1	SS	27		442				
			2	SS	52						
	Silty clay		3	SS	39		440				
	some sand		4	SS	59						
	trace of Gravel		5	SS	68						
			6	SS	48		438				
	To		7	SS	72						
	Trace of sand		8	SS	57						
			9	SS	75		436				
434.2	Hard		10	SS	92						
8.1	End of Borehole										

+3, x5: Numbers refer to  
Sensitivity

20  
15 5 (%) STRAIN AT FAILURE  
10



# RECORD OF BOREHOLE No 3

METRIC

W P 74-85-05 LOCATION Sra. 14 + 342.4; O/S 8.0 m LT of C ORIGINATED BY JM  
DIST 3 HWY 6 BOREHOLE TYPE Washbore - Nx Casing COMPILED BY JM  
DATUM Geodetic DATE 87 08 07 to 87 08 10 CHECKED BY \_\_\_\_\_

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			20 40 60 80 100						
442.6	Ground Level												
0.0			1	SS	26								
	Silty clay		2	SS	52								1 19 (80)
	Trace of Organics		3	SS	69								
	Some sand		4	SS	46								
	To trace Gravel		5	SS	41								7 20 (73)
			6	SS	37								
			7	SS	42								
			8	SS	54								
			9	SS	35								
	To trace of sand		10	SS	19								2 2 (96)
			11	SS	52								
432.6	V.stiff to hard		12	SS	73	15 cm							29 17 (54)
10.0	End of Borehole												

+3, x5: Numbers refer to  
Sensitivity

20  
15 5 (%) STRAIN AT FAILURE  
10



# RECORD OF BOREHOLE No 4

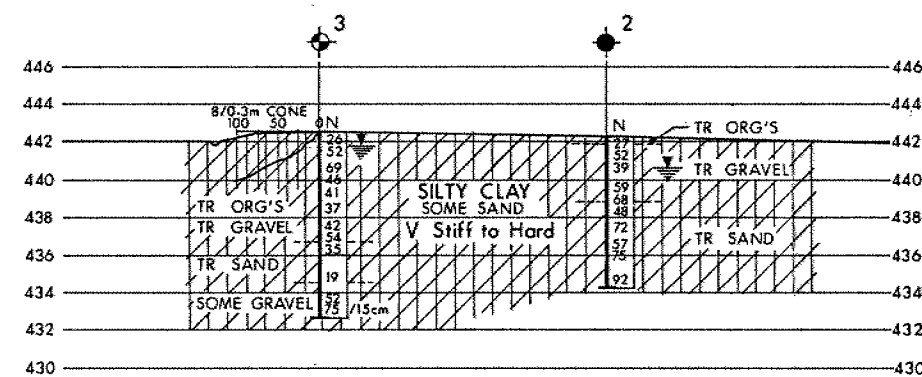
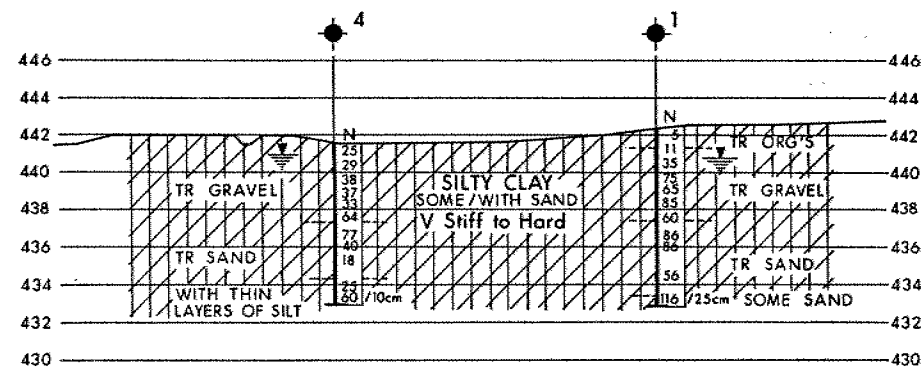
METRIC

W P 74-85-05 LOCATION Sta. 14 + 333.7; O/S 7.0 m Lt of C ORIGINATED BY JM  
DIST 3 HWY 6 BOREHOLE TYPE Washbore - Nx Casing COMPILED BY JM  
DATUM Geodetic DATE 87 08 11 CHECKED BY

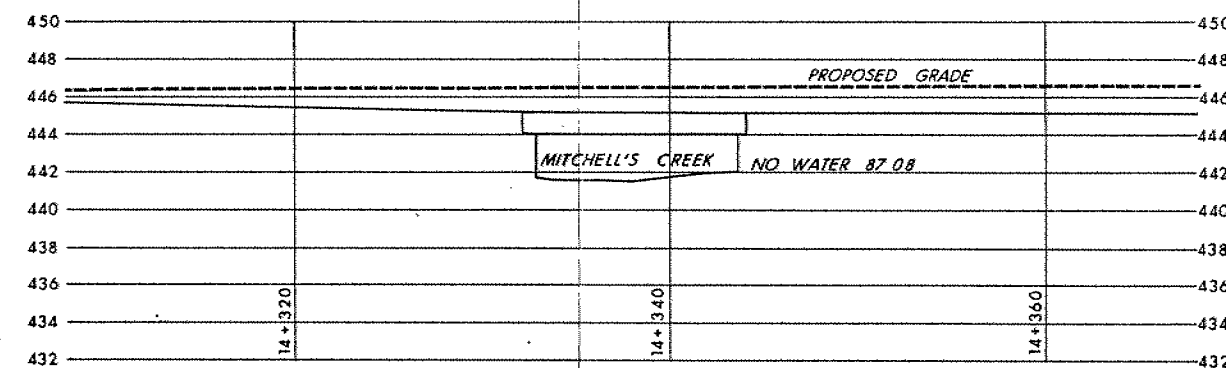
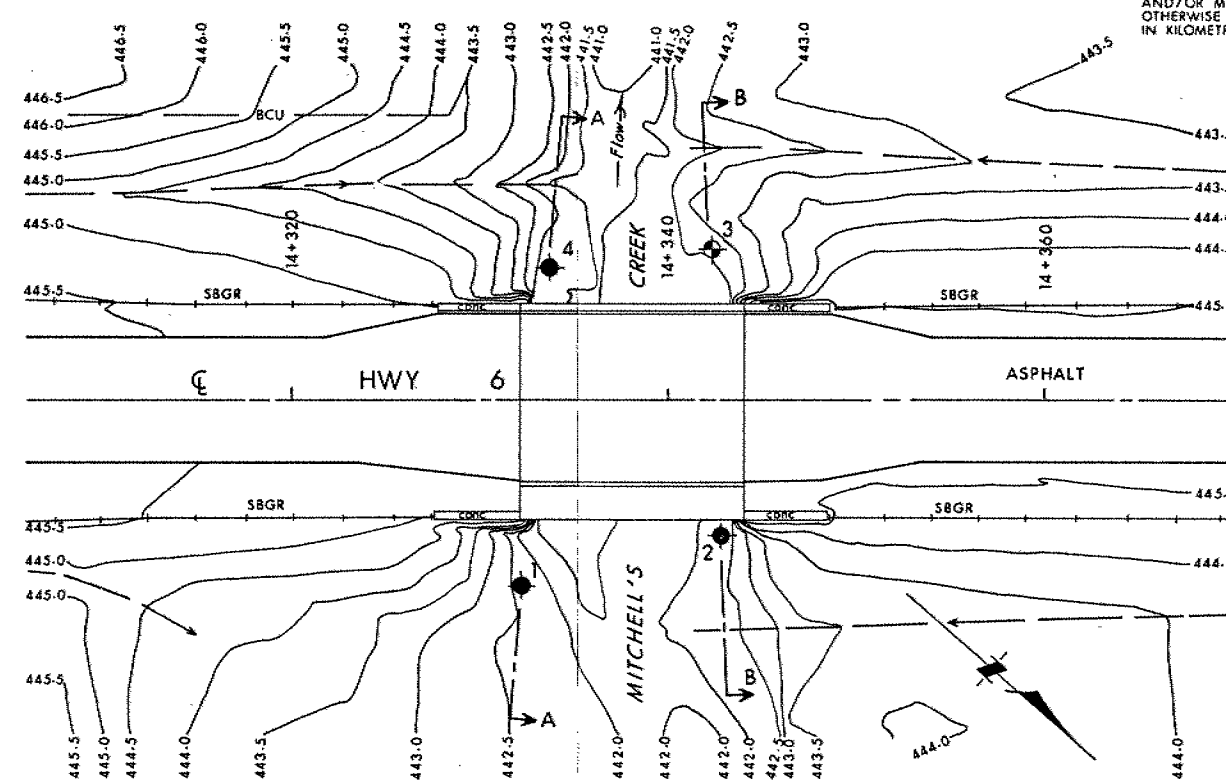
SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	WATER CONTENT (%)					
441.6	Ground level												
0.0													
		1	SS	25									2 18 (80)
		2	SS	29									
	Silty clay	3	SS	38									
	Some sand	4	SS	37									6 19 (75)
	Trace of Gravel	5	SS	33									
	V.stiff to hard	6	SS	64									
		7	SS	77									
		8	SS	40									1 1 (98)
	To trace sand	9	SS	18									
		10	SS	25									
	With thin layers of silt	11	SS	60/	10 cm								2 6 (92)
432.9													
8.7	End of Borehole												

+3, x5: Numbers refer to  
Sensitivity

20  
15 5 (%) STRAIN AT FAILURE  
10



**SECTIONS**  
SCALE  
4m 2 0 4m

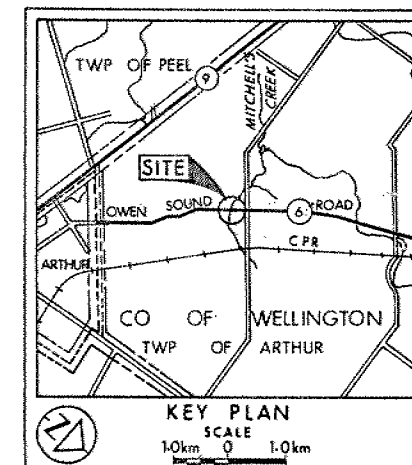


**METRIC**  
DIMENSIONS ARE IN METRES  
AND/OR MILLIMETRES UNLESS  
OTHERWISE SHOWN. STATIONS  
IN KILOMETRES + METRES.

CONT No  
WP No 74-85-05

MITCHELL'S CREEK  
BORE HOLE LOCATIONS & SOIL STRATA

**SHEET**



**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 1987 08

No	ELEVATION	STATION	OFFSET
1	442.4	14+332.1	10.0m Rt
2	442.3	14+342.8	7.2m Rt
3	442.6	14+342.4	8.0m Lt
4	441.6	14+333.7	7.0m 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.

REV.	DATE	BY	DESCRIPTION

Geacres No 40P15-029

HWY No 6	DIST 3
SUBM'D PM	CHECKED DATE 87 10 27 SITE 35-136
DRAWN DT	CHECKED APPROVED DWG 748505-A

